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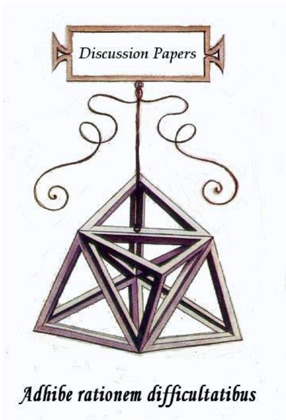

Luciano Fanti and Domenico Buccella

Tax Evasion and Unions in a Cournot duopoly

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Indirizzo degli Autori:

Luciano Fanti, Department of Economics and Management, University of Pisa, Via Cosimo Ridolfi, 10, I –56124 Pisa (PI), Italy. E-mail address: luciano.fanti@unipi.it; tel.: +39 050 22 16 369; fax: +39 050 22 16 384.

Domenico Buccella, Department of Economics, Kozminski University, Jagiellońska Street, 57/59 – 03301 – Warsaw, Poland. E-mail: buccella@kozminski.edu.pl; tel.: + 48 22 51 92 153

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Discussion Paper
n. 266

Luciano Fanti - Domenico Buccella

Tax Evasion and Unions in a Cournot duopoly

Abstract

In a Cournot duopoly with indirect taxes evasion, this paper counter-intuitively shows that, in the presence of unions, a higher taxation may increase profits because taxes reduce wage claims. This result is likely to occur if the market size is adequately large and the detection probability is not too high. Moreover, unionisation 1) leaves unaltered the absolute while reduces the relative tax evasion; and 2) increases tax revenue. Since consumer and social welfare are unaffected by taxation, the policy implication is that higher taxes (which are always revenue-enhancing) ultimately lead to a redistribution from wages to profits.

Keywords: Tax Evasion, Sales Tax, Cournot duopoly, Unions
JEL Classification: H20, H25, H26, J5

1. Introduction

In the last decades, starting from the pioneering work of Allingham and Sandmo (1972), the economic literature on tax evasion has increasingly developed as a branch of the public finance. However, scholars have mainly focused on individuals' direct taxes, while the research on indirect taxes lags behind[1] despite their increasing relevance in the public tax revenue as well as in tax evasion. In fact, only limiting to the sales tax considered in this paper, it suffices to say that the revenues from taxes on general consumption (predominantly the VAT) is about 18.9% of total tax revenues in countries belonging to the OECD (OECD, 2008) and 27.8% in 2018 for European Union countries (European Commission, 2020a).

VAT evasion is a well known concern (Keen and Smith, 2006), whose dimension is impressive: the European Commission (2020b) has pointed out that the VAT gap in 2017 and 2018 – mainly due to tax evasion - as a percentage of the VAT total tax liability is roughly 10% for the median country but above 30% for countries such as Greece and Romania, and around 25% for Italy and Lithuania, as Figure 1 displays.

Moreover, the literature investigating the incentives for tax-evading firms under different market structures has been prevalently concentrated on perfect competition (Virmani, 1989; Cremer and Gahvari, 1992, 1993, 1999; Panteghini, 2000; Hashimzade et al., 2010), and on monopoly (Marrelli, 1984; Kreutzer and Lee, 1986; 1988; Wang and Conant, 1988; Wang, 1990; Yaniv, 1996; Lee, 1998). Oligopolistic markets have been considered by Marrelli and Martina (1988), Goerke and Runkel (2006, 2011), Bayer and Cowell (2009), Besfamille et al. (2009a, 2009b) and Fanti and Buccella (2020).

