On the (in)efficiency of production taxes and firms' organizational choice*

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Abstract

The present paper analyzes the impact of production taxes on economic efficiency when firms' production is fragmented, contracts are incomplete and managers can choose either an integrated or an outsourced structure for their firm. Results indicate that a tax on production creates inefficiencies under outsourcing as it prevents managers to enhance coordination between their units. Integration instead implements full coordination which protects the firm against such 'tax induced' inefficiencies. Thus, any production tax that induces an organizational switch from integration to outsourcing reduces economic surplus. However a production tax that induces a switch from outsourcing to integration increases economic surplus provided that demand or integration cost are not too high.

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1 Introduction

Under the assumption that firms which operate in perfect competition are composed by single units (or by multiple units able to coordinate perfectly) a well established result in public economics is that a tax on production (such as on sales, value added etc.) which reduces the producer price is detrimental to economic efficiency. In reality, firms' internal organization is featured by incomplete contracts e.g. lack

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of fully enforceable labor contracts, specifiable production functions or marketable inputs etc.. Thus a firm can react to a tax which cuts its producer price not only by changing the quantities supplied in the market but also switching the organizational structure chosen to cope with incomplete contracting.

The present paper analyzes the impact of a production tax on economic efficiency when firms which endogenously set their organizational structure in the presence of incomplete contracts. We feature the widely acknowledged property rights approach to the organization of firms with incomplete contracting (Grossman and Hart [7], Hart and Moore [9], Hart and Holmstrom [8]) and particularly the theory of managerial firms by Legros and Newman [10]. The latter assumes each firm is composed by operational units run by managers that choose the organizational setting in order to maximize their payoff rather than shareholders' profits. The production process depends on the adoption of non-contractible decisions such that while there is no objectively right decision, production efficiency is higher the more decisions are in the same direction. Thus managers have an incentive to coordinate their decisions, however they also present conflicting preferences over the decisions. Managers can choose either an outsourced structure and maintain control over their units or an integrated structure and delegate the control of the two units to an headquarter (HQ). With outsourcing, managers run their units independently on each other and choose the degree of coordination which maximizes their payoff. Given their confilicting preferences a lack of coordination results which reduces the production efficiency of the firm.[1] Integration conversely, centralizes the decision making process, *'.. harmonizes interests .. and permits an efficient decision process to be utilized'* (Williamson [12] page 117) while entailing a fixed cost in terms of administrative coordination, bureaucreacy, lack of skill specificity of the HQ etc.

While being in line with the traditional Grossman-Hart-Moore view of organization decisions as the outcome of a trade-off between revenue maximization and private costs minimization due to effort or working conditions, this framework has the advantage of being genuinely perfect competitive. This allows us to abstract from the (potentially confounding) effect of market power and focus on the (tax-induced) production inefficiencies triggered solely by contract incompleteness. Moreover it also allows to design explicitly the effect of the organizational choice on the efficiency of the production process by modeling an 'organizationally augmented supply curve'. This allows us to evaluate the impact of production taxes on the efficiency of organizational choices in terms of changes in economic surplus. In this setting we show that the choice of an integrated structure 'protects' the firm from the 'tax induced' inefficiencies which arise due to managers' failure to coordinate under outsourcing. Production taxes shift managers' preferences towards integration, particularly when the fixed cost associated to integration is low: a 'tax

[1] Bertrand and Mullainathan [4] provide some evidence that with outsourcing, managers want to 'enjoy a quiet life' at the possible expenses of productivity-enhancing re-organizations. Notice that while such inefficiencies do not strictly depend on firms pricing behaviour, they are nevertheless affected by the degree of competition in the markets; high competition encourages managers to coordinate allowing firms to get closer to their production possibilities frontier (see also Legros and Newman [10]).

induced switch' from outsourcing to integration occurs for those firms which would suffer most of the production losses i.e. those characterized by a big revenue potential. Conversely, a 'tax induced switch' from integration to outsourcing occurs only for those firms characterized by little revenue potential as the revenue losses from lower production are comparatively small relative to savings in private costs. From the welfare viewpoint of a social planner willing to maximize total surplus, our results indicate that any production tax that induces an organizational switch from integration to outsourcing has a negative impact on total welfare. However a production tax that induces a switch from outsourcing to integration has a positive impact on total welfare provided that demand or integration cost are not too high. These results contribute to the literature inspired by the well known 'Production Efficiency Theorem' (Diamond and Mirlees [6]) which analyzes the impact of indirect taxation on production efficiency in the presence of some form of market failure (Delipalla and Keen [5], Andersen et al. [2] and Andersen et al. [3]). This literature focuses on imperfect competition in the products market as the main source of inefficiency while disregardinbg other market failures such as those related to incomplete contracting.

The rest of the paper is structured as follows. Section 2 describes the framework. Sections 3 analyzes the impact of production taxes on equilibrium organization and managers' production decisions. Section 4 describes the welfare analysis. Section 5 concludes.

2 Production taxation, incomplete contracting and managerial firms

We build upon the recent theory of managerial firms by Legros and Newman [10]) which assumes a production technology involving the adoption of standards and firms' ownership (by shareholders) as distinct from firms' control (by the management). This framework is more suitable to the present analysis than others available in literature (e.g. Grossman and Hart [7], Hart and Moore [9]). In fact it allows us to promptly show how the introduction of the tax modifies the incentives of a rent maximizer management in a way which may be detrimental (or favourable) to production and economic efficiency.

2.1 The framework

We assume a mass of firms with size equal to one producing an output Q to be sold on a perfect competitive market. Each firm is composed of two unit types, A and B, that are run by managers M_a and M_b, respectively. M_a types are in excess supply relative to M_b types. Running A and B entails taking (and implementing) non contractible decisions $a \in [0,\ 1]$ and $b \in [0,\ 1]$, respectively. Call q the productivity of firms which depends on managers' ability to coordinate their decisions:

$$q = 1 - \frac{1}{2}(a-b)^2, \quad with \ \ a \geq b; \tag{1}$$

In the present framework, $0 < q < 1$ provides a measure of production efficiency in the sense of Diamond and Mirlees [6]: the production plan which involves fully coordinated decisions (i.e. $a = b$) is efficient in that any other feasible plan provides a smaller net output. [2] However managers M_a and M_b 'disagree' over the direction they ought to go and choose a and b to minimize their private cost functions $C(a)$ and $C(b)$, respectively:

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

The cost functions (2) indicate that M_a's preferences are increasing in a while M_b's ones are decreasing in b. They describe the idea that managers have opposite preferences over decisions regarding e.g. the technology adopted. To give an example, M_a may want to endow its unit with McIntosh machines since these are 'aestethically pleasing' while M_b may prefer PCs for their practicality. Given its preferences, each manager finds it costly to accomodate to the other's choice and prefers 'enjoying a quiet life' rather than undertaking re-organizations aimed at harmonizing the decisions taken in the two units. However, if contracts were complete, all the contingencies could be specified in a contract, the decisions implemented in the two units would be perfectly coordinated (i.e. $a = b$) and firm's production plan would be efficient (i.e. $q = 1$). However contract incompleteness hinders the ability of the two units to coordinate, which in turn reduces the production efficiency of the firm described by a $q < 1$.

While decisions a and b are not contractible, both the control structure (i.e. the right to take decisions over each unit) and the revenue shares accruing to each manager can be specified in a contract. Managers can choose between an outsourced and an integrated structure. Under outsourcing, M_a and M_b retain full control over their asset and choose a and b that maximize their individual payoff. Output under outsourcing only depends on firm's production efficiency i.e.

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

Under integration managers concede decision power over their units to an Headquarter (HQ). Employing HQ, however, entails some direct costs in terms of foregone output due to increased administration, bureaucreacy etc. which in turn causes the loss of a fixed share σ of output. Output under integration depends on both firm's coordination and integration costs:

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

At a given producer price, managers observe which organization ensures them higher payoffs and sign a contract that specifies the organization and the revenue shares. Once they agreed on a contract, managers do not have any incentive to deviate i.e. an equilibrium emerges in the supplier market. At

[2] Notice that, from the function (1), there is not any objectively 'right' decision but simply the adoption of standards. The more decisions go in the same direction (i.e. the closer are standards a and b) the higher is the efficiency of firm's production. Legros and Newman [10] also interpret q as the probability of success of the project jointly run by managers M_a and M_b.

this equilibrium decisions are taken over the units (by the management or the HQ) which determine the production efficiency of the firm. Output is then sold on a perfect competitive market.

As we will see below, the introduction of a tax (e.g. on sales) which reduces the producer price, in this framework alters managers' incentives, thus their organizational choice and production efficiency at the equilibrium. To facilitate the exposition we start the analysis by describing the structure of managers' incentives and the organizational choice in the benchmark case by Legros and Newman [10] where production is not taxed.

