Social Welfare and Profit-Sharing Rule in a Unionised Duopoly with Profit Tax/Subsidy[*]

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Abstract

This paper investigates the effects of the introduction of a profit-sharing rule and a profit tax/subsidy (T/S) policy on social welfare in a Cournot duopoly in the presence of decentralized firm-union bargaining over wage rates. It is shown that 1) the social welfare is always increasing in the share of profits distributed to workers and profit taxation is not neutral: the optimality rule prescribes complementarity in their use; 2) although an increasing profit-sharing parameter has conflicting effects (i.e. the net profit accruing to the firms reduces, workers and consumers' welfare increase), a sufficiently high profit-sharing rule may be in the interest of the society, because it allows for eliminating the inefficiency due to the labour market imperfections. Moreover, we show that a "third best" optimal social welfare (given the institutional constraint of a non-negative wage rate) can be achieved. Interestingly, in this case, firms and workers achieve the maximal welfare. Therefore, we argue that profit-subsidisation may be used for motivating firms to apply the "socially optimal profit-sharing rule", which warrants Pareto-superior outcomes for producers (firms and workers) (for instance, in the special case of monopoly unions and perfect substitute goods, the rule corresponding to a 50 per cent net profit share distributed to workers, jointly with a 50 per cent profit subsidisation).

Keywords: Profit-sharing, profit tax/subsidy, social welfare, unions, Cournot duopoly.

JEL Classification JEL: H25, L13, J3, J51

1. Introduction

Product and labour markets have strong interactions for years, as a vast literature argues (Correa-López and Naylor, 2004; Fanti and Meccheri, 2012). As Booth (1995) remarks, "It appears to be an empirical regularity that imperfections in the labour market are correlated with imperfections in the product market". Furthermore, the literature on unionised oligop-

oly has considered in depth the role of unionised labour (Naylor, 2003), different bargaining agendas (Fanti and Buccella, 2018) and different payment schemes (fixed wage vs performance related pay, in particular profit-sharing rules) (Lazear, 2000, Sørensen, 1992, Buccella, 2016). On the other hand, it is also widely acknowledged that product market performances and social welfare outcomes are strictly mutually dependent. Indeed, economists as well as policymakers have focused their attention on the effects of the market competition on social welfare, also recognising the role played by the taxation policy (for instance, the profit tax, Appelbaum and Katz, 1996) on the market structures and, consequently, on the social welfare. However, the embodiment of unionised labour in the analysis of the interconnections between taxation, market competition and welfare is, to the best of the authors knowledge, relatively new. Thus, the mechanisms through which labour market aspects counterbalance product market imperfections, and their effects on welfare are not yet fully explored.

As known, profit-sharing arrangements[1] are increasingly widespread in many OECD countries, as the OECD (1995) documents through a cross-country evidence[2], and in many EU-countries, as Pendleton *et al.* (2001) report. The effects of introducing profit-sharing arrangements in different market structures with different assumptions concerning the labour market have received a great deal of attention, either without or with the presence of strategic interactions which affect the firm's incentive to introduce profit-sharing. In the former case, monopolistic competition in the goods market is assumed with i) perfect competition in the labour market (Weitzman, 1985), ii) insiders having wage bargaining power (Weitzman, 1987; Wadhwani, 1988) and iii) unions having wage bargaining power (Jackman, 1988). In the strategic context case, a Cournot oligopoly is assumed with i) perfect competition in the labour market (Stewart, 1989)[3] , ii) monopolistically unionised labour market in which the firm unilaterally sets the profit-sharing parameter (or it is exogenously imposed), and the union unilaterally sets the wage rate (Fung, 1989) and iii) an union-firm bargaining about both the profit-sharing parameter and the wage rate (Sørensen, 1992)[4]. On the other hand, the economic literature has found that, in general, a profit tax/subsidy (T/S) policy is neutral, in that it does not affect the first order conditions on market variables (Gravelle and Rees, 2004). By contrast, this paper shows that, provided a profit-sharing rule is implemented, a profit T/S policy is not neutral[5].

While the received literature on the profit-sharing arrangements has mainly focused on firms and unions' viewpoint, this paper concentrates on social welfare. In this respect, we pose the following questions: should a profit-sharing arrangement be introduced? If yes, does an optimal level exist? Should a profit T/S policy be introduced in the presence of a profit-sharing arrangement? Which is the interaction between profit-sharing arrangement and profit T/S policy? Which is the welfare gain due to the introduction of the profit-sharing rule?

Our model is based on the following set of assumptions. First, we assume that the Government (for instance by law) is able to: 1) fix the workers' remuneration system (*i.e.* the percentage of profit-sharing, which is assumed to be, for simplicity, uniform between firms); and 2) implement a profit tax. Second, we assume a benevolent Government aiming at max-

imising the social welfare, by setting the optimal level of the profit-sharing (or inducing firms to set it) and the profit T/S rate. Third, the model assumes decentralised firm-union bargaining units to fix the wage rate taking as given the percentage of profit-sharing. Moreover, we add a plausible institutional constraint: unions cannot chose a negative wage rate. In other words, the key point of the present work is that the government may compulsorily impose or induce firms –through an opportunely designed T/S policy– to set the optimal profit-sharing parameter to improve the overall social welfare. Put differently, firms either do not decide about "how much" to share of their profits because the share parameter is given by law, or decide it, and in the latter case they may set exactly the welfare-maximising share parameter induced by the working of the profit T/S policy. Then, in any case, profit maximisation occurs through the base wage negotiations and the subsequent choice of the optimal output for the market.

As a consequence, the model presents a three-stage game with the following structure: in the first stage, the Government (social planner) chooses the profit-sharing rule (the share λ) and the profit T/S rate (z) to maximise social welfare[6]. In the second stage, decentralised firm-union bargaining units negotiate the base wage. In the third stage, firms compete à la Cournot in the product market. Sørensen (1992) has shown that a profit-sharing system may emerge as an equilibrium only when unions are sufficiently weak in the bargaining process with firms (while unions would always prefer profit-sharing system). Thus, if unions have sufficiently high power in the bargaining process it can be expected that firms would never choose a profit-sharing system. However, Sørensen (1992, p. 166) also conjectures that "the introduction of profit-sharing is probably beneficial for the rest of the society" and "if the firms do not introduce profit-sharing by themselves, there may be reason for the government to motivate the firms to do this". Moreover, as Weitzman (1984) explicitly suggests, the tax system may be used to motivate firms to use the profit-sharing system in a socially optimal way. In the current paper, we take seriously into account this issue, and we investigate whether and how a Government, using solely the profit T/S system, may induce firms to introduce the profit-sharing rule exactly at the social welfare-maximising level. The present work shows that profit-sharing is beneficial for the society to an extent that is depending on the profit T/S policy (i.e. the higher taxation, the higher the share of the profit distributed to workers which is "optimal" for society). This finding suggests that profit subsidisation may be used as a policy device to motivate firms to apply the socially optimal profit-sharing rule; in such a case, this rule allows for a complete elimination of the "inefficiency" caused by the imperfection in the labour market and is also in the interest of both producers (firms and workers). Moreover, this finding is robust both to the assumptions of price (Bertrand) competition with decentralised bargaining units and full centralised negotiations under quantity (Cournot) competition.

The rest of the paper is organised as follows. In Section 2 we present the model, which is solved in Section 3, with discussion, qualifications and numerical examples of the results. Section 4 discusses how the government may induce the firms to introduce a profit-sharing scheme into the economy. Section 5 describes some extensions of the basic model. A few concluding remarks are given in Section 6.

2. The model

Following an established literature on unionised oligopoly (Correa-López and Naylor, 2004; Fanti and Meccheri, 2011), we assume that firm i produces output q_i through the following production function with constant (marginal) returns to labour: $q_i = L_i$, where L_i represents the labour force employed by the i th firm.

