UNIVERSITÀ CATTOLICA DEL SACRO CUORE
Dipartimento di Economia e Finanza

Working Paper Series

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Working Paper n. 43

June 2016

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Taxation, industry integration and production efficiency*

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June 11, 2016

Abstract

Taxes levied on production processes (e.g. VAT), are today a very important source of government revenues in developed economies. Theories of optimal taxation conclude that these taxes are detrimental to production efficiency, when firms operate in perfectly competitive markets. These theories draw on the neoclassical approach, which regards firms as single production units. The present paper investigates the effects of taxation on production efficiency, accounting for the organization of an industry. The model shows that a lump-sum tax does not have any effect on the organization of the industry, while a non lump-sum tax can be designed that induces an organizational change of the industry. The paper shows that the effect of this "tax induced organizational change" on production efficiency ultimately depends on the characteristics of the market.

JEL Classification: H21, L22 and H32
Keywords: taxation, organizational change, vertical integration, and production efficiency

*I am particularly grateful to Salvatore Piccolo and Pasquale Schiraldi for valuable comments and suggestions. I also thank colleagues who attended presentations at the 22^{nd} congress of the European Economic Association, the 10^{th} Journée Louis-André Gérard-Varet, the 13^{th} Annual Conference of the Association of Public Economic Theory and the invited seminar at the economic department of Università di Verona for very helpful discussions. The usual disclaimer applies.

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1 Introduction

Taxes that are incurred as a result of the production process, are a very important source of government revenues in developed economies. In 2014 Value Added Taxation alone accounts for over 20% of tax revenues in OECD countries, with VAT rates that are steadily increasing from the 1970s (OECD [36]). Theories of optimal taxation show that any non-lump-sum tax is detrimental to production efficiency when firms operate in perfectly competitive markets (see Auerbach and Hines [3] for a synthesis). This conclusion draws on the so-called Production Efficiency Theorem of Diamond and Mirrlees [15], which says that, in a competitive economy, the optimal tax structure leaves firm choices unaffected by taxes. This widely acknowledged result is often seen as providing a rationale for a tax system that is neutral with respect to firm decisions, and inspired recommendations by the Meade Committee and the Mirlees Review (see Mirlees et al. [34] for a discussion). However, this result draw on the neoclassical approach, which adopts a technological perspective and considers firms only as production units (see e.g. Mas-Colell et al. [33]). A criticism commonly leveled at this approach is that it treats the firm as a perfectly efficient black box, in the face of an increasing fragmentation of production processes in multiple steps (Coase [9], Hart [18]). An alternative view, which provides support for modern theories of the firm (e.g. Grossman and Hart [17], Hart and Moore [20], Hart and Holmstrom [19]), considers firms as a way to organize fragmented production activity, in the presence of pervasive transaction costs (see Williamson [40] for a review).

The present paper proposes a theory to investigate the effects of production taxation on the organizational structure of an industry. In particular, the effects of taxes are described in an industry where firms are composed by two units, which have to coordinate their activity to produce a marketable output in the presence of incomplete contracts. Depending on the incentives of the units' managers, firms can adopt either a non-integrated or an integrated production structure. With non-integration, managers fail to coordinate, reducing the firms' production efficiency. Integration provides a solution to such coordination failure, and allows firms to implement the efficient production plan. I analyze the effect of taxation on managers' incentives, thus the internal organization of firms at the industry equilibrium. The effects of taxation on production efficiency and welfare are then evaluated at the industry equilibrium, comparing a non-lump sum tax with a lump sum tax on firm profits.

The analysis just described builds on the theory of managerial firms with incomplete contracts by Legros and Newman [30]. This framework is in line with Holmstrom [19]'s firm boundaries theory,[1] but allows to describe the effects of taxes at the industry equilib-

[1] According to this theory, firm boundaries define not only the allocation of residual control rights, but also the efficiency of the operating decisions to be taken inside the firm (e.g. the choice of production techniques, marketing campaigns, etc.). This view contrasts with contributions by Grossman and Hart [17] and Hart and Moore [20], which provide the first asset governance theories with incomplete contracts. The Grossman-Hart-Moore approach cannot be considered to be firm theory 'per se'. In fact, while it analyzes the efficient allocation of property rights over productive assets, it also neglects key organizational issues such as firm scope, delegation, monitoring, and information sharing. Up to my knowledge, Hart and Holmstrom [19] are the first to incorporate issues related to intra-firm coordination within a property-rights

rium, which is a general equilibrium of the supplier and the product market. Accordingly, it embeds the organization of the industry in a "organizationally augmented" supply function, which prompts a description and welfare analysis of the industry equilibrium in the standard Neoclassical framework.

The model shows that a lump-sum tax does not have any effect on the organization of the industry, while a non lump-sum tax can be designed that, starting from an integrated equilibrium, induces an organizational change to a non-integrated equilibrium. This organizational change is shown to be inefficient, as it induces coordination failures between the two units, thus reducing industry production. The baseline model is then extended to account for failures to reach the minimum efficient scale of production under integration (e.g. due to information or communication, failures, or loss of specific managerial skills). This extension allows to feature a case where a non lump-sum turns out to be second best efficient, compared to a welfare neutral lump-sum tax. This extended setting also features an elasticity of the integration outcome to the tax, and allows to compare the organizational effects of a tax per unit of output with an ad valorem tax (see e.g. Delipalla and Keen [14]).

These results suggest that taxation not only affects production efficiency through the "intensive margin" by Diamond and Mirlees [15] (i.e. the production scale), but also affects the "extensive margin" of production i.e. the efficiency of the organizational structure, for a given production scale. When integration implements the perfect efficient production plan, accounting for this extensive margin confirms the widely acknowledged finding that non-lump-sum taxes are detrimental to production efficiency in perfectly competitive markets. However, when production failures are present under integration, a corrective role may emerge for non lump-sum taxation, and ad valorem taxation is shown to make an integration equilibrium more likely to occur relatively to a tax per unit of output. These latter results recall the corrective role of non-lump sum taxation and the welfare superiority of ad valorem relative to per unit taxation in imperfectly competitive settings (see Auerbach and Hines [3] for a review). [2]

Since incomplete contracts provide a natural formalization of transaction costs,[3] this paper is also related to the literature that discusses the interactions between taxation and transaction costs inside the firm. In this respect, the contribution more closely related to mine is the pioneering work by Barzel [4], who shows that the equivalence between ad valorem and per unit taxes with perfect competition is altered when transaction costs are positive. In similar vein, Logue and Slemrod [32] show that, under the assumption of different transaction costs for producers and consumers, traditional public finance results, such as the 'invariance of tax incidence' and the 'invariance of tax remittance', no longer

approach.

[2]Starting from Wicksell [37]'s pioneering work on the efficiency of taxation in a monopoly setting, more recent contributions discuss non-lump sum taxation ad valorem and per unit of output with symmetric Cournot-Nash oligopolies (Delipalla and Keen [14]), horizontal and vertical product differentiation (Kay and Keen [24], Cremer and Thisse [13], Keen [25]) and Bertrand price competition with differentiated products (Andersen et al. [2]). Kotsogiannis and Serfes [27] shows that ad valorem taxation may not welfare dominate per unit taxation in the presence of uncertainity regarding firms' cost structures.

[3]Williamson [40] defines the asset governance theories with incomplete contracts proposed by Grossman and Hart[17] and Hart and Moore[20] as the 'natural progression' of transaction cost economics.

hold.

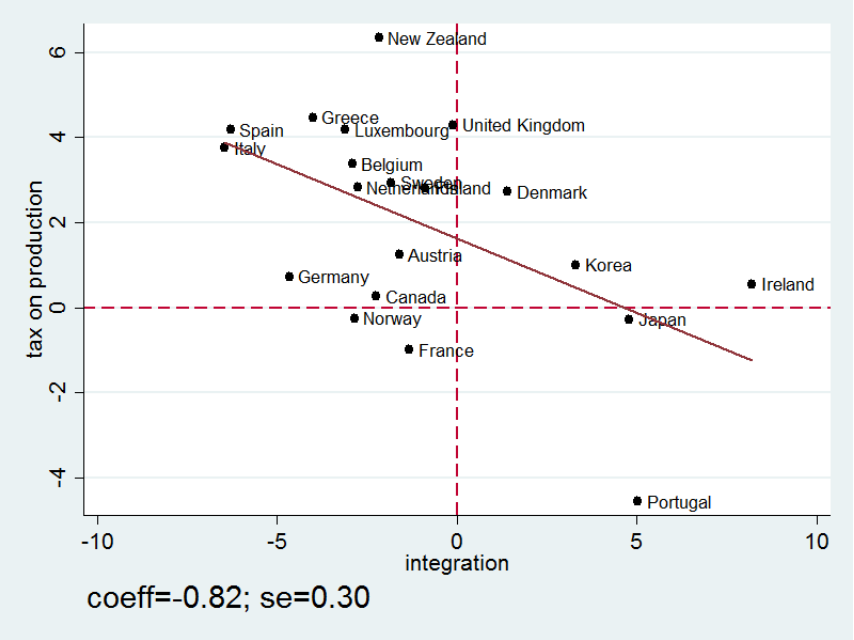
The rest of the paper is structured as follows. To motivate the analysis, Section 2 presents some evidence on production taxation and the integration of manufacturing firms in OECD countries. Section 3 describes the theoretical model. Section 4 describes the impact of taxation on the industry equilibrium welfare. Section 5 extends the baseline analysis to account for production failures under integration. Section 6 concludes.

2 Some Evidence on Production Taxation and Integration

Figure 1 presents some descriptive evidence on the relationship between production taxation (on the Y axis) and the degree of integration (on the X axis) in the manufacturing sector of 21 OECD countries during 1970-2005. Production taxes are drawn from the OECD National Accounts. These are taxes (net of subsidies) on products, as share of gross value added. They include general sales taxes, 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). Variables are taken in 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. Changes in production taxation appear to be negatively correlated with changes in the degree of integration in the manufacturing industry. The correlation is sizeable, and statistically significant at the 5% level (coefficient equal to -0.82, standard error 0.30). During the sample period, the degree of integration in the manufacturing sector increased in countries such as Japan or Korea, while it decreased in the majority of countries from the European Union. This is consistent with the findings from Bloom et al. [7] that firms located in Asian countries have a much more centralized structure than firms located in European countries. The negative correlation suggests that integration considerably increased in countries that maintained a constant tax burden on production, and decreased in countries such as Italy and Spain, where the tax burden on production has increased during the sample period.

The negative association between production taxation and integration emerges clearly in panel data regressions, which better account for the time varying economic and institutional determinants of industry integration (see Table A-2 in the Appendix). Estimates suggest that one standard deviation increase of taxation on production (which is about 4 percentage points) explains a decrease in vertical integration by about 1.6 percentage points, which is about the 37% of a standard deviation in OECD countries, on average. While these should be interpreted as correlations, the magnitudes of the estimated coefficients is sizeable if one considers the general tendency experienced by OECD countries in the recent years, to increase the tax burden on the production processes e.g. through the steady increases in VAT statutory rates. To make a few examples, starting from 1999, on average the statutory VAT rate in the euro area increased by about 3 percentage points. Spain and Greece increased the statutory VAT rate by 5 percentage points. Germany and the Netherlands by about 3 percentage points. Italy and Ireland increased VAT rate by 2

Figure 1: Production Taxation and Integration in the Manufacturing Sector.



Notes: Differences between country averages over the periods 1995-2005 and 1970-1980. Authors' calculation on OECD data.

percentage points (see OECD [36]).[4]

3 Theoretical Model

In this section I present a model that describes the effect of taxation on the equilibrium of an industry, when firms can choose their organizational structure. I build on the organizational framework by Legros and Newman [30], which describes the organizational choice of firms in the industry in a general equilibrium that includes the product market. This is genuinely perfectly competitive, which allows to abstract from the effect of market power in the baseline analysis, and discuss the behavioral effects of taxation that are triggered solely by incomplete contracts.[5]

3.1 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 homogenous good.

[4]This raises concerns on whether there should be coordination devices for VAT setting (e.g. at the EU level) or whether countries should be allowed to compete on VAT taxation. The commodity tax competition literature has shown that the welfare properties of tax coordination relative to tax competition depend on market structure and the choice of the principle of commodity taxation (Keen et al. [26]. See Haufler and Pfluger [23] for a review.)

[5]An extension where the organizational choice is also affected my monopoly power is presented in Appendix B.

Production units are run respectively by managers M_a and M_b, who are risk neutral, cash-constrained and have limited liability.[6]

A production plan consists of the operating decisions to be taken for each unit. Let $a \in [0,\ 1]$ and $b \in [0,\ 1]$ be the decisions taken for units A and B, respectively. Coordination among units increases the efficiency of firm's production:

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

From (1), the production plan with fully coordinated decisions $a = b$ ensures the highest attainable output, $q = 1$, among all feasible plans. However, any deviation from full coordination entails a loss of production efficiency, described by a $q < 1$.[7]

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 cost of accommodating a different approach, borne by M_a and M_b, respectively:

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

$C(a)$ and $C(b)$ indicate that managers M_a and M_b 'disagree' over direction as M_a's preferences are increasing in a while M_b's ones are decreasing in b.[8] Equations (1) and (2) introduce a tradeoff between the benefits and the costs of coordination for managers. The benefits of coordination are related to the activities of the firm as a whole, thus they are monetary and fully transferable within the firm. The costs of coordination are related to the managers' subjective preferences, thus they are private in nature and not transferable to any other agent (Legros and Newman [30]).

Organizational structure. Managers can choose between a *non-integrated* and an *integrated* governance structure. Under a non-integrated structure, managers retain control over their units, and their decisions determine the efficiency of the production plan (1). In an integrated structure, managers sell the firm to a Headquarter (HQ), who centralizes the decision making process, 'instructs' managers about the decisions to implement and obtains part of the revenues. I assume that HQs have a cash endowment that allows them

[6] In modern firm boundary theories, the distinction made between ownership and control is due to the inability of cash-constrained managers to raise the funds required to purchase the ownership rights (see Bolton and Dewatripont [6] for a review). The assumption of constraints to cash availability also prevents managers from subsidizing the firm i.e. induces an outcome where managers have to enjoy profits.

[7] Legros and Newman[30] also interpret q as the probability of success for a project run jointly by the two units. The function (1) implies there is no objectively 'right' decision, but that coordination is fostered by the adoption of common standards. The more that decisions are in the same direction (i.e. the closer are standards a and b) the higher will be the efficiency of firm's production process.