2.2 Benchmark: the no-tax case

When firms' production is not taxed, the payoffs of M_a and M_b are respectively:

$$\pi^a = s\ P\ Q_j - \frac{1}{2}(1-a)^2, \qquad \pi^b = (1-s)\ P\ Q_j - \frac{1}{2}(b)^2, \qquad j = I, O. \tag{5}$$

In the absence of production taxation, the market price (P) corresponds to firms' producer price. s is the revenue share accruing to M_a and Q_j is total production under organization $j = I, O$. With outsourcing, M_a and M_b retain full decision power over their units and choose non cooperatively a and b to maximize their payoffs (5) given the production function (3); at the Nash equilibrium we have:

$$a_O^{nt} = \frac{1+(1-s)P}{1+P}; \qquad b_O^{nt} = \frac{(1-s)P}{(1+P)}. \tag{6}$$

Substitute (6) in (1) to obtain equilibrium output under outsourcing:

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

Equations (6) and (7) evidence the typical feature of the theory of managerial firms by Legros and Newman [10]; managers coordination efforts, thus production levels, increase with the market price. Intuitively, when the market price increases, managers value more output and increase their efforts to coordinate to minimize output losses under outsourcing. Notice that the assumption that managers' behave non cooperatively is critical to (6) and (7). While admittedly overstated, the latter wants to reflect the decisional conflict which arises between managers characterized by opposite preferences over non contractible decisions.

Now turn to the integration case in which managers concede decision power to a HQ. Since it receives a payment that is proportional to firm's revenue, HQ behaves as a 'revenue maximizer' and implements full coordination. While in principle this would only require $a_I^* = b_I^*$, we assume the HQ sets $a_I^{nt} = b_I^{nt} = 1/2$ since this maximizes the joint management's payoff, which is perfectly transferable via the sharing rule s. From (4) equilibrium output under integration is:

$$Q_I^{nt} = (1-\sigma). \tag{8}$$

A comparison of (8) with (7) shows that market prices do not affect output with integration. HQ is only motivated by monetary considerations, incurs no costs from the decisions a and b, thus it only

wishes to maximize the income of the integrated firms and implements full coordination regardless of the level of the market price.

Substitute output levels (7) and (8) as well as equilibrium decisions (6) and $a_I^* = b_I^* = 1/2$ in (5) to obtain managers' payoffs under outsourcing and integration, respectively. Since operational units A and B are perfectly symmetric, we can derive the aggregate payoff of the management by a simple utilitarian criterion i.e. $\Pi_j = \pi_j^a + \pi_j^b$ with $j = I, O$. Under the assumption of excess supply of M_a types we have:[3]

$$\begin{aligned}\Pi_O^{nt} =& P\left(1 - \frac{1}{2(1+P)^2}\right) - \frac{1}{2}\left(\frac{P}{1+P}\right)^2; \\ \Pi_I^{nt} =& P(1-\sigma) - \frac{1}{4}.\end{aligned} \tag{9}$$

At given market prices, the management adopts the organization that ensures the higher payoff:

$$\begin{aligned}&\Pi_I^{nt} > \Pi_O^{nt} \quad \Leftrightarrow \quad \underline{P} < P < \overline{P}, \\ &\quad where \;\; \underline{P} = \frac{1 - 4\sigma - \Delta(\sigma)}{8\sigma} \;\; and \;\; \overline{P} = \frac{1 - 4\sigma + \Delta(\sigma)}{8\sigma};\end{aligned} \tag{10}$$

where $\Delta(\sigma) = \sqrt{1 - 24\sigma + 16\sigma^2}$.[4]. When the market price falls in the interval $P \in (\underline{P}, \overline{P})$, the management maximizes its payoff under an integrated structure. When $P < \underline{P}$ or $P > \overline{P}$, the management maximizes its payoff under an outsourced structure. Finally, when $P = \underline{P}$ or $P = \overline{P}$, managers obtain the same profits under outsourcing and integration.

From equation (10), an increase in σ shifts upward the price treshold for which managers switch from outsourcing to integration i.e. $\partial \underline{P}/\partial\sigma > 0$, and shifts downward the price treshold for which managers switch from integration to outsourcing i.e. $\partial \overline{P}/\partial\sigma < 0$. Both effects signal that an increase in the fixed cost of integration raises the profitability of outsourcing relative to integration at any market price i.e. makes an outsourcing outcome more likely to occur than an integration outcome.

2.3 Production taxation, managers' incentives and organizational choice

Assume now that a tax is applied at the market price P that weighs on production such that the firm gets a producer price $p = P(1-t)$.[5] The payoffs of M_a and M_b are then simply obtained by replacing P

[3]The assumption of excess supply of M_a types is a necessary condition to guarantee that some interval in market prices exists such that integration ensures management a higher aggregate payoff than outsourcing (see Legros and Newman [10] for details). It implies that under an outsourced structure, M_a and M_b set $a_o^* = 1$ and $b_o^* = 0$ respectively and obtain $\pi_o^a = 0$ and $\pi_0^b = P\left(1 - \frac{1}{2(1+P)^2}\right) - \frac{1}{2}\left(\frac{P}{1+P}\right)^2$. Under an integration structure, the HQ sets $a_i^{nt} = b_i^{nt} = 1/2$, thus M_b gets $\pi_i^b = P(1-\sigma) - \frac{1}{8}$ and transfers 1/8 to cover M_a's losses.

[4]$\Delta(\sigma)$ is defined for $\sigma < \frac{3}{4} - \frac{\sqrt{2}}{2} \equiv \sigma_{\max}$. From now on we assume that this assumption is always satisfied. This condition also guarantees that $\overline{P} > \underline{P} > 0$. $\Delta(\sigma)$ is also defined for $\sigma > \frac{3}{4} + \frac{\sqrt{2}}{2} > \sigma_{\max}$. However for any $\sigma > \sigma_{\max}$, we also have $\Pi_O^{nt} > \Pi_I^{nt}$ i.e. outsourcing dominates integration in managers profits for any price level. We accordingly exclude this possibility and concentrate the analysis on the case $\sigma < \sigma_{\max}$ (see also Legros and Newman [10]).

[5]One can think of t as a tax imposed on sales in a market characterised by a perfect elastic demand function. More generally t can be the interpreted as the share of the sales tax that is borne by producers. In the present analysis in fact we want to abstract from any problems related to tax incidence and focus on the way managers incentives respond to the tax burden which weighs on them.

with p in (5). With outsourcing, M_a and M_b choose non cooperatively a and b to maximize their payoffs given the production function (3). At the Nash equilibrium we now have:

$$a_O^t = \frac{1+(1-s)p}{1+p}; \qquad b_O^t = \frac{(1-s)p}{(1+p)} \quad where \quad p = P(1-t). \tag{11}$$

From (11), $\partial a_O^t/\partial t > 0$, and $\partial b_O^t/\partial t < 0$; at any market price, the tax reduces the producer price and shifts managers' decisions towards the level that minimizes their cost functions i.e. shift a_O^t towards 1 and b_O^t towards 0. By substituting (11) in (3), we obtain equilibrium output under outsourcing:

$$Q_O^t = 1 - \frac{1}{2(1+p)^2} < Q_O^{nt}. \tag{12}$$

It can be easily shown that $\partial Q_o^t/\partial t < 0$. As it discourages managers' coordination, the production tax also reduces output under outsourcing. Now turn to the integration case. The HQ behaves as a 'revenue maximizer' and implements full coordination by setting $a_I^* = b_I^* = 1/2$. Accordingly, from (4) equilibrium output under integration is:

$$Q_I^t = (1-\sigma) = Q_I^{nt}. \tag{13}$$

Contrary to the case of outsourcing, equilibrium output under integration in the presence of the tax is the same as in the no-tax case. We can summarize these results in the following:

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

Under outsourcing, a higher production tax, as it reduces firm's marginal revenue, induces managers to choose a 'quiter life' i.e. discourages their efforts to coordinate resulting in a inefficient production plan. With integration conversely, the HQ behaves as a revenue maximizer and implements full coordination independently on the level of the tax. In this way, an integrated structure 'protects' the firm against 'tax induced' inefficiencies related to the weaker managers' incentives to coordinate.

Substitute output levels (12) and (13) as well as equilibrium decisions (11) and $a_I^t = b_I^t = 1/2$ in (5), and obtain the aggregate payoffs of the management under outsourcing and integration in the presence of the tax:

$$\begin{aligned} \Pi_O^t =& p\left(1 - \frac{1}{2(1+p)^2}\right) - \frac{1}{2}\left(\frac{p}{1+p}\right)^2, \\ \Pi_I^t =& p(1-\sigma) - \frac{1}{4}. \end{aligned} \tag{14}$$

The management adopts the organization that ensures the higher payoff given firm's producer price:

$$\Pi_I^t > \Pi_O^t \quad \Leftrightarrow \quad \underline{P} < p < \overline{P}. \tag{15}$$

From (15), the management prefers an integrated structure when the producer price falls in the interval $p \in (\underline{P}, \overline{P})$.

3 Industry equilibrium

The industry equilibrium is a general equilibrium of the supplier and the product market. An equilibrium in the supplier market consists of one-to-one matches between A and B types via contracts which specify the organizational structure of the firm and an allocation of surplus between managers. An equilibrium in the products market simply requires that supply equals demand. Provided that in the industry there is a mass of firms of size 1, the supply is an average of the supply under integration and under outsourcing, weighted by the share of firms which decides to integrate and outsource, respectively, given the market price. On the demand side, in this section we assume a general downward sloping demand function while for the welfare analysis we assume a perfect elastic demand curve which fixes the market price.

