Perfect Competition and Organizational Inefficiencies*

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Abstract

We construct a price-theoretic model of integration decisions and show that these choices may adversely affect consumers, even in the absence of monopoly power in supply and product markets. Integration is costly to implement but is effective at coordinating production decisions. The price of output helps to determine the organizational form chosen: there is an inverted-U relation between the degree of integration and product prices. Moreover, organizational choices affect output: integration is more productive than nonintegration at low prices, and less productive at high prices. Since shocks to industries affect product prices, reorganizations are likely to take place in coordinated fashion and be industry specific, consistent with the evidence. Since the price range in which integration maximizes productivity generally differs from the one in which it maximizes managerial welfare, organizational choices will often be second-best inefficient. We show that there are instances in which entry of low-cost suppliers can hurt consumers by changing the terms of trade in the supplier market, thereby inducing reorganizations that raise prices.

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1 Introduction

Do consumers have an interest in the internal organization of the firms that make the products they buy? There are good reasons to believe that they do: the purpose of organizational design is to influence the incentives of the firm's decision makers, and that is bound to have an impact on the quantity and quality of goods that the firm produces, as well as the prices at which they are delivered.

Since organizational design matters mostly when decisions made in the firm are noncontractible, the real question is whether there is reason to expect that the forms of organization that emerge are efficient in a second-best sense. Conventional economic wisdom seems to answer affrimatively, at least if product markets are reasonably competitive: 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]

On the other hand, the extensive literature on the theory of the firm raises suspicion against this view because it repeatedly identifies situations in which some stakeholders – most often shareholders – settle for second-best inefficient contracts. (Most often the efficiency concept that is used reckons total surplus, not merely Pareto optimality.)[2] Consumers, however, have rarely been represented in the analysis, and the connection between the efficiency of contract choices and the standard economic variables of prices and quantities has been given scant attention.[3]

To assess whether second-best inefficiencies are likely to arise from the point of view of *all* stakeholders, it is necessary to delineate how the market influences organizational design. In this paper we develop a simple competitive model in which integration and transfer price choices are made to mediate managerial tradeoffs between organizational goals – profits – and noncontractible ones such as managerial effort, working conditions, corporate culture, or leadership vision.

In our set-up, organization is influenced by product prices, because they affect the terms of managerial trade-offs. At the same time, as we have suggested, organizational choice affects prices because it determines productivity. Even in a competitive world,

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

[2] For examples of organizational and contractual failures to maximize surplus, see Aghion Bolton (1987,1992); etc.

[3] Bolton-Whinston 1993, plus the old lit on verticval integration in IO which emphasizes market power.

inefficiencies are likely to be significant: both too much and too little integration are possible outcomes. Consumers need not get the goods they want at the lowest cost-covering price.[4]

To focus on effects of purely organizational origin, we rule out market foreclosure altogether by assuming competitive product and supplier markets. The basic model of an organization that we embed in this setting is an adaptation of the one in Hart and Holmström (2002). Production of consumer goods requires the combination of exactly two complementary suppliers, each consisting of a manager and his collections of assets. When the suppliers form a joint enterprise (or "firm"), the managers operate the assets by taking noncontractible decisions. While there is no objectively "right" decision, output is higher on average the more decisions are in the same direction.

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 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.[5] But integration does not come for free, and generates two types of losses. First are costs imposed on the initial managers in the form of a profit share for HQ and the private costs that HQ imposes on them. Second, using HQ to enforce coordination may have direct costs in terms of reduced output. For instance, HQ may lack expertise in the tasks carried out by the suppliers, (e.g., Hart and Moore 1999), there may be additional communication and delay costs

[4]Obviously, organizational imperfections are essential for this result in a competitive market. In the traditional IO literature, where firms are unitary profit maximizers, there is a gap between the price and the marginal cost only when firms have market power.

[5]Other models that take a similar view of integration include Alchian and Demsetz (1972) and Mailath et al. (2002).

(e.g., Radner 1993, Bolton and Dewatripont 1994), 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". The firms' output is sold in a competitive product market, wherein all firms and consumers are price-takers.[6]

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 to forego 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-shaped relationship between product price and the degree of integration.

Derivation of equilibrium organizational choices and product prices reduces to a standard supply-and-demand analysis, where the industry supply curve embodies the price-dependent organizational decisions described above. We apply this framework to show how internal organization, as well as prices and quantities, respond to shocks such as changes in product demand or imposition of a sales tax.

The price mechanism also provides a natural explanation for the tendency for organizational restructuring to be *widespread*. There is considerable evidence that firms integrate (or divest) in "waves" and that reorganizations of this sort are most pronounced at the industry level. Since product price is common to a whole industry, anything that changes it will not only have the classical price-theoretic quantity and consumer welfare effects, but will have organizational effects as well. And as we have suggested, these organizational effects will in turn feed back to quantity and welfare.

Incorporating organizational design into this otherwise standard analysis can also lead to surprising results: for instance we identify regimes where product prices *increase* and consumer welfare decreases following positive shocks, such as the entry of low-cost suppliers.

A consumer welfare criterion would favor output-enhancing organizations, and

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[6]The model is thus related to our earlier work (Legros and Newman 1996, 2008) that shows how relative scarcities of different types of stakeholders determine aspects of organizational design such as the degree of monitoring or the allocation of control. Those papers do not consider the interaction of organization design with the product market. The formal treatment of the effects of organizational design on consumer welfare is new as far as we are aware. Our focus on the effect of prices on organizational design rather than the power of incentive schemes distinguishes our work from earlier papers on competition and incentives, such as Hart (1983) and Schmidt (1997).

there is a simple characterization of the prices at which the managers' organizational choices fail this measure. If we use a total-surplus criterion, weighing consumer and firm surpluses equally, the inefficiency persists as long as managers are not full residual claimants and demand is sufficiently elastic. This begs the question of whether outside owners can discipline managers into taking the profit maximizing organizational decision. We show that instruments such as variable profit shares, free cash flow, or imposing the integration decision directly will not eliminate the inefficiencies – and in some cases make things worse.

2 Model

There are two types of supplier, denoted A and B. To produce a unit of 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 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 with a probability proportional to $1 - (a - b)^2$, in which case it generates a unit of output; 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.[7]

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*

[7]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).

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. Alternatively, they can can *integrate* by engaging the service of a headquarters (HQ).

HQ is empowered to decide both a and b, and is motivated only by monetary concerns, incurring no direct cost from the decisions. Using HQ does impose a (social) cost that we model as a reduction $\sigma \geq 0$ in the expected output. One interpretation is that this arise from a moral hazard problem: given its considerable decision power, HQ may be able to divert resources into other activities, including private benefits, other ventures, or pet projects.[8] Alternatively, σ arises from added costs of communication, additional personnel, or the use of decision makers who are less specialized than the A and B managers. In this case, HQ gets a fixed share of the revenue, with σ being (approximately) the sum of the output loss and HQ's share.[9]

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.[10]

To summarize, expected output is $(1-(a-b)^2)(1-\sigma\mathbf{I})$, where $\mathbf{I}$, denoting the *ownership structure*, is equal to one if the firm is integrated and zero if it is not.

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).

There is a competitive *product market*. Firms take the (correctly anticipated)

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[8]For instance, suppose that after output is realized, there is a probability σ that HQ has a chance to divert whatever output there is to an alternative use valued at ν times its market value, where $\sigma < \nu < 1$. If output is diverted, it doesn't reach the market, and the verifiable information is the same as if the firm had failed. Managers could prevent diversion by offering a share ν to HQ, leaving $(1-\nu)$ of the revenue to be shared between the managers, but since $\nu > \sigma$, it is actually better for them to give HQ a zero share of market revenue and let him divert when he is able, so that successfully produced output reaches consumers only $(1-\sigma)$ of the time.

[9]There is a small difference between the interpretation in that in the first case, the reduction in output and the reduction in revenue perceived by the managers are identical, whereas in the latter case, these differ by the amount of HQ's share; no substantial difference in any of our conclusions would arise if we were to take explicit account of this distinction.

[10]Logically speaking, there is an alternative form of integration which does without HQ, instead delegating full control to one of the managers, who will subsequently perfectly coordinate the decisions in his preferred direction. It is straightforward to show (section 2.2) that this form of integration is dominated by the other forms in this model.

price P as given when they sign contracts and take their decisions. The demand side of the product market is modeled as a decreasing demand function $D(P)$.

