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A PRICE THEORY OF VERTICAL AND LATERAL INTEGRATION (REVISED VERSION)

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ABSTRACT

A Price Theory of Vertical and Lateral Integration (Revised Version)*

We present a perfectly-competitive model of firm boundary decisions and study their interplay with product demand, technology, and welfare. Integration is privately costly but is effective at coordinating production decisions; non-integration is less costly, but coordinates relatively poorly. Output price influences the choice of ownership structure: integration increases with the price level. At the same time, ownership affects output, since integration is more productive than non-integration. For a generic set of demand functions, the result is heterogeneity of ownership and performance among ex-ante identical enterprises. The price mechanism transmutes demand shifts into industry-wide re-organizations and generates external effects from technological shocks: productivity changes in some firms may induce ownership changes in others. If the enterprise managers have full title to its revenues, market equilibrium ownership structures are second-best efficient. When managers have less than full revenue claims, equilibrium can be inefficient, with too little integration.

JEL Classification: D2, D4, L1 and L2

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1 Introduction

While it is clear to many economists that organizational design is crucial for the behavior of the business firm, there is rather less consensus on whether it matters at the industry level. Industrial Economics, at bottom the study of how firms deliver the goods, has downplayed the internal organization of its key protagonists: instead, the stage on which they play, the imperfectly competitive market, dominates the show. There are good reasons for this. Analytical parsimony is one. More fundamental is the presumption that departures from Arrow-Debreu behavior by the individual firm will be weeded out by the discipline of competition: in effect, imperfection *in the market* is the root of all distortion. What is missing to challenge this view is a clear demonstration that imperfections *within firms* can, by themselves, affect industry conduct and performance. In other words, if organizational design matters for the concerns of industrial economics, its impact ought to be apparent in the simplest of all industrial models, perfect competition.

This paper provides such a model and shows that internal organization — specifically ownership and control in the incomplete-contract tradition of Grossman-Hart (Grossman and Hart 1986, Hart and Moore 1990) — has distinctive positive and normative implications for industry behavior. It presents a simple textbook-style industry model in which “neoclassical black-box” firms are replaced by partnerships of manager-led suppliers who choose ownership structures to govern trade-offs between private costs and coordination benefits. All other aspects of the model are standard for perfect competition: enterprises and consumers are price takers, the formation of the partnerships between suppliers is frictionless, and entry is allowed.

The organizational building block at the heart of our analysis is an adaptation of the model in Hart and Holmström (2010). In order to produce a unit of the consumer good, two complementary suppliers, each consisting of a manager and his collection of assets, must enter into a relationship. The managers operate the assets by making non-contractible production decisions. Technology requires mutual compatibility of the decisions made for different parts of the enterprise.

The problem is that decisions that are convenient for one supplier will be inconvenient for the other, and vice versa, which generates private costs for each manager. This incompatibility may reflect a technological need for adaptability (the BTU and sulphur content of coal needs to be optimally tailored to a power plant’s boiler and emissions equipment), or occupational backgrounds (engineering favors elegant design and low maintenance; sales prefers redundant features and user-friendliness). Each party will find it costly to accommodate the other’s approach, but if they don’t agree on something, the enterprise will be poorly served.

The main organizational decision the managers have to make is whether to integrate. If they retain control over their assets and subsequently make their decisions independently, this may lead to low levels of output, since they overvalue the private costs and are apt

to be poorly coordinated. Integration addresses this difficulty via a transfer of control rights over the decisions to a third-party “HQ” who, like the managers, enjoys profit, but unlike them, has no direct concern for the decisions. Since HQ will have a positive stake in enterprise revenue, she maximizes the enterprise’s output by enforcing a common, compromise decision. The cost of this solution is that the compromise will be moderately inconvenient to both managers.

The industry is composed of a large number of suppliers of each type who form enterprises in a matching market, at which time they decide whether to integrate and how to share revenues. The industry supply curve will embody a relationship between the price and ownership structure, as well as the usual price-quantity relationship. Once this “Organizationally Augmented Supply” curve (OAS) has been derived, it is feasible to perform a textbook-style supply-and-demand analysis of both the comparative statics and the economic performance of equilibrium ownership structures.

One set of findings concerns the positive implications of the structure of the OAS. First is the relationship between market price and ownership structure. At low prices, managers do not value the increase in output brought by integration since they are not compensated sufficiently for the high costs they have to bear. At higher prices, managers value output enough that they are willing to forgo their private interests in order to achieve coordination, and therefore choose to integrate. Thus, demand matters for the determination of equilibrium ownership structure, because it helps determine the market price. As product price is common to a whole industry, the price mechanism provides a natural impetus toward widespread, demand-induced restructuring, as in “waves” of mergers or divestitures.

Second is a theory of heterogeneity in ownership structure and performance. Endogenous coexistence of different ownership structures, even among firms facing similar technology, is a generic outcome of market equilibrium. The heterogeneity is an immediate consequence of the productivity difference between integration and non-integration: while managers may be indifferent between the two, integration produces more output. Thus if per-firm demand is in between the output levels associated with each ownership structure, there must be a mixture of the two in equilibrium. In this part of the supply curve, changes in demand are accommodated less by price adjustments than by ownership changes.

Third, product price is also a key source of “external” influence on organizational design, which raises the possibility of supply-induced restructuring. For instance, technological shocks that occur in a few firms will affect market price and therefore potentially the ownership choice of many other firms. One implication of this external effect is that positive technological progress may have little impact on aggregate performance because of “re-organizational absorption”: the incipient price decrease from increased productivity among some firms may induce the remaining firms to choose non-integration, thereby lowering their output and keeping industry output unchanged.

These findings help us interpret some recent empirical findings on the determinants of ownership structure and performance in the air travel and ready-mix concrete industries.

Evidence on air travel corroborates our basic result relating integration to product price. Forbes and Lederman (2009, 2010), provide evidence that the tendency for major airlines to own local carriers is greatest in markets where routes are most valuable. This relationship reflects the above-mentioned dependence of integration on price and demand-driven restructuring. In the concrete industry, Hortaçsu and Syverson (2007) show that enterprises with identical technology make different integration choices, a finding that is difficult to reconcile with a model of integration that is based only on technological considerations, but is easily understood in terms of our heterogeneity result. Moreover, their other findings, which relate price and the degree of integration in the market, are explained in terms of supply-driven restructuring.

The model is amenable to simple consumer-producer surplus calculations, from which we derive two main welfare results. We show first that the competitive equilibrium is “ownership efficient,” as long as managers fully internalize the effect of their decisions on the profit, as in small or owner-managed firms. That is, a planner could not increase the sum of consumer and producer surplus by forcing some enterprises to re-organize.

However, for firms in which the managers’ financial stakes are lower, there is always a set of demand functions for which equilibria are ownership inefficient. Specifically, since integration favors consumers because it produces more than non-integration, inefficiencies assume the form of too little integration: managers without full financial stakes overvalue their private costs. By analogy to the Harberger triangle measure of deadweight loss from market power, we identify a “Leibenstein trapezoid” that measures the extent of organizational deadweight loss.¹ In contrast to the case of market power, in which welfare losses are greatest when demand is least elastic, we show that organizational welfare losses are greatest when demand is *most* elastic.

These welfare losses are unlikely to be mitigated by instruments that reduce frictions. Indeed, if managers have access to positive cash endowments or can borrow the cash with which to make side payments to each other, they are *more* likely to adopt non-integration, which hurts consumers. This result offers a new perspective on the costs of “free cash flow”: managers use it to pursue their private interests, but here it may take the form of too little rather than too much integration. In a similar vein, free entry into the product market does not significantly affect results: the “long run” OAS typically has a similar shape to the short run OAS, in particular admitting generic heterogeneity, and the long-run welfare results parallel those of the short run.

Related Literature

There is a long line of research that examines various aspects of organizational behavior and how it interacts with the market environment.² Perhaps the earliest relates the the

¹The possibility that firms may persistently underperform is related to the “X-inefficiency” tradition started by Leibenstein (1966); see also Bertrand and Mullainathan, 2003.

²Legros and Newman (2011) surveys this literature.

degree of competition to managerial incentives (Machlup 1967, Hart 1983, Sharfstein 1988, in a competitive setting; and Schmidt 1997, Fershtman and Judd 1987, and Raith 2003 in an imperfectly competitive framework). The focus there is on the power of compensation schemes, leaving organizational design (and firm boundaries in particular) exogenous. There is also a literature that relates market forces to investment in monitoring technologies (Banerjee and Newman 1993, Legros and Newman 1996), but allocations of decision rights, firm boundaries and ownership are not considered.

Our earlier work on the external determinants of ownership structure (Legros and Newman 2008) studies how relative scarcities of different types of suppliers determine the allocation of control. It does not examine the effects of the product market, nor does it consider consumer welfare.

Marin and Verdier (2008) and Alonso et al. (2008) consider models of delegation in imperfectly competitive settings; firm boundaries are fixed in these models and the issue is whether information acquisition is facilitated by delegated or centralized decision making.

There is also a literature containing models that explain the pattern of outsourcing and integration in industries when there is incomplete contracting. McLaren (2000) and Grossman and Helpman (2002) proceed in the Williamsonian tradition, where integration alleviates the hold-up problem at an exogenous fixed cost, and use search frictions to create relationship specificity. McLaren (2000) shows that globalization, interpreted as market thickening, leads to non-integration and outsourcing. Grossman and Helpman (2002) adds monopolistic competition with free entry to examines the effects of technological and demand elasticity parameters on the propensity to integrate; it also obtains endogenous heterogeneity in organizational choices, but only as a non-generic phenomenon. Aghion et al. (2006) also considers the impact of the degree of competition on the degree of integration and finds a non-monotonic relationship. There is also a literature in international trade (e.g. Antras 2003, Antras and Helpman 2004), which embeds the Grossman and Hart (1986) framework into models of monopolistic competition, and is focused on how technological or legal parameters (capital intensity, productivity, contract enforceability) affect the the locational as well as firm-boundary decisions of multinational firms.

Generic heterogeneity of ownership is obtained in the recent paper by Gibbons, Holden and Powell (2011), though via a very different mechanism. It studies a model in which ownership structure, via its impact on incentives, affects the firm's ability to acquire information about an aggregate state, while that information is also incorporated into market prices. Rational expectations equilibrium entails that some firms acquire information while the rest infer it from prices.