Moreover, we consider the usual linear inverse demand given by (Singh and Vives, 1984):

$$p_i = 1 - q_i - \gamma q_j \tag{1}$$

where p_i denotes price, q_i and q_j are the firms' output levels for $i, j = 1, 2$ and $i \neq j$ and $0 < \gamma \leq 1$ (resp. $-1 < \gamma < 0$) representing the degree of substitutability (resp. complementarity) among goods (if $\gamma = 0$, goods are completely differentiated, and each firm is a monopolist for its own product). We assume that i) the profit-sharing scheme consists in the share $\lambda \in [0,1]$ of the profit going to the workers, ii) the profit tax/subsidy rate is $z \in (-1,1)$, iii) the base wage is w_i and iv) w_0 represents the unemployment benefit/opportunity wage outside the specific industry under consideration.

As a consequence, the gross profit function of firm i is as follows:

$$\pi_i (q_i, q_j) = [p_i(q_i, q_j) - w_i]q_i, \quad i = 1,2 \tag{2}$$

Following Sørensen (1992), the owners of the firm are assumed to be risk neutral. Therefore, their utility levels can be measured by income levels. Thus, net profits are:

$$\pi_i^N = (1 - \lambda)(1-z) \, \pi_i(q_i, q_j) = (1-\lambda)(1-z)[p_i(q_i, q_j)-w_i]q_i, \quad i = 1,2 \tag{3}$$

The labour unions are also assumed to be risk neutral and to have, as usual, a Stone-Geary utility function (Pencavel, 1984). In particular, it is assumed that unions are rent-maximising. Thus, the utility function of firm i's union is[7]:

$$V_i = (\Omega_i - w^o) L_i \tag{4}$$

where $\Omega_i = w_i + \dfrac{\lambda(1 - z)\pi_i}{L_i}$ is the worker's remuneration targeted by the union. For simplicity, we assume $w^o = 0$[8]. Therefore, the utility function of firm i's union can be definitively written as:

$$V_i = \left[w_i + \frac{\lambda(1-z)\pi_i}{q_i} \right] q_i \tag{5}$$

where $q_i = L_i \leq N_i$ is employment in the firm, and N denotes the number of available workers: the inequality simply means that there is never labour shortage. Each union aims to maxim-

ise its utility function with respect to the base wage in a bargaining with the corresponding firm, taking as given the profit-sharing parameter λ.

With regard to the game structure of the model, we assume that there are three stages. In stage one, the Government maximises social welfare choosing the optimal levels of the couple of profit-sharing parameter and profit T/S rate. Moreover, the Government may impose or not the optimal profit-sharing rule. In particular, we have two possibilities with respect to the setting of the profit-sharing rule: either it is set by the Government or it is freely chosen by firms and unions. However, what matters is that, in any case, it would be chosen the "socially optimal profit-sharing rule"[9].

Then, in stage two, for a given profit-sharing parameter, firm i and union i bargain about the base wage, and the outcome is assumed to be given by the asymmetric Nash bargaining solution (Binmore *et al,*, 1986).

In stage three, the firms determine the output (*i.e.* employment) levels[10]. As usual, we solve the model backwards to get a subgame perfect Nash equilibrium[11].

Hence, the equilibrium of the third stage of the game (the market game) must satisfy:

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

for $i, j = 1, 2$ and $i \neq j$. From (6), by substituting for the counterpart firm j, we get the equilibrium output by firm i, for given w_i, w_j:

$$q_i(w_i, w_j) = \frac{2(1 - w_i) - \gamma(1 - w_j)}{4 - \gamma^2} \tag{7}$$

We assume that firm-specific labour unions negotiate wages at the second stage of the game, taking as given the profit-sharing rule. Therefore, each firm-union bargaining unit maximises the following Nash product:

$$\max_{\underbrace{NP_i}_{w.r.t. w_i}} = (\pi_i^N)^{1-b}(V_i)^b = \left\{ (1 - \lambda)(1 - z)\left[p_i\left(q_i, q_j\right) - w_i \right]q_i \right\}^{1-b} \left\{ \left[w_i + \frac{\lambda(1 - z)\pi_i}{q_i} \right]q_i \right\}^b \tag{8}$$

where $b \in [0,1]$ is the unions' bargaining power, assumed to be equal across bargaining units.

Substituting (7) in (3) and subsequently (3) and (5) in (8), and maximising (8) with respect to w_i, we get:

$$w_i(w_j) = \frac{[2 - (1 - w_j)\gamma][4\lambda(1 - z) - b(4 - \gamma^2)]}{4[2\lambda(1 - z) - (4 - \gamma^2)]} \tag{9}$$

which defines the sub-game perfect best-reply function in wages of the union-firm pair *i* (under the assumption of a non-cooperative Cournot-Nash equilibrium in the product market). Solving the system composed by (9) and its counterpart for *j*, we obtain the sub-game perfect equilibrium wage, for given λ and z:

$$w_i(\lambda, z) = \frac{[4\lambda(1-z) - b(4-\gamma^2)]}{[4\lambda(1-z) - (4-b\gamma)(2+\gamma)]} \tag{10}$$

By substituting (10) in (7), we get output as a function of λ and z only:

$$q_i(\lambda, z) = \frac{4-2b}{[(2+\gamma)(4-b\gamma) - 4\lambda(1-z)]} \tag{11}$$

From the observation of (10) and (11) the following remark is derived:

Remark 1: $\dfrac{\partial w_i}{\partial \lambda} < 0 \left(\dfrac{\partial q_i}{\partial \lambda} > 0 \right)$: *an increasing λ reduces (increases) wages (output). On the other hand,* $\dfrac{\partial w_i}{\partial z} > 0 \left(\dfrac{\partial q_i}{\partial z} < 0 \right)$: *an increasing z increases (reduces) wages (output).*

Finally, substituting both $w_i(\lambda, z)$ [Eq. (10)] and $q_i(\lambda, z)$ [Eq. (11)] we get the following expression for gross profits as a function of the levels of the profit-sharing and the profit T/S rate:

$$\pi_i(\lambda, z) = \frac{4(2-b)^2}{[(2+\gamma)(4-b\gamma) - 4\lambda(1-z)]^2} \tag{12}$$

The consumer surplus is given by[12]:

$$CS(\lambda, z) = \frac{(q_i^2 + q_j^2 + 2\gamma q_i q_j)}{2} = \frac{4(1+\gamma)(2-b)^2}{[(2+\gamma)(4-b\gamma) - 4\lambda(1-z)]^2} \tag{13}$$

The tax revenue (which becomes a subsidy expenditure if $z < 0$) is given by:

$$T(\lambda, z) = 2z\pi_i = \frac{8z(2-b)^2}{[(2+\gamma)(4-b\gamma) - 4\lambda(1-z)]^2} \tag{14}$$

The utility of each union is given by:

$$V_i(\lambda, z) = \frac{2b(2-b)\left[4-\gamma^2 - 2\lambda(1-z)\right]}{[(2+\gamma)(4-b\gamma) - 4\lambda(1-z)]^2} \tag{15}$$

Social welfare is defined as:

$$SW(\lambda, z) = CS + T + 2V_i + 2\pi_i^N \tag{16}$$

and, making use of Eqs. (12)-(16), it is given by[14]:

$$SW(\lambda, z) = \frac{4(2-b)\left[2(3+\gamma) + b(1-\gamma-\gamma^2) - 4\lambda(1-z)\right]}{[(2+\gamma)(4-b\gamma) - 4\lambda(1-z)]^2} \tag{17}$$

3. Social welfare, profit-sharing and profit tax

Preliminarily, we assume that institutional as well as practical reasons imply that the wage emerging form the stage of wage negotiation is always non-negative. Indeed, as Fanti and Meccheri (2012) argue[15], wage negotiations as well as minimum wage legislations tend to establish a wage floor[16]. Therefore, given that i) the institutional constraint requires that the wage rate is non-negative, and ii) the economic feasibility requires that output is non-negative, the following lemmas hold[17]:

Lemma 1: $w_i(\lambda, z) \geq 0 \Leftrightarrow \lambda \leq \lambda^{\circ\circ} = \dfrac{b(4-\gamma^2)}{4(1-z)}$

Lemma 2: $q_i(\lambda, z) > 0 \ \forall z \in (0,1) \wedge \lambda \in [0,1]$

The relationship between the profit-sharing parameter (resp. the profit T/S rate) and net profits, consumer surplus and unions' utility is described in the following results:

Result 1: i) *Net profits may be maximised by a value of the profit-sharing parameter, which is given by* $\lambda = \lambda^{**} = -\dfrac{[4(\gamma+2z) - b\gamma(\gamma+2)]}{4(1-z)}$ *; ii) consumer's surplus is increasing with an increasing profit-sharing parameter, while net profits and consumer's surplus are both decreasing with z.*

Proof: the part i) of the result straightforwardly follows from:

$$\frac{\partial \pi_i(\lambda, z)}{\partial \lambda} = \frac{4(1-z)(2-b)^2[4\lambda(z-1) - 8z - 2\gamma(2-b) + b\gamma^2]}{[4\lambda(1-z) - 8 - 2\gamma(2-b) + b\gamma^2]^3} \overset{>}{\underset{<}{=}} 0 \Leftrightarrow \lambda \overset{<}{\underset{>}{=}} \lambda^{**}$$; part ii) directly follows from the simple inspection of Eqs. (12) and (13).