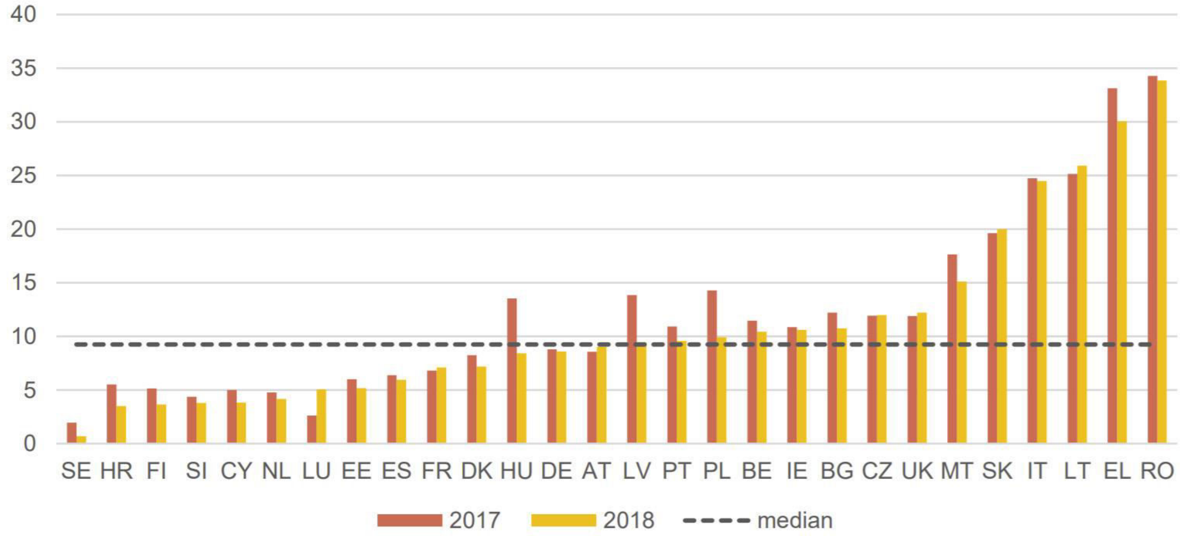

Figure 1. *VAT Gap as a percent of the VAT total tax liability in EU-28 Member States, 2018 and 2017. Source: European Commission (2020b).*

[1] As Bayer and Cowell (2009, p. 1131) suggest "The behaviour of firms is sometimes glossed over in the economic analysis of tax policy. In the analysis of tax compliance it is often omitted altogether."

Surveys on firms' tax-evasion activities are Cowell (2004), Sandmo (2005), Slemrod (2007) and Franzoni (2008). As the majority of the surveys, those scholars prevalently consider the individuals' tax evasion; however, they also offer short sections on the firms' tax evasion. However, none of the above-mentioned contributions deals with the presence of a unionised labour market.

Indeed, an important feature characterizing oligopolies is that their workforce is often organized in unions.[2] In particular, firm-specific unions and decentralized wage setting are largely predominant in UK, North America and Japan (e.g. Flanagan 1999); however, in the last decades, an overall decentralization trend has been observed in Europe and other OECD countries (Buccella, 2018). In industrial organization theory, the relevant role that unions play in oligopolistic contexts has been recognized by the literature on unionized oligopolies (e.g. Horn and Wolinsky 1988; Dowrick and Spencer 1994; Naylor 1999; Correa-López and Naylor 2004; Haucup and Wey, 2004; Lommerud et al. 2005). Such models incorporate two stages of decisions: at stage 1, wages are either unilaterally set by monopoly unions or bargained between firms and unions;[3] at stage 2, for given wages, each firm decides its optimal, profit-maximizing output (or price), which also determines its labour demand.

Because the issue of tax evasion in the presence of unions has not been so far explored, the aim of this paper is precisely to fill this gap. This paper contributes to the public finance literature, extending the economic analysis of tax compliance to the behaviour of firms and unions in a two stage game. The main findings are as follows.

First, in the presence of unions, high tax rates may, rather counter-intuitively, increase profits. Second, unionization leaves unchanged the absolute tax evasion, but it reduces the relative tax evasion. Third, unionization increases public tax revenues. Fourth, taxation does not affect consumer and social welfare. Above all, the interesting finding of the relation "more taxation-higher profits" is more likely obtained if the market size is sufficiently large and the likelihood of the detection probability is not too high. The driving force of this results is that taxes reduce wage claims.

As a policy insight, the paper yields the following implication. Higher tax rates (which are always revenue-enhancing) eventually lead to a redistribution from wages to profits. This redistributive effect may even result involuntary in the following sense: because the welfare of consumers and the society as a whole are unaffected by

[2] Booth (1995, p. 95) notes that "it appears to be an empirical regularity that imperfections in the labor market are correlated with imperfections in the product market".

[3] In this paper we concentrate on the monopoly union case which is largely adopted in the literature on unionized oligopolies (e.g., among others, Haucap and Wey, 2004; Lommerud et al., 2005). Note, however, that the paper's results can be extended to the case of a union-firm wage bargaining in which unions have sufficiently strong bargaining power: in fact, the monopoly union model is the polar case of union-firm negotiations in which the union has full bargaining strength.

taxation, then it suffices that the Government is just slightly self-interested for preferring a high taxation with consequent indirect redistributive effects from wages to profits.

The remainder of the paper is organized as follows. Section 2 presents the model and characterizes the market equilibrium and the tax effects in the case of competitive labour market. Section 3 introduces unions into the model. Section 4 determines the impact of unionization on the tax effects, on the market equilibrium, and overall social welfare. Section 5 closes the paper summarizing the findings and outlining future research.

