A Price Theory of Vertical and Lateral Integration*

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Abstract

We construct a price-theoretic model of firms' integration decisions under perfect competition and study their interplay with consumer demand and welfare. Integration is costly to implement but is effective at coordinating production decisions. The price of output influences the ownership structure chosen: there is an inverted-U relation between the degree of integration and product price. Ownership in turn affects output: integration is more productive than non-integration at low prices, and less productive at high prices. If the managers deciding organizational design have full claim to firm revenues, market equilibrium ownership choices will be second-best efficient. When managers have less than a full claim on profits, however, total welfare may sometimes be increased by a social planner who could force some firms to reorganize. The price mechanism tends to correlate reorganizations across firms and generates external effects of technological shocks: productivity changes in some firms may have little effect on their own organization, while inducing changes of ownership in the rest of the industry. Terms of trade in supplier markets also affect ownership structure; entry of low-cost suppliers may induce reorganizations that raise prices. The model can generate coexistence of different ownership structures, even among ex-ante identical firms.

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1 Introduction

Consumers are seldom seen in the theory of the firm. In the theory, as in reality, they rarely involve themselves directly with organizational design. They have no seat at the contracting table where firm boundaries, ownership structures, or compensation schemes are determined. Rather, their contact with firms is limited to the product market, where their influence is confined to purchasing decisions. Yet they surely have an interest in the internal organization of the firms that make the products they buy: organizational design affects the incentives of the firm's decision makers, and those determine the quantity, quality, and prices of the goods it makes.

How then does consumers' market behavior influence organizational design? Are the resulting organizational outcomes efficient? 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.[1] While plausible, perhaps, for firms that are unitary profit maximizers, this view has received scant scrutiny in light of the modern theory of the firm, where profit maximization is not a given.[2] It is fair to say, then, that both questions remain open.

In this paper, we develop a model of the interaction of the market and organizational design that focuses on ownership structure, à la Grossman and Hart (1986), and use it to assess the efficiency of equilibrium organizational choice. Firm-boundary (i.e., whether to integrate) and profit-share choices are made to mediate managerial trade-offs between organizational goals (profits) and private ones (managerial effort or implementation costs). Consumers influence organization through the product price, because that affects the terms of managerial trade-offs. At the same time, organizational choice affects price because it determines productivity.

To focus on organizational issues, we assume competitive product and supplier markets; this rules out the possible confounding effects of market power that have usually been invoked in discussions of integration and consumer welfare in the industrial organization literature. The basic model of an organization that we embed in this setting is an adaptation of the firm scope model of Hart and Holmström (2008). Production of consumer goods requires the combination of exactly two complementary suppliers in a vertical or

[1] The "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).

[2] Among papers on the theory of the firm, consumers do make an appearance in Hart and Moore (1990), which characterizes efficient contracting when the consumer does sit at the contracting table, and Bolton and Whinston (1993), which considers potentially inefficient integration decisions by firms with market power.

lateral relationship, each consisting of a manager and his collection of assets. When the suppliers form a joint enterprise (or "firm"), the managers operate the assets by taking non-contractible decisions. The technology involves a kind of standard setting: for output to be high, it does not matter so much what decisions are made in each unit, so long as they are compatible with each other.

The problem is that managers disagree about which direction they ought to go. This may reflect differences in background (engineering favors elegant design; sales prefers user-friendliness and redundant features), information (a content provider may want to broadcast mass-market programming, while the local distributor thinks programs must be specifically tailored to a local market), or technology (the BTU and sulphur content of coal needs to be optimally adapted to a power plant's boiler and emissions equipment). Each party will find it costly to accommodate the other's approach, but if they don't agree on something, the market will be poorly served.

Under non-integration, managers make their decisions independently, and this may lead to low levels of output. Integration addresses this difficulty via a transfer of control rights over these decisions (e.g., through a sale of the assets) to a third party, called HQ; like the managers, HQ enjoys profit, but unlike them, he has no direct concern for the decisions since he is not involved in implementing them. Therefore, he maximizes the enterprise's output by enforcing a common standard.[3] But integration does not come for free, and generates two types of losses. First there are managerial costs coming from the compromise decisions that HQ imposes. Second, there are social costs in the form of reduced output: HQ may lack expertise in the tasks carried out by the suppliers (e.g., Hart and Moore 2005); there may be costs due to additional communication and delay (e.g., Radner 1993, Bolton and Dewatripont 1994) or managerial "shading" (Hart and Holmström 2008); or HQ may have its own moral hazard problems.

Whether to integrate is decided by managers when the firms form; this takes place in a competitive supplier market in which the two types of suppliers "match."[4] The firms' output is sold in a competitive product market, wherein all firms and consumers are price-takers.

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 very high prices, managers value output so much that under non-integration they are willing

[3]Other models that offer a related view of integration include Alchian and Demsetz (1972) and Mailath et al. (2004).

[4]The model is thus related to our earlier work on the external determinants of internal organization (Legros and Newman 1996, 2008), which shows how relative scarcities of different types of suppliers determine aspects of organizational design such as the level of monitoring or the allocation of control. Those papers do not consider the interaction of ownership structure with the product market.

to forgo their private interests in order to achieve coordination. Therefore integration only emerges for intermediate levels of price. In other words, there is an "inverted-U" relationship between product price and the degree of integration.

The industry supply curve will embody this relationship between the price and ownership structure, as well as the usual price-quantity relationship.[5]. Once it has been derived (Section **??**), 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.

In Section **??**, we investigate some of the sources of *changes* in ownership structure, such as shifting tastes or technological shocks, as well as the effects of policies such as excise taxes. Since product price is common to a whole industry, the price mechanism provides a natural impetus toward *widespread* restructuring, as in "waves" of mergers or divestitures. Organizational responses sometimes lead to unexpected effects in the market: for instance, entry by low-cost suppliers may generate a wave of integration that in turn *raise* product prices. Product price is also a key source of "external" influence on organizational design: technological shocks to some firms may lead, via price changes, to organizational restructuring in *other* firms. Finally, *coexistence* of different ownership structures, even among firms facing similar technology, is a frequent outcome of market equilibrium (we consider other sources in Section **??**).

The efficiency of equilibrium ownership structure can be assessed by simple consumer-producer surplus calculations. Managers' organizational choices frequently fail to maximize profit and consumer welfare, so one wonders whether the overall outcome is efficient taking into account managerial costs. Our benchmark result concerns a second-best notion of efficiency that respects all non-contractibilities: the competitive equilibrium is *second-best efficient, as long as managers fully internalize the effect of their decisions on the profit*, as in small or owner-managed firms. But as Section **??** shows, when there is separation of ownership and control, equilibria can be inefficient. Absent some mechanism to perfectly align the interests of shareholders and managers, both too much and too little integration are possible. The non-contractibilities that necessitate retention of managerial (or HQ) control over operational decisions imply that pecuniary instruments that shareholders might use, such as variable profit shares or free cash flow, or even direct imposition of the integration decision, are unlikely to remove the inefficiencies. Consumers need not get the goods they want at the lowest cost-covering price; this finding has implications for corporate governance policy that we discuss in the Conclusion.

[5]Our work therefore complements a literature initiated by Hart (1983) (see also Schmidt, 1997) that focuses on the interplay between competition in the product market and the power of incentive schemes within a given ownership structure

2 Model

In this section we present the basic model, where managers fully internalize the firm's revenue. The basic organizational building block is a continuous (in actions and profit shares) version of Hart and Holmström's (2008) model and illustrates a tradeoff between flexibility and coordination. The main aim is to derive an industry supply curve that summarizes the relationships among price, quantity and ownership structure.

2.1 Technology and Contracting Possibilities

There are two types of supplier, denoted A and B. To produce marketable output requires the coordinated input of one A and one B, and we call their union a firm. Examples of A and B might include game consoles and game software, upstream and downstream enterprises, or manufacturing and customer support. For each provider, a non-contractible decision is rendered indicating the way in which production is to be carried out. For instance software can be elegant or user friendly, or a product line and its associated marketing campaign can be mass- or niche-market oriented. Denote the decision in an A supplier by $a \in [0, 1]$, and a B decision by $b \in [0, 1]$.

It is important that decisions made in each part of the firm do not conflict, else there is loss of output. More precisely, the enterprise will succeed, in which case it generates $R > 1$ units of output, with a probability that is linear in $1 - (a - b)^2$; otherwise it fails, yielding 0.

Overseeing each provider is a risk-neutral manager, who bears a private 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 $y^A \geq 0$ and $y^B \geq 0$ are the respective realized incomes.[6] Managers do not have any means of making fixed side payments, that is, they enter the scene with zero cash endowments (we shall relax this assumption in Section **??**).

Decisions are not contractible, but the managers have two contractual instruments with which to resolve their interest conflicts. First, the firm's revenue is contractible, allowing for the provision of monetary incentives via sharing rules. Second, *the right to make decisions* can be contractually assigned. Here there are two options. Managers can remain *non-integrated*, in which case they retain control over their respective decisions. The success probability in this case is $(1 - (a - b)^2)/R < 1$, yielding expected output $(1 - (a - b)^2)$.

[6] Although we model the managers' disagreement as differences in preferences, we expect very similar results could be generated by a model in which they differ in "vision" as in van den Steen (2005).

Instead, managers could delegate control on their unit to another agent. Remember that regardless of who determines a and b, managers bear the cost, because they have to "live with the decision": their primary function is to implement them and to convince their workforces to agree.

One solution would be for one of the managers to transfer control on his unit to the other manager. This mmanager will subsequently perfectly coordinate the decisions in his preferred direction. It is straightforward to show (section **??**) that this form of integration is dominated by other ownership structures in this model.

Another solution is for both managers to relinquish control by engaging the service of a headquarters (HQ): by selling the assets to HQ, the managers empower him to decide both a and b.[7] This solution leads effectively to an "integration" of the two units.

HQ is motivated only by monetary concerns, incurring no direct cost from the decisions, which are borne by the managers of the two units.

2.2 Markets

There is a competitive *product market*. On the demand side, a large number of consumers are represented by the utility

$$v(q) + m,$$

where q is the good produced by our firms and m is a numeraire; $v(\cdot)$ has the usual properties: $v' > 0 \geq v''$. Consumers maximize this utility through a choice of q, taking the product price P as given. Their demand is given by the function $D(P)$. The quasi-linear formulation facilitates welfare analysis, but is otherwise not crucial. Firms also take the (correctly anticipated) price P as given when they sign contracts and make their production decisions.

Before production, B managers match with A managers in the *supplier market*, signing contracts $(s, \mathbf{I})$, that specify the ownership structure $\mathbf{I}$ and the share $s \in [0, 1]$ of managerial revenue accruing to the manager of A, with $1 - s$ accruing to the B (note that both receive zero in case of failure). The share s is endogenous: it is derived as part of the overall market equilibrium and reflects in particular the outside options of the managers.[8] Once matched, the managers are locked into the relationship until the production outcome is realized. In

[7] An alternative interpretation is that control is transferred without an explicit asset sale, for instance by giving the HQ the "key to the control room." See Hart and Holmström (2008) and references therein for a discussion of interpretations and contractibility issues.

