February 2022

iFLAME WORKING PAPER SERIES

2022-iFLAME-03

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Managerial Firms, Taxation and Welfare*

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February 14, 2022

Abstract

This paper investigates the welfare properties of an economy where firms are managerial, i.e., composed of two complementary units, each run by its own manager. We show that in the market equilibrium, welfare is generally lower in the case of managerial firms than in that of standard production firms due to the private costs that managers bear to coordinate their operating decisions within the firm. In this organizational setting, we also derive a number of interesting results regarding the welfare effects of taxation. We show that while a lump-sum tax is welfare-neutral, a nonlump-sum tax may have negative, positive or zero net effect on welfare, depending on market conditions, tax levels, and the structure of managerial incentives. In some cases, these welfare effects are due to 'tax-induced' changes in the ownership structure of firms in the industry equilibrium.

JEL Classification: D21, D60, H21, L23

Keywords: managerial firms, welfare, taxation

*We acknowledge financial support by LEM-CNRS 9221. The usual disclaimer applies.

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1 Introduction

It is undisputed nowadays that organizational practices and managerial behaviors are critical determinants of productivity of firms. Modern theories consider a firm as a way to organize production activity in the presence of complex production processes and pervasive transaction costs, which requires managerial governance (see, e.g., Bolton and Dewatripont [10]). Empirical evidence supports this view, and suggests that organizational incentives matter for (variously defined) empirical measures of productivity and economic efficiency.[1] In the face of this general consensus, it seems important to develop a theory that analyzes the welfare effects of organizational incentives inside the firms. In fact, the leading approach to welfare economics still adopts a technological perspective, which neglects the analysis of welfare implications of firms being run by managers (or headquarters) with a private, possibly nonmonetary, stake in the production process (e.g., due to their specific training, information, background experiences, or motivations).

Gaining some insight on the welfare properties of a market equilibrium where firms take organizational decisions is very important to better understand the welfare consequences of specific policy interventions, even in perfect competitive markets. The analysis of the economic effects of taxation offers a good example of this. The crucial result in this field is the production efficiency theorem by Diamond and Mirrlees [17].[2] Their study builds upon technological considerations only, and inspired widely acknowledged fiscal policy guidelines (see Mirrlees et al. [36] for a discussion). These reviews recommend to design tax systems that are neutral with respect to firm production decisions, but do not clarify whether

[1] Bertrand and Schoar [7] showed that managers were important in a wide range of corporate decisions in the US in the second half of the 20th century. More recently, Bandiera *et al.* [5] pointed out the effect of managerial behavior on performance of large manufacturing firms in Brazil, France, Germany, India, the UK and the US. These and other related papers in economics and finance (see, e.g., Hoffman and Tadelis [25]; Lazear [30]; Bolton et al. [9]; Kaplan [26]) have argued that the behavior of management and CEOs is codetermined by a set of private incentives that are either costs or benefits, some of which nonmonetary by nature, e.g., related to specific skills or preferences, or self-motivation.

[2] The production efficiency theorem states that in a competitive economy, the optimal tax structure leaves firm production choices unaffected. Based on this fundamental result, theories of optimal taxation show that non lump-sum taxes reduce welfare when firms operate in perfect competitive markets, while envisage their corrective role with market power (see Auerbach and Hines [4] for a synthesis).

firm ownership decisions should be taken into account. This seems an important shortcoming, considering that many empirical facts suggest that increasing tax burdens make the organization of production processes more and more disconnected from economic efficiency considerations. As an example, the ZEW/European Commission research report by Spengel *et al.* [39] shows that the EU average tax profitability ratio (proxied by tax-to-EBT ratio) in the manufacturing sector is higher for small-medium enterprises compared to large enterprises. This measures a deadweightloss of taxation, e.g. due to lower managerial engagement in decision-making process (related to financing, investments, legal aspects, etc.) in small firms that operate non-integrated production processes compared to large integrated firms.[3] Own calculations based on aggregate data for 21 OECD countries suggest some empirical regularities for indirect taxation too: during 1970-2005 the degree of integration in the manufacturing sector decreased in countries where the average effective tax rate on goods and services have correspondingly increased (see Appendix A for details).

This paper makes a first step to investigate the welfare properties of a market equilibrium where firms choose their organization. We feature the organizational theory by Legros and Newman [33] and focus on managerial firms, i.e., those composed of two complementary units, each run by a separate manager. The technology of managerial firms implies that managers have to bear private costs to coordinate the decisions of the two units to avoid production losses. Managers also choose the governance structure of the firm to maximize their joint payoffs. We use this theoretical framework to address a twofold research question. First, we analyze welfare of an economy where production decisions are made by managerial firms under alternative contractual paradigms, and governance structures. Second, we consider the welfare effects of taxation on production decisions by managerial firms under incomplete contracts, distinguishing between lump-sum and nonlump-sum taxes.

As in textbook microeconomic analysis, we adopt economic efficiency as the benchmark

[3]Spengel *et al.* [39] conduct their study on a sample of 20 EU contries in 2013. The report includes a quantitative part, measuring the ration between profit-based taxes and earnings-before-taxes (EBT), separately for small medium enterprises (SME) and large enterprises (LE) in the manufacturing sector. It also includes a qualitative analysis of the determinants of differences between tax-to-EBT ratios of SME vs. LE through in-depth case studies, surveys and desk research.

welfare criterion. In our perfectly competitive setting, the highest welfare in the economy is associated with the profit-maximizing behavior by a standard production (neoclassical) firm (see Mas-Colell *et al.* [35], Chapter 5). Such a firm does not incur managerial costs, and optimally chooses to produce on the frontier of its (production) possibilities. In the first part of the paper, we apply this benchmark to the standard Legros and Newman [33]'s framework. This allows us to evaluate welfare properties of a market equilibrium where production decisions are made by managerial firms, and uncover new welfare effects of taxation with incomplete contracts inside the firm. In the second part of the paper we propose an extension to Legros and Newman [33], inspired by the aforementioned empirical literature on managerial incentives and organizational decisions (e.g., Bertrand and Schoar [7], Bandiera *et al.* [5]). In this novel extension, the behavior of the headquarters is determined by a trade-off between HQs private reward (e.g., due to own satisfaction, or reputation effects from good performance) and executive inefficacy that reduces firm's performance under integration.[4]

The first important finding of this paper is that private managerial costs reduce the total welfare in a perfect competitive market equilibrium. This is true regardless of whether contracts are complete or incomplete within a firm. With complete contracts, self-motivated managers bear a private cost in the effort to coordinate their production decisions. With incomplete contracts, managers negotiate the governance structure of the firm (between integration and nonintegration), and bear the corresponding private costs to coordinate production under either organization. Next, we uncover new welfare effects of taxation with incomplete contracts inside the firm. We find that a lump-sum tax does not have any effect on ownership, production decisions and welfare. We also show that a nonlump-sum (per unit) tax on consumers produces a range of different effects on the organizational margin. In the extension with HQs private reward and production losses under integration, we find a positive welfare effect of private headquarters' benefits that balances managerial welfare costs, so that a nonlump-sum tax may be designed that increases the total welfare.

[4]By itself, the possibility of incurring fixed output losses under integration is already present in an earlier working paper version, Legros and Newman [32]. Our extension is novel as far as HQs' private reward is concerned, as well as the trade off between private benefits and output losses.

This paper primarily contributes to a rich theoretical literature that analyzed welfare consequences of various types of market distortions. Some papers emphasized adverse selection due to information asymmetries, and quantified its welfare costs in perfectly competitive settings by examining the insurance market (see Einav *et al.* [18]). Other papers identified adverse welfare consequences of changes in ownership (e.g., horizontal mergers), consequent to market concentration (see Whinston, [43] for a synthesis). Up to our knowledge, there are not theoretical studies pointing out negative welfare consequences of organizational decisions within the firm. This seems an important limitation, considering that many empirical studies have quantified firm-level inefficiencies are large, and geographically very widespread both in developed and developing countries (Leibenstein [34], Frantz [19]).[5] This paper moves a first step to fill in this gap. Our main contribution to this literature is to point out theoretically new welfare costs that operate at the organizational margin in a perfectly competitive market's equilibrium. These costs are generated by managerial incentives described by Legros and Newman [33], which are consistent with modern theories of the firm (e.g., Grossman and Hart [21], Hart and Moore [24], Hart and Holmstrom [23]). As an additional contribution, we extend Legros and Newman [33], and consider private benefits of the headquarters from implementing an own task. In this way, we highlight the opposite welfare effects of managerial costs and the headquarters' benefits in the market equilibrium.

We also contribute to the literature on optimal taxation (see Auerbach and Hines [4] for a synthesis). A recent strand of this literature emphasizes the importance of deviating from the standard production behavior of neoclassical firms to account for the central role of administrative transaction costs that are needed for firms to remit taxes to the government. These costs may differ depending on the type of tax (e.g., a value added tax as opposed to

[5]Leibenstein [34] calls them X-inefficiencies to underline they are an anomaly with respect to the then conventional wisdom, in which markets could be inefficient due to market power but firms were always efficient. Frantz [19] reviews empirical estimates of firm level inefficiencies for the banking sector. He argues that, nowadays, an average firm produces about 20% below their (output and/or cost) frontier, even less in developing countries e.g. India and China. He also confirms that X-inefficiencies are much larger than inefficiencies due to market power.

a general sales tax), implying that the degree of tax enforcement may vary with the tax system (Kopczuk and Slemrod [28]). In this paper, we do not compare alternative tax regimes, but put forward a complementary argument for departing from the production paradigm of Diamond and Mirrlees [17], i.e., that firms being managerial, and contracts being incomplete within a firm matters for the efficiency of taxation.[6] We confirm the well-known result that lump-sum taxes are welfare-neutral with perfect competition, while we point out a broad range of new effects of nonlump-sum taxes, which operate on the organizational margin, and depend on external market conditions, the characteristics of the tax, and attributes of managerial incentives themselves. In particular, we highlight a specific welfare effect of nonlump-sum taxation that operates through managers' decision to switch organization type. We call this a 'tax-induced organizational change'.[7] In the main framework, we show that tax-induced organizational changes (from integration to nonintegration) reduce welfare. However, in the extended model, we also show that nonlump-sum taxes may have a corrective impact on the organizational margin by inducing firms to switch to the more productive organization structure (integration). The existence of a corrective role of nonlump-sum taxation is already well known in the presence of market power distortions, examined starting from the pioneering study by Wicksell [40]. Similar effects of nonlump-sum taxation, despite very different underlying mechanisms, arise also with nonlinear consumption taxes (see, e.g., Carbonnier, [11]), and in the presence of different pricing behaviors of firms (e.g., multipart tariffs; see D'Annunzio, *et al.* [15]) and various market arrangements (e.g., with multiproduct retailers; see Hamilton, [22]). We are the first to envisage a corrective role of nonlump-sum taxation solely attached to an organization margin, without departing from perfect competition.

The rest of the paper is structured as follows. Section 2 describes the baseline frame-

[6]Note that the two approaches can be regarded as complementary since incomplete contracts provide a natural formalization of transaction costs. In fact, Williamson [42] defines the asset governance theories with incomplete contracts proposed by Grossman and Hart [21] and Hart and Moore [24] as the 'natural progression' of transaction cost economics.

[7]In the CEPR working paper version, Legros and Newman [32] recognize that taxes may have organizational consequences, but neither investigate them, nor analyze any welfare effects of taxation.

work. Section 3 presents the welfare analysis and describes the impact of taxation. Section 4 extends the baseline analysis to model a richer behavior of the headquarters. Section 5 concludes the paper.

2 Managerial firms: the baseline framework

In this section, we review the existing model of managerial firms by Legros and Newman [33]. This provides the theoretical benchmark to the welfare analyses of managerial costs and taxation in Section 3, and to further extension developed in Section 4.

2.1 The Economy

Environment and technology. There are two types of production units, A and B, which are matched one-to-one to create firms that produce a marketable homogeneous good. Production units are run respectively by managers M_a and M_b, who are risk-neutral and cash-constrained and have limited liability.

For simplicity, we assume an exogenous firms' production target $\overline{f}$. This production plan needs to be implemented by making operating decisions for each unit. Let $a \in [0,\ 1]$ and $b \in [0,\ 1]$ be the decisions made for units A and B, respectively, so that the actual production is $q = \overline{f}[1 - (a - b)^2]$, such that increasing the degree of coordination among units (i.e., setting closer a and b) increases the productivity of the production process. Without a loss of generality, we normalize $\overline{f}$ to unity to obtain the following:[8]

$$q = 1 - (a - b)^2. \tag{1}$$

According to (1), a production plan with fully coordinated decisions $a = b$ ensures the highest attainable output $q = 1$ among all feasible plans, while any deviation from full

[8]The mechanisms and results of the paper will still hold with a more general production process, e.g., one featuring the use of nonmanagerial inputs such as labor. Legros and Newman [33] in this case show that organizational choices would carry over to factor demand and employment in the equilibrium (see Section IV.B of the cited study for details).

coordination entails a production loss, described by a $q < 1$.