None of these papers addresses the performance impact of organizational design, which is one of the chief motivations for an organizational industrial economics. A perfectly competitive framework allows for transparent treatment of this issue. The model highlights the basic relationship between price *levels* and integration embodied in the OAS. Its organizational heterogeneity is coupled with performance differences among firms. And it provides

a simple characterization of the impact of equilibrium ownership structures on consumer and social welfare. The model also points to issues that have received little treatment in the organizational and industrial economic literatures, such as the role of corporate governance on consumer welfare, and the connection among industry performance, finance, and ownership structure that stands in contrast to the strategic use of debt that has been studied in the IO literature (e.g., Brander and Lewis 1986).

2 Model

This section presents the basic model, where managers are full claimants to the revenue. The basic organizational building block is a single-good, continuous-action version of Hart and Holmström’s (2010) model. The aim is to derive an industry supply curve that summarizes the relationships among price, quantity and ownership structure. This is best thought of as a “short run” supply curve, for which entry into the industry is limited. Discussion of entry and long-run supply is deferred to section 5.

2.1 Environment

Technology, Preferences and Ownership Structures

There is one consumer good, the production of which requires the coordinated input of one A and one B . Call their union an “enterprise.” Each supplier can be thought of as collection of assets and workers, overseen by a manager, that cannot be further divided without significant loss of value. Examples of A and B might include “lateral” relationships such as manufacturing and customer support, as well as vertical ones such as microchips and computers. The industry will comprise of a continuum of each type of supplier, but for the moment confine attention to a single pair.

For each supplier, a non-contractible decision is rendered indicating the way in which production is to be carried out. For instance, networking software and routing equipment could conform to many different standards; material inputs may be well- or ill-suited to an assembler’s production machinery. Denote the decision in an A supplier by $a \in [0, 1]$, and a B decision by $b \in [0, 1]$. The decision might be made by the supplier’s manager, but could also be made by someone else, depending on the ownership structure, as described below.

As the examples indicate, these decisions are not ordered in any natural way; what is important for expected output maximization is not which particular decision is made in each part of the enterprise, but rather that it is coordinated with the other. Formally, the enterprise will succeed, in which case it generates 1 unit of output, with probability $1 - (a - b)^2$; otherwise it fails, yielding 0.

The manager of each supplier is risk-neutral and bears a private (non-contractible) cost of the decision made in his unit. The managers’ payoffs are increasing in income, but they

disagree about the direction decisions ought to go: what is easy for one is hard for the other, and vice versa. Specifically, we assume that the A manager’s utility is $y^A - (1 - a)^2$, and the B manager’s utility is $y^B - b^2$, where y^A and y^B are the respective realized incomes. A manager must live with the decision once it is made: his function is to implement it and convince his workforce to agree; thus regardless of who makes a decision, the manager bears the cost.³

Managers have limited liability (thus $y^A \geq 0$, $y^B \geq 0$) and do not have any means of making fixed side payments, that is, they enter the scene with zero cash endowments. The significance of this assumption is that the equilibrium division of surplus between the managers, which is determined in the supplier market, will influence the choice of ownership structure. By contrast, if cash endowments were sufficiently large, the “most efficient” ownership structure (from the managers’ point of view) would always be chosen, independent of supplier market conditions. We consider arbitrary finite cash endowments in Section 5.

The ownership structure can be contractually assigned. Here there are two options; following the property rights literature, each implies a different allocation of decision making power. First, the production units can remain two separate firms (*non-integration*), in which case the managers retain control over their respective decisions. Alternatively, the managers can *integrate* into a single firm, re-assigning control in the process. They do so by selling the assets to a headquarters (HQ), empowering her to decide both a and b and at the same time giving her title to (part of) the revenue stream.⁴ We assume that HQ’s always have enough cash to finance the acquisition.

HQ’s payoff is simply her income $y^H \geq 0$; thus she is motivated only by monetary concerns and incurs no direct cost from the a and b decisions, which are always borne by the managers of the two units. As a self-interested agent, HQ can no more commit to a pair of decisions (a, b) than can A and B . Integration simply trades in one incentive problem for another.⁵

Contracts

The enterprise’s revenue is contractible, allowing for the provision of monetary incentives via *sharing rules*: any “budget-balancing” means of splitting the managerial share of realized revenue is permissible. For the benchmark analysis, assume that the entire revenue

³Thus, the cost function need not be a characteristic of the individual manager, although that is one interpretation, so much as an inherent property of the type of input or employee he oversees: if the managers switched assets, they’d “switch preferences” (as happens when a professor of economics becomes a dean of a business school). We expect very similar results could also be generated by a model in which managers differ in “vision” as in van den Steen (2005).

⁴In fact, giving HQ the power to decide (a, b) implies that she will get a positive share of the revenue, as we show below.

⁵An alternate way to integrate would be to have one of the managers — A , say — sell his assets to B . It is straightforward to show (section 2.3) that this form of integration is dominated by other ownership structures in this model — the cost imposed on the subordinate manager A is simply too great.

generated by the enterprise accrues to the managers and HQ.⁶ The assumption will be relaxed later to allow for the possibility that the managers and HQ accrue only a fraction of the revenue, the rest of which goes to “shareholders.”

A *contract* for A, B is a choice of ownership structure and conditional on that a share of revenues accruing to each manager.

- Under non-integration, a share contract specifies the share s accruing to A when output is 1; B then gets a share $1 - s$. By limited liability each manager gets a zero revenue when output is 0.⁷
- Under integration, HQ buys the assets A, B for prices of π_A and π_B in exchange for a share structure $\mathbf{s} = (s_A, s_B, s_H)$ where $\mathbf{s} \geq \mathbf{0}$ and $s_A + s_B + s_H = 1$.

The shares of revenue along with the assets prices π_A and π_B are endogenous, and will be determined in the overall market equilibrium.

Markets

The *product market* is perfectly competitive. On the demand side, consumers maximize a quasilinear utility function taking P as given. This optimization yields a demand $D(P)$. Suppliers also take the (correctly anticipated) price P as given when they sign contracts and make their production decisions.

In the *supplier market*, there is a continuum of A and a continuum of B suppliers with potentially different measures. In the *HQ market*, HQ's are supplied elastically with an opportunity cost normalized to zero.

2.2 Equilibrium

There are three types of enterprises that correspond to the formation of the following coalitions:⁸

⁶Since there is a single product produced by the enterprise and the revenue from its sale is contractible, it does not matter in which hands the revenue is assumed to accrue initially. A more general formulation would suppose that the suppliers produce complementary products (e.g., office suite software and operating systems) that generate separate revenue streams, which accrue separately to each supplier; the present model corresponds to the case where these streams are perfectly correlated. A full treatment of that case, which not only admits the possibility of richer sharing rules in which each manager gets a share of the other's revenue, but also would form the basis for a property-rights theory of multi-product firms, is beyond the scope of this paper, so to speak.

⁷There is no allowance for third-party budget breakers: as is well known, they can improve performance only if they stand to gain when the enterprise fails. (Note also that because output in case of failure is equal to zero, budget breaking is not effective when managers have zero cash endowments.) For simplicity, borrowing from third parties to make side payments is also not allowed; relaxation of this assumption is discussed in Section 5.

⁸While there are many other potential coalitions, because of the production technology none of them can achieve payoffs different from what can be achieved by unions of the three we describe.

- Single agent coalitions, the feasible set of payoffs for which are independent of the product market price and coincide with payoffs lower than an exogenous opportunity cost. The opportunity cost of HQ 's is equal to zero, but the opportunity cost of other agents may be positive.
- Coalitions consisting of one A supplier and one B supplier. The feasible set for these coalitions will depend, among other things, on the product market price and corresponds to the set of payoffs that are achievable through contracts when supplier A has ownership of asset A and supplier B has ownership of asset B .
- Coalitions consisting of one A supplier, one B supplier and a HQ . The feasible set for these coalitions will depend on the product market price and corresponds to the set of payoffs that are achievable through contracts where HQ has ownership of the assets of A, B .

The feasible sets for each enterprise will be derived in the following sections.

For a given coalition, the contract that is chosen determines the decisions that will be taken and therefore the probability that a positive output is produced by the enterprise. While output is a random variable at the level of an enterprise, a law of large numbers implies that at the level of industry output is deterministic. Hence, once coalitions are formed and contracts agreed upon, there is a well defined *industry supply* $S(P)$.

Definition 1. An equilibrium consists of a partition of agents into coalitions, a payoff to each agent and a product price P such that:

- (1) the payoffs to the agents in an equilibrium coalition are feasible given the equilibrium price P ;
- (2) no coalition can form and find feasible payoffs for its members that are strictly greater than their equilibrium payoffs;
- (3) the total supply in the industry $S(P)$ is equal to the demand $D(P)$.

2.3 Choice of Organization

Consider a matched pair A and B who will accrue the entire enterprise revenue P in case of success (0 in case of failure). In order to determine the relative merits of integration and non-integration and the choice of shares s , they will anticipate their behavior and resulting payoffs given each possible contract and choose that which optimizes the payoff of B while guaranteeing A his equilibrium payoff. To construct the Pareto frontier for A and B , it is convenient to treat each ownership structure in turn.

Non-integration

Since each manager retains control of his activity, given a share s , A chooses $a \in [0, 1]$, B chooses $b \in [0, 1]$. A 's payoff is $(1 - (a - b)^2)sP - (1 - a)^2$ and B 's is $(1 - (a - b)^2)(1 - s)P - b^2$.

The (unique) Nash equilibrium of this game is:

$$a = 1 - s \frac{P}{1 + P} \quad b = (1 - s) \frac{P}{1 + P}. \quad (1)$$

The resulting expected output is:

$$Q^N(P) \equiv 1 - \frac{1}{(1 + P)^2}. \quad (2)$$

For a given value of s , as the revenue P increases, A and B are willing to concede to each other's preferences more (a decreases and b increases). Output is therefore increasing in the price P : larger values raise the relative importance of the revenue motive against private costs, and this pushes the managers to better coordinate. The functional forms generate a convenient property for the model, namely that the output generated under non-integration does not depend on s , i.e., on how the managers split the firm's revenue. This will also be true of integration.