3.1 Supplier market equilibrium: the 'organizationally augmented supply curve'

An equilibrium in the supplier market is given by a share $\alpha \in [0,1]$ of firms in the industry that chooses to integrate, given the structure of incentives sketched above. From equation (15), it follows that:

$$\alpha(P) = \begin{cases} 1 & if \quad p \in (\underline{P},\ \overline{P}), \\ \in [0,1] & if \quad p = \underline{P} \ \ or \ \ p = \overline{P}, \\ 0 & if \quad p < \underline{P} \ or \ p > \overline{P}. \end{cases} \tag{16}$$

The system (16) describes three cases of interests. When producer price is high i.e. $p > \overline{P}$, the big revenue potential induces managers to choose outsourcing and take closer decisions. When $p \in (\underline{P}, \overline{P})$, the revenue potential is not high enough to render outsourcing a profitable option to managers which prefer to integrate and concede power to the HQ. However, when the producer prices are very low i.e. when $p < \underline{P}$, managers choose outsourcing to pursue a strategy of 'cost minimization' which would be constrained by the HQ under integration. Finally, when $p = \underline{P}$ or $p = \overline{P}$, managers are indifferent between integration and outsourcing, each firm randomly chooses between the two organizations and any $\alpha \in [0,1]$ can occur. We thus obtain the 'organizationally augmented supply curve':

$$Q_s(P, \alpha(P)) = \ \alpha\ Q_I^t + \ (1-\alpha)\ Q_O^t. \tag{17}$$

where α is given by (16). The black line in Figure 1 describes the supply curve for the 'no tax case' (see Appendix A for the analytical derivation). The latter provides a useful benchmark to evaluate the impact of a production tax on product supply by managerial firms. The introduction of the tax drives a wedge $p = (1-t)P$ between market price and the corresponding producer price. Under outsourcing, as they get a lower producer price at any market price, managers choose to coordinate less. The Q_o^{nt} curve shifts upward to Q_o^t in Figure 1. Under integration instead, since the HQ implements full coordination,

the tax does not have any impact on product supply.

The 'organizationally augmented supply curve' relevant for producers after the introduction of the tax is then the red line in Figure 1. We can also get some insight over the impact of the production tax on the market prices' interval for which a pure integration equilibrium occurs in the supplier market. Derive the market price tresholds which ensure producer prices equal to $\underline{P}$ and $\overline{P}$, respectively:

$$\underline{P}^t = \frac{\underline{P}}{(1-\bar{t})} = \frac{1-4\sigma-\Delta(\sigma)}{8\sigma(1-t)} > \underline{P},$$
$$\overline{P}^t = \frac{\overline{P}}{(1-\bar{t}).} = \frac{1-4\sigma+\Delta(\sigma)}{8\sigma(1-t)} > \overline{P}. \tag{18}$$

From equations (18) the management now needs a higher market price $\underline{P}^t$ to obtain the producer price $\underline{P}$. Similarly, managers need a market price $\overline{P}^t$ to obtain a producer price $\underline{P}$. We can thus derive the market prices' interval I^t for which producer prices are such to induce managers to choose integration i.e.

$$I^t = (\overline{P}^t - \underline{P}^t) = \frac{\Delta(\sigma)}{4\sigma(1-t)}. \tag{19}$$

We have the following:

Proposition 2: *A production tax increases the price interval for which an integration equilibrium occurs in the supplier market* $\frac{\partial I^t}{\partial t} = \frac{I^t}{1-t} > 0$.

Proposition 2 basically indicates that a production tax renders integration a profitable organizational choice to the management for a wider interval of market prices. On the one hand, the tax puts more emphasis on private costs' minimization relative to output maximization in managers' payoffs; on the other hand, from Proposition 1 the choice of an integrated structure also provides the management an instrument to protect its aggregate payoff against tax induced production inefficiencies. Overall, in the presence of a tax on production, integration is the organizational choice which maximizes managers' payoff for a wider range of market prices;

We obtain further insight over the relationship between the production tax and the organizational choice at the supplier market equilibrium by looking at a simple measure of the responsiveness of managers' integration choice to the level of taxes i.e. the *lowest tax rate* $\bar{t}$ *which induces a switch to outsourcing by managers that would choose integration in the absence of taxes.* $t = \bar{t}$ can be derived as the tax rate which, applied at a market prices $P = \overline{P}$, leaves firms a producer price $p = \underline{P}$.

It can be shown that (see Appendix B for the analytical details):

Lemma: *Managers' choice to integrate is more (less) responsive to the level of the production tax as the fixed cost of integration increases (decreases) i.e.:*

$$\lim_{\sigma\to 0} \bar{t} = 1, \qquad \lim_{\sigma\to\sigma_{max}} \bar{t} = 0, \qquad \frac{\partial \bar{t}}{\partial \sigma} < 0 \;\; if \;\; \sigma < \sigma_{\max}.$$

The relationship between $\bar{t}$ and σ is depicted in Figure 2: (i) a falling fixed cost increases the relative attractiveness of integration to managers which will be induced to switch to outsourcing only if a production tax is introduced that considerably cuts their producer price. Conversely, (ii) an increasing fixed cost, raises the attractiveness of an outsourcing outcome to managers which will then be induced to switch to outsourcing even by a little tax increase. In other words, taxes and integration costs are competing incentives for managers: since a high tax and a low fixed cost both favour an integration outcome, any increase in σ has to be matched to a reduction in $\bar{t}$ for managers to mantain the same preferences over integration.

3.2 Product market equilibrium: 'tax induced organizational change'

An equilibrium in the product market consists of a price and a quantity which equate supply (17) and demand. Assume a linear downward sloping demand curve $Q_d(P)$. Equation (17) suggests that depending on the equilibrium in the product market i.e. the point where $Q_d(P)$ intersects $Q_s(P, \alpha(P))$, three types of equilibria may arise in the supplier market: a pure equilibrium in which all firms integrate, a mixed equilibrium in which only a share α of firms integrate and a pure equilibrium where all firms outsource. The introduction of a tax which modifies the equilibrium in the products market may then alter the equilibrium in the supplier market i.e. induce a change in the organization of the industry.

In Figure 3 we illustrate two types of 'tax induced organizational change' which may arise in pure equilibria.[6] In panel 1, we describe a market characterized by demand Q_d^1 which intersects Q_s at an equilibrium such as point X. At this equilibrium, firms' revenue prospects, thus managers' incentives to coordinate, are high enough that they maximize their payoff by choosing outsourcing. The introduction of a production tax rate t^1 however would reduce the producer price, thus weaken managers' incentives to coordinate under outsourcingbring and bring the industry to an equilibrium such as X^1. At this new equilibrium managers maximize their payoff by switching to integration as this allows them to save on private costs. Managers would also switch to integration, but the switch would be qualitatively different if a tax rate $t^2 > t^1$ was applied. In this case, managers' incentives to coordinate under outsourcing after the introduction of the tax are so low that delegating decision power to the HQ becomes a way to protect their payoffs from 'tax induced production inefficiencies'. [7]

In panel 2, we describe a market characterized by demand Q_d^2 which identifies on the supply curve Q_s an equilibrium such as point Y. Here managers choose integration as this is the organization which ensures them the lowest private costs, despite revenues would be higher under outsourcing[8]. After the

[6]This is mostly done for expositional simplicity as the analysis of mixed equilibria (before or after the tax) where some firms integrate and others do not, does not add anything in qualitative terms.

[7]In fact, by retaining outsourcing, managers would bring the industry to an equilibrium such as X^2 where production is lower than at X^1.

[8]Notice again that there might be integration equilibria may differ qualitatively. At Y, due to the relatively low revenue prospects of the firm, the cost minimization motive prevails in managers' payoff and managers choose integration. A

introduction of tax rate t^1, the industry moves to an equilibrium such as Y^1. The tax in fact reduces the producer price and weakens so much managers' incentives to coordinate under outsourcing that they find it convenient to switch to an outsourced structure to save on their private costs.

To summarize, the analysis in this section uncovers that (i) with incomplete contracts a production tax induces managers to choose an integration equilibrium in the supplier market for a wider interval of market prices. Integration in fact gives managers a useful instrument to 'protect' their payoff from tax induced production inefficiencies or extract rents in terms of lower private costs. (ii) Depending on the characteristics of the (before tax) industry equilibrium, a production tax may induce an industry equilibrium characterized by an organizational switch in the supplier market from outsourcing to integration and viceversa.