[8] Because there are only two levels of output and managers have limited liability (they have no cash to make transfers when the firm fails to produce output), there is no loss of generality in assuming that the sharing rule takes this linear form.

this market, there is a continuum of both types of suppliers. The A's are on the long side of the market: their measure is $n > 1$, while the B's have unit measure. All unmatched A managers receive an outside option payoff $\underline{u}_A$ (the outside option of B-managers will play little role here and can be taken to be 0).[9]

Finally, in the *HQ market*, HQ's are supplied elastically with an opportunity cost normalized to zero; they have positive cash endowments and so can pay a fixed fees to the managers in exchange for positive shares η of the revenue.

2.3 Choice of Organization

2.3.1 Non-integration

Since each manager retains control of his activity, given a share s, A chooses $a \in [0,1]$, B chooses $b \in [0,1]$ as the (unique) Nash equilibrium of a game with payoffs

$$u_A^N = (1-(a-b)^2)sP - (1-a)^2$$
$$u_B^N = (1-(a-b)^2)(1-s)P - b^2.$$

These choices are:

$$a^N = 1 - s\frac{P}{1+P} \qquad\qquad b^N = (1-s)\frac{P}{1+P}. \tag{1}$$

The resulting expected output is

$$Q_N(P) = 1 - \frac{1}{(1+P)^2} \tag{2}$$

which is *independent* of s.

When $s = 0$, $a = 1$: the A manager makes no concession, and only the B bears a positive private cost. This will be typically the case when the outside option of the A manager is equal to zero. Hence as s is small, A is not willing to concede and most of the coordination is done by B; as s increases however, A starts conceding while B can reduce his cost. For a given value of s, as the price increases A and B are willing to concede more (a decreases and b increases).

For a given value of s, as the price increases A and B are willing to concede more (a decreases and b increases). Output is therefore increasing in the price P: a higher product price raises the relative importance of the revenue motive against private costs,

[9] In fact it is a simple matter to generalize the model to the case of positive and heterogeneous outside options all around; see Conconi et al. (2008) for an illustration.

and this pushes the managers to better coordinate. The fact that output generated under each ownership structure does not depend on how the managers split the firm's revenue considerably simplifies the analysis.

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

$$u_A^N(s,P) = Q_N(P)sP - s^2\left(\frac{P}{1+P}\right)^2 \tag{3}$$

$$u_B^N(s,P) = Q_N(P)(1-s)P - (1-s)^2\left(\frac{P}{1+P}\right)^2. \tag{4}$$

Varying s, one obtains the Pareto frontier for non-integration. It is straightforward to verify that it is strictly concave and that the total managerial payoff

$$W^N(s,P) = Q_N(P)P - (s^2 + (1-s)^2)\left(\frac{P}{1+P}\right)^2 \tag{5}$$

is maximized at $s = 1/2$ and minimized at $s = 0$ or $s = 1$.

Using $W^N(0,P) = P^2/(1+P)$, it is now readily shown that giving B full control will be dominated by non-integration. For under B control, $a = b = 0$ and even assuming no additional integration cost, the total surplus is $P - 1$ which is everywhere less than $W^N(0,P)$. For this reason, the only other organizational form of interest is when control is given to an outside HQ.

2.3.2 Integration

With integration, an HQ's interim payoff is $\eta(1-(a-b)^2)P$, and he therefore chooses $a = b$, yielding expected revenue P. Among all $a = b$ choices, the one that minimizes the total managerial cost $(1-a)^2 + b^2$ is $a = b = 1/2$, and we assume that HQ will choose these decisions (indeed, as the managers' payoffs are perfectly transferable by varying the share s, this choice is Pareto optimal among the firm's decision makers). The cost to each manager is then $\frac{1}{4}$, and since the acquisition fee that HQ pays just compensates for the share of revenue he takes, payoffs to the A and B managers are

$$u_A^I(s,P) = sP - \frac{1}{4}$$

$$u_B^I(s,P) = (1-s)P - \frac{1}{4}.$$

Total managerial welfare under integration is $W^I(P) = P - \frac{1}{2}$ and, as we have noted, is fully transferable.

2.3.3 Comparison of Ownership Structure

The overall Pareto frontier is the outer envelope of the integration and non-integration frontiers (for simplicity, we rule out contracts that permit randomization between ownership structures; little substantive would change if they were introduced). The relative positions of these frontiers depend on the price. Figure **??** depicts a situation in which neither integration nor non-integration dominates. Instead, the organization the managers choose depends on where they locate along the frontier, i.e., on the terms of trade on the supplier market: if the division of surplus is unfavorable to the A, so that he obtains $\underline{u}_A$, the firm integrates. If the A receives $\underline{u}'_A$, it remains non-integrated.

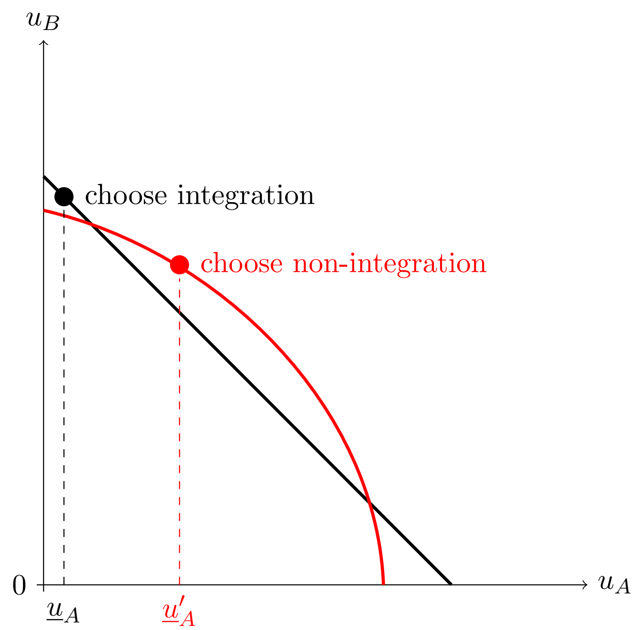


Figure 1: Frontiers and organizational choices

Total welfare under integration is equal to $P - 1/2$. The minimum of the total welfare under non-integration is achieved at $s = 0$ and is equal to $\frac{P^2}{1+P}$,[10] which is greater than the welfare under integration when the price is low, when $P \leq 1$.

By contrast, simple algebra shows that the maximum welfare under non-integration (achieved at $s = 1/2$ in (**??**)) is always greater than the welfare under integration.

Lemma 1. *Managerial welfare with integration*
(i) is smaller than the maximum welfare with non-integration for all prices.
(ii) is smaller than the minimum total welfare with non-integration if and only if $P \leq 1$.

[10] As $\underline{u}_A = 0$, $s = 0$ is optimal for the B manager and therefore (**??**) gives the expression in the text.

This lemma illustrates the natural tension between division of surplus within firms and welfare: for equal distribution of the surplus, non-integration will emerge while for unequal distribution – typically when the A are more numerous than the B and have small outside options – non-integration emerges only at low prices.

Indeed, when $s = 0$, the B managers will bear higher costs when P increases since he will concede more by (**??**). Integration has then the benefit of having A bear some of the cost and by convexity of the cost function this more equal burden in the cost compensates the fact that the A manager must now receive part of the output in order to meet his outside option.

As $\underline{u}_A$ is positive, the B manager needs to give a positive share of output to the A manager. Precisely, the share under non-integration solves[11]

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

While higher outside options increase the total surplus, since the share of A increases, the surplus of manager B decreases. Nevertheless, when comparing integration to non-integration, manager B will prefer non-integration for a larger set of prices when the outside option increases.

Proposition 1. *Suppose that manager B offers contracts that gives manager A his outside option $\underline{u}_A$. Then manager B prefers to use integration if and only if P is greater than a cutoff value $P^*(\underline{u}_A)$, which is strictly increasing in $\underline{u}_A$ and which satisfies $P^*(0) = 1$.*

2.4 Industry Equilibrium and the "Organizationally Augmented Supply"

Industry equilibrium comprises a general equilibrium of the supplier market and product markets. In the supplier market, an equilibrium consists of matches of A and B suppliers, along with a feasible surplus allocation among all the managers (i.e., a point on the frontier generated by the product price for an A-B pair, or the outside option payoffs for any unmatched managers). Such an allocation must be stable in the sense that no (A,B) pair can form an enterprise that generates payoffs to each manager that exceed their equilibrium levels. In the product market, the large number of firms implies that the industry supply is almost surely equal to its expected value of output given the product price; equilibrium requires that the price adjusts so that the demand equals the supply. Since each point of an (A,B) pair's frontier uniquely determines a contract $(s, \mathbf{I})$, the equilibrium automatically specifies the organizational choices of all firms as well.

[11]Simple algebra shows that $s = \frac{1}{2}[2 + P - \sqrt{(2+P)^2 - 4\underline{u}_A(1+P)^2}]$

Since A suppliers outnumber B suppliers, some of the A's will remain unmatched and receive their outside option $\underline{u}_A$. Those A's that do find a match will also receive $\underline{u}_A$, since otherwise they could be replaced by an unmatched A.

Assume that $\underline{u}_A = 0$. Then if the product price is such that frontiers are as depicted in Figure 1, integration would be chosen since it maximizes B's payoff given that A gets zero. At other product prices, the B-maximal payoff may be generated through non-integration. All B's receive the same equilibrium payoff, which is $P - \frac{1}{2}$ if they integrate, and $\frac{P^2}{1+P}$, if they do not, corresponding to the case $s = 0$ in (**??**). From Lemma **??**, integration will be chosen by managers in equilibrium only when $P \geq 1$.

If now $\underline{u}_A > 0$, the A managers will get this level in equilibrium and integration will be chosen (Proposition **??**) only if $P \geq P^*(\underline{u}_A)$. While the cost under integration is different when $\underline{u}_A$) varies, output is not since it depends only on the price.

Expected output supplied to the product market under integration, is always greater than under non-integration since perfect coordination is implemented.

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

$$\Sigma(P, \alpha) \equiv \alpha + (1 - \alpha) \left(1 - \left(\frac{1}{1 + P} \right)^2 \right). \tag{6}$$

When $P < P^*(\underline{u}_A)$, $\alpha = 0$ 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, as α increases total supply increases. When $\alpha = 1$ output is 1 and stays at this level for all $P \geq P^*(\underline{u}_A)$.

We write $S(P) \equiv \Sigma(P, \alpha(P))$ to represent the supply correspondence, where $\alpha(P)$ is described in the previous paragraph. The supply curve is represented in Figure **??**. The dotted curve corresponds to the industry supply when no firms are integrated.