From the part i) of Result 1, the following Lemma is straightforwardly derived:

Lemma 3. $\lambda^{**} > 0 \Leftrightarrow z < z^{**} = -\dfrac{\gamma[4 - b(2 + \gamma)]}{8}$ and $z^{**} \underset{<}{\overset{>}{=}} 0$ if $\gamma \underset{>}{\overset{<}{=}} 0$

Moreover, it is assumed that $\lambda^{**} = 0 \Leftarrow z \geq z^{**}$.

This means that firms may find convenient the introduction of a profit-sharing system only if an opportune profit subsidy (resp. tax) is present when products are substitutes (resp. complements).

Result 2: *The unions' utility i) is maximised by* $\lambda = \lambda^{\infty}$ $\forall$ $\gamma \in (-1,1]$ *while ii) is always decreasing with an increasing z.*

Proof: i) From eq. (15) it is obtained $\dfrac{\partial V_i(\lambda, z)}{\partial \lambda} \underset{<}{\overset{>}{=}} 0 \Leftrightarrow \lambda \underset{>}{\overset{<}{=}} \lambda^{***} = \dfrac{(2 + \gamma)[4(1 - \gamma) + b\gamma]}{4(1 - z)}$

However, from Lemma 1, it follows that, $\forall$ $\gamma \in (-1,1]$, $\lambda^{\infty} \leq \lambda^{***}$; thus, V_i is maximised in a constrained way at the level λ^{∞}, because λ^{***} would violate the institutional non-negativity constraint on wages; ii) the proof follows from a simple differentiation, which shows

that $\dfrac{\partial V_i(\lambda, z)}{\partial z} < 0$.

Both results imply that an increasing share of the profit going to the workers is always beneficial for consumers and workers, while it may be beneficial or harmful for firms depending on the value of the profit T/S rate, affected by the degree of substitutability/complementarity among products.

Now we are in a position to analyse social welfare.

Result 3: *Social welfare may be maximised by a value of the profit-sharing parameter, which is given by* $\lambda = \lambda^* = \dfrac{4 + b(2 - \gamma^2)}{4(1 - z)}$. *Alternatively social welfare may be maximised by a value of the profit tax/subsidy rate, which is given by* $z = z^* = -\dfrac{4(1 - \lambda) + b(2 - \gamma^2)}{4\lambda}$ [19].

It can be checked that, in the case of a profit tax (*i.e.* $z > 0$), $\lambda^* > 1$. As a consequence, the existence of a positive, feasible share parameter $\lambda^* \leq 1$ requires a subsidy $z^* \leq 0$. Then, the feasible optimal (second-best)[20] solutions would be $\lambda^* = 1$, $z^* = 0$: however, such solutions would violate the institutional constraint of non-negative wages. Given Lemma 1, the following remark holds:

Remark 2: *Since it is easy to see that* $\lambda^{\infty} < \lambda^*$, *then* $\lambda = \lambda^{\infty}$ *is the achievable optimal (third- best) solution.*

In what follows, $\lambda^{\infty}(z)$ represents the profit-sharing rule which optimises the welfare of the society as a whole. Clearly, in the absence of a profit-sharing rule (*i.e.* $\lambda = 0$), the choice of the T/S rate on profit is irrelevant for the equilibrium outcomes, as commonly believed by the received literature. Nevertheless, this conclusion no longer holds if λ is positive; thus, the following remark holds.

Remark 3: *Provided that a positive profit sharing does exist (i.e. $\lambda > 0$), then the profit taxation policy is non-neutral.*

By using $\lambda^{\infty}(z)$, as observed in Remark 2, then one can examine the effect of policy menu on the optimal social welfare, as well as the interplay between the two policy instruments, to prove:

Lemma 4: *In correspondence of the optimal social welfare, profit-sharing and profit taxation are strategic complements[21].*

Proof: It suffices to observe that $\dfrac{\partial \lambda^{\infty}}{\partial z} > 0$.

Hence, the menu available to the policy-maker(s) is characterised by a positive marginal rate of substitution between the two instruments.

It remains to analyse whether there may be an interior optimal value of the profit-sharing parameter as well as of the profit T/S rate. The following remark holds:

Remark 4: *From the simple observation (see Lemma 1 and Remark 2) of the welfare maximising value of the profit-sharing parameter, λ^{∞}, we may note that this can be feasible (i.e., included between zero and one) depending on whether z is sufficiently low. In particular, this holds for the interval of the profit tax/subsidy rate* $z \in \left(-1, 1 - \dfrac{b(4 - \gamma^2)}{4} \right)$ *for which* $\lambda^{\infty} \in \left(\dfrac{b}{8}(4 - \gamma^2), 1 \right)$.

To disentangle the role of λ and z with respect to the social welfare, the following Lemmas are presented:

Lemma 5: *Social welfare is always an increasing function of λ (in the feasible domain* $\lambda^{\infty} \in \left(\dfrac{b}{8}(4 - \gamma^2), 1 \right)$ *, for a given z)[22].*

Lemma 6: *Social welfare is always a decreasing function of z (in the feasible domain,* $z \in \left(-1, 1 - \dfrac{b(4 - \gamma^2)}{4} \right)$ *for a given λ)[23].*

Finally, we remark that:

Remark 5: *The choice of the welfare-maximising values of the couple λ, z [i.e. the "third best" λ^{∞} (z)] leaves unaltered the levels of the unions' utility and consumer surplus.*

This remark is interesting because Results 1-2, claiming that λ and z have different effects on the pay-offs of firms, workers and consumers, could suggest that the choice of the welfare-maximising values of the couple λ, z affects all these pay-offs. By contrast, for whatever couple λ, z maximising social welfare as a whole, the workers' and consumers' welfare remains unchanged, while the higher the values of the couple, the higher (lower) the tax revenue (the net profit). For instance, an increase of both values of the parameters couple that maximises social welfare leaves unchanged workers' and consumers' welfare; however, it negatively affects the firms' profits causing a corresponding increasing transfer from profits to Government revenue (and ultimately rebated to consumers).

Therefore, a social-welfare maximising Government should choose a profit-sharing parameter and a profit T/S rate according to the rule mentioned in Remarks 2 and 4. In particular, given the institutional constraint of a non-negative wage rate, it is always socially optimal introducing the profit-sharing rule at a level such that unions fix a zero base wage rate and workers get their remuneration only through the profit-share. This means that the "third best" solution can be always achieved through an appropriate choice of a couple λ, z.