Of course, the managers' *payoffs* depend on s ; they are:

$$u_A^N(s, P) \equiv Q^N(P)sP - s^2 \left(\frac{P}{1 + P} \right)^2 \quad (3)$$

$$u_B^N(s, P) \equiv Q^N(P)(1 - s)P - (1 - s)^2 \left(\frac{P}{1 + P} \right)^2. \quad (4)$$

Varying s , one obtains a Pareto frontier given non-integration. It is straightforward to verify that it is strictly concave in $u_A - u_B$ space, a result of the convex cost functions, and that the total managerial payoff:

$$U^N(s, P) \equiv Q^N(P)P - (s^2 + (1 - s)^2) \left(\frac{P}{1 + P} \right)^2 \quad (5)$$

varies from $\frac{P^2}{1 + P}$ at $s = 0$ (or $s = 1$) to $(\frac{3}{2} + P) \left(\frac{P}{1 + P} \right)^2$ at $s = 1/2$.

Non-integration has clear incentive problems: A and B managers put too little weight on the organizational goal in favor of their private benefits. The alternative is integration, but this introduces other incentive problems: whoever makes the decision will put too little weight on the private costs. An extreme version of this is when integration gives title to A or B : in this case the decisions made are so costly to the other manager that the ownership structure is dominated by non-integration. To see this, note that the managerial surplus under non-integration is always at least $U^N(0, P) = P^2/(1 + P)$. If B were to have control (the argument is similar for A), he would choose a and b to maximize his own payoff

$(1 - (a - b)^2)(1 - s)P - b^2$, which entails $a = b = 0$. This maximizes A 's cost, and the total surplus is only $P - 1$, which is less than $U^N(0, P)$. Thus B -control is Pareto dominated by non-integration, and the only other organizational form of interest is when control is given to an HQ.

Integration

Consider an integration contract in which the shares of revenue are $\mathbf{s} = (s_A, s_B, s_H)$. Suppose that HQ has financed the asset acquisition with cash.⁹ Then as long as $s_H > 0$, HQ will choose to maximize output since her objective function is $(1 - (a - b)^2)s_HP$. Hence the decisions that will be taken by an HQ with positive residual rights on revenue must satisfy $a = b$; assume that HQ opts for $a = b = 1/2$, which minimizes the total managerial cost $(1 - a)^2 + b^2$ among all such choices. The cost to each manager is then $1/4$. Since HQ's compete and have zero opportunity cost, the purchase prices for the assets must total s_HP . Total managerial welfare under integration is therefore $U^I(P) \equiv P - 1/2$, which is fully transferable between A and B via adjustments in \mathbf{s} or the asset prices. The reason for transferability is simple: the actions taken and costs borne by A and B do not depend on their shares. Neither, of course, does integration output.

Notice that the cost of integration is fixed, independent of P . This is a *result* of the fact that HQ is an incentive-driven agent who has a stake in the firm's revenue. If she had no stake ($s_H = 0$), HQ would be acting as a "disinterested authority," indifferent among all decisions $(a, b) \in [0, 1]^2$, and hypothetically she could be engaged by the managers to make the first-best choices.¹⁰

The problem with this is that she would be equally happy to choose the "doomsday option," setting $a = 0, b = 1$, thereby inflicting maximal costs on the managers and generating zero output. For this reason, disinterested authority is not feasible: HQ would always use the doomsday threat (or a suitably mollified one) to renegotiate a zero-share contract to one with a positive share.¹¹ Anticipating this renegotiated outcome, the managers will give her a positive stake in the first place.¹²

Since the decision outcome is the same with *any* positive share for HQ, and the managers would always recoup her anticipated revenue via the fixed payments, there is no loss of generality in assuming that integration contracts give a full share to HQ ($\mathbf{s} = (0, 0, 1)$). She

⁹Appendix A shows that HQ needs to have some cash in order for integration to emerge but that the level of cash may be arbitrarily small.

¹⁰These maximize $(1 - (a - b)^2)P - (1 - a)^2 - b^2$, yielding $(a^*, b^*) = (\frac{1+P}{1+2P}, \frac{P}{1+2P})$ (thus $a^* \neq b^*$) and costs $\frac{2P^2}{(1+2P)^2}$, which do depend on P . The first-best surplus is $\frac{2P^2}{1+2P}$.

¹¹See Legros and Newman (2012) for a more detailed argument.

¹²There are of course other reasons why an agent with significant control rights would have a positive stake of contractible revenue. Moral hazard is one: if enforcing the decisions involves any non verifiable cost, giving HQ a large enough share will ensure she acts. Or, if she has an ex-ante positive opportunity cost of participating, the cash-constrained managers would have to give her a positive revenue share to compensate. Finally, the managers could engage in a form of influence activities, lobbying for their preferred outcomes with shares of revenue.

makes decisions $a = b = 1/2$, and asset prices are such that $\pi_A = u_A + 1/4$ and $\pi_B = P - \pi_A$, where u_A is the equilibrium payoff to A . Hence, the Pareto frontier under integration is $u_B = P - 1/2 - u_A$.

Comparison of Ownership Structure

Ownership structure presents a tradeoff. From the A and B managers' point of view, integration generates too much coordination relative to the first best; non-integration generates too little. The choice of ownership structure will depend on distributional as well as efficiency considerations. Given the product price P , total managerial welfare is constant under integration, independent of how it is distributed, while for non-integration, it depends on s and therefore on surplus division. In general, neither Pareto dominates the other, so that supplier market equilibrium, which determines the distribution of surplus and s , as well as product market equilibrium, which determines P , will both influence the decision whether to integrate.

The relationship between the individual payoffs and the price has a simple characterization in the managers' payoff space. Since the minimum non-integration welfare is $\frac{P^2}{1+P}$ (corresponding to $s = 0$ or 1) exceeds $P - 1/2$ if and only if $P < 1$, non-integration dominates integration at low prices. Because the frontiers are symmetric about $u_A = u_B$, with the integration frontier linear and the non-integration frontier strictly concave, they intersect twice. The loci of intersections is given by $|u_A - u_B| = \frac{P}{1+P}$;¹³ thus we have:

Proposition 1. (a) *Integration is chosen when product price $P > 1$ and $|u_A - u_B| > \frac{P}{1+P}$.*

(b) *Non-integration is chosen when $P < 1$ or $|u_A - u_B| < \frac{P}{1+P}$.*

(c) *Either ownership structure may be chosen when $P \geq 1$ and $|u_A - u_B| = \frac{P}{1+P}$.*

The result is depicted in Figure 1, where the $|u_A - u_B| = \frac{P}{1+P}$ locus is represented by the dark heavy curves; the integration regions (I) and non-integration region (N) are also shown, along with integration (straight) and non-integration (curved) frontiers for some price greater than 1.

Parts (a) and (b) suggest that integration is partly an artifact of inequality in managerial surplus division, but the extent to which this is true will decline as the price of output increases.¹⁴ Integration, with its centralized decision-making, has a comparative advantage in distributing surplus, since it can do so with minimal distortion of the production choices. Under the decentralized decision making of non-integration, performance is much more

¹³To see this, use (3) and (4) to get the absolute difference in payoff $|u_A - u_B| = |2s - 1| \frac{P^2}{P+1}$; setting $P - 1/2 = \left(\frac{P}{1+P}\right)^2 (2 + P - s^2 - (1 - s)^2)$ to solve for s (solutions exist only for $P \geq 1$) gives $|2s - 1| = 1/P$, from which the result follows.

¹⁴A measure of inequality on these loci is $\frac{|u_A - u_B|}{u_A + u_B} = I(P) \equiv \frac{2P}{(1+P)(2P-1)}$, which has a maximum value of 1 at $P = 1$ and declines monotonically to 0 as P gets large. Integration occurs whenever inequality exceeds $I(P)$; thus non-integration becomes decreasingly "likely" for high-value enterprises.

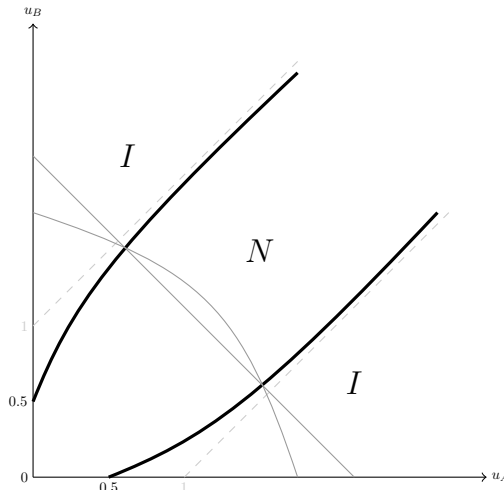


Figure 1: Division of the surplus and integration decisions

sensitive to how the benefits are distributed. Thus, *inequality is a force for integration*. Result (c) will play a significant role in generating heterogeneity of organizational form (co-existence of integrated and non-integrated firms).¹⁵

Some intuition for the role of the industry price level can be obtained by considering the extreme case in which one of the managers (say A) receives zero surplus. Then $s = 0$, and the A manager has *no* interest in revenue, and sets $a = 1$, thereby bearing no cost, if he runs his own firm. Manager B's cost will increase with P , since his large interest in revenue will induce him to increase his concession to A. As revenue becomes large, B's cost is driven close to the maximum; total cost is large because of the convexity of the cost functions. Integration has the benefit of forcing A to compromise; he needs to be compensated with a positive share of revenue, but if the total revenue is large, this is a small sacrifice (the needed share gets small). Thus when P is high enough, B will prefer integration. If P is small, though, then the fixed cost of integration is not worth its improved output performance, which has little value in the market.

On the other hand if A has a share closer to $1/2$, under non-integration he takes account of the revenue as well as his private costs, and concedes, all the more so as P increases. The decisions will remain on either side of $1/2$ (so output will fall short of the integration level, but at high revenues this is a small gap), taking account of the private costs, and so non-integration remains preferable.

The incomplete contracts literature has tended to emphasize the technological (supply-side) aspects, though distributional aspects have received some attention (Aghion and Tirole 1994, Legros and Newman 1996, 2008). The present analysis emphasizes the additional role played by demand, and Proposition 1 illustrates the interplay of demand (P) and distribution (u_A, u_B).

¹⁵For simplicity, we do not allow for lotteries among these ownership structures.

2.4 Industry Equilibrium and the “Organizationally Augmented Supply”

Industry equilibrium comprises a general equilibrium of the supplier, HQ and product markets. To focus on the role played by market price in determining organizational design, assume that the suppliers have a zero opportunity cost of participating in this industry and that the measure of A suppliers exceeds that of the B 's, which is equal to unity. Thus some of the A 's will remain unmatched and receive their opportunity cost of 0. Stability then implies that matched A 's receive 0 as well. In other words, we will be looking along the vertical axis in Figure 1, where B gets $\max\{u_B^N(0, P), u_B^I(0, P)\}$. Since $u_A = 0$, proposition 1 implies that there is indifference between integration and non-integration when $P = 1$.