3 Organizational Choice, Market Equilibrium and Welfare

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 **??**, 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

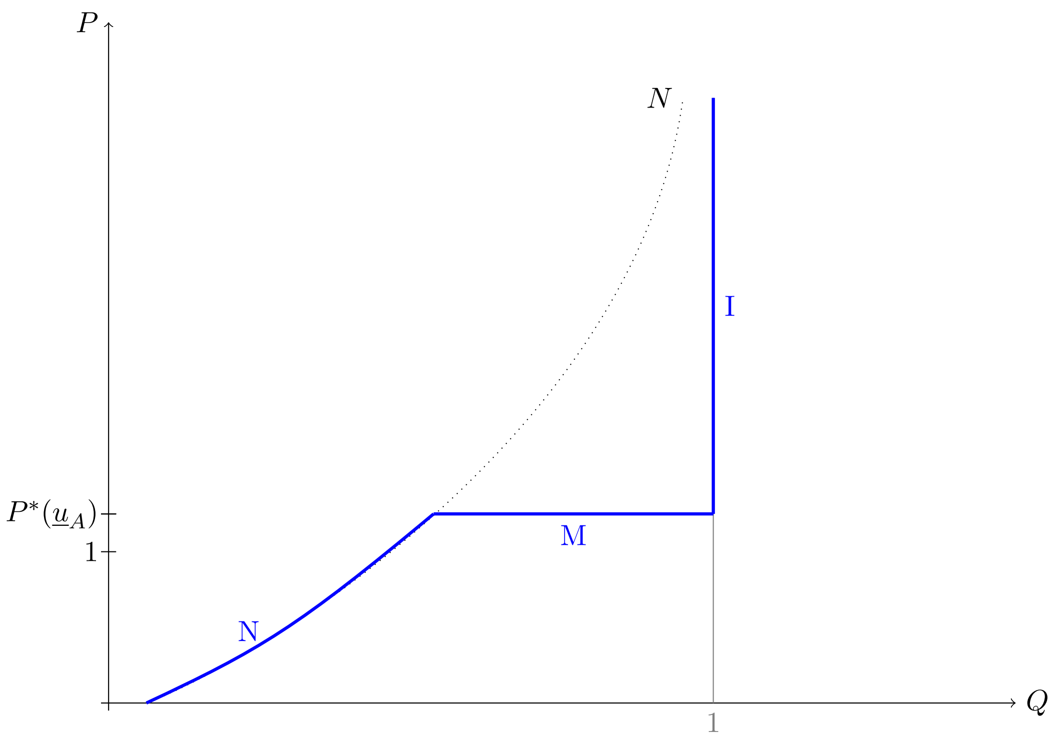


Figure 2: Organizationally augmented supply curve for $\underline{u}_A > 0$

do not (M), and a pure non-integration equilibrium (N). There is therefore in this version of the model a monotonic relationship between the price and integration.

In the mixed regions (M) we have coexistence of organizational forms within industries, something that is frequently observed. 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.

3.1 Second-Best Efficiency

Welfare analysis is straightforward if we are only interested in consumer welfare, i.e., the area under the demand curve: in this case, we say that the equilibrium organizational outcome is *consumer optimal* if a social planner could not raise consumer welfare by forcing (some) firms to switch their ownership structures (e.g., from integration to non-integration). Notice this criterion is weak in the sense that we do not empower the planner to set the managerial shares s, let alone the decisions a and b, for any firm.

Since consumer welfare increases with output, equilibrium is not consumer optimal whenever the total revenue P accruing to a firm's managers is less than 1, for output would increase if some firms were forced to integrate rather than remain non-integrated. There is some evidence that managers sometimes enjoy the "quiet life" at the expense of productivity-enhancing integration (Bertrand and Mullainathan 2003.)

Of course, this assessment of organizational choices does not take account of costs, particularly those of the managers. The remainder of our normative analysis will focus on a total welfare measure that comprises the payoffs of all of the firm's stakeholders (consumers and managers).

For simplicity, we assume that $\underline{u}_A = 0$. We compare the equilibrium welfare with that which would be generated if a social planner could impose the ownership structure on each firm and allowed the shares, production decisions, prices and quantities to be determined by market clearing. Equilibrium will be *second-best efficient* if welfare cannot be increased by forcing some firms to choose an ownership structure that differs from the one they choose in equilibrium. If the planner can if necessary make lump sum transfers from consumers to managers, then second-best inefficient equilibria in our sense are also Pareto inefficient. [12]

It is convenient to express the managerial cost as a function of the expected quantity

[12] A 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 $\underline{u}_A = 0$. However, this higher welfare would be generated at the expense of the B-managers in favor of the As, who would not be able to make lump-sum compensating transfers. Indeed, as is shown in Section **??**, if the As had the cash to make such transfers, they would choose $s = 1/2$ themselves.

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 and they bear no cost since $a = 1$. Suppose that manager B chooses decision b. Since $1 - (1-b)^2 = Q$ has a unique solution, we can write the managerial cost as a function of Q only:

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

For manager B, the solution to $\max_b \pi(1-(1-b)^2) - b^2$ is then the same as the solution to $\max_Q \pi Q - c(Q)$. It follows that along the graph $(\pi, Q_N(\pi))$, we have $\pi = c'(Q_N(\pi))$: when the manager faces revenue π, expected output equates π to the marginal managerial cost, which coincides with the supply function under non-integration. The managerial cost under integration is the shaded area in Figure **??**. To see this, note that at the revenue level $\underline{\pi}$, managers are indifferent between integration and non-integration: we have $Q_N(\underline{\pi})\underline{\pi} - c(Q_N(\underline{\pi})) = (1-\sigma)\underline{\pi} - 1/2$. Thus the integration cost of 1/2 is equal to the area delimited by $c'(Q)$, $\underline{\pi}$, $1-\sigma$, and the horizontal axis.

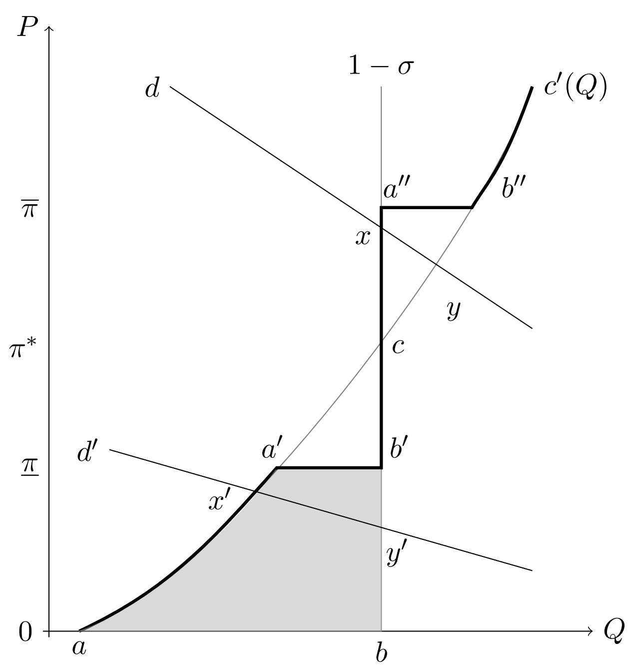


Figure 3: Second-best efficiency

Since equilibria with $P \in (\underline{\pi}, \pi^*)$ or $P > \overline{\pi})$ are consumer optimal, they are also second-best efficient. Thus it remains to ascertain the efficiency of equilibria when prices are in the other regions.

Consider first the case $P < \underline{\pi}$ and a typical demand function d'. Industry equilibrium is at x' and total welfare is the area $d' - x' - a$. If integration is "forced", equilibrium will be at point y': consumer surplus is larger but since the managerial costs are the same for all prices in this region, the total welfare is the area $d' - x' - a$ *minus* the area $x' - a' - b' - y'$. Hence the equilibrium is second-best efficient. It is simple to verify that this is true for any demand function for which the equilibrium is at $P < \underline{\pi}$. It is also clear that forcing integration of any measure of firms is welfare-reducing.

Consider now an equilibrium price $P \in (\pi^*, \overline{\pi})$, as in point x in the figure. Total welfare is the area $d - x - b' - a' - a$. If integration is prevented, the equilibrium would be at point y and non-integration will result. Contrary to the previous case, managerial cost is now larger with non-integration than with integration. Total welfare is the area $d - y - a$. The difference in total welfare between non-integration and integration is therefore the difference between the area $x - y - c$ and the area $a' - c - b'$. For elastic demand functions, a necessary and sufficient condition for the equilibrium to be second-best efficient with $P \in (\pi^*, \overline{\pi})$ is that the area $a'' - b'' - c$ is not larger than the area $a' - c - b'$. However we show now that these two areas are equal, and therefore that equilibria are second-best efficient.

Let G be the area $a'' - b'' - c$ and L the area $a' - c - b'$. We have

$$G = \int_{\pi^*}^{\overline{\pi}} [Q_N(P) - (1-\sigma)] dP$$
$$L = \int_{\underline{\pi}}^{\pi^*} [(1-\sigma) - Q_N(P)] dP$$

Hence,

$$G - L = \int_{\underline{\pi}}^{\overline{\pi}} Q_N(P) dP - (1-\sigma)(\overline{\pi} - \underline{\pi})$$

By definition of $\overline{\pi}, \underline{\pi}$, we have

$$Q_N(\overline{\pi})\overline{\pi} - C(Q_N(\overline{\pi})) = (1-\sigma)\overline{\pi} - \frac{1}{2}$$
$$Q_N(\underline{\pi})\underline{\pi} - C(Q_N(\underline{\pi})) = (1-\sigma)\underline{\pi} - \frac{1}{2}$$

Note that for any π, we have $C(Q_N(\pi)) = Q_N(\pi)\pi - \int_0^{\pi} Q_N(x)dx$. Operating this substitution in the two left hand sides of the previous equalities and subtracting the second inequality from the first we obtain

$$\int_{\underline{\pi}}^{\overline{\pi}} Q_N(\pi) d\pi = (1-\sigma)(\overline{\pi} - \underline{\pi})$$

proving that $G - L = 0$.

As we show in the Appendix, the efficiency result generalizes to case in which the A managers have positive outside options.

Proposition 2. *When managers have full claim to firm revenues, equilibria are second-best efficient: it is not possible to increase total welfare by forcing a change in ownership structure.*

While this proposition may comfort the conventional wisdom that competition in the product market induces firms to choose efficient organization, it is derived under the assumption that managers are full residual claimants to the firm's revenues, or more generally, where they fully internalize the consequence of their decisions on the firm's revenue. In most cases, this assumption appears to be a strong one. In the next section, we show it is also crucial.

4 Separation of Ownership and Control

For many firms, the managers have small pecuniary stakes, and this creates significant interest conflicts between them and the "shareholders" who have the remaining stakes. To reflect this situation, we assume now that for any price P, managers internalize only a fraction $\pi(P) = \gamma P$ of the firm's revenues. An obvious interpretation of γ is that it is a exogenous share of the firm's revenue. More broadly, it can be interpreted as an index of manager-shareholder consonance: this could stem from non-monetary means of aligning incentives (monitoring or regulation) or from behavioral considerations (professionalism or organizational identification) — in short, good governance.

As we shall see in this section, consumers as well as shareholders stand to gain from increases in γ, with second-best efficiency obtaining at $\gamma = 1$. But if alignment of interests can only be accomplished through revenue shares, which come at shareholders' expense, then , efficiency can no longer be guaranteed.

We will first revisit the efficiency of the industry equilibrium when γ is less than 1. Managers no longer equate their marginal cost to the total marginal revenue, and second-best inefficiencies emerge. We then consider the possibility that shareholders influence organizational design, either by setting compensation schemes for managers or by imposing the organization. We show that the second-best inefficiencies persist.