2. The model

A standard Cournot duopoly with homogeneous goods is considered in which firms have to pay an ad valorem sales tax that, however, firms may partially evade. The (inverse) demand function is assumed linear:

$$p = z - Q \tag{1}$$

where p is the price of goods and $Q = q_i + q_j$ denotes the industry output. The parameter $t \in (0,1)$ defines the sales tax rate. Firm *i*'s authentic tax base is pq_i. To evade taxes, firms undervalue their sales volume: firm *i* discloses as tax base to the tax authority $a_i \in [0, pq_i]$. Therefore, the amount $pq_i - a_i$ is firm *i*'s unreported revenues, and its tax bill equals $t a_i$. The tax authority detects evasion with a probability $y \in (0,1)$. If evasion is detected, in addition to taxes on the entire sales revenues, pq_i, firm *i* has to pay a penalty function $P(pq_i - a_i)$ which depends on evaded revenues,[4] and whose analytical expression is

$$P(q_i, a_i) = \frac{(pq_i - a_i)^2}{2} \tag{2}$$

The expected penalty, $yP(pq_i - a_i)$, is a measure of the expected cost of tax avoidance. In this model, the detection probability, y, is assumed constant; on the other hand, the penalty function, *P*, is quadratic, therefore strictly increasing and convex in evaded revenues. As a consequence, given the convexity of *T* and the constant value of y, the expected penalty, yT, is increasing and convex in evaded sales as well.

In general, tax authorities design four forms of penalty: automatic financial, automatic nonfinancial, criminal financial, and criminal nonfinancial (Tait, 1988). The form of the penalty function *P* can be justified as follows (Goerke and Runkel, 2011, p. 716, F in their terminology): "The penalties generally increase with the

[4] It may be assumed, alternatively, that the penalty is be a function of taxes evaded rather than undeclared revenues. However, the equilibrium results are qualitatively the same because the tax rate is assumed constant.

severity and extent of insufficient tax payments, supporting our assumption that F is increasing in evaded revenues. Moreover, many penalty schemes involve prison sentences for severe tax evasion activities. If F reflects not only monetary but also non-monetary penalties, such prison sentences suggest that F will be convex."
Numerous countries, in fact, contemplate in their legislations the presence of penalties whose properties are in line with the penalty function the model proposes. Furthermore, countries such as Denmark and Spain (and Ireland as regards interests to be paid for late tax payments) have financial penalties increasing in the amount of evaded taxes (see OECD 2009, 2011, 2013). [5]
Let us assume that firms use only labour as input for production, which exhibits constant returns,

$$q_i = l_i \tag{3}$$

which represents the number of workers employed by the firm *i* to produce q_i output units. Firm *i*'s cost function is $w_i q_i$, where w_i is the per-worker wage paid by firm *i* (in a competitive labour market frame, it corresponds to the reserve wage $\bar{w}$). Given the constant returns technology, marginal costs are constant.
Firm i's expected net profits are given by

$$\pi_i = y\left\{(1-t)pq_i - w_i q_i - \frac{(pq_i - a_i)^2}{2}\right\} + (1-y)\left\{pq_i - w_i q_i - ta_i\right\}. \tag{4}$$

The first term in brackets in Eq. (4) is firm *i*'s profits if tax evasion is detected, while the second term represents profits if such an evasion remains undetected. Firm *i* maximizes π_i , simultaneously[6] choosing output q_i and declared revenues a_i, taking as given the rival firm's output.
The first-order conditions for an interior solution are, as regards declared revenues

$$\frac{\partial \pi_i}{\partial a_i} = 0 \Leftrightarrow a_i = \frac{y[q_i z - (q_i q_j + q_i^2 - t)] - t}{y} \tag{5}$$

and, exploiting (5), as regards output

$$\frac{\partial \pi_i}{\partial q_i} = 0 \Leftrightarrow q_i = \frac{z(1-t) - w_i - q_j(1-t)}{2(1-t)} \tag{6}$$

---

[5] From a theoretical point of view, in a similar context, Hashimzade et al. (2010) conceive a penalty function $\Phi = \phi E^{\gamma}$ in which $\phi > 0$ is a constant scale parameter, and $\gamma > 0$ a government's choice parameter. When $\gamma \geq 1$, the punishment is convex. The authors obtain that "If the objective of the government is to control fraud it therefore has to choose a convex penalty with $\gamma > 1$".

[6] Note that the findings of the paper remains unaltered if choices are sequential (i.e. first the declared revenue, and then output).