In the supplier 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 $\underline{u}_A$, which we take to simplify to be zero (the outside option of B-managers will play little role here and can be taken to be 0).[11]

For now we take the total managerial revenue in case of success to be the product market price P.

2.1 Integration

With integration, HQ receives an expected surplus proportional to $(1-(a-b)^2)P$ and therefore chooses $a = b$, which maximizes the firm's expected revenue. Among all $a = b$ choices, the one that minimizes the total cost is $a = 1/2$, 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 the payoffs to the A and B managers are

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

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

2.2 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

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

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

These choices are:

$$a^N = \frac{1+(1-s)P}{1+P} \tag{1}$$
$$b^N = \frac{(1-s)P}{1+P}, \tag{2}$$

and the resulting expected output is

$$Q^N(P) = 1 - \frac{1}{(1+P)^2} \tag{3}$$

which is *independent* of s. Output is increasing in the price P : a higher product price raises the relative importance of the revenue motive against private costs,and this pushes the managers to better coordinate.

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

$$u_A^N(s,P) = Q^N(P)sP - s^2\left(\frac{P}{1+P}\right)^2 \tag{4}$$
$$u_B^N(s,P) = Q^N(P)(1-s)P - (1-s)^2\left(\frac{P}{1+P}\right)^2. \tag{5}$$

Varying s, one obtains the Pareto frontier for nonintegration. It is straightforward to verify that it is strictly concave and that the total managerial payoff $W^N(s,P) = Q^N(P)P - (s^2+(1-s)^2)\left(\frac{P}{1+P}\right)^2$ is maximized at $s = 1/2$ and minimized at $s = 0$ or $s = 1$. Note that when $s = 0$, $a = 1$: the A manager makes no concession, and only the B bears a positive private cost.[12]

2.3 Choice of Organizational Form

The overall Pareto frontier is the outer envelope of the integration and nonintegration frontiers. The relative positions of these frontiers depend on the price. Figure 1 depicts a situation in which neither integration nor nonintegration 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

[12]Using $W^N(0,P) = P^2/(1+P)$, it is now straightforward to show that giving B full control will be dominated by nonintegration. 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 $W^N(0,P)$.

$\underline{u}'_A$, it remains non-integrated.

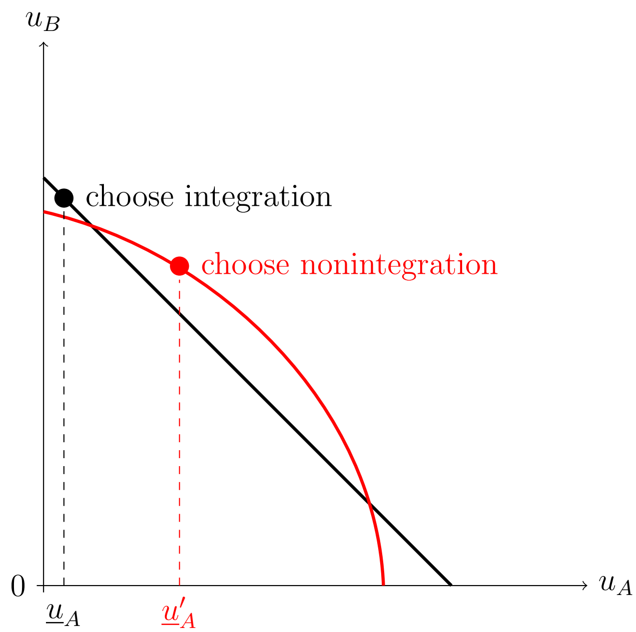

Figure 1: Frontiers and Organizational Choices

As the following proposition establishes, nonintegration may dominate integration when product price is low or high, but integration never dominates nonintegration. There is a range of prices where integration is preferred to nonintegration when B's share of surplus is large enough.

Proposition 1 *When σ is positive, managerial welfare with integration*
(i) is smaller than the minimum total welfare with nonintegration if and only if P does not belong to 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) is smaller than the maximum welfare with nonintegration.

It is straightforward to see that $[\underline{\pi}, \overline{\pi}]$ is nonempty only when σ is weakly smaller than a positive upper bound $\bar{\sigma}$, that $\underline{\pi}$ is increasing and $\overline{\pi}$ is decreasing in σ, and that $\overline{\pi}$ becomes unbounded as $\sigma \to 0$.

2.4 Industry Equilibrium and the "Organizationally Augmented" Supply

Industry equilibrium comprises a general equilibrium of the supplier market and product market. In the supplier market, an equilibrium consists of matches of one upstream firm and one downstream firm, along with a surplus allocation among all the 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.

For the rest of the paper, except for section **??**, we will assume that the A agents would earn zero if unmatched. Since they are in excess supply, their competitive payoff must be equal to zero. Then if frontiers are as in Figure 1, integration would be chosen since it maximizes B's payoff given that A gets zero. At other product prices, the maximum payoff to B may be generated through nonintegration. The maximum payoff for B under integration is equal to the total welfare $(1-\sigma)P - \frac{1}{2}$, and the maximum payoff for B under nonintegration is $\frac{P^2}{1+P}$, corresponding to the case $s = 0$ in (5). From Proposition 1, integration will be chosen by managers in equilibrium only when $P \in [\underline{\pi}, \overline{\pi}]$.

We note that output supplied to the product market under integration $(1-\sigma)$ is smaller than output under nonintegration $(1 - \frac{1}{(1+P)^2})$ if and only if

$$\sigma > \frac{1}{(1+P)^2}, \tag{6}$$

that is when

$$P > \pi^*(\sigma) = \sqrt{\frac{1}{\sigma}} - 1. \tag{7}$$

It is straightforward to see that $\pi^* \in (\underline{\pi}, \overline{\pi})$ whenever $\sigma < \overline{\sigma}$.

The reason nonintegration generates higher output as price increases is simple enough: the higher is P, the more revenue figures in managers' payoffs. This leads one to " concede" to the other's decision in order to reduce output losses.

The non-monotonicity of managers' organizational preference in price when $\sigma \in (0, \bar{\sigma})$ is more subtle. At low prices, despite integration's better output performance, revenue is still small enough that the managers (in particular the manager of B) are more concerned with their private benefits, i.e., they like the quiet life. At high prices, nonintegration performs well enough in the output dimension that they do not want to incur the cost σ of HQ. Only for intermediate prices do managers prefer integration. In this range, the B manager knows that revenue is large enough that he will be induced to bear a large private cost to match the perfectly self indulgent A manager, who generates little income from the firm ($s = 0$) and therefore chooses $a = 1$. B prefers the relatively high output and moderate private cost that he incurs under integration.[13]

As mentioned earlier, the demand side of the product market is represented by the demand function $D(P)$. To derive 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

$$S(P, \alpha) = \alpha(1 - \sigma) + (1 - \alpha)\left(1 - \left(\frac{1}{1 + P}\right)^2\right). \tag{8}$$

For $\sigma < \bar{\sigma}$, when $P < \underline{\pi}$, $\alpha = 0$ and total supply is just the output when all firms choose nonintegration. At $P = \underline{\pi}$, α can vary between 0 and 1 since managers are indifferent between the two forms of organization; however because $\underline{\pi} < \pi^*$, output is greater with integration and as α increases total supply increases. When $\alpha = 1$ output is $1 - \sigma$ and stays at this level for all $P \in (\underline{\pi}, \overline{\pi})$. At $P = \overline{\pi}$, managers are again indifferent between the two ownership structures and α can decrease from 1 to 0 continuously; because $\pi^* < \overline{\pi}$, output is greater the smaller is α. Finally for $P > \overline{\pi}$ all firms remain non-integrated and output increases with P.

When $\sigma \geq \bar{\sigma}$, managers always choose nonintegration and $\alpha = 0$ for all prices.

We therefore write $S(P, \alpha(P))$ to represent the supply correspondence, where $\alpha(P)$ is described in the previous paragraph. The supply curve for the case $\sigma \in (0, \bar{\sigma})$ is represented in Figure 2. The dotted curve corresponds to the industry supply when no firms are integrated.