4.1 Second-Best Inefficiency

When γ is large, Proposition **??** suggests there should be little inefficiency. As γ falls, the managerial revenue γP falls, reducing non-integration output, and increasing the prices at which managers are indifferent between integration and non-integration. As a result, the industry supply shifts up, as shown in Figure **??**, where a supply curve with $\gamma < 1$ and one with $\gamma = 1$ are shown. If the social planner can choose γ, he can raise total welfare by setting $\gamma = 1$. Lump-sum transfers from consumers could in principle be used to compensate shareholders, who would likely lose from reduced prices. Equilibrium will often be inefficient (the exception is if demand intersects the two supply curves were they coincide, which can occur only in the integration range, and then only if γ is not too small).

It is perhaps of greater interest to adhere to the notion of efficiency employed in Section **??**, where the planner can impose the organizational design but not γ. In this case, equilibrium may still be inefficient. Recall from Section **??** that under non-integration, the managerial cost is equal to the area under the marginal cost curve, while under integration, it is equal to the area delimited by $c'(Q)$, $\underline{\pi}$, $1-\sigma$, and the horizontal axis, as illustrated by the light shaded area in Figure **??**.

The analysis is most transparent if one considers a family of *perfectly elastic* demand functions (the utility $v(\cdot)$ being linear), since this effectively reduces the number of stakeholder groups to two, namely shareholders and managers. Start with the demand that is perfectly elastic at $P = \underline{\pi}/\gamma$. Since managers receive $\underline{\pi}$, they are indifferent between integration and non-integration. On the other hand, since $Q_N(\underline{\pi}) < 1-\sigma$, shareholders would have larger incomes with integration than with any degree of non-integration, and any equilibrium in which some firms do not integrate is therefore inefficient. For demand below $\underline{\pi}/\gamma$, the unique equilibrium involves non-integration, and there are welfare gains from moving to integration; we have represented in Figure **??** the "organizational deadweight loss" (OWDL) resulting from inefficient ownership structures for such a level of demand.

Now consider a perfectly elastic demand at $\underline{\pi}$. In this case, the total welfare under integration and non-integration are equal when $\gamma = 1$. By revealed preference, when $\gamma = 1$, managers prefer $Q_N(\underline{\pi})$ to $Q_N(\gamma\underline{\pi})$. Hence, we have

$$(1-\sigma)\underline{\pi} - \frac{1}{2} = \underline{\pi} Q_N(\underline{\pi}) - C(Q_N(\underline{\pi})) > \underline{\pi} Q_N(\gamma\underline{\pi}) - C(Q_N(\gamma\underline{\pi}))$$

and when $\gamma < 1$, total welfare is strictly greater under integration at $P = \underline{\pi}$. Hence, the lower bound on prices for which non-integration dominates integration is strictly smaller than $\underline{\pi}$. Since as γ increases, the supply under non-integration increases, this lower bound is increasing in γ. (At $\gamma = 1$ the lower bound is equal to the upper bound and non-integration is second-best efficient.)

With perfectly elastic demands, the region of second-best inefficient organizational choices therefore corresponds to an interval of price $(P^N(\gamma), \underline{\pi}/\gamma)$, where $P^N(\gamma)$ is increasing in γ and is bounded above by $\underline{\pi}$.

If demand is not perfectly elastic and if all firms are forced to integrate, the price may fall enough to reduce welfare relative to the non-integration equilibrium. However, forcing only a few firms to integrate can ensure that there is a welfare gain. As demand elasticity decreases, the deadweight loss from inefficient non-integration decreases.

Hence, demand elasticity plays a role here that is nearly *opposite* to that which it plays in the theory of monopoly, where it is well known that the deadweight loss is decreasing in the demand elasticity. Here, the organizational deadweight loss is *increasing* in the elasticity. *This suggests that the less we worry about market power, the more we may have to worry about organizational inefficiency.* Insofar as non-integration here corresponds to a "quiet life" for managers, this finding is reminiscent of Leibenstein's (1966) claims about the relative importance of "X-inefficiency" and monopoly distortions.

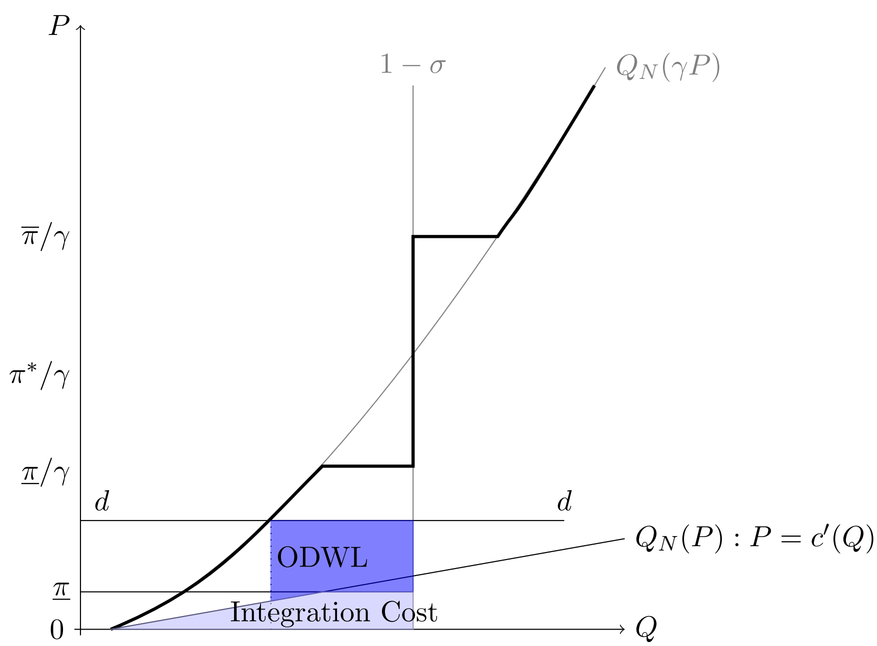


Figure 4: Second-best inefficiency with $\gamma < 1$

A similar argument shows that $\overline{\pi}/\gamma$ is the upper bound of equilibrium prices at which inefficient *integration* obtains. The lower bound is strictly greater than π^*/γ: at this price, shareholders (and consumers) are indifferent between the two forms of organization, while managers strictly prefer integration. We can also show that the lower bound is strictly greater than $\overline{\pi}$. Indeed, the total surplus of shareholders and managers would be equal under the two forms of organization if $\gamma = 1$; however since $\gamma < 1$, non-integration brings less surplus to the firm and integration dominates at this price.

We summarize this discussion in the following proposition. The proof for general demand functions is in the Appendix.

Proposition 3. *Suppose that managers internalize only a fraction $\gamma < 1$ of the firm's revenue and that the planner can only impose the organizational design but cannot change γ. There exist increasing functions $P^N(\gamma)$, $P^I(\gamma)$, with $P^N(\gamma) \leq \underline{\pi}$ and $P^I(\gamma) \geq \max\{\overline{\pi}, \pi^*/\gamma\}$ such that if P is the equilibrium price corresponding to a demand function D.*

(i) There is inefficient non-integration if and only if $P \in (P^N(\gamma), \underline{\pi}/\gamma)$.

(ii) There is inefficient integration if and only if $P \in (P^I(\gamma), \overline{\pi}/\gamma)$.

Note that the possibility of too little integration may arise even if, contrary to our assumption, $\sigma > \bar{\sigma}$, in which case managers would never choose integration. For even if the HQs are relatively inefficient, the performance of non-integration for low γ is sufficiently poor that consumers and shareholders may benefit from imposed integration.

5 Comparative Statics

The fact that all firms face the same price means that anything that affects that price – a demand shift or foreign competition, for instance – can lead to widespread and simultaneous reorganization, as in a merger or divestiture wave. Here we perform textbook-style demand and supply analysis to study these phenomena. In the next subsection, we evaluate the efficiency of equilibria.

Falling Costs May Raise Prices: Terms of Trade in the Supplier Market As we pointed out in Section **??**, a feature of this model is that surplus division between managers has no effect on the output generated by each ownership structure. But it does affect the choice between them. This implies that another channel of coordinated reorganization is the supplier market: changes in the relative scarcities of the two sides or to outside opportunities on one side, say from foreign competition, will change the way surplus is divided between managers, and this too will lead to reorganization.[13] In some cases, the effects on product market outcomes may be surprising.

[13]See Legros and Newman (2008) for a detailed analysis of this mechanism.

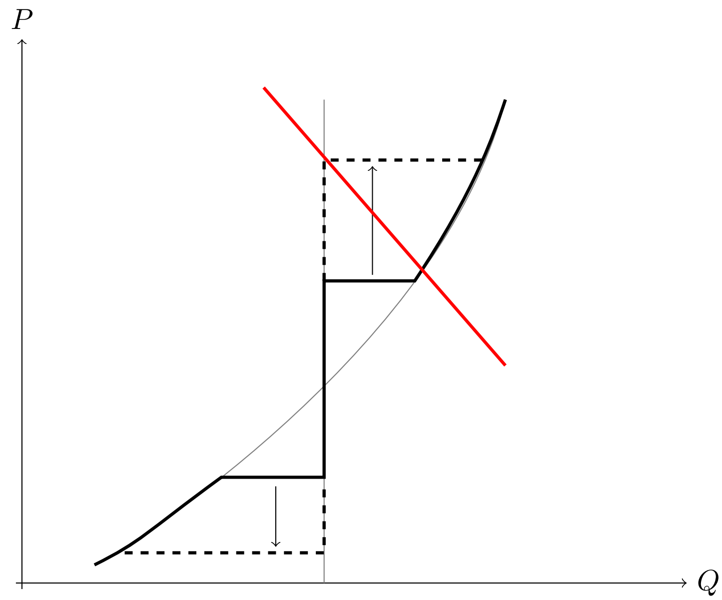


Figure 5: Entry of lower cost suppliers ($\underline{u}'_A < \underline{u}_A$) leads to a price increase

Suppose that $\underline{u}_A > 0$; we want to compare the contracting choice to the case in which the A's have opportunity cost $\underline{u}'_A < \underline{u}_A$.[14]

As is apparent from Figure **??**, for levels of $\underline{u}_A$ that are sufficiently high, non-integration will be chosen. As A's opportunity cost decreases, it becomes feasible (and optimal) for the B to integrate with A. Hence, if at price P integration is optimal at cost $\underline{u}_A$, it will be also be optimal for any $\underline{u}'_A < \underline{u}_A$; because the preference is strict at $\underline{u}'_A$ when there is indifference at $\underline{u}_A$, there are more prices for which integration is preferred under $\underline{u}'_A$. Thus, *reduced opportunity costs are a force toward integration.* This is represented in Figure **??**.

Of particular interest when low-cost suppliers take over the market is whether the resulting cost savings are passed on to consumers in the form of lower prices. As shown in the figure, this need not be the case: if prices are initially moderately high, the reorganization used to accommodate the changing terms of trade in the supplier market (i.e., a move toward integration) leads to a *reduction* in output and an *increase* in prices. When demand is low, though, entry of low-cost A's yields the the usual comparative static of lower prices and higher quantities.