From (6), by substituting its counterpart for firm *j*, we get the equilibrium output and declared sales revenue, respectively, by firm *i*, for given w_i, w_j.

$$q_i(w_i, w_j) = \frac{z(1-t) - 2w_i + w_j}{3(1-t)} \qquad (7)$$

$$a_i = \frac{y\{9t^3 + (z^2 - 18)t^2 + [9 - 2z^2 + (w_i - 2w_j)z]t + (w_i + w_j + z)(z + w_j - 2w_i)\} - 9t(1-t)^2}{9y(1-t)^2} \qquad (8)$$

In the standard case of competitive labour market the exogenous wage is given by an uniform reserve wage, that is $w_i = w_j = \overline{w}$. Then, the equilibrium outcomes are [7]

$$q_i(\overline{w}) = q_j(\overline{w}) = q(\overline{w}) = \frac{z(1-t) - \overline{w}}{3(1-t)} \qquad (9)$$

and

$$a_i = a_j = a = \frac{y[9t^3 + (z^2 - 18)t^2 + (9 - 2z^2 - wz)t + (2w + z)(z - w)] - 9t(1-t)^2}{9y(1-t)^2} \qquad (10)$$

In what follows, we assume, for simplicity, a zero reserve wage (i.e. $\overline{w} = 0$).[8] This implies that the equilibrium outcomes are:

$$q = \frac{z}{3} \qquad (11)$$

$$a = \frac{y\left(z^2 + 9t\right) - 9t}{9y} \qquad (12)$$

$$\pi = \frac{9t^2(1+y^2) - 2y\left[z^2(t-1) + 9t^2\right]}{18y}. \qquad (13)$$ [9]

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[7] Since the equilibrium price is $p_i(\overline{w}) = \frac{z}{3} + \frac{2\overline{w}}{3(1-t)}$, then it is easy to see that, as usual, the possibility and the degree of tax-shifting would depend on the level of costs.

[8] We note that most paper's results qualitatively hold also with a positive (and sufficiently low) reserve wage.

[9] Note that, since $p = \frac{z}{3}$ and $pq = \left(\frac{z}{3}\right)^2$, then, as expected, when the detection occurs with probability one (i.e. *y=1*) firms do not evade (i.e. *a=pq*).

The condition ensuring that an interior solution for a does exist, i.e. $a \in (0, pq)$, is

$$y > y^{\circ} = \frac{9t}{\left(z^2 + 9t\right)}. \tag{14}$$

This means that a market size (i.e. a value of z) sufficiently large, as generally assumed in Cournot duopoly models, always ensures an economically meaningful of the declared tax base. The next proposition shows the effect of the taxation on profits and evasion in the benchmark model without unions.

Proposition 1. *a) Profits are always decreasing with an increasing tax rate; b) the declared tax base decreases with an increasing tax rate.*

Proof: See the Appendix.

Proposition 1 is in line with the common wisdom that the higher the sales tax rates are, the lower are both profits and reported sales. In the next section, we investigate whether the presence of unions changes the common wisdom.

3. Unions

We analyse a *non-cooperative two-stage game*. At the second stage, firms simultaneously choose outputs and tax evasion for given wages, precisely as in the standard case without unions above considered. At the first stage, monopoly unions fix wages, anticipating the output and the tax evasion firms choose.

We assume two decentralized, firm-specific monopoly unions which have weighted preferences on wage and employment. Unions simultaneously fix wages for their own workers. The utility of the firm i's union is given by the following general Stone-Geary utility function (e.g. Dowrick and Spencer, 1994):

$$V_i = w_i^{\theta} L = w_i^{\theta} q_i \tag{15}$$

where $\theta \in (0, \infty)$ is the relative weight unions place on wages with respect to employment. In particular, a value of $\theta > (<) 1$ means that unions have preferences relatively more wage-oriented (employment-oriented), while a value of $\theta = 1$ refers to the special case of total wage-bill maximization.

Unions maximize their objective functions with respect to wages, anticipating output decisions. Substituting (7) in (15) and maximizing with respect to w_i, (and the same for the counterpart *j),* we obtain the sub-game perfect equilibrium wage:

$$w_i = w_j = w = \frac{\theta z(1-t)}{2+\theta} \tag{16}$$

To simplify algebra, from now on we assume that unions are "wage-bill" maximiser (i.e. $\theta = 1$). In the next steps, we carry out an analysis of the tax effects on wages, profits, tax revenue and tax evasion in the presence of unions.

Lemma 1. *The sales tax reduces wages.*

Proof: Differentiation of (16) shows that $\frac{\partial w}{\partial t} < 0$.

Substitution of (16) in (7) and (8) leads to the next equilibrium output and declared sales, respectively, and hence profits (the apex U denotes the case with unions):

$$q^U = \frac{2z}{9} \qquad (17)$$

$$a^U = \frac{y(10z^2 + 81t) - 81t}{81y} \qquad (18)$$

$$\pi^U = \frac{81t^2y^2 - 2y[4z^2(t-1) + 81t^2] + 81t^2}{162y} \qquad (19)$$

With unions, the condition ensuring that an interior solution for a^U does exist, that is $a^U \in (0, pq^U)$, is given by

$$y > y^{\circ\circ} = \frac{81t}{(10z^2 + 81t)}.[10] \qquad (20)$$

The presence of unions does not alter the result that higher sales tax rates always increase the unreported tax base. In fact it is straightforward to see that $\frac{\partial a^U}{\partial t} = -\frac{y-1}{y} < 0$, precisely as in the case without unions. By contrast, the effect of taxation on profits may drastically challenge the conventional wisdom, as the next proposition reveals.