An equilibrium in the product market is a price and a quantity that equate supply and demand: $D(P) \in S(P, \alpha(P))$. There are three distinct types of industry equilibria, depending on where along the supply curve the equilibrium price occurs: those

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[13] For this outcome, it is crucial that A or B accrues the preponderance of the surplus. For as we already noted, the total surplus under nonintegration when it is equally shared ($s = 1/2$) always exceeds that generated by integration. Thus if surplus is (nearly) equally shared by A and B, (for instance, if one side has a nonzero outside option), they never integrate. On the other hand, our specific functional forms are not critical to this kind of outcome: similar results obtain if the managers have a standard partnership problem, where total net revenue is $Pf(a, b)$ and there are non-contractible cost functions that are increasing in a and b. Details are in section 6.1 in the Appendix.

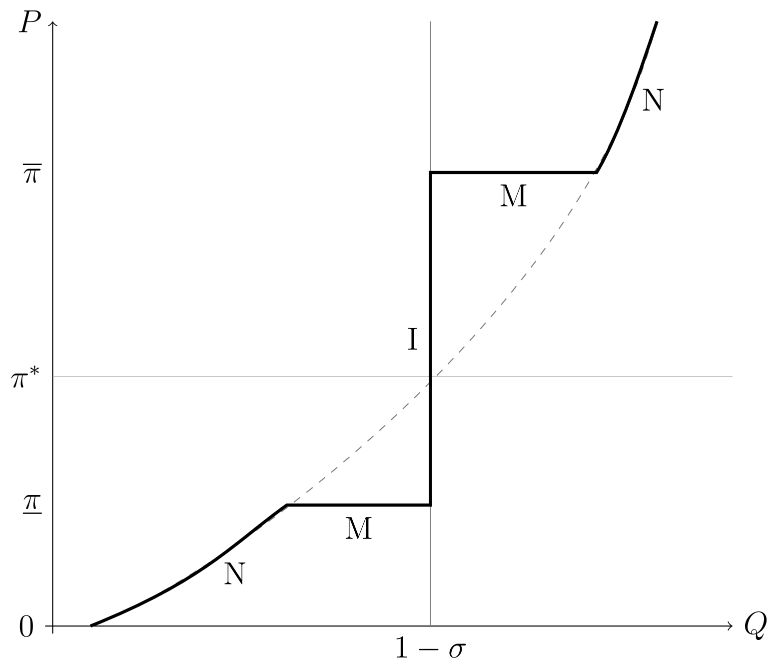

Figure 2: Organizationally Augmented Supply Curve (Zero Outside Options, $\sigma < \overline{\sigma}$)

in which firms integrate (I), the mixed equilibria in which some firms integrate and others do not (M), and a pure nonintegration equilibrium (N).[14]

The product market supply embodies organization choices by managers. The model suggests that industries in which product prices are high or low will be predominately composed of non-integrated firms, while those with intermediate prices will tend to be integrated.

The model is also useful for illuminating sources of *changes* in organization and their welfare effects. The fact that all firms face the same price means that anything that affects that price – a demand shift or foreign competition – can lead to widespread and simultaneous reorganization, e.g., a merger wave or mass divestiture. In particular, we can replicate textbook demand and supply shift analysis, with the caveat that the change in price indicates also a change in organization. We can also perform textbook welfare analysis to evaluate the efficiency of equilibria. We turn to these two points in the next section.

[14] As we show in section 4.2, introducing heterogeneity in types of HQs or in cash holdings of firms will yield an OAS that is a function, rather than a correspondence, of the price level. It will be also the case that there will be generic coexistence of organizational forms.

3 Normative and Positive Analysis of Organizational Choice

3.1 Welfare

Welfare analysis is straightforward if we use as criterion consumer welfare, i.e., the area under the demand curve: managers choose integration inefficiently when their revenue π is in the interval (π^*, π) and choose nonintegration inefficiently when their revenue is less than $\underline{\pi}$. Thus as long as the welfare criterion puts enough weight on consumer surplus, the equilibrium choice of organization will be inefficient for some prices.

Of course organizational choices should be evaluated taking account all of their costs, which in this case includes the managers' private costs. For this reason, we now use a total welfare measure that comprises the payoffs of all the firm's stakeholders (consumers, shareholders, and managers). We compare the equilibrium welfare with that would be generated a social planner could impose the level of integration. For instance, we will say that the equilibrium with integration is second-best efficient if welfare exceeds that would could result if some firms were forced to choose nonintegration while prices and surplus shares were determined by market clearing.[15]

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 nonintegration, 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:

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

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

[15] A stronger concept of second efficiency would also allow the planner to impose a share s. In this case, it is welfare improving to set $s = 1/2$, which makes nonintegration more attractive and therefore increased the region of prices for which integration is second-best inefficient and makes the nonintegration equilbrium second-best inefficient for any price because the outside option of the A is zero.

marginal managerial cost.

In most firms, top managers accrue only a small share of the revenue. To reflect this situation, we assume that for any price P, managers have a revenue $\pi(P) = \lambda P$, where $\lambda < 1$; the remainder accrues to the shareholders.[16] While λ is literally a share of total revenue, it could be also construed as a crude measure of corporate governance; large λ mean that managers' interests are strongly aligned with those of other revenue claimants, i.e., shareholders. When λ is small, the resulting misalignment of interests will lead managers to choose inefficient organizations.

To see why such organizational inefficiency is possible, first observe that under nonintegration, the managerial cost is equal to the area under the marginal cost curve. On the other hand, since at the revenue level $\underline{\pi}$, managers are indifferent between integration and nonintegration, 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 $\underline{\pi}$, $c'(Q)$ and $Q^I(P)$.

It is perhaps easiest to begin by considering a family of *perfectly elastic* demand functions, since consumer welfare is then always zero. Start with the demand that is perfectly elastic at the price $\underline{\pi}/\lambda$. Since managers receive $\underline{\pi}$, they are indifferent between integration and nonintegration. On the other hand, since $Q^N(\underline{\pi}) < 1 - \sigma$, shareholders would have larger incomes with integration than with any degree of nonintegration, and any equilibrium in which some firms do not integrate is therefore inefficient. For demand below $\underline{\pi}/\lambda$, the unique equilibrium involves nonintegration, and there are welfare gains from moving to integration; we have represented in Figure 3 the deadweight loss associatied to the inefficient choice of organization for such a level of demand.

Now consider a perfectly elastic demand at $\underline{\pi}$. In this case, the total welfare under integration and nonintegration are equal when $\lambda = 1$, however since $Q^N(\underline{\pi}) > Q^N(\lambda\underline{\pi})$, total welfare is strictly greater under integration at $P = \underline{\pi}$ when $\lambda < 1$. Hence, the lower bound on prices for which nonintegration dominates integration is strictly greater than $\underline{\pi}$. Since as λ increases, the supply under nonintegration increases, this lower bound is increasing in λ. At $\lambda = 1$ the lower bound is equal to $\underline{\pi}$.

With perfectly elastic demands, the region of second-best inefficient organizational choices corresponds therefore to an interval of price $(P^N(\lambda), \underline{\pi}/\lambda)$.

[16] The linear share is for simplicity; nothing depends on this assumption. As we will show in section 4.1, with nonlinear compensation rules, the results generalize.

If demand is not perfectly elastic, if all firms integrate the price may fall sufficiently that the welfarare is lower than with nonintegration. However, if only a few firms integrate, the drop in price is small enough that the there is a welfare gain. As demand elasticity decreases, the deadweight loss from inefficient nonintegration 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, however, the organizational deadweight loss is *increasing* in the elasticity. This suggests that the less we worry about market power, the more we may have worry about organizational inefficiency.