The primary function of managers is to implement decisions within their respective units. Managers regard operations differently, based on their different experience, training, information and available technology so that each manager finds it costly to accommodate another's approach. Let $C(a)$ and $C(b)$ be the costs of accommodating a different approach, borne by M_a and M_b, respectively:

$$C(a) = (1-a)^2, \quad C(b) = b^2. \tag{2}$$

$C(a)$ and $C(b)$ indicate that managers M_a and M_b 'disagree' over direction, as the preferences of M_a are increasing in a while those of M_b are decreasing in b. Equations (1) and (2) introduce the trade-off between the benefits and the costs of coordination for managers in Legros and Newman [33]. The benefits of coordination are related to the activities of the firm as a whole, and thus are monetary and fully transferable within the firm. The costs of coordination are related to the managers' subjective preferences, and thus are private in nature and not transferable to any other agent.

Organizational structure. Managers can choose between *nonintegrated* and *integrated* governance structures. Under a nonintegrated structure, managers retain control over their units, and their decisions determine the production plan (1). In an integrated structure, managers integrate into a single firm and hire a cash-constrained headquarters (HQ) that centralizes the decision-making process and obtains a part of the revenue as the performance compensation. This assumption is made without excuse as the reasonable share of overall CEO compensations consists of performance-related payments (See Kaplan and Rauh [27], Gabaix and Landier [20]). [9] We also assume that the HQ's payoff is purely monetary, and the HQ can perfectly 'instruct' managers about the decisions to be implemented. This implies that

[9]The assumption that managers hire the HQs is a small departure from Legros and Newman [33], which assume that HQs buy the firm instead. This assumption does not have any implication for this baseline setting, but becomes important in Section 4, where we allow HQs to get a non monetary private benefit from enhancing coordination, as implies HQs do not need to compensate back managers.

HQs make decisions a and b that maximize their income and that decisions are implemented in the production process at zero cost (besides the private costs incurred by managers). In Section 4, we will relax this assumption and assume that HQs also enjoy some nonmonetary private benefit from coordination (e.g., reputation), but also lack some unit-specific skills (e.g., in the implementation of tasks), which imposes some fixed production losses.

Contracts. If managers could write an enforceable contract, they would specify ex-ante operating decisions a and b, and how to share coordination costs. The formal description of this case is in Appendix B. However, enforcing such a contract can be infinitely costly in practice, which leads to incomplete contracting. Nevertheless, we assume that managers can, under ex-ante competitive conditions, negotiate different contracts that specify the governance structure G and revenue shares. A contract for M_a and M_b is structured as follows:

- under nonintegration ($G = N$), a contract specifies a share $s_a \in [0, 1]$ accruing to M_a. Accordingly, M_b obtains $s_b = 1 - s_a$.
- under integration ($G = I$), the HQ is hired in exchange for a revenue share η such that $\mathbf{s} = (s_a, s_b, \eta)$ and $s_a + s_b + \eta = 1$.

Each contract 'locks' the managers into a relationship by making their operations fully specific to the match until the production outcome is realized.

Markets. We describe a general equilibrium model with a product market, a supplier market and an HQ market. The product market is perfectly competitive with price-taker firms producing a homogeneous consumption good Q. We assume that there is a representative consumer with the following quasi-linear utility function:

$$U(x) - Px,$$

where $x \geq 0$ represents the quantity consumed, P the market price, $u'(\cdot) > 0$ and $u''(\cdot) \leq 0$. Since consumers are price-takers, the first-order condition for utility maximization, $U'(x) = P$, yields a standard differentiable downward-sloping demand function $Q_d(P) = U'^{-1}(P)$.

The supplier market is perfectly competitive with managers of type M_a being more numerous than those of type M_b: their measure is $n > 1$, while managers of type M_b have unit measure.

Timing. The timing is as follows:

- managers sign the contract (G, s) specifying the governance structure and the revenue shares,
- managers or the HQ (depending on the governance structure chosen) make the decisions for the units, and
- managers (or whatever party is entitled to make the decisions) implement the decisions and bear the private costs, production takes place and markets clear.

Payoffs and assumptions. The payoffs of M_a and M_b under organization $G = N, I$ are, respectively:

$$\pi_G^a = s_a \, P \, q - \, C(a_G), \qquad \pi_G^b = s_b \, P \, q - \, C(b_G), \tag{3}$$

where P is the market price, s_a and s_b are managers' revenue shares, and q is the output of the firm under organization $G = N, I$.

We assume that under nonintegration, M_a and M_b implement the decisions a and b simultaneously, without consultation or negotiation, to maximize their payoffs (3). Conversely, under integration, managers pay the HQ a positive share η of the firm's revenue to make a decision. The HQ's payoff is as follows:

$$\pi^{HQ} = \eta \left[Pq \right], \tag{4}$$

which implies that the HQ is motivated only by monetary concerns and bears no cost from decisions a and b.

In this setting, a symmetric competitive equilibrium consists of a market clearing price P^*, a share of firms $\alpha \in [0, 1]$ that choose to integrate, and a distribution of revenue shares

$\mathbf{s} = (s_a, s_b, \eta)$ such that

- the product market clears, i.e., $Q_d(P^*) = Q_s(P^*) \equiv \ \alpha\ Q_I^* + \ (1-\alpha)\ Q_N^*$, where Q_I^* and Q_N^* are the optimal production quantities under integration and nonintegration, respectively, and

- managers choose to hire an HQ if and only if

$$\Pi_I^* \geq \Pi_N^*, \quad \textit{where} \ \ \Pi_G^* = \pi_G^{a*} + \pi_G^{b*} = P^* Q_G^* - (C(a_G^*) + C(b_G^*)), \quad G = I, N \tag{5}$$

- The distribution of revenue shares $\mathbf{s}^*$ satisfies managers' and the HQ's incentives compatibility constraints, i.e., $s_a \geq 0$, $s_b \geq 0$ and $\eta \geq 0$.

2.2 Market equilibrium and industry structure

2.2.1 Production decisions under each organization

Under nonintegration, managers make the decisions for their units. Accordingly, there is no HQ and $\eta = 0$. To simplify the notation, in this case revenue shares accruing to M_a and M_b are denoted by s and $(1-s)$, respectively. Substituting the production plan (1) and the cost functions (2) in the profit functions (3), we obtain the following Nash equilibrium:

$$a_N^* = \frac{1}{1+P} + \frac{(1-s)P}{1+P}; \qquad b_N^* = \frac{(1-s)P}{(1+P)}. \tag{6}$$

We substitute (6) in (1) to obtain the equilibrium output under nonintegration:

$$Q_N^* = 1 - \frac{1}{(1+P)^2}. \tag{7}$$

Equations (6) and (7) show that revenue shares s, $(1-s)$ and market price P provide managers with different types of monetary incentives. (i) *Revenue shares determine the distribution of the coordination effort between managers*: if s is small, M_a makes a decision that she likes (a_N^*

high), while M_b makes a decision that she dislikes (b_N^* high); thus, the burden of coordinating weighs more on M_b.[10] (ii) *The market price determines the level of managers' coordination efforts*. If P is high, production is valuable because the revenue potential of the firm is high. Thus, both managers make decisions they dislike in order to minimize coordination failures (M_a chooses a low a_N^*, and M_b chooses a high b_N^*).

Under integration, a self-interested HQ maximizes (4). Accordingly, the HQ sets $a = b$. This is indeed the fully coordinated decision that maximizes production, and thus the HQ's income. Since an infinite number of $a = b$ combinations exist, we assume that the HQ makes the decision that minimizes managers' total private costs, i.e., $a_I^* = b_I^* = 1/2$, and production under integration is maximized, i.e., $Q_I^* = 1$ (Legros and Newman [33]).[11]

2.2.2 Organizational choice and industry supply

At the contracting stage, managers specify the governance structure and revenue shares. The negotiation over revenue shares plays a pivotal role in determining managers' payoffs in the equilibrium. An excess supply of managers of type M_a drives their revenue share to zero under either governance structure. According to (6), the sharing rule $s = 0$ under non integration defines the outcome $a_N^* = 1$ and $b_N^* = P/1 + P$: since M_a receives no revenue, that manager makes the decision according to own preferences and leaves all the coordination effort to M_b.

Under integration, the HQ's decision $a_I^* = b_I^* = 1/2$ induces the total managerial cost $C(a_I^*) + C(b_I^*) = 1/2$. Without a loss of generality, we also assume that HQs operate at zero opportunity cost; thus, $\eta = 0$.[12] Then, managers have the same revenue shares as

[10] The opposite holds true if s is large. This occurs due to the assumption that M_a and M_b behave noncooperatively, as discussed by Legros and Newman[33]. Note also that the distribution of coordinating efforts between managers has no effect on the production plan, and thus on the total production under nonintegration.

[11] Note that neither revenue shares nor producer prices affect output. In fact, the HQ receives a payment that is proportional to the firm's production and incurs no costs from the implementation of its decisions because these are privately borne by managers. Accordingly, the HQ wants only to maximize production by implementing full coordination.

[12] This assumption is made for expositional simplicity. Results will not be altered if HQs are allowed to have a positive reservation wage, as in Conconi, Legros and Newman[13]. Under a zero opportunity cost of the HQ, the outcome implemented will be the same as that under complete contracts because hiring an HQ is costless for managers. In section 4, we will examine the case of an HQ causing some production loss due to its

in the nonintegration case. In particular, $s = 0$, which implies that M_a suffers a net loss $\pi_I^a = -1/4$. This net loss is fully covered by M_b because under integration any surplus is fully transferable between units.

We substitute the equilibrium decisions and output levels for $s = 0$ into (5) to obtain the equilibrium aggregate payoffs for managers under nonintegration and integration, respectively:

$$\Pi_N^* = \frac{P^2}{(1+P)}, \qquad \Pi_I^* = P - \frac{1}{2}. \tag{8}$$

Note that Π_N^* fully depends on the production of the firm for a given price P, while Π_I^* contains an additional constant term of managerial cost that is unrelated to firm productivity and is a cost that the HQ imposes on managers. The convexity of cost functions (2) implies that aggregate costs $(C(a_G^*) + C(b_G^*))$ are maximized by the sharing rule $s = 0$ under nonintegration (i.e., in Π_N^*) while being minimized by the HQ's behavior under integration (i.e., in Π_I^*). This specifies a typical equilibrium in modern theories of the firm (e.g., Williamson[41]; Hart and Holmstrom[23]), where a negotiation that leads to 'winners' as opposed to 'losers' produces greater aggregate losses than does an equilibrium in which the parties share the benefits and costs equally. In fact, if $s = 0$, under nonintegration M_a leaves the entire burden of coordination to M_b who is the 'winner' in the negotiation. Under integration, the HQ implements the fully coordinated plan that minimizes the aggregate managerial costs, i.e., partly internalizes the managers' wishes, regardless of revenue shares.[13]

Equations (8) describe the set of managers' incentives. At given producer prices, the management will adopt the organization type that ensures the highest payoff:

$$\Pi_I^* \geq \Pi_N^* \;\Leftrightarrow\; P \geq 1. \tag{9}$$

According to (9), the organizational choice depends on the market price because this

incompetence, and the equivalency of contracts will not hold anymore.

[13]The 'transaction cost economics' literature (see Coase[12]; Williamson[42]) generally assumes that in the presence of pervasive transaction costs, a socially inefficient outcome is more likely to occur with nonintegration than with integration because in the latter case the HQ operates as a 'benevolent regulator'.

determines the strength of cost minimization relative to revenue maximization in the payoff functions (8). If $P < 1$, the revenue motive in the payoff of M_b is not high enough to compensate for the costs that manager has to bear to implement an efficient production plan. Thus, M_b chooses nonintegration, which allows that manager to live a 'quiet life' and save on private costs. Conversely, if $P > 1$, the unbalanced set of incentives to coordinate disproportionately increases the aggregate costs under nonintegration. Then, M_b chooses integration because this organization type maximizes the output at the lowest private cost consistent with full intra-firm coordination. Finally, if $P = 1$, the combination of revenue and cost minimization incentives make M_b indifferent between integration and nonintegration.[14]

Lemma: *The profit-maximizing plan is $Q_I = 1$ only if $P > 1$. If $P < 1$, the profit-maximizing plan is interior to the production possibility frontier, i.e., $Q_N < 1$.*

This result, which builds upon Proposition 1 by Legros and Newman [33], allows us to point out an important difference of managerial firms with the standard production (referred to as neoclassical) firms. In the present framework, such a firm would maximize the production function (1), where the only inputs are decisions a and b. By doing so, it would completely abstract from any disagreement in the production process, described by cost functions (2). In other words, a neoclassical firm would behave as a revenue maximizer, and optimally choose a plan on the production possibility frontier, i.e., $a = b$ and $q = 1$, consistent with Mas Colell et al. [35] (cfr. Proposition 5.F.1). In contrast, a managerial firm internalizes managers' private costs into the profit maximization decision instead. According to equation (9), managers choose to maximize production only when market prices are sufficiently high (i.e., $P > 1$) by entitling the HQ to behave as a revenue maximizer. However, if market prices are sufficiently low, the managers' profit-maximizing choice is not to integrate and to enjoy a 'quiet life', which leaves unexploited production possibilities.