Proposition 2. *Profits may be increasing (resp. are always decreasing) with an increasing tax rate if $y < (>)\ y_1^{\circ\circ}$. In particular, the above inequality holds true: a) for whatever tax rate if the market size is sufficiently high, i.e. z>2.3; and b)*

[10] Also in the case with unions, it is easy to see that when the detection occurs with probability one (i.e. *y=1*), since $p^U = \frac{5z}{9}$ and $pq^U = 10\left(\frac{z}{9}\right)^2$, firms do not evade (i.e. $a^U = pq^U$), and a sufficiently large market size ensures an economically meaningful value of the reported tax base.

provided that the tax rate is sufficiently low if also the market size z is sufficiently low,' i.e. $z<2.35$.

Proof: See the Appendix.
A simple comparison between Propositions 1 and 2 shows that the presence of unions is the necessary element that may explain the occurrence of a positive profit-taxation relationship: this counter-intuitive result is, in essence, driven by the fact that taxes reduce wage claims (as Lemma 1 shows).
From the above considerations and the fact that in absence of tax evasion (that is, $y=1$) profits are always decreasing in the tax rate, it can be also deduced that this unconventional result does not depend only on the presence of unions, but on the interactions between 1) the imperfect tax enforcement, which is the origin of the possibility of evasion; and 2) the presence of unions.
The rationale for the profit increasing effect of higher taxes occurring only when y is sufficiently low is as follows. First, notice that higher tax rates intuitively reduce the firms' sales declaration (see Eq. 18), while they do not affect price and output (see Eq. 17). Second, it is easy to observe from that the tax induced reduction of the declared sales has a twofold effect on profits. On the one hand, it reduces profits through the penalty effect (see the first bracketed term in Eq. 4), and this reductive effect is higher the higher is the probability (y) of being detected. On the other hand, it increases the profit through the reduction of the tax burden (see the second bracketed term in Eq. 4) in the case in which tax evasion is undetected, whose probability is inversely related to y. Thus, when the latter effect is adequately strong (i.e. the probability to be detected is adequately low), profits increase with increasing taxation.
Figure 2 provides a quantitative illustration of the profit-enhancing effect of an increasing tax (given a sufficiently high level of the size market, i.e. $z=3$, to ensure the outcomes' "feasibility").

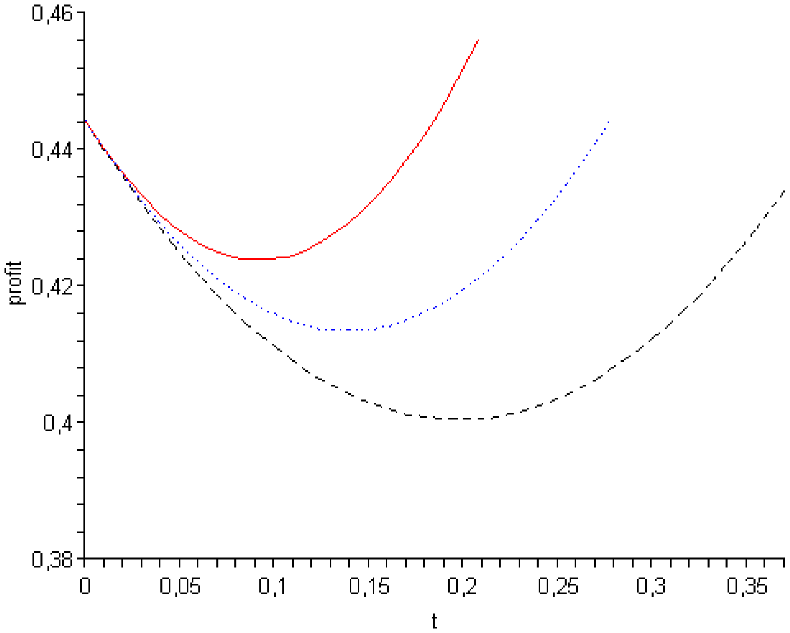

Figure 2. *Profits as function of the tax rate, for different (low) detection probability: y=0.15 (red solid line), y=0.20 (blue dotted line), y=0.25 (black dashed line). The critical values* $t^{U\circ\circ}$ *are given by, respectively:* $t^{U\circ\circ} = 0.197, t^{U\circ\circ} = 0.278, t^{U\circ\circ}\circ\circ = 0.37$.