[8] Private costs can be interpreted in terms of broadly defined job dis-satisfaction of workers. When each unit's employees' human capital is tied to a particular, familiar technology, accommodating to another's technology will be costly, in terms of wages, career prospects, and the opportunity cost related to learning new skills (Hart and Holmstrom[19]). Underlying this interpretation is the assumption that each manager aligns her preferences to those of her workers, because of shared interests or concern for their well-being.

to acquire the firm. HQs are self-interested, thus they also cannot commit to production decisions. However their payoff is purely a monetary one, which implies that HQs take decisions a and b that maximize their income, while the direct costs of these decisions is still suffered by managers.

Contracts. I assume that operating decisions a and b cannot be specified in an ex-ante enforceable contract. However managers can, under ex-ante competitive conditions, negotiate contracts that specify the governance structure G and revenue shares. I assume that the entire revenue by firm activity accrues to managers and HQ. A contract for M_a and M_b is structured as follows:

- under non-integration ($G = N$), 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 ($G = I$), HQ acquires the firm, 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 (Hart and Moore[22]).[9]

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

$$U(x) - Px,$$

where $x \geq 0$ represents the quantity consumed and P the market price, with $u'(\cdot) > 0$ and $u''(\cdot) \leq 0$. Since consumers are price takers, the first order condition for the 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 M_a types being more numerous than M_b types: their measure is $n > 1$, while the M_b types have unit measure.[10] Finally, in the HQ market HQs are supplied perfectly elastically.

Timing. The timing is as follows:

- managers sign the contract (G, s) specifying the governance structure and the revenue shares,

[9] This is an application of the approach to contracts as 'reference points', first proposed by Hart and Moore[22] as an alternative to ex-post renegotiation with side payments, which is the more typical solution to incomplete contracts proposed by Grossman and Hart[17]. Fehr, Hart and Zehnder[16] provide experimental support for this approach by showing that ex-ante competition legitimizes the terms of the contract.

[10] As is usual in modern theories of the firm (e.g. Hart and Moore[21]; Hart and Holmstrom[19]), this assumption is made to simplify the mechanism of surplus sharing. In fact it provides a sufficient condition to exclude equilibria where one contractual outcome always Pareto dominates the other.

- managers or HQ (depending on the governance structure chosen) make the decisions for the units,
- managers implement the decisions (whatever party is entitled to make them) 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, s_b are managers' revenue shares, q is the output of the firm under organization $G = N, I$.

I assume that under non-integration, M_a and M_b implement the decisions a and b simultaneously, without consultation or negotiation, in order to maximize their payoffs (3). Conversely, under integration, managers pay HQ a positive share η of the firm's revenue to take decision. HQ's payoff is:

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

which implies that 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 chooses 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 non-integration, respectively,
- managers choose to hire a 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 HQ's incentives compatibility constraints i.e. $s_a \geq 0$, $s_b \geq 0$ and $\eta \geq 0$.

3.2 Market equilibrium and industry structure

3.2.1 Production decisions under each organization

Under non-integration, managers take the decisions for their units. Accordingly, there is no HQ and $\eta = 0$. To save on notation, in this case revenue shares accruing to M_a and M_b are denoted as s and $(1 - s)$, respectively. By inserting the production plan (1) and the cost functions (2) in the profit functions (3), at the Nash equilibrium:

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

Substitute (6) in (1) to obtain equilibrium output under non-integration:

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

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*: when s is small, M_a takes a decision she likes (a_N^* high) while M_b takes a decision she dislikes (b_N^* high), thus the burden of coordinating weighs more on M_b. The opposite holds true when s is big.[11] However, the distribution of coordinating efforts between managers has no effect on the efficiency of the production plan, thus total production under non-integration. (ii) *The market price determines the level of managers' coordination efforts*. When P is high, production is valuable because the revenue potential of the firm is high. Thus, both managers take decisions they dislike to minimize coordination failures (M_a chooses a_N^* low, M_b chooses b_N^* high).

Under integration, self-interested HQ maximizes (4). Accordingly HQ sets $a = b$. This is indeed the fully coordinated decision that maximizes production efficiency, thus HQ's income. Since an infinite number of $a = b$ combinations exist, I assume that HQ takes the decision that minimizes managers' total private costs i.e. $a_I^* = b_I^* = 1/2$ (see Legros and Newman [30]). From equation (1), production under integration is perfectly efficient i.e. $Q_I^* = 1$. Notice that neither revenue shares nor producer prices affect output. In fact, 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, HQ wants only to maximize production by implementing full coordination.

3.2.2 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 at the equilibrium. Assuming contracts as the reference point, excess supply of M_a types drives their revenue share to zero under either governance structure.[12] From (6), the sharing rule $s = 0$ under non integration defines the outcome $a_N^* = 1$, $b_N^* = P/1+P$: since she gets no revenue, M_a takes the decision she prefers and leaves all the coordination effort to M_b.

Under integration, the HQ's decision $a_I^* = b_I^* = 1/2$ induces total managerial costs $C(a_I^*) + C(b_I^*) = 1/4$. Without loss of generality, I also assume that HQs operate at zero

[11] This is due to the assumption that M_a and M_b behave non-cooperatively. In the spirit of Hart and Moore[22], non cooperative behavior reflects the idea that each manager feels entitled to her preferred outcome within the contract i.e. M_a feels entitled to $s = 1$ and M_b feels entitled to $1 - s = 1$. For this reason, when $0 < s < 1$, each manager may feel aggrieved and stint on performance. In particular, when s is small, M_a feels aggrieved and stints by choosing a high a (which she likes) while M_b is pleased and 'concedes' to M_a a high b (which she dislikes). The opposite holds when s is high. The underlying assumption here is that, since operating decisions are judicially not enforceable, they are made in the 'spirit' and not according to the 'letter' of the contract (Williamson[39]; Hart and Moore[22]).

[12] Using contracts as a reference point postulates that contracts are negotiated under competitive conditions and that each contract 'locks' managers into the relationship (Hart and Moore[22]). With excess supply of M_a types, these assumptions drive M_as' surplus shares to their outside option, $s = 0$.

opportunity cost, thus $\eta = 0$.[13] Then, managers have the same revenue shares as in the non-integration case. In particular $s = 0$, which implies that M_a suffers a net loss $\pi_I^a = -1/8$. This net loss is fully covered by M_b, because under integration surplus is fully transferable between units.

Plug equilibrium decisions and output levels for $s = 0$ into (5) to obtain the equilibrium aggregate payoff for managers under non-integration and integration, respectively:

$$\Pi_N^* = \frac{P(1+2P)}{2(1+P)}, \qquad \Pi_I^* = P - \frac{1}{4}. \tag{8}$$

The convexity of the cost functions (2) implies that aggregate costs $(C(a_G^*) + C(b_G^*))$ are maximized by the sharing rule $s = 0$ under non-integration (i.e. in Π_N^*) while they are minimized by HQ's behavior under integration (i.e. in Π_I^*). This denotes a typical equilibrium in modern theories of the firm (e.g. Williamson[38]; Hart and Holmstrom[19]), where a negotiation that leads to 'winners' as opposed to 'losers', produces bigger aggregate losses than an equilibrium in which the parties share the benefits and costs equally. In fact, when $s = 0$, under non-integration M_a leaves the entire burden of coordination to M_b who is the 'winner' in the negotiation. Under integration, HQ implements the fully coordinated plan that minimizes aggregate managerial costs, i.e. partly internalizes the managers' wishes, regardless of revenue shares.[14]

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

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

From (9), the organizational choice depends on the market price because this determines the strength of cost minimization relative to revenue maximization in the payoff functions (8). When $P < 1$, the revenue motive in M_b's payoff is not high enough to compensate for the costs she has to bear to implement an efficient production plan. Thus M_b chooses non-integration, which gives her a 'quiet life' and allows her to save on private costs. Conversely, when $P > 1$, the revenue motive is large enough that the unbalanced set of incentives to coordinate under non-integration disproportionately increases aggregate costs. Then, M_b chooses integration because this organization maximizes output, at the lowest private cost consistent with full intra-firm coordination. Finally, when $P = 1$ the combiantion of revenue and cost minimization incentives make M_b indifferent between integration and non-integration.[15]

The industry equilibrium is a general equilibrium of the supplier market and the product market. The equilibrium in the supplier market consists of a mass of firms of size

[13] This assumption is made for expositional simplicity. Results are not altered if HQs are allowed to have a positive reservation wage, as in Conconi, Legros and Newman[11].

[14] The 'transaction cost economics' literature (see Coase[10]; Williamson[40]) generally assumes that in the presence of pervasive transaction costs, a socially inefficient outcome is more likely to occur with non-integration relative to integration, because in this latter case HQ operates as a 'benevolent regulator'.

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

equal to 1 (this is due to M_b types, being on the 'short side' of the market with a unit measure). At equilibrium, a share $\alpha \in [0,1]$ chooses to integrate such 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) denotes 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 non-integrated structure, and a pure strategy equilibrium with non-integration 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 $P = 1$, M_b types obtain the same payoff under either organization and a mixed strategy equilibrium emerges in the supplier market where firms randomly choose one of the two organizations, $\alpha \in [0,1]$.

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

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

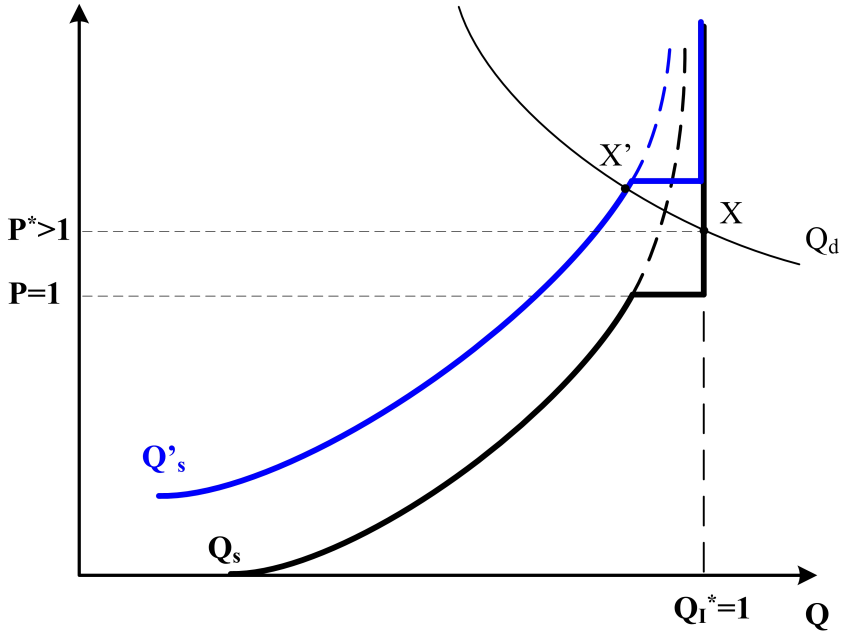
where α is the equilibrium in the supplier market described by (10). Equation (11) incorporates into the Neoclassical supply concept those incentives that determine the design of firm governance at the industry equilibrium. This "organizationally augmented" supply curve is depicted as the black line in Figure 2. When $P < 1$, $\alpha = 0$ and market supply results from a non-integrated industry structure, as in (7) above. When $P > 1$, $\alpha = 1$ and supply is obtained under an integrated structure, which is $Q_I^* = 1$. Finally, when $P = 1$, $\alpha \in (0,1)$ and Q_N^*, Q_I^* are weighted by the industry shares $1-\alpha$ and α of non-integrated and integrated firms, respectively.

4 Taxation, Integration and welfare

The industry equilibrium is given by the intersection of the downward-sloping demand $Q_d(P)$, and the organizationally augmented supply function (11), above. This is a general equilibrium, which features both the quantities which are exchanged in the product market as well as the organizational structure chosen in the supplier market.

Consider for example an equilibrium such as X in Figure 2. At this equilibrium, quantity $Q_I^* = 1$ is consumed in the product market at price P^*, and firms in the supplier market produce under an integrated structure. I now assess the effects of taxes on organization and production at the industry equilibrium. I can also evaluate the effects on taxation on welfare in terms of changes in producer surplus. I start from the analysis of a lump sum tax, then turn to non-lump sum taxes.

Figure 2: Taxation, organizationally augmented supply, and the equilibrium of the industry



4.1 Lump-sum tax

Consider a lump-sum tax, T is imposed on firm revenues. Payoffs of managers after the introduction of the tax are as follows:

$$\pi_G^a = s_a\,(Pq - T) - \,C(a_G), \qquad \pi_G^b = s_b\,(Pq - T) - \,C(b_G), \tag{12}$$

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

$$\pi^{HQ} = \eta\,[Pq - T]\,, \tag{13}$$

Under non-integration, From (12), the lump sum tax does not enter the first order conditions for managers optimal decisions as there is no Spence-Mirlees. Accordingly, a^* and b^* are still given by (6) and total output is given by equation (7). Similarly, under integration, the HQ still behaves as a revenue maximizer, despite of the introduction of the tax, i.e. production is still $Q_I^* = 1$.

Plug the equilibrium decisions and output levels into (12), to obtain the equilibrium

aggregate payoff for managers under non-integration and integration, respectively:[16]

$$\Pi_N^* = \frac{P(1+2P)}{2(1+P)} - T, \qquad \Pi_I^* = P - \frac{1}{4} - T. \tag{14}$$

Equations (14) describe the set of managers' incentives. In particular, it can be easily shown that $\Pi_I^* > \Pi_N^*$ when $P > 1$, as in equation (9) above.

Accordingly, the introduction of a lump-sum tax does not change managers' incentives to integrate, thus the share $\alpha \in [0, 1]$ of firms that chooses integration at the supplier market equilibrium. The lump-sum tax does not even affect production levels under integration or non-integration. Being neutral with respect to production and organization decisions of firms, the lump-sum tax is also neutral to welfare: its only effect is to redistribute surplus from producers to tax revenue.

These findings can be summarized in the following:

Proposition 1: *A lump-sum tax does not affect firm production and organization decisions. Thus, it does not have any effect on welfare at the industry equilibrium.*

This finding recalls the production efficiency theorem in a setting with endogenous organization of firms. Diamond and Mirrlees [15] show that, in a competitive economy, lump sum taxes leave firm production choices unaffected by taxes. Their result is based on the Neoclassical approach, which neglects firm organizational decisions. Proposition 1 shows that the neutrality of lump-sum taxes to firm decisions holds also in a setting where firms are regarded not only as production units, but also as a way to organize production activity.