The industry equilibrium is a general equilibrium of the supplier market and the product

[14]Note that the sharing rule $s = 0$ identifies M_b as the 'real player'. In fact, since M_a always obtains her outside option, that manager is indifferent between the two organization types. M_b instead chooses the organization type that ensures her the highest aggregate payoff.

market. The equilibrium in the supplier market consists of a mass of firms of size equal to 1 (this is due to managers of type M_b being on the 'short side' of the market with a unit measure). In equilibrium, a share $\alpha \in [0,1]$ chooses to integrate so that:

$$\alpha = \begin{cases} 0 & if \quad P < 1, \\ \in [0,1] & if \quad P = 1, \\ 1 & if \quad P > 1. \end{cases} \tag{10}$$

The set of conditions (10) specifies three possible equilibria in the supplier market, depending on the structure of M_b's incentives described by (9). If $P < 1$, all firms adopt a nonintegrated structure, and a pure strategy equilibrium with nonintegration emerges in the supplier market, $\alpha = 0$. If $P > 1$, all firms prefer an integrated structure and a pure strategy equilibrium with integration occurs in the supplier market, $\alpha = 1$. Finally, if $P = 1$, managers of type M_b obtain the same payoff under either organizational type and a mixed strategy equilibrium emerges in the supplier market where firms randomly choose one of the two organizational types, $\alpha \in [0,1]$.[15]

We now turn to the description of the general equilibrium. The supply function is simply the sum of supply from integrated and nonintegrated firms:

$$Q_s = \alpha + (1-\alpha)\, Q_N^*, \tag{11}$$

where α is the equilibrium in the supplier market described by (10). Equation (11) incorporates into the neoclassical supply concept those incentives that determine the design of firm governance in the industry equilibrium. This "organizationally augmented supply"(OAS) curve is shown as the black line in Figure 1. If $P < 1$, $\alpha = 0$ and the market supply results from a nonintegrated industry structure as in (7) above. If $P > 1$, $\alpha = 1$ and supply is obtained under an integrated structure, which is $Q_I^* = 1$. Finally, if $P = 1$, $\alpha \in (0,1)$ and Q_N^*, Q_I^* are weighted by the industry shares $1-\alpha$ and α of nonintegrated and integrated firms,

[15] All of these results hold under the assumption that the opportunity cost of the long side is zero; thus, $s = 0$.

respectively.

3 Welfare analysis

The derivation of the OAS curve prompts a welfare analysis in terms of the total surplus in the market equilibrium. As we are interested in forces that operate on the supply side of the economy, we can abstract from consumers' welfare without a loss of generality. Thus, we consider an infinitely elastic demand function such as $Q_d(P)$ in Figure 1. We start by establishing our benchmark welfare criterion. Afterwards, we discuss the efficiency of the market equilibrium with managerial firms. Then, we discuss the effects of taxation.

3.1 Managerial costs and Welfare

To evaluate welfare at the market equilibrium with managerial firms, we adopt as a benchmark the welfare level in a perfectly competitive equilibrium with neoclassical firms. As discussed above, in the present framework there are only managerial inputs involved in the production process, so a neoclassical firm would choose $q = 1$. Thus, market supply by neoclassical firms would be perfectly inelastic at $Q^* = 1$. At market price P^*, the total surplus would be measured by the area of the rectangle $(0, P^*), X, (1, 0), (0, 0)$ in Figure 1, Panel c, and would be equal to $P^*(= P^*$ x $1)$. This is the highest attainable welfare level corresponding to the case of a costless effort by managers. In the present setting, this is entirely enjoyed by firms, as demand is perfectly elastic.

Having this welfare benchmark in mind, we are now ready to evaluate welfare in the case of managerial firms. In particular, we can state the following:

Proposition 1: *Private managerial costs imply that the total welfare in a perfectly competitive market equilibrium is lower than P^*, either with complete or incomplete contracts inside the firm.*

Proposition 1 points out a novel result in the welfare economics literature, as it shows that private managerial costs associated with organizational decisions have negative welfare

effects in a perfectly competitive market equilibrium. Welfare losses arise under either contracting paradigm and governance arrangements with incomplete contracts. With complete contracts, even though managers could write an ex-ante enforceable contract that specifies all occurrences, they would set operating decisions that maximize joint profits by inducing $Q^*_{complete} < 1$, thus $W^*_{complete} = \Pi^*_{complete} < P^*$. The ensuing deadweight loss $(P^* - W^*_{complete})$ is due to a coordination failure, despite managers' decision is taken into a cooperative environment, as the optimal contracted decisions are taken to minimize total private managerial costs (See Appendix B for details).[16] With incomplete contracts, the relevant supply is the OAS curve in Figure 1 (see equation (11) above). If $P < 1$, a no-integration equilibrium emerges in the supplier market. In this equilibrium, managers choose not to coordinate their production plans due to their competing private costs' incentives, which leads to $Q_N < 1$, and $W_N = \Pi^*_N < P^*$ according to equation (8). If $P > 1$, all firms in the supplier market choose integration. In a market equilibrium such as X in Figure 1, Panel c, the market supply is $Q^* = 1$, and it is the HQ that requires managers to fully coordinate and imposes the ensuing welfare cost. The total welfare is $W_I = P^* - 1/2$ (i.e., Π^*_I, cfr. equation (8)). This is the highest possible welfare level in the market equilibrium if $P > 1$; in fact, according to equations (8) and (9), welfare under nonintegration would be even lower.

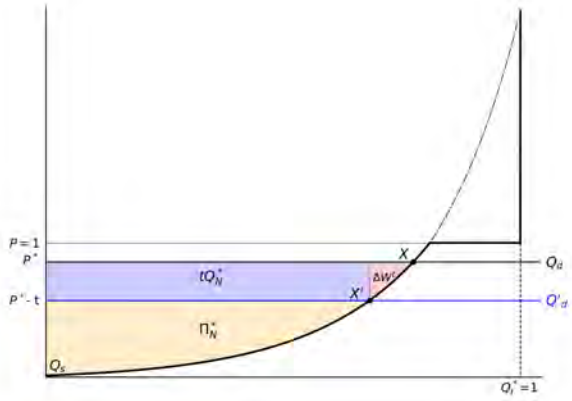
3.2 Welfare Effects of Taxation

How does taxation affect welfare in the case of managerial firms? We now turn to the analysis of the welfare effects of taxation. We start from a lump-sum tax, and then consider a nonlump-sum tax on consumers.

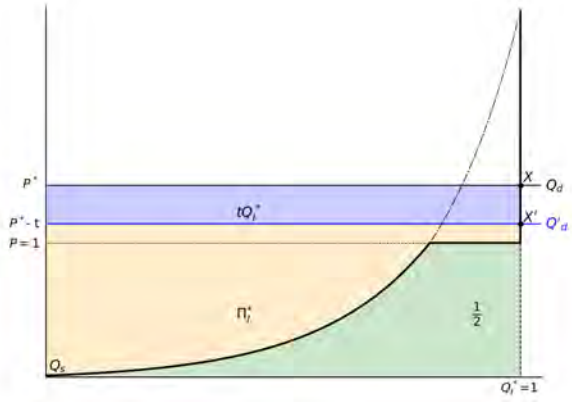
Lump-sum tax. Under nonintegration, it can be easily shown that the lump-sum tax does not appear in the first-order conditions for managers' optimal decisions (see Appendix D.1 for payoff details). Accordingly, a^* and b^* are still given by (6), and the total output is given

[16] Managers may still choose integration and concede their control rights to the HQ, which sets $Q = 1$. However, as we show in Appendix B, with complete contracts managers never choose this option, as this is strictly welfare-dominated by nonintegration.

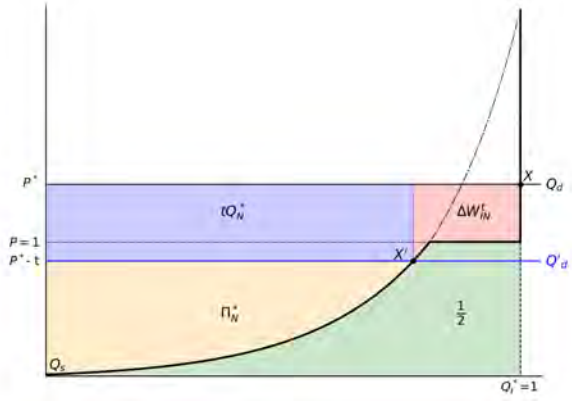
Figure 1: Taxation and Welfare in the case of Managerial Firms



(a) Taxation under nonintegration



(b) Taxation under integration



(c) Tax-induced organizational change

by equation (7). Similarly, under integration, the HQ still behaves as a revenue maximizer despite the introduction of the tax, i.e., production is still $Q_I^* = 1$. The equilibrium aggregate payoffs for managers under nonintegration and integration are:

$$\Pi_N^* = \frac{P^2}{(1+P)} - T, \qquad \Pi_I^* = P - \frac{1}{2} - T. \tag{12}$$

Equations (12) describe the set of managers' incentives. In particular, it can be easily shown that $\Pi_I^* > \Pi_N^*$ if $P > 1$, as in equation (9) above. Accordingly, the introduction of a lump-sum tax does not change managers' incentives to integrate, and thus the share $\alpha \in [0,1]$ of firms that choose integration in the supplier market equilibrium. The lump-sum tax does not even affect production levels under integration or nonintegration. The lump-sum tax, being neutral with respect to production and organization decisions of firms, is also neutral to welfare: its only effect is to redistribute surplus from managers to the government as tax revenues.

Non lump-sum tax. Let us now consider a tax t levied per unit of consumption, given the market price P.[17] The equilibrium decisions of managers under nonintegration become (see Appendix D.2 for payoff details):

$$a_N^* = \frac{1}{1+(P-t)} + \frac{(1-s)(P-t)}{1+(P-t)}; \qquad b_N^* = \frac{(1-s)(P-t)}{(1+(P-t))}. \tag{13}$$

Accordingly, we obtain the equilibrium output under nonintegration:

$$Q_N^* = 1 - \frac{1}{(1+(P-t))^2}. \tag{14}$$

According to equations (13), a nonlump-sum tax reduces managers' incentives to coordinate at any given P. In fact, $da_N^*/dt > 0$, and $db_N^*/dt < 0$: since the tax reduces the firm's

[17] At this stage of the analysis, this can be done without a loss of generality. In an online appendix, we discuss the equivalence of per-unit and ad valorem taxation on welfare, conditional on the occurrence of the organizational change. Note also that results would be exactly equivalent if a producer tax were introduced instead of the consumption tax (see Moriconi [37] for details).

marginal revenue, managers 'opt for a quiet life', i.e., move towards the decision they like and reduce private costs (Bertrand and Mullainathan [6]). As a result, the nonlump-sum tax reduces output under nonintegration, as is apparent from equation (14). Conversely, a nonlump-sum tax has no effect on production under integration. In fact, the HQ still maximizes its payoff by implementing full coordination, and firms still produce $Q_I^* = 1$.[18]

At the contracting stage, the equilibrium aggregate payoffs for managers under nonintegration and integration are, respectively:

$$\Pi_N^* = \frac{(P-t)^2}{(1+(P-t))}, \qquad \Pi_I^* = (P-t) - \frac{1}{2}. \tag{15}$$

From equations (15), it follows that:

$$\Pi_I^* \geq \Pi_N^* \;\Leftrightarrow\; P \geq 1 + t \tag{16}$$

Figure 1 illustrates the effect of an introduction of a nonlump-sum tax on welfare. Panels a-c examine three alternative situations. In Panel a, we explore an initial equilibrium X, where demand identifies a market price $P^* < 1$ so that a share $\alpha = 0$ of firms choose to integrate in the supplier market (cfr. equations (10) and (11)). Consider a tax levied on consumers, which induces a downward shift of the demand curve to Q_d' (the blue curve). An introduction of this tax reduces the revenue motive in managers' payoff and induces them to coordinate less under nonintegration. In the new equilibrium X', the corresponding deadweight loss is depicted as the red-shaded area in Figure 1, Panel a.