Heterogeneous Supply Shocks and External Effects The examples above share a common theme: the organization of a particular firm depends not only on its own tech-

[14]We focus on situations where $\underline{u}_A$ is 'small' in the sense that for the range of prices under consideration, it is less than half the maximum surplus under non-integration.

nology and managers' preferences but also on prices determined outside it. In particular, technological shocks that directly affect some firms may induce reorganizations to *other firms* as well as to themselves; indeed in some cases, as we now illustrate, they may do so without reorganizing themselves.

To see this, consider a positive technological shock (e.g., a product or process innovation) that raises the success output in joint production to $R' = \lambda R$ for a fraction ϕ of the B-suppliers. For these affected firms, expected output is now equal to $Q_N(\lambda\pi)\lambda$ under non-integration and to $(1-\sigma)\lambda$ under integration. Moreover, integration occurs for these firms if the new equilibrium price is in $(\underline{\pi}/\lambda, \overline{\pi}/\lambda)$. For the unaffected firms, the supply correspondence is unchanged.

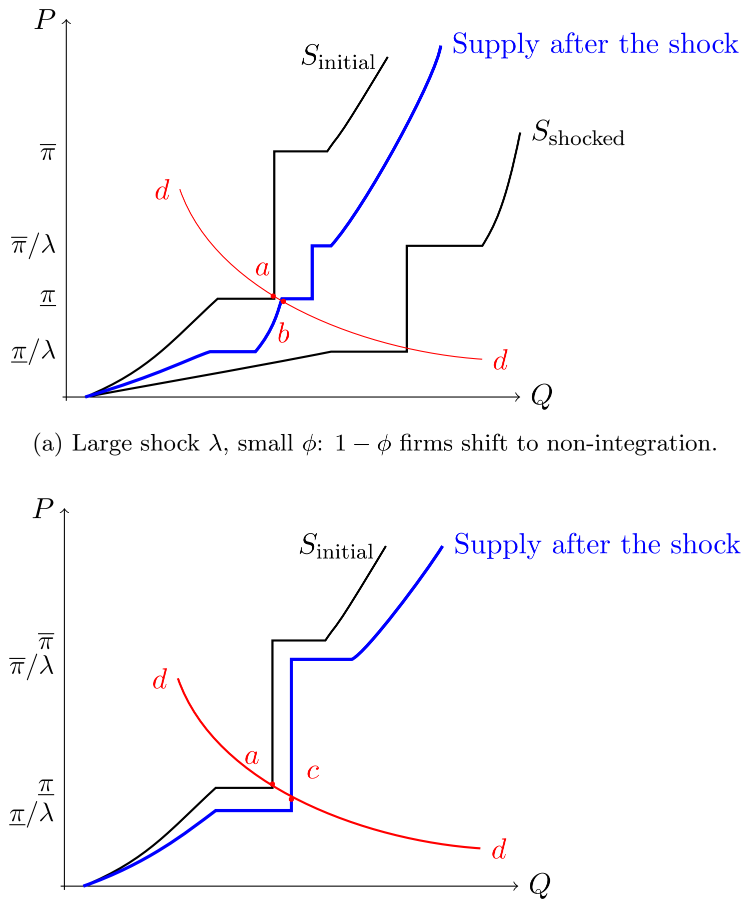
The industry supply is a convex combination of the supplies for the affected and unaffected firms. For instance, if $P \in (\underline{\pi}/\lambda, \underline{\pi})$, total supply is $\phi(1-\sigma)\lambda + (1-\phi)Q_N(P)$, while for $P \in (\overline{\pi}/\lambda, \overline{\pi})$, it is $\phi Q_N(\lambda P) + (1-\phi)(1-\sigma)$.

We have represented the supply after the shock in Figure **??**(a) for a case in which ϕ is small but λ is large. For the demand function dd, initially the industry equilibrium is at point a and all firms are integrated. Following the shock, the new equilibrium is at point b: since the equilibrium price is between $\underline{\pi}/\lambda$ and $\underline{\pi}$, the high-productivity firms remain integrated but the low-productivity firms switch to non-integration: only the *unaffected* firms reorganize. Notice that in this example, because those firms become less productive due to their reorganization, industry output hardly increases.

Clearly, other outcomes are possible. For instance, as illustrated in Figure **??**(b), if *all* the firms experience a small shock (say with $\hat{\lambda} = 1+\phi(\lambda-1)$), then no firm need reorganize and industry output increases by a factor of $\hat{\lambda}$ – point c in the diagram (in the previous case, had it not been for reorganization, industry output would have increased by the same amount). Thus the impetus for a reorganization need not come from the firm itself, and the way shocks are distributed in the market may have a significant impact not only on organizational outcomes but also on prices and quantities.

5.1 Active Shareholders

In our competitive world, shareholders have nearly the same interests as consumers: they value output enhancing organizations. In particular, both shareholders and consumers would benefit if γ – the index of consonance between shareholders and managers – increases. However, in most firms, increasing consonance is often costly for shareholders. For instance, providing larger shares of profits to managers in order to induce them to better coordinate their decisions comes at the expense of lower dividends. Hence it is not clear that shareholders *will want* to provide the best incentives to managers, even if they



(a) Large shock λ, small ϕ: $1-\phi$ firms shift to non-integration.

(b) Small shock $\hat{\lambda}$, $\phi = 1$: no reorganization

Figure 6: Concentrated Large vs Diffused Small Shocks

are given considerable leeway to do so.

We assume below that shareholders can simultaneously choose the ownership structure and compensation contingently on the price. Despite this extreme form of control that they exert within the firm, we will show that outcomes can be inefficient because managers still have control over the production decisions a and b under non-integration. Moreover, the industry supply curve will be qualitatively similar to that we have already described: integration is used for intermediate price levels and non-integration for low and high prices.

Providing good incentives is costly under non-integration, since it entails giving up a share of profit to management, and that cost is fairly sensitive to P. By contrast, integration has the benefit of providing full coordination, while its cost will be independent of the price. Hence, if shareholders can impose integration and also design compensation schemes, two types of inefficiencies are likely to emerge. First, non-integration will underperform relative to the social optimum. Second, the choice between integration and (distorted) non-integration will itself fail to be optimal.

Suppose that both $\underline{u}_A$ and $\underline{u}_B$ are zero. We suppose that the shareholders do not control s, which can still be determined by supplier market clearing (even if they could, it would make little difference to the analysis below). Since shareholders can choose the organization as a function of the price, they can dissociate the choice of compensation from the organization choice.

With integration, shareholders have to cover the managerial cost of 1/2 and their total profit is

$$V_I(P) = (1-\sigma)P - 1/2, \tag{7}$$

The best payoff under non-integration is given by the function $V_N(P)$,

$$V_N(P) = \max_{\pi \geq 0} \left(1 - \frac{1}{(1+\pi)^2}\right)(P - \pi). \tag{8}$$

Lemma 2. *The solution $\pi^N(P)$ to (**??**) is a strictly increasing function of P. The value $V_N(P)$ is strictly increasing and strictly convex.*

Proof. The objective is strictly concave in π and strictly supermodular in (π, P), so that the (unique) optimum $\pi^N(P)$ is increasing in P. Strict convexity of $V_N(P)$ follows from the fact that $V_N'(P) = Q_N(\pi(P))$ by the envelope theorem. □

Since the value of integration is linear in P and negative at $P = 0$, there are at most two prices at which the two value functions are equal; shareholders prefer integration at prices between these two bounds. By Lemma **??**, $Q_N(\pi_N(P))$ is increasing, and there are unique values of prices $\underline{P}, P^*$, and $\overline{P}$ such that $\underline{\pi} = \pi_N(\underline{P})$, $\pi^* = \pi_N(P^*)$, and $\overline{\pi} = \pi_N(\overline{P})$.

Proposition 4. *Suppose that shareholders can impose the organization and the compensation. Integration is chosen if, and only if, $P \in [P_0, P_1]$, where $P_0 < \underline{P}$ and $P_1 > P^*$.*

Thus, the qualitative features of the OAS, along with the comparative static results of Section **??** are largely preserved with active shareholders. Moreover, from Proposition **??**, the market outcome is always inefficient since shareholders would never choose to give full share to the managers. However, this benchmark implicitly assumes that the social planner could set $\gamma = 1$, which would benefit the managers at shareholder expense if γ is given the pecuniary interpretation we have employed in this subsection; unless managers are wealthy enough to buy the firm outright from the shareholders (in which case they would), it is difficult to see how they could make compensating lump-sum transfers.

If we use a weaker concept of efficiency corresponding to the one used in Section **??**, and allow the planner to change only the ownership structure, the market outcomes can still be second-best inefficient. At price P_0, shareholders are indifferent between integration and non-integration, while for managers their cost is less than their revenues. Denote by $\pi_0 = \pi_N(P_0)$ the managers' share under non-integration at price P_0. We have,

$$(1-\sigma)P_0 - \frac{1}{2} = Q_N(\pi_0)(P_0 - \pi_0)$$
$$\pi_0 Q_N(\pi_0) > C(Q_N(\pi_0)).$$

Substituting the cost for the managerial revenue in the first line, we have $(1-\sigma)P_0 - \frac{1}{2} < P_0 Q_N(\pi_0) - C(Q_N(\pi_0))$, proving that total *firm* (shareholder+manager) surplus is strictly larger with non-integration. If demand is perfectly elastic, this implies that giving shareholders full control of organizational decisions will lead to inefficient integration. This is reminiscent of "too much monitoring" results (Legros-Newman, 1996; De Meza-Southey, 1999): integration is chosen to avoid paying the managers rents.

On the other hand, if demand is less elastic, then in general the shareholders do not capture the full social surplus, even if they capture the full firm surplus; in this case, at low prices they may underutilize integration just as managers might (in other words, $P_0 > \underline{\pi}$). Finally, at higher prices, too much integration is the likely outcome, just as it was with an exogenous $\gamma < 1$.

This discussion shows that even if shareholders have substantial control over organizational decisions, managers may yet enjoy the quiet life (at low prices and inelastic demand). In other cases, however, they won't enjoy it often enough.

6 Extensions: Heterogeneity and Coexistence of Organizational Forms

In Section **??** we noted that there are two equilibrium prices at which there is coexistence of integrated and non-integrated firms, even though all are identical in preferences and technology. This "endogenous" organizational variation is a consequence of the discreteness of ownership structure and market clearing. Coexistence of ownership structures can also arise from various types of fundamental heterogeneity across firms – we saw on example with the technology shocks in Section **??**. Here we discuss two other sources of organizational variation. First we consider the consequences of letting the HQs differ in their efficiency loss σ. Second, we relax the assumption that managers have no cash and allow their holdings ℓ to vary across individuals. For continuous distributions of σ or ℓ, the OAS becomes a strictly increasing function, and at a generic set of prices, non-integrated and integrated firms coexist.

6.1 Heterogeneous HQs

Suppose that the HQ's are heterogeneous in their output loss σ. This construction will yield a strictly increasing supply function. To simplify the exposition, suppose that managers fully internalize the revenue of the firm ($\gamma = 1$), and let the outside options of all As and HQs be zero. Suppose that σ has a continuous distribution H with density h supported on $[0, \overline{\sigma}]$, with $H(\overline{\sigma}) < 1$.