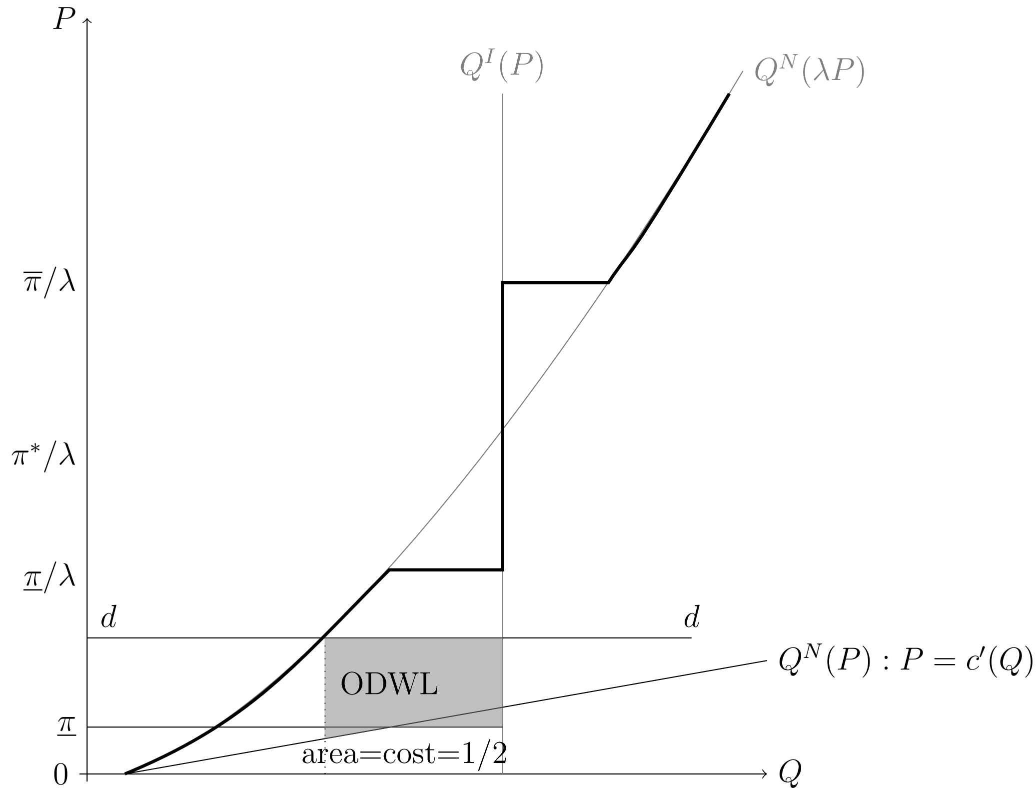

Figure 3: Second-Best Inefficiency: Perfectly Elastic Demand

A similar argument shows that $\overline{\pi}/\lambda$ is the upper bound of equilibrium prices at which inefficient *integration* obtains. The lower bound is strictly greater than π^*/λ: 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 $\lambda = 1$; however since

$\lambda < 1$, nonintegration 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 2 *There exist increasing functions $P^N(\lambda)$, $P^I(\lambda)$, with $P^N(\lambda) \leq \underline{\pi}$ and $P^I(\lambda) \geq \max\{\overline{\pi}, \pi^*/\lambda\}$ such that if P be the equilibrium price corresponding to a demand function D.*
(i) There is inefficient nonintegration if and only if $P \in (P^N(\lambda), \underline{\pi}/\lambda)$.
(ii) There is inefficient integration if and only if $P \in (P^I(\lambda), \overline{\pi}/\lambda)$.
(iii) As $\lambda = 1$, equilibria are second best efficient.

3.2 Demand and Supply Shocks

In addition to welfare analysis, the model provides a simple framework for the positive analysis of organizational choice. As an illustration, we consider the effects of "shocks" to demand and to supply.

Assume that demand is increasing over time, beginning at a very low level in which firms are nonintegrated, while supply remains constant. As demand grow, we get some indication of how organization should be expected to evolve. When demand is initially low and the product begins to mature, rms will begin to integrate and the synergies will rst benet all stakeholders (managers, shareholders and consumers). As demand continues to grow, integration becomes detrimental to consumers, and later, when demand is high enough, we will observe a series of "divestiture" and the firms will be nonintegrated.

In addition to the nonmonotonic relationship between prices and integration, this simple exercice emphasizes the industry wide re-organizational choices. This seems consistent with recent findings by a number of authors who have emphasized the empirical regularities surrounding "clustering" of takeovers and divestitures. For instance, Mitchell and Mulherin (1996) argue that for the US at least, merger waves are best explained empirically by the joint effects of macroeconomic and industry-level variables. In particular, Powell and Yawson (forthcoming), looking at data from the UK, emphasize growth in sales and foreign competition as important determinants of takeovers, while divestitures are associated with negative demand shocks.

Beyond structural shifts in supply and demand, *taxation* is another source of shifts in demand and supply. In our model, tax incidence will have the usual properties: ad-valorem taxes decrease the welfare of buyers and sellers, and there is neutrality of tax burden. What is new however are the organizational consequences of taxation: the shift in demand or in supply may lead to a new equilibrium that involves a new organizational structure in the economy. As far as we know, while the literature has tried to identified the effects of taxation on the *form of incorporation*, there has been little research linking the level of taxation on consumer goods or on profits and integration decisions by firms.

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, will change the way surplus is divided between managers, and this too will lead to reorganization.[17] In some cases, these changes in the supplier market terms of trade will have surprising effects on product market outcomes. Suppose that it costs the A a fixed amount ω to participate in joint production with B, who continues to have zero costs. We want to study the contracting choice in this situation and compare it to the case in which A has a cost $\omega' < \omega$.[18]

Think of contracting with an A manager with a plant that could fetch a profit of ω in some other use. The contracting problem is very similar to what we have done before with the caveat that A must now be assured of an expected payoff of ω.

As is apparent from Figure 1, for levels of ω that are sufficiently high, nonintegration 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 ω, it will be also be optimal for any $\omega' < \omega$; because the preference is strict at ω' when there is indifference at ω, there are more prices for which integration is preferred under ω'. Thus, *if sharing rules are employed, reduced costs are a force toward integration.* This is represented in Figure 4.

Of particular interest when low-cost suppliers enter 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 accomodate the changing terms of trade in the supplier

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

[18]We focus on situations where ω is 'small' in the sense that for the range of prices we consider ω is less than half the maximum surplus under nonintegration.

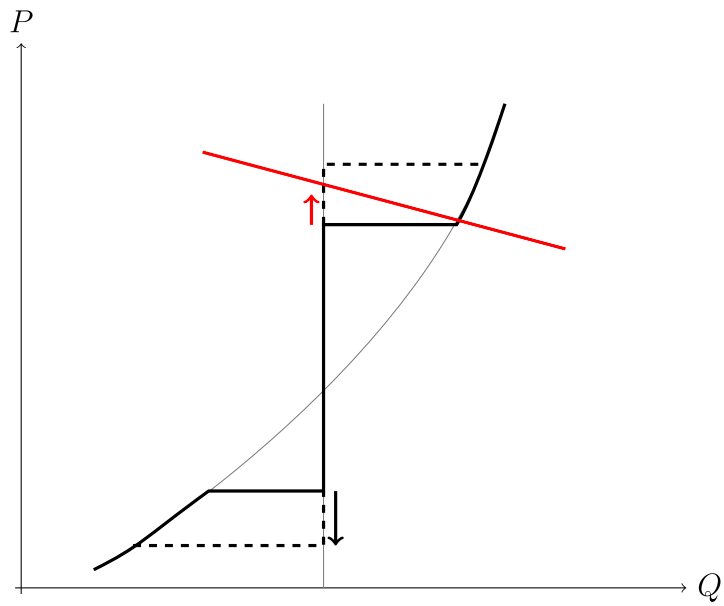

Figure 4: Entry of lower cost suppliers ($\omega' < \omega$) leads to a price increase

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.

4 Shareholders and the Managerial Market

In our competitive world, when the managers are not full residual claimants, shareholders have nearly the same interests as consumers: they value output enhancing organizations. Corporate control by outside owners or the characteristics of the market for HQs influence the opportunity costs of integration and may therefore mitigate the inefficiencies we have identified in the previous sections.

We first consider the possibility for the shareholders to use general, rather than linear, compensation rules for the managers and also to have a voice in the integration decision. As we show, this generalization does not eliminate inefficiencies, but in fact sometimes magnifies them. We then introduce heterogeneity in the model, first in cash holdings and second in the types of HQs available in the market. In both cases, the qualitative results of the basic model are preserved.

4.1 Price Contingent Compensation and Shareholder Activism

We assume here that owners can choose managerial shares $\pi(P)$ that are contingent on the market price P. We will consider first the situation where managers are delegated the right to decide integration or nonintegration. We will then analyze the case where the owners have full control on the organization.