To illustrate the point, let us consider the extremely simple case of unions having full bargaining power ($b = 1$) and goods perfect substitutes ($\gamma = 1$). In the case in which the Government chooses to tax profits (*i.e. z > 0*), the "third best" profit-sharing parameter should be fixed at the following values, depending on the level of the profit tax rate: $\lambda^{\infty} = 0.75$, $z = 0$; $\lambda^{\infty} = 0.833$, $z = 0.10$; $\lambda^{\infty} = 0.937$, $z = 0.20$; $\lambda^{\infty} \approx 1$ for $z > 0.25$. We denote the profit-sharing rule λ^{∞} (z) –fixed by a public authority– as *PPS*. When profits are untaxed ($z = 0$), the "third best" share of profits distributed to workers would be 75%. To sum up, note that in general 1) profit taxation is not neutral, and 2) there is a monotone relationship between the two policy instruments (i.e. the profit-sharing rule and the profit tax), to achieve the (either second or third best) optimal social welfare: that is, the higher λ, the higher z.

Therefore, we have shown that, if the government's objective is to maximise social welfare (and, even more so, to prefer the maximisation of the tax revenue component), then to set a profit-sharing parameter equal to λ^{∞} and/or combined with an appropriate profit tax will unambiguously ensure the (third-best) social optimum. However, λ^{∞} is Pareto-inferior because it would entail a redistributive effect from profits to the government's tax revenue (due to the profit tax). Therefore, as a matter of fact, firms will voluntarily introduce, as Lemma 3 shows, neither a profit-sharing system nor, a fortiori, the optimal profit-sharing value λ^{∞}.

Now we discuss how the profit-sharing rule *PPS*, which allows to achieve the maximal social welfare, is socially preferred to the standard wage system. First, we calculate the social welfare under the *PPS* rule.

Lemma 7. *By applying the PPS rule, the social welfare expressed in Eq. (17) reduces to the following:*

$$SW^{PSS} = \frac{3 + \gamma}{(2 + \gamma)^2} \tag{18}$$

It is noted that the union's power measuring the degree of imperfection in the labour market does no longer affect the social welfare.

In the absence of *PPS*, the model boils down to the standard unionised Cournot duopoly with Right-To-Manage (RTM) labour market institution whose equilibrium outcomes are well known (Dowrick, 1989, Naylor, 2003). The social welfare under such a RTM model is given by[24]:

$$SW^{RTM} = \frac{4(2 - b)\left[2(3 + \gamma) + b(1 - \gamma^2 - \gamma)\right]}{(2 + \gamma)^2 (4 - b\gamma)^2} \tag{19}$$

Therefore, it is easy to evaluate the "welfare gain" (*WG*) due to the introduction of the *PPS* rule:

$$WG = SW^{PPS} - SW^{RTM} = \frac{b(2 - \gamma)\left[8 + b(2 - \gamma^2 - \gamma)\right]}{(2 + \gamma)^2 (4 - b\gamma)^2} \tag{20}$$

Remark 6. *The "welfare gain" is increasing in the degree of product differentiation and the unions' power, suggesting that the PPS rule is particularly indicated in markets where unions and firms have a strong "monopolistic" power in labour and product markets, respectively. Moreover, it is easy to see that the "welfare gain" vanishes when unions are absent (b=0): this means that the PPS rule is able to restore the "efficiency" of a competitive labour market despite the presence of unions potentially monopolistic.*

4. Induced profit-sharing

We have shown in the previous section that firms would not choose a positive value of the profit-sharing parameter in the presence of a tax on profits. Therefore, unless we consider, rather unrealistically, the profit-sharing rule as a policy parameter enforceable by law, we could investigate whether and how firms, pursuing their profit maximising behaviour, would be induced to choose the socially optimal distribution of profits to workers.

This leads to the following question: how may the tax system be used to motivate the firms to use the profit-sharing system in a socially optimal way (Weitzman, 1984, 1985)?[25] In this paper, it is suggested that the profit subsidisation may be used as an instrument to achieve the social optimum (*i.e.* for firms implementing the socially optimum profit-sharing scheme) as clarified below.
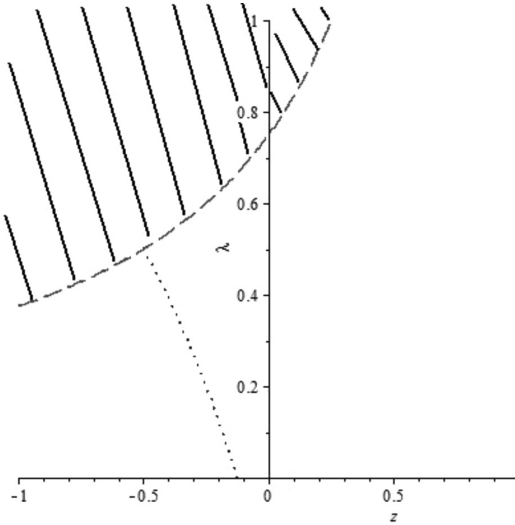
Figure 1: The curves of the maximum values of the union's utility (grey dashed line) and the net profits (black dotted line) in the parametric plane (z,λ) in the case of monopolistic unions (b=1) and perfect substitute goods (γ=1). The intersection point of the curves indicates the couple λ^{OPS}, z^{OPS} (i.e., OPS denotes the "socially optimal profit-sharing" introduced by firms). The shadowed area represents the economically unfeasible region where wages are negative

Result 4. *Both union's welfare and firms' profits are maximised by a single value of parameters:* $z = z^{OPS} \equiv \dfrac{b(\gamma^2 + \gamma - 2) - 2\gamma}{4}$ *and* $\lambda = \lambda^{OPS} \equiv \dfrac{b(2-\gamma)}{2 + b(1-\gamma)}$ *, where OPS stands for "socially optimal profit-sharing" system, which is not only preferred by society as a whole, but it is also Pareto-superior for both producers (firms and workers). Indeed, in such a case, also consumer's surplus and social welfare are at their maximum value, given the constraint of non-negative wages.*

Proof: simply equating $\lambda^\infty = \lambda^{**}$.[26]

For instance, focusing on the case of perfect substitutes and unions with full bargaining power, from Result 4 it is easily obtained that the social welfare is maximised when $-z = \lambda = .5$; see also the illustration of this single optimal couple λ^{OPS}, z^{OPS} in Figure 1.

Result 4 shows that with a unique simple value of the parameters z and λ firms and work-ers achieve a Pareto-superior equilibrium outcome for them[27]. In turn, this implies that, once Government has fixed z, firms (in accord with their unions) find profitable to set the socially optimal λ. From Result 4, the following remark follows.

Remark 7. *The profit subsidisation can be interpreted as a "device" to motivate firms to introduce the profit-sharing percentage which is socially optimal (in alternative to fixing such a percentage by law).*

Now we may calculate the social welfare also when the *OPS* rule is applied.

Lemma 8. *By applying the OPS rule, the social welfare expressed in Eq. 17 reduces to the following:*

$$SW^{OPS} = \frac{3+\gamma}{(2+\gamma)^2} \tag{21}$$

Therefore, by observing that both *PPS* and *OPS* rules lead to the same social welfare, we may conclude that, irrespective of the way of setting the rule –by the public regulator by law or freely by firms (induced by the tax policy)– a profit-sharing system always eliminates the inefficiencies caused by the imperfect labour market.

To illustrate also quantitatively the predicted effects of the previous results and stress the characteristics of the *OPS* and of its "induced" adoption, we have calculated the equilibrium values of the model both in the *OPS* regime and the benchmark case of the wage system (*WS*) (*i.e.*, without profit-sharing, which can be obtained simply setting $\lambda = 0$ in the model in section 2) under different levels of the union's bargaining power and degrees of product differentiation, as reported in Table 1. An in-depth investigation of those results leads us to articulate several observations.

