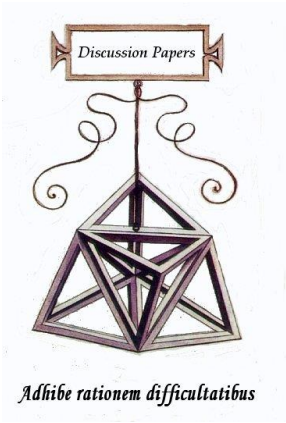
Discussion Papers
Collana di
E-papers del Dipartimento di Economia e Management – Università di Pisa



Domenico Buccella, Luciano Fanti and Luca Gori

Tax evasion in a Cournot duopoly with unions

Discussion Paper n. 293

2023

Discussion Paper n. 293, presentato: **Aprile 2023**

Indirizzo degli Autori:

Domenico Buccella – Department of Economics, Kozminski University, Jagiellońska Street, 57/59, 03301, Warsaw – Poland. E-mail: buccella@kozminski.edu.pl

Luciano Fanti – Dipartimento di Economia e Management, Università di Pisa, Via Cosimo Ridolfi, 10, 56124 Pisa (PI) – Italy. E-mail: luciano.fanti@unipi.it

Luca Gori – Dipartimento di Giurisprudenza, Università di Pisa, Via collegio Ricci, 10, 56126 Pisa (PI) – Italy. E-mail: luca.gori@unipi.it oppure dr.luca.gori@gmail.com

Si prega di citare così:
Domenico Buccella, Luciano Fanti and Luca Gori (2023), "Tax evasion in a Cournot duopoly with unions", Discussion Papers del Dipartimento di Economia e Management – Università di Pisa, n. 293 (http://www.ec.unipi.it/ricerca/discussion-papers.html).

Discussion Paper
n. 293

Domenico Buccella, Luciano Fanti and Luca Gori

Tax evasion in a Cournot duopoly with unions

Abstract

In a Cournot duopoly with indirect taxes evasion, this paper counter-intuitively shows that, in the presence of unions, a higher indirect 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. As 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

Tax evasion in a Cournot duopoly with unions

Domenico Buccella • Luciano Fanti • Luca Gori

Abstract In a Cournot duopoly with indirect taxes evasion, this paper counter-intuitively shows that, in the presence of unions, a higher indirect 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. As 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.

JEL Classification H20, H25, H26, J5

Keywords Tax Evasion, Sales Tax, Cournot duopoly, Unions

D. Buccella (corresponding author)
Department of Economics, Kozminski University, Jagiellońska Street, 57/59 – 03301 – Warsaw, Poland
e-mail: buccella@kozminski.edu.pl
tel.: + 48 22 51 92 153

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

L. Gori
Department of Law, University of Pisa, Via Collegio Ricci, 10, I–56126 Pisa (PI), Italy, and GLO
e-mail: luca.gori@unipi.it or dr.luca.gori@gmail.com
tel.: +39 050 22 12 847

1. Introduction

In the last decades, at least since the pioneering work of Allingham and Sandmo (1972), the economic literature on tax evasion has 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. Merely limiting to the sales tax examined in this paper, data reveal that the revenues raised from general consumption taxes (predominantly the VAT) are about 18.9% of total tax revenues in the OECD countries (OECD, 2008) and 27.8% for European Union member countries in 2018 (European Commission, 2020a).

VAT evasion has impressive dimensions; therefore, it represents a huge public finance worry (Keen and Smith, 2006). The European Commission (2020b) has pointed out that, in the European Union – mostly because of tax evasion – the VAT gap, as a percentage of the VAT total tax liability, is approximately 10% for the median country in 2017 and 2018; however, the figures are above 30% for countries such as Greece and Romania, and around 25% for Italy and Lithuania.

Moreover, the literature investigating the incentives for tax-evading firms under different market structures has been prevalently concentrated on perfect competition

[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."

(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, like those considered in this work, have been investigated by Marrelli and Martina (1988), Goerke and Runkel (2006, 2011), Bayer and Cowell (2009), Besfamille et al. (2009a, 2009b) and Fanti and Buccella (2021).

In particular, Marrelli and Martina (1988) build a model in which firms choose tax evasion in terms of taxes not paid. In case of detection, firms incur a fine that includes the tax plus the tax evaded which is multiplied for a penalty rate larger than one. The main result is that the more markets are competitive, the lower is the amount of the tax evaded, both in symmetric and asymmetric duopolies with non-excessive differences in production costs.