To derive the industry supply, suppose that a fraction α of firms are integrated and a fraction $1 - \alpha$ are non-integrated. Total supply at price P is then almost surely (because of the continuum of enterprises and law of large numbers):

$$\alpha + (1 - \alpha)Q^N(P).$$

When $P < 1$, $\alpha = 0$ and total supply is just the output when all firms choose non-integration. At $P = 1$, α can assume any value between 0 and 1 since managers are indifferent between the two forms of organization; however because output is greater with integration, total supply increases with α . When $\alpha = 1$ output is 1 and stays at this level for all $P \geq 1$.

We write $S(P)$ to represent the supply correspondence, where α depends on P as described in the previous paragraph. The supply curve is represented in Figure 2.

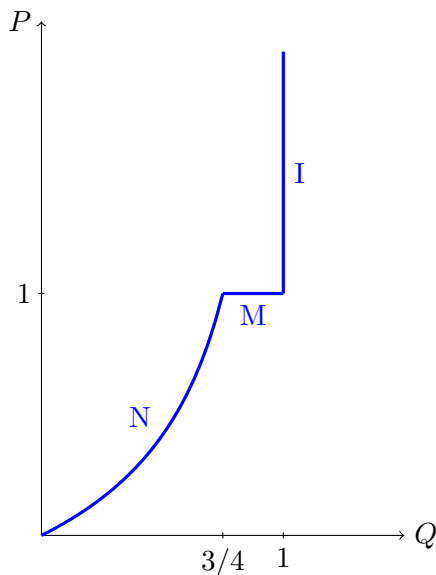


Figure 2: Organizationally Augmented Supply Curve

An equilibrium in the product market is a price and a quantity that equate supply and demand: $D(P) \in S(P)$. There are three distinct types of industry equilibria illustrated in Figure 2, depending on where along the supply curve the equilibrium price occurs: those in which firms integrate (I), the mixed equilibria in which some firms integrate and others do not (M), and a pure non-integration equilibrium (N). The model predicts a monotonic relationship between the price and integration. As demand increases, the equilibrium price increases, inducing a greater tendency to integrate.

3 Conduct and Performance of an Organizational Industry

This section emphasizes three consequences of the model pertaining to industry conduct and performance. First, there is robust coexistence of different ownership structures. Second, the organization of one enterprise depends not only on its own technology and managers' preferences but also on prices determined outside it, implying that "local" changes can have industry-wide effects. Finally, equilibrium has welfare properties readily characterized in terms of consumer and producer surplus.

3.1 Heterogeneity of Ownership Structure

In the mixed region of the OAS (M) there is coexistence of organizational forms (ownership structure) within the industry. Notice that this organizational heterogeneity is an endogenous consequence of market clearing given a discrete set of ownership structures, and occurs even though all firms are ex-ante identical.

There is much evidence of productivity variation within industries even among apparently similar enterprises; Syverson (2010) notes that within 4-digit SIC industries in the U.S. manufacturing sector, a "plant at the 90th percentile of the productivity distribution makes almost twice as much output with the same measured inputs as the 10th percentile plant" and that other work on Chinese or Indian firms find even larger differences. Moreover as emphasized by Gibbons (2006, 2010) there is correlation between organizational and productivity variations but there is little theoretical work attempting to explain it.¹⁶ The model provides a simple explanation for part of this correlation, since whenever they coexist, a non-integrated enterprise generates only a fraction of the expected output of an integrated one.

Observe that while there is only a single price at which the heterogeneous outcome occurs, it is generated by a generic set of demand functions:

Proposition 2. *Consider any demand function $D(P)$ with that is positive and has finite elasticity at $P = 1$. There exists a non-empty open interval $(\underline{\delta}, \bar{\delta}) \subset \mathcal{R}_+$ such that for any*

¹⁶An early exception is Hermalin (1994) who obtains heterogeneity in incentive schemes in a principal-agent model when the product market is imperfectly competitive. More recently Gibbons et al. (2011) find heterogeneity in control structures among identical firms in a rational-expectations model where input prices reveal information.

demand function $\delta D(P)$, with $\delta \in (\underline{\delta}, \bar{\delta})$ there exists a mix of non-integrated and integrated firms in equilibrium.

Recall that the pool of HQs is large enough to integrate every enterprise. If instead the HQs are in short supply, heterogeneity is even more endemic. Indeed, at all prices exceeding 1, managers would prefer integration if the HQs continued to accrue zero net surplus, but since there are not enough HQs to go around, some enterprises must be non-integrated; in equilibrium, HQs extract enough surplus to render managers indifferent between integration and non-integration. Similarly, if we relax our simplifying assumption that rules out lotteries among ownership structures then heterogeneity would also be easier to obtain.

In contrast to the robust co-existence of ownership structures found here, other papers investigating endogenous heterogeneity (notably Grossman-Helpman 2002) have found it to be only non-generic, occurring only for a singular set of parameters. Further consideration of the difference in results is deferred to the discussion of entry in section 5.

3.2 Supply Shocks and External Effects

The fact that all enterprises face the same price means that anything that affects it – a demand shift, foreign competition, or a tax on profits – can lead to widespread and simultaneous reorganization, as in a merger or divestiture wave. Straightforward demand and supply analysis can be used to study these phenomena. For instance, growth in demand might raise the price from below 1 to above it, resulting in a merger wave as firms switch from non-integration to integration.

By the same token, the organization of a particular enterprise depends not only on its own technology and managers' preferences but also on prices (product price and surplus division) determined outside it. In particular, technological “shocks” that directly affect some firms may induce reorganizations to *other firms* that are unaffected by the shock, as well as to themselves; in fact, sometimes *only* the unaffected firms reorganize, as in the following example.

A positive technological shock (e.g., a product or process innovation) raises the success output in joint production to $R > 1$ for a fraction z of the B-suppliers. For these affected enterprises, expected output is now equal to $Q^N(RP)R$ under non-integration and to R under integration. Managers are indifferent between the two ownership structures when $PR = 1$: integration occurs for the innovating firms if the new equilibrium price is greater than $1/R$. For the unaffected firms, the supply correspondence is unchanged. The industry supply is a convex combination of the supplies for the affected and unaffected firms. In particular, the supply is increasing in z .

Let demand have constant elasticity, $D(P) = P^{-\epsilon}$, with $\epsilon > 1$. In the absence of a shock ($z = 0$), the market clearing condition $S(P) = D(P)$ requires that $P = 1$; in this

case $S(1) = D(1) = 1$ and though managers are indifferent between the two ownership structures, market clearing requires that *all firms are integrated*.

Consider two cases.

Homogeneous shocks: $z = 1$. All firms success output is now $R^* > 1$. If all firms are integrated, which requires that in the new equilibrium, $P^* > 1/R^*$, the market clearing condition is $R^* = (P^*)^{-\epsilon}$, or $P^* = 1/R^{*(1/\epsilon)} > 1/R^*$, where the inequality follows from the fact that R^* and ϵ both exceed 1. If a positive measure of firms were non-integrated, then $P^* \leq 1/R^*$, but then demand $(P^*)^{-\epsilon} \geq (R^*)^\epsilon > R^*$ would exceed supply. Thus, the only equilibrium has no change in organization after the shock – *all firms remain integrated*, and industry output increases to R^* .

Heterogeneous shocks: $z < 1$. Suppose the affected enterprises are subject to a larger shock $R > R^*$, where the average productivity change is the same, that is:

$$zR + 1 - z = R^*$$

Since supply is increasing in z , the new equilibrium price cannot exceed 1. On the other hand, since supply is bounded above by R^* , from the calculation done above for homogeneous shocks, equilibrium price will always exceed $1/R^* > 1/R$, so *none of the shocked firms re-organize*. In fact, market clearing will require that *at least some of the unshocked firms reorganize* by becoming non-integrated: if the price falls below 1, all of them do, and if it remains at 1, they cannot all remain integrated, for supply would be R^* , exceeding demand, which is 1. This is an example of an organizational *external effect*: the impetus for organizational change may be come from outside the firm, transmitted by the market.

Because the newly non-integrated enterprises produce less then they did before, there is a “reorganizational dampening” effect from the heterogenous shocks: in contrast to the homogeneous case, aggregate output must end up being *less* than R^* . In fact, in case the price remains at 1, which obtains for an open set of parameter values, *all* of the productivity increase is absorbed by reorganization; some managers (the innovating B 's) benefit, but consumers do not.¹⁷ Absent strategic considerations, it would be difficult for different distributions of technological shocks to lead to such different outcomes in a neoclassical model, since the aggregate production set, which is all that matters in competitive analysis, is simply the sum of individual production sets and thus does not depend on the distribution of shocks.

This example may be summarized by saying

- A firm benefiting from a significant change in technology need not re-organize.
- A firm that undergoes a large re-organization need not have experienced any change in technology.

¹⁷For the price to remain at 1 simply requires that supply when all unshocked enterprises are non-integrated to be less than the demand, or $zR + (1 - z)Q^N(1) \leq D(1) = 1$; since $Q^N(1) = \frac{3}{4}$, $R > \frac{4-3R^*}{2-R^*}$.

- Re-organizational dampening may substantially absorb the aggregate benefit of heterogeneous technological improvements.

Much empirical work in the property rights or transaction cost tradition on the determinants of integration has focused on “supply-side” factors, e.g., asset specificities or complementarities (see, e.g., Whinston 2001 for a summary). The present model points to the importance of demand: once taken into account, the simple intuition of supply-side analysis may be overturned.

3.3 Welfare

Since integration produces more than non-integration, consumers would stand to benefit the more firms are integrated. Since there are equilibria in the model in which no firm is integrated, one wonders if there is a sense in which such equilibria deliver too little integration. For this to happen, the gains to other stakeholders (particularly consumers) would have to offset any managerial losses resulting from increased costs.