Table 1

EQUILIBRIUM VALUES IN THE ECONOMY UNDER OPS AND WS UNDER DIFFERENT UNION'S BARGAINING POWER AND DEGREE OF PRODUCT DIFFERENTIATION'S CONFIGURATIONS

Parameter	Regime	λ	z	π	w	V	q	SW
$b=1$, $\gamma=1$	OPS	0.5	-0.5	0.111	0	0.083	0.338	0.444
	WS	0	0	0.0493	0.333	0.074	0.222	0.346
$b=0.5$, $\gamma=1$	OPS	0.25	-0.50	0.111	0	0.0417	0.333	0.444
	WS	0	0	0.0816	0.1429	0.0408	0.2857	0.408
$b=0.5$, $\gamma=0.5$	OPS	0.333	0.4063	0.16	0	0.075	0.40	0.56
	WS	0	0	0.1024	0.2	0.064	0.32	0.486
$b=1$, $\gamma=0.5$	OPS	0.6	-0.562	0.16	0	0.101	0.40	0.56
	WS	0	0	0.052	0.428	0.098	0.228	0.379
$b=0.1$, $\gamma=1$	OPS	0.05	-0.5	0.111	0	0.00833	0.333	0.503
	WS	0	0	0.105	0.026	0.00832	0.3248	0.492

Remark 8. *With respect to a WS, the introduction of a OPS increases in a wider scale the social welfare when the unions' bargaining power increase. In other words, the switch toward a OPS scheme is more efficient in presence of strong union's bargaining power and, therefore, it would be advisable to introduce it in economies or industries highly unionised. For example, as a consequence of the regime switch, the social welfare would increase (in the case of homogenous goods) by 1.8% and 8.8% when the union's bargaining power is at a low level (b=0.1) and an intermediate level (b=0.5) respectively, while it rises by 28.7% in the presence of monopoly unions (b=1). Noteworthy, the introduction of a OPS also increases the firms and unions' welfare as well as the consumer's surplus in a wider scale when the unions' bargaining power increase.*

Remark 9. *An increase in the degree of product differentiation raises the welfare of firms' shareholders and workers, the consumer surplus and the social welfare in both remuneration schemes. By passing, it should be noted that, when the products are more differentiated (and, thus, the market is more "monopolistic"), also the consumer surplus increases. The rationale for this result is that the "market-expansion effect", implicit in the Singh and Vives' (1984) demand function here adopted, more than compensates the anti-competitive effect of differentiation. However, it has to be noted here that the positive effect of the regime switch from WS to OPS on profits, unions' utility, consumer surplus and the social welfare is largely increasing with the degree of product differentiation. It follows that the OPS here proposed is more advantageous where the degree of monopoly power in the market is higher.*

Remark 10. *The effects of the union's bargaining power (b) and of the degree of product differentiation (γ) on the "relevant parameters" of the OPS are non-monotonic (non-linear). For example, 1) the shift from homogeneous products to differentiated products with γ = .5 in the case of monopoly unions, increases the profit-sharing parameter from 50% to 60%, and the profit subsidy from 50% to 56.25%, while in the presence of unions having the bargaining power identical to the one of firms (b = .5), the profit-sharing parameter increases from 25% to 33%, however the profit subsidy decreases from 50% to 40.6%; 2) in the case of homogeneous goods, a rise in the union's bargaining power from 0.1 to 0.5 and, finally to 1, it always causes an increase of the profit-sharing parameter from 5% to 33% and then 50%, respectively, while the profit subsidy keeps constant at the rate of 50%; however, in the case of differentiated products with γ=.5, an increase in the union's bargaining power from 0.5 to 1 causes again an increase both of the profit-sharing parameter (from 33% to 60%) and of the profit subsidy rate (from 40.625 % to 56.25%).*

Remark 11. *An important characteristic of the OPS is that an increase of the union's bargaining power leaves unaltered both the levels of profits and CS, and the welfare benefits are transferred only to workers and, as a consequence, to the overall social welfare. Two considerations follow: 1) the social welfare increases with the degree of monopolisation (unionisation) of the labour market, in contrast to the common wisdom (in other words, the OPS transforms the labour market "distortion" in a "corrective action" of the product market distortion); 2) the welfare of firms' shareholders and consumers' surplus are "sterilised" from variations of the union's bargaining power (i.e. shocks in the industrial relations).*

Remark 12. *The distributive effects of a passage from a WS to a OPS indicate that mainly the profits, then the CS and, finally, the SW, would be the relatively largest recipients of a switch with respect to workers, who benefit in a (sensibly) minor scale: in fact, for example, considering the case of an intermediate level of union power and differentiation degree (b = γ = .5), the regime switch would cause a 56.25% increase in profits, a 25% increase in CS, a 17.8% in the social welfare, and only of the 17.1% in the union utility. In the case of low unions' bargaining power (b = .1), those effects are magnified at an extremely reduced scale and, as observed in Remark 7, the benefits from a regime switch would be minimal: under those circumstances, the profits' gain are 5.3%, the CS' gains are 2.6%, the social welfare increases by 1.8% while workers' welfare just 0.1%.*

5. Extensions

In the next subsections, we briefly discuss some extensions of the main model. The analytical details are omitted for economy of space; however, those results are available from the authors upon request.

5.1. Decentralised unions, Cournot competition and positive reservation wage

Usually, the literature on profit-sharing (Sørensen, 1992; Göddeke, 2010) points up that the union-firm bargaining units can agree on a level of the base wage below the outside remuneration/unemployment benefit to expand employment (production) above the labour demand to maximise their joint utilities. In other words, the union can accept less money in the immediate to seek more profit-sharing when the profit (*i.e.*, the size of the "cake" to share) is realised. The assumptions of the main model (risk-neutral trade unions, normalisation to zero of the outside remuneration for workers) can lead to an equilibrium base wage which can be negative. However, relaxing the assumption that unions do not maximise the base wage w_i but the wage surplus $w_i^s = (w_i - w_0)$, where $w_0 \in (0,1)$, it is obtained that, under this linear transformation, a former negative base wage may become positive, though below the unemployment benefit/reservation wage level. In a supplement, available upon request from the authors, we have analysed this model specification. The key results correspond to the main model in the text with all the relevant expressions for profits, union utility, tax revenues and overall social welfare scaled simply down by the factor $(1 - w_0)^2$. In particular,

Lemma 1 holds for $w_i(\lambda,z) \geq 0 \Leftrightarrow \lambda \leq \lambda^{\infty} = \dfrac{b[4w_0 - b\gamma + 2b(1-w_0)](2+\gamma)}{4(1-z)}$. However, the pres-

ence of a positive reservation wage modifies the results of the reference model. In fact, $w_i(\lambda,z) \geq 0 \Leftrightarrow \lambda \leq \lambda^{\infty}$; nevertheless, given $w_0 > 0$, it can be that $(w_i - w_0) \leq 0$. As a consequence, to guarantee a positive union utility, $V_i(\lambda,z) \geq 0$, the profit-sharing parameter has to

be sufficiently high. Simple algebra shows that $V_i(\lambda,z) \geq 0 \Leftrightarrow \lambda \geq \lambda^{NN} = \dfrac{4-\gamma^2}{2(1-z)}$ where the

upper script *NN* stands for "non-negative utility"; to satisfy simultaneously the two constraints, the profit-sharing parameter has to be $\lambda^{NN} \leq \lambda \leq \lambda^{\infty}$.

Consequently, Result 2 modifies as follows. It is again obtained that $\dfrac{\partial V_i(\lambda, z)}{\partial \lambda} \overset{>}{\underset{<}{=}} 0 \Leftrightarrow \lambda \overset{<}{\underset{>}{=}} \lambda^{***}$ which now implies that $\lambda^{\infty} < \lambda^{***}$ for $\gamma > 1 - c$, and V_i is maximised in a constrained way at the level λ^{∞}, because λ^{***} would violate the institutional non-negativity constraint on wages; on the other hand, $\lambda^{***} < \lambda^{NN}$ for $\gamma > 0$ and V_i is maximised in a constrained way at the level λ^{NN}, because λ^{***} would violate the non-negativity constraint on union utility. Summarising:

$$\begin{cases} if \quad \gamma > 1 - w_0, \quad \lambda^{\circ\circ} < \lambda^{***}; \lambda^{\circ\circ} \text{ optimal} \\ if \quad 1 - w_0 \geq \gamma > 0, \quad \lambda^{NN} < \lambda^{***} \leq \lambda^{\circ\circ}; \lambda^{***} \text{ optimal} \\ if \quad \gamma \leq 0, \quad \lambda^{***} \leq \lambda^{NN}; \lambda^{NN} \text{ optimal} \end{cases}$$

Our preliminary results for the case of perfect substitutes ($\gamma = 1$) and unions with full bargaining power ($b = 1$) reveal that the optimal λ is $\lambda^{\circ\circ} = \dfrac{3(1+2w_0)}{4(1-z)}$.[28]

It follows that, to obtain feasible values of $\lambda \in [0,1]$, the reservation wage has to be equal to $0 < w_0 \leq \dfrac{1}{6} - \dfrac{2}{3}z$. Moreover, if we interpret w_0 as a policy tool, such as a minimum wage and

an unemployment benefit, from Lemma 1 it can be obtained an optimal value w_0^{∞} that respects the non-negativity conditions on quantities and whose relation with the other policy instruments is of strategic complementarity with λ and strategic substitutability with z. Then, the government can combine two instruments, the minimum wage/unemployment benefit and the profit tax rate (whose maximum level is now $z < 1/4$), to determine the profit-sharing share parameter. As a consequence, the rule such that both union's welfare and firms' profits are maximised is given by and $z = z^{OPS} \equiv -\dfrac{1}{2} - \dfrac{3w_0}{4}$ and $\lambda = \lambda^{OPS} \equiv \dfrac{1+2w_0}{2+w_0}$.