4.2 Non lump-sum tax

I now turn to the case of a non-lump sum tax. In particular, consider a tax t levied per unit of output, given the market price P.[17] Payoffs of managers after the introduction of the tax under organization $G = N, I$ are as follows:

$$\pi_G^a = s_a\,(P-t)q - C(a_G), \qquad \pi_G^b = s_b\,(P-t)q - C(b_G), \tag{15}$$

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

$$\pi^{HQ} = \eta\,[(P-t)q]\,. \tag{16}$$

[16] At the contracting stage, excess supply of M_a types drives their revenue share to zero under either governance structure, as in the not-tax case. Accordingly, from (6), the sharing rule $s = 0$ under non integration defines the outcome $a_N^* = 1$, $b_N^* = P/1 + P$. As in the no tax case, I still assume the HQ implements $a_I^* = b_I^* = 1/2$ under integration. Without loss of generality, I also assume that HQs operate at zero opportunity cost, thus $\eta = 0$ so that $s = 0$, and M_a suffers a net loss $\pi_I^a = -1/8$, which is fully covered by M_b.

[17] At this stage of the analysis this can be done without loss of generality. In Appendix E I discuss the equivalence of per unit and ad valorem taxation with respect to the organization decision.

Equilibrium decisions of managers under non-integration become:

$$a_N^* = \frac{1}{1+(P-t)} + \frac{(1-s)(P-t)}{1+(P-t)}; \qquad b_N^* = \frac{(1-s)(P-t)}{(1+(P-t))}. \tag{17}$$

Accordingly, I obtain equilibrium output under non-integration:

$$Q_N^* = 1 - \frac{1}{2(1+(P-t))^2}. \tag{18}$$

From equations (17), a non lump-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 marginal revenue, managers 'opt for a quiet life', i.e. move towards the decision they like and economize on private costs (Bertrand and Mullainathan [5]). As a result, the non lump-sum tax reduces output under non-integration, as it is apparent from equation (18). Conversely, the non lump-sum tax has no effect on production under integration. In fact, the HQ still maximizes (16) by implementing full coordination, and firms still produce $Q_I^* = 1$ under integration. Overall, the discussion above suggest that, at any market price P, a non-lump sum tax reduces the production efficiency of non-integration *vis-à-vis* integration. In fact, at any market price level, the lower producer price induces managers to opt for a quiet life.

At the contracting stage, the equilibrium aggregate payoff for managers under non-integration and integration, are respectively:

$$\Pi_N^* = \frac{(P-t)(1+2(P-t))}{2(1+(P-t))}, \qquad \Pi_I^* = (P-t) - \frac{1}{4}. \tag{19}$$

From equations (19), it follows that:

$$\Pi_I^* \geq \Pi_N^* \;\Leftrightarrow\; P \geq 1+t \tag{20}$$

Equation (20) shows that the introduction of a non lump-sum tax affects managers' organization decisions at the industry equilibrium.

I are now ready to analyze the effect of the tax on the equilibrium of the industry. This is represented by an upward shift of the organizationally augmented supply curve in Figure 2. Consider the initial equilibrium at point X in Figure 2, where demand Q_d intersects supply Q_s in the absence of any tax. From equation (11), at X a share $\alpha = 1$ chooses to integrate in the supplier market. Consider a tax that induces an upward shift of the supply curve to Q_s' (blue curve). This leads to a new industry equilibrium $X^{'}$, where the industry is characterized by a share $\alpha = 0$ of integrated firms. This is a "tax induced organizational change" from a fully integrated to a fully non-integrated industry structure. Notice that output at $X^{'}$ is smaller than at equilibrium X. This means that the introduction of the tax triggered some production inefficiencies. However, these inefficiencies are solely due to the organizational change from integration to non-integration. Inefficiencies would not occur if, in response to the tax, the industry retained an integrated structure. In this case the industry would remain at the initial equilibrium, X.

What are the effects on welfare? Since the behavioral forces just described operate on the supply side of the economy, let's focus on producer surplus, and consider an infinitely elastic demand function that sets the market price at $P = P^*$. When both integration and non-integration are available options in the supplier market, a non lump-sum tax may alter the organizational choice at the industry equilibrium. Figure 3 describes this case. At the initial no tax equilibrium, X, producer surplus under integration is $W_I^* = P^*$.[18]

Now consider a non lump-sum tax. This tax reduces production efficiency under non-integration only, which results into an upward shift of the supply curve. This may induce a new equilibrium, such as X', where all firms in the supplier market at new producer price $P^* - t$, 'switch' to non-integration as this organizational form allow managers to save on private costs. At the new equilibrium, an excess burden emerges:

$$DW_{IN}^t = \frac{P^*(1+P^*) - 2P^*t + t^2}{2(1+P^*-t)^2} > 0,$$

where $DW_{IN}^t > 0$ is guaranteed by the incentive compatibility constraint $P^* - t < 1$ for a non-integration equilibrium to emerge in the supplier market after the tax. These results can be summarized in the following:

Proposition 2: *A non lump-sum tax may induce an organizational change from integration to non-integration, which reduces production efficiency and welfare at the industry equilibrium.*

The deadweight loss of non lump-sum tax, DW_{IN}^t is depicted as the red shaded area in Figure 3. This is a version of the "Leibenstein trapezoid", which measures the welfare losses caused by the switch to a less efficient organization.[19] This suggests that, besides the well known effects on production efficiency a là Diamond and Mirrlees [15], there are also organizational reasons why a non lump-sum tax reduces the efficiency of production. While Diamond and Mirrlees [15]'s effects operates on the intensive margin (i.e. by reducing production, regardless of the organization), the effect of distortionary taxation pointed out in Proposition 2 operate on the extensive margin (i.e. by inducing a change in the organizational structure of the industry, given a certain production scale under each organization).

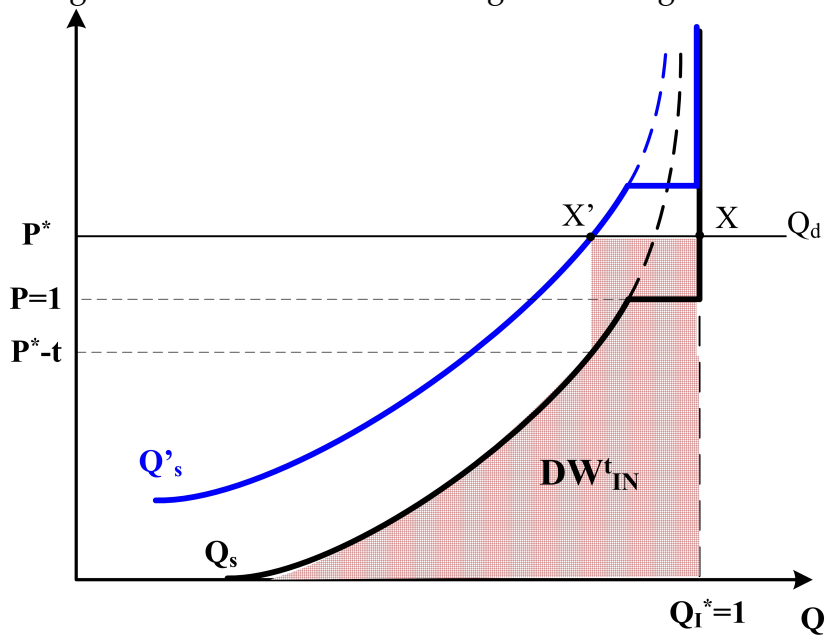
Propositions 1 and 2 can be used to compare the efficiency of lump-sum and non lump-sum taxation in the following:

Corollary 1: *A lump-sum tax is always more efficient that a non lump-sum tax that induces a switch from an integration to a non-integration equilibrium.*

[18]This is the first-best efficient outcome. With incomplete contracts, this emerges with integration only. Under non-integration, incomplete contracts generate a deadweight loss on the "intensive margin" as firms produce too little (Legros and Newman [30]). Notice that if contracts were complete, in this setting non-integration would be as production efficient as integration. In fact, the perfect efficient production plan could be specified in a contract.

[19]The idea that production inefficiencies may have organizational origins was first pointed out by Leibenstein [31], who calls them as X-inefficiencies. See Legros and Newman [30] for details.

Figure 3: Deadweight loss of a tax induced change from integration to non-integration



Finally, two remarks are in order. First, results in this section are derived for the case of a non lump-sum tax that induces an organizational change from integration to non-integration. This does not need to be necessarily the case, as a tax can be introduced, which does not affect sufficiently managers' incentives to induce them to change organization (details are in section C.2 of the on line Appendix). Second, results in this section are obtained in the benchmark case of perfect competition. In Appendix B I show they hold in a qualitatively similar manner when I consider firms' market power, whose only effect in the present framework is to reinforce managers' preferences towards an integrated structure.

5 An Extension: taxation and production failures under integration

Up to now I assumed integration delivers the highest attainable output in the industry, by implementing the fully coordinated production plan within firms. In this section, I investigate how the effects of taxation on the equilibrium of the industry change when integration fails to deliver the highest attainable output e.g. due to failures in information transfer and communication (Bolton and Dewatripont[6]), slow reactivity to market changes e.g. due to the HQ's lack of the specific skills that are necessary to run the firm (Hart and Moore[21]), or monitoring failures with an additional layer of governance. These production failures may prevent from reaching their minimum scale of efficiency under integration.[20] In the presence of production failures under integration, tax schemes

[20]Such production failures are more often associated with market power, but their importance is largely acknowledged in the transaction cost economics' literature (see e.g. Williamson [38]). Leibenstein [31]

may be designed with appealing welfare properties.

5.1 Integration losses and industry structure

Let me now assume the HQ's activity induces some fixed output losses, σ. Output under integration depends on the efficiency of the production plan chosen by HQ, net of losses under integration:

$$Q_I = (1-\sigma)q. \tag{21}$$

From equation (21), production levels under integration are still increasing with coordination levels. However, full coordination is no longer sufficient to deliver the highest attainable output provided that $\sigma > 0$. [21]

Technology, contracts, characteristics of markets are the same as in Section 3 above. Payoffs of managers under non-integration are still described by equation (3). The only difference is now in managers' and HQs' payoffs under integration:

$$\pi_I^a = s_a\, P\, Q_I - \ C(a_G), \quad \pi_I^b = s_b\, P\, Q_I - \ C(b_G), \quad \pi_I^{HQ} = \eta[PQ_I] \tag{22}$$

where Q_I is now given by (21). Under non-integration, production decisions and output are still described by equations (6) and (7). With integration, HQ still sets the fully coordinated plan that minimizes total managerial costs, but equilibrium output is lower:

$$Q_I^* = 1-\sigma. \tag{23}$$

Under the usual set of assumptions (i.e. excess supply of M_a types, zero opportunity cost for HQs) the equilibrium managers' payoff under non-integration and integration become:

$$\Pi_N^* = \frac{P(1+2P)}{2(1+P)}, \quad \Pi_I^* = P(1-\sigma) - \frac{1}{4}. \tag{24}$$

Equations (24) describe the new set of managers' incentives. Compared to payoffs (8), the integration loss σ reduces output, thus managerial profits under integration by a fixed amount. Managers adopt integration when:

$$\Pi_I^* \geq \Pi_N^* \ \Leftrightarrow \ \underline{P} \leq P \leq \overline{P}, \text{ where } \underline{P} = \frac{1-4\sigma-\Delta(\sigma)}{8\sigma}, \ \overline{P} = \frac{1-4\sigma+\Delta(\sigma)}{8\sigma}, \tag{25}$$

and $\Delta(\sigma) = \sqrt{1-24\sigma+16\sigma^2}$.[22] The comparison of equation (25) with equation (9) above, reveals that allowing for production failures under integration enriches the set of managers' incentives. The corresponding organizational choices are now described by

shows that production losses attributable to organizational failures are significantly larger than losses due to the exercise of market power.

[21] This situation is consistent with the so-called productivity paradox i.e. the apparent contradiction between the remarkable advances in computer power between the early 1970s to the early 1990s and the relatively slow growth of productivity (see Brynjolfsson and Yang [8], for a review).

[22] $\Delta(\sigma)$ is defined for $\sigma < \frac{3}{4} - \frac{\sqrt{2}}{2} \equiv \sigma_{\max}$, which is also the condition that guarantees $\overline{P} > \underline{P} > 0$. From hereon it is accepted that this assumption is always satisfied.

the tresholds $\underline{P}$, and $\overline{P}$. When $P < \underline{P}$, managers choose non-integration, to enjoy a 'quiet life' and save on private costs (as in the case $P < 1$, in equation (9)). When $P \in [\underline{P}, \overline{P}]$, managers choose integration because this organization maximizes total output, net of the integration losses, at the lowest possible private cost for managers (as in the case $P > 1$ above). However, a new possible outcome is now available: when $P > \overline{P}$, the revenue motive in managers' payoffs is so high that they find it convenient to choose non-integration, to enhance coordination and avoid the fixed output losses associated with integration. In doing so, managers forgo their private interests i.e. accept to bear relatively high private costs to enjoy the revenue advantages of a non-integrated structure.

The new supply function at the supplier market equilibrium becomes:

$$Q_s = \alpha\, Q_I^* + (1-\alpha)\, Q_N^*, \tag{26}$$

where Q_I^*, Q_N^* are given by equations (23), (7), respectively, and $\alpha \in [0,1]$ is the share of firms that chooses to integrate such that:

$$\alpha = \begin{cases} 0 & if \quad P < \underline{P} \; or \; P > \overline{P}, \\ \in [0,1] & if \quad P = \underline{P} \;\; or \;\; P = \overline{P}, \\ 1 & if \quad \underline{P} < P < \overline{P}. \end{cases} \tag{27}$$

The new "organizationally augmented" supply curve is depicted in Figure 4. Output losses make the outcome $Q = 1$ out of reach under integration. As a result of this, when market prices are high enough, $P > \overline{P}$ managers maximize output and profits by choosing non-integration. Thus, market supply results from a non-integrated industry structure, as in (7) above.