Following the industrial organization convention, focus on total welfare. Equilibrium welfare will be compared to what could be achieved by a social planner who can impose the ownership structure on each enterprise, but allows participation, non-contractible decisions, prices and quantities to be determined by market clearing. Define an equilibrium to be *ownership efficient* if welfare cannot be increased by forcing some enterprises to choose an ownership structure that differs from the one they choose in equilibrium. Since such forced re-organization may hurt the B managers, if the planner can make lump sum transfers from consumers to managers, then ownership inefficient equilibria are also Pareto inefficient. Notice this criterion is weak in the sense that it does not empower the planner to set the managerial shares s , let alone the decisions a and b , for any enterprise.¹⁸

Full Revenue Claims

It is convenient to express the managerial cost as a function of the expected quantity produced by the firm. When there is integration, this cost is equal to $1/2$. For non-integration, in equilibrium the A 's revenue shares are equal to zero, so they set $a = 1$ regardless of price or expected output and bear no cost. For the manager of B , if he makes decision b , expected output is $Q = 1 - (1 - b)^2$, which can be inverted to express the equilibrium managerial cost as a function of Q :

$$c(Q) = \left(1 - \sqrt{1 - Q}\right)^2$$

¹⁸A stronger concept of efficiency would also allow the planner to impose the share s . In this case, it is welfare maximizing to set $s = 1/2$ whenever there is non-integration, which would never be part of an equilibrium when the opportunity cost is zero and managers have no initial wealth. However, this higher welfare would be generated at the expense of the B -managers in favor of the A s, who would not be able to make lump-sum compensating transfers. Indeed, as is shown in Section 5, if the A 's had the cash to make such transfers, they would choose $s = 1/2$ themselves.

When B receives income P in the case of success, the solution to $\max_b P(1-(1-b)^2)-b^2$ is then the same as the solution to $\max_Q PQ - c(Q)$. It follows that along the graph $(P, Q^N(P))$, $P = c'(Q^N(P))$, when the manager faces revenue P , expected output equates P to the marginal managerial cost, which coincides with the supply function under non-integration.

Under integration, the cost is constant and equal to $\frac{1}{2}$. Since at $P = 1$, the B manager is indifferent between integrating and not integrating, $1 \cdot Q^N(1) - c(1) = 1 - \frac{1}{2}$, and the cost of integration is equal to $c(1) + 1 - Q^N(1)$. To produce $Q \in [Q^N(1), 1)$ requires the manager to choose integration with probability $\frac{Q-Q^N(1)}{1-Q^N(1)}$ (equivalently that fraction of firms must integrate) at cost $c(1) + Q - Q^N(1)$. Hence the marginal cost is just 1 when $Q \in [Q^N(1), 1)$. In other words, when the managers have full residual claim on the revenue of the enterprise, the industry supply coincides with the marginal cost curve. It then follows that equilibria are ownership efficient: any increase in consumer surplus resulting from an imposed increase in integration would be more than offset by losses in managerial surplus. In the Appendix this argument is generalized to the case $\underline{u}_A \geq 0$ (indeed, all results in this section hold in this more general case).

Proposition 3. *When managers have full residual claim on revenues, equilibria are ownership efficient.*

Managerial Firms

Since few top managements, at least in large firms, would appear to have full revenue claims, it is worth asking what changes in the model when enterprises are “managerial,” in the sense that managers have low financial stakes. It turns out that while the qualitative properties of the positive analysis remain unchanged, the welfare conclusions differ substantially. The principal lesson from the analysis will be that *corporate governance affects industry performance*.

The simplest way to model this situation is to suppose that managers receive only a fraction γ of the revenue, with the remaining $1 - \gamma$ accruing to passive shareholders. These shareholders, like HQ’s, only care about income. However they are unable to choose either the revenue share accruing to the managers or the contractual variables (ownership structure and s), decisions over which remain with the managers.¹⁹

The managers now get γP in case of success. By arguments parallel to those made for the case of productivity shocks in section 3.2, it is straightforward to verify then that under non-integration, the expected output is $Q^N(\gamma P)$, and the quantity produced solves $\gamma P = c'(Q^N(\gamma P))$. Moreover, the shift to integration happens when $\gamma P = 1$, i.e. $P = 1/\gamma > 1$. Since the integration output is still 1, the effect is for the supply curve to shift

¹⁹Section 5 provides a summary discussion of how the presence of active shareholders, who choose only the revenue share optimally, has little impact on the results, whereas if they choose ownership structure as well, they are apt to integrate too often.

up, and everywhere along it the price is strictly greater than the marginal cost.

Since supply no longer coincides with marginal cost, it is entirely possible that the equilibrium will entail inefficiency in the generation of consumer surplus. If the equilibrium price is below $1/\gamma$, there may be too little integration from the consumer (and shareholder) point of view, even taking account of the managers' costs.

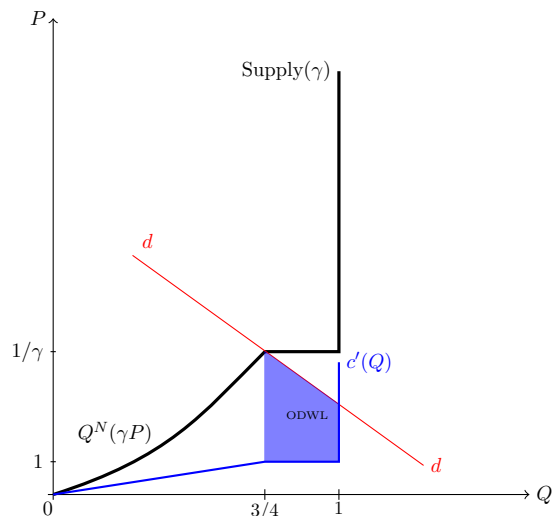


Figure 3: Ownership Inefficiency when Managers have a Partial Claim on Revenues

An example is illustrated in Figure 3, where the trapezoidal shaded area is the welfare loss due to organizational inefficiencies when $\gamma < 1$. While figure 3 is illustrative, it is also clear that as the demand function rotates clockwise around the equilibrium price to become flatter, the deadweight loss is larger, suggesting that demand elasticity plays a role in determining the magnitude of the welfare loss. We confirm these observations in the following proposition.

Proposition 4. *Suppose that managers are not full revenue claimants ($\gamma < 1$).*

- (a) *There is an interval $(P(\gamma), 1/\gamma)$, with $P(\gamma)$ continuously increasing to $P(1) = 1$ such that the equilibrium is ownership inefficient if, and only if, the equilibrium price lies in this interval.*
- (b) *Consider two demand functions with one more elastic than the other at any price. If both demands generate the same equilibrium price in $(P(\gamma), 1/\gamma)$, the organizational welfare loss is larger for the more elastic demand.*

The result that high demand elasticity maximizes welfare losses stands in sharp contrast to the theory of monopoly with neoclassical firms: there, higher demand elasticities lead to *lower* welfare losses. This is one example of how organizational distortions may differ systematically from market power distortions.

4 Empirical Illustrations: Airlines and Concrete

Recent studies of two very different industries, airlines and concrete (Forbes and Lederman, 2009, 2010; and Hortaçsu and Syverson, 2007), present an opportunity to show how the model can be used to make sense of the evidence.

4.1 Airlines

Forbes and Lederman (2009, 2010) describe the relationships between major airlines and regional carriers. The majors subcontract with the regionals to operate the relatively short flights that are sold as major carrier flights. In some cases, the major and the regional are separate firms (non-integration), in others the regional is owned by the major (integration). Given the hub-and-spoke design of airline networks, the good required by anyone not living in a hub and needing to travel to another non-hub must consist of at least two complementary parts, the main carrier flight and the regional carrier flight, which corresponds rather closely to the situation we model. There is integration if the major carrier owns the regional carrier.

Forbes and Lederman note that there is heterogeneity of ownership structures: a major may own some of its regional flights and outsource to others, even on flights originating out of the same airport. The main issue affecting ownership structure is the flexibility in adjusting schedules in response to weather or other sources of delay — in other words a coordination problem where each side is bound to have its own most convenient departure times. Their data show (a) that integrated relationships perform better (in the sense of fewer delays and cancellations); (b) that integration is more prevalent on routes in which the costs of delay are higher (routes with endpoints that have more of the major's departing flights or which involve a hub); and (c) that integration is more likely on routes with more adverse weather conditions or other exogenous sources of delay such as airport congestion.

A simple way to adapt the model to the airline setting is to add a parameter $\omega \in [0, 1]$, reflecting the severity of the weather or congestion, to the loss function. Hence the success probability becomes $1 - \omega(a - b)^2$ (higher ω corresponds to worse weather). It is straightforward to show that (1) the non-integration supply is $1 - \frac{\omega}{(1 + \omega P)^2}$, decreasing in ω when $\omega P < 1$, and (2) that the shift to integration occurs when $\omega P = 1$. Integration supply remains equal to 1, as before. Finding (a) is consistent with a basic feature of the basic model: the frequency of successful delivery of the good is higher under integration than non-integration, given the weather parameter ω .

Notice that P is revenue lost when a good fails to be delivered. Thus it can be interpreted as a cost of delay as well as a reflection of demand (indeed, delayed passengers need to be accommodated, either with refunds or with seats on other flights). Forbes and Lederman (2009) interpret the presence of a hub on the route as a reflection of high demand; high numbers of connecting flights at the destination might imply high demand or a large potential number of accommodations that need to be made in case of delay. Either way,

the basic model’s prediction that integration is associated with higher enterprise value is consistent with their finding (b). That is, airline organization appears to be at least partly demand-driven.

Finally, finding (c), that routes with more adverse weather are more likely to be integrated, is explained by result (2): the larger is ω , the smaller the price at which integration occurs, and in this sense, the more likely is integration. (In fact, combined with (1), the result can be sharpened: more demand functions generate integration on the bad weather routes than on the good weather routes.) Interestingly, this implies that routes with bad weather may actually perform better: via a kind of “organizational leapfrogging,” a bad-weather route may have few delays because it is integrated, while with the same demand, a non-integrated good-weather route experiences delays.

4.2 Cement and Concrete

Hortaçsu and Syverson (2007) study the vertical integration levels and productivity of U.S. cement and ready-mixed concrete producers over several decades and many local markets. They find that these industries are fairly competitive, that demand is relatively inelastic, and that there is little evidence that vertical-foreclosure effects of integration are quantitatively important. Three of their major findings are (a) prices are lower and quantities are higher in markets with more integrated firms, (b) high productivity producers are more likely to be integrated, and (c) some of the more productive firms are non-integrated. They tie the productivity advantages to improved logistics coordination afforded by large local concrete operations, regardless of whether it presides in integrated or non-integrated enterprises.

Though the negative correlation between integration and prices would go against a single-productivity version of our model, shutting down productivity variation is obviously a simplification imposed to highlight the importance of demand in determining ownership structure. The importance of supply-side factors (relationship specificity, complementarity of assets and investments, and the like) has received the bulk of the emphasis in the literature.