Therefore, the presence of a positive (though not excessively high) reservation wage (or minimum wage/unemployment benefit) requires, on the one hand, that the government has to fix a higher profit subsidy to induce firms to introduce the profit-sharing system; however, on the other hand, it can set a larger profit-sharing parameter. In addition, the result of the consumer's surplus and union utility invariance (Remark 5) is still valid and, as a consequence, the crucial Result 4 holds also under this model configuration. The remaining results are qualitatively equivalent to those of the reference model; in particular, the social welfare lowers at the level $SW = \dfrac{(1-w_0)^2(3+\gamma)}{(2+\gamma)^2}$.[29]

5.2. Decentralised unions, Bertrand competition

The results of our model have also been checked for the case of Bertrand competition with decentralised unions. The qualitative results are substantially confirmed also under this model specification. More in detail, in this case Lemma 1 holds for

$$w_i(\lambda, z) \geq 0 \Leftrightarrow \lambda \leq \lambda^{\circ\circ} = \frac{b(4 - \gamma^2)}{2(2 - \gamma^2)(1 - z)}$$ with $\gamma \in (-1, 1)$, from which it can directly be observed

that, under price competition, the level of the profit-sharing parameter which is optimal for unions is larger than under quantity competition.

The rationale for this result is as follows: under quantity competition the market game is played in strategic substitutes, while under Bertrand competition in strategic complements. This leads the firms under the Bertrand conjecture to a fiercer competition that lowers price and increases output which, in turns, shrinks the profit-sharing part of the workers' compensation. Therefore, to sustain the unions' utility component in the social welfare, the Government should fix a higher share parameter. Also with price competition, the conclusions of Result 3 apply: in the case of a profit tax (*i.e.* $z > 0$), $\lambda^* > 1$. Therefore, the existence of a positive, feasible profit-sharing parameter $\lambda \leq 1$ requires a subsidy $z^* \leq 0$, and the feasible optimal (second-best) solutions would be $\lambda^* = 1$, $z^* = 0$. However, such solution no longer violates the institutional constraint of non-negative wages when the unions' bargaining strength is rather high in the presence of very complements/substitutes, as Figure 2 shows.
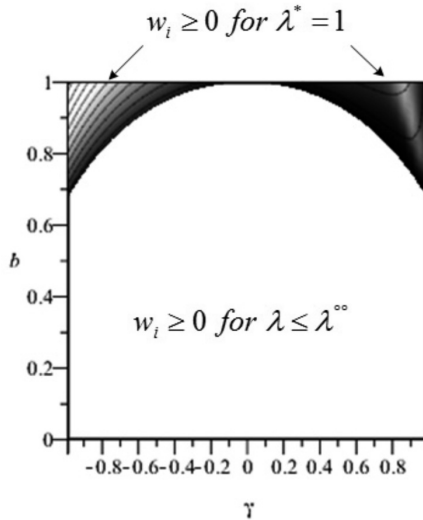

Figure 2: Relation between the institutional constraint on wage and the optimal profit-sharing scheme parameter under decentralised bargaining and Bertrand competition in the space (γ,b)

Therefore, if the government can introduce the profit-sharing scheme, the optimal policy is as follows:

$$\begin{cases} if & b \le \dfrac{2(2-\gamma^2)}{4-\gamma^2}, & \lambda \le \lambda^{\circ\circ} = \dfrac{b(4-\gamma^2)}{2(2-\gamma^2)(1-z)} \\ \\ if & b > \dfrac{2(2-\gamma^2)}{4-\gamma^2}, & \lambda^* = 1, z^* = 0 \end{cases}$$

On the other hand, the policy rule to induce the adoption of the profit-sharing scheme so that both union's welfare and firms' profits are maximised is

$$z = z^{OPS} \equiv -\frac{4b+2\gamma(2-3b)-\gamma^3(2-b)}{4(1-\gamma)(2-\gamma^2)} \text{ and } \lambda = \lambda^{OPS} \equiv \frac{2b(1-\gamma)(2+\gamma)}{2(2+b-\gamma)-b\gamma(2+\gamma)}.$$

A further analytical inspection reveals that the profit subsidy under Bertrand competition is always higher than under Cournot competition; however, in line with the conventional result of Singh and Vives (1984) concerning the profit levels, the optimal profit-sharing parameter the Government fixes to maximise social welfare under Bertrand competition is higher (lower) than the one under Cournot when goods are complements (substitutes). All the other results are qualitatively confirmed also under this model specification. In particular, the social welfare equals $SW = \dfrac{3-2\gamma}{(1+\gamma)(2-\gamma)^2}$. Finally, a straightforward comparison of the equilibrium outcomes under Cournot and Bertrand competition with decentralised bargaining reveals the following noteworthy result. In the large area in which the Government induces the profit-sharing system, the standard results that the consumer's surplus and the social welfare are higher under Bertrand than under Cournot are confirmed; however, in contrast to the standard result and at first glance rather surprisingly, also profits under Bertrand are higher than under Cournot[30]. The rationale for this results is as follows. As above mentioned, the subsidy with Cournot competition is always lower than under Bertrand, and in the latter case the level the Government fixes is adequately high to reverse the conventional wisdom.

5.3. Industry union, full centralised bargaining

Finally, the robustness of our findings has been tested for a model with Cournot competition and full centralised bargaining, in which an industry-wide union negotiates with an employers' confederation[31]. Also in this case, the qualitative results are significantly substantiated. Lemma 1 now holds for $w_i(\lambda, z) \ge 0 \Leftrightarrow \lambda \le \lambda^{\circ\circ} = \dfrac{b(2+\gamma)}{2(1-z)}$. A direct comparison reveals that the profit-sharing parameter which is optimal for unions under centralised negotiations is larger (lower) than under decentralised negotiations when goods are substitutes

(complements). Result 3 also holds true under this model specification: a profit tax (*i.e.* $z >$ 0) implies that $\lambda^* > 1$. Thus, the existence of a positive, feasible share parameter $\lambda \leq 1$ needs a subsidy $z^* \leq 0$, and the feasible optimal (second-best) solutions would be $\lambda^* = 1$, $z^* = 0$.

Nonetheless, in a small area of the parameter space characterised by combinations of extremely high union's bargaining power and close substitute goods (which, remarkably, includes the case of perfect substitutes and monopoly union), the solution $\lambda^* = 1$, $z^* = 0$ guarantees that the institutional constraint of non-negative wages is not violated, as depicted in Figure 3.