4.1.1 Managers Choose the Organization

Suppose that owners want the managers to choose *integration*: the cheapest way for them to do so is to give a fixed compensation in case of success of $\underline{\pi}$ (or ϵ greater than this to avoid indifference). Hence, the maximum payoff to owners when they want to implement integration is

$$v^I(P) = (1-\sigma)(P-\underline{\pi})$$

Suppose now that the owners want to implement *nonintegration*. They are constrained in their choice since they need to choose π that is not in the interval $[\underline{\pi}, \overline{\pi}]$. Let us, however, ignore the constraint for the moment. The value under nonintegration is given by the function $v^N(P)$,

$$v^N(P) = \max_{\pi \geq 0} \left(1 - \frac{1}{(1+\pi)^2}\right)(P-\pi) \tag{9}$$

Lemma 3 *The solution $\pi^N(P)$ to (9) is a strictly convex and strictly increasing function of P. The value $v^N(P)$ is strictly increasing and 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. Consequently, $Q^N(\pi(P))$ is also increasing, and there exist unique values of prices $\underline{P}$, P^*, and $\overline{P}$ such that $\underline{\pi} = \pi(\underline{P})$, $\pi^* = \pi(P^*)$, and $\overline{\pi} = \pi(\overline{P})$. Since by the envelope theorem $v^{N\prime}(P) = Q^N(\pi(P))$, $v^N(P)$ is (strictly) convex. ■

Convexity of v^N, linearity of v^I and the fact that for prices less than 1 integration leads to a negative payoff while nonintegration always leads to a positive payoff, imply that there is an intermediate region of prices for which integration is preferred by the owners. Since owners cannot decide on the organization, they have to take into account the fact that the compensation of the managers cannot be in the interval $(\underline{\pi}, \overline{\pi})$ if they want to implement nonintegration. Taking into account this constraint may force the owners to distort the compensation from its optimal value $\pi^N(P)$ under nonintegration, as illustrated in the following proposition.

Proposition 4 *(1) Suppose $\sigma < \overline{\sigma}$. There exists two price levels $P_0 < \underline{P}$ and $P_1 \geq P^*$, where $\pi^N(\underline{P}) = \underline{\pi}, \pi^N(P^*) = \pi^*$ with $\pi^N(P)$ defined in Lemma 3 such that the compensation to the managers and their choices of organization are as follows:*
(i) There is integration if $P \in [P_0, P_1]$ and the compensation is $\underline{\pi}$ for all prices in this region
(ii) There is nonintegration for the other prices and the compensation is

$$\pi(P) = \begin{cases} \pi^N(P) & \text{if } P < P_0 \\ \overline{\pi} & \text{if } P \in [P_1, \overline{P}] \\ \pi^N(P) & \text{if } P > \overline{P}. \end{cases}$$

(2) Suppose that $\sigma > \overline{\sigma}$. Managers face a compensation scheme $\pi^N(P)$ and choose nonintegration.

The analysis therefore shows that when shareholder optimize, they will decide to keep the organizational form that is not output maximizing because it is too costly to provide incentives when $P < P_0$ and when $P \in [P^*, P_1)$. Note that the industry supply curve is similar to the case dealt with in section 4 (with $\underline{\pi}/\lambda$ replaced by P_0 and $\overline{\pi}/\lambda$ replaced by $\hat{P}_1$) and that ranges of both inefficient nonintegration and inefficient integration persist.

Remark 5 *Because P_0 is likely to be larger than $\overline{\pi}$ when a firm has a large capitalization, integration arises at higher product market prices than when managers have full residual claim on the revenue.*

4.1.2 Owners Choose the Organization

If owners can also choose the organization as a function of the price, they can dissociate the choice of compensation from the organization choice.

For integration, they save on incentive costs, since they have only to cover the managerial cost of 1/4 and their total profit is now

$$\hat{v}^I(P) = (1 - \sigma)P - 1/2, \tag{10}$$

with $\hat{v}^I(P) > v^I(P)$ for all P.

Since the best payoff under nonintegration is given by $v^N(P)$ in (9), it is immediate that the owners will now choose to implement integration for a larger set of prices when $\sigma < \overline{\sigma}$. If $\sigma > \overline{\sigma}$, by definition of $\overline{\sigma}$, owners cannot benefit from integration even if they give managers the minimal compensation consistent with them covering their costs.

Corollary 6 *Suppose that owners can impose the organization.*
(1) If $\sigma < \overline{\sigma}$, integration is chosen if, and only if, P belongs to the interval $[\hat{P}_0, \hat{P}_1]$, $\hat{P}_0 < P_0$, $\hat{P}_1 > P_1$.
(2) If $\sigma > \overline{\sigma}$, managers face compensation scheme $\pi^*(P)$ and choose nonintegration.

Note that when $P \in (\hat{P}_0, P_0)$, managers will choose nonintegration by Proposition 4 while owners prefer integration. If corporate governance does not allow existing owners to impose organizational changes, a price in this interval may trigger an hostile takeover whereby the raider puts in place an integrated structure. For other prices however, nonintegration decisions are immune to takeovers, even if they are second-best inefficient.

Bertrand and Mullainathan (2003) provide evidence that managers prefer a "quiet life" at the possible expense of productivity-enhancing integration. The corollary shows that even if owners can make organizational decisions, managers may enjoy a quiet life – with a second-best inefficient organization – because it is too costly for owners to implement integration.

4.2 Heterogeneity and Coexistence of Organizational Forms

We introduce two sources of heterogeneity: one linked to the ability of shareholders to transfer lump sum amounts to their managers, the other linked to differences in types of HQs.

4.2.1 Free Cash Flow

One important difference between integration and nonintegration 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 nonintegration. This explains why the organizational choice will not necessarily coincide with that maximizes the total managerial welfare.

This is no longer true if the managers have access to cash, or other free cash flow that can be transferred without loss to the B manager before production takes place, since in this case the advantage of integration in terms of transferability is reduced.[19] Indeed, under nonintegration, cash is a more efficient instrument for surplus allocation than the sharing rule s since a change of s affects total costs. By contrast, when firms are integrated, a change in s has no effect on output or on costs and therefore shares permits as efficient an allocation of surplus than cash. Hence, the introduction of cash favors nonintegration and we should observe in equilibrium a smaller number of firms that are integrated.

Large cash holdings will make transactions between firms more efficient. However there is no reason to expect that what is "more efficient" for managers is also best for consumers. And indeed, as we will see, when cash holdings are sufficiently large, nonintegration is always chosen, and this implies that the region of inefficient nonintegration — from consumers' view point – expands.

To simplify, assume that the owners are forced to use linear compensation rules with managers, that is that for each price P, the managers receive λP, where $\lambda < 1$. The range of market prices for which managers choose integration is therefore $[\underline{\pi}/\lambda, \overline{\pi}/\lambda]$

Consider a distribution of cash $F(l)$ among the A managers, where $\int dF(l) = n > 1$, and let l_F be the *marginal cash*, that is there is a measure n of A managers with cash greater than l_F

$$F(l_F) = n - 1.$$

There is no loss of generality in assuming that only A firms with cash greater than l_F will be active on the matching market.

Since there is a measure $n-1$ of A units that will not be matched, A managers will try to offer the maximum payoff consistent with being matched with a B unit while getting a nonnegative payoff. Fix the product price at P. The maximum surplus that a B manager can obtain via integration is $(1-\sigma)P - 1/4$. The maximum he can obtain when the sharing rule is s is $W^N(s, P)$; however this can be achieved only if

[19] Jensen (1986) argued that 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 firms size that is below the optimum. Legros and Newman (1996) and (forthcoming) discuss the role of cash in equilibrium models of organizations.

the A manager has cash at least equal to $\pi_A^N(s, P)$ that can be transfered ex ante to B.

We have three regimes. First, when $\lambda P \leq \underline{\pi}$, or when $\lambda P \geq \overline{\pi}$, integration is dominated by nonintegration (Lemma 1) and therefore cash has no effect on the supply curve: each firm produces $Q^N(\lambda P) = 1 - \frac{1}{(1+\lambda P)^2}$ and the role of cash is to increase managerial surplus since the transfer of cash enables firms to choose s closer to 1/2.