Recall that given a product price P, the total surplus generated by a non-integrated firm is $\frac{P^2}{1+P}$, and this accrues to the B since $s = 0$. The firm will be indifferent between integrating with a type-σ HQ and not integrating when

$$\frac{P^2}{1+P} = P(1-\sigma) - \frac{1}{2}$$

or

$$\sigma(P) \equiv \frac{P-1}{2P(P+1)}.$$

At P, all firms strictly prefer to integrate with an HQ having $\sigma < \sigma(P)$ than to remain non-integrated. Suppose that firms that integrate pay transfers $t_\sigma(P)$ to the HQ of type σ (this might be incorporated into the share η). Equilibrium in the HQ market requires that

$$P(1-\sigma) - \frac{1}{2} - t_\sigma(P) = \frac{P^2}{1+P};$$

clearly, $t_\sigma(P)$ is decreasing in σ and by definition, for the marginal HQ, $t_{\sigma(P)}(P) = 0$. Thus the most productive HQs are used first and earn rents.

For prices below 1, all firms are integrated ($\sigma(P) < 0$ in this case). As P increases, $H(\sigma(P))$ of the firms integrate, using the most productive HQs. Since $\sigma(P)$ is first increasing and then decreasing, the degree of integration will also increase and then decrease as a function of P, reaching a maximum of $H(\overline{\sigma})$ at $P_\sigma = 1 + \sqrt{2}$. The industry supply is

$$[1 - H(\sigma(P))]Q_N(P) + \int_0^{\sigma(P)} (1-\sigma)h(\sigma)d\sigma,$$

which is strictly increasing. [15]

[15] Direct computation gives $[1 - H(\sigma(P))]Q'_N(P) + \sigma'(P)h(\sigma(P))[(1-\sigma(P)) - Q_N(P)]$ for the variation

Thus, we have coexistence of integration and non-integration for a generic set of prices; in fact there is always a positive measure of integrated firms for any price exceeding 1, as integration with a type-0 HQ is more efficient than non-integration at any such price. However, the overall degree of integration in the industry does become vanishingly small as P becomes large.

Since we have assumed $\gamma = 1$, this outcome will be efficient; similarly positive results could be obtained with $\gamma < 1$, but the organizational choice would then not generally be efficient.

6.2 Free Cash Flow

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), this is no longer true with non-integration. This explains why the organizational choice will not necessarily maximize the total managerial welfare.

If the A manager have 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. Indeed, 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.

Cash holdings will make transactions between firms more efficient *for the managers*. However there is no reason to expect that this will also benefit consumers or shareholders. For instance, when cash holdings are sufficiently large, non-integration is always chosen since it is welfare maximizing for the managers; but this implies that the region of inefficient non-integration expands.[16]

In general, if managers internalize only a fraction $\gamma < 1$ of the firm's revenue, cash transfers can lead to a change in organization only when integration is not dominated by non-integration, that is when $P \in (\underline{\pi}/\gamma, \overline{\pi}/\gamma)$. For each price in this range, there exists a

in supply; a simple envelope argument shows that $\sigma'(P) = [(1 - \sigma(P)) - Q_N(P)]/P$, and the result follows.

[16] Jensen (1986) argued that "free cash flow" can lead managers to choose projects with a low rate of return, and in particular may lead to firm growth beyond the "optimal" size, i.e., excessive integration. Our analysis points out the possibility of a distortion in the opposite direction, namely that managers will use their cash to *avoid* integration, possibly leading to firm size that is below the optimum. Legros and Newman (1996) and (2008) discuss the role of cash in equilibrium models of organizations.

sharing rule $s_0(P)$ for which

$$W^N(s_0(P), \gamma P) = W^I(\gamma P).$$

Then, manager B is indifferent between using integration and using non-integration where A gets a share $s_0(P)$ and makes an ex ante transfer of

$$L(P) = u_A^N(s_0(P), \gamma P).$$

If cash ℓ is distributed among the A managers according to the continuous distribution $F(\ell)$, the measure of firms that choose non-integration is the measure of A managers with cash holdings greater than $L(P)$, that is $n - F(L(P))$, which is continuous in P (because the As must give the preponderance of surplus to the Bs, and not the other way round, the B managers' cash holdings play little role). Because the output with integration is equal to that with non-integration when $P = \pi^*/\gamma$ we conclude that the supply curve "rotates" at π^*/γ, as illustrated in Figure **??**.

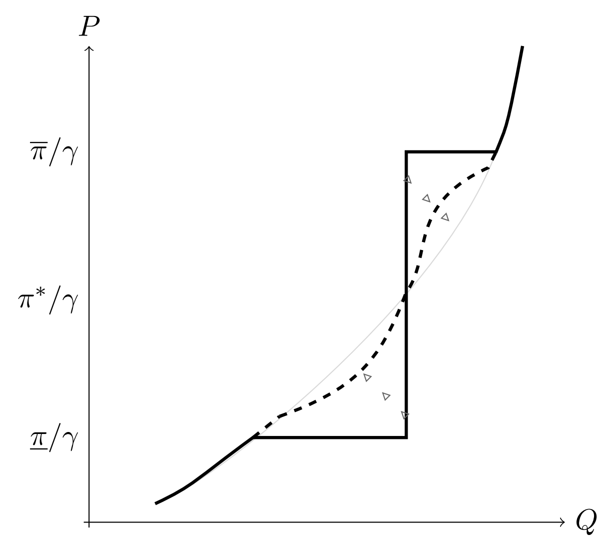


Figure 7: The effect of cash on industry supply

Going back to the characterization of the conflict between managers and the other stakeholders we note two opposite effects of cash. First, inefficient integration occurs less frequently in the region $P \in (\pi^*/\gamma, \overline{\pi}/\gamma)$ and therefore output is larger and prices lower. Second, there will be some non-integration in the price region $(\underline{\pi}/\gamma, \pi^*/\gamma)$; since integration is output maximizing in this region, inefficiencies increase from the point of view of consumers and shareholders. This result is squarely in the second-best tradition: giving the managers an instrument of allocation that is more efficient for them may induce them to minimize *their costs* of transacting, but this may exacerbate the inefficiency of the equilibrium contract. This role of cash appears to be new to the literature.

7 Conclusion

Many models of organization have at their core a managerial trade-off between pecuniary benefits derived from firm revenue and private costs of implementing production decisions. Our model is no exception, and in it two key variables affect the terms of this trade-off: product prices, over which managers have no control, and the choice whether to integrate, over which they do. In particular, non-integration performs well from the managerial point of view under both high and low prices, while integration is chosen at middling prices. At the same time, ownership structure affects production. When managers are full residual claimants on the firm's profits, their choice whether to integrate coincides with social surplus-maximizing one. This is no longer true when they must share revenues with shareholders, absent some other mechanism to keep interests aligned.

This raises the issue of what policy remedies might be indicated to improve consumer welfare. It is likely that these policies may be unconventional. For instance, in the case of inefficient integration (where welfare would be higher under non-integration), standard merger policy implemented by an antitrust authority that blocks a potentially harmful merger may be effective in increasing output and lowering market prices. But the policy is surely unconventional, in the sense that it does nothing to enhance competition, which by assumption is perfect both before and after a proposed merger – thus it is unlikely that the antitrust authority would be called upon to act. In the range of prices in which managers inefficiently opt not to integrate, conventional merger policy is rather ineffective – there is no merger to prevent.

In our competitive world, shareholder and consumer interests are (nearly) aligned since they both would value higher levels of output. Aligning them with managers interests, say through effective corporate governance, is important at *low* prices (and profitability levels) in this model, when there is inefficiently little integration, as well as at medium-high ones, where there is inefficient integration. This contrasts with much literature on corporate governance, which emphasizes high profit regimes as most conducive to managerial cheating. Presumably, this is because high profit regimes are most conducive to "profit taking," diversion of revenues to private managerial benefits or investments in pet projects. Our analysis underscores that governance also matters for "profit making": proper organizational design affects managers' production decisions, and is particularly important when low profitability provides weak incentives for them to invest in a profit or output maximizing way.

The question remains how best to accomplish this alignment of consumer, shareholder and managerial interests. Second best efficiency requires that the managers act as if they had full residual share of the output. Short of making managers the sole shareholders of the firm, non pecuniary instruments like monitoring or auditing, or "behavioral" ones such as managerial professionalism or organizational identification may achieve this goal.

Of course, these instruments do not come for free, and the corporate governance literature provides plenty of evidence to suggest that these instruments will be often inefficiently employed. As Section **??** underscores, the form of shareholder empowerment that strong corporate governance achieves is important: if the alignment of interests is done through monetary schemes, or even if shareholders can choose the ownership structure, inefficiencies are likely to persist. By the same token, facilitating takeovers may not achieve efficiency either, as it appears little can be accomplished through takeovers that cannot be imposed by the empowered shareholders we have analyzed.

We mentioned that taxes on consumers products may affect the organizational choice, albeit in a welfare-reducing way. In a standard supply-demand model, production *subsidies* will also be distortionary. In our model when there is separation of ownership and control, though, they may be beneficial: since supply lies above the marginal cost curve, subsidies not only enhance the output of non-integrated firms, they also lower the prices at which shifts to more efficient ownership structures occur. The relative merits of subsidies and other policies remains to be investigated.

Though the effects we have identified can occur absent market power, this is not to say that market power is irrelevant to the effects of – or its effects on – major organizational decisions. When firms have market power, incentives to integrate may be also linked to efficiency enhancements, such as the desire to eliminate double markups. However firms may also recognize that by reducing output they will raise prices, and some of the effects we describe happen all the more strongly.

Moreover, the impact of "effective" corporate governance may be quite different in this case. In a noncompetitive world, shareholders and consumers interests are no longer aligned, and as we have already noted, managerial discretion may be a way for shareholders to commit to low output and therefore high profits. The relative effects of corporate governance regulation and competition policy may therefore depend non trivially on the intensity of product market competition. These points warrant further investigation.

8 Appendix

8.1 Proof of Lemma ??

(i) Managerial welfare under integration is smaller than the minimum managerial welfare under non-integration when

$$(1-\sigma)P - \frac{1}{4} < \left(1 - \frac{1}{(1+P)^2}\right)P - \left(\frac{P}{1+P}\right)^2,$$
$$\iff \sigma > \frac{P-1}{2P(1+P)}$$
$$\iff 2\sigma P^2 + (2\sigma - 1)P + 1 > 0,$$

which holds whenever P is outside the interval $[\underline{\pi}, \overline{\pi}]$, where $\underline{\pi}$ and $\overline{\pi}$ are the two solutions of the equation $\sigma = \frac{P-1}{2P(1+P)}$.
(ii) Managerial welfare under integration is always smaller than the maximum non-integration welfare. From (**??**), maximum welfare under non-integration is obtained at $s = 1/2$, and welfare with integration is smaller than this maximum welfare when

$$(1-\sigma)P - \frac{1}{2} < \left(1 - \frac{1}{(1+P)^2}\right)P - \frac{1}{2}\left(\frac{P}{1+P}\right)^2$$

which simplifies to

$$\sigma > -\frac{2+P}{2(1+P)^2} - \frac{1}{2P},$$

which is true for all nonnegative σ since the right hand side is negative for all values of P.