4 Welfare analysis

We now examine the consequences of production taxation for welfare which we define in terms of economic surplus. The mechanisms highlighted in the present framework operate on the supply side of the economy. For this reason, we can concentrate without loss of generality on the case a perfect elastic demand function. The latter in fact fixes the market price at $P = P^*$ and leaves to the industry the choice of both supply levels and organizational structure. We find it convenient to focus on this special case as, under the assumption of perfect elastic demand, consumers do not enjoy any surplus. We can thus express economic surplus simply as the sum of producer surplus and tax revenue.

$$W = PS + TR.$$

As a benchmark case it is useful to evaluate total welfare with complete contracts. From equation (1), managers in this case would be able to specify an efficient production plan involving fully coordinated decisions (i.e. $a = b$) which would lead to a perfect inelastic supply curve $Q = 1$ making it redundant the choice of an organizational form. At $P = P^*$, the industry equilibrium would then be the one described in Figure 4. In the absence of the production tax, economic surplus would be fully enjoyed by producers i.e. (Figure 4a):

$$W^* = PS = P^*Q = P^*. \tag{20}$$

The introduction of a tax at a rate $t \in [0, 1]$ redistributes welfare from producers to the government but does not reduce total surplus. The adoption of the efficient production plan which involves full coordination between units is in fact specified in the contract plan, thus the tax does not alter managers'

qualitatively different equilibrium would be one such as y. Here revenue maximization prevails over cost minimization in managers' payoff and managers incentives to coordinate under outsourcing are so low that they choose integration to protect their payoff from tax induced production inefficiencies.

incentives to coordinate. As a consequence, the introduction of a production tax with complete contracts is neutral with respect to welfare i.e. $W = PS + TR = P^*(1-t)Q + P^*tQ = P^*$.

4.1 Production taxation, incomplete contracting and welfare

We can now move to the welfare analysis of production taxation in the presence of incomplete contracting. We find it convenient proceeding in two steps. In the first step, we analyze welfare under the assumption that the organizational structure is exogenous i.e. that either integration or outsourcing is available to managers. This allows us to evaluate the welfare impact of production taxes under either organization. We then move to analyzing welfare when firms' organization is endogenous i.e. when both integration and outsourcing are available options to managers. This allows us to illustrate the welfare impact of a 'tax induced organizational change' which may occur whenever the management can choose between two alternative settings.

4.1.1 Outsourcing

Assume managers operate with incomplete contracting under an outsourced structure. With outsourcing managers incentives to coordinate is increasing, thus the degree of production efficiency increases with the market price. The relevant supply curve is then Q_O^* in Figure 5 which is defined as (3). In the absence of taxes (Figure 5a) total welfare goes to producers:

$$W_O = \ PS_O = \ \int_0^{P^*} \left(1 - \frac{1}{2(1+P)^2}\right) dP = \frac{P^*(1+2P^*)}{2(1+P^*)}, \tag{21}$$

which corresponds to the shaded grey area in Figure 5a. By a comparison of (21) with the first best (20), it readily follows that incomplete contracting produces a deadweightloss under outsourcing:

$$DWL_O = \ P^* - \frac{P^*(1+2P^*)}{2(1+P^*)} = \frac{P^*}{2(1+P^*)}, \tag{22}$$

which corresponds to the shaded red area in Figure 5a. The economic meaning of DWL_O can be easily explained in terms of the distinction between firms' ownership and control in the theory of managerial firms. At any market price, firms' owners (shareholders) want the efficient production plan $Q = 1$; if contracts were complete, managers would implement such plan and, at market price P^* shareholders would get total surplus (20). However when contracts are incomplete, under outsourcing managers decide to implement an inefficient production plan which entails a loss of shareholders' profits equal to (22).

The impact of an ad valorem production tax on total welfare is illustrated in Figure 5b. The tax raises tax revenue under outsourcing:

$$TR_O = \ P^*t\left[1 - \frac{1}{2(1+P^*(1-t))^2}\right]. \tag{23}$$

However, under outsourcing, the tax discourages managers to coordinate under outsourcing, resulting in a further reduction in production efficiency. This also entails a deadweightloss of taxation under

outsourcing:

$$DWL_O^t = \int_{P^*(1-t)}^{P^*} \left(1 - \frac{1}{2(1+P)^2}\right) dP - TR_O = \frac{1}{2(1+P^*)} \left[\frac{P^* t}{1+P^*(1-t)}\right]^2. \tag{24}$$

Equations (22) and (24) uncover that incomplete contracting provides two distinct sources of inefficiency under outsourcing. The former is a direct one due to the fact that managers choose an inefficient production plan which produces a deadweightloss. The latter is an indirect source which appears once a production tax is applied which further reduces managers' incentives to coordinate.

4.1.2 Integration

Assume now managers cope with incomplete contracting by operating only under integration. With integration, control is passed to the HQ which implements the efficient production plan at the cost of a fixed share σ of foregone output. The relevant supply curve is now the perfect inelastic Q_I^* in Figure 6 which is defined by (4). In the absence of taxes total welfare is:

$$W_I = PS_I = P^*(1-\sigma), \tag{25}$$

which corresponds to the shaded grey rectangle in Figure 6a. The deadweightloss of incomplete contracting under integration is:

$$DWL_I = P^*\sigma, \tag{26}$$

which is the shaded red rectangle in Figure 6a. Under integration, the implementation of the efficient production plan entails a fixed loss of surplus. Figure 6b illustrates the impact of an ad valorem production tax on social welfare. The tax entails a redistribution from producer surplus to tax revenue equal to:

$$TR_I = P^* t(1-\sigma). \tag{27}$$

However, under integration, as the HQ implements the efficient production plans irrespective of firm's revenue the introduction of the tax does not have any effect on production efficiency. The resulting deadweightloss of taxation under integration is equal to zero.

4.1.3 Endogenous organizational choice

We finally analyze the case managers have both integration and outsourcing as available options to cope with incomplete contracting. If we focus only on pure equilibria, we need to distinguish two cases depending on the size of the production tax. If the tax rate t is such to leave the industry at the same organizational equilibrium in the supplier market, its impact on total welfare is exactly the same if only that organization was available to managers. However, as we have seen in the previous section, a production tax may also induce a new pure equilibrium in the supplier market where all firms

switch organization. To analyze the impact of the tax on economic efficiency in the presence of such a 'tax induced' organizational change, it is important to compare the two organizations in terms of their production efficiency. In particular it holds that:

$$Q_I > Q_O \quad \Leftrightarrow \quad P < \frac{1-\sqrt{2\sigma}}{\sqrt{2\sigma}} \equiv \widetilde{P}. \tag{28}$$

Condition (28) indicates that integration guarantees a more efficient production plan than outsourcing whenever $P < \widetilde{P}$. Also in this case, the economic interpretation of $\widetilde{P}$ can be better understood in terms of the distinction between firms' ownership and control: At any $P < \widetilde{P}$, the shareholders would implement the efficient production plan $Q = Q_I$ while managers decide to implement the production plan $Q = Q_O$ which does not maximize shareholders' profits but maximizes managers' rents. Viceversa at any $P > \widetilde{P}$, the efficient production plan is $Q = Q_O$ while managers maximize their rents by implementing the inefficient plan $Q = Q_I$.

To evaluate the impact of the production tax on welfare, we need to distinguish a tax induced switch from outsourcing to integration from a tax induced switch from integration to outsourcing. In the former case, described in Figure 7, the product demand before the introduction of the tax identifies a pure outsourcing equilibrium such as E. At this equilibrium, since production occurs under an outsourced structure, producer surplus is given by (21) (see Figure 7a). The introduction of a production tax makes all firms switch to an integrated structure in the supplier market inducing an industry equilibrium such as E'. This produces a three-fold impact of the production tax on welfare (see Figure 7b). First of all, a share of the producer surplus $TR = P^* t(1-\sigma)$ is redistributed to tax revenue. Second, the tax induced organizational change produces a deadweightloss:

$$DWL^t_{OI} = \int_{\widetilde{P}}^{P^*} (Q_O - Q_I)\, dP = (P^* - \widetilde{P}) \left[\sigma - \frac{1}{2(1+P^*)(1+\widetilde{P})}\right]. \tag{29}$$

DWL^t is associated with two qualitatively different types of production inefficiency. The first is due to the tax inducing managers to coordinate less under outsourcing, the same as kind of loss described by equation (24). The second is associated with the tax induced organizational switch from outsourcing to integration which entails the switch from an efficient to an inefficient production plan at any $P \in (\widetilde{P}, P^*]$.[9] Finally, the organizational change also induces a gain in producer surplus:

$$PS^t_{OI} = \int_0^{\widetilde{P}} (Q_I - Q_O)\, dP = \widetilde{P} \left[\frac{1}{2(1+\widetilde{P})} - \sigma\right]. \tag{30}$$

Equation (30) shows that the introduction of the tax associates an increase in producer surplus with the organizational switch from outsourcing to integration at any $P \in [0, \widetilde{P}]$ is efficient. The tax induced

[9] These effects can be more clearly distinguished by rewriting equation (29) as follows:

$$DWL^t_{OI} = DWL^t_O + P^* t \left[1 - \frac{1}{2(1+P^*(1-t))^2} - (1-\sigma)\right] + \int_{\widetilde{P}}^{P^*(1-t)} (Q_O - Q_I)\, dP.$$

It readily follows that the first term is the deadweightloss under outsourcing (24), while the second and the third terms are the losses in tax revenues and producer surplus respectively, due to the tax induced change from outsourcing to integration.

switch from an outsourced to an integrated structure in fact allows the shareholders to extract higher infra-marginal profits from production at any $P \in [0, \widetilde{P}]$.