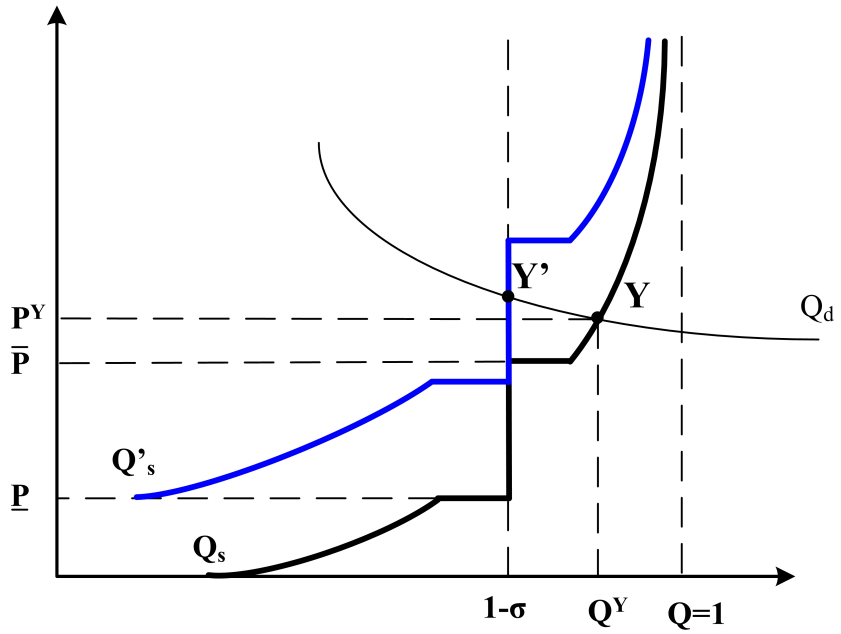
5.2 Taxation, integration and welfare

This new structure of the supply outcome allows to investigate the welfare effects of taxation starting from an equilibrium such as Y in Figure 4. At Y, quantity Q^Y is consumed in the product market, and market price P^Y is such that firms produce under a non-integrated structure (i.e. $\alpha = 0$). I now want to assess the effects of taxation on the industry equilibrium and welfare.

5.2.1 Efficiency of non lump-sum taxation

The effect of a lump-sum tax, T is identical to the case of zero production failures under integration. Under non-integration, T does not enter the first order conditions for managers' optimal decisions, thus output is still given by (7). Under integration, the HQ behaves as revenue maximizer despite of the positive losses and output is given by (23). The equilibrium aggregate payoffs for managers describe the same set of managers incentives as (25) above. Overall, also with output losses with integration, the introduction of T is neutral with respect to production and organization decisions of firms, thus welfare, which confirms Proposition 1 above.

Figure 4: Taxation and the industry equilibrium with production failures under integration



Consider now the effects of a per unit tax, t. Under non-integration, optimal managers' decisions and output are still described by equations (17) and (18) above i.e. t reduces managers' incentives to coordinate, thus it reduces output at any given P. Under integration, t has no effects on production, as the HQ still implements full coordination, which leads to production levels (23). At the contracting stage, the equilibrium aggregate payoff for managers under integration is still Π_N^*, as in (19), while under integration revenue losses, $\sigma(P-t)$ are subtracted from Π_I^* in (19). It follows that:

$$\Pi_I^* \geq \Pi_N^* \Leftrightarrow \underline{P} \leq P \leq \overline{P}, \text{ where } \underline{P} = \frac{1-4\sigma-\Delta(\sigma)}{8\sigma} + t, \ \overline{P} = \frac{1-4\sigma+\Delta(\sigma)}{8\sigma} + t, \quad (28)$$

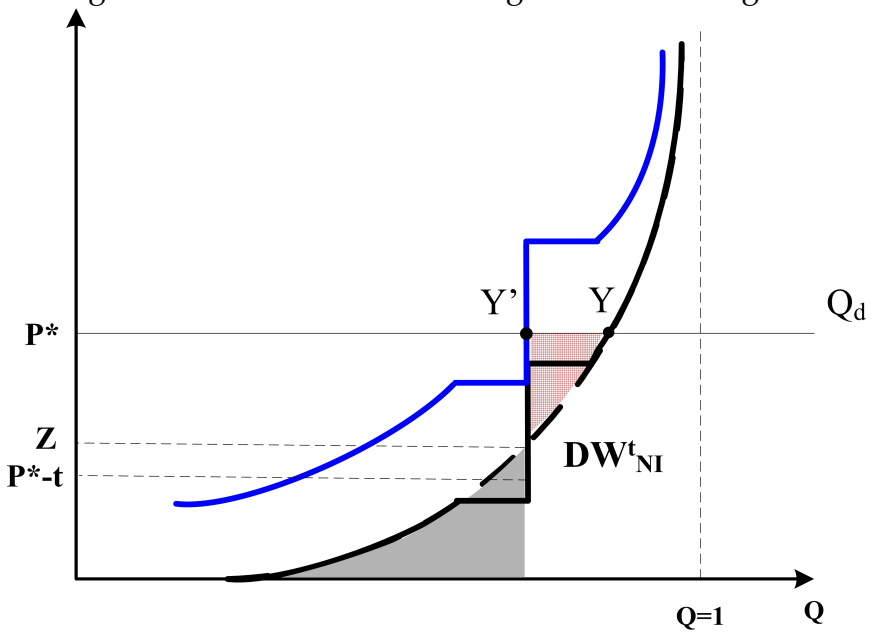
Figure 4 describes the effect of the per unit tax. The organizationally augmented supply curve shifts upwards, to Q_s' (blue curve). This leads to a new industry equilibrium Y', where the industry is characterized by a share $\alpha = 1$ of integrated firms. The introduction of the tax induced an organizational change from a fully non-integrated to a fully integrated industry structure.

In Figure 5, the effects of the tax on producer surplus are described. At the initial equilibrium, Y, where firms in the industry choose non-integration, producer surplus is:

$$W_N^* = \int_0^{P^*} Q_N^* dp = \frac{P^*(1+2P^*)}{2(1+P^*)} \quad (29)$$

The introduction of the tax induces a new industry equilibrium, such as Y', where all firms in the industry switch to integration. At this new equilibrium, the tax causes an excess burden due to the lower production of infra-marginal units at any $P \in (Z, P^*)$ (red shaded area in Figure 5). However, at the new integration equilibrium, the tax also

Figure 5: Deadweight loss of a tax induced change from non-integration to integration



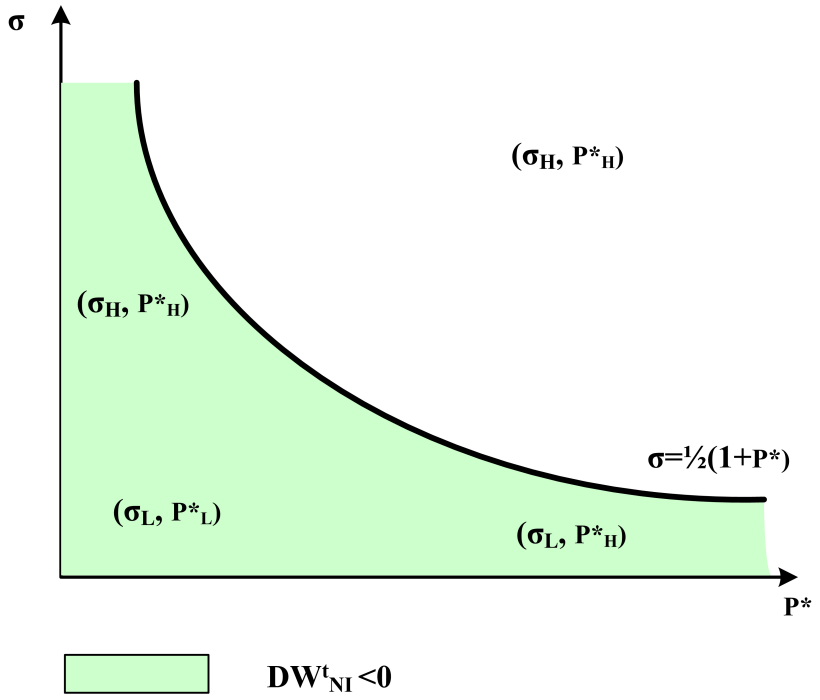
produces a surplus gain. This is due to the switch to integration, which guarantees a more efficient production of infra-marginal units at any $P \in (0, Z)$ (grey area in Figure 5, panel b). The net deadweight loss is:

$$DW_{NI}^{t} = P^{*}\left(\sigma - \frac{1}{2(1+P^{*})}\right) \lesseqgtr 0. \tag{30}$$

Equation (30) shows that whether the non-lump sum produces a net producer surplus loss (i.e. $DW_{NI}^{t} > 0$), or gain (i.e. $DW_{NI}^{t} < 0$), ultimately depends on the relationship between the size of output losses under integration σ and market price P^{*}. This is depicted as the downward sloping curve $\sigma = \frac{1}{2(1+P^{*})}$ in Figure 6, which describes the set of (σ, P^{*}) combinations that correspond to a welfare neutral tax induced change from non-integration to integration (i.e. $DW_{NI}^{t} = 0$). The area below the curve includes all possible combinations featuring a tax induced shift from non-integration to integration that produces a net producer surplus gain (i.e. $DW_{NI}^{t} < 0$). Conversely, the area above the curve includes all possible combinations corresponding to a shift that produces a net surplus loss (i.e. $DW_{NI}^{t} > 0$).

The interpretation of Figure 6 is straightforward. When the integration losses and market prices are very low, e.g. corresponding to (σ_L, P_L^{*}), the production losses under non-integration are remarkably high while integration is close to the first best. In this case, a non lump-sum tax that induces firms in the industry to switch from non-integration to integration increases welfare. At market price P_L^{*}, output losses under non-integration are so high that the tax still raises welfare when output losses under integration are σ_H. Symmetrically, at σ_L the output losses under integration are so negligible that a tax that induces a change from non-integration to integration increases welfare even when the

Figure 6: Producer surplus gains of a tax induced change from non-integration to integration



market price, such as P_H^*, increases the relative efficiency of non-integration. Finally, the same tax has a negative impact on welfare for (σ, P^*) combinations above the curve. In fact when market prices and integration losses are both very high, e.g. at (σ_H, P_H^*), the surplus gains from the 'tax induced' switch to integration are negligible relative to the deadweight loss of abandoning non-integration.

These results are summarized as follows:

Proposition 3: *With production failures under integration, a non lump-sum may induce an organizational change from non-integration to integration that increases production efficiency, provided that the market price and the integration loss are not too high.*

Proposition 3 implies that, if firms can choose their governance structure, a non lump-sum tax that induces firms to choose integration may be (second-best) efficient, by correcting the distortions induced by incomplete contracts under non-integration. The literature on taxation and welfare ignores the existence of a welfare effect of non lump-sum taxation via a change in firms' internal organization. This suggests a 'caveat' to the widely acknowledged view in microeconomics and public economics that taxation is always distortionary in perfectly competitive product markets (see Aurbach and Hines[3] for a synthesis).

Moreover, also in this case the welfare properties of lump-sum and non lump-sum taxation can be directly compared in the following:

Corollary 2: *With production failures under integration, a non lump-sum tax that induces*

a switch from an integration to a non-integration equilibrium is more efficient than a lump-sum tax, provided that the market price and the integration losses are not too high.

5.2.2 Non lump-sum taxation and the choice of integration

The analysis up to now has shown that the introduction of a non lump-sum tax may induce a change in the organizational choice of managers at the industry equilibrium. An obvious question to ask is how sensitive is the organizational choice to the tax? In the present setting, an intuitive measure of this sensitivity can be derived i.e. the *"smallest non lump-sum tax consistent with an organizational change from a fully integrated industry (i.e. $\alpha = 1$) to a fully non-integrated industry (i.e. $\alpha = 0$) when $\underline{P} < P < \overline{P}$."* This measure can be derived by analyzing the equilibria in the supplier market at any market price level. In particular, from equations (25) and (28), after the introduction of the tax an integrated equilibrium will be replaced by a non-integrated equilibrium at any $\underline{P} < P < \overline{P}$ whenever:

$$\underbrace{\frac{1-4\sigma-\Delta(\sigma)}{8\sigma}+t}_{\underline{P}\ \ after\ \ tax} \geq \underbrace{\frac{1-4\sigma+\Delta(\sigma)}{8\sigma}}_{\overline{P}\ \ before\ \ tax} \quad \Rightarrow \quad t \geq \tilde{t} \equiv \frac{\Delta(\sigma)}{4\sigma} \tag{31}$$

A tax $t = \tilde{t}$ implies that at any $\underline{P} < P < \overline{P}$, the industry switched from integration to non-integration (see Figure D-2) Simple comparative statics on $\tilde{t}$ show that:

$$\tilde{t}(0) = \infty, \qquad \tilde{t}(\sigma_{\max}) = 0, \qquad \partial\tilde{t}/\partial\sigma < 0 \tag{32}$$

From (32), tax and output losses under integration provide managers competing incentives. Thus, the effects of a non lump-sum tax on the organizational structure of an industry critically depends on integration losses. In the presence of a high tax, integration is relatively more efficient in term of production than non-integration. Accordingly, when σ is very low, the industry can bear a very high tax without having changed incentives toward either organisation structure (i.e. $\tilde{t}$, is high). However, increasing levels of σ reduce the relative efficiency of integration. At the outset, when σ is very high, even a low tax is enough to induce managers to switch to non-integration (i.e. $\tilde{t}$, is low). This result can be summarised in the following:

Proposition 4: *The choice of integration at the industry equilibrium is less (more) sensitive to a non lump-sum tax when production failures under integration are low (high).*

5.2.3 Per unit versus ad valorem taxation

Up to now I considered the effect of a non-lump sum tax per unit of production. Under the assumption that there are production failures under integration, this 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. However, this is no longer the case in the presence of production failures with integration.

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

$$Q_N^* = 1 - \frac{1}{2(1+P(1-\tau))^2}. \tag{33}$$

As before, τ has no effect on production under integration, so Q_I^* is still given by (23). At the contracting stage, managers choose integration if

$$\Pi_I^* \geq \Pi_N^* \;\Leftrightarrow\; \underline{P} \leq P \leq \overline{P}, \text{ where } \underline{P} = \frac{1-4\sigma-\Delta(\sigma)}{8\sigma(1-\tau)},\ \overline{P} = \frac{1-4\sigma+\Delta(\sigma)}{8\sigma(1-\tau)}, \tag{34}$$

It is instructive to compare $\underline{P}$ and $\overline{P}$ in (28) and (34). In particular, consider the market price interval $I = \overline{P} - \underline{P}$, where integration is an optimal choice. It easily follows that

$$I_t = \frac{\Delta(\sigma)}{4\sigma}, \quad I_\tau = \frac{\Delta(\sigma)}{4\sigma(1-\tau)}. \tag{35}$$

Equations (35) show that $I_\tau > I_t$, because $0 < \tau < 1$. Moreover, the market price interval for 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. I have the following:

Proposition 5: *The price interval where integration is an optimal choice for managers is larger an the case of ad valorem tax compared to a per unit tax, and increasing with the ad valorem tax rate.*

Compared to a specific tax, an ad valorem tax reduces managers' incentives to coordinate under non-integration. Accordingly, the market price interval increases where managers find it convenient to delegate production to the HQ, so as 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 (See the on line Appendix for details).