In the next two panels, we consider a scenario where demand sets a market price $P^* > 1$ so that a share $\alpha = 1$ of firms choose to integrate in the no-tax equilibrium X. In this case, an introduction of a nonlump-sum tax may induce two alternative outcomes, their relative likelihoods depending on a combination of external market conditions and the size of the tax. The first potential outcome is described in Panel b, where the tax rate is not too high

[18]This occurs because no nonmanagerial inputs such as labor are used in the production process. If we were to consider other contractible inputs (e.g., labor), taxation would induce production distortions also under integration. This would be consistent with Diamond and Mirrlees [17].

compared to the market price, i.e., $t \leq P^* - 1$. In this case, in the new equilibrium X' managers still choose $\alpha = 1$, so HQs continue to implement full coordination, and the tax does not produce any welfare loss, but only redistributes surplus from managers to the government.[19] Panel c discusses the alternative case of $t > P^* - 1$. Now, the introduction of a nonlump-sum tax induces an organizational change from integration to nonintegration in the industry equilibrium so that in the new equilibrium $X^{'}$ the industry has a share $\alpha = 0$ of integrated firms. We call this a "tax-induced organizational change" from a fully integrated to a fully nonintegrated industry structure. The corresponding change in welfare is measured as follows:

$$\begin{aligned}\Delta W_{IN}^t =& W_N^t - W_I^* = (\Pi_N^* + tQ_N^*) - W_I^* = \\ =& \underbrace{\frac{1}{2}}_{\substack{(II)\ private\ costs\ savings\ >0}} \underbrace{-\frac{P^*(1+P^*) - 2P^*t + t^2}{(1+P^*-t)^2}}_{(I)\ production\ loss\ <0} < 0. \end{aligned} \tag{17}$$

where Π_N^* and Q_N^* are given by equations (15) and (14), respectively. In the initial no-tax equilibrium X, the total welfare under integration is $W_I^* = P^* - \frac{1}{2}$. This is equal to the total surplus under integration, attributable to managers (i.e., Π_I^* as in equation (8)). After the tax, the total welfare under nonintegration is W_N^t, given by the sum of managerial surplus under nonintegration (the yellow shaded area in Figure 1, Panel c) and tax revenues (the blue shaded area in Figure 1, Panel c). It can be shown that $\Delta W_{IN}^t < 0$ is guaranteed for any t, given the knowledge that $P^* > 1$ (see Appendix D.3 for details). This excess burden is depicted as the red shaded area in Figure 1, Panel c. It is associated with a production loss due to the switch from integration to nonintegration (term (I) in (17)), which is attenuated by private cost savings under nonintegration because managers are no longer obliged by the HQ to coordinate and maximize the output (term (II) in (17)).

The results in this section can be summarized as follows:

[19] If $t = P^* - 1$, managers are indifferent between integration and nonintegration after the introduction of the tax. However, we assume that they still choose integration, as this is the organization type that maximizes the total output (cfr. Panel c below).

Proposition 2: *A lump-sum tax does not have any effect on production and welfare in the industry equilibrium. The effect of a nonlump-sum tax on welfare is as follows:*

i if $P^* < 1$, *a nonlump-sum tax reduces production and welfare in the industry equilibrium;*

ii if $P^* > 1$, *a nonlump-sum tax* $t \leq P^* - 1$ *has no effect on production and welfare in the industry equilibrium, and*

iii if $P^* > 1$, *a nonlump-sum tax* $t > P^* - 1$ *induces an organizational change from integration to nonintegration and reduces production and welfare in the industry equilibrium.*

We can compare the efficiency of lump-sum and nonlump-sum taxation as follows:

Corollary: *From an organizational perspective, a nonlump-sum tax that does not induce a switch from an integration equilibrium to a no-integration one is as efficient as a lump-sum tax.*

These novel findings incorporate organizational aspects into the results of Diamond and Mirrlees [17] about the effects of taxation on production choices in a competitive economy.[20] If $P^* < 1$, nonlump-sum taxes produce organizational distortions through managers' decisions under nonintegration. If $P^* > 1$, lump-sum taxes do not lead to organizational distortions under integration: from an organizational perspective, nonlump-sum taxes under integration can be considered as efficient as lump-sum taxes.[21] However, if $P^* > 1$, sufficiently large nonlump-sum taxes may reduce production and welfare through inefficient organizational change. Overall, these novel results add up to standard distortive effects on the production margin that occur in the standard neoclassical framework regardless of organization concerns.

[20] In Appendix C, we show that they hold qualitatively similarly in the case of a monopoly structure, the only effect of which in the present framework is to reinforce managers' preferences towards integration.

[21] However, nonlump-sum taxes are less efficient than lump-sum taxes from a production perspective (Auerbach and Hines [4]). Standard production distortions would result in the present framework in the more general case of $q = f(L)[1 - (a - b)^2]$ (cfr. Legros and Newman [33], Section IV.B).

4 Extension: enriching HQs behaviors

So far, we have assumed that HQs are only motivated by income maximization and are able to implement organizational alignment at no cost. We now enrich the model to reconcile it with the recent findings on the relevance of HQs' behaviors to organizational performance. We start by modeling nonpecuniary returns accruing to the HQ from implementing full coordination, e.g., due to own satisfaction, or reputation effects. Then, we recognize that a switch to an integrated structure induces production losses, e.g., due to HQs lacking some essential executive skills related to supervision, monitoring, and implementation of plans in the single units (see Bandiera et al. [5]; Kotter [29]).

4.1 Nonmonetary HQ benefits

Let us assume additionally that HQs have a nonpecuniary incentive component in their payoff. We write the new payoff function of the HQ as follows:

$$\pi^{HQ} = \eta[Pq] + h(a,b), \quad where \quad h(a,b) = \frac{L^{(a-b)^2}}{2}, \quad and \quad 0 \leq L < 1. \tag{18}$$

The function $h(a,b)$ in equation (18) measures an additional nonmonetary component of HQs' payoff that increases with coordination between managers and is thus correlated with production levels. The chosen functional form has a compelling interpretation and was already used in contract theory literature: Schmidt [38] also introduced a private nonmonetary benefit of managers as a reputation effect from a higher production level and provided a possible interpretation of this behavior as the managers being "empire builders". Similarly, we model h as an increasing function of coordination between units since it reflects the benefit of effective leadership (or reputation).[22] We assume that this nonmonetary bene-

[22]These two interpretations give the same result in our framework since having maximum coordination provides maximum production. As we will show later, the choice of the functional form $h(a,b)$ implies that the private benefit of HQ balances the private cost of managers in welfare under integration. This is a convenient feature, as it helps to point out the contribution of production losses to the analysis of welfare under integration.

fit is private, being nontangible, and thus managers cannot appropriate it. (see, e.g., Aghion and Bolton [1]) Also note that HQs are cash constrained in the model, so they cannot make any monetary transfers to the managers in exchange to this additional non-monetary benefit.

The managers' incentives are unaffected, so their choice between nonintegration and integration still depends on equation (9) so that integration emerges as an equilibrium in the supplier market if $P > 1$.[23] In this equilibrium, the HQ chooses $a = b = 1/2$, which maximizes its own payoff function (18) and minimizes the total managerial cost. The total welfare under integration becomes:

$$W_I^* = \underbrace{\left(P^* - \frac{1}{2}\right)}_{\Pi_I^*} + \frac{1}{2} = P^*, \tag{19}$$

where the first term in parentheses is the managerial payoff (exactly the same as in (8)), while the second term (equal to $1/2$) is the nonmonetary private benefit accruing to the HQ from maximizing coordination. Thus, in the end the total welfare W_I^* consists of the only monetary value that is the overall surplus created by the firm, P^*. We establish the following:

Proposition 3: *The total welfare in the case of managerial firms is equal to P^* under integration, as the private benefit of the HQ balances the private cost of managers.*

Proposition 3 demonstrates an arguably general result that the benchmark efficiency level can be reached even in the case of managerial firms as long as private benefits (of the HQ) exist that counteract private costs (borne by managers).

Note also that the introduction of a tax has results that are qualitatively similar to those described in the previous section. A nonlump-sum tax that induces an organizational change from integration to nonintegration will merely produce a larger deadweight loss. In fact, by switching from integration to nonintegration, HQs will no longer enjoy private benefits. The

[23] As in the previous section, the HQ has a zero opportunity cost. Thus, managers only offer the HQ the revenue share $\eta = 0$.

ensuing welfare loss (equal to $-1/2$) exactly balances the private cost savings in (17). Hence, the net deadweight loss will feature only the production loss term (I) in equation (17).

4.2 Production losses under Integration

In addition to private benefits for the HQ, let us now assume that the integration choice also induces some fixed output losses σ such that:

$$Q_I = (1 - \sigma)q. \tag{20}$$

Equation (20) shows that integration can still guarantee full coordination (i.e., $q = 1$); however, it no longer maximizes production, as fixed production costs $\sigma > 0$ arise in the presence of this layer of governance.[24]

The payoffs of managers under nonintegration are still described by equation (3). The only difference arises in the payoffs of managers and HQs under integration:

$$\pi_I^a = s_a \, P \, Q_I - \, C(a_G), \quad \pi_I^b = s_b \, P \, Q_I - \, C(b_G), \quad \pi_I^{HQ} = \eta[PQ_I] + h(a, b) \tag{21}$$

where Q_I is now given by (20). Under nonintegration, production decisions and output are still described by equations (6) and (7). In the case of integration, the HQ still specifies the fully coordinated plan that minimizes the total managerial costs and maximizes own returns. However, fixed production losses occur, so the equilibrium output is $Q_I^* = 1 - \sigma$.

Under the usual set of assumptions (i.e., an excess supply of managers of type M_a, and a zero opportunity cost for HQs), the equilibrium payoffs of managers under nonintegration and integration become:

$$\Pi_N^* = \frac{P^2}{(1+P)}, \qquad \Pi_I^* = P(1 - \sigma) - \frac{1}{2}. \tag{22}$$

[24] We borrow this modeling choice from Legros and Newman [32]. This approach features the view of Aghion and Tirole [2] that production losses arise if operating decisions are made by the party with less information on the unit, the HQ in our case. In contrast to Aghion and Tirole [2], in the present setting the managers accept delegation to the HQ (despite the cost σ) to maximize coordination between units.

Equations (22) describe the new set of managers' incentives. Compared to payoffs (8), the integration loss σ reduces output, and thus the managerial profits under integration by a fixed amount. Managers adopt integration if:

$$\Pi_I^* \geq \Pi_N^* \;\Leftrightarrow\; \underline{P} \leq P \leq \overline{P}, \; where \; \underline{P} = \frac{1-2\sigma-\Delta(\sigma)}{4\sigma}, \; \overline{P} = \frac{1-2\sigma+\Delta(\sigma)}{4\sigma}, \tag{23}$$

and $\Delta(\sigma) = \sqrt{1-12\sigma+4\sigma^2}$.[25] The organizational choices are now described by the thresholds $\underline{P}$ and $\overline{P}$. If $P < \underline{P}$, managers choose nonintegration to enjoy a 'quiet life' and save on private costs (as in the case of $P < 1$ in equation (9)). If $P \in [\underline{P}, \overline{P}]$, managers choose integration because this organization type maximizes the total output net of production losses at the lowest possible private cost for managers (equivalent to the case of $P > 1$ in equation (9) above). However, a new possible outcome occurs if $P > \overline{P}$. In this case, the revenue motive in managers' payoffs is so strong that they find it convenient to choose nonintegration, and avoid the production losses under integration.