Instead, Goerke and Runkel (2011) assume that firms evade in terms of undeclared sales; the fine that tax authorities impose is an increasing, convex function of revenues evaded. The authors conclude that no clear-cut relation exists between market competition and evasion activities: positive if demand is inelastic, negative if elastic.

In line with the methodology of Goerke and Runkel (2011), Fanti and Buccella (2021) further investigate the nexus between market competition and the tax evasion of firms in a duopoly with differentiated goods under both Cournot and Bertrand competition. Their key result is to show that a negative or a positive relation between competition and tax activities depends on the source of the competitive pressure (that is, a marginal cost increase, higher product substitutability or a change in the competition mode) and

the pre-existing level of competition. However, none of the above-mentioned contributions deals with the presence of a unionised labour market. [2]

Indeed, an important feature characterizing oligopolies is that their workforce is often organized in unions: as Booth (1995, p. 95) notes, "it appears to be an empirical regularity that imperfections in the labour market are correlated with imperfections in the product market".[3] 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

[2] Surveys on firms' tax-evasion activities are Cowell (2004), Sandmo (2005), Slemrod (2007) and Franzoni (2008). As most of the surveys, those scholars prevalently consider the individuals' tax evasion; however, they also offer short sections on the firms' tax evasion.

[3] This paper focuses on the interaction between the (unionized) labour market (labour as input) and product market with quantity competition. Previous contributions have also analyzed the interaction between the inputs markets and the Cournot equilibrium, see i.a. Szidarovszky and Yakowitz (1977), Chang and Tremblay (1991), Okuguchi (1998), Chen and Zhao (2014), among others.

unions;[4] at stage 2, for given wages, each firm decides its optimal, profit-maximizing output (or price), which also determines its labour demand.

To the best of our knowledge, only two contributions have dealt with the issue of tax evasion in a unionized framework, that is, Lai et al. (1995) and Wu (2016). In particular, Wu (2016) analyses the neutrality of profit taxes levied on firms and the implications of tax evasion both in the cases of right-to-manage and efficient bargaining institutional arrangments. In contrast to the case of competitive labor markets, the author shows that profit taxes are not neutral, and the firm's tax evasion decision is not separable from its production decision, with similar qualitative conclusions irrespective of the bargaining arrangements. Moreover, wage bargaining is crucial in determining the optimal profit tax and the enforcement policy. However, this contribution focuses on a single firm-union bargaining unit and it does not consider the strategic interactions that take place both in the product and labour markets. Moreover, and more importantly, the above-mentioned contributions are not concerned with the issue of the indirect taxation.

Because the issue of tax evasion in the presence of unions – particularly as regards the indirect taxation - has not been so far explored in oligopolistic contexts, the aim of this

[4] 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.

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 indirect 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, commodity 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 commodity taxes reduce wage claims.

As a policy insight, the paper yields the following implication. Higher indirect 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 are unaffected by indirect taxation, then it suffices that the Government is just slightly self-interested in 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 commodity tax effects on the market equilibrium and overall social welfare. Section 5 briefly discuss the case of a centralized, industry-wide

union. Section 6 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 must pay an ad valorem sales tax that, however, firms may partially evade. The (inverse) demand function is assumed linear:

$$p = z - Q \qquad (1)$$

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 indirect taxes, firms undervalue their sales volume: firm *i* discloses as tax base to the tax authority $a_i \in [0, p\,q_i]$. 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* must

pay a penalty function $P(pq_i - a_i)$ which depends on evaded revenues,[5] 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. Consequently, given the convexity of *P* and the constant value of y, the expected penalty, yP, 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 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

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

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). [6]

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.

[6] 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 $\gamma > 1$".

Firm i's expected net profits are given by

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

(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[7] 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

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

(5)

and, exploiting (5), as regards output

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

(6)

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

In the present framework, the firms' quantity and evasion decisions are taken on their own. To see this fact clearly, equation (4) can be re-arranged as follows

$$E[\pi_i] = [(1-t)p - w_i]q_i + (1-y)te - y\frac{e^2}{2}$$

where the term $e = (pq_i - a_i)$ represent the under-reported sales. The profit-maximizing quantity in the Cournot-Nash equilibrium is as in (6) while the first-order condition w. r. t. e leads to $e = \frac{(1-y)t}{y}$. In addition, the two firms' evasion decisions are independent of each other.