Figure 2 shows that, until the detection probability is sufficiently low, profits are increasing with *t*: 1) for *t> 0.09*; interestingly, profits become even larger than when there is no sales tax for *t>0.18* when *y=0.15*; [11] and 2) for *t> 0.14* when *y=0.20*; 3) for *t> 0.20* when *y=0.25*. By contrast, if the detection probability is relatively high (namely when *y> 0.52*) profits are always decreasing for whatever tax rate. Note that when the detection probability is sufficiently low (for instance the case with *y=0.15*), not only profits may increase together with tax rates but firms prefer the highest tax rate.[12]

4. Unionization, taxation and social welfare

We now study the effects of the presence of unions on evasion and tax revenues.

Lemma 2. *Sales revenue and declared sales revenue are higher with unions than without. For both measures, their difference is identical.*

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[11] Note that until *y* is lower than about 0.48 the non-negativity condition for the reported sales (i.e. Eq. 20) requires an upper bound for *t*, i.e. $t = t^{U\circ\circ} = \frac{yz^2}{9(1-y)}$, while for *y* larger than 0.48 the reported sales are an interior value for any level of *t*.

[12] Figure 2 clearly shows that, when *y=0.15,* with tax rates larger than *0.17* profits are higher than without taxation.

Proof: Under unionisation, sales revenue is $pq^U = \frac{10z^2}{81}$; without unionization $pq = \frac{z^2}{9}$. The difference is $\frac{z^2}{81}$. The difference between the declared sales revenue with (Eq. 17) and without (Eq. 11) unions is $\frac{z^2}{81}$ as well.

The rationale for the finding in Lemma 2 is as follows. The presence of labour unions increases the marginal costs of firms. As a consequence, the higher the firms' marginal costs are, the lower the output is, and the higher the price is (Fanti and Buccella, 2020). Therefore, unionized firms produce on a point of their demand which is more elastic than non-unionized ones and, because a linear demand function is relatively elastic, their revenues and declared revenue are larger than non-unionized firms.

Now, let us define the indicators of tax evasion. Following the established literature (e.g. Marrelli and Martina, 1988, Virmani, 1989, Cremer and Gahvari, 1992; 1993; 1999; Goerke and Runkel, 2011) the considered indicators of tax evasion are:

i) the absolute tax evasion (i.e. the absolute amount of tax evaded) per firm (*E*):

$$E = (1-y)t(pq-a); \qquad (21)$$

ii) the relative aggregate tax evasion (ε), which represents the fraction of aggregate tax revenues successfully evaded. This is given by the ratio between the total evasion in the entire market, *2E*, and the hypothetical tax revenues (*h*), which is the amount of tax revenue that would arise without evasion ($h = 2tpq$):[13]

$$\varepsilon = (1-y)(1-\frac{a}{pq}). \qquad (22)$$

Proposition 4. *The absolute tax evasion is the same with and without unions.*

Proof: This straightforwardly derives from Lemma 2.

Proposition 5. *The relative tax evasion is higher without unions.*

[13] As Goerke and Runkel (2011, 720) note, the advantage of the tax evasion ratio as an indicator of evasion behaviour is that "it describes tax evasion relative to the size of the market" and also captures the effects of the policies which cause changes in the firms' activities.

Proof: simple calculations obtains the relative tax evasion with and without unions, respectively: $\varepsilon = \frac{9t(1-y)^2}{yz^2}$; $\varepsilon^U = \frac{81t(1-y)^2}{10yz^2}$. Then, it is straightforward to check that $\varepsilon^U < \varepsilon$. *Q.E.D.*

The intuition behind Proposition 5 is that higher marginal costs due to unionization increase the competitive pressure and this, in turn, decreases the relative tax evasion because the linear product demand function is relatively elastic (see Fanti and Buccella, 2020, Result 1).
Public tax revenue is defined as

$$R = 2\left[ytpq + y\frac{(pq-a)^2}{2} + (1-y)ta \right] \tag{23}$$

and in the cases without and with unions is, respectively,

$$R = \frac{t\left[-9ty^2 + 2y(z^2 + 9t) - 9t\right]}{9y} \tag{24}$$

$$R^U = \frac{t\left[-81ty^2 + 2y(10z^2 + 81t) - 81t\right]}{81y} \tag{25}$$

Proposition 6. *Under conditions (14) and (20), the tax revenue is always increasing with the tax rate in both cases.*

Proof: see the Appendix.

Proposition 7. *The tax revenue is always higher in the presence of unions and the difference between the cases with and without unions is increasing with the tax rate and the market size.*

Proof: This straightforwardly follows from the analytical inspection of $\left(R - R^U\right) = -\frac{2tz^2}{81}$.