Figure 2 shows the new OAS curve, given by the following:

$$Q_s = \alpha \, Q_I^* + (1-\alpha) \, Q_N^*, \tag{24}$$

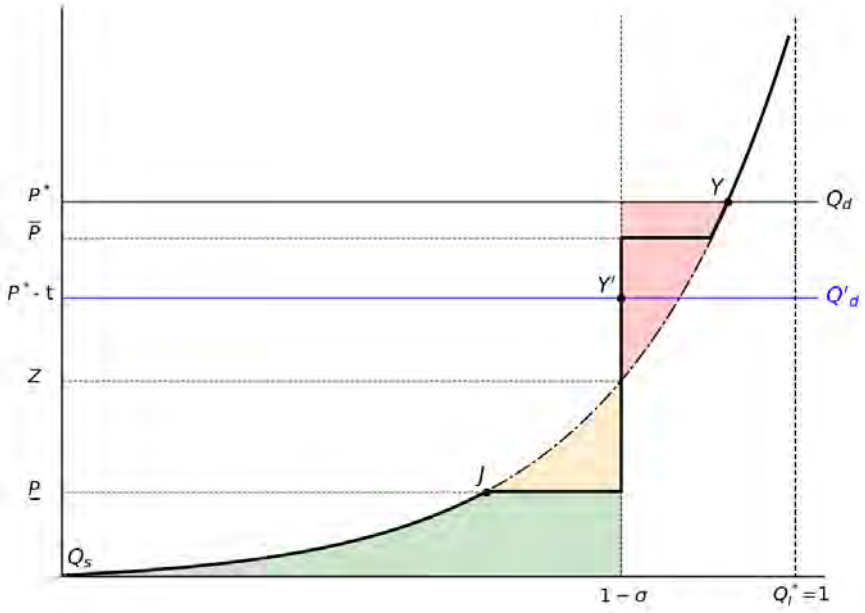
where $Q_I^* = 1-\sigma$, Q_N^* is given by equation (7), and

$$\alpha = \begin{cases} 0 & if \quad P < \underline{P} \; or \; P > \overline{P}, \\ \in [0,1] & if \quad P = \underline{P} \; or \; P = \overline{P}, \\ 1 & if \quad \underline{P} < P < \overline{P}. \end{cases} \tag{25}$$

Compared to the baseline OAS curve in (11), in this extended framework output losses under integration cause supply $Q = 1$ to be out of reach. As a result, when market prices are sufficiently high, i.e., $P > \overline{P}$, managers maximize the output and profits by choosing non-

[25] $\Delta(\sigma)$ is defined for $\sigma < \frac{3}{2} - \sqrt{2} \equiv \sigma_{\max}$, which is also the condition that guarantees $\overline{P} > \underline{P} > 0$. From here on, it is accepted that this assumption always holds.

Figure 2: OAS curve with production losses under Integration.



integration. In doing so, they forgo their private interests to enjoy the revenue advantages of a nonintegrated structure. This supply outcome is unavailable in the baseline framework with $\sigma = 0$, as for any price $P > \underline{P}$ managers find it convenient to choose integration.

Nonlump-sum taxation and welfare. In this extended framework, all effects of nonlump-sum taxation described by Proposition 2 still occur for $P^* < \overline{P}$.[26] In addition to them, now a per-unit tax on consumers $P^* - \underline{P} \geq t > P^* - \overline{P}$ can be introduced, which induces an organizational change from nonintegration to integration.[27] In Figure 2, we analyze the welfare effects of this tax when a perfectly elastic demand sets the market price at $P^* > \overline{P}$. At the no-tax equilibrium Y, firms produce under nonintegration (i.e., $\alpha = 0$). The quantity exchanged in the market is given by (7), and the total welfare is equal to the total managerial

[26] In particular, we observe nonlump-sum tax distortions under nonintegration for $P^* < \underline{P}$; if $P^* \in (\underline{P}, \overline{P})$ we note that any $t < P^* - \underline{P}$ is welfare-neutral, while any $t > P^* - \underline{P}$ induces an inefficient organizational change from integration to nonintegration. In this framework, it can also be shown that ad-valorem and per-unit taxes are not neutral in organizational terms. In particular, in Appendix F we show that an ad-valorem tax increases the probability of the integration decision compared to the effect of a per-unit tax if $\sigma > 0$.

[27] Any $t \leq P^* - \overline{P}$ would instead reduce welfare under nonintegration as in Proposition 2(i).

surplus under nonintegration, i.e., the area between the demand curve Q_d and the curve Q_s under nonintegration in Figure 2 ($W_N^* = \Pi_N^*$ according to equation (8) above). After the tax, the perfectly elastic demand curve shifts downwards to Q_d' (the blue curve) so that all firms switch to integration (i.e., $\alpha = 1$). The total welfare in the new industry equilibrium $Y^{'}$ is given by the sum of the managerial surplus under integration (the area between the points $(0,0)$, $(0, P^* - t)$, Y', $(1-\sigma, \underline{P})$ and J),[28] tax revenues (the upper left rectangle with height t and length $1-\sigma$) and the private HQ's benefits (the green shaded area).

Figure 2 demonstrates the opposite effects of the tax on total welfare. On the one hand, the tax induces a lower supply at any $P \in (Z, P^*)$ (the red shaded area in Figure 2). However, integration also guarantees a higher supply than in the case of nonintegration at any $P \in (0, Z)$ (the yellow shaded area in Figure 2). Finally, the tax-induced switch to integration implies private gains for the HQ that fully balance managers' private costs (the green shaded area in Figure 2). The net welfare change depends on the relative size of these effects; i.e.:

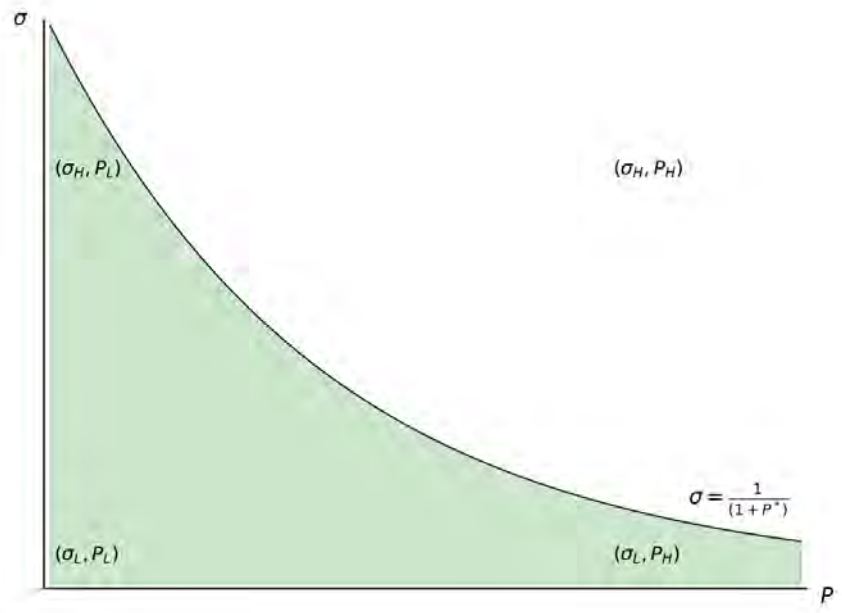
$$\begin{aligned}\Delta W_{NI}^t = W_I^t - W_N^* = \left[\left((P^* - t)Q_I^* - \frac{1}{2} + \frac{1}{2}\right) + tQ_I^*\right] - \Pi_N^* = \\ = P^*\left(\frac{1}{(1+P^*)} - \sigma\right) \lesseqgtr 0. \end{aligned} \tag{26}$$

Equation (26) shows that whether the tax produces a net welfare loss (i.e., $\Delta W_{NI}^t < 0$) or gain (i.e., $\Delta W_{NI}^t > 0$) ultimately depends on the relation between σ and P^* in the second line of equation (26). Figure 3 plots σ (on the y-axis) against P^* (on the x-axis), and shows that all combinations corresponding to a welfare-neutral effect of the tax (i.e., such that $\Delta W_{NI}^t = 0$) lie on the downward sloping curve $\sigma = \frac{1}{(1+P^*)}$. The green shaded area below the curve includes all possible combinations featuring a tax-induced shift from nonintegration to integration that produces a net welfare gain. Conversely, the area above the curve includes all possible combinations corresponding to a shift that produces a net deadweight loss.

The interpretation of Figure 3 is straightforward. If the integration losses and market

[28] This is obtained by subtracting the total managerial cost (equal to $1/2$) from the area of the rectangle $(0,0)$, $(0, P^* - t)$, Y', $(1-\sigma, 0)$.

Figure 3: Welfare-neutral tax-induced change from nonintegration to integration.



prices are very low, e.g., at (σ_L, P_L^*), welfare losses under nonintegration are large, while integration is close to first-best efficiency. In this case, a nonlump-sum tax that induces firms in the industry to switch from nonintegration to integration is welfare-improving. This remains true if output losses under integration are large, provided that prices are sufficiently low, i.e., at $(P_L^*\ \sigma_H)$ and vice-versa (i.e., at $(P_H^*,\ \sigma_L)$). However, the same tax has a negative impact on welfare if market prices and integration losses are both sufficiently high, e.g., at (σ_H, P_H^*). In this case, the welfare gains from the 'tax induced' switch to integration are negligible relative to the deadweight loss of abandoning nonintegration. These results are summarized as follows:

Proposition 4: *With production losses under integration and private HQs benefits, a nonlump-sum tax that induces an organizational change from nonintegration to integration may increase welfare, provided that the market price or the integration loss are not too high.*

The literature on taxation and welfare (see, e.g., Aurbach and Hines [4]) ignores the existence of a welfare effect of nonlump-sum taxation via a change in firms' internal organi-

zation. The result stated in Proposition 4 contributes to this literature by showing that in the presence of managerial firms, an introduction of nonlump-taxation may increase welfare even in perfectly competitive product markets. Admittedly, this occurs as long as HQs enjoy some private benefits that balance managers' private costs under integration. In Appendix G, we show that if we abstract from HQs' benefits, i.e., for $L = 0$ in equation (18), the tax produces a deadweight loss, i.e., $\Delta W^t_{NI} < 0$ in equation (26) due to private costs of managers.

5 Discussion and conclusions

While modern theories of the firm and recent empirical evidence suggest that organizational practices are critical determinants of the productivity of firms, existing theories in welfare and public economics are based on the neoclassical theory of the firm that abstracts from organizational concerns and views firms only as production units.

This paper has investigated the welfare properties of a perfectly competitive equilibrium and the effects of taxation in an economy where production decisions are made by managerial firms. We used as a benchmark the welfare level associated with the perfectly competitive market equilibrium in the presence of standard production firms that do not present any managerial concern. In the main part of the paper, we showed that at market equilibrium with managerial firms, private costs of managers always reduce welfare regardless of any contractual or organizational arrangements within the firm. We also derive a number of interesting results regarding the welfare effects of taxation. We extend to managerial firms the well-known result that a lump-sum tax does not have any effect on welfare. However, we observe that a nonlump-sum tax produces a range of different effects on the organizational margin, depending on external market conditions, the level of the tax itself and the attributes of managerial firms. In particular, we show that a nonlump-sum tax may produce a deadweight loss due to a change in the organization of an industry to a less productive organization type (i.e., from integration to nonintegration). Finally, we obtain a wider range

of welfare effects as we extend the properties of HQs, in line with empirical evidence from literature on CEOs' performance.

Our results open the way to a broader discussion on whether and how firms' organization should be accounted for, to evaluate welfare. This is a first step to recognize the welfare effect of public policies (such as taxes and subsidies) also pass through organizational channels, as actual "firms" are made up of managers with competing interests and own private incentives.

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Appendix A Taxation and Integration in the Manufacturing Sector: Empirical Evidence

Appendix A.1 Data

The main variables of interest are drawn from the OECD National Accounts and the OECD STAN Database. The other variables used in the regression analysis presented in Table A-2 below are drawn from the OECD International Regulation Database, the World Value Survey and the European Value Study, the OECD Economic Outlook, the World Bank's Database on Political Institutions (DPI), the World Development Indicators (WDI) and the Doing Business (DOBUS) database. The reader will find below a detailed description of the variables.

General taxation on goods and services: Taxes less subsidies on products ($B1G\_P119$) specified as a share of the gross value added at basic prices, excluding FISIM ($D21\_D31$). We use the GDP definition, the output approach, current prices in millions of US dollars, and constant exchange rates.

Integration: Share of value added, produced "in-house" by the firm, defined as $100 * (1 - INTI/PROD)$, where INTI are intermediate inputs and PROD is total production (gross output). This variable is determined at current prices (OECD Structural Analysis, the STAN Database).

POP: Total population (millions of individuals, World Bank's WDI).

GDP: Gross domestic product, current US dollars (World Bank's WDI).

UNR: Number of unemployed persons divided by the labor force (harmonized; OECD Economic Outlook).

GDPxc: Per-capita GDP: gross domestic product/total population (World Bank's WDI).

labor productivity: Labor productivity in the total economy (PDTY); the value in year 2005 is set to 1 (OECD Economic Outlook).

Irate: Long-term interest rate on government bonds (OECD Economic Outlook).

Output gap: Percentage deviation of output from the potential level (OECD Economic Outlook). Using this variable, we generated a dummy variable for the occurrence of an economic crisis, **Crisis**, equal to 1 whenever the effective output falls 4 standard deviations below its potential level.

Real exchange rate: Ratio of home country's prices to a weighted average of a competitor country's prices, determined relative to a base year (2000) and measured in US dollars. Therefore, an increase represents an appreciation of the home country's real exchange rate (OECD Main Economic Indicators).

Trade-to-GDP ratio: Ratio of trade flows to the total GDP (OECD Main Economic Indicators).