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

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

(7)

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

In the standard case of competitive labour market, the exogenous wage is given by a uniform reserve wage, that is $w_i = w_j = \overline{w}$. Then, the equilibrium outcomes are[8]

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

and

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

In what follows, we assume, for simplicity, a zero-reserve wage (i.e., $\overline{w} = 0$).[9] This implies that the equilibrium outcomes are:

$$q = \frac{z}{3} \tag{11}$$

[8] 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, with a linear demand, the possibility and the degree of tax-shifting would depend on the level of costs. With a non-linear demand, the results concerning tax-shifting in non-competitive markets are less general (see Hindriks and Myles, 2006).

[9] We note that most of the results of this paper qualitatively hold also with a positive (and sufficiently low) reserve wage.

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

(12)

$$\pi = \frac{9t^2(1+y^2) - 2y\left[z^2(t-1) + 9t^2\right]}{18y} \ .^{10}$$

(13)

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

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

(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 value 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) Expected net profits are always decreasing with an increasing tax rate; b) the declared tax base decreases with an increasing tax rate.*

[10] 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. $a = pq$).

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, wage-bill maximizing firm-specific monopoly unions which fix wages for their own workers.[11] Therefore, the utility of the firm *i*'s union is:

$$V_i = w_i L = w_i q_i \qquad (15)$$

[11] The choice of the monopoly union is dictated by the issue of analytical tractability. In fact, the use of the generalized Nash Bargaining regarding the wage level leads to extremely complex solutions of the problem, loosing the opportunity of having any interpretation.

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:

$$w_i = w_j = w = \frac{z(1-t)}{3} \tag{16}$$

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.[12]

Lemma 1. *The sales tax reduces wages.*

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

[12] Notice that the firms' quantity choices are independent of the extent of tax evasion (see eq. (7)) and, therefore, of the probability of its detection, irrespective of whether the labour market is competitive, or a trade union sets wages. Since the trade union maximises the wage bill, its optimal wage depends on labour demand and its slope. Because output and, hence, labour demand are independent of tax evasion activities, the union's preferred wage is also unaffected by the firm's evasion behaviour. Consequently, the optimisation problem can be separated into two exercises: In the first, the firm chooses its output level optimally, given a monopoly trade union. In the second, the firm chooses its evasion level optimally, given its output choice.

The economic intuition behind Lemma 1 is as follows. Since unions are "wage-bill-maximizers", union i will choose w_i such that the elasticity of l_i with respect to w_i equals -1. Thus, $\frac{\partial w_i}{\partial t} < 0$ derives from the fact that $\frac{\partial l_i}{\partial t} < 0$ and $\frac{\partial^2 l_i}{\partial w_i \partial t} < 0$.

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):

$$q^U = \frac{2z}{9} \tag{17}$$

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

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

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

$$y > y^{\circ\circ} = \frac{81t}{\left(10z^2 + 81t\right)}.$$ [13]

(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 increase (resp. always decrease) with an increasing tax rate if* $y < (>) y_1^{\circ\circ}$. *This inequality holds true: a) irrespective of the tax rate if the market size is adequately large, i.e.,* $z > 2.35$*; and b) also for a relatively low tax rate if the market size is sufficiently small, i.e.,* $z < 2.35$.

Proof: See the Appendix.

A simple comparison between Propositions 1 and 2 shows that, in the present context, the presence of unions can explain the occurrence of a positive profit-taxation

[13] 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.

relationship: this counter-intuitive result is, in essence, driven by the fact that taxes reduce the endogenous choice of wage claims (as Lemma 1 shows).[14]

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.

[14] This result complements that of Seade (1985)who has shown that, In a conventional Cournot duopoly with non-linear market demand, an exogenous increase in cost may increase the profits of firms in a duopoly, provided some conditions on the price elasticity of demand hold.

Figure 1 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 1 about here]

Figure 1 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*; [15] 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.[16]

4. Unionization, taxation and social welfare

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

[15] 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., $t = t^{U\infty} = \frac{yz^2}{9(1-y)}$, while for *y* larger than 0.48 the reported sales are an interior value for any level of *t*.

[16] Figure 1 clearly shows that, when *y=0.15*, with tax rates larger than *0.17* profits are higher than without taxation.