The production tax may have a positive impact on total welfare if the gain in producer surplus (30) exceeds the deadweightloss (29):

$$PS^t_{OI} \; > \; DWL^t_{OI} \quad \Leftrightarrow \quad \sigma < \frac{1}{2(1+P^*)}, \tag{31}$$

which leads to the following:

Proposition 3: *A production tax that induces a switch from outsourcing to integration has a positive impact on total welfare when demand or integration cost are not too high.*

The relationship between the level of the integration cost σ and the demand level $P = P^*$ stated in Proposition 3 can be easily explained by looking at Figure 8. The downward sloping curve $\sigma = \frac{1}{2(1+P^*)}$ represents the combinations of σ and P^* such that the production tax is welfare neutral i.e. such that $PS^t_{OI} = DWL^t_{OI}$. The area below the curve is the locus of all the (σ, P^*) combinations such that the production tax has a positive impact on economic efficiency (i.e. $PS^t_{OI} > DWL^t_{OI}$). The welfare gains from a production tax are remarkably high in correspondence of a combination such as (σ_L, P^*_L) where the integration cost and the level of demand (i.e. the degree of production efficiency under outsourcing) are both very low. The tax would increase welfare even at an equilibrium such as (σ_H, P^*_L) where due to the low demand, the deadweightloss is negligible relative to the gain from a tax induced switch from outsourcing to integration, even when the integration cost is high. The tax would increase welfare even at an equilibrium such as (σ_L, P^*_H). Here, due to the very low cost of integrating, a tax induced gains from the switch from outsourcing to integration overwhelm the deadweightloss, even in the presence of very high demand levels. Finally the production tax has a negative impact on welfare at an equilibrium such as (σ_H, P^*_H). Here both demand level and integration cost render are such to make the gain the tax induced change negligible with respect to the deadweightloss implying that a production tax which induces an organizational switch from outsourcing to integration has a negative impact on welfare.

Now turn to the welfare evauation of a tax induced switch from integration to outsourcing (see Figure 9). Here demand before the introduction of the tax identifies a pure integrated industry equilibrium such as F. At this equilibrium, shareholders enjoy the surplus under integration, given by (25) (see Figure 9a). The introduction of a production tax makes all firms switch to an outsourced structure in the supplier market inducing an equilibrium such as F' in Figure 9b. In this case, the tax has a two fold impact on total surplus. First of all, a share of producer surplus equal to (23) is redistributed to tax revenue. Second, as it induces a switch to an organization which delivers an inefficient production plan,

the tax produces a deadweightloss:

$$DWL_{IO}^{t} = P^{*}t\left[\frac{1}{2(1+P^{*}(1-t))^{2}} - \sigma\right] + \int_{0}^{P^{*}(1-t)} (Q_I - Q_O)\, dP = \tag{32}$$
$$= \frac{P^{*}(1+P^{*}(1-t)^{2})}{2(1+P^{*}(1-t))^{2}} - P^{*}\sigma.$$

The first term on the first line in (32) measures the lower tax revenue accruing to the government while the second term on the first line in (32) measures the lower surplus enjoyed by producers. We can summarize these results in the following:

Proposition 4: *A production tax that induces a switch from integration to outsourcing always has a negative impact on economic surplus.*

5 Conclusions

We studied the impact of production taxes on economic efficiency when contracts are incomplete and firms can choose between outsourcing and integration. We showed that the introduction of a tax on production modifies firms' preferences regarding the choice of an outsourced vis-a-vis an integrated structure. The choice of an integrated structure 'protects' the firm against the 'tax induced' inefficiencies which arise under outsourcing due to managers' inability to coordinate. Thus, the introduction of a production tax shifts managers' preferences towards integration, particularly when the fixed cost associated to integration is low. From the welfare viewpoint of a government which wants to maximize total surplus, our results indicate that production taxes have a negative impact on welfare under outsourcing while this is not the case under integration. Moreover production taxes have a negative impact on welfare when they induce an 'organizational switch' from integration to outsourcing while have a positive impact on welfare when they induce an 'organizational switch' from outsourcing to integration provided that fixed costs and level of market demand are not too high

While being admittedly very simple, the present analysis creates a new 'caveat' in the idea that indirect taxes which are (partly) borne by producers are always distortive when the product market is perfect competitive. Our results indicate that an accurate evaluation of the distortions produced by such taxes must keep into account that not only firms' production scale, but also their organization structure is endogenous, thus affected by the tax itself. An obvious implication of our analysis is tax instruments such as on sales, value added, that are generally flat across industries, may have an asymmetric impact across sectors characterized by a different degree of integration. A high tax burden of production can heavily affect the organization and production decisions in sectors characterized by a high share of firms presenting an outsourced structure while the converse is true in sectors where firms generally adopt an integrated structure. The choice of the tax burden should also be designed in a way that keeps into account characteristics of the products and the supplier market. In particular high taxes can be

distortive when applied to technology intensive sectors as these face generally high market demand and high integration costs. Conversely, indirect taxation may be of less concern for firms in traditional labour or capital intensive sectors, since these face generally lower market demand and integration costs.

Our model opens the way to a number of further directions of research. First it might be very interesting an empirical exploration of the idea that indirect taxes favour an integration relative to an outsourced outcome especially in industries facing a relatively high demand regime. Moreover one could test the prediction that indirect taxes have a relatively stronger negative impact on production in industries characterized by a relatively low degree of integration. All these topics are left as directions for further research.

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

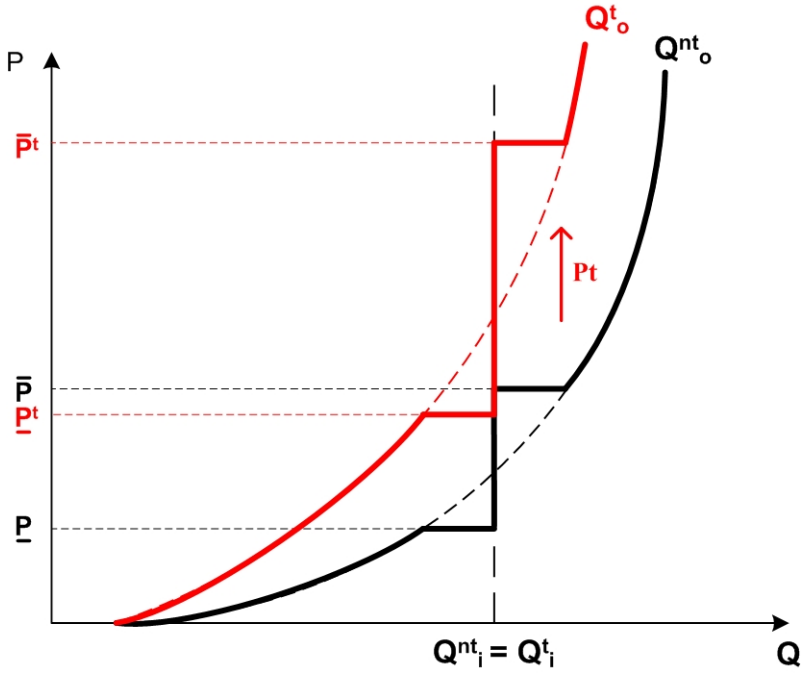


Figure 2: .