Ydem: A categorical variable for the youth of democratic institutions. It is equal to 3 if the democracy has been in place for less than 20 years ($TENSYS < 20$), equal to 2 in the case of 20–40 years ($20 \leq TENSYS < 40$), and equal to 1 in the case of more than 40 years ($TENSYS \geq 40$).

Prtyage: A categorical variable for the age of the parties in parliament. It is equal to 1 if $PARTYAGE < 20$, equal to 2 if $20 \leq PARTYAGE < 40$, and equal to 3 if $PARTYAGE \geq 40$.

Left, Right: Indicators of leftwing or rightwing orientation of the government in office (EXECRLC=1, World Bank's DPI).

Distrust Major Companies, Distrust others: *Distrust Major Companies* is constructed as the percentage of respondents that answer '4' (i.e., 'None at all') to questions *E*069_13 in WVS1-5, v219 in EVS4, 027 in EVS3, q554K in EVS2, and v547 in EVS1 (measuring the magnitude of confidence in major companies). *Distrust others* is constructed as the percentage of respondents that answer '2' (i.e., 'Cannot be too careful') to questions A165 in WVS1-5, V62 in EVS4, V66 in EVS3, Q241 in EVS2, and V208 in EVS1. We assigned country observations for the available years to five periods, with each period broadly corresponding to the intended coverage of an EVS/WVS wave. Periods are *1980-89* (EVS1/WVS1 and

EVS2), *1990-94* (EVS2/WVS2), *1995-99* (EVS3/WVS3), *2000-04* (EVS3/WVS5), and *2005-08* (EVS4/WVS5).

VAT: A dummy variable equal to 1 if a VAT system of commodity taxation is in effect (OECD Consumption Tax Trends, 2008).

ETCR: A $0-6$ indicator that aggregates qualitative information on entry barriers, public ownership, and vertical integration in seven non-manufacturing industries: electricity, gas, air passenger transport, rail transport, road freight, and postal services (see Conway and Nicoletti [14] for further details).

Union Density: Union density (% of unionized workers; OECD Employment Outlook).

UBRR: Average unemployment benefit replacement rates (average of replacement rates across various earnings levels, family situations and durations of unemployment; OECD Benefits and Wages Database).

EU, Euro: A dummy variable equal to 1 if a country is part of the European Union or, respectively, the European Monetary Union.

Appendix A.2 Empirical results

Figure A-1 shows a negative correlation between changes in the level of taxes on goods and services (on the Y axis) and changes in the degree of integration in the manufacturing sector, measured as the share of "in-house"production in the total production of manufacturing firms (on the X axis) of 21 OECD countries. During 1970-2005, the degree of integration increased considerably in countries (e.g., Japan and Korea) where general taxes on goods and services decreased or at most remained constant; conversely, it decreased in countries (e.g., Italy and Spain) where taxes increased during the sample period. This is consistent with Bloom *et al.* [8], who show that production processes are more centralized in Asian countries than in most European countries. This cross-country correlation may hide large heterogeneity depending on the characteristics of manufacturing sectors, firms or external market conditions. The correlation in Figure A-1 is confirmed by panel data regressions

Table A-1: Taxation and vertical integration, means and standard deviations by country, OECD countries in the period 1970-2005.

Country	Integration	Production Tax
Austria	36.22	12.12
	(1.67)	(2.33)
Belgium	27.21	10.16
	(1.60)	(1.64)
Canada	32.85	7.17
	(1.60)	(0.94)
Denmark	33.91	15.58
	(1.48)	(1.44)
Finland	32.21	13.48
	(1.07)	(1.57)
France	28.90	11.87
	(1.40)	(0.61)
Germany	37.08	10.00
	(2.14)	(0.52)
Greece	31.90	8.73
	(2.02)	(2.12)
Ireland	30.61	11.21
	(4.03)	(1.87)
Italy	32.25	8.78
	(2.74)	(1.95)
Japan	34.06	0.33
	(2.74)	(0.16)
Korea	22.67	10.90
	(2.10)	(1.24)
Luxembourg	33.15	8.52
	(2.01)	(2.24)
Netherlands	28.54	9.42
	(2.10)	(1.52)
New Zealand	33.22	4.79
	(1.63)	(3.12)
Norway	29.49	13.79
	(1.88)	(1.25)
Portugal	24.18	14.86
	(3.15)	(3.25)
Spain	31.72	7.74
	(3.10)	(1.99)
Sweden	31.61	12.54
	(1.69)	(2.00)
United Kingdom	36.69	9.94
	(1.06)	(1.81)
Total	31.37	10.10
	(4.34)	(3.89)

Notes: Averages are shown for the respective countries; standard deviations are in parentheses.

in Table A-2, which account for a wide range of time-varying economic and institutional determinants of industry integration.

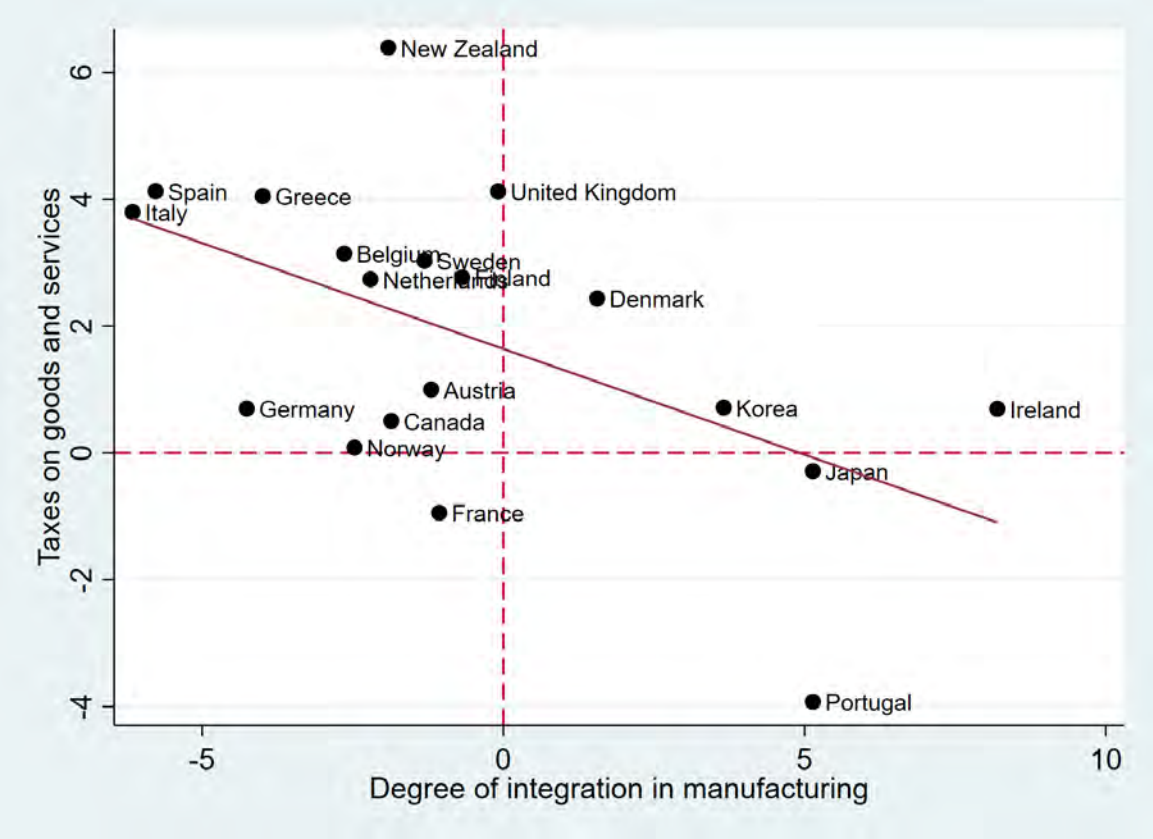
It is interesting to match this evidence with the one by Spengel et al. [39]. We notice that the tax-to-EBT differential, thus the deadweightloss differential between SME and LE is particularly large in countries characterized by decreasing integration in the manufacturing sector over the sample period (and increasingly high tax burdens on goods and services). Looking at Figure 4.12 of Spengel et al. [39], these are Belgium (tax-to-EBT differential between SME and LE equal to 4.5 p.p.), Germany (5.1 p.p), Italy (6.2 p.p.), Finland (10 p.p.). All these countries are indeed in the top-left quadrant of Figure A-1 in Appendix. This is consistent with the view that with increasing tax burdens, aggregate ownership outcomes become more and more disconnected from efficiency considerations.

Table A-2: Taxation and integration: empirical regression analysis.

	[1]	[2]	[3]	[4]	[5]
Production tax	–0.24**	–0.35***	–0.27***	–0.29**	–0.44**
	(0.09)	(0.09)	(0.09)	(0.14)	(0.18)
R sq.	0.76	0.83	0.87	0.90	0.90
N	686	686	677	619	543
country FE	yes	yes	yes	yes	yes
time dummies	no	yes	yes	yes	yes
competition and economic cycle	no	no	yes	yes	yes
manufacturing sector	no	no	no	yes	yes
institutional quality	no	no	no	no	yes

Notes: The dependent variable in all regressions is the share (in value added of total production) of value added for in-house production. Controls for competition and economic cycle include total population, per-capita GDP, real exchange rate, change in inflation, and a dummy variable for belonging to the European monetary union. Controls for the manufacturing sector include the unit cost of labor, the employment rate, and an index of labor productivity. Controls for institutional quality include a measure of youth of democratic institutions and the age of the main political parties. Robust standard errors, clustered by country, are shown in parentheses. Significance levels are indicated as follows: $*$: 10% $**$: 5% $***$: 1%.

Figure A-1: Taxation and Integration in the Manufacturing Sector



Notes: The tax measure is obtained from the OECD National Accounts. These are taxes (net of subsidies) on products, determined as a share of gross value added. They include general sales taxes, the VAT, excise taxes, taxes on financial and capital transactions and other taxes on specific services or markets. The measure of integration is drawn from the OECD STAN Database. This is the share of value added produced "in-house" by firms in the manufacturing sector (see Appendix A.1 for details regarding data sources and variables' construction). For all variables, we consider differences between their averages in the final and initial periods of the sample (resp., 1995-05 and 1970-80) to account for heterogeneity due to time-invariant country-specific factors. The chart shows results of authors' calculation performed on the OECD data.

Appendix B Baseline Model with Complete Contracts

Let us now assume that contingent on the couple's match, each couple M_a and M_b can write an ex-ante enforceable contract that specifies the following:

1. Revenue share s of manager M_a (thus, $1 - s$ is attributable to B),
2. Decisions a and b to be made contingent on market price P, and
3. A transfer payment made between M_a and M_b if one of the two does not reach own reservation payoff when decisions a and b are implemented.

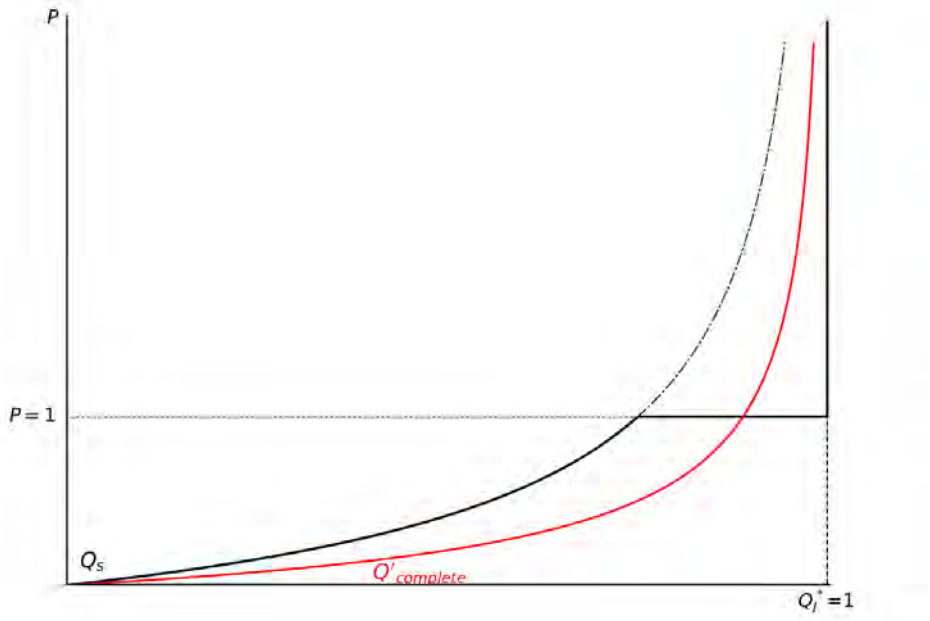
As decisions a and b, as well as transfer payments between the two managers, are now contractible, it is no longer necessary to specify the governance structure $G = N, I$ in the contract; managers can freely continue to operate under nonintegration. We show below that integration is welfare-dominated by nonintegration with complete contracts. Besides the contracting factors that have just been sketched, all other assumptions regarding the functioning of the economy continue to hold, as described in Section 2.1.