A last important remark is in order. Proposition 5 is to be interpreted as an ad valorem tax making an integration outcome "more likely" to occur than a per unit tax, 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 at the industry equilibrium. In Appendix E, I indeed show that for a given per unit tax that induces an organizational change from non-integration 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 producer surplus. This recalls a well-known result with 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 compared to a specific tax that raises equal tax revenue (See e.g. Delipalla and Keen [14], Andersen et al. [2], and Kotsogiannis and Serfes [27], who also consider the role of uncertainty. A review of the literature is in Auerbach and Hines [3])

6 Discussion and conclusions

This paper studied the impact of taxation on economic efficiency in the presence of incomplete contracts at firm level and endogenous firm boundaries. The paper showed that the choice of an integrated structure 'protects' the industry against the production inefficiencies associated with the introduction of a non lump-sum tax under non-integration, while a lump-sum tax is always neutral. By altering intra-firm incentives, a non lump-sum tax may induce a new industry equilibrium based on managers' changes to the organization of their firms. In particular, a 'tax induced organizational change' from integration to non-integration always reduces welfare. However when some production failures also occur under integration, a non lump-sum tax may induce an organizational change from non-integration to integration, which is second best efficient.

While these results are derived in a very simple framework, they suggest that an accurate evaluation of the effects produced by taxation on the production of an inudstry, should take account firms' organizational choice. Tax instruments, such as sales or value added taxes, which are generally flat across industries, may have an asymmetric impact across sectors characterized by different integration costs or demand regimes. The same tax can have major effects on production efficiency in industries characterized by a high share of non-integrated firms, but a very small effect in sectors where integration is the dominant governance structure. These results suggest that sectors closer to the technology frontier, those in more heterogeneous environments, and those with a higher share of young firms, should be taxed at a lower rate than traditional and labor intensive sectors. In fact, the former are likely to enjoy the highest gains from non-integration, exploiting complementarities between innovation, decentralization and high market potential. Conversely, the latter are generally characterized by firms with a higher propensity to integrate, due to lower integration costs and smaller opportunities to expand their market (see Acemoglu et al.[1]).

Finally, this model suggests several directions for further research. It would be interesting to model how the choice of integration influences firm's market power. Also the idea that taxation favors integration relative to a non-integrated outcome could be analyzed empirically - especially for industries characterized by high integration costs and big market potential.

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Appendix A Production Taxation and Integration on 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 analysis are 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), World Development Indicators (WDI) and Doing Business (DOBUS). The reader will find below a precise description of the variables.

Production tax: Taxes less subsidies on products ($B1G\_P119$) as share of Gross value added at basic prices, excluding FISIM ($D21\_D31$). GDP definition, output approach, US Dollar, millions current prices, constant exchange.

Integration: Share of Value Added produced "in-house" by the firm = $100 * (1 - INTI/PROD)$, where INTI are intermediate inputs and PROD is total production (Gross Output). Current prices (OECD Structural Ananlysis - STAN - Database).

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

GDP: Gross Domestic Product, current US dollars (World Bank's WDI).

UNR: unemployed persons divided by the labour force (harmonised; 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), year 2005==1 (OECD Economic Outlook).

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

Output gap: Percentage deviation of output from potential level (OECD Economic Outlook). From this variable I 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 competitor country's prices, relative to a base year (2000) and measured in US dollars. Therefore an increase is an appreciation of the home country's real exchange rate (OECD Main Economic Indicators).

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

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

Prtyage: categorical variable for the age of the parties in parliament. Equal to 1 if $PARTYAGE < 20$; equal to 2 if $20 \leq PARTYAGE < 40$; equal to 3 if $PARTYAGE \geq 40$.

Left, Right: Leftwing, 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 which gives answer 4 (i.e., 'none at all') to questions *E*069_13 in WVS1-5, v219 in EVS4, 027 in EVS3, q554K in EVS2, v547 in EVS1 (how much confidence in major companies). *Distrust others* is constructed as the percentage of respondents which gives answer 2 (i.e., 'Can't be too careful') to questions A165 in WVS1-5, V62 in EVS4, V66 in EVS3, Q241 in EVS2, V208 in EVS1. I assigned country observations for the available years to five periods, each period broadly corresponding to the intended coverage of a EVS/WVS wave. Periods are *1980-89* (EVS1/WVS1 and EVS2), *1990-94* (EVS2/WVS2), *1995-99* (EVS3/WVS3), *2000-04* (EVS3/WVS5), *2005-08* (EVS4/WVS5). See Moriconi et al. [35] for further details.

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

ETCR: $0-6$ 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 [12] for further details).

Union Density: union density (% of unionised 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: Dummy variable equal to 1 if a country is part of the European Union, European Monetary Union.

Appendix A.2 Empirical results

Table A-1: Production taxation and vertical integration, means and standard deviations by country, OECD countries 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)

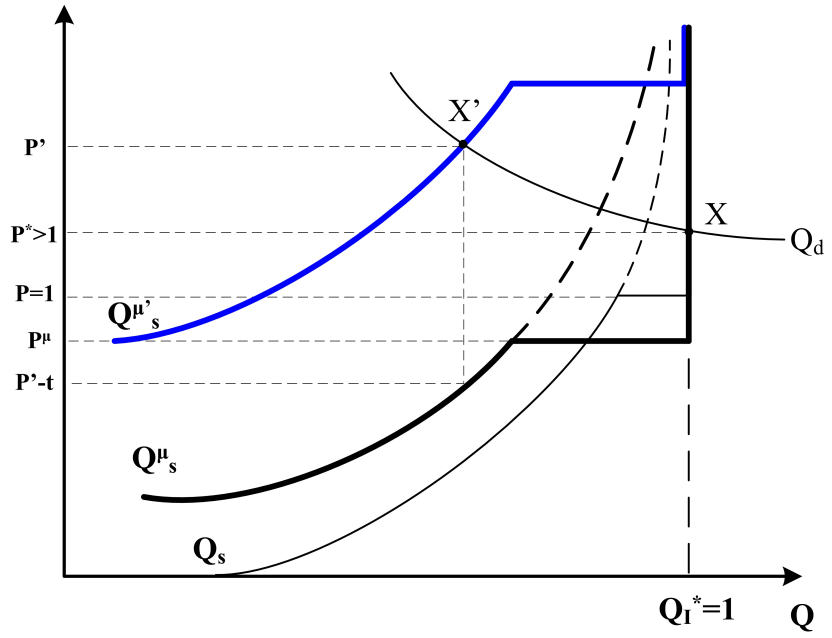
Notes: Averages by country, standard deviations in parentheses.

Table A-2: Production Taxation and Integration

	[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 of value added produced in house in total production. controls for competition and economic cycle include total population, per capita GDP, real exchange rate, change in inflation, and a dummy for belonging to the European monetary union. controls for the manufacturing sector include the unit cost of labour, the employment rate, and an index of labour productivity. Controls for institutional quality include a measure of youth of democratic institutions and the age of the main political parties. Robust standard errors in parentheses, clustered by country. Significance levels: $*$: 10% $**$: 5% $***$: 1%.

Figure A-1: Taxation and organizationally augmented industry equilibrium with market power



Appendix B Monopoly Power

To introduce monopoly power, I relax the assumption that the supplier market is perfect competitive and existence of a one-to-one correspondence between managers and production units. I now assume that there is one multi-plant manager M_b who owns a measure one of B units and several (at least two) managers M_a suppliers who 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 [28]). All other assumptions the economy are the same as in Section 2.

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

Under non-integration, each manager chooses the decision that maximizes its pay off, subject to this demand function. At the NE, I have the following decisions:

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

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

Substitute (B-1) in (1) to obtain equilibrium output under non-integration:

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

which indeed shows that market power induces managers to produce less under non-integration. Under integration, 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 perfectly efficient still under monopoly, with managers enjoying the lowest private costs consistent with the fully coordinated plan.

The equilibrium aggregate payoff for managers under non-integration and integration, become respectively:

$$\Pi_N^* = \frac{P(-1+2P) + 4P\mu + \mu^2}{2(\mu+P)^2} \qquad \Pi_I^* = P - \frac{1}{4}, \tag{B-3}$$

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

The effect of market power in our organizational setting is described in Figure A-1, below. Market power makes managers less willing to coordinate under non-integration, which means that the supply curve under non-integration is in an upward position compared to the one under perfect competition. However, market power does not affect output under integration. Thus, managers have now 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 are qualitatively similar to the case of perfect competition. The introduction of a lump-sum tax is again neutral with respect to production and organization decisions of firms, thus welfare. The effects of a non lump-sum tax on the equilibrium of the industry are again represented by an upward shift of the organizationally augmented supply curve from Q_s^μ to $Q_s^{\mu'}$ in Figure A-1. These effects are qualitatively similar to those described in Section 4.2 as a non-lump sum tax may induce an "organizational change" from a fully integrated to a fully non-integrated industry structure. As mentioned above, the main difference with respect to the competitive case is that market power makes the integration choice more profitable to managers. Accordingly an organizational switch to non-integration with market power may be more difficult to occur.

Appendix C organizationally augmented supply with integration losses

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

$$P(1-\sigma) - 1/4 > P(1 - \frac{1}{2(1+P)^2}) - \frac{1}{2}\left(\frac{P}{1+P}\right)^2. \tag{C-4}$$

After simplification this can be rewritten as follows:

$$4\sigma P^2 + P(4\sigma - 1) + 1 < 0;$$

which holds true for $\underline{P} < P < \overline{P}$ as stated in (25). I can thus derive the equilibrium in the supplier market which is described by the share α of firms willing to integrate. When

$P \in (\underline{P}, \overline{P})$, the management maximizes its payoff by choosing integration and a pure integrated equilibrium emerges with $\alpha = 1$ in (27). Conversely, when $P < \underline{P}$ and $P > \overline{P}$, from (25) the management chooses non-integration and a pure non-integrated equilibrium emerges with $\alpha = 0$ in (27). Finally when $P = \underline{P}$ or $P = \overline{P}$, managers are indifferent between integration and non-integration and randomly choose the organization of their firm. Accordingly a mixed equilibrium occurs where with a share $\alpha \in (0, 1)$ of firms that choose integration.

From the equilibrium in the supplier market it can be derived the organizationally augmented supply curve (26). When $\alpha = 1$ the relevant supply function is defined by (23); when $\alpha = 0$ the relevant curve is defined by (7). When $\alpha \in (0, 1)$ the relevant supply function is the average of product supply under integration and non-integration weighted by the shares α and $1 - \alpha$, respectively. To facilitate graphical representation, derive the inverse organizationally augmented supply curve, from (26) and (27).

$$P = \begin{cases} \left(\frac{1}{\sqrt{2(1-Q)}} - 1 \right), & Q \in [1/2, \underline{Q}];\ Q \in [\overline{Q}, 1]; \\ \underline{P}, & Q \in [\underline{Q}, 1 - \sigma]; \\ \in [\underline{P}, \overline{P}], & Q = 1 - \sigma; \\ \overline{P}, & Q \in [1 - \sigma, \overline{Q}]; \end{cases}$$

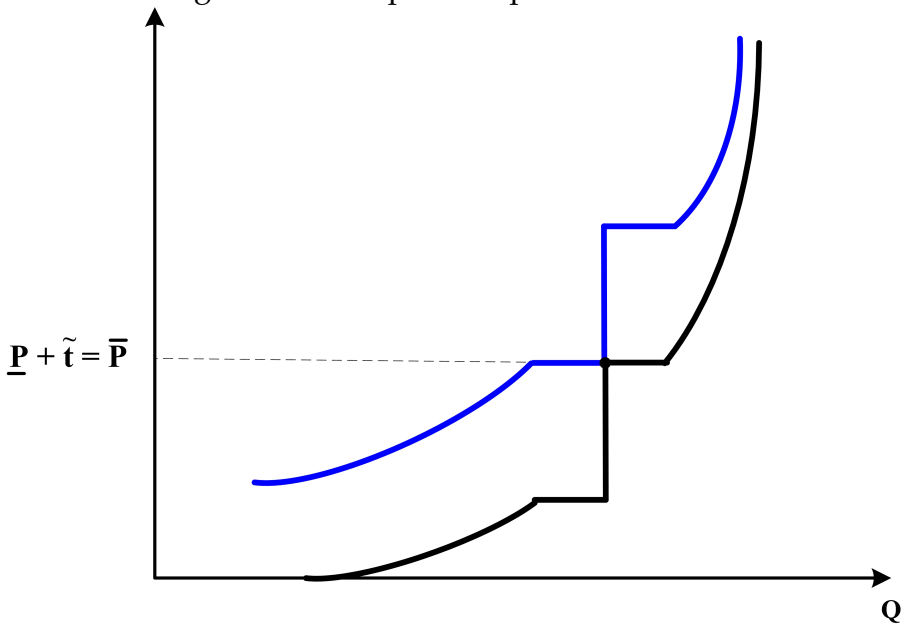
where $\underline{Q}$ and $\overline{Q}$ are the quantity tresholds which correspond to $\underline{P}$ and $\overline{P}$ under non-integration i.e.:

$$\underline{Q} = 1 - \frac{32\sigma^2}{[\Delta(\sigma) - (1 + 4\sigma)]^2}, \ \textit{and} \ \overline{Q} = 1 - \frac{32\sigma^2}{[\Delta(\sigma) + (1 + 4\sigma)]^2}.$$

From (C-5) I derive the organizationally augmented supply curve in the absence of taxes depicted as the black line in Figure 2.

Appendix D Sensitivity of the organizational choice to taxation at the industry equilibrium

Figure D-2: Graphical representation of $\tilde{t}$



Appendix E Equivalence of ad valorem and per unit taxation

In this section, I consider the welfare equivalence between per unit and ad valorem taxation, when these two tax instruments induce an organizational change at the industry equilibrium. I follow Auerbach and Hines [3] and compare an ad valorem and a specific tax that induce the same amount of revenues. I evaluate the welfare equivalence of these two tax instruments, when they induce an organizational change. I 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 $\sigma > 0$).

Appendix E.1 Tax induced organizational change from integration to non-integration

Let us now consider an initial equilibrium, where price $P^* > 1$, i.e. from (10) a share $\alpha = 1$ chooses to integrate and from (11), $Q_s = 1$.

Consider a combined use of equivalent and ad-valorem taxation that induce an organizational change from integration to non-integration. Producer prices after the combined tax scheme are $P(1-\tau) - t$. New versions of equations (3) - (19) can be obtained accordingly. Managers decision to integrate is now described as follows:

$$\Pi_I^* \geq \Pi_N^* \;\Leftrightarrow\; P \geq \frac{1+t}{1-\tau}, \tag{E-5}$$

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

$$DW_{IN}^{\tau t} = \frac{P^*(1+P^*) - 2P^*t + t^2 - 2P^{*2}\tau + 2Pt\tau + P^{*2}\tau^2}{2(1+P^*-t-P^*\tau)^2} > 0,$$

which goes back to DW_{IN}^{t} in section 4.2 for $\tau = 0$.