With regard to public revenue, this is indirectly related to the magnitude of the marginal costs (via the pass through on price) and, as for tax evasion, it crucially depends on the price elasticity of demand (see Fanti and Buccella, 2020). Proposition 7 (which holds true even in without evasion) also suggests that a "Leviathan" Government would prefer the presence of unions.
Consumer surplus is defined as

$$CS = 2q^2 \tag{26}$$

and is, in the cases without and with unions, respectively

$$CS = \frac{2z^2}{9} \tag{27}$$

$$CS^U = \frac{4z^2}{81} \tag{28}$$

with $CS > CS^U$ because directly linked to output produced.
The utility of each union is

$$V = \frac{2z^2(1-t)}{27} \tag{29}$$

The expressions of the social welfare are, in the cases without and with unions, respectively

$$SW = 2\pi + CS + R \tag{30}$$

$$SW^U = 2\pi^U + CS^U + 2V + R^U \tag{31}$$

whose values are

$$SW = \frac{4z^2}{9} \tag{32}$$

$$SW^U = \frac{8z^2}{27} \tag{33}$$

Proposition 8. *Union's utility is reduced by sales tax rate, while consumer surplus and social welfare are unaffected by the taxation policy*[14] *(as Eqs. (27)-(33)) show.*

From the above Propositions, it follows a remark suggesting the policy implications.

Remark. *Since both consumer and social welfare are unaffected by taxation, higher tax rates (which are always revenue-enhancing) ultimately lead to a redistribution from wages to profits.*

This means that Government may use taxation policies, preserving efficiency in the overall, as a re-distributive instrument in favour of profits. Furthermore, it may be

[14] They are independent of the tax policy because of the assumption of zero reserve wage. Therefore this assumption, although it may seem a special case, permits the focus only to the tax effects on public revenue, profits and workers' welfare and their redistributive consequences. Of course the paper's results but the final part of Prop.8 qualitatively hold in the case of positive reserve wages.

also argued that a Government which is just barely self-interested may, on the one hand, could favour the presence of unions and, on the other hand, set the highest feasible tax rate, because both are revenue-enhancing: this leads to an endogenous (and even involuntary) redistribution from workers to firms.

5. Conclusions

This paper investigates a unionized Cournot duopoly model with evasion of indirect taxes. The main finding is that, rather counter-intuitively, a higher taxation may increase profits in the presence of unions. In particular, the result of "more taxation and higher profits" is can be obtained if the market size is adequately large and the likelihood of the detection probability is not too high. The reason for this result is that taxes reduce wage claims. Moreover, it is shown that 1) unionisation leaves unaltered the absolute tax evasion while it has the effect of reducing the relative tax evasion; 2) unionisation increases public revenue.

The policy implication is that higher tax rates ultimately lead to a redistribution from wages to profits. More in general, a Government can always use taxation policies (tax rates as well as the intensity of the enforcement of tax obligations) as a re-distributive instrument in favour of profits and preserve the overall efficiency because, in this context, taxation does not affect consumers and social welfare. Moreover, since higher tax rates are always revenue-enhancing, it follows that under a sufficiently low detection probability, Government and firms may agree on setting the highest feasible tax rate, causing a maximal redistribution from workers to firms: this may occur even involuntarily in the case of a slight self-interested Government.

Given the widespread phenomenon of the indirect tax evasion, this paper has shown, even in a simplified framework, another so far neglected channel through which Governments, either voluntarily or involuntarily, may pursue redistributive policies.

We are aware of the extremely simplified nature of the model employed, which is based on a set a specific assumptions such as a convex penalty rate function, linear demand schedule, firm-level monopoly unions and zero reserve wage. In future research, several of those caveats need to be relaxed. For instance, different penalty functions, centralized unions and a wider firm-union bargaining framework call for a robustness check of our results. However, even with such a stylized model, one can gain some insights on the tax evasion phenomenon in a unionized economy and, therefore, on the redistributive (between firms and unions) characteristics of a socially efficient taxation policies.

Appendix

Proof of Proposition 1

Part *a*)

i) $\dfrac{\partial \pi}{\partial t} = \dfrac{9ty^2 - y\left(z^2 + 18t\right) + 9t}{9y}$;

ii) $\dfrac{\partial \pi}{\partial t} > (<)\, 0 \Leftrightarrow y < y_1^{\circ} \; or \; y > y_2^{\circ} \; \left(y_1^{\circ} < y < y_2^{\circ}\right)$,

where $y_1^{\circ} = 1 + \dfrac{z^2}{18t} - \dfrac{\sqrt{z^4 + 36tz^2}}{18t}$, $y_2^{\circ} = 1 + \dfrac{\sqrt{z^4 + 36tz^2}}{18t} + \dfrac{z^2}{18t} > 1$;

iii) since $y_2^{\circ} > 1$ and $y_1^{\circ} < y^{\circ}$ then part a) of Proposition 1 is proved.