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

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. 18) and without (Eq. 12) 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. Consequently, 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*):

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

(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 ($h = 2tpq$):[17]

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

(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.*

[17] 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 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: $\varepsilon^U = \frac{81t(1-y)^2}{10yz^2}$; $\varepsilon = \frac{9t(1-y)^2}{yz^2}$. Then, it is straightforward to check that $\varepsilon^U < \varepsilon$. *Q.E.D.*

Proposition 4 simply tells us that, basically, nothing goes unreported of all the additional revenue that is generated with unions. 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 $R = 2\left[ytpq + y\frac{(pq-a)^2}{2} + (1-y)ta\right]$, and in the cases without and with unions is, respectively,

$$R = \frac{t\left[-9ty^2 + 2y(z^2+9t) - 9t\right]}{9y} \tag{23}$$

$$R^U = \frac{t\left[-81ty^2 + 2y(10z^2+81t) - 81t\right]}{81y} \tag{24}$$

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 $\left(R - R^{U}\right) = -\frac{2tz^{2}}{81}$.

Regarding 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, 2021). Proposition 7 (which holds true even without evasion) suggests that a "Leviathan" Government would prefer the presence of unions.

Consumer surplus is defined as $CS = 2q^{2}$, and its value is, in the cases without and with unions, respectively

$$CS = \frac{2z^{2}}{9} \tag{25}$$

$$CS^U = \frac{8z^2}{81}$$

(26)

with $CS > CS^U$ because directly linked to output.

The utility of each union is

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

(27)

The expressions of the social welfare are, in the cases without and with unions, respectively $SW = 2\pi + CS + R$ and $SW^U = 2\pi^U + CS^U + 2V + R^U$, whose values are

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

(28)

$$SW^U = \frac{28z^2}{81}$$

(29)

Proposition 8. *Union's utility is reduced by sales tax rate, while consumer surplus and social welfare are unaffected by the taxation policy.*[18]

Proof: simple analytical inspection of Eqs. (25)-(29).

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.*[19]

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 also argued that a Government which is just barely self-interested may, on the one hand,

[18] 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 results of the paper but the final part of Proposition 8 qualitatively hold in the case of positive reserve wages.

[19] This result derives from the characteristic of separability in our model, discussed in footnote 10, which leads output and consumer surplus to be unaffected both by the tax rate and tax evasion activities.

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. Extensions

In this section, we briefly discuss the key results of some extensions to the basic model. All details are available upon request from the authors.

5.1 Industry-wide union

Despite the decentralization trend underlined in the Introduction, industry-wide unions and, consequently, more centralized wage setting structures still play a predominant role in several continental European countries. Therefore, an investigation of a centralized structure represents a natural extension to check the robustness of the results of the model. Here, briefly described, the key findings (details available upon request from the authors).

From the qualitative perspective, most of the results described in the previous section are valid. However, there are some extremely important quantitative differences, with relevant policy implications, that arise. As a premise, in a centralized setting, it is irrelevant whether the industry-wide union fixes wages separately in each firm or uniformly for the whole industry: the equilibrium values of wages and output are identical. As expected, with a centralized union, wages are higher (due to the internalization of wage competition), and employment is lower than with decentralized

unions. However, in equilibrium, firms declare the same amount of sales as in the case of competitive labour markets reported in eq. (12). The rationale for these results is as follows: with a higher wage set by the union, firms produce a lower output, on a relatively elastic point of their labour demands. Firms charge higher prices; nonetheless, they faces a more inelastic demand for goods, which lead to a reduction of revenues with respect to the case of decentralized unions.

A direct consequence of the above result is that the absolute and relative tax evasion as well as public tax revenues with a centralized wage setting are identical to those of competitive labour markets. To some extent, it exists a sort of "wage-setting structure Laffer curve". A policy implication is that a Leviathan government prefers the presence of unions to collect more tax revenues; however, it would be oriented towards decentralization, and therefore to intervene in labour market regulations to change wage setting structures.

Profits are also increasing in the tax rate, but it is sufficient a smaller market size to obtain this effect. Organized workers improve their position: the industry-wide union utility is larger than the sum of the two decentralized unions. However, because output is the lowest under centralization, consumer surplus and social welfare, which directly linked to production levels, are the lowest as well.

5.2 Different degrees of competition

Making use of a Cournot oligopoly model with an endogenous number of firms and evasion of indirect taxes, Goerke and Runkel (2011) show that more intense