Tax revenue from the joint tax scheme is:

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

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

As in Auerbach and Hines [3], the relative size of the deadweightloss under the two tax schemes, must be compared for taxes that induce the same tax revenues. It can be easily shown that:

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

This implies that a revenue equal substitution of ad valorem for specific taxation leaves the deadweight loss 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, for the reasons explained in the main text.

Appendix E.2 Tax induced organizational change from integration to non-integration

Let us now consider an initial equilibrium, where price $P^* > 1$, and from (27) 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. From (26), the relevant initial supply curve is $Q_s = Q_N^*$.

Replicating the analysis in Section 5, it can be shown that the combined use of per unit and ad-valorem taxation changes managers' incentives to integrate as follows:

$$\Pi_I^* \geq \Pi_N^* \;\Leftrightarrow\; \underline{P} \leq P \leq \overline{P}, \text{ where } \underline{P} = \frac{1-4\sigma+8t\sigma-\Delta(\sigma)}{8\sigma(1-\tau)},\ \overline{P} = \frac{1-4\sigma+8t\sigma+\Delta(\sigma)}{8\sigma(1-\tau)}, \tag{E-6}$$

which includes (28) and (34) as special cases, for $\tau = 0$, and $t = 0$, respectively. Consider a combined tax scheme, which identifies an upward shift of the organizationally augmented supply curve, such that $P^* < \frac{1-4\sigma+8t\sigma+\Delta(\sigma)}{8\sigma(1-\tau)}$. Such combined tax scheme then induces an organizational change from non-integration to integration. It can be shown that the deadweight loss associated with the tax scheme is still given by (30). 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.

On-Line Appendix of Taxation, industry integration and production efficiency (not for publication)

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April 12, 2016

Contents

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A A model of ad valorem taxation, organizational design and production efficiency

We describe a general equilibrium model with a product market and a supplier market. The product market is perfectly competitive with price taker firms producing a consumption good Q for a large number of consumers characterized by demand $Q(P)$ with $Q'_P < 0$ and $\epsilon = -PQ'_P/Q > 0$.

The supplier market includes two types of production units, A and B, run respectively by risk neutral and cash-constrained managers M_a and M_b, which are matched, one to one, to create firms.[1] We assume the supplier market is perfectly competitive, with M_a types being more numerous than M_b types: their measure is $n > 1$, while the M_b types have unit measure.[2] We build on Legros and Newman [16]'s framework, which can be considered as a continuos version, in actions and profit shares of the Hart and Holmstrom [14]'s theory of the firm.[3] We assume a production plan consists of the operating decisions to be taken for each unit. Operating decisions cannot be specified in an ex-ante enforceable contract. However managers can, under ex-ante competitive conditions, negotiate contracts that specify the governance structure G and the share $s \in (0, 1)$ of managerial revenue accruing to M_a. Each contract 'locks' the managers into a relationship by making their operations fully specific to the match until the production outcome is realized (Hart and Moore [15]).[4]

We assume government needs to raise revenue to cover fixed expenditure, such as defense. If government knows the effective 'ability' of firms to make profits, it should impose no distortionary lump-sum taxes on profits. However, an incomplete contract is a barrier to lump-sum taxation leaving distortionary taxation as the only available option. We assume imposition of an ad valorem tax at the (tax-inclusive) rate $0 < t < 1$ such that, at market price P, the producer price is $p = P(1 - t)$. Generally, this tax is consistent with either

[1] In modern firm boundary theories, the distinction made between ownership and control is not to diversify risk, but is due to the inability of cash-constrained managers to raise the funds required to purchase the ownership rights (see Bolton and Dewatripont [5] for a review).

[2] As is usual in modern theories of the firm (e.g. Hart and Moore [15], Hart and Holmstrom [14]), this assumption is made to simplify the mechanism of surplus sharing. In fact it provides a sufficient condition to exclude equilibria where one contractual outcome always Pareto dominates the other.

[3] Hart and Holmstrom [14]'s theory, in contrast to the Grossman-Hart-Moore approach, postulates a distinction between shareholder ownership of the firm and its control by professional managers. It thereby attaches the value of a firm to both the allocation of residual control rights and to the efficiency of the operating decisions to be taken 'ex-post' in each unit (e.g. the choice of production techniques, marketing campaigns, etc.).

[4] This is an application of the approach to contracts as 'reference points', first proposed by Hart and Moore [15] as an alternative to ex-post renegotiation with side payments, which is the more typical solution to incomplete contracts proposed by Grossman and Hart [11]. Fehr et al. [10] provide experimental support for this approach by showing that ex-ante competition legitimizes the terms of the contract.

a tax on sales or consumption, or a tax on the factors of production, this being equivalent to a tax on intermediate goods under the assumption of constant returns to scale in the intermediates sector (see Diamond and Mirlees [9]).

A .1 Organizational forms and production efficiency

The choice of governance structure consists of the allocation of residual control rights. The party that acquires the control rights is entitled to make operating decisions for the units. Let $a \in [0,\ 1]$ and $b \in [0,\ 1]$ be the decisions taken for units A and B, respectively. Coordination among units increases the firm's efficiency:

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

From (A-1), the production plan with fully coordinated decisions $a = b$ will ensure the highest attainable output, $q = 1$, among all feasible plans. However, any deviation from full coordination will entail a loss of production efficiency, described by a $q < 1$.[5]

The primary function of managers is to implement decisions within their respective units, whatever the allocation of residual control rights. 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 cost of accommodating a different approach, borne by M_a and M_b, respectively:

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

$C(a)$ and $C(b)$ indicate that managers M_a and M_b 'disagree' over direction as M_a's preferences are increasing in a while M_b's ones are decreasing in b.[6] Equations (A-1) and (A-2) introduce a tradeoff between the benefits and the costs of coordination for managers. The benefits of coordination are related to the activities of the firm as a whole, thus they are monetary and fully transferable within the firm. The costs of coordination are related to the managers' subjective preferences, thus they are private in nature and not transferable to any other agent.

[5] Legros and Newman [16] also interpret q as the probability of success for a project run jointly by the two units. The function (A-1) implies there is no objectively 'right' decision, but that coordination is fostered by the adoption of common standards. The more that decisions are in the same direction (i.e. the closer are standards a and b) the higher will be the efficiency of firm's production process. Leibenstein [17] suggests that losses attributable to this form of managerial slack, might be significantly larger than losses due to the exercise of market power.

[6] Private costs can be interpreted in terms of broadly defined job dis-satisfaction of workers. When each unit's employees' human capital is tied to a particular, familiar technology, accommodating to another's technology will be costly, in terms of wages, career prospects, and the opportunity cost related to learning new skills (Hart and Holmstrom [14]). Underlying this interpretation is the assumption that each manager aligns her preferences to those of her workers, because of shared interests or concern for their well-being.

In relation to the firm's internal organization, managers can choose between a *non-integrated* and an *integrated* governance structure. Under a non-integrated structure, managers retain residual control rights and take decisions for their units, with the result that output depends on the efficiency of the production plans chosen by the managers:

$$Q_N = q = 1 - \frac{1}{2}(a-b)^2. \tag{A-3}$$

In an integrated structure, managers transfer the residual control rights to a third party, the HQ, which centralizes the decision making process and 'instructs' managers about which decisions to implement.[7] However, the transfer of control rights induces some output losses, e.g. due to the need for additional communication, and delay, and HQ's lack of expertise or moral hazard exerting control on behalf of the shareholders (Hart and Moore [15], Bolton and Dewatripont [5]). Since these costs are associated with the transfer of control rights to HQ, they are independent of the efficiency of the production plan. Output under integration depends on the efficiency of the production plan chosen by HQ, net of structural integration costs:

$$Q_I = (1-\sigma)q. \tag{A-4}$$

Comparison between (A-3) and (A-4) reveals that the production structure of the firm depends on the choice of organization. Under non-integration, output levels depend on the monetary incentives for managers: these will determine the efficiency of the production plan implemented. Under integration, managers' incentives are irrelevant because output levels depend on the production plan chosen by HQ, net of the unavoidable integration cost.

The timing is as follows: at an 'ex-ante' stage, managers sign the contract (G, s) specifying the governance structure and the revenue share accruing to M_a. Once the contract is signed, managers or HQ (depending on the governance structure chosen) make the decisions for the units, and managers implement these decisions and bear the private costs, and production outcome is realized.

A .2 Taxation and production efficiency

We proceed by backward induction and start by analyzing the decision making process related to the two units, after the contract (G, s) has been signed by managers. The payoffs of M_a and M_b under organization $G = N, I$ are respectively:

$$\pi_G^a = s\ p\ Q_G - \ C(a), \qquad \pi_G^b = (1-s)\ p\ Q_G - \ C(b), \tag{A-5}$$

where $p = P(1-t)$ is the producer price, Q_G is the output of the firm under organization $G = N, I$ as defined by (A-3) and (A-4), respectively.

[7] The transfer of control rights can be 'de iure' via the sale of assets, or 'de-facto' by conceding to the HQ the 'key to the control room', but without any explicit 'sale'. Hart and Holmstrom [14] provide a comprehensive discussion of these contractual issues.

We first consider the case where managers, 'ex-ante', have opted for a non-integrated structure. In this case, they retain residual control rights and take the decisions for their units. We assume that under non-integration, M_a and M_b implement the decisions a and b simultaneously, without consultation or negotiation, in order to maximize their payoffs (A-5). If we plug in the production plan (A-3) and the cost functions (A-2) to (A-5), at the Nash equilibrium we have:[8]

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

Substitute (A-6) in (A-3) to obtain equilibrium output under non-integration:

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

Equations (A-6) and (A-7) show that revenue shares s, $(1-s)$ and producer price p provide managers with different types of monetary incentives. (i) *Revenue shares determine the distribution of the coordination effort between managers*: when s is small, the burden of coordinating weighs more on M_b and viceversa. However, this has no effect on the overall degree of coordination between the units, or thus on the efficiency of the production plan. However, (ii) *the producer price determines the level of managers' coordination efforts* with P and t providing managers with opposite incentives. When P is high, production is valuable because the revenue potential of the firm is high. Thus, managers try to minimize production inefficiencies. However, at any given P, the tax reduces the firm's revenue potential, increasing managers' incentives to 'opt for a quiet life' and economize on private costs (Bertrand and Mullainathan [4]).[9]

Next we turn to the case where the managers in the contract choose an integrated structure, thereby transferring residual control rights to HQ, which makes decisions for both units and 'instructs' managers on the decisions to be implemented. Assume HQ has a positive cash endowment so that it can pay a fixed fee to managers in exchange for a positive share η of the firm's revenue.[10] As the cost of HQ's decisions is borne privately by managers, HQ's payoff equals a share η of the total revenue under integration. From (A-4) and (A-1) obtain:

[8]In the spirit of Hart and Moore [15], non cooperative behavior reflects the idea that each manager feels entitled to her preferred outcome within the contract i.e. $s = 1$ for M_a and $s = 0$ for M_b. For this reason, at any $0 < s < 1$, each manager feels aggrieved and stints on performance. When s is small, M_a feels more aggrieved and stints relatively more by choosing a high a (which she likes) while M_b 'concedes' to M_a a high b (which she dislikes). The opposite holds when s is high. The underlying assumption here is that operating decisions are made in the 'spirit' and not according to the 'letter' of the contract, thus judicially are not enforceable (Williamson [22], Hart and Moore [15]).

[9]From equation (A-6), $p = P(1-t)$ implies $da_N^*/dP < 0$, $db_N^*/dP > 0$ while $da_N^*/dt > 0$, $db_N^*/dt < 0$ i.e. a high market price fosters coordination, while a high tax induces cost minimization.

[10]Without loss of generality we can assume that there is an HQ market which supplies HQs elastically at zero opportunity cost.

$$\pi^{HQ} = \eta \left[p(1-\sigma)(1-\frac{1}{2}(a-b)^2) \right]. \tag{A-8}$$

HQ maximizes (A-8) by implementing full coordination. From (A-4), equilibrium output under integration when $a_I^* = b_I^*$ is:

$$Q_I^* = (1-\sigma). \tag{A-9}$$

Equation (A-9) indicates that, in the case of integration, neither managers' revenue shares nor producer prices affect output. In fact, 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, HQ wants only to maximize production efficiency by implementing full coordination. From (A-9) the only output losses under integration are due to the structural inefficiencies associated with the transfer of control rights.

We can summarize these results as follows:

Proposition 1: *A tax reduces coordination and production efficiency under non-integration while this does not hold true under integration.*

Proposition 1 suggests that taxation reduces the efficiency of the firm's production plan under non-integration while under integration HQ implements the efficient production plan (net of the fixed integration cost) disregarding the tax. In other words, an integrated structure 'protects' the firm against the production inefficiencies induced by taxes under non-integration.

A .3 Production efficiency and organizational choice

At the contracting stage, managers specify the governance structure and revenue shares. Managers choose the organization that ensures them the highest aggregate payoff. Since operational units A and B are perfectly symmetric, this can be derived by employing a simple utilitarian criterion:

$$\Pi_G = \pi_G^a + \pi_G^b = pQ_G - (C(a) + C(b)), \tag{A-10}$$

where $G = N, I$. The negotiation over revenue shares plays a pivotal role in determining managers' payoffs at the equilibrium. Assuming contracts as the reference point, excess supply of M_a types drives their revenue share to zero under either governance structure.[11]

[11] Using contracts as a reference point postulates that (i) contracts are negotiated under competitive conditions and that (ii) each contract 'locks' managers into the relationship (Hart and Moore [15]). With excess supply of M_a types, the former assumption drives M_as' surplus shares to their outside options while the latter brings their outside option to zero. Then, with an excess supply of M_a types, (i)-(ii) are the necessary and sufficient conditions for $s = 0$.