In particular, we still assume an excess supply of managers of type M_a in the supplier market. Under this assumption, once a match has been formed in the supplier market, a revenue share $s = 0$ will be contracted so that each manager M_b appropriates all benefits, and managers M_a are available to concur to the optimal production decision as long as a transfer payment from M_b is specified in the contract, which fully compensates for any loss manager M_a with reservation payoff $\pi_A = 0$ may incur.

The operating decisions a and b specified in the contract are coordinated decisions over the two units that maximize the total profit $\pi^a + \pi^b$ as in equation (3) in the main text (we omit the subscript N for complete contracts to simplify notation). This is described as the following maximization problem:

$$\max_{a,b} \left\{ \left(1 - (a-b)^2\right) P - (1-a)^2 - b^2 \right\} \tag{B-1}$$

Figure B-2: Comparison of complete and incomplete contracts.



From the first-order conditions, we derive the optimal production decisions

$$b^* = \frac{P}{2P+1}, \quad a^* = \frac{P+1}{2P+1} \tag{B-2}$$

that we can substitute into equation (1) to obtain the optimal quantity produced under complete contracts:

$$Q^*_{complete} = 1 - \left(\frac{1}{2P+1}\right)^2. \tag{B-3}$$

The red curve in Figure B-2 depicts the supply function in the complete contracts' case. This corresponds to a version of the supply function under nonintegration, which converges faster to Q=1 than under incomplete contracts.

We can compute the total welfare under complete contracts by substituting equations

(B-2) and (B-3) into Π_N^* in equation (5) and obtain:

$$\Pi_{complete}^* = (\pi^{a*} + \pi^{b*}) = \frac{2P^2}{2P+1} \tag{B-4}$$

Note that as $s = 0$, profit (B-4) is fully appropriated by manager M_b that transfers $(1 - a)^2 = \frac{P^2}{2P+1}$ to M_a and covers its private costs to guarantee that $\pi^{a*} = 0$ for any given price P.

Appendix B.1 Comparison with the Incomplete Contracts' Case

We now compare the quantities and profits in the complete contract case with the corresponding outcomes under incomplete contracts when $G = N, I$. We show that welfare under complete contracts is greater than welfare for each governance structure under the assumption of incomplete contracts.

Comparison with nonintegration: It can be easily shown that production is higher in the case of complete contracts than in that of incomplete contracts under nonintegration:

$$Q_{complete}^* = 1 - \left(\frac{1}{2P+1}\right)^2 > Q_N^* = 1 - \left(\frac{1}{1+P}\right)^2$$

Under complete contracts, operating decisions a and b are made cooperatively; i.e., they are relatively more coordinated than in the incomplete contracts' case, where they are the outcome of a Nash bargaining. It also easily follows that welfare with complete contracts is higher than that in the case of a nonintegrated structure when contracts are not complete:

$$\Pi_{complete}^* = \frac{2P^2}{2P+1} > \Pi_N^* = \frac{P^2}{P+1}$$

Welfare is higher under complete contracts, as it is derived from the coordinated maximization problem (B-1) that takes into account simultaneously the payoff functions of M_a and M_b (and thus considers their revenues and their costs together).

Comparison with integration It is straightforward to observe that production is lower in the case of complete contracts than in that of incomplete contracts under integration:

$$Q^*_{complete} = 1 - \left(\frac{1}{2P+1}\right)^2 < Q^*_{Integration} = 1$$

For any finite P, the quantity is lower in the case of complete contracts than in that of incomplete contracts under integration since the HQ maximizes the revenue ηPQ by not taking into account the private cost of the managers.

However, it can be shown that welfare is higher in the case of complete contracts than in that of incomplete contracts under integration:

$$\Pi^*_{complete} = \frac{2P^2}{2P+1} > \Pi^*_I = P - \frac{1}{2}$$

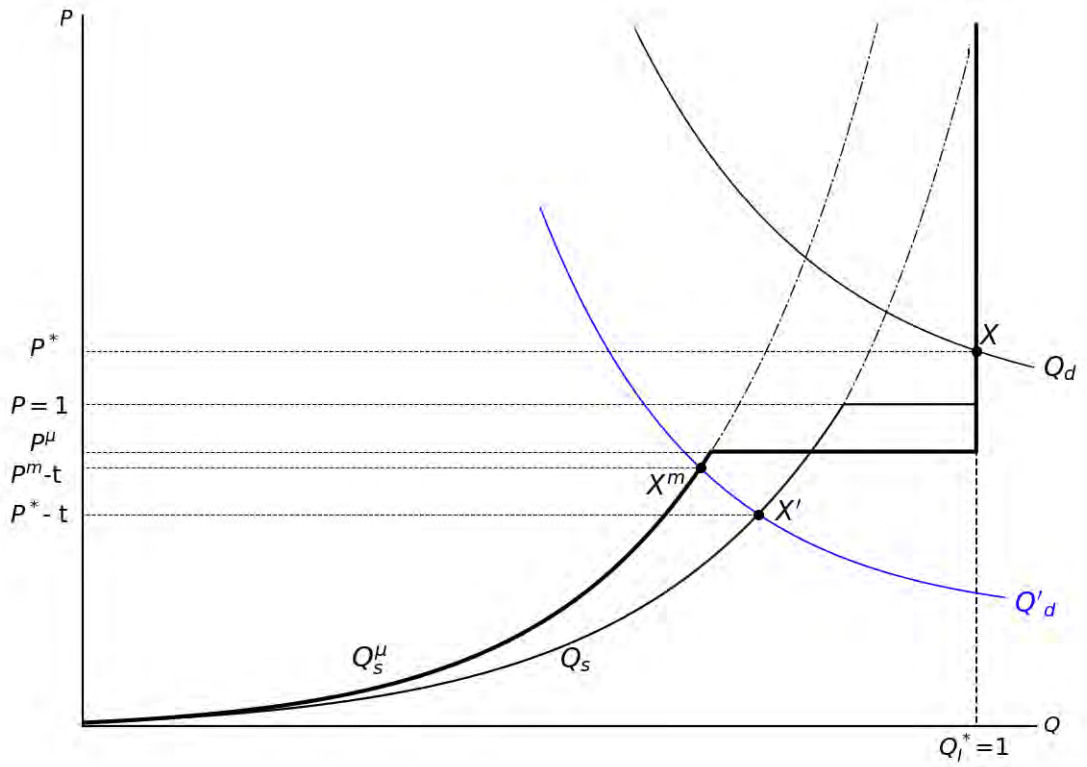
In fact, under integration the HQ maximizes the total revenue rather than the total profit and minimizes the total managerial cost $C(a) + C(b)$ subject to the constraint that revenue is maximized, i.e., $Q = 1$. This implies that the total managerial cost with incomplete contracts is greater than that with complete contracts, and the welfare is lower.

Appendix C Monopoly Power

To introduce monopoly power, we relax the assumption of the supplier market being perfectly competitive and that of the existence of a one-to-one correspondence between managers and production units. We now assume that there is one multiplant manager M_b who owns a measure 1 of B units and several (at least two) managers M_a who are suppliers and own a measure 1 of A units. This assumption gives the firm some monopoly power and still leaves M_b as the actual mover (see Legros and Newman [31]). All other assumptions on the economy are the same as in Section 2.

We find it convenient to focus on the case of an iso-elastic demand curve and assume $Q_d(P) = P^{-\epsilon}$. We also assume $\epsilon > 1$, which guarantees that it is profitable for the monopo-

Figure C-3: Taxation and organizationally augmented industry equilibrium with market power.



list to produce.

Under nonintegration, each manager chooses the decision that maximizes its payoff subject to this demand function. At the NE, we have the following decisions:

$$a_N^* = \frac{\mu}{\mu + P} + \frac{(1-s)P}{\mu + P}; \qquad b_N^* = \frac{(1-s)P}{(\mu + P)}. \tag{C-5}$$

where $\mu = 1/(1 - 1/\epsilon) > 1$ is the mark-up applied by M_b over marginal costs. Compared with 6, equations C-5 show that market power shifts managers' optimal decisions towards their preferred ones, i.e., those that minimize their private costs.

We substitute (C-5) into (1) to obtain the equilibrium output under nonintegration:

$$Q_N^* = 1 - \frac{\mu^2}{(\mu + P)^2}, \tag{C-6}$$

which indeed shows that market power induces managers to produce less under nonintegration. Under integration, the self-interested HQ maximizes (4) under the iso-elastic demand function. The HQ still sets $a = b$, and in particular, $a_I^* = b_I^* = 1/2$, so production under integration is still perfectly efficient under a monopoly, with managers enjoying the lowest private costs consistent with the fully coordinated plan.

The equilibrium aggregate payoffs of managers under nonintegration and integration become, respectively:

$$\Pi_N^* = \frac{P^2\left((P-1) + 2\mu\right)}{(\mu + P)^2} \qquad \Pi_I^* = P - \frac{1}{2}, \tag{C-7}$$

which shows that $\Pi_I^* > \Pi_N^*$ if $P > P^\mu \equiv \mu(1-\mu) + \sqrt{2\mu^2 - 2\mu^3 + \mu^4} < 1$, which is now lower than 1.

The effect of market power in our organizational setting is described in Figure C-3 above. Market power makes managers less willing to coordinate under nonintegration, which means that the supply curve under nonintegration is above that under perfect competition. However, market power does not affect output under integration. Thus, managers now have incentives to switch to integration for lower market price levels, as described by $P^\mu < 1$.

It now readily follows that the effect of taxes in this setting that also incorporates market power is qualitatively similar to that in the case of perfect competition. The introduction of a lump-sum tax is again neutral with respect to production and organization decisions of firms and thus, to welfare. The effects of a nonlump-sum tax on the equilibrium of the industry are again represented by a downward shift of the demand curve from Q_d to Q_d' in Figure C-3. These effects are qualitatively similar to those described in Section 4.2, as a nonlump-sum tax may induce an "organizational change" from a fully integrated to a fully

nonintegrated industry structure. As mentioned above, the main difference with respect to the competitive case is that market power makes the integration choice more profitable for managers. Accordingly, it may be more difficult for an organizational switch to nonintegration to occur with market power.

Appendix D Payoffs and the deadweight loss under taxation

Appendix D.1 Lump-sum tax

This appendix subsection shows the payoffs that are used to derive the results for lump-sum taxation in Section 3.2. Consider a lump-sum tax T imposed on firm revenue. Payoffs of managers after the introduction of the tax are as follows:

$$\pi_G^a = s_a\,(Pq - T) - \,C(a_G), \qquad \pi_G^b = s_b\,(Pq - T) - \,C(b_G), \tag{D-8}$$

where $Pq - T$ is the after-tax firm revenue. As before, s_a and s_b are managers' revenue shares, and q is the output of the firm. Under integration, the HQ's payoff is:

$$\pi^{HQ} = \eta\,[Pq - T]\,, \tag{D-9}$$

Appendix D.2 Nonlump-sum tax

This subsection shows the payoffs used as the baseline for the analysis of nonlump-sum taxation in Section 3.2. After the introduction of tax t levied per unit of output, payoffs of managers under organization $G = N, I$ are as follows:

$$\pi_G^a = s_a\,(P - t)q - \,C(a_G), \qquad \pi_G^b = s_b\,(P - t)q - \,C(b_G), \tag{D-10}$$

where the only difference from equation (5) is that firm revenues now depend on the after-tax price $P - t$. Similarly, under integration the HQ's payoff is:

$$\pi^{HQ} = \eta\left[(P-t)q\right]. \tag{D-11}$$

Appendix D.3 Sign of the deadweight loss due to a tax-induced change from integration to nonintegration

Equation (17) can be rewritten step-by-step as follows:

$$\Delta W_{IN}^{t} = \frac{(P^*-t)^2}{(1+P^*-t)} + t\left(1-\frac{1}{(1+P^*-t)^2}\right) - (P^*-\frac{1}{2}) = \frac{1-2t-(P^*-t)^2}{2\left(1+P^*-t\right)^2} \tag{D-12}$$

Here, it is easy to observe that this expression is less than zero for any t. In fact, considering the numerator of equation (D-12), a necessary condition for $\Delta W_{IN}^{t} > 0$ would be $t \leq \frac{1}{2}$. Let us then assume this, and rearrange the numerator as follows:

$$(1-P^*)[(P^*+1)-2t] - t^2 \tag{D-13}$$

Recall that before the introduction of a tax, the equilibrium market price was P^* and the organizational structure was integrated; according to (9), this means that $P^* \geq 1$. Then, it easily follows that the term (D-13) is less than 0 even if $t \leq 1/2$. Thus, it can be concluded that ΔW_{IN}^{t} is positive.