As a consequence, if the government can mandatorily introduce the profit-sharing scheme, the optimal policy will be:

$$\begin{cases} if \quad b \leq \dfrac{2}{2+\gamma}, \quad \lambda \leq \lambda^{\circ\circ} = \dfrac{b(2+\gamma)}{2(1-z)} \\[2ex] if \quad b > \dfrac{2}{2+\gamma}, \quad \lambda^* = 1, z^* = 0 \end{cases}$$
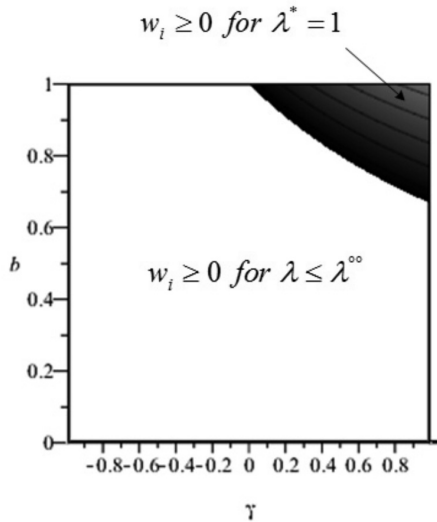

Figure 3: Relation between the institutional constraint on wage and the optimal profit-sharing scheme parameter under centralised bargaining and Cournot competition in the space (γ,b)

On the other hand, the policy rule to induce the adoption of the profit-sharing scheme with the purpose of maximise both union's welfare and firms' profits is:

$$z = z^{OPS} \equiv -\frac{(b+\gamma)}{2} - \frac{b\gamma}{4} \text{ and } \lambda = \lambda^{OPS} \equiv \frac{2b}{2+b}.$$

Note that the socially optimal share parameter does not depend on the degree of product differentiation. The rationale for this result is as follows. In the case of full centralisation, the employers' association acts as a unique body and, therefore, during the bargaining process, it tends to internalise the degree of product differentiation. As a consequence, the Government fixes a profit-sharing parameter which depends exclusively on the parties' bargaining power. An analytical inspection shows that the tax/subsidy level under centralised negotiations is always higher (lower) than under decentralised negotiations when goods are substitutes (complements); however, the profit-sharing parameter under centralised negotiations is larger (lower) than under decentralised negotiations when goods are substitutes (complements). All the other findings are qualitatively substantiated also under this model specification. Finally, a direct comparison of the equilibrium outcomes under centralised/decentralised bargaining under Cournot competition shows the following result. The degree of centralisation of the wage negotiations leaves unaffected net profits, consumer's surplus and the social welfare, while the union utility increases. Therefore, the unique social welfare component which modifies is the tax revenue the Government collects which lowers.

6. Conclusions

In this paper we have mainly focused on whether it is optimal for the society introducing profit-sharing as well as a profit T/S policy in a Cournot duopoly, where decentralised labour unions bargain with firms over the wage rate. It is suggested that i) the optimality policy rule prescribes the use of a profit-sharing system, ii) profit T/S policy is not neutral, iii) the higher the profit-sharing parameter, the higher profit taxation. Moreover we argue that, although an increasing profit-sharing parameter has conflicting effects (*i.e.* the net profit accruing to the firms is reduced, workers and consumers' welfare is increased), a sufficiently high profit-sharing rule is always in the interest of the society as a whole. Moreover, we have shown that, under an opportune profit T/S policy, a profit-sharing system is also convenient for firms (and unions). Thus, this finding suggests that an opportune T/S policy may be an example of the use of the tax system to encourage firms to introduce voluntarily the profit-sharing system in a socially optimal way, as suggested by Weitzmann (1984).

This paper picks up the simple social welfare maximising recipe consisting in a proportional profit subsidy which implies that firms have an incentive to choose a profit-sharing rule. Importantly, this "socially optimal profit-sharing system" is also the rule maximising the welfares of firms' shareholders and workers (given the institutional constraint of a non-negative wage) and thus it achieves a Pareto-superior outcome for them (for instance, in the

special case of monopoly unions and perfect substitute goods, the "socially optimal profit-sharing system" implies a 50 per cent net profit share distributed to workers, jointly with a 50 per cent profit subsidisation).

More generally, the key characteristics of the current model are as follows. With respect to a standard wage setting system, the magnitude of the positive effect on the social welfare due to the introduction of the profit-sharing scheme rises with increasing unions' bargaining power, making the "socially optimal profit-sharing system" particularly suited for industries highly unionised. Furthermore, the relatively higher gain in terms of social welfare allowed by such a system in significantly unionised industries also holds true in terms of welfare gains of all the single agents. The higher the degree of product differentiation, the higher the welfare of all the economic agents and the social welfare in both remuneration schemes, but the welfare gain allowed by "socially optimal profit-sharing system" is sizably higher. The union's bargaining power and product differentiation's impact on the "relevant parameters" of the optimal profit-sharing scheme are non-monotonic. In the profit-sharing system, an increase of the union's bargaining power leaves unchanged both the profit levels and consumer surplus; therefore, the welfare benefits are transferred only to workers. The distributive effects of a possible change from a wage system to a profit-sharing scheme, which is Pareto-superior for firms and workers, indicates that relatively largest welfare recipients are, in order, profits, consumer surplus and, finally, workers.

The essential message is that a unique optimal recipe does exist and this may be implemented by Government without coercive intervention on the structure of the pay system in the labour market: indeed firms, by maximising their profits under the presence of an appropriate profit subsidy rate, apply precisely the socially optimal profit-sharing rule. In particular, it is shown the relevant feature which holds for a profit-sharing rule set by the public regulator as well as voluntarily by firms: such a rule completely eliminates the social welfare loss due to the imperfection in the labour market. Those results have been tested under different model specifications (presence of a positive reservation wage/unemployment benefits; price competition; quantity competition and industry-wide negotiations); it was found that the key features of the model are confirmed and, therefore, our findings are robust to different characteristics of the product market and labour market institutions.

The paper is constructed on a precise set of assumptions. To verify the robustness of our findings, a straight forward extension of analysis is to introduce other performance related pay schemes such as the piece-rate pay scheme. Finally, the model has considered the case of perfect symmetry in labour productivity. However, different labour productivities may exist among the firms active in the market. These observations may encourage future research.

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Notes

1. Such arrangements, broadly speaking, denote a performance related remuneration mechanism, generally constituted by a base wage plus a percentage share of profits of firms.

2. As regards the incidence of profit-sharing in OECD countries, OECD (1995, 139) reports that it "covers 5 per cent or more of employees in Canada, France, Germany, Italy, Japan, Mexico, the Netherlands, the United Kingdom and the United States".

3. He shows that it is never optimal for a monopoly firm to introduce profit-sharing, but it is always optimal for a firm in a Cournot oligopoly.

4. Both Fung (1989) and Sørensen (1992) find that it is ambiguous whether it is optimal for the firms to introduce profit-sharing, and in particular Sørensen relates this ambiguity to the bargaining power of the unions. In line with Sørensen (1992), Buccella (2016) finds that, depending on the institutional features, both fixed wages and a profit-sharing system can arise as equilibria in Nash strategies; however, he also shows that unions and firms may agree on a profit-sharing scheme as a market entry deterrent mechanism if the unions are not too strong.

5. Broadly speaking, every tax that does not cause individuals or firms to shift their economic choices may be defined as neutral. More in detail, with regard to the firm's taxation, the established conditions for its neutrality in the long run is that no tax falls on the return of the marginal investment project (Stiglitz, 1973). It is easy to see that, in the standard short-run unionised Cournot duopoly here adopted, the profit tax would never appear in the equilibrium outcomes, unless a profit-sharing system is implemented, which is a novelty of this paper.

6. The enforcement by law of an "optimal" profit-sharing rule may be not too much realistic as well as considered an "unpleasant" intervention in the labour market arrangements. Indeed, it could be preferred that firms freely and voluntarily would set a profit-sharing rule which is also social welfare-improving. In this respect, we show that the profit T/S decision of the Government can induce firms to introduce a profit-sharing scheme and the latter possibility is analysed and discussed in this paper in Section 4.

7. For the sake of precision, the following utility function is a commonly used specific case of the more general Stone-Geary utility function.

8. The case of a positive w^o will be briefly discussed in Section 5.

9. In the case of choice by firms (and unions), the "socially optimal profit-sharing rule" would be chosen because, under the effects of the socially optimal profit T/S rate, it would result to be optimal also for firms (and unions), as it will be discussed more in detail in Section 4.