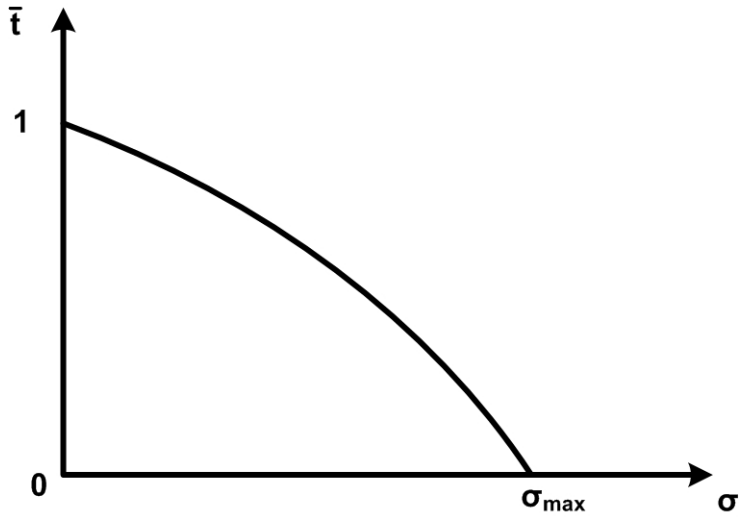


Figure 3: **Tax induced organizational change**

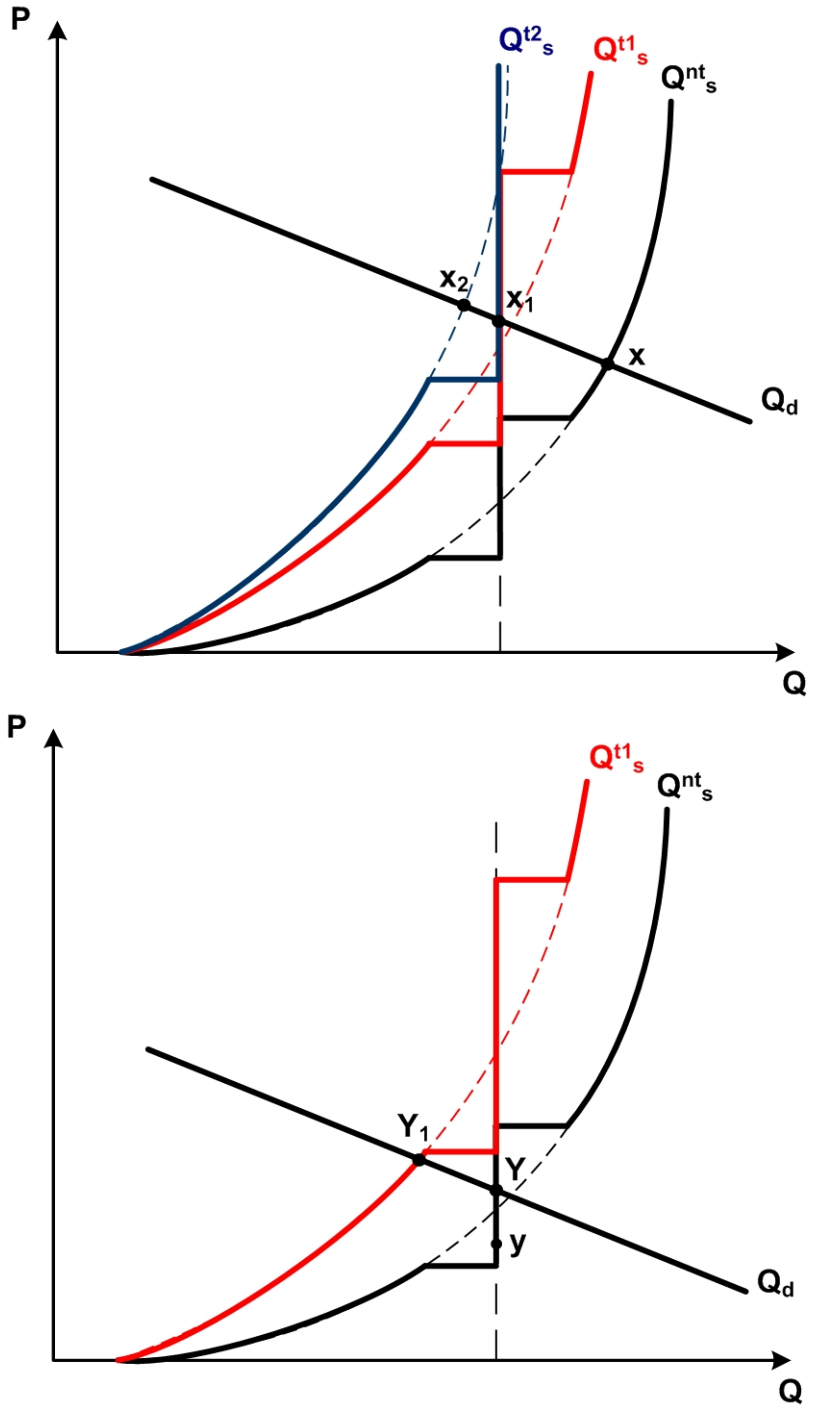


Figure 4: Welfare analysis - **complete contracts**

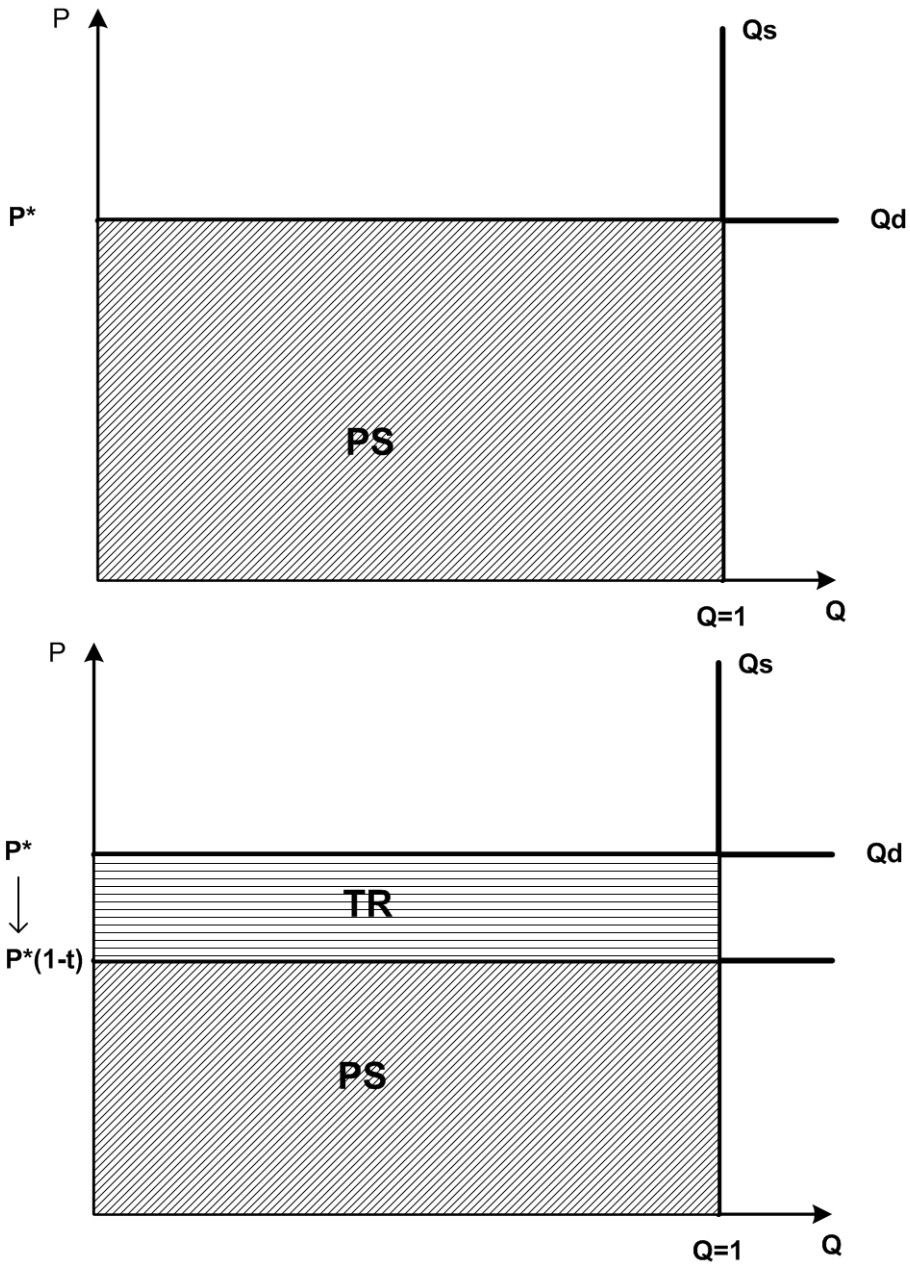


Figure 5: Welfare analysis - **incomplete contracts under outsourcing**

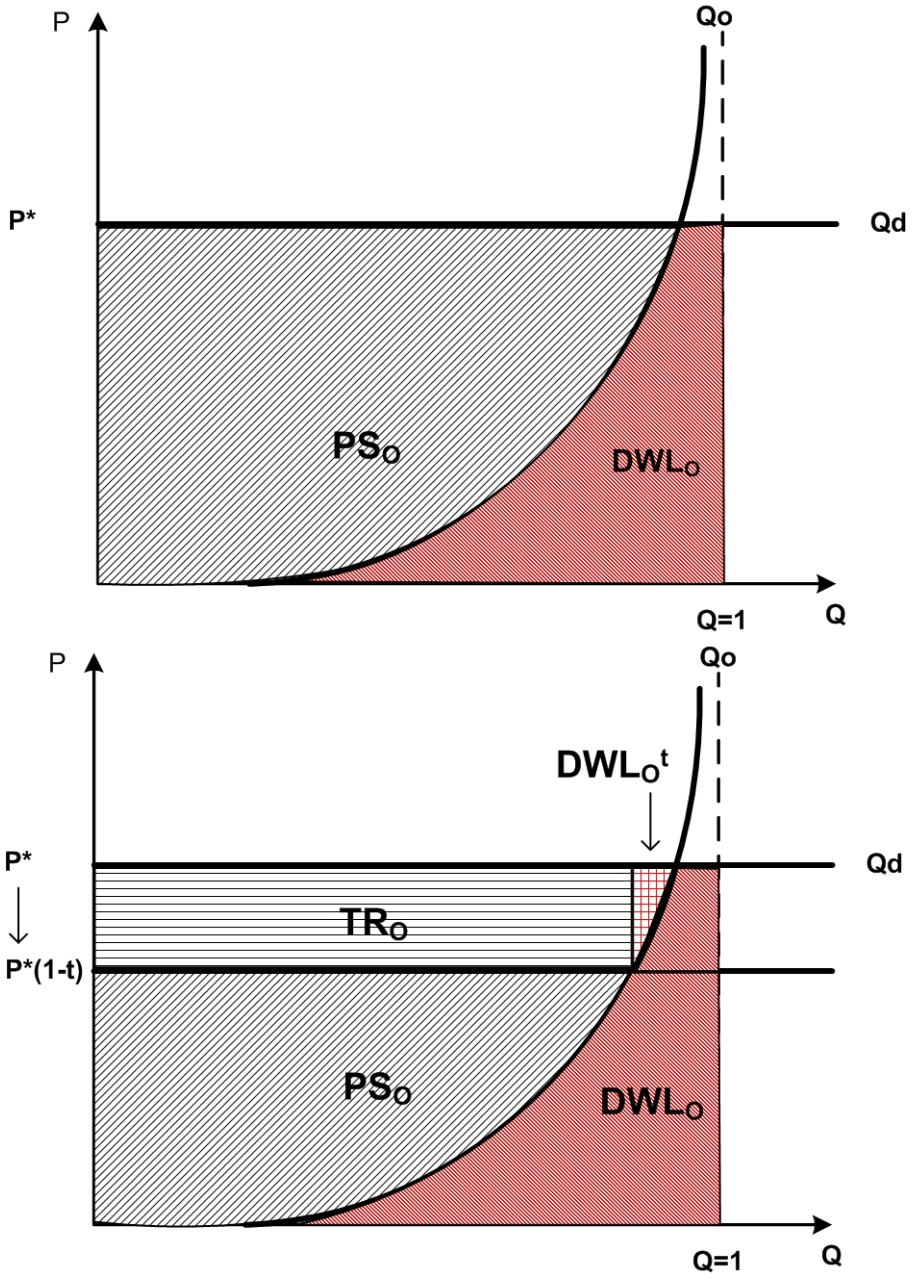


Figure 6: Welfare analysis - **incomplete contracts under integration**

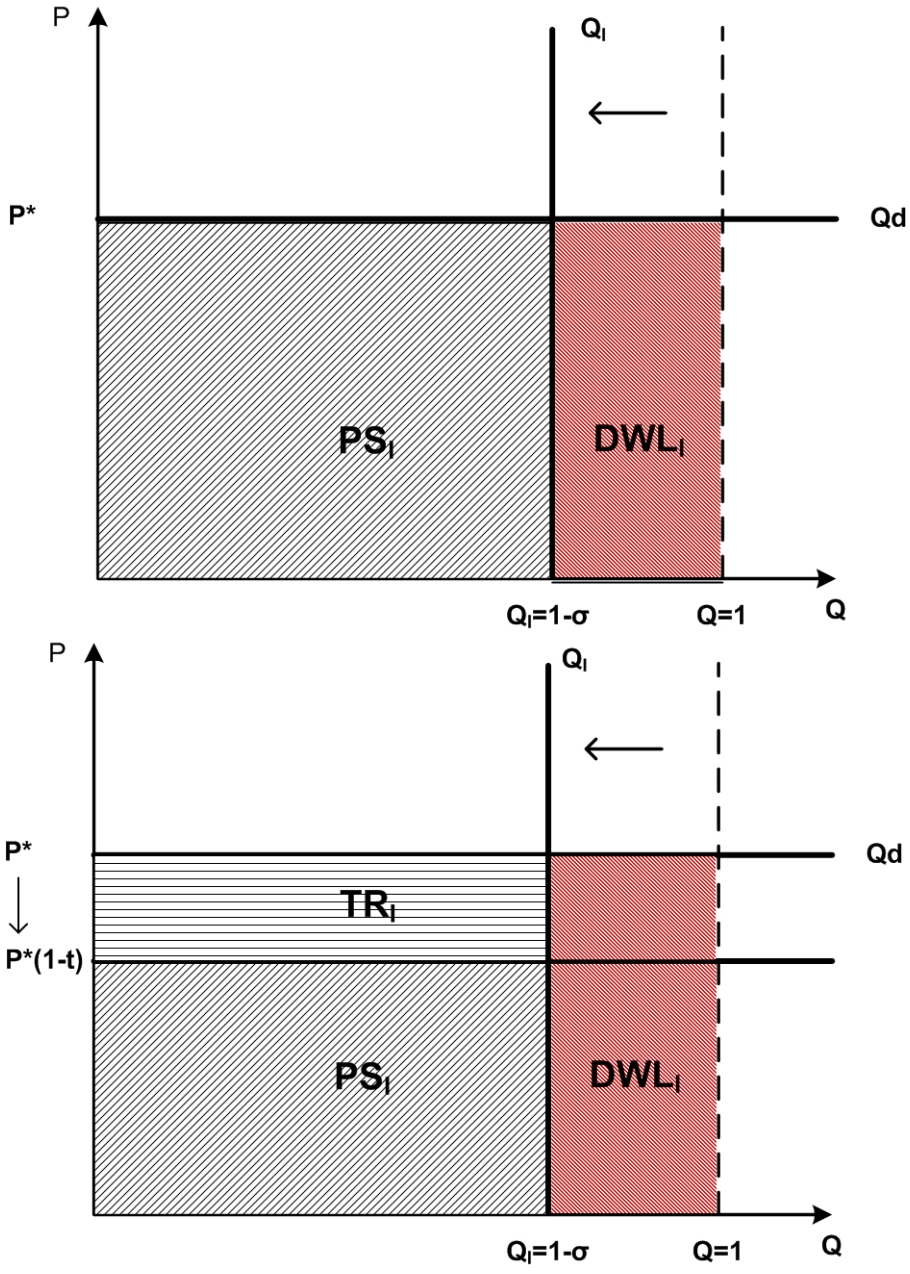


Figure 7: Welfare analysis - tax induced change from outsourcing to integration

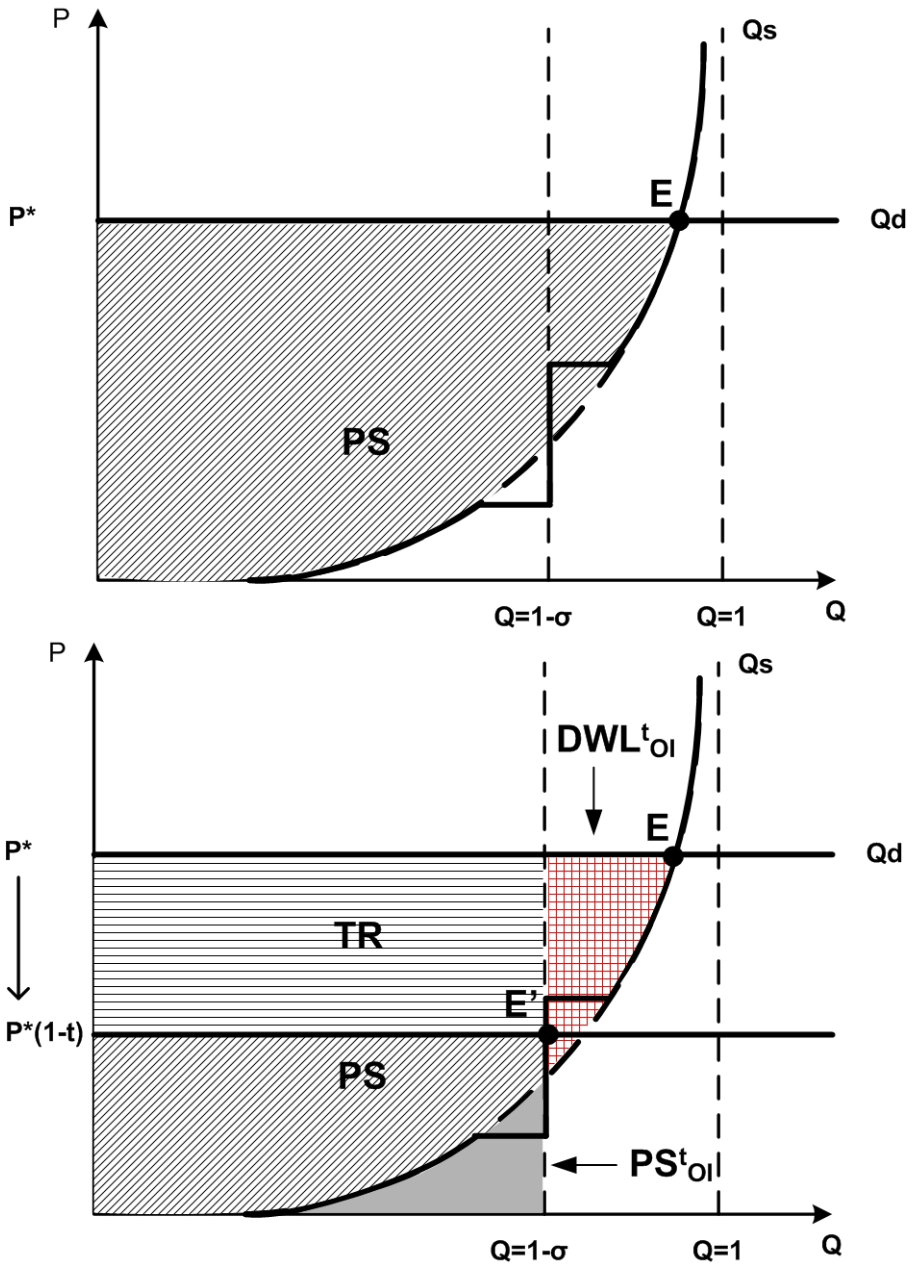


Figure 8: welfare enhancing tax induced change from outsourcing to integration

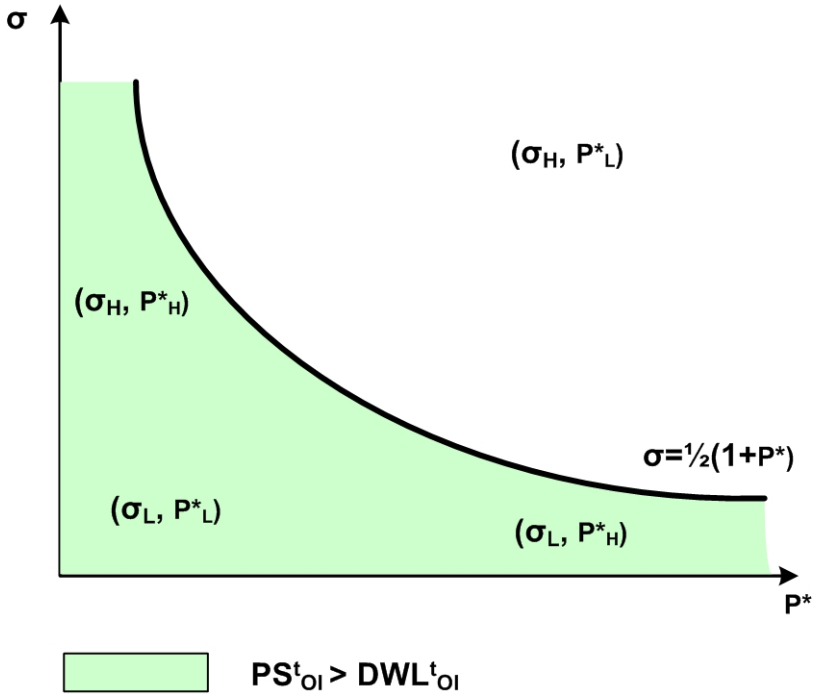
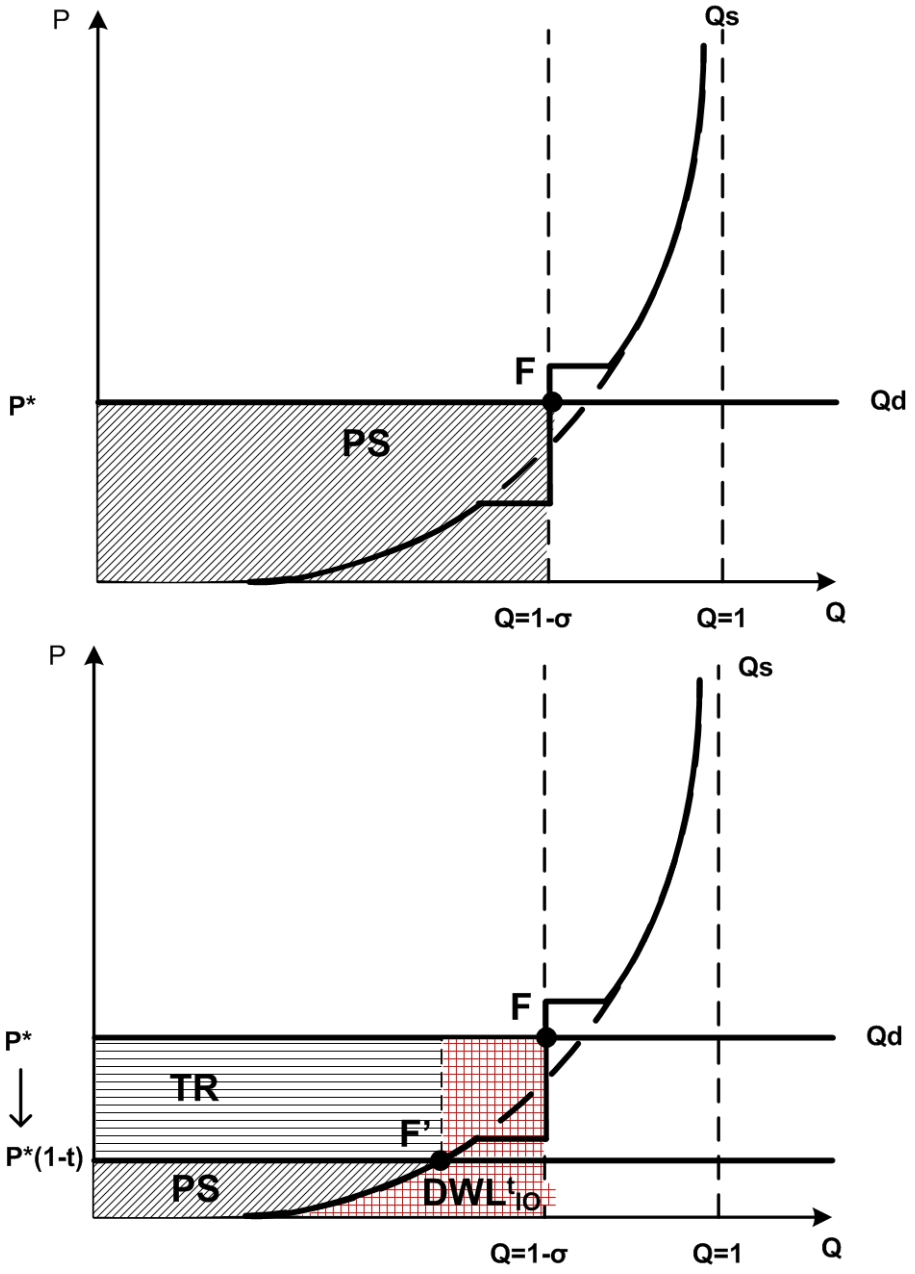


Figure 9: Welfare analysis: tax induced change from integration to outsourcing



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Appendix A: *Analitical derivation of the organizationally augmented supply function*

Rewrite condition $\Pi_I^* > \Pi_O^*$ as:

$$P(1-\sigma) - 1/4 > P(1 - \frac{1}{2(1+P)^2} - \frac{1}{2}\left(\frac{P}{1+P}\right)^2. \tag{A1}$$