Since as we saw in section 3.2 higher productivity implies integration will occur at lower price, the Hortaçsu-Syverson findings (a) and (b) are explained by the presence, which are documented in the paper, of multiple productivity levels, interpreted as exogenous — markets with more integrated firms are likely to be those with more productive firms, so equilibrium prices will be lower, assuming equal demands.

But technological variability alone (and models which exploit this as their only source of variation in organizational form) cannot fully explain the findings either: if higher productivity causes integration, why aren’t all productive firms integrated, in contradiction to finding (c)? Neither supply alone, nor demand alone would seem to be able to explain the facts of the U.S. concrete and cement industries. But together they can explain the

Hortacısu-Syverson findings.

Suppose, as in section 3.2, that there is exogenous variation in the productivity of the enterprises in the industry, specifically two productivity levels, 1 and R , with $1 < R$. Demand is isoelastic, with $D(P) = \frac{3}{4}P^{-1}$. Letting z be the proportion of high productivity firms, the equilibrium price at $z = 0$ is $P = 1$ and all (low productivity) firms are non-integrated. Now, as z increases in the interval $(0, 1)$ the equilibrium price will decrease from 1 to $1/R$.

If the price is strictly larger than $1/R$, low productivity firms choose non-integration while high productivity firms choose integration. If price is equal to $1/R$, some of the high productivity firms will be non-integrated. Either way, high productivity firms are more likely to be integrated, as in finding (b).

As long as $P > 1/R$, the proportion of integrated firms is z , and the equilibrium price solves:

$$zR + (1 - z)Q^N(P) = \frac{3}{4}P^{-1}$$

where the left hand side is the industry supply given the organizational choices of high and low productivity firms, and the right hand side is the demand. As z increases, the equilibrium price decreases. Thus, consistent with finding (a), price is negatively correlated with the degree of industry integration.

For z above z^* , where $z^*R + (1 - z^*)Q^N(1/R) = \frac{3}{4}R$, the equilibrium price is $1/R$. At this price managers in high productivity enterprises are indifferent between integration and non-integration. Some high productivity firms will have to be non-integrated in order to satisfy the market clearing condition, while low productivity firms continue to be non-integrated. Hence, there will be heterogeneity of ownership structure among high productivity enterprises, as in finding (c). Of course, this computation assumes the coexistence of integrated and non-integrated plants is within a local market. For coexistence across markets, it is enough to posit that they have different demands. Either way, the evidence on cement and ready-mix concrete highlights the importance of demand as well as supply for understanding the determinants of ownership and its relation to industry performance.

5 Extensions

We now sketch some extensions of the basic model and directions for future research.

5.1 Entry

The model considered so far has a fixed population of price-taking suppliers, corresponding to the standard Arrow-Debreu notion of competition. Industrial economics is also concerned with ease of entry, which in the present model would also include the choice

of “side” (A or B). Since managers (particularly B 's) earn rents, it is fair to ask what happens if these rents could be competed away.

Consider the following simple model of entry. There is an unlimited population of ex-ante identical potential entrants, each of whom receives zero outside the industry and can choose to become an A or a B . If n_A and n_B are the measures of people choosing A and B respectively, the cost of entry borne by an individual entrant is $e_A(n) = e(n_A)$, $e_B(n) = \beta e(n_B)$ where $e(\cdot)$ is a non-decreasing function.²⁰

The idea is that one side takes a larger investment than the other (e.g., production requires a larger investment than marketing), unless $\beta = 1$, but that resources devoted to training for either side become scarce as the industry expands.

A (long-run) equilibrium will consist of measures n_A and n_B of entrants on each side; a market clearing product price P and quantity $D(P)$; and payoffs u_A and u_B to each of the entrants, according to which side they take. In equilibrium agents are indifferent between the two occupations and markets clear; this requires in particular that $n_A = n_B$. The scale (measure of $A-B$ pairs) of the industry will be the common value n . In the product market, supply embodies ownership choice, as before; following Proposition 1 the integration/non-integration decisions, and therefore industry output, are determined jointly by $|u_A - u_B|$ and P . The supply of the industry is $nS(|u_A - u_B|, P)$ where $S(|u_A - u_B|, P)$ is the output generated by a unit measure of enterprises, as described in Proposition 1, and n equates supply and demand.

If $e(\cdot)$ is strictly increasing, since agents must be indifferent between the two sides, we have a payoff expansion path $u_B = \beta u_A$. At low enough prices, this path lies in the non-integration region $|u_A - u_B| < \frac{P}{1+P}$. As price increases, the measure n of A 's and B 's, also increases, as do the payoffs. Unless $\beta = 1$, eventually the payoff expansion path crosses the $|u_A - u_B| = \frac{P}{1+P}$ loci at a price $P^*(\beta)$ and there is a switch to integration. Increases in β starting above 1 (or decreases starting below 1) imply more inequality in the distribution of surplus, which in turn increase the likelihood of integration; see figure 4. This echoes our remark following Proposition 1.

As in the standard neoclassical case, the long run supply will be more price elastic than the short run supply. Indeed, when P is less than $P^*(\beta)$, enterprises are non-integrated and produce $Q^N(P)$, increasing in P . Total managerial surplus must be equal to the total cost of entry $(1 + \beta)e(n)$ and therefore since surplus is increasing in P , the number of firms must also increase with P . The same reasoning holds when P is greater than $P^*(\beta)$.

At $P = P^*(\beta)$, where managers are indifferent between integration and non-integration, the quantity supplied will depend on the fraction of integrated enterprises, but their number is fixed. Thus, as in the short run, the supply curve has a horizontal segment at $P^*(\beta)$, and there is generic heterogeneity of organizational forms in a free-entry equilibrium.

²⁰Our baseline model is equivalent to having a fixed set of B suppliers, while entry or exit into A or HQ supply is permitted; what we called \underline{u}_A before is equal to $e(1)$, while as before the opportunity cost of HQ's is zero. The long run analysis also allows entry into B supply.

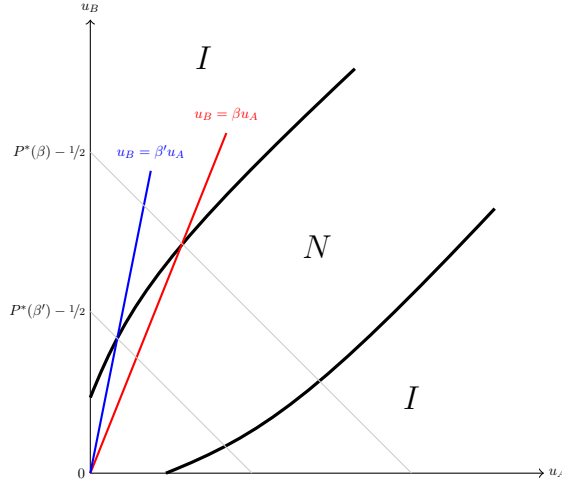


Figure 4: Payoff Expansion Path for $\beta' > \beta$

In the special case where $e(n)$ is a constant, the payoff expansion path is degenerate; the payoffs u_A, u_B are independent of demand. For almost all values of the cost of entry, the vector of equilibrium payoffs will lie either in the non-integration or integration region, making heterogeneity of organizational forms a non-generic outcome. This is similar to the Grossman and Helpman (2002) finding.

Finally, the short run welfare results extend to the long run; the equilibrium will be ownership efficient if $\gamma = 1$ but not in general otherwise.

5.2 Scale and Scope

So far, enterprises produce at most one unit of output, but it is not difficult to extend the model to allow for variation in enterprise scale, employee quality or other contractible input level. Suppose that enterprises may increase the volume of successful production by a multiplicative factor $f(l)$, a function of some contractible input l that represents quantity or quality, at cost represented by the schedule $w(l)$. Then expected profit is $(1 - (a - b)^2)f(l)P - w(l)$. For simplicity assume that the private managerial cost is unaffected by l . The input is paid contingently on success: the amount paid, $d(l)$, satisfies $(1 - (a - b)^2)d(l) = w(l)$, with a, b assuming their equilibrium values (equivalently, a loan can be procured ex-ante to pay the input and the loan is repaid upon success). When enterprises form, managers contract on shares, ownership structure, and scale; then non-contractible decisions a, b are chosen last.

As before, the success probability under integration will be 1; assuming differentiability of $f(\cdot)$ and $w(\cdot)$, the integration scale l^I will satisfy:

$$P f'(l^I) = w'(l^I).$$

For the non-integrated enterprise, a straightforward computation shows that its scale l^N satisfies:

$$QPf'(l^N) = w'(l^N),$$

where $Q = Q^N(Pf(l^N) - d(l^N))$. Thus marginal returns to l are greater under integration. From Topkis's theorem, $l^I > l^N$. And as before, there will be a price at which managers are indifferent between integration and non-integration.

Hence, when they coexist, integrated firms are both bigger and “smarter” (in the alternative interpretation of l as quality) than non-integrated ones.²¹ Therefore the output gap between the two kinds of enterprises is amplified. Whether these endogenous output differences could explain the large productivity differences that observed in many industries is left for further research. Some indication of its plausibility is offered by Hortaçsu and Syverson (2007), which does report such that integrated firms are larger and more capital intensive, as well as more productive.

Another extension of the model involves the analysis of firm scope, wherein each supplier produces its own distinct good for sale on the market, as in the original Hart-Holmström model. Because it involves strategic interactions among different parts of the enterprise, this is somewhat intricate, particularly if the number of suppliers is greater than two. Legros and Newman (2010) considers such a model. As here, integration yields coordination but at a high cost for the managers of individual product lines. Moreover, an integrated firm provides coordination benefits not only to its members, but also for “outsiders,” who can free ride. The integrated firm is typically tempted to follow the preferences of the outsiders, who therefore enjoy coordination benefits at lower cost than insiders. This mechanism provides a limit to the extent of integration, and the paper shows that the scope of multi-product firms depends on both the mean and the variance of individual product prices.

5.3 Finance

The responsiveness of ownership choice to industrial conditions in the model emerges in large measure because managers have finite (in fact, zero) wealth. This assumption implies that the ownership structure is dependent on the distribution of surplus between them, and that in turn leads to the relationship between industry price and degree of integration embedded in the OAS. It is worth devoting some attention to the comparative statics of the wealth endowments, as this appears to be connected more generally to the role that financial contracting would have in affecting industry performance.