10. Therefore, the structure of the game between firms and unions represents what has been called a Right-to-Manage model (Nickell and Andrews, 1983).

11. Note that the Government (or firms) chooses (choose) λ, while firms and unions bargain only on w_i. This frame is different from that of Sørensen (1992), where both λ and w_i are negotiated between firms and unions, while it is in accord with the frame of Fung (1989).

12. It is straightforward to observe from (13) that the consumer's surplus is increasing in the profit-sharing parameter and decreasing in the profit tax rate.

13. Note that the tax revenue (resp. the subsidy expenditure) is rebated as a lump-sum subsidy (resp. lump-sum tax) to consumers.

14. Notice that social welfare is always positive for whatever values of λ, z and γ since:

$$SW \geq 0 \Leftrightarrow \lambda \leq \lambda^\circ = \frac{6 + 2\gamma + b(1 - \gamma - \gamma^2)}{4(1-z)}, \quad \lambda^\circ > 1$$

15. Those authors introduce the institutional constraint of a non-negative fixed wage base in a context of a classic agency model in which each single principal-agent pair could freely define each single pay-component (independently of the non-negativity constraints).

16. "Moreover, the imposition of wage floors is also accomplished in many countries by institutionally defining minimum wages that, as suggested by a variety of evidence including the spike at the wage distribution at the minimum […] are binding for some workers." (Fanti and Meccheri 2012, 291). Consequently, in the main model, we retain the non-negative "institutional constraint": in fact, several countries in the world consider the presence of minimum wages. For example, in the EU, almost all countries have a legal minimum wage (exceptions are Denmark, Italy, Cyprus, Austria, Finland and Sweden with no legal minimum wages) (Eurostat, 2017). Among the OECD countries, Iceland and Switzerland do not have statutory minimum wages, while labour market regulations in the other member countries contemplate their existence (OECD, 2015).

17. The proofs of lemmas are straightforwardly derived from Eq. (10) and the non-negativity condition of Eq. (11), respectively.

18. This is a technical condition necessary because a negative profit-share is physically meaningless.

19. The proof is straightforwardly derived by the differentiation of Eq. (17) with respect to λ and with respect to z, respectively, and omitted here for economy of space.

20. This paper conducts a welfare analysis in which the social welfare is compared under the possible configurations with regard to the tax/subsidy policy. Thus, for simplicity, it is defined, loosely speaking, the first position in the social welfare ranking under the feasible policy recipes as "the best achievable welfare outcome", the second position in the ranking as the "second best achievable outcome", and so on. Therefore, when the emergent equilibrium is the best achievable and the interests of all the agents (both firms, consumers and social welfare as a whole) coincide, the best achievable outcome can be also defined as the Pareto-superior outcome (while if the interests of a couple of agents coincide, it may be said that the outcome is Pareto-superior for them).

21. As Bulow (1985) state, let α_i denote (in general terms) economic agent i's action, and let $\pi_i(\alpha_i, \alpha_j)$ be the economic agent i's payoff associated to action α_i and the economic agent j takes action α_j. Then, strategic substitutes are defined as $\frac{\partial \pi_i^2}{\partial a_i \partial a_j} < 0$, while strategic complements are defined as $\frac{\partial \pi_i^2}{\partial a_i \partial a_j} > 0$.

22. This follows from Result 3.

23. This follows from Result 3.

24. This may be straightforwardly calculated by applying the standard analysis to the model in Section 2 by setting $\lambda = 0$ (the easy calculations are omitted for economy of space).

25. The fact that public regulator may use policy instruments to induce the profit-sharing rule may be justified for instance when the wage system "represents some sort of institutional Nash equilibrium, with other combinations of (w, λ) not sustainable in the face of possible externality/free-rider problems… If true, it might justify public policy to induce high values of λ" (Weitzman, 1985, 946).

26. Note that in the extreme case of the absence of unions (*i.e.* $b = 0$), the optimal profit-share is zero and cannot be positive for any level of profit subsidy because it would violate the wage non-negativity constraint. Then, z^{OPS} loses importance when $b = 0$.

27. Note, however, that it is easy to demonstrate that, since the optimality requires a subsidy whose financing is a lump-sum tax burdening on consumers, then the net welfare of consumers –although the consumer surplus would not be affected (as claimed in Remark 5)– is always decreasing in the optimal profit subsidy parameter. Therefore, such a rule is optimal for the society as a whole and Pareto-superior for producers (firms' shareholders and workers) but it is not also Pareto-superior for all the agents because consumers reduce their net welfare.

28. A general treatment for the case of $\gamma \in [-1,1]$ and $b \in [0,1]$ with positive reservation wage is in progress and object of further research.

29. Therefore, also in the case of a positive reservation wage, the *OPS* rule restores the efficiency eliminating the distortion created by the imperfection in the labour market.

30. As known, the Singh and Vives (1984) established result is that profits under Cournot (Bertrand) competition are higher than Bertrand (Cournot) for substitute (complement) goods. However, in the current model, we argue that firms compare the net profits when decide their competitive strategic variable. In this case, because λ is lower in Bertrand (Cournot) with substitute (complement) goods and z is always higher in Bertrand than in Cournot, it follows that net profits under Bertrand overcome those under Cournot for whichever degree of product differentiation, reversing the established result. Thus, the switch toward the profit-sharing regime has also an impact on the firms' competition mode. However, this is beyond of the scope of this paper.

31. The economic literature usually refers to a situation as full centralised negotiations when a central trade union (in other words, a trade unions' confederation) negotiates with a central employers' association. Under this circumstance, it is rather plausible to think that the two bargaining parties' outside option equals zero. In fact, in case of negotiations' breakdown, the firms' management may lock out activities and the unions may call for a general strike. On the other hand, if only one party coordinates bargaining activity (semi-centralisation), that party has the incentive to adapt "opportunism in bargaining" during its negotiations with the other party (McAfee and Schwartz, 1994), increasing the disagreement point and improving its bargaining position. The parties' endogenous choice of conducting centralised/decentralised negotiations in the current context (therefore, considering a possible Government's intervention in the labour market regulation) is left for future research. For an analysis of full decentralised, semi-centralised and full centralised negotiations in the labor market, see Buccella (2013) and Santoni (2014).

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Resumen

Este artículo investiga los efectos sobre el bienestar social de la introducción de una regla de reparto de beneficios y de una política de impuestos o subsidios sobre los mismos en el marco de un duopolio de Cournot cuando se desarrolla una negociacion descentralizada sobre la tasa salarial entre la empresa y el sindicato.

Se concluye que 1) el bienestar social se incrementa de manera continua al subir la parte de los beneficios que va a los trabajadores y la imposición sobre los beneficios no es neutral: la regla de optimalidad prescribe que se usen de manera complementaria; 2) aunque un mayor parámetro de reparto de beneficios tiene efectos conflictivos (i.e. los beneficios netos que reciben las empresas reducen el aumento de bienestar de los trabajadores y consumidores), una regla que fije un reparto de beneficios lo suficientemente elevado puede ser beneficiosa para la sociedad porque permite la eliminación de la ineficiencia causada por las imperfecciones del mercado de trabajo. Además, se muestra que un tercer mejor óptimo de bienestar social (dadas las limitaciones institucionales de la no negatividad de la tasa salarial) puede ser alcanzado. Resulta interesante que, en este caso, las empresas y los trabajadoresçs alcancen el máximo de bienestar. Por tanto, se argumenta que las subvenciones a los beneficios pueden ser usadas para motivar a las empresas a aplicar "la regla socialmente óptima de reparto de beneficios", lo que garantiza resultados superiores en sentido de Pareto para los productores (empresas y trabajadores) como, por ejemplo, en el supuesto especial de sindicatos monopolistas y perfecta sustituibilidad de bienes, la regla de un reparto del 50% de los beneficios netos a los trabajadores junto a una subvención a los beneficios del 50%.

Palabras clave: reparto de beneficios, subsidios e impuestos a los beneficios, bienestar social, sindicatos, modelo de duopolio de Cournot.

Clasificación JEL: H25, L13, J3, J51