From (A-6), the sharing rule $s = 0$ under non integration defines the outcome $a_N^* = 1$, $b_N^* = p/1 + p$. Under integration, we assume instead that HQ implements the decision that minimizes aggregate managerial costs $a_I^* = b_I^* = 1/2$ because this is the Pareto dominant decision among those decisions ensuring full coordination. Since $s = 0$, this implies that M_a suffers a net loss $\pi_I^a = -1/8$, which is fully covered by M_b, because the surplus is fully transferable between units. If we plug the equilibrium decisions and output levels for $s = 0$ into (A-10) we obtain the aggregate payoff for managers under non-integration and integration, respectively:

$$\begin{aligned} \Pi_N^* =& p\left(1 - \frac{1}{2(1+p)^2}\right) - \frac{1}{2}\left(\frac{p}{1+p}\right)^2, \\ \Pi_I^* =& p(1-\sigma) - \frac{1}{4}. \end{aligned} \tag{A-11}$$

The convexity of the cost functions (A-2) denotes (A-11) as a typical outcome in modern firm boundary theories (e.g. Williamson [21], Hart and Holmstrom [14]), where a negotiation that leads to 'winners' as opposed to 'losers', produces bigger aggregate losses than an outcome in which the parties share the benefits and costs equally. When $s = 0$, under non-integration M_a leaves the entire burden of coordination to M_b because the latter is the 'winner' in the negotiation. Under integration, HQ's decision to minimize aggregate managerial costs partly internalizes the managers' wishes, regardless of revenue shares. Thus, aggregate costs in (A-11) are maximized by the sharing rule $s = 0$ under non-integration while they are minimized by HQ's behavior under non integration.[12] Equations (A-11) describe the set of 'revenue-based' incentives accruing to managers. At given producer prices, management will adopt the organization that ensures the highest payoff:

$$\Pi_I^* \geq \Pi_N^* \;\Leftrightarrow\; \underline{p} \leq p \leq \overline{p},\; \textit{where}\; \underline{p} = \frac{1 - 4\sigma - \Delta(\sigma)}{8\sigma},\; \overline{p} = \frac{1 - 4\sigma + \Delta(\sigma)}{8\sigma}, \tag{A-12}$$

and $\Delta(\sigma) = \sqrt{1 - 24\sigma + 16\sigma^2}$.[13] From (A-12), managers' organizational choice depends on the producer price because this determines the strength of cost minimization relative to revenue maximization in the payoff functions (A-11). When $p < \underline{p}$, the revenue motive in managers' payoff is not sufficiently high to compensate for the costs they have to bear to implement an efficient production plan. Thus managers choose non-integration, which gives them a 'quiet life' and allows them to save on private costs. Conversely, when $p >$

[12] The 'transaction cost economics' literature (see Coase [6], Williamson [23]) generally assumes that in the presence of pervasive transaction costs, a socially inefficient outcome is more likely to occur with non-integration relative to integration, because in this latter case HQ operates as a 'benevolent regulator'. In the present framework, with complete contracts (i.e. zero transaction costs), a welfare maximizing sharing rule $s = 1/2$ could be implemented under non-integration, which would induce managers never to integrate (see Legros and Newman [16] for details).

[13] $\Delta(\sigma)$ is defined for $\sigma < \frac{3}{4} - \frac{\sqrt{2}}{2} \equiv \sigma_{\max}$, which is also the condition that guarantees $\overline{p} > \underline{p} > 0$. From hereon it is accepted that this assumption is always satisfied.

$\overline{p}$, the revenue motive is so high that managers forgo their private interests to enhance production efficiency. Also, in this case, managers choose non-integration. However, now they are motivated by a willingness to enjoy its revenue advantages, and save on integration costs. Managers have a weak preference for integration only at intermediate levels of the producer price, $p \in [\underline{p}, \overline{p}]$. Here the revenue motive is large enough that the unbalanced set of incentives to coordinate between M_a and M_b disproportionately increases aggregate costs under non-integration. Then, managers choose integration because this organization guarantees a moderately high degree of production efficiency at a reasonable private cost.

B Ad valorem taxation and the equilibrium of the industry

The industry equilibrium is a general equilibrium involving the supplier market and the product market. The former consists of the mass of firms that produce under governance structure $G = N, I$. The latter requires firms' supply and consumers' demand to be equalized. Given the structure of our model, the impact of taxation on the industry equilibrium presents some interesting general equilibrium features. In fact, any tax that affects the equilibrium in the supplier market also has an indirect effect on the equilibrium in the product market via change in the organization of the industry.

B .1 Taxation and governance at supplier market equilibrium

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

$$\alpha = \begin{cases} 0 & if \quad p < \underline{p} \ or \ p > \overline{p}, \\ \in [0,1] & if \quad p = \underline{p} \ \ or \ \ p = \overline{p}, \\ 1 & if \quad \underline{p} < p < \overline{p}. \end{cases} \tag{B-13}$$

The set of conditions (B-13) describes three possible equilibria in the supplier market, depending on the structure of managers' incentives described by (A-12). If $p < \underline{p}$ or $p > \overline{p}$, all firms adopt a non-integrated structure, and a pure strategy equilibrium with non-integration emerges in the supplier market, $\alpha = 0$. If $p \in (\underline{p}, \overline{p})$, all firms prefer an integrated structure and a pure strategy equilibrium with integration occurs in the supplier market, $\alpha = 1$. Finally, if $p = \underline{p}$ or $p = \overline{p}$, managers obtain the same payoff under either organization and a mixed strategy equilibrium emerges in the supplier market where firms randomly choose one of the two organizations, $\alpha \in [0, 1]$.

While they describe the set of possible equilibria, conditions (B-13) are not informative about their relative likelihood in the market. To analyze the impact of taxation on the probability of a pure strategy equilibrium with an integrated governance (from hereon integration equilibrium), we need to switch the focus to market conditions. From (A-12) we can derive the price levels $\underline{P}$ and $\overline{P}$ that would need to emerge in the product market to generate the structure of incentives described by (B-13):

$$\begin{aligned} \underline{P} &= \frac{\underline{p}}{(1-\bar{t})} = \frac{1-4\sigma-\Delta(\sigma)}{8\sigma(1-t)}, \\ \overline{P} &= \frac{\overline{p}}{(1-\bar{t}).} = \frac{1-4\sigma+\Delta(\sigma)}{8\sigma(1-t)}. \end{aligned} \tag{B-14}$$

The price thresholds (B-14) determine the price interval Ψ, which delimits an integration equilibrium:

$$\Psi = \ (\overline{P} \ - \underline{P}) = \frac{\Delta(\sigma)}{4\sigma(1-t)}. \tag{B-15}$$

Therefore:

Proposition 2: *A tax increases the market price interval, which delimits an integration equilibrium in the supplier market:* $\partial\Psi/\partial t = \Psi/(1-t) > 0$.

As we have seen already, the unbalanced distribution of incentives under non-integration produces high managerial costs. Under integration, HQ minimizes the managerial costs conditional on implementing the fully efficient production plan. A tax increase, by reducing the producer price, emphasizes managers' wishes to alleviate private costs at any market price. Integration then becomes a profitable choice relative to non-integration for a wider interval of market prices.

B .2 General equilibrium effects of taxation

Market supply is simply the sum of supply from integrated and non-integrated firms:

$$Q_s = \ \alpha \ Q_I^* + \ (1-\alpha) \ Q_N^*, \tag{B-16}$$

where α is the equilibrium in the supplier market described by (B-13). (B-16) incorporates into the Neoclassical supply concept function those incentives that determine the design of firm governance at the industry equilibrium. Let the black line in Figure 1 denote the supply curve for the no tax case (see Appendix A for its analytical derivation). When $P > \ \overline{p}$ or $P < \ \underline{p}$, $\alpha = 0$ and market supply results from a non-integrated industry structure, as in (A-7) above. When $P \in \ (\underline{p}, \overline{p})$, $\alpha = 1$ and supply is obtained under an integrated structure, as in (A-9) above. Finally, when $P = \underline{p}$ or $P = \overline{p}$, $\alpha \in (0,1)$ and (A-7) and (A-9) are weighted by the industry shares $1-\alpha$ and α of non-integrated and integrated firms, respectively.

The red and blue lines in Figure 1 represent the impact of taxation on the 'organizationally augmented' supply function (B-16). The tax reduces supply by non-integrated firms because the lower producer price induces managers to opt for a quiet life, at any market price level. However, the tax has no impact on market supply by integrated firms, since their HQs implement the most efficient production plans (net of integration costs), regardless of the producer price.

Figure 1 depicts two different cases. Assume initially a (downward sloping) demand function Q_d intersects supply Q_s in the absence of taxes at point X. Consider the effect of imposing a tax rate $t^{'}$,which induces an upward shift of supply to $Q_s^{'}$ (the red line in Figure 1). While at X the supplier market was at equilibrium with a share $\alpha = 0$ of integrated firms, at the new equilibrium (call it $X^{'}$) the industry is characterized by a share $\alpha = 1$ of integrated firms. The imposition of the tax induces a change from a non-integrated to an integrated industry structure. However, output at $X^{'}$ is lower than at point $x^{'}$ which would emerge as an equilibrium if the firms at the industry equilibrium had not had a change of organization. Thus, the organizational change induced by $t^{'}$ is not productively efficient, because it positions the industry further away from the highest attainable supply. Consider instead the effect of a tax rate $t^{''} > t^{'}$ which induces an upward shift in the market supply to $Q_s^{''}$ (the blue line in Figure 1). In this case, the same equilibrium $X^{'}$ presents qualitatively different features. In fact, at $X^{'}$ supply is higher than it would be at equilibrium $x^{''}$, which would prevail if firms had not changed their organization. The organizational change induced by $t^{''}$ is productively efficient because it protects the industry from production losses induced by non-integration.

Next we turn to the second case where the demand function $Q_d^{'}$ in the no tax case intersects Q_s at point Y identifying an industry equilibrium with integration. After the introduction of $t^{'}$ or $t^{''}$, the industry moves to $Y^{'}$ or $Y^{''}$, respectively. In both cases the supplier market moves to a non-integration equilibrium and the organizational change is productively inefficient, as described above.

C Ad valorem taxation, organizational design, and welfare

In this section we address two sets of issues related to welfare and policy. The first is the possibility that taxation might have different economic efficiency effects under integration and non-integration, based on the different behavioral responses by firms under each organization. The second is a direct consequence of the first, i.e. the possibility that taxation may usefully serve a purely corrective function. This would apply if government wanted to deploy the (otherwise distortionary) tax instrument simply as a response to the inefficiencies

of incomplete contracting, even were it free to apply lump-sum taxation on firms' profits.

We evaluate the impact of taxation on economic efficiency by considering its effect on economic surplus. Since we are interested in behavioral forces that operate on the supply side of the economy, we limit our examination to the case of an infinitely elastic demand function, which fixes the market price at a $P = P^*$ denoting an equilibrium where total surplus (W) is simply the sum of producer surplus (PS) and tax revenue (TR), whereas consumers do not enjoy any surplus.

C .1 First best efficiency: complete contracts

In the benchmark case of complete contracts, under non-integration the efficient production plan $a = b$ can be specified in a contract. Under integration the firm would still bear the integration cost because it is associated with the transfer of control rights to HQ, regardless of contractual issues. At $P = P^*$, the industry equilibrium would be as depicted in Figure 2. Market supply under non-integration and integration are perfectly inelastic at $Q_N^* = 1$ and $Q_I^* = 1 - \sigma$, respectively. In the absence of any tax, the economic surplus would be enjoyed entirely by producers and:

$$W_N^c > W_I^c \quad as \quad P^* \; > P^*(1-\sigma). \tag{C-17}$$

From (C-17), the choice of non-integration with complete contracts is first-best efficient, while any transfer of control rights to HQ produces a deadweight loss $W_N^c - W_I^c = P^*\sigma$. Figure 2 also shows that taxation with complete contracts is not distortionary because it does not induce any deviation from the efficient production plan. The tax simply redistributes the surplus from producers to government, as $PS + TR = P^*(1-t)Q_N^* + P^*tQ_N^* = P^*$.[14]

C .2 Second-best efficiency: incomplete contracts

Incomplete contracts impose a deadweight loss, whose characteristics depend on the organization of firms at the industry equilibrium. As this deadweight loss cannot be removed, an efficiency evaluation of taxation with incomplete contracts is second-best. We find it useful to proceed in two steps. First, we assume that the available options to cope with incomplete contracts in the supplier market are either integration or non-integration, and evaluate the efficiency of taxes when firms' governance is exogenous at the industry equilibrium. Second, we look at the case where the supplier market options are integration and non-integration, and evaluate the efficiency of a tax that induces an 'organizational change' at the industry equilibrium.

[14] In this section, for expositional simplicity, we prefer to describe the effects of a tax which is imposed on consumers. The theory of tax incidence shows that this is fully equivalent to a tax imposed on producers such as is described in Figure 1.

Exogenous organization

When only one type of organization is possible, the introduction of the tax does not alter the supplier markete quilibrium. Figure 3, panel 'a' describes the case of a non-integration equilibrium. In this case, the relevant supply curve is (A-3) and the total surplus in the no tax case is:

$$W_N^* = \int_0^{P^*} Q_N^* dp = \frac{P^*(1+2P^*)}{2(1+P^*)}. \tag{C-18}$$

Comparison of (C-18) and (C-17) shows that incomplete contracts typically induce a deadweight loss under non-integration (Legros and Newman [16], Hart and Holmstrom [14]):

$$DW_N = W_N^c - W_N^* = \frac{P^*}{2(1+P^*)},$$

denoted by the red shaded area in Figure 3, panel 'a'. Introduction of the tax, by lowering the producer price from P^* to $P^*(1-t)$, produces an additional excess tax burden:

$$DW_N^t = W_N^* - PS_N - TR_N = \frac{1}{2(1+P^*)}\left[\frac{P^*t}{1+P^*(1-t)}\right]^2,$$

where $PS_N = \int_0^{P^*(1-t)} Q_N^* dp$ is the producer surplus after the introduction of the tax, and $TR_N = P^*tQ_N^*$ is the tax revenue. DW_N^t is represented by the shaded gray area in Figure 3, panel 'a' and adds up to DW_N under non-integration.

Now turn to the case of integration as the only organizational form available in the supplier market. In this case, the relevant supply curve at the industry equilibrium is the perfect inelastic Q_I^* in Figure 3, panel b. From (A-4), total surplus in the absence of taxes is:

$$W_I^* = P^*(1-\sigma). \tag{C-19}$$

The deadweight loss under integration is:

$$DW_I = W_N^c - W_I^* = P^*\sigma.$$

Represented by the red shaded area in Figure 3, panel 'b'. Note that DW_I is due the transfer of control rights, as in (C-17), above. However in this case, the introduction of a tax simply redistributes the surplus $TR_I = P^*t(1-\sigma)$ from producers to government, in the form of tax revenue i.e.:

$$W_I^* = PS_I + TR_I, \tag{C-20}$$

We can summarize these results in the following:

Proposition 3: *With incomplete contracts, the introduction of a tax has a negative impact on the social surplus in a non-integrated industry but not in an integrated industry.*

Proposition 3 suggests that with incomplete contracts, taxation is distortionary under non-integration while being (second-best) efficient under integration. Taxation, in fact, reduces aggregate productive efficiency under non-integration but not integration. In other words, integration protects the industry against the tax distortions that would occur under non-integration, preserving (second-best) economic efficiency.