One important difference between integration and non-integration is the degree of transferability in managerial surplus: while managerial welfare can be transferred 1 to 1 with integration (that is one more unit of surplus given to B costs one unit of surplus to A)

²¹This result persists if l represents a vector of complementary inputs, or if managerial costs are a function of the scale, as long as these costs do not grow too quickly with respect to l . Details available upon request.

by adjusting the revenue shares, this is not true of non-integration. If the A manager has cash that can be transferred without loss to the B managers before production takes place, the advantage of integration in terms of transferability is reduced. This has immediate consequences for the OAS.

Proposition 5. *Positive increases in the cash endowments of A suppliers shift the OAS to the left and decrease the level of integration.*

This result implies in particular that if managers have access to infinite amounts of cash, they will always contract for equal sharing in non-integrated organizations. However, for any finite cash holdings, there is a level of price high enough for which there will be integration.

These observations apply with equal force when the managers are not full residual claimants on the revenues of the firm. Since integration is output maximizing, giving managers cash increases the inefficiencies from the point of view of consumers and shareholders. Thus, in contrast to previous literature that has suggested that managerial cash holdings may lead to firms that are too large, this model suggests it may generate firms that are too small.²²

Borrowing can sometimes be a substitute for cash, but its efficacy depends on the ownership structure. Under integration, a cash-poor HQ can finance the acquisition with debt without affecting output. By contrast, under non-integration, if a debt D has to be repaid in case of success, it is as if the managers face a success revenue of $P - D$, and expected output will decrease from $Q^N(P)$ to $Q^N(P - D)$; this leads to a decline in total welfare that has to be weighed against the ex-ante lump-sum payment. If $\underline{u}_A = 0$, as we have assumed in most of the paper, it can be shown that there is no gain to using such a contract. When \underline{u}_A is positive, however, there is a range of prices for which small amounts of debt for side-payments may raise managerial welfare, enlarging slightly the set of prices for which non-integration is chosen. But since debt reduces output, leveraged non-integrated firms lower consumer surplus, and if the managers are not full revenue claimants, may also lower total welfare. A more general analysis is available from the authors upon request.²³

Proposition 6. *Suppose that $\underline{u}_A = 0$. Non-integrated firms do not use debt for ex-ante side-payments. HQ may use debt to finance the purchase of assets.*

²²As in Jensen (1986) managers will tend to use cash for their own interest rather than that of shareholders or consumers, but while in the free cash flow theory they will tend to use cash for “empire building” or over-expansion, here they use cash to keep firms small and buy a “quiet life”.

²³It can be shown that debt will be used for a range of share values bounded away from $1/2$; the debt-modified non-integration frontier “bulges” slightly but remains convex and is connected to the no-debt frontier at the axes and around the 45° line, while the integration frontier, as we have noted, is unchanged. Suppose the managerial revenue share $\gamma < 1$, and the demand is such that without debt there is indifference between integration and non-integration, with most firms integrated. Then adding debt raises the payoff of the B ’s only slightly, but now no firm is integrated; the resulting discrete drop in consumer and shareholder surplus more than offsets any managerial gain.

Note that debt is here used only to finance ex-ante side payments and not acquisition of assets from outside the relationship. If firms have investment opportunities, e.g., to expand their scale of production, non-integrated firms are at a disadvantage for borrowing since debt has a depressing effect on expected output.

5.4 Active Shareholders

In our model, managers have control over the integration decisions and ownership inefficiencies take the form of too little integration. Since shareholders have similar objectives to consumers — as price takers, they value high output — a reasonable conjecture is that efficiency may be improved when shareholders have control over integration decisions and compensation to managers. Corporate governance is now relevant not only for shareholders but also for consumers.

Providing good incentives is costly to shareholders under non-integration, since it entails giving up a share of profit to management. Hence, if shareholders have control over the share of revenue accruing to managers, non-integration will underperform relative to how it does when managers retain all the revenue. By contrast, integration performs well at all managerial shares. Shareholders will therefore tend to integrate “too often.” Thus, while shareholder control may implement a planner’s forced integration as a means of protecting consumers, it can be taken too far.

Proposition 7. *Suppose that the shareholders control the decision to integrate and the shares of output going to the two managers. The minimum price at which shareholders choose integration is strictly lower than the ownership efficient level.*

The policy question of how to regulate governance when consumers are affected by firm’s organizational choices is still open and an important subject for future research.

6 Conclusion

By embedding a simple model of the determination of firm boundaries into a perfectly competitive setting, this paper suggests that internal organizational effects can have significant consequences at the industry level, quite apart from the strategic and collusive interactions among firms that have dominated the industrial economics literature. Our organizational industry equilibrium offers an explanation for heterogeneity in firm performance and shows that the response of the industry to demand or technology shocks is dependent on integration decisions. At the same time, it illustrates how market forces can be important determinants of organizational design.

Our model of industry equilibrium is based on one important tradeoff between non-integration and integration: non-integration is strong on internalizing private costs and weak on coordinating decisions; integration has the opposite strength and weakness. The

model's predictions are consistent with a number of empirical findings in the cement and airlines industries. But an organizational industrial economics is hardly restricted to this tradeoff. Other underlying models of integration or other aspects of organizational design may generate other relationships among prices, quantities and organization: the OAS may have different shapes for different theories. One benefit of unifying organizational and industrial economics is that market data become a proving ground for different organizational tradeoffs, thereby helping us to identify the relative importance of each in different contexts.

While the model goes some way toward the objective of jointly determining market structure, ownership structure, and industry conduct and performance, much remains to be done. In particular, rather than assuming perfect competition, environments where market power would play a role could also be considered, so that the degree of competition would be endogenous.

Finally, on the welfare side, the analysis also shows that consumers have an interest in the organization of the firms that make the products they buy. An influential strand of thought asserts that competition in the product market must assure efficient outcomes: firms that do not deliver the goods at the lowest feasible cost, whatever the reason, including inefficient organization, will be supplanted by ones that do.²⁴ The present framework confronts such claims directly. While efficient ownership may prevail when managers have full title to enterprise revenue, in the general case, organizational choices may not be ownership efficient. Much as Leibenstein argued, and as we quantify with the eponymous trapezoid, our analysis suggests that the welfare losses from this kind of organizational inefficiency may be significant.

A Appendix: Proofs

Proofs of the Results in Section 3.3

The results in the text are stated in the context of zero opportunity costs for the A managers, we prove below that these results hold for any level of opportunity cost.

With non-integration, in order to meet his opportunity cost, A must get a share $s(P; \underline{u}_A)$ solving :

$$u_A^N(s, P) = \underline{u}_A.$$

Defining $\alpha(s) \equiv s^2 + (1 - s)^2$, $U^N(s, P)$ in (5) can be written as:

$$U^N(s, P) = Q^N(P)P - \alpha(s) \left(\frac{P}{1 + P} \right)^2.$$

²⁴The "form of organization that survives... is the one that delivers the product demanded by customers at the lowest price while covering costs." (Fama and Jensen, 1983).

Therefore the maximum payoff to B when the opportunity cost of A is \underline{u}_A is equal to :

$$U^N(s(P; \underline{u}_A), P) - \underline{u}_A. \quad (\text{A.1})$$

Finally, the cost under non-integration is:

$$C^N(Q^N(\gamma P); \underline{u}_A) = \alpha(s(\gamma P; \underline{u}_A))c(Q^N(\gamma P)).$$

Proof of Proposition 3

Suppose that demand is perfectly elastic. With integration, B gets $P - \frac{1}{2} - \underline{u}_A$, while with non-integration he gets $u_B^N(s(P; \underline{u}_A), P) = U^N(s(P; \underline{u}_A), P) - \underline{u}_A$. It follows B manager chooses an organization if, and only if, the total managerial welfare is greater. Because when demand is perfectly elastic the total welfare coincides with the total managerial welfare, the result follows.

With a less elastic demand, let P^N be the equilibrium price under non-integration. If firms are forced to integrate, industry supply increases and therefore the new equilibrium is $P^I < P^N$ since demand is decreasing. The difference in total welfare between forced integration at price P^I and non-integration at price P^N is bounded above by $U^I(P^N) - U^N(P^N)$, which is negative by the previous argument. Hence the initial equilibrium is ownership efficient.

Proof of Proposition 4

We first consider the welfare of shareholders and managers: this coincides with the total welfare when the demand is perfectly elastic. We will then consider general demand functions.

Perfectly Elastic Demand. Let us define the sum of the welfares of shareholders and managers when γ is less than 1 by:

$$\begin{aligned} V^N(P, \gamma) &= (1 - \gamma)Q^N(\gamma P)P + U^N(s(\gamma P; \underline{u}_A), \gamma P), \\ V^I(P) &= P - 1/2 \end{aligned}$$

Furthermore, let $P^*(\underline{u}_A)$ be the unique value solving $U^N(s(P; \underline{u}_A), P) = U^I(P)$.

Lemma A.1. Suppose that shareholders receive a share $1 - \gamma > 0$ of the firm's revenue and that the opportunity cost of A managers is \underline{u}_A . Then there exist $p(\gamma) < P^*(\underline{u}_A)/\gamma$ such that equilibria with $P \in (p(\gamma), P^*(\underline{u}_A)/\gamma)$ are such that $V^N(P, \gamma) < V^I(P, \gamma)$.

Proof. From Proposition 1, non-integration is chosen if and only if the price is less than $P^*(\underline{u}_A)/\gamma$. For this price, the managers act as if they faced a revenue of $P^*(\underline{u}_A)$ and

therefore will choose to produce $Q^N(P^*(\underline{u}_A))$ under non-integration:

$$\begin{aligned}
V^N(P^*(\underline{u}_A)/\gamma, \gamma) &= (1 - \gamma) \frac{P^*(\underline{u}_A)}{\gamma} Q^N(P^*(\underline{u}_A)) + U^N(s(P^*(\underline{u}_A); \underline{u}_A), P^*(\underline{u}_A)) \\
&= (1 - \gamma) \frac{P^*(\underline{u}_A)}{\gamma} Q^N(P^*(\underline{u}_A)) + P^*(\underline{u}_A) - 1/2 \\
&< \frac{P^*(\underline{u}_A)}{\gamma} - 1/2 \\
&= V^I(P^*(\underline{u}_A)/\gamma)
\end{aligned}$$

where the strict inequality follows $Q^N(P^*(\underline{u}_A)) < 1$. Now, since the functions $V^N(P, \gamma)$, $V^I(P)$ are continuous in P , there exists $p(\gamma)$ with the desired property and proves the lemma. \square

Letting $\Omega(P)$ be the consumer surplus at price P , total welfare under laissez-faire is then $\Omega(P) + \alpha(P)V^I(P, \gamma) + (1 - \alpha(P))V^N(P, \gamma)$, here $\alpha(P)$ is the equilibrium measure of integrated firms (see section 2.4.)