When $\lambda P \in (\underline{\pi}, \overline{\pi})$, as in Figure 1, there exists a sharing rule s_0 for which

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

Then, assuming that the A managers have a zero outside option, manager B is indifferent between using integration with a share of $s = 0$ to A or using nonintegration with a share $s_0(P)$ to A and getting an ex ante transfer of

$$L(P) = \pi_A^N(s_0(\lambda P), \lambda P).$$

If $l < L(P)$, the maximum payoff to a B manager is less with nonintegration and an ex ante transfer of l than with integration. Hence, all A firms with $l \leq L(P)$ will still offer integration contracts in order to be matched; however, firms with $l > L(P)$ will offer nonintegration contracts.

The measure of firms that integrate is the measure of A managers with cash greater than $L(P)$. Hence, there is a measure $F(L(P)) - F(l_F) = F(L(P)) - n + 1$ of firms that integrate and a measure of $n - F(L(P))$ of firms that do not integrate. With cash there is a smaller measure of firms that integrate, and because the output with integration is larger than with nonintegration when $P < \pi^*/\lambda$ we conclude that the supply curve rotates at π^*/λ, as illustrated in Figure 5 and the next proposition

Proposition 7 *With cash, the supply curve coincides with the no cash case when $P \notin (\underline{\pi}/\lambda, \overline{\pi}/\lambda)$. When $P \in (\underline{\pi}/\lambda, \pi^*/\lambda)$ the supply curve is shifting in and when $P \in (\pi^*/\lambda, \overline{\pi}/\lambda)$ the supply curve is shifting up.*

Going back to the characterization of the conflict between managers and the other stakeholders we note two opposite effects of cash. First, there is less often inefficient integration in the region $P \in (\pi^*/\lambda, \overline{\pi}/\lambda)$ and therefore output is larger and prices lower. Second, there is more inefficient nonintegration since firms stay non integrated in the price region $(\underline{\pi}/\lambda, \pi^*/\lambda)$ while they were integrated before; since integration

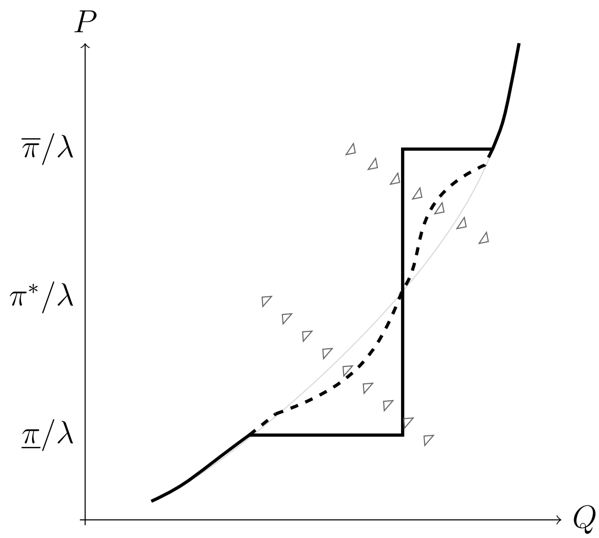

Figure 5: The effect of cash

is output maximizing in this region, inefficiencies increase from the point of view of consumers and owners. 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. Here while cash reduces the over-internalization of the benefits of coordination, it increases the over-internalization of the benefits of specialization. This role of cash seems new to the literature.

4.2.2 Heterogeneous HQs types σ

Assume that HQs have type σ with distribution function F; suppose they all have the same outside option $u > 0$. We define σ_F by

$$F(\sigma_F) = 1$$

Hence if all firms choose integration, the 'marginal' HQ has type σ_F.

A firm using integration with a HQ of type σ generates a total surplus of $(1 - \sigma)P - \frac{1}{4} - u$, while the surplus with nonintegration is the same as in the text. It follows that managers are indifferent between integration and nonintegration at

$$\sigma(P,u) \equiv \frac{P-1}{2P(P+1)} - \frac{u}{P}. \tag{11}$$

Now, if the managers are willing to hire an HQ of type σ and pay him a compensation of h, they are also willing to hire an HQ of type σ' and give him a compensation h' such that $(1-\sigma)(1-h) = (1-\sigma')(1-h')$. In fact, since $(1-\sigma')h' = (1-\sigma)h+\sigma-\sigma'$, it must be the case that *all* HQ with type less than σ are hired. An equilibrium will therefore specify a marginal HQ type σ^* such that $F(\sigma^*)$ is the measure of integrated firms.

Proposition 8 *Suppose that $u < 1/2$; let P^0 be the maximand of $\sigma(P,u)$.*

(i) If $\sigma_F < \sigma(P_0,u)$, all firms choose nonintegration.

(ii) If $\sigma_F > \sigma(P_0,u)$, there exist $\underline{\pi}(\sigma_F), \overline{\pi}(\sigma_F,u)$ solving $\sigma(P,u) = \sigma_F$, such that a measure $F\left(\min\{\sigma_F, \sigma(P,u)\}\right)$ integrate and the other firms choose nonintegration.

The derivation of the marginal HQ is illustrated in Figure 6 below.

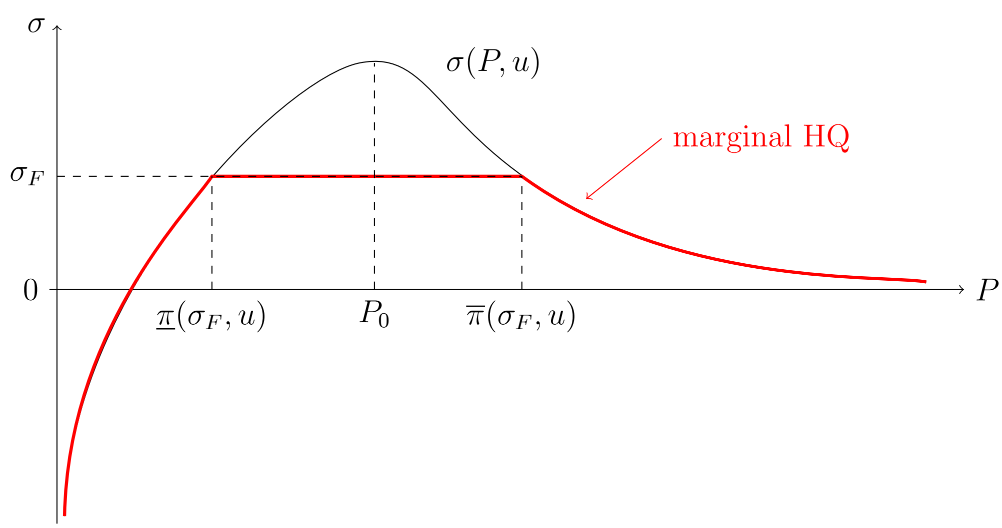

Figure 6: Marginal HQ: $\min\{\sigma_F, \sigma(P,u)\}$

The OAS will appear similar to the one depicted in Figure 5. As long as $F(\sigma_F) < 1$, we will have coexistence of integration and nonintegration for almost all prices. Except for this difference, we have the same qualitative properties as before: for low prices, integration would be preferred by consumers (and shareholder) but is not chosen by managers, while for middle prices integration is chosen while nonintegration would lead to a higher level of output.

5 Conclusion

In many models of organization, managers trade off pecuniary benefits derived from firm revenue against private costs of implementing decisions. In our model, 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, nonintegration 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, organizational choices also affect production: nonintegration produces relatively little output compared to integration at low prices, as managers prefer a "quiet life"; at certain higher prices, integration can be less productive than nonintegration, despite being preferred by managers. Thus, organizational decisions rendered by managers acting in their own interests can lead to lower output levels and higher prices than would occur if they were forced to act in consumers' interests. This result is obtained even with a competitive product market, i.e., firms or managers do not take into account the effect of reorganization or vertical integration on product prices.

We believe that these effects can be identified in practice. For instance, the model can identify conditions under which "waves" of integration are likely to occur – e.g., growing demand in an initially non-integrated industry – or when opening borders to low cost suppliers might lead to increased product prices. More generally, as prices, quantities, and integration decisions are easily measured, we are hopeful that models such as the present one will encourage empirical investigations that will quantify the real-world significance of the effects of prices on organization and vice versa.