Appendix E Organizationally augmented supply with integration losses

Condition $\Pi_I^* > \Pi_N^*$ implies that:

$$P(1-\sigma) - 1/2 > \frac{P^2}{1+P}. \tag{E-14}$$

After a simplification, this can be rewritten as follows:

$$2\sigma P^2 + P(2\sigma - 1) + 1 < 0,$$

which holds true for $\underline{P} < P < \overline{P}$, as stated in (F-15). We can thus derive the equilibrium in the supplier market that is described by the share α of firms willing to integrate. If $P \in (\underline{P}, \overline{P})$, the management maximizes its payoff by choosing integration and a pure integrated equilibrium emerges with $\alpha = 1$ in (25). Conversely, if $P < \underline{P}$ and $P > \overline{P}$, according to (F-15) the management chooses nonintegration, and a pure nonintegrated equilibrium emerges with $\alpha = 0$ in (25). Finally, if $P = \underline{P}$ or $P = \overline{P}$, managers are indifferent between integration and nonintegration and randomly choose the organization of their firm. Accordingly, a mixed equilibrium occurs with a share $\alpha \in (0, 1)$ of firms that choose integration.

From the equilibrium in the supplier market, it is possible to derive the organizationally augmented supply curve (24). If $\alpha = 1$, the relevant supply function is defined by $Q_I^* = 1 - \sigma$; if $\alpha = 0$, the relevant curve is defined by (7). If $\alpha \in (0, 1)$, the relevant supply function is the average of product supply under integration and nonintegration weighted by the shares α and $1 - \alpha$, respectively. To facilitate a visual representation, we derive the inverse organizationally augmented supply curve from (24) and (25):

$$P = \begin{cases} \left(\frac{1}{\sqrt{(1-Q)}} - 1 \right), & Q \in [0, \underline{Q}];\ Q \in [\overline{Q}, 1); \\ \underline{P}, & Q \in [\underline{Q}, 1 - \sigma]; \\ \in [\underline{P}, \overline{P}], & Q = 1 - \sigma; \\ \overline{P}, & Q \in [1 - \sigma, \overline{Q}]; \end{cases}$$

where $\underline{Q}$ and $\overline{Q}$ are the quantity thresholds that correspond to $\underline{P}$ and $\overline{P}$ under nonintegration,

i.e.:

$$\underline{Q} = 1 - \frac{16\sigma^2}{[(1+2\sigma) - \Delta(\sigma)]^2}, \text{ and } \overline{Q} = 1 - \frac{16\sigma^2}{[(1+2\sigma) + \Delta(\sigma)]^2}.$$

From (E-15), we derive the organizationally augmented supply curve shown by the black line in Figure 2.

Appendix F Per-unit versus ad valorem taxation

Under the assumption that there are no production failures under integration, the assumption of a nonlump-sum tax per unit of choice does not entail any loss of generality, as a per-unit tax is equivalent to an ad valorem tax with respect to organizational choice. We now show that there is a difference between per-unit and ad valorem taxation in the presence of production failures with integration. Under the production failure model, managers adopt integration if:

$$\Pi_I^* \geq \Pi_N^* \Leftrightarrow \underline{P} \leq P \leq \overline{P}, \text{ where } \underline{P} = \frac{1 - 2\sigma - \Delta(\sigma)}{4\sigma}, \overline{P} = \frac{1 - 2\sigma + \Delta(\sigma)}{4\sigma}, \tag{F-15}$$

If a per-unit tax is introduced, (F-15) becomes:

$$\Pi_I^* \geq \Pi_N^* \Leftrightarrow \underline{P} \leq P \leq \overline{P}, \text{ where } \underline{P} = \frac{1 - 2\sigma - \Delta(\sigma)}{4\sigma} + t, \overline{P} = \frac{1 - 2\sigma + \Delta(\sigma)}{4\sigma} + t, \tag{F-16}$$

Assume that instead of a tax per unit of output, an ad valorem tax τ is imposed. This implies that, at a given market price P, the producer price in managers' and the HQ's payoffs is $P(1-\tau)$. Production under nonintegration becomes:

$$Q_N^* = 1 - \frac{1}{(1 + P(1-\tau))^2}. \tag{F-17}$$

As before, τ has no effect on production under integration, so Q_I^* is still given by $(1-\sigma)$.

At the contracting stage, managers choose integration if:

$$\Pi_I^* \geq \Pi_N^* \;\Leftrightarrow\; \underline{P} \leq P \leq \overline{P},\ \textit{where}\ \underline{P} = \frac{1-2\sigma-\Delta(\sigma)}{4\sigma(1-\tau)},\ \overline{P} = \frac{1-2\sigma+\Delta(\sigma)}{4\sigma(1-\tau)}, \tag{F-18}$$

It is instructive to compare $\underline{P}$ and $\overline{P}$ in (F-16) and (F-18). In particular, consider the market price interval $I = \overline{P} - \underline{P}$, where integration is an optimal choice. It easily follows that:

$$I_t = \frac{\Delta(\sigma)}{2\sigma}, \quad I_\tau = \frac{\Delta(\sigma)}{2\sigma(1-\tau)}. \tag{F-19}$$

Equations (F-19) show that $I_\tau > I_t$ because $0 < \tau < 1$. Moreover, the market price interval in which managers choose integration is fixed in the case of per-unit tax, while this is not the case for an ad valorem tax. Compared to a specific tax, an ad valorem tax removes a fraction (equal to the ad valorem tax rate) of a managers' revenues, increasing their incentives to choose integration. We establish the following:

Proposition A1: *The price interval where integration is an optimal choice for managers is larger in the case of an ad valorem tax than for a per-unit tax and is increasing with the ad valorem tax rate.*

Compared to a specific tax, an ad valorem tax reduces managers' incentives to coordinate under nonintegration. Accordingly, there is a widening market price interval where managers find it convenient to delegate production to the HQ to implement the fully coordinated production plan. It can be easily shown that all the rest of the analysis equally holds as in the case of a per-unit tax.

The last important remark is in order. Proposition A1 is to be interpreted as an ad valorem tax making an integration outcome "more likely" to occur than a per unit tax would, at a given market price level. However, this does not imply that an ad valorem tax is not organizationally equivalent to a per-unit tax that raises the same revenue in the industry equilibrium. In the on-line Appendix, we indeed show that for a given per-unit tax that induces an organizational change from nonintegration to integration in the industry, the ad

valorem tax that raises the same revenue induces the same organizational change, i.e., imposes the same effect on the managerial surplus. This is reminiscent of a well-known result under perfect competition. Conversely, it is well known that these two tax instruments are no longer equivalent in imperfectly competitive markets: an ad valorem tax is associated with much less deadweight loss than is a specific tax that raises equal tax revenue (see, e.g., Delipalla and Keen [16], Andersen et al. [3]; a review of the literature is provided in Auerbach and Hines [4]).

Appendix G Net welfare change of (26) in the absence of the HQ's private benefit

In this section, we examine the derivation and the sign of the net welfare change in (26) if $L = 0$, i.e., in the absence of HQ's benefits. The calculation is as follows:

$$\Delta W_{NI}^{t} = \left((P^* - t)(1-\sigma) - \frac{1}{2}\right) + t(1-\sigma) - \frac{P^{*2}}{(1+P^*)} = P^* \left(\frac{P^* - 1}{2P^*(1+P^*)} - \sigma\right) < 0, \tag{G-20}$$

where the first term is the managerial surplus under integration with a production failure and per-unit tax, the second term represents the total tax collected by the government under the integrated production with failure, and the last term is the managerial surplus Π_N^* under nonintegration, given by equation (8).

To understand why a tax always generates a negative welfare change when the organizational structure is switched from nonintegration to integration, we provide the following proof.

The roots of the quadratic equation in the numerator of (G-20) above are as follows:

$$\underline{P^*} = \frac{1 - 2\sigma - \Delta(\sigma)}{4\sigma},\ \overline{P^*} = \frac{1 - 2\sigma + \Delta(\sigma)}{4\sigma}, \tag{G-21}$$

where $\Delta(\sigma) = \sqrt{1 - 12\sigma + 4\sigma^2}$. It is clear that ΔW_{NI}^{t} is nonnegative whenever $P^* \in [$

$\underline{P^*}, \overline{P^*}$]. These roots are exactly equivalent to what is obtained by (F-15) as $\underline{P}$ and $\overline{P}$; thus, let $\underline{P^*} = \underline{P}$ and $\overline{P^*} = \overline{P}$. Recall that before the introduction of a tax, the organizational structure was nonintegrated; therefore, from (F-15) it follows that $P^* \notin [\underline{P^*}, \overline{P^*}]$. As a result, this analysis proves that ΔW_{NI}^t in (G-20) is strictly negative. Hence, in the absence of the HQ's private benefit, the tax-induced organizational switch always creates a negative welfare change due to managers' private costs.

On-Line Appendix of Managerial Firms, Taxation, and Welfare

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February 14, 2022

1 Equivalence of ad valorem and per unit taxation, conditional on the organizational choice

In this section, we consider the welfare equivalence between per unit and ad valorem taxation, when these two tax instruments induce an organizational change at the industry equilibrium. We follow Auerbach and Hines [2] and compare an ad valorem and a specific tax that induce the same amount of revenues. We evaluate the welfare equivalence of these two tax instruments, when they induce an organizational change. We start from a tax induced change from integration to non-integration (when $\sigma = 0$), then turn to a tax induced change from non-integration to integration (when $\sigma > 0$).

1.1 Tax induced organizational change from integration to non-integration

Let us now consider an initial equilibrium, where price $P^* > 1$, then a share $\alpha = 1$ chooses to integrate and the corresponding supply quantity is $Q_s = 1$.

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Consider a combined use of equivalent and ad-valorem taxation that induce an organizational change from integration to non-integration. The price after the combined tax scheme is $P(1-\tau)-t$. Managers decision to integrate is now described as follows:

$$\Pi_I^* \geq \Pi_N^* \;\Leftrightarrow\; P \geq \frac{1+t}{1-\tau}, \tag{1}$$

which identifies an upward shift of the organizationally augmented supply curve, such that $P^* < \frac{1+t}{1-\tau}$. The deadweight loss associated with the tax scheme is

$$\Delta W_{IN}^{\tau t} = \frac{1-2(P^*\tau+t)-(P^*(1-\tau)-t)^2}{2(1+P^*(1-\tau)-t)^2} < 0,$$

which goes back to ΔW_{IN}^{t} in section 3.2 for $\tau = 0$.

Tax revenue from the joint tax scheme is:

$$TR_N^{\tau t} = (P\tau+t)(1-\frac{1}{(1+P(1-\tau)-t)^2}.)$$

where tax revenues are obtained given total production under non-integration.

As in Auerbach and Hines [2], the relative size of the welfare change under the two tax schemes, must be compared for taxes that induce the same tax revenues. It can be easily shown that:

$$\frac{\frac{d\Delta W_{IN}^{\tau t}/dt}{d\Delta W_{IN}^{\tau t}/d\tau}}{\frac{dTR_N^{\tau t}/dt}{dTR_N^{\tau t}/d\tau}} = \frac{1/P}{1/P} = 1$$

This implies that a revenue equal substitution of ad valorem for specific taxation leaves the welfare difference unchanged at any t, τ combination. Notice that this equivalence result holds provided that the tax induced an organizational change at the industry equilibrium

i.e. it does not account for the fact that a revenue equal substitution of ad valorem and per unit tax changes the probability of an integration outcome in the industry.

1.2 Tax induced organizational change from non-integration to integration

Let us now consider an initial equilibrium, where price $P^* > \overline{P}$, then a share $\alpha = 0$ chooses to integrate due to integration costs, which reduce output under integration by a fixed amount $\sigma > 0$ for any market price level. Thus the relevant initial supply curve is $Q_s = Q_N^*$.

It can be shown that the combined use of per unit and ad-valorem taxation changes managers' incentives to integrate as follows:

$$\Pi_I^* \geq \Pi_N^* \Leftrightarrow \underline{P} \leq P \leq \overline{P}, \text{ where } \underline{P} = \frac{1 - 2\sigma + 4t\sigma - \Delta(\sigma)}{4\sigma(1-\tau)}, \ \overline{P} = \frac{1 - 2\sigma + 4t\sigma + \Delta(\sigma)}{4\sigma(1-\tau)}, \quad (2)$$

which includes special cases for $\tau = 0$, and $t = 0$, respectively. Consider a combined tax scheme, which induces an organizational change from non-integration to integration. Being independent on the tax, it can be shown that the deadweight loss associated with the tax scheme is still given by (26) in the paper. This is independent on the type of tax which is levied, which is enough to demonstrate that it is indifferent to choose an ad valorem or a specific tax, provided that they induce an organizational change.

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