competition may have the negative side effect of increasing tax evasion, thereby, lowering public revenues and welfare. To address this issue, keeping the duopoly structure with decentralized unions of the basic model, we have introduced a conjectural variation (CV) model (see, e.g., Martin 2002). In essence, the CV parameter, defined in our case by the Greek letter $\phi \in (-1,1)$, covers the full range of market competition degrees, from Bertrand competition to joint profit maximization. The key results are as follows. More competitive markets lower the unions' wage demands. This reduces the cost pressure on firms. However, more intense competition lowers price as well. Indeed, it is found that, for $\phi \leq -\frac{1}{2}$, $\frac{\partial a_i}{\partial \phi} > 0$: sufficiently competitive markets leads firms to increase the size of undeclared sales. Moreover, the higher the degree of competition is, the lower is the probability of detection. Those elements have an impact of evasion activities. Indeed, it is found a slightly degree of competition is sufficient to increase the absolute tax, for instance $\frac{\partial E}{\partial \phi} \gtrless 0$ if $\phi \lessgtr .16$. Concerning the relative tax evasion, given the analytical complexity of the expression, some numerical simulations have been performed. We have obtained that, irrespective of the market size, for low detection probability the relative tax evasion is higher with more competition. Given these findings, we have analyzed the impact of competition on public revenues. Provided that the both the detection probability and the tax rate are not too low, we obtain an inverted U-shaped relation between the degree of competition and tax revenues, a kind of "market competition Laffer curve" with the highest revenues in the case of Cournot competition. However, the tax revenues collected

under full collusion are higher than those the government collects under (almost) perfectly competitive markets. These findings are in line with those of Goerke and Runkel (2011). Profits increase in the tax rate. Nonetheless, the standard result that higher degree of competition leads to higher social welfare levels hold: the negative impact on public finances is more than offset by the beneficial effects of an increased consumer surplus due to output expansion.

5.3 Duopoly with Corporate Social Responsibility

In recent years, because of its worldwide expansion as a dominant business phenomenon (see e.g. KPMG 2020), corporate social responsibility (CSR) has received increasing attention in the economic research and practical management fields, with a few recent papers that focuses on the impact of CSR on wage-settings and negotiations (see e.g. Goerke 2022). Therefore, we have developed an extension of tax evasion in a duopoly with firms undertaking CSR activities. As common in the recent literature, we consider the case of "consumer-friendly" CSR (see e.g. Fanti and Buccella 2017a,b, and Planer-Friedrich and Sahm 2020): the objective function of firms is a parameterized combination of profits and consumer surplus, in which we denote with the parameter $k \in [0,1]$ the exogenous weight that CSR firm assigns to consumer surplus. The main results are as follows.

An increase in the level of CSR activities lead to an increase in production, and therefore an increase in the labor demand which induces unions to claim higher wages. This increases the cost pressure on firms as well as lowers prices because of output

expansion. Both channels affect the decision concerning the amount of undeclared sales, and the relation between CSR and unreported sales is not always monotonic: indeed, it is found that in the relevant parametric space $\frac{\partial a_i}{\partial k} \gtreqless 0$ if $k \gtreqless k(y,t)$. However, a graphical analysis reveals that $\frac{\partial a_i}{\partial k} > 0$ for whichever (technically feasible) tax rate if the level of CSR is low, and for all levels of CSR when the tax rate is high. Moreover, the higher the level CSR is, the higher is the probability that audit activities can detect evasion. Further analysis shows that the relative tax evasion rate is increasing in the degree of CSR, while the absolute tax evasion is independent of the CSR parameter and identical to that of the basic model, with and without unions. The impact of CSR activities on public revenues qualitatively mirrors that of unreported sales. The profit part of the CSR firms' objective follows the standard result: profits are decreasing in the tax rate. As a consequence, CSR activities can have, for precise combinations of the model's parameters, either a positive or a negative effect on the overall social welfare. In fact, an in-depth analysis of the social welfare reveals that, in the area of economic feasibility, $\frac{\partial SW}{\partial k} \gtreqless 0$ if $k \lesseqgtr 1-t$, i.e. the level of CSR activities should not exceed the actual sales' net rate.

6. Conclusions

This paper investigates a unionized Cournot duopoly model with evasion of indirect taxes. The main finding is that, rather counter-intuitively, a higher indirect 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 commodity 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 indirect 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, indirect taxation does not affect consumers and social welfare. Moreover, since higher indirect 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 of 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,

the presence of differentiated goods call for additional 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) $\frac{\partial \pi}{\partial t} = \frac{9ty^2 - y\left(z^2 + 18t\right) + 9t}{9y}$;

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

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

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

Part *b)*

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

Proof of Proposition 2

Part *a)*

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

[Figure A.1 about here]

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

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

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 A.1 provides a graphical representation. It plots the boundary function $f = (y_1^{\circ\circ} - y^{\circ\circ}) = 0$: 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.*