Our analysis 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 output would be higher under nonintegration), 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.

Instead, the model suggests a novel benefit of corporate governance regulation: in competitive markets, strengthening owners' ability to force appropriate integration decisions may improve consumer welfare as well as shareholder interests. In our competitive world, shareholder and consumer interests are (nearly) aligned since they both would value higher levels of output. However, as we have shown, even if owners control organizational choice, their interests will typically diverge somewhat from those of consumers.

Notice in particular that governance matters 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 is in contrast to 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.

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, owners and consumers interests are no longer aligned, and as we have already noted, managerial discretion may be a way for owners 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.

6 Appendix

6.1 Proof of the Claim in Footnote 13

Consider a specification $Pf(a,b)$ and increasing costs $C_A(a)$, $C_B(b)$. Assume that $C_B(0) = 0$ and that $f(a,b)$ is strictly increasing in a, b and has an upper bound of y. We prove the claim that there is nonintegration at low and high prices and that if integration is used, it must be for intermediate values of price.

Assume that the long side managers have a zero outside option and therefore that the payoff to the short side managers (B) is the total welfare.

We show that either nonintegration is always preferred to integration for low values of P and for large values of P.

With integration, HQ chooses a, b to maximize $f(a,b)$. Assume that HQ chooses the cost minimizing solution (a^I, b^I) if there is more than one optimum solution. Payoff to the B manager is $u_B^I(P) = Py(1-\sigma) - C_A(a^I) - C_B(b^I)$, where y is the maximum output.

With nonintegration, the short side chooses s to maximize $(1-s)Pf(a,b) - C_B(b)$ where (a,b) is a Nash equilibrium of the game induced by s. Let $u_B^N(P)$ be the optimal value for B. If $u_B^N(P) > u_B^I(P)$ for all P, there is nothing to prove. If however there exists P such that integration is preferred to nonintegration we show that necessarily nonintegration is preferred to integration for large values of P.

As $P = 0$, the Nash equilibrium is $a = b = 0$ and B has a zero payoff; therefore for low prices nonintegration is preferred to integration. For $P > 0$, the payoff $u_B^N(P)$ is greater than what B can achieve with $s = 0$. If $s = 0$, for any P a Nash equilibrium requires $a = 0$. Let $b(P)$ be the solution of $\max_a Pf(0,b) - C_B(b)$. The payoff to B when $s = 0$ is then $v_B(P) = Pf(0, b(P)) - C_B(0, b(P))$ and by the envelop theorem, $v_B'(P) = f(0, b(P))$. Note that $b(P)$ is strictly increasing in P, and therefore that $v''(P) = b'(P) f_2(0, b(P)) > 0$. Hence $v_B(P)$ is convex increasing in P. Because $dv_B^I(P)/dP = y(1-\sigma)$, there exists b^* such that $f(0, b^*) = y$, and therefore there exists P^* such that $b(P^*) = b^*$ and $v_B'(P) > y(1-\sigma)$, for all $P > P^*$. This shows that for P large enough $u_B^N(P) \geq v_B(P) > u_B^I(P)$, as claimed.

6.2 Proof of Proposition 1

(i) Managerial welfare under integration is smaller than the minimum managerial welfare under nonintegration 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 (5), maximum welfare under nonintegration 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.

6.3 Proof of Proposition 2

(i) From the text, the lower bound $P^N(\lambda)$ on prices for which nonintegration 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 $P_a \in (P^N(\lambda), \underline{\pi}/\lambda)$. Consider the supply function as in (8) when α firms integrate. Let $P(\alpha)$ the equilibrium price with this supply function: $S(P(\alpha), \alpha) = D(P(\alpha))$. As long as $P_a \in (P^N(\lambda), \underline{\pi}/\lambda)$, there exists $\alpha > 0$ such that $P(\alpha) \in (\underline{\pi}, \underline{\pi}/\lambda)$ and $P(\alpha) \geq c'(Q^N(P_b))$. See figure 7 where we have represented a typical demand function going through point a and a feasible α.

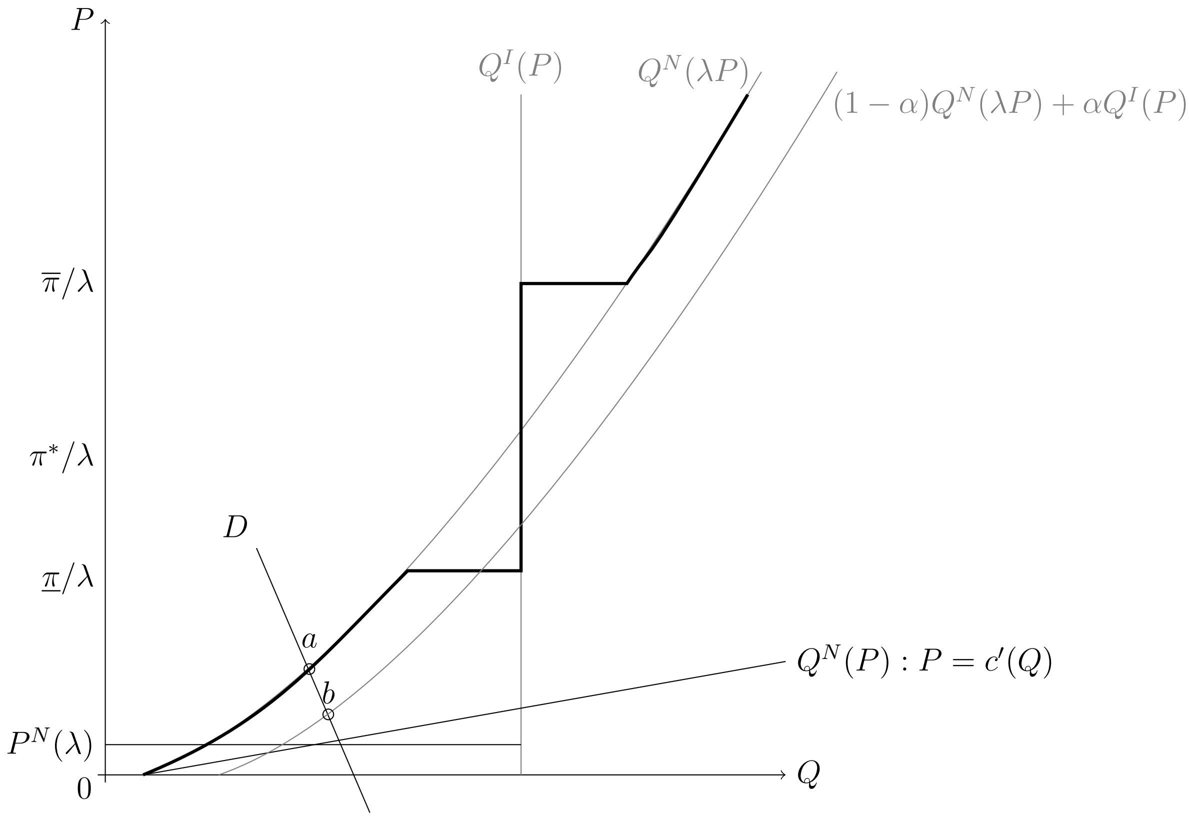

Figure 7: Nonintegration is Second-Best Inefficient: General Case

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

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

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

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

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

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

Since $P(\alpha) \in (P^N(\alpha), \underline{\pi}/\lambda)$, 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 in figure 8 a typical case. At price P_a, going from integration to nonintegration, 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 indeed a unique price P_a such that total surplus for integration and nonintegration 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 $(P^I(\lambda), \overline{\pi}/\lambda]$.