8.2 Proof of Proposition ??

We generalize the argument in the text to the case with a positive outside option for A; assume to simplify that $\underline{u}_B = 0$. Suppose that A has outside option $\underline{u}_A > 0$. Under non-integration,

$$Q_N(P) = 1 - \frac{1}{(1+P)^2} \tag{9}$$

is independent of s. In the optimal contract under non-integration, the participation constraint of A binds and

$$\underline{u}_A = Q_N(P)sP - s^2\frac{P^2}{(1+P)^2}.$$

There is an $s \in [0,1]$ solving this only if $\underline{u}_A < P^2/(1+P)$. Hence for small values of P, non-integration cannot generate enough surplus to cover the outside option of A. In this case, if integration can cover $\underline{u}_A$, then it is second-best efficient; if integration cannot either, then the market shuts down, which is also efficient

For larger values of P, B chooses the root that maximizes B's payoff, denoted $s(P, \underline{u}_A)$, which is continuously decreasing in P, which implies that B's payoff is increasing in P. Total cost of producing $Q_N(P)$ is then $(s(P,\underline{u}_A)^2 + (1 - s(P,\underline{u}_A))^2)\frac{P^2}{(1+P)^2}$.

From (**??**),

$$P = \sqrt{\frac{1}{1-Q}} - 1. \tag{10}$$

Define $\psi(Q) = s\left(\sqrt{\frac{1}{1-Q}} - 1, \underline{u}_A\right)$. Total cost can then be written using (**??**)

$$\hat{C}(Q) = (\psi(Q)^2 + (1 - \psi(Q)^2))(1 - \sqrt{1-Q})^2 \tag{11}$$

Manager B's payoff under non-integration can then be written as $QP - \hat{C}(Q) - \underline{u}_A$ while his payoff under integration is $(1-\sigma)P - 1/2 - \underline{u}_A$.

If demand is perfectly elastic, then the total welfare under each ownership structure is simply B's payoff less $\underline{u}_A$. Thus nothing can be gained by forcing a different ownership structure, since that lowers payoff by revealed preference. If demand is not perfectly elastic, the only cases worthy of consideration are when the quantity would be larger if the managers used another form of organization.

We denote the consumer surplus at price is P by $\omega(P)$. Let P', where $P' < P$, be the new equilibrium price when the other organization is imposed.

Case 1: Non-integration is used at P but $1 - \sigma > Q_N(P)$. Let $P' < P$ be the equilibrium price when moving from non-integration to integration. Consider the three allocations $(Q_N(P), P)$, $(1-\sigma, P)$, and $(1-\sigma, P')$. The first is the equilibrium outcome, the third is the result of forcing integration.

We note first that the increase in consumer surplus when moving from laissez-faire to integration is bounded above by the change in firm's revenue under integration when the price decreases from P to P':

$$\begin{aligned} \omega(P') - \omega(P) &< Q_N(P)(P - P') + (1 - \sigma - Q_N(P))(P - P') \\ &= (1-\sigma)(P - P') \end{aligned} \tag{12}$$

Total welfare under laissez-faire is

$$W_N = \omega(P) + Q_N(P)P - \hat{C}(Q_N(P))$$

while if integration is imposed, it is

$$W_I = \omega(P') + (1-\sigma)P' - 1/2$$

Hence, using (**??**)

$$\begin{aligned} W_I - W_N &= \omega(P') - \omega(P) + (1-\sigma)P' - \frac{1}{2} - Q_N(P)P + \hat{C}(Q_N(P)) \\ &< (1-\sigma)P - \frac{1}{2} - \Big(Q_N(P)P - \hat{C}(Q_N(P))\Big) \leq 0, \end{aligned}$$

where the last inequality is due to assumption that managers prefer non-integration to integration at price P.

Case 2: Integration is used at P but $1-\sigma < Q_N(P)$. This case is only slightly more difficult. Suppose the planner imposes non-integration, yielding an equilibrium price $P' < P$. Now we have

$$\hat{C}(Q_N(P)) - \frac{1}{2} > (Q_N(P) - (1-\sigma))P > 0. \tag{13}$$

As with the previous case, the consmuer surplus gain is bounded:

$$\omega(P') - \omega(P) < Q_N(P')(P - P')$$

Hence,

$$\begin{aligned} W_N - W_I &= \omega(P') - \omega(P) + Q_N(P')P' - \hat{C}(Q_N(P')) - (1-\sigma)P + 1/2 \\ &< Q_N(P')P - \hat{C}(Q_N(P')) - ((1-\sigma)P - 1/2) \end{aligned}$$

We show in the following lemma that $Q_N(P')P - \hat{C}(Q_N(P')) < Q_N(P)P - \hat{C}(Q_N(P))$, which concludes the proof since (**??**) then implies that total welfare is larger under integration.

Lemma 3. $Q_N(P')P - \hat{C}(Q_N(P')) \leq Q_N(P)P - \hat{C}(Q_N(P))$

Proof. The allocation $(Q_N(P'), P)$ can be generated by a non-integration contract in which B agrees to a *smaller* than $1-s$ share of the profit, with the remainder accruing to a third party who takes no action. (Indeed it cannot be generated without such a contract: from the discussion in Section **??**, the non-integration output is independent of the shares if they exhaust the budget.) By straightforward calculation similar to those in Section **??**, if A gets s and B gets s', the output at P will be $1 - \left(\frac{1}{1+(s+s')P}\right)^2$, A's cost will be $s^2 \left(\frac{P}{1+(s+s')P}\right)^2$, and B's will be $s'^2 \left(\frac{P}{1+(s+s')P}\right)^2$. Thus to generate $Q_N(P') = 1 - \frac{1}{1+P'}$, incentive compatibility implies that $s + s' = P'/P$. Manager B then maximizes his payoff at $(Q_N(P'), P)$ by solving

$$\max_{s,s'} s'P \left(1 - \left(\frac{1}{1+P'}\right)^2\right) - s'^2 \left(\frac{P}{1+P'}\right)^2 \tag{14}$$

$$\text{s.t. } sP \left(1 - \left(\frac{1}{1+P'}\right)^2\right) - s^2 \left(\frac{P}{1+P'}\right)^2 \geq \underline{u}_A \tag{15}$$

$$s + s' = P'/P \tag{16}$$

or, substituting the incentive constraint (**??**),

$$\max_{s} \left(\frac{P' - sP}{P}\right) P \left(1 - \left(\frac{1}{1+P'}\right)^2\right) - \left(\frac{P' - sP}{P}\right)^2 \left(\frac{P}{1+P'}\right)^2$$

$$\text{s.t. } sP \left(1 - \left(\frac{1}{1+P'}\right)^2\right) - s^2 \left(\frac{P}{1+P'}\right)^2 \geq \underline{u}_A$$

It it is not hard to verify that the smallest s satisfying (**??**) also satisfies $s < P'/P$ if and only if $\underline{u}_A < P'^2/(1 + P')$. If this isn't satisfied, then as above, non-integration with free market clearing is not feasible and therefore cannot raise welfare in our second-best sense. (Since the only case in which non-integration can outproduce integration is when $P' > \pi^*$, this is not a particularly stringent condition.) Increasing P' relaxes the constraint (**??**); straightforward computation reveals that the objective also increases in P'. Thus, the value of the problem to B is higher at P, where it generates the output $Q_N(P)$ at cost $\hat{C}(Q_N(P))$, since at P, $s' = 1 - s$.

Now, if $(s_0, 1 - s_0)$ is the sharing rule used by manager B when the equilibrium price is P', then $(s_0(\frac{P'}{P}), (1 - s_0)(\frac{P'}{P}))$ satisfies both (**??**) and (**??**) and generates a cost of $(\frac{P'}{P})^2[s_0^2 + (1-s_0)^2](\frac{P}{1+P'})^2 = \hat{C}(Q_N(P')$. But then, by B's revealed preference, the optimal value of problem (**??**)-(**??**) is greater than $Q_N(P')P - \hat{C}(Q_N(P')) - \underline{u}_A$, which proves the result. □

8.3 Proof of Proposition ??

(1) Suppose that the planner can only impose the organizational design but not γ. (i) From the text, the lower bound $P^N(\gamma)$ on prices for which non-integration is not second-best efficient is lower than $\underline{\pi}$. The result has been established in the text when the demand function is perfectly elastic. We consider here the general case. Consider a demand function yielding an equilibrium price $P_a \in (P^N(\gamma), \underline{\pi}/\gamma)$. Consider the supply function as in (**??**) when α firms integrate. Let $P(\alpha)$ be the equilibrium price with this supply function: $\Sigma(P(\alpha), \alpha) = D(P(\alpha))$. As long as $P_a \in (P^N(\gamma), \underline{\pi}/\gamma)$, there exists $\alpha > 0$ such that $P(\alpha) \in (\underline{\pi}, \underline{\pi}/\gamma)$ and $P(\alpha) \geq c'(Q_N(P_b))$. See figure **??** where we have represented a typical demand function going through point a and a feasible α.

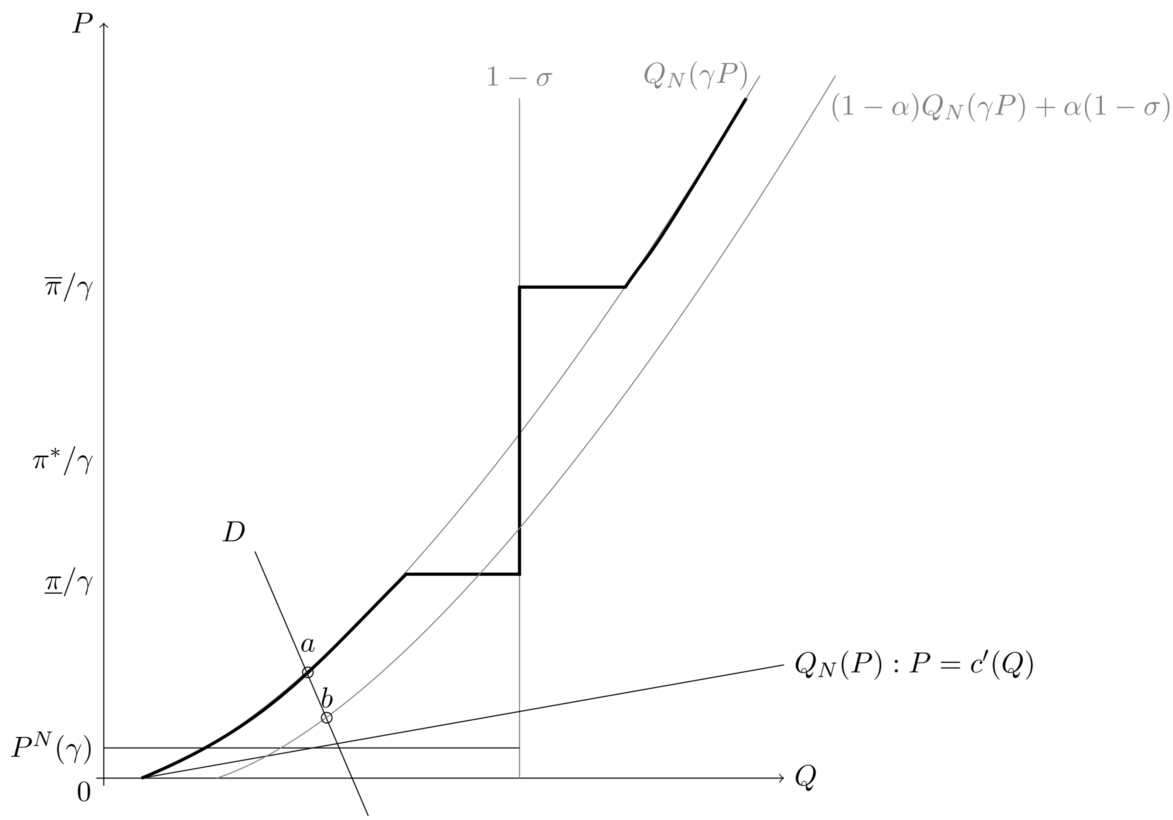


Figure 8: Non-integration is Second-Best Inefficient: General Case

Total welfare is

$$W(\alpha) = \int_{P(\alpha)}^{\infty} D(p)dp + (1-\alpha)\left[P(\alpha)Q_N(P(\alpha)) - c(Q_N(P(\alpha)))\right] + \alpha\left[P(\alpha)(1-\sigma) - \frac{1}{2}\right]$$