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 (10). We 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 (16). Conversely, when $P < \underline{P}$ and $P > \overline{P}$, from (10) the management chooses outsourcing and a pure outsourced equilibrium emerges with $\alpha = 0$ in (16). Finally when $P = \underline{P}$ or $P = \overline{P}$, managers are indifferent between integration and outsourcing 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 (17). When $\alpha = 1$ the relevant supply function is defined by (8); 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 outsourcing weighted by the shares α and $1 - \alpha$, respectively. To facilitate graphical representation, derive the inverse organizationally augmented supply curve, from (17) and (16).

$$P = \begin{cases} \left(\frac{1}{\sqrt{2(1-Q)}} - 1\right), & Q \in [1/2, \underline{Q}];\ Q \in [\overline{Q}, 1]; \\ \underline{P}, & Q \in [\underline{Q}, 1-\sigma]; \\ \in [\underline{P}, \overline{P}], & Q = 1 - \sigma; \\ \overline{P}, & Q \in [1-\sigma, \overline{Q}]; \end{cases} \tag{A2}$$

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

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

From (A2) we derive the organizationally augmented supply curve in the absence of taxes depicted as the black line in Figure 1.

Appendix B: *Analitical derivation of* $\bar{t}$

We derive the tax rate $t = \bar{t}$ as the solution of $\underline{P} = \overline{P}(1-t)$ where $\underline{P}$ and $\overline{P}$ are given by (10):

$$\bar{t} = \frac{2\Delta(\sigma)}{1 - 4\sigma + \Delta(\sigma)} \tag{B1}$$

where $0 < \bar{t} < 1$ is always satisfied when $0 < \sigma < \sigma_{\max}$. $\bar{t}$ can be interpreted as the tax rate which applied at a market prices $P = \overline{P}$, leaves firms a producer price $p = \underline{P}$. It is easy to verify that:

$$\lim_{\sigma \to 0} \bar{t} = 1 \qquad \lim_{\sigma \to \sigma_{max}} \bar{t} = 0 \tag{B2}$$

$$\frac{\partial \bar{t}}{\partial \sigma} = \frac{6\sigma^2 - 10\sigma - 1}{\Delta(\sigma)[1 - 4\sigma + \Delta(\sigma)]^2} < 0 \quad if \quad \sigma < \sigma_{max}.$$