Proof of Proposition 6

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

i) $\frac{\partial R}{\partial t} = -\frac{2\left(9t + 9ty^2 - 18ty - yz^2\right)}{9y} \underset{<}{\overset{>}{}} 0 \Leftrightarrow t \underset{>}{\overset{<}{}} t^* = \frac{yz^2}{9(1-y)^2}$; since for satisfying inequality (14)

$t < t^{\circ\circ} = \frac{yz^2}{9(1-y)}$, then it follows that $\left(t^* - t^{\circ\circ}\right) = \frac{y^2 z^2}{9(1-y)^2}$ and $t^* > t^{\circ\circ}$;

ii) $\frac{\partial R^U}{\partial t} = -\frac{2\left(81ty^2 - 10yz^2 - 162ty + 81t\right)}{81y} \underset{<}{\overset{>}{=}} 0 \Leftrightarrow t \underset{>}{\overset{<}{=}} t^{U*} = \frac{10yz^2}{81(1-y)^2}$; since for satisfying inequality (20) $t < t^{U\circ\circ} = \frac{10yz^2}{81(1-y)}$, 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.*

Compliance with ethical standards

Disclosure of potential conflict of interest The authors declare that they have no conflict of interest.

Funding The authors declare that this study was not funded by any institution.

Declarations of interest None.

References

Allingham, M. G. and Sandmo A (1972). Income tax evasion: A theoretical analysis. *Journal of Public Economics* 1, 323–338.

Bayer, R. and Cowell, F. A. (2009). Tax compliance and firms' strategic interdependence. *Journal of Public Economics* 93, 1131–1143.

Besfamille, M., De Donder, P. and Lozachmeur, J.-M. (2009a). The political economy of the (weak) enforcement of sales tax. CEPR Discussion Paper 7108.

Besfamille, M., De Donder, P. and Lozachmeur, J.-M. (2009b). Tax enforcement may decrease government revenue. *Economics Bulletin* 29, 2665–2672.

Booth, A.L., 1995. *The Economics of the Trade Union*. Cambridge University Press, Cambridge.

Buccella, D., 2018. *The choice of the bargaining agenda in imperfectly competitive markets*. Poltext, Warsaw.

Chang, Y. M., and Tremblay, V. J. (1991). Oligopsony/oligopoly power and factor market performance. *Managerial and Decision Economics*, 12(5), 405-409.

Chen, Z., and Zhao, B. (2014). Unemployment and product market competition in a Cournot model with efficiency wages. *Canadian Journal of Economics/Revue canadienne d'économique*, 47(2), 555-579.

Correa-López, M. and Naylor, R.A. (2004), The Cournot-Bertrand profit differential: a reversal result in a differentiated duopoly with wage bargaining. *European Economic Review* 48, 681–696.

Cowell, F. A. (2004). Carrots and sticks in enforcement. In H. Aaron and J. Slemrod (eds), *The Crisis in Tax Administration*. Washington DC: Brookings Institution Press, 230–275.

Cremer, H. and Gahvari, F. (1992). Tax evasion and the structure of indirect taxes and audit probabilities. *Public Finance/Finance Publiques* 47, 351–365.

Cremer, H. and Gahvari, F. (1993). Tax evasion and optimal commodity taxation. *Journal of Public Economics* 50, 261–275.

Cremer, H. and Gahvari, F. (1999). Excise tax evasion, tax revenue, and welfare. *Public Finance Review* 27, 77–95.

Dowrick, S. and Spencer, B.J. (1994). Union attitudes to labor-saving innovation: when are unions luddites? *Journal of Labor Economics* 12, 316–344.

European Commission (2020a). Taxation Trends in the European Union, 2020 Edition. Luxembourg: Publications Office of the European Union (available online at https://op.europa.eu/en/publication-detail/-/publication/c0b00da7-c4b1-11ea-b3a4-01aa75ed71a1).

European Commission (2020b). Study and Reports on the VAT Gap in the EU-28 Member States 2020, Final Report. Luxembourg: Publications Office of the European Union (available online at https://ec.europa.eu/taxation_customs/sites/taxation/files/vat-gap-full-report-2020_en.pdf).

Fanti, L., and Buccella, D. (2017a). Corporate social responsibility, profits and welfare with managerial firms. *International Review of Economics*, *64*, 341-356.

Fanti, L., and Buccella, D. (2017b). Corporate social responsibility in a game-theoretic context. *Economia e Politica Industriale*, *44*, 371-390.

Fanti, L., and Buccella, D. (2021). Tax evasion and competition in a differentiated duopoly. *Journal of Industrial and Business Economics* 48, 385–411.