Part *b)*

i) since $\dfrac{\partial a}{\partial t} = -\dfrac{1-y}{y} < 0$, then part b) of Proposition 1 is proved. *Q.E.D.*

Proof of Proposition 2

Part *a)*

i) $\dfrac{\partial \pi^U}{\partial t} = \dfrac{81ty^2 - 2y\left(2z^2 + 1t\right) + 81t}{81y}$;

ii) $\dfrac{\partial \pi^U}{\partial t} > (<)\, 0 \Leftrightarrow y < y_1^{\circ\circ} \; or \; y > y_2^{\circ\circ} \; \left(y_1^{\circ\circ} < y < y_2^{\circ\circ}\right)$,

where $y_1^{\circ\circ} = 1 + \dfrac{2z^2}{81t} - \dfrac{2z\sqrt{z^2 + 81t}}{81t}$, $y_2^{\circ\circ} = 1 + \dfrac{2z\sqrt{z^2 + 81t}}{81t} + \dfrac{2z^2}{81t} > 1$;

iii) since $y_2^{\circ\circ} > 1$, then the first sentence of Proposition 2 is proved;

Part *b*)

Since the condition (20) must hold, the existence of a positive relationship between profits and taxes is observable only if $y^{\circ\circ} < y_1^{\circ\circ}$. Direct analytical inspection reveals that the latter inequality is satisfied when *z<2.35* only if the tax rate is sufficiently low, while it is always satisfied for whatever *t* when *z>2.35.*

Figure 1.A provides a graphical representation. It plots the boundary function $f = (y^{\circ\circ} - y_1^{\circ\circ}) = 0$ derived from ii): given that the function f depends only on the parameters *t* and *z*, then its graphical representation in the feasible (*t, z*) parametric space is exhaustive. *Q.E.D.*

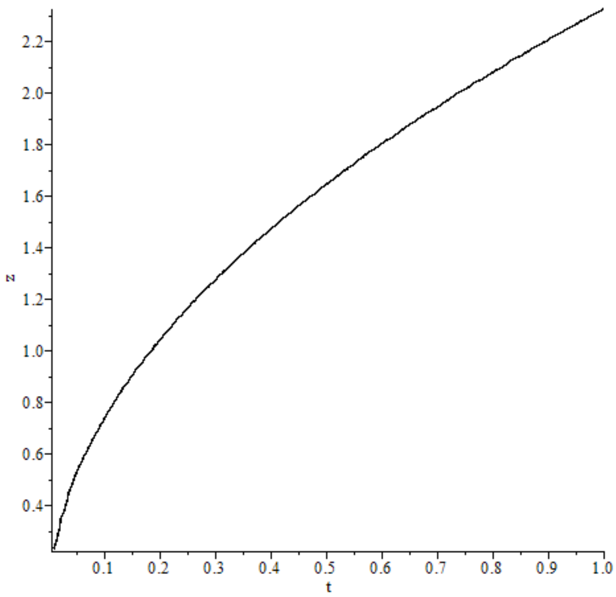

Figure 1.A *The curve* $f = (y^{\circ\circ} - y_1^{\circ\circ}) = 0$ *in the plane (t,z).In the area above (resp. below) the curve, profits may be increasing (resp. are always decreasing) with an increasing tax rate.*

Proof of Proposition 6

By analysing the functions *R(t)* and R^U *(t),* we see that:

i) $\frac{\partial R}{\partial t} = -\frac{4\left[9ty^2 - yz^2 - 9t + 9\right]}{9y} \gtrless 0 \Leftrightarrow t \lessgtr t^* = \frac{yz^2}{9\left(1 + y^2 - 2y\right)}$; since for satisfying inequality (14) $t < t^{\circ\circ} = \frac{yz^2}{9(1-y)}$, then it follows that $\left(t^* - t^{\circ\circ}\right) = \frac{y^2z^2}{9(1-y)^2}$ and $t^* > t^{\circ\circ}$;

ii) $\frac{\partial R^U}{\partial t} = -\frac{4\left[9ty^2 - yz^2 - 9t + 9\right]}{9y} \gtrless 0 \Leftrightarrow t \lessgtr t^{U*} = \frac{yz^2}{9\left(1 + y^2 - 2y\right)}$; since for satisfying inequality (20) $t < t^{U\circ\circ} = \frac{yz^2}{9(1-y)}$, then it follows that $\left(t^{U*} - t^{U\circ\circ}\right) = \frac{10y^2z^2}{81(1-y)^2}$ and $t^{U*} > t^{U\circ\circ}$. *Q.E.D.*

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