The variation in total welfare is therefore

$$\begin{aligned} W(\alpha) - W(0) = & \int_{P(\alpha)}^{P_a} D(p)dp \\ & + (1-\alpha)\left[P(\alpha)Q_N(\gamma\underline{\pi}) - c(Q_N(\gamma P(\alpha))) - P_a Q_N(\gamma P_a) + c(Q_N(\gamma P_a))\right] \\ & + \alpha\left[P(\alpha)(1-\sigma) - \frac{1}{2} - P_a Q_N(\gamma P_a) + c(Q_N(\gamma P_a))\right] \end{aligned}$$

where P_a is the initial equilibrium price (at point a in the figure). This can be rewritten as

$$\begin{aligned} & W(\alpha) - W(0) \\ & \quad = (1-\alpha)\left[\int_{P(\alpha)}^{P_a} D(p)dp + P(\alpha)Q_N(\gamma P(\alpha)) - c(Q_N(\gamma P(\alpha))) - P_a Q_N(\gamma P_a) + c(Q_N(\gamma P_a))\right] \\ & \quad + \alpha\left[\int_{P(\alpha)}^{P_a} D(p)dp + P(\alpha)(1-\sigma) - \frac{1}{2} - P_a Q_N(\gamma P_a) + c(Q_N(\gamma P_a))\right] \end{aligned}$$

The first term is positive since welfare continuously increases when the price decreases towards the marginal cost. By standard arguments, as long as demand is elastic, the consumer surplus satisfies:

$$\int_{P(\alpha)}^{P_a} D(p)dp > (P_a - P(\alpha))Q_N(P_a)$$

Hence, substituting this lower bound in the second term of the welfare difference, we have

$$\begin{aligned} & \int_{P(\alpha)}^{P_a} D(p)dp + P(\alpha)(1-\sigma) - \frac{1}{2} - P_a Q_N(\gamma P_a) + c(Q_N(\gamma P_a)) \\ & \qquad > P(\alpha)(1-\sigma) - \frac{1}{2} - P(\alpha)Q_N(\gamma P_a) + c(Q_N(\gamma P_a)) \end{aligned}$$

Since $P(\alpha) \in (P^N(\alpha), \underline{\pi}/\gamma)$, the difference is positive by our previous observation that moving to full integration is welfare maximizing when demand is perfectly elastic in this range of prices.

(ii) Consider first a demand that is perfectly elastic. We have represented a typical case in figure **??**. At price P_a, going from integration to non-integration, there is first – keeping total output constant at $1-\sigma$ – an additional cost corresponding to the area *edf* but there is an increase in quantities produced and the surplus going to shareholders and managers increases by the area *abcd*. Since this area is strictly increasing in P_a, there exists a unique price P_a such that total surplus for integration and non-integration are equal. At this price, areas *edf* and *abcd* are equal. Hence for perfectly elastic demand functions, integration prices are inefficient if and only if they are in the interval $(P^I(\gamma), \overline{\pi}/\gamma]$.

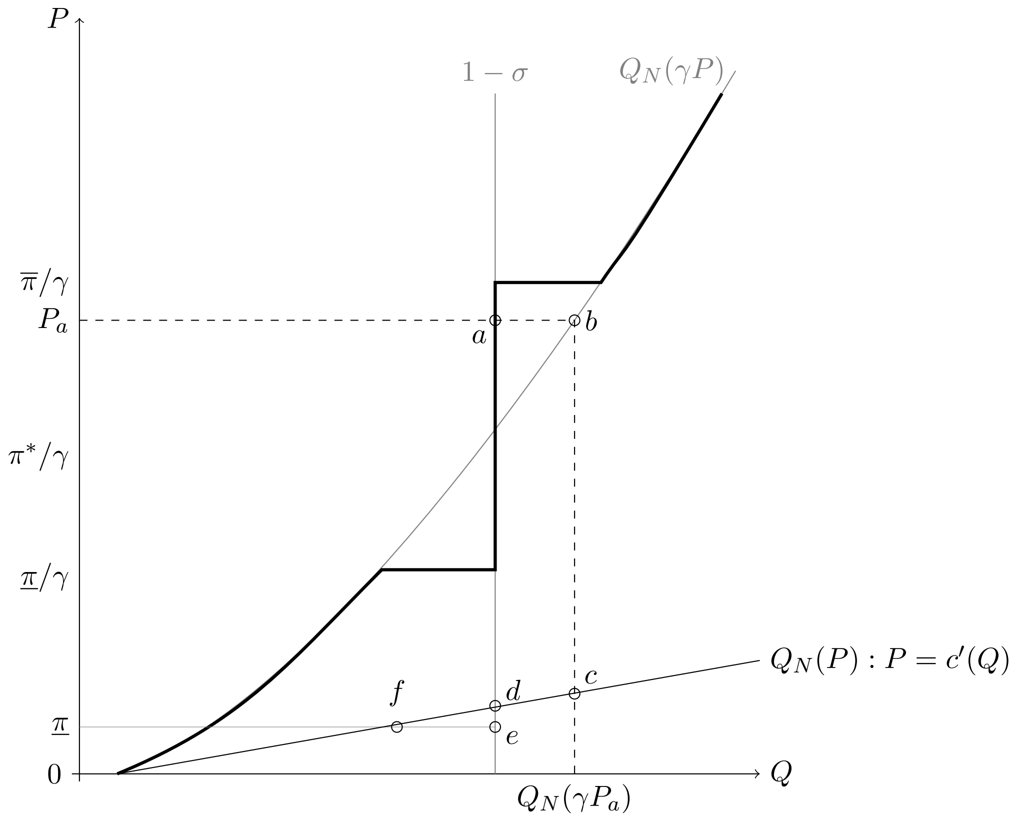


Figure 9: Integration is Second-Best Inefficient

Suppose now that the demand going through a is not perfectly elastic. There exists β positive and small enough such that there exists a solution $P(\beta) \in (P^I(\gamma), P_a)$ such that $D(P(\beta)) = S(P, 1-\beta)$. The variation in welfare is

$$W(\beta) - W(0) = \beta \left[\int_{P(\beta)}^{P_a} D(p)dp + P(\beta)Q_N(\gamma P(\beta)) - c(Q_N(\gamma P(\beta))) - P_a(1-\sigma) + \frac{1}{2} \right] + (1-\beta) \left[\int_{P(\beta)}^{P_a} D(p)dp + (P(\beta) - P_a)(1-\sigma) \right]$$

Again, it is straightforward to show that $\int_{P(\beta)}^{P_a} D(p)dp > (P_a - P(\beta))(1-\sigma)$. Hence, the second term in the above welfare difference is positive. Substituting the lower bound for the consumer surplus in the first term we obtain $P(\beta)Q_N(\gamma P(\beta)) - c(Q_N(\gamma P(\beta))) - P(\beta)(1-\sigma)+\frac{1}{2}$, which is positive since we know that for perfectly elastic demand functions in the interval $(P^I(\gamma), \overline{\pi}/\gamma)$, total welfare is greater with non-integration. This proves (ii).

(iii) As $\gamma = 1$, $P^N(1) = \underline{\pi}$ and therefore the interval $(P^N(\gamma), \underline{\pi}/\gamma)$ converges to the empty set. Since $P^I(\gamma) > \overline{\pi}$ for $\gamma < 1$, $P^I(1) \geq \overline{\pi}$, but then the interval $(P^I(\gamma), \overline{\pi}/\gamma)$ converges to the empty set.

(2) Suppose that $\gamma < 1$. From above, the industry supply curve lies above the industry supply when $\gamma = 1$. If demand is perfectly elastic, second best inefficiency follows. If demand is not perfectly elastic, we can replicate the argument made in (1)(ii) above to show that by imposing $\gamma = 1$ and possibly a different organizational design to a subset of firms, total welfare will increase.

8.4 Proof of Proposition ??

Recall that P^* is the price solving $\pi^N(P^*) = \pi^*$, where $\pi^N(P)$ is the solution to (**??**). Note that $V_N(0) = 0 > V_I(0)$. On the other hand, $V_N(P^*) < V_I(P^*)$: by definition of π^*, $Q_N(\pi^*) = 1 - \sigma$ and therefore, $V_N(P^*) = \left(1 - \frac{1}{(1+\pi^*)^2}\right)(P^* - \pi^*) = (1-\sigma)(P^* - \pi^*) < (1-\sigma)(P^* - \underline{\pi})$, since $\underline{\pi} < \pi^*$. Moreover, the marginal payoffs satisfy $V_N'(P^*) = V_I'(P^*) = 1 - \sigma$; thus for $P > P^*, V_N'(P) > V_I'(P)$, and for $P < P^*, V_N'(P)/dP < V_I'(P)/dP$ and we conclude that $V_N(\cdot) = V_I(\cdot)$ at two prices P_0 and P_1', with $0 < P_0 < P^* < P_1'$. Since $Q_N(\underline{\pi}) < 1 - \sigma$, $V_N(\underline{P}) < V_I(\underline{P})$. Therefore, $P_0 < \underline{P}$ and $\pi^N(P_0) < \pi^N(\underline{P}) = \underline{\pi}$.

At $\underline{P}$, we have

$$\begin{aligned} \frac{1}{2} - C(Q_N(\underline{\pi})) &= \left[(1-\sigma) - Q_N(\underline{\pi})\right]\underline{\pi} \\ &< \left[(1-\sigma) - Q_N(\underline{\pi})\right]\underline{P} \end{aligned}$$

hence, $(1-\sigma)(\underline{P} - \underline{\pi}) > Q_N(\underline{\pi})(\underline{P} - \underline{\pi})$. But the left hand side is less than $(1-\sigma)\underline{P} - 1/2$ since $(1-\sigma)\underline{\pi} > 1/2$. It follows that $(1-\sigma)\underline{P} - 1/2 > Q_N(\underline{\pi})(P - \underline{\pi})$, that is shareholders strictly integration at price $\underline{P}$. Therefore, $P_0 < \underline{P}$ as claimed.

Consider now price P^*. By definition of π^*, $Q_N(\pi^*) = 1 - \sigma$ and therefore shareholders are indifferent between integration and non-integration at this price. It follows that $P_1 > P^*$ as claimed.

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