Flanagan, R. J. (1999). Macroeconomic performance and collective bargaining: an international perspective, *Journal of Economic Literature* 37, 1150–1175.

Franzoni, L. A. (2008). Tax compliance (available at SSRN: http://ssrn.com/abstract=1271168).

Goerke, L. (2022). Trade unions and corporate social responsibility. *Annals of Public and Cooperative Economics*, 93(1), 177-203.

Goerke, L. and Runkel, M. (2006). Profit tax evasion under oligopoly with endogenous market structure. *National Tax Journal* 59, 851–857.

Goerke, L. and Runkel, M. (2011). Tax evasion and competition. *Scottish Journal of Political Economy* 58, 711–736.

Hashimzade, N., Huang, Z. and Myles, G. D. (2010). Tax fraud by firms and optimal auditing. *International Review of Law and Economics* 30, 10–17.

Horn, H. and Wolinsky, A. (1988). Worker substitutability and patterns of unionisation, *Economic Journal* 98, 484–497.

Haucup, J. and Wey, C. (2004). Unionisation structures and innovation incentives, *Economic Journal* 114, 149–165.

Hindriks, J., and Myles, G.D. (2006). *Intermediate Public Economics*. Cambridge: The MIT Press.

Keen, M. and Smith, S. (2006). VAT fraud and evasion: what do we know and what can be done? *National Tax Journal* 59, 861–887.

KPMG (2020). The time has come. The KPMG Survey of Sustainability Reporting 2020. Available online at https://assets.kpmg/content/dam/kpmg/xx/pdf/2020/11/the-time-has-come.pdf

Kreutzer, D. and Lee, D. R. (1986). On taxation and understated monopoly profits. *National Tax Journal* 39, 241–243.

Kreutzer, D. and Lee, D. R. (1988). Tax evasion and monopoly output decisions: a reply. *National Tax Journal* 41, 583–584.

Lai, C. C., Chang, J. J., and Chang, W. Y. (1995). Tax evasion and efficient bargains. *Public Finance/Finances Publiques* 50, 96–105.

Lee, K. (1998). Tax evasion, monopoly, and nonneutral profit taxes. *National Tax Journal* 51, 333–338.

Lommerud, K.E., Straume, O.R. and Sørgard, L. (2005). Downstream merger with upstream market power. *European Economic Review* 49, 717–743.

Marrelli, M. (1984). On indirect tax evasion. *Journal of Public Economics* 25, 181–196.

Marrelli, M. and Martina, R. (1988). Tax evasion and strategic behaviour of the firms. *Journal of Public Economics* 37, 55–69.

Martin, S. (2002). *Advanced industrial economics* (2nd ed.). Oxford, UK: John Wiley & Sons.

Panteghini, P. M. (2000). Tax evasion and entrepreneurial flexibility. *Public Finance Review* 28, 199–209.

Planer-Friedrich, L., and Sahm, M. (2020). Strategic corporate social responsibility, imperfect competition, and market concentration. *Journal of Economics*, *129*(1), 79-101.

OECD (2008). Consumption Tax Trends: VAT/GST and Excise Rates, Trends and Administration Issues. Paris: OECD.

OECD (2009). Tax Administration in OECD and Selected Non-OECD Countries: Comparative Information Series (2008). Paris: OECD.

OECD (2011). Tax Administration in OECD and Selected Non-OECD Countries: Comparative Information Series (2010). Paris: OECD.

OECD (2013). Tax Administration 2013. Comparative Information on OECD and Other Advanced and Emerging Economies. Paris: OECD.

Okuguchi, K. (1998). Existence of equilibrium for Cournot oligopoly-oligopsony. *Keio economic studies*, 35(2), 45-53.

Sandmo, A. (2005). The theory of tax evasion: a retrospective view. *National Tax Journal* 58, 643–663.

Slemrod, J. (2007). Cheating ourselves: the economics of tax evasion. *Journal of Economic Perspectives* 21, 25–48.

Seade, J. (1985). Profitable cost increases and the shifting of taxation: equilibrium responses of markets in oligopoly, Warwick Economic Research Papers, No. 260, The University of Warwick.

Szidarovszky, F., and Yakowitz, S. (1977). A new proof of the existence and uniqueness of the Cournot equilibrium. *International Economic Review* 18(3), 787-789.

Tait, M. A. A. (1988). *Value added tax: International practice and problems*. Washington, Washington D.C.: International Monetary Fund.