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 $P(\beta) \in (P^I(\lambda), P_a)$ such

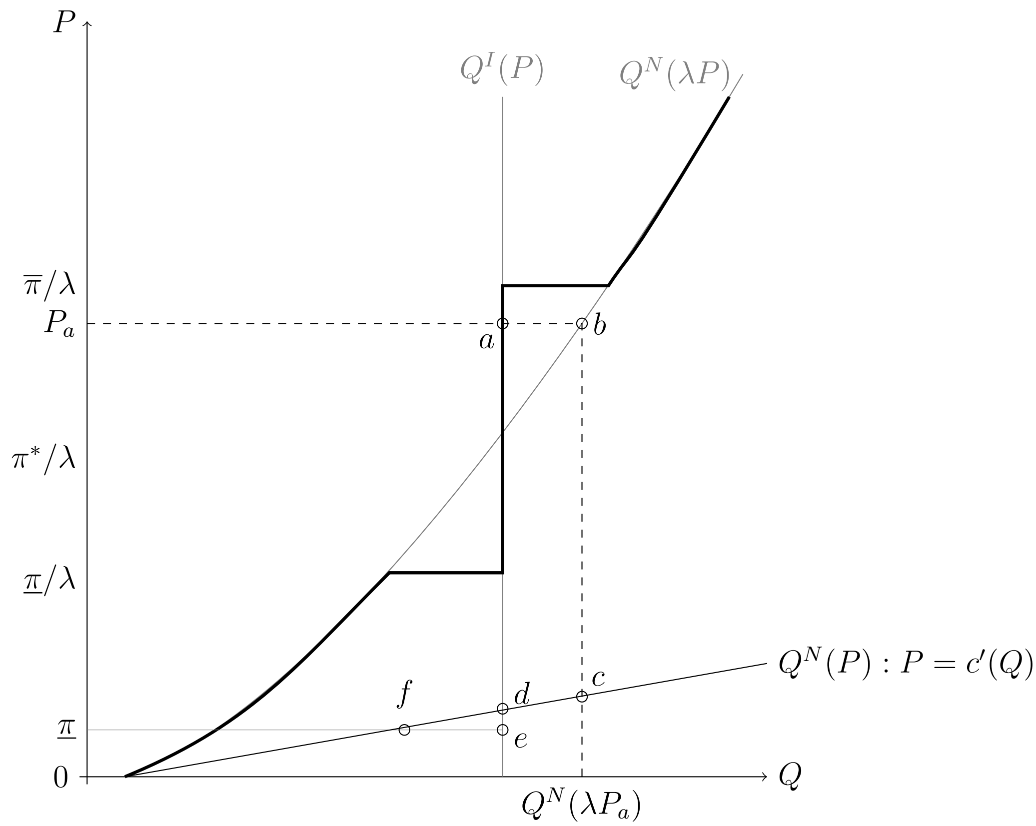

Figure 8: Integration is Second-Best Inefficient

that $D(P(\beta)) = S(P, 1-\beta)$. The variation in welfare is

$$
\begin{aligned}
W(\beta) - W(0) =& \beta \left[\int_{P(\beta)}^{P_a} D(p)dp + P(\beta)Q^N(\lambda P(\beta)) - c(Q^N(\lambda P(\beta))) - P_a(1-\sigma) + \frac{1}{2} \right] \\
&+ (1-\beta) \left[\int_{P(\beta)}^{P_a} D(p)dp + (P(\beta) - P_a)(1-\sigma) \right]
\end{aligned}
$$

Again, it is straightrforward 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 $P(\beta)Q^N(\lambda P(\beta)) - c(Q^N(\lambda P(\beta))) - P(\beta)(1-\sigma) + \frac{1}{2}$, which is positive since we know that for perfectly elastic demand functions in the interval $(P^I(\lambda), \overline{\pi}/\lambda)$, total welfare is greater with nonintegration. This proves (ii).

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

converges to the empty set.

6.4 Proof of Proposition 4

(1) Note that $v^N(0) = 0 > v^I(0)$. On the other hand, $v^N(P^*) < v^I(P^*)$: by definition, $v^N(P^*) = \left(1 - \frac{1}{(1+\pi^*)^2}\right)(P^* - \pi^*) = (1-\sigma)(P^* - \pi^*) < (1-\sigma)(P^* - \underline{\pi})$, since $\underline{\pi} < \pi^*$. Moreover, the marginal payoffs satisfy $v^{N\prime}(P^*) = v^{I\prime}(P^*) = 1 - \sigma$; thus for $P > P^*, v^{N\prime}(P) > v^{I\prime}(P)$, and for $P < P^*, v_N'(P) < v_I'(P)$ 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, $P_0 < \underline{P}$.

As for P_1' however, we do not know if it is greater than $\overline{P}$. If it is, then $\pi^*(P_1') > \overline{\pi}$ and managers will indeed choose nonintegration if they are offered the compensation $\pi^*(P_1')$; using $P_1 = P_1'$ proves the result.

If however $\pi^*(P_1') < \overline{\pi}$, managers will choose integration while owners want to implement nonintegration.[20] If the owners are implementing nonintegration, they must offer a compensation $\pi \notin (\underline{\pi}, \overline{\pi})$ for prices in the interval $[\underline{P}, \overline{P}]$. Remember that the slope of $v^N(\overline{P})$ is $Q^N(\overline{\pi})$. It follows that using a compensation $\underline{\pi}$ cannot be optimal since integration dominates (the graph of the payoff function $Q^N(\underline{\pi})(P - \underline{\pi})$ is tangent to the graph of $v^N(P)$ at $P = \underline{P}$ and is therefore strictly lower than $v^I(P)$ for prices greater than $\underline{P}$.) For a compensation of $\overline{\pi}$ however, the payoff with nonintegration is equal to the integration payoff for a price P_1 in the interval $(P_1', \overline{P})$, proving the result.

(2) If $\sigma > \overline{\sigma}$, managers always prefer nonintegration and the result follows.

6.5 Proof of Proposition 8

The Proposition follows from the following two lemmas.

Lemma 9 *A measure $F(\min\{\sigma_F, \sigma(P,u)\})$ integrate, the other firms choose nonintegration:*

(i) If $\sigma(P,u) \geq \sigma_F$, all firms integrate and the marginal HQ type is σ_F
(ii) If $\sigma(P,u) > \sigma_F$, a measure $F(\sigma(P,u))$ firms integrate and the marginal HQ is $\sigma(P,u)$ and a measure $1 - F(\sigma(P,u))$ choose nonintegration.

Proof.

[20] The necessary and sufficient condition for having $P_1' < \overline{P}$ is $\overline{P} > \frac{Q^N(\overline{\pi})\overline{\pi} - (1-\sigma)\underline{\pi}}{Q^N(\overline{\pi}) - (1-\sigma)}$.

Note first that the highest type HQ that is hired in integrated firms has type $\sigma^* \leq \sigma(P,u)$. Indeed, if $\sigma^* > \sigma(P,u)$, that type has a payoff equal to his outside option u, but then by definition of $\sigma(P,u)$, managers A, B strictly prefer to not integrate rather than integrate with an HQ σ^*.

(i) By definition of $\sigma(P,u)$, managers are indifferent between all HQ with types less than that of the marginal HQ. Since at $\sigma < \sigma(P,u)$ managers strictly prefer integration, it follows that all firms integrate and that the marginal type of HQ is indeed σ_F.

(ii) If $\sigma_F > \sigma(P,u)$, by our initial remark, managers integrate only with HQ types less than $\sigma(P,u)$. The result follows. ■

We then establish single peakedness of the function $\sigma(P,u)$ when $u < 1/2$.

Lemma 10 *For any $u < 1/2$, the function $\sigma(P,u)$ is single peaked in P and is positive for some prices.*

Proof. Clearly, from 11, $\sigma(P,u)$ is positive only if u is small enough; in particular we need $u < 1/2$. The variation of $\sigma(P,u)$ with respect to P has the same sign as that of the quadratic $(2u-1)P^2 + 2(2u+1)P + 2u + 1$ with roots $P_0 = \frac{2u+1-\sqrt{2(2u+1)}}{1-2u}$ and $P_1 = \frac{2u+1+\sqrt{2(2u+1)}}{1-2u}$. If $u < 1/2$, then $P_1 < 0 < P_0$; since the quadratic has opposite sign to that of $(P-P_0)(P-P_1)$, it is positive when $P < P_0$ and negative when $P > P_0$ and therefore $\sigma(P,u)$ is single peaked, with a maximum at P_0. It follows that for a given $\sigma_F < \sigma(P_0,u)$, there are two prices at which $\sigma_F = \sigma(P,u)$, and we call these prices $\underline{\pi}(\sigma_F,u), \overline{\pi}(\sigma_F,u)$. ■

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