Endogenous organization

When both integration and non-integration are available options in the supplier market, the introduction of a tax may alter the organizational choice at the industry equilibrium.[15] To evaluate the impact of taxation on welfare, we need to distinguish a change from an integration to a non-integration equilibrium, from a change from a non-integration to an integration equilibrium.

Figure 4, panel 'a' describes the former case where demand in the no tax case identifies an integration equilibrium such as E and the total surplus is given by (C-19). Consider the introduction of a tax that induces a new equilibrium, such as E', where all firms in the supplier market 'switch' to non-integration. The excess burden of taxation at E' is (red shaded area in Figure 4, panel 'a'):

$$DW_{IN}^t = \ W_I^* - PS_N - TR_N = \ \frac{P^*(1+P^*(1-t)^2)}{2(1+P^*(1-t))^2} - P^*\sigma,$$

where TR_N and PS_N^t are the tax revenue and producer surplus at the new non-integration equilibrium. $DW_{IN}^t > 0$ is guaranteed by the existence condition $0 < \sigma < \sigma_{\max}$ and the incentive compatibility constraint $p < \underline{p}$ for a non integration equilibrium in the supplier market.

Figure 4, panel 'b' describes the opposite case where demand in the absence of the tax identifies a non-integration equilibrium, such as F, with the total surplus given by (C-18). The introduction of a tax induces a new industry equilibrium, such as F', where all firms switch to integration. At the new integration equilibrium, the tax produces a surplus gain PS_{NI}^t associated with higher production efficiency at any $P \in (\underline{P}, Z)$ and a deadweight loss DW_{NI}^t due to a lower production efficiency at any $P \in (Z, \overline{P})$.[16] Total change in social

[15] Obviously, this does not need necessarily to be the case since a tax could be introduced that does not affect the equilibrium in the supplier market. The welfare evaluation of a tax that does not alter the equilibrium in the supplier market is similar to the evaluation in the case of exogenous governance.

[16] Z is the market price threshold that determines the relative productive efficiency of integration i.e. $Q_I^* > Q_N^*$ when $P < Z$. Then, the surplus gain PS_{NI}^t is due to the increase of infra-marginal production units at any $P \in (\underline{P}, P)$, following the switch to integration and DW_{NI}^t is associated with (i) the non-integrated industry being less productively efficient at any $P > \overline{P}$ and (ii) the switch to integration being productively inefficient at any $P \in (Z, \overline{P})$.

surplus is:

$$\Delta W_{NI}^{t} = \ W_{I}^{*} - W_{N}^{*} = P^{*}\left(\frac{1}{2(1+P^{*})} - \sigma\right) \lesseqgtr 0. \tag{C-21}$$

The relationship (C-21) between the level of the integration cost σ and market price P^* is described in Figure 5. The downward sloping curve $\sigma = \frac{1}{2(1+P^*)}$ is the set of (σ, P^*) combinations that correspond to a welfare neutral change from non-integration to integration (i.e. $\Delta W_{NI}^{t} = 0$). The area below the curve includes all possible combinations corresponding to an increase in the social surplus (i.e. $\Delta W_{NI}^{t} > 0$). In fact, when the integration cost and market prices are very low, e.g. corresponding to (σ_L, P_L^*), the inefficiencies under non-integration are remarkably high while integration is close to be first-best efficient. In this case imposition of a tax that induces a change of governance in the industry is very beneficial to welfare. At market price P_L^*, inefficiencies under non-integration are so high that the tax still raises social welfare at an integration cost such as σ_H, where welfare under integration is much lower. Symmetrically, at σ_L the welfare losses under integration are so negligible that a tax that induces a change from non-integration to integration increases welfare even when the market price, such as P_H^*,increases the relative efficiency of non-integration. Finally, the same tax has a negative impact on welfare for (σ, P^*) combinations above the curve (i.e. $\Delta W_{NI}^{t} < 0$). In fact when market prices and integration costs are both very high, e.g. at (σ_H, P_H^*), the welfare gains from the 'tax induced' switch to integration are negligible relative to the welfare loss of abandoning non-integration.

We can summarize results in this section as follows:

Proposition 4: *A tax that induces a switch from an integration to a non-integration equilibrium reduces social welfare. A tax that induces a switch from a non-integration to an integration equilibrium has a positive impact on social welfare if market price and integration cost are not too high.*

In adopting a Neoclassical approach, the literature on taxation on economic efficiency (see Aurbach and Hines [3] for a review), ignores the existence of an indirect impact of taxation on welfare via a change in firms' internal organization. Proposition 6 states that if the firm can choose its governance structure, a tax that induces firms in the industry to adopt a non-integrated structure instead of an integrated one is (second-best) inefficient. However, a tax that induces firms to choose integration instead of non-integration may play a corrective role, thus being (second-best) efficient.

Figure 1: **Production taxation and organizationally augmented supply**

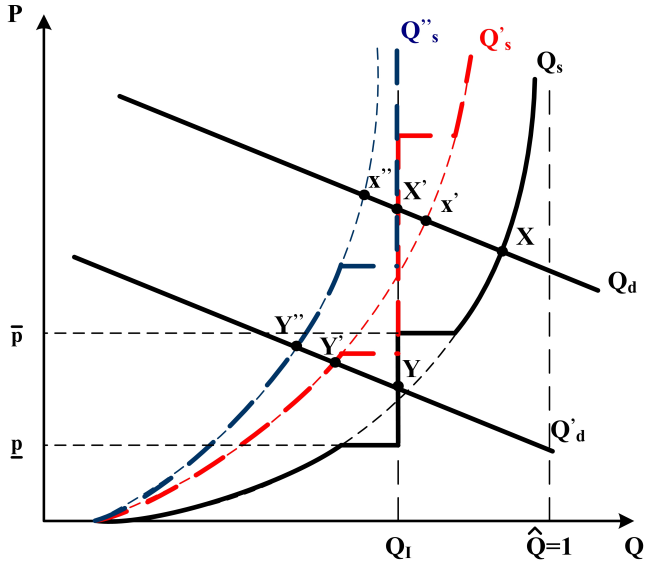


Figure 2: **Social surplus and complete contracts**

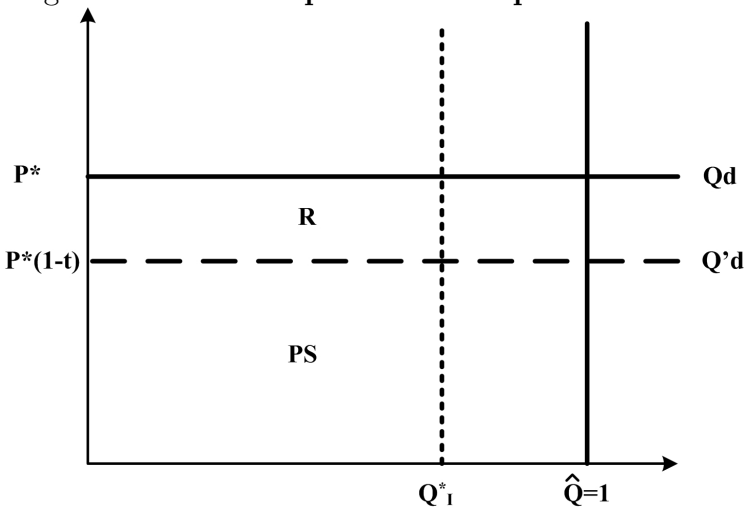


Figure 3: **Social surplus and incomplete contracts: exogenous organization**

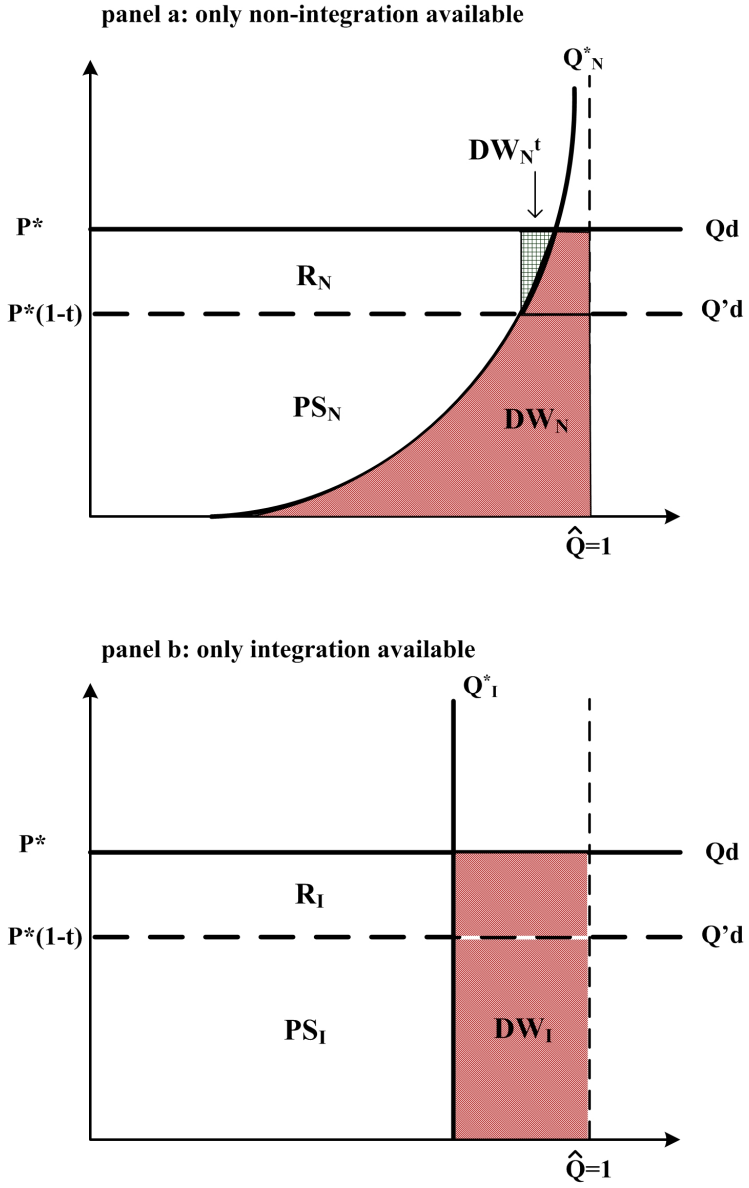
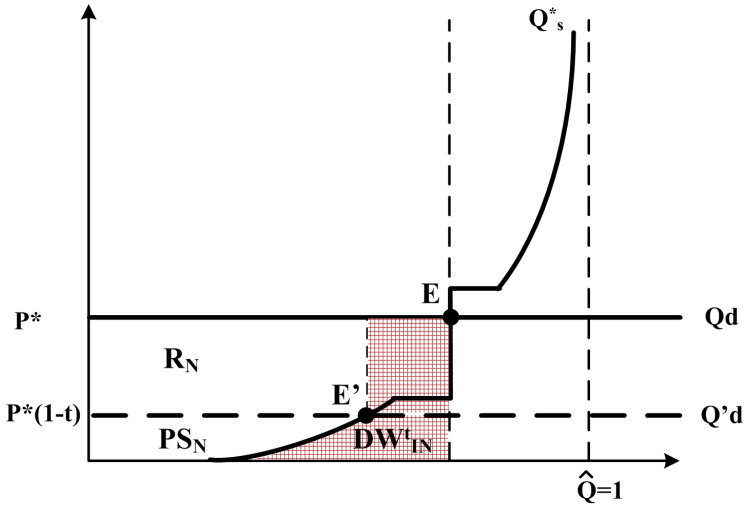


Figure 4: **Social surplus and incomplete contracts: endogenous organization**

panel a: integration → non-integration



panel b: non-integration → integration

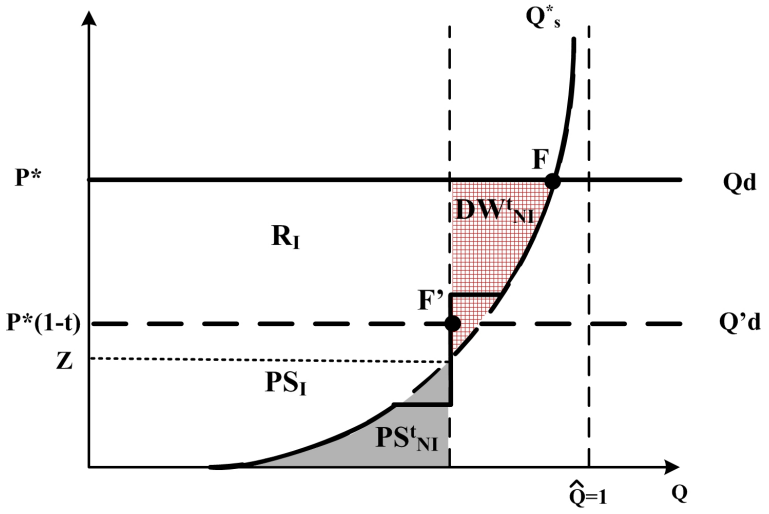
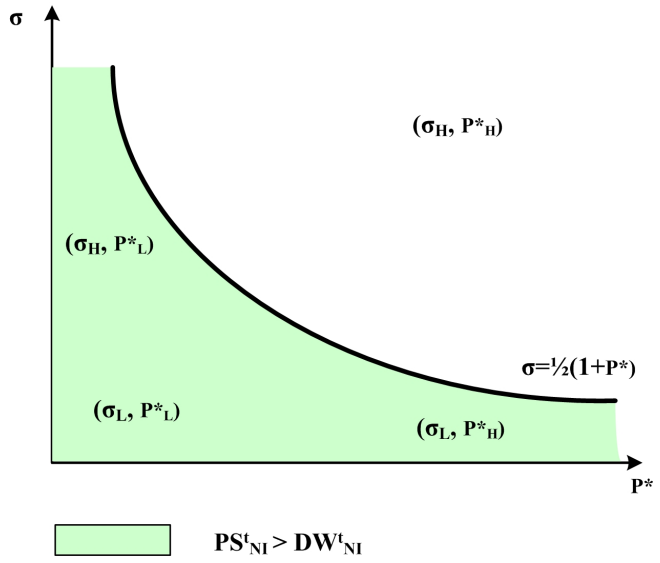


Figure 5: welfare enhancing tax induced change from non-integration to integration



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