Virmani, A. (1989). Indirect tax evasion and production efficiency. *Journal of Public Economics* 39, 223–237.

Wang, L. F. S. (1990). Tax evasion and monopoly output decisions with endogenous probability of detection. *Public Finance Quarterly* 18, 480–487.

Wang, L. F. S. and Conant, J. L. (1988). Corporate tax evasion and output decisions of the uncertain monopolist. *National Tax Journal* 41, 579–581.

Wu, T. M. (2016). Profit Tax Evasion under Wage Bargaining Structure. *B.E. Journal of Theoretical Economics* 16, 817–834.

Yaniv, G. (1996). Tax evasion and monopoly output decisions: note. *Public Finance Quarterly* 24, 501–505.

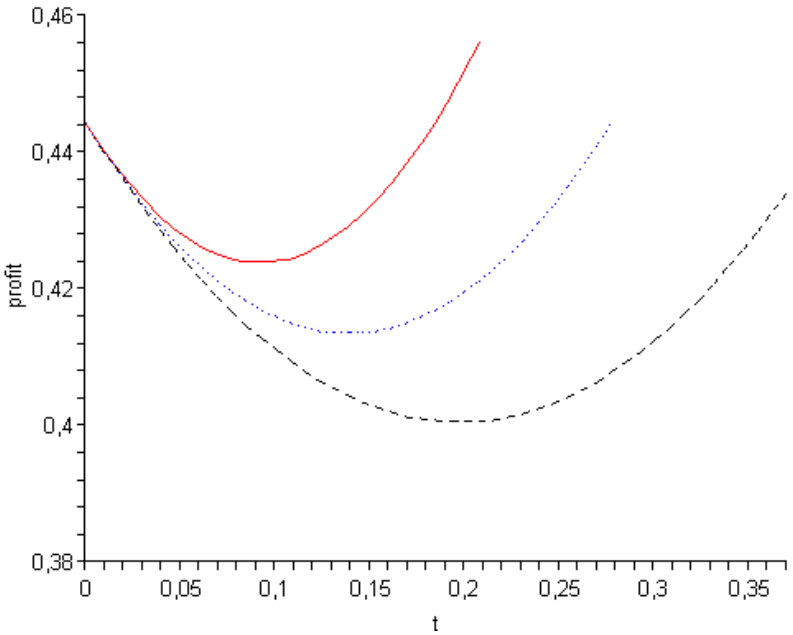


Figure 1. *Profits as function of the tax rate, for different (low) detection probability: y=0.15 (red solid line), y=0.20 (blue dotted line), y=0.25 (black dashed line). The critical values* $t^{U\circ\circ}$ *are given by, respectively:* $t^{U\circ\circ} = 0.197, t^{U\circ\circ} = 0.278, t^{U\circ\circ}{}^{\circ\circ} = 0.37$.

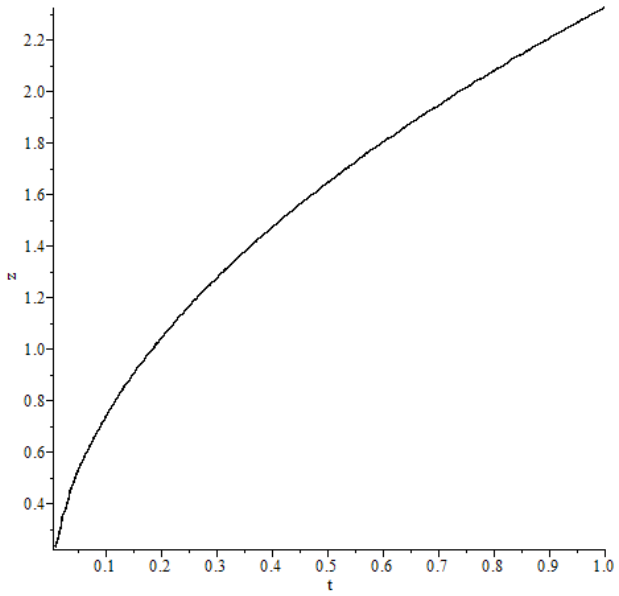


Figure A.1. *The curve* $f = (y_1^{\circ\circ} - y^{\circ\circ}) = 0$ *in the* $(t, z)-$ *plane. In the area above the curve, profits increase (resp. always decrease) with an increasing tax rate if* $y < (>) y_1^{\circ\circ}$.

Discussion Papers
Collana del Dipartimento di Economia e Management, Università di Pisa

Email della redazione: luciano.fanti@unipi.it