For perfectly elastic demand functions, $\Omega(P) \equiv 0$ and therefore total welfare coincides with $\alpha(P)V^I(P, \gamma) + (1 - \alpha(P))V^N(P, \gamma)$ implying that equilibria are ownership inefficient for all prices in the interval described in lemma A.1.

Arbitrary Demand Functions. Consider an arbitrary demand function and let $\Omega(P)$ be the consumer surplus associated to this demand function. Since utility is quasi-linear:

$$\Omega'(P) = -D(P). \quad (\text{A.2})$$

Let us denote by $\epsilon_D(P)$, $\epsilon_S(P)$ the price elasticities of demand and of supply. Suppose that the equilibrium is achieved at a price P in the interval $(p(\gamma), P^*(\underline{u}_A)/\gamma]$ of Lemma A.1.

We write the total welfare when the price is P and the proportion of firms that integrate is α as:²⁵

$$W(P, \alpha) \equiv \Omega(P) + \alpha V^I(P, \gamma) + (1 - \alpha) V^N(P, \gamma). \quad (\text{A.3})$$

As $P < P^*(\underline{u}_A)/\gamma$, firms choose non-integration with probability one. Therefore total welfare at this equilibrium is $W(P, 0) = \Omega(P) + V^N(P, \gamma)$ while we know that $V^N(P, \gamma) < V^I(P, \gamma)$ by lemma A.1. We consider a thought experiment where the planner forces a small proportion α of firms to integrate; the firms that are free to choose their organization continue to choose non-integration and therefore the total supply in the industry is $\alpha + (1 - \alpha)Q^N(\gamma P)$ if the price is P . However because total supply increases after the planner's

²⁵Under laissez-faire, we have $\alpha = \alpha(P)$ but this is not the case under planner's intervention.

intervention, the new equilibrium on the market is at price $p^e(\alpha) < P$ satisfying:

$$D(p^e(\alpha)) = \alpha + (1 - \alpha)Q^N(\gamma p^e(\alpha)). \quad (\text{A.4})$$

The welfare after the planner's intervention is now:

$$W(p^e(\alpha), \alpha) = \Omega(p^e(\alpha)) + \alpha V^I(p^e(\alpha), \gamma) + (1 - \alpha)V^N(p^e(\alpha), \gamma).$$

Implicitly differentiating (A.4) and using (A.2) we compute $dW(p^e(0), 0)/d\alpha$ by taking the limit of $dW(p^e(\alpha), \alpha)/d\alpha$ as α converges to 0; $dW(p^e(0), 0)/d\alpha$ therefore captures the local benefit of forcing firms to integrate. After straightforward computations we have $dW(p^e(0), 0)/d\alpha > 0$ if, and only if:

$$(1 - \gamma) \frac{\epsilon_S(\gamma P)}{\epsilon_S(\gamma P) + |\epsilon_D(P)|} < \frac{V^I(P, \gamma) - V^N(P, \gamma)}{1 - Q^N(\gamma P)}. \quad (\text{A.5})$$

If the demand function is perfectly elastic, the right hand side of (A.5) is the average welfare gain when all firms are forced to integrate. The left hand side is the welfare loss for the $1 - \gamma$ non-integrated firms due to the decrease in price.

As $|\epsilon_D| \rightarrow \infty$, the left hand side goes to zero and we recover the condition of lemma A.1. As $|\epsilon_D|$ decreases, the left hand side increases and therefore the condition is harder to satisfy at a given equilibrium price P , proving the proposition.

As a matter of illustration, consider the case $\underline{u}_A = 0$ and a demand function such that the equilibrium price is $1/\gamma$ and the equilibrium quantity is $Q^N(1) = 3/4$. In this case, $\epsilon_S(1) = 1/3$ and the condition reduces to $\gamma < 1 + 3|\epsilon_D|$ which is always satisfied. Hence, the condition holds indeed strictly at $P = 1/\gamma$, and therefore the range of prices for which there is local ownership inefficiency is a non-trivial subset of the interval $(P^N(\gamma), 1/\gamma]$ of Lemma A.1.

Proof of Proposition 5

Under non-integration, cash is a more efficient instrument for surplus allocation than the sharing rule s between managers A and B since a change of s affects total costs. By contrast, when firms are integrated, a change in s has no effect on output or costs and therefore shares are as efficient at allocating surplus as cash. Hence, introducing managerial cash endowments favors non-integration, and we would observe fewer integrated firms.

Let us return to our baseline environment where the population of B 's is fixed and $\underline{u}_A = 0$. Assume for simplicity that all A managers have the same cash holding of ℓ . A contract now specifies a lump sum transfer t from the A manager to the B manager together with a share s of output and an organization. Because the managerial surplus is transferable under integration, cash transfers are neutral. For non-integration however, since the total surplus is increasing on $s \in [0, 1/2]$, the ability for the A managers to make

cash transfers in exchange for a greater share of output will increase managerial surplus. Final payoffs are then $u_A^N(s, P) - t$ and $u_B^N(s, P) + t$, where u_A^N, u_B^N are given by (3).

By competition, the marginal manager A must have a zero surplus. For a given market price P , if $\ell > U^N(1/2, P)$, A managers are able to transfer $t = U^N(1/2, P)/2$ to the B manager at the signing of the contract in exchange for a share of $1/2$ of the output. In this case, the payoff to the B managers is $U^N(1/2, P)$. If $\ell < U^N(1/2, P)$, the A manager uses a transfer $t = \ell$ in exchange for a share $s_\ell(P)$ of the revenue satisfying:

$$u_A^N(s_\ell(P), P) = \ell.$$

In this case, managers B have, after the transfer of $t = \ell$, a payoff of:

$$u_B^N(s_\ell(P), P) + \ell = U^N(s_\ell(P), P).$$

While there is a larger managerial surplus, the output under non-integration is the same as before. Because non-integration is now more efficient from the point of view of manager B , integration will be chosen for a price greater than 1.²⁶ Indeed, as ℓ increases, $s_\ell(P)$ increases, therefore welfare under non-integration increases, and the shift to integration happens at higher prices.

Proof of Proposition 6

Debt and Non-Integration. Suppose that A makes a side payment T to B that is financed with a debt. Specifically, an amount D is repaid in case of success, and by limited liability, there is no repayment in case of failure. Then A 's revenue share s must satisfy $sP \geq D$, and the payoffs to the two managers are respectively $u_A = (1 - (a - b)^2)(sP - D) - (1 - a)^2$ and $u_B = (1 - (a - b)^2)(1 - s)P - b^2 + T$. By making the change of variable $\hat{s} = (sP - D)/(P - D)$, the payoffs can be written as $u_A = (1 - (a - b)^2)\hat{s}(P - D) - (1 - a)^2$ and $u_B = (1 - (a - b)^2)(1 - \hat{s})(P - D) - b^2 + T$. The game in (a, b) played by the managers is then equivalent to our baseline model of non-integration with a price equal to $P - D$, where both A and B are responsible for the debt repayment. The probability of success is $Q^N(P - D)$ and therefore in equilibrium $T = Q^N(P - D)D$. Since $Q^N(P - D)$ is declining in D , consumers are harmed if non-integrated enterprises borrow for side payments.

Now, if $u_A = 0$, then $\hat{s} = 0$, and the optimal choice of D maximizes B 's payoff, which can be written $Q^N(P - D)P - \left(\frac{P - D}{1 + P - D}\right)^2$. Maximizing this over D yields as the optimum $D = 0$. Hence, manager A will not use debt to make lump-sum payments to manager B , as claimed.

²⁶Total managerial welfare under non-integration can be written as $U^N(s_\ell(P), P) = PQ^N(P) - \beta(s_\ell(P))c(Q^N(P))$ with $\beta(s) \equiv s^2 + (1 - s)^2$. Since $\beta(s)$ is a decreasing function of $s \in [0, 1/2]$, total managerial welfare increases in s . By contrast, managerial welfare under integration is $U^I(P) = P - 1/2$ which is independent of ℓ .

Debt and Integration. Contrary to non-integration, debt may have substantial value when there is integration. We know from section 2.3 that HQ must have a strictly positive share of the firm's revenue, and that there is no loss of generality in assuming that this stake is 100%. The maximum ex-ante transfer she is willing to make to the managers is P . If her cash endowment is positive (however small), she can always finance the rest of the asset purchase with debt, since debt has no distortionary effects on her incentives. Indeed, if she owes D , her interim payoff is $(1 - (a - b)^2)(P - D)$, which still results in $a = b = 1/2$, provided $D < P$.

If however she is fully leveraged, with $D = P$, then neither she nor the managers have a positive stake in the revenue, and ex-post they would all agree to implement $(a, b) = (1, 0)$, resulting in zero expected revenue, in order to minimize costs. Anticipating this, a lender would refuse a loan. It follows that HQ's must finance their acquisitions partly with cash.

Proof of Proposition 7

Under integration, shareholders obtain $P - 1/2$ when managers have a zero opportunity cost. Under non-integration, shareholders have an expected revenue $Q^N(\pi)(P - \pi)$ if they give a total compensation π to the managers. Let $\pi(P)$ be the optimal solution to this problem and $V(P)$ be the value at the optimum. Because the objective function has positive cross partials in (π, P) , $\pi(P)$ is an increasing function of P . By the envelope theorem, $V'(P) = Q^N(\pi(P))$ is positive and since $\pi(P)$ is increasing in P , $V(P)$ is a convex and increasing function of P . Note that $\lim_{P \rightarrow \infty} V'(P) = 1$, hence $V(P)$ is equal to $P - 1/2$ at a unique point. We claim that $V(P) = P - 1/2$ at $P < 1$. It is sufficient to show that at $P = 1$, $V(1) < 1/2$. Because $\pi(1)$ solves the equation $(1 + \pi)^3 = 3 - \pi$, we have $\pi(1) \approx 0.38$, and therefore $V(1) \approx 0.29$ which is less than $1/2$ as claimed. Since the minimum price at which it is efficient to switch to integration is $P = 1$ (this follows from Proposition 3 and the fact that managers never choose integration below this price), there is "too much integration" when shareholders have full control.

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