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Profit Tax Evasion under Wage Bargaining Structure

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Abstract: This paper deals with the neutrality of profit taxes levied on firms as well as the implications of tax evasion in economies with right-to-manage wage formation and efficient bargaining, respectively. Contrary to the outcome under competitive labor markets, we show that profit taxes are not neutral and the firm's tax evasion decision is not separable from its production decision under right-to-manage wage formation, where a trade union and firm bargain over the wage rate (except in the special case of a monopoly union). A similar conclusion follows from an efficient bargaining model, where a trade union and firm bargain over both the wage rate and employment. In addition, wage bargaining plays an important role in determining the optimal profit tax and the enforcement policy.

Keywords: profit tax evasion, separability, wage bargaining
JEL Classification: D8, H25, H26

1 Introduction

In their seminal reports, Wang and Conant (1988) and Yaniv (1995) all concluded that a firm's output decision can be separated from its evasion behavior in the context of an uncertain monopoly. They refer to this phenomenon as unidirectional separability, which means that tax evasion will not have an influence on output.[1] The implication of separability demonstrates that changes in tax parameters that may alter tax evasion behavior, such as penalty rate and profit tax, exert no indirect influence on output choices. Thus, profit taxes are neutral. These predictions induce researchers to identify exceptions to their findings.

1 Note that any change in the production will clearly alter the optimal amount of tax evaded. Unidirectional separability says that the possibility of tax evasion will not have an impact on the output.

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The subsequent literature applies the non-separability property to provide a justification for the existence of non-neutral profit taxes. First, Marrelli (1984), Marrelli and Martina (1988), Virmani (1989), and Lee (1998) stated that if the audit probability or penalty rate varies with reported cost, revenue or output level, production and evasion choices may not be separable for monopolistic firms. Second, Panteghini (2000) observed that the separability feature would no longer hold when the investment decision of a firm is irreversible. Third, according to Goerke and Runkel (2006), profit tax evasion may influence output if the number of firms alternates under oligopoly and an endogenous market structure. Moreover, Bayer and Cowell (2009) argued that due to a relative audit regime creates externalities in the declaration of profits,[2] the quantity choice under such a regime can be affected by tax evasion decision. One more point should be noted is that the study of Baumann and Friehe (2010) suggested that within an intertemporal framework, the separability trait will not hold if a firm invests in its long-term competitiveness. Finally, Wu and Yang (2011) demonstrated that if a monopolistic firm has alternative objectives other than maximizing profit, the profit taxes won't be neutral and a firm's output decision cannot be separated from its evasion behavior.

Our paper relates to, but not the same as, the work on tax evasion and wage bargaining by Goerke (2003), who has also addressed the issue of tax evasion in a unionized economy. Goerke focused on individual tax evasion rather than on corporate tax evasion as in our model. Our analysis, therefore, is intended to complement for the findings of Goerke (2003). To the best of our knowledge, there is no past study exploring the scenario marked with a collective bargaining between a tax evading firm and its labor union. Being an important issue, collective bargaining between a firm and its labor union is a dominant form of wage determination in most Western European economies as well as in OECD countries (see Lockwood 1990; Cahuc, Postel-Vinay, and Robin 2006). Union bargaining also plays a crucial role in various areas such as income tax policy (Lockwood 1990; Aronsson 2005), privatization policy (Haskel and Sanchis 1995; Goerke 1998) and employment fluctuations (Danthine and Hunt 1994; Kennan 2010).

Our aim is to revisit whether profit taxes are neutral when wage bargaining is available. In this paper, two wage setting structures that have received much attention in the labor market are presented: the right-to-manage model (bargaining over wage only)[3] and the efficient bargain model (negotiating over both

2 In a relative audit regime, a competitor *j's* increasing its declaration will raise the probability of firm *i's* being audited. See Bayer and Cowell (2009) for detailed discussions.

3 See Koskela and Schöb (1999) and Aronsson and Sjögren (2004).

wage and employment).[4] For simplicity, we assume that labor is the only input[5] with another assumption that the union can correctly anticipate the firm's evasion behavior. The union can refer to the information of wage rate and status of employment therefore capable of discerning the firm's evasion behavior, thereby sharing the economic rents generated by tax evasion. In contrast, the tax authorities are not able to detect such an evasion occurring with no accessibility on inside information,[6] in which can be supported by several papers such as those by Pirttilä and Tuomala (1997), Aronsson and Blomquist (2003), Blomquist and Micheletto (2006), and Micheletto (2008).

Our findings can be summarized as follow. The level of tax evasion influences wages in a right-to-manage wage setting and in an efficient bargaining context. Since employment is determined with wages, a firm's output decision cannot be separated from its evasion behavior.

The rationale behind our findings is that, prior to the decision of profit tax evasion, the firm and its labor union should negotiate over wages, either with or without employment levels. With evasion the expected profit for the firm is greater for a given wage. Therefore evasion opportunities increase the surplus available. As bargaining gives fixed proportions to the parties, then the firm moves some of the total surplus towards the unions by a higher wage. Consequently, tax evasion will affect wage formation. Since wage and employment are jointly determined, this tax evasion transmission process implies that non-separability holds.

As indicated in the literature, tax evasion exerts indirect influence on output level by increasing the number of firms (Goerke and Runkel 2006) or by affecting investment (Baumann and Friehe 2010). With the proposed model, we also find tax evasion affecting firm activities indirectly through its influence on wage formation. Our contribution is to explain why the non-neutrality and non-separability results are important in the presence of wage bargaining structure. From a broader perspective, one reason is that the policy implications may differ from those that follow in competitive labor markets. In other words, the mix of tax policy and policy to counteract evasion may be different under non-competitive wage formation compared to the case with competitive wage formation. In the

4 See McDonald and Solow (1981) and Grandner (2006).

5 This is a simplifying assumption allowing us to focus on the relationship between production and tax evasion.

6 Bigio and Zilberman (2011) outlined a model to optimally monitor self-employed entrepreneurs when, in addition to reported profits, the tax collection agency also observes the number of workers employed at each firm. Including a monitoring scheme that depends on observable labor input in the model should be considered for future studies.

presence of wage bargaining, profit tax and enforcement policy influence labor market outcomes. It would be very interesting to investigate how exactly these relationships look like and what we can learn for profit tax and enforcement policy.[7]

The remainder of this paper proceeds as follows. Section 2 presents the proposed model. Sections 3 and 4 introduce respectively the right-to-manage model and the efficient bargain model. Section 5 introduces optimal profit tax, auditing, and unemployment benefit. Section 6 offers concluding remarks.

2 The Model

For the proposed model, we consider a risk-neutral firm facing a proportional profit tax rate t with $t \in (0,1)$.[8] According to McDonald and Solow (1981), the production function is given by $Q = g(L)$ with $g' > 0 \geq g''$, where L is total employment measured as the hours of work per employee (normalized to 1) times the number of employed persons, L. For ease of exposition, we assume that production of each unit of output needs one unit of employment level, i. e., $Q = L$. In an environment without tax evasion, the actual profit of the firm is $\pi(w, L) = R(L) - wL$,[9] where w is the wage rate, and the total revenue R is a function of output L with $R'(L) > 0$ and $R''(L) < 0$.

As in Yaniv (1995), we assume that it is possible that company evades taxes by understating its actual profit π, revenue or overstating wage cost to tax authorities. Let $S > 0$ denote the absolute amount of understated profit with $0 \leq S \leq \pi$. As a result, if tax evasion is not detected, the net profits of the firm will become

$$\Gamma^n = (1-t)\pi + tS. \quad [1]$$

However, the firm faces an exogenous audit probability p. As in the standard model of tax evasion, we assume that the actual profit of the firm will be fully revealed once its tax return is audited. As in Yitzhaki (1974), the penalty of tax evasion is based on the amount of tax evaded according to a penalty function $f = f(tS)$ with the properties of $f(0) = 0$ and $f'(tS) > 0$ and $f''(tS) > 0$ for $S > 0$. Thus, if tax evasion is detected, the net profits of the firm is

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7 We are grateful to a reviewer for linking wage bargaining to the government policy.

8 Models that focus on optimal commodity taxation with tax evasion (Cremer and Gahvari 1993) or tax neutrality with tax evasion (Baumann and Friehe 2010) often assume that the firm is risk neutrality.

9 This is a frequent assumption in the analysis of union bargaining models, for example, McDonald and Solow (1981) and Aronsson and Sjögren (2004).

$$\Gamma^d = (1-t)\pi - f(tS), \quad [2]$$

and the expected profit of the firm is

$$\Pi = (1-p)\Gamma^n + p\Gamma^d = (1-t)\pi + (1-p)tS - pf(tS). \quad [3]$$

Note that tax evasion takes place only when firms are better off from misreporting their true profits to tax authorities, i. e., $(1-p)tS - pf(tS) > 0$. If no agreement is reached, the fall-back position for the firm is normalized as zero profit, i. e., $\Pi^0 = 0$.[10] Thus, Π is the firm's rent from bargain. Note that if we consider the case where $\Pi^0 > 0$, we find that it cannot change our main result.

In addition, most of the wage bargaining literature assumes that the union's members are identical and risk averse.[11] The union tries to maximize the utility of its N members. Each worker supplies one unit of labor if employed and zero labor if unemployed. For every unemployed workers, he or she can receive an unemployment benefit b which leads us to the objective function of the union emerges to be

$$U = L\varphi(w) + (N-L)\varphi(b), \quad [4]$$

where $\varphi(\cdot)$ is a utility function with $\varphi' > 0$ and $\varphi'' < 0$, and $N - L$ is the number of unemployed union members. If no contract is signed, the union members become unemployed and obtain the fall-back utility $U^0 = N\varphi(b)$, i. e., if all members are unemployed, each of them receives the same unemployment benefit. Thus, $U - U^0 = [\varphi(w) - \varphi(b)]L$ is the union's rent from bargaining.

3 The Right-to-Manage Model

3.1 Characterization of the Solution

As is typical in the right-to-manage approach,[12] we assume that the firm and the union bargain over the wage rate w only. The timing of the game is as follows: (i) we set the proportional profit tax rate t and the firm and the union negotiate over the wage rate w; (ii) taking t and w as given, the firm chooses optimal tax evasion S^* and the employment level L^*. We proceed to solve it by backward induction.

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10 Goerke (1996), however, also discussed the case of $\Pi^0 > 0$. We are grateful to a referee for pointing this out.

11 See Layard and Nickell (1990) and Goerke (1996) for a similar setup.

12 See Koskela and Schöb (1999) and Aronsson and Sjögren (2004) for the related setup.

Step 2: Firm's tax evasion and employment decisions

Taking t and w as given, the firm chooses S and L to solve the following problem:

$$\max_{S,L} \Pi = (1-t)\pi + (1-p)tS - pf(tS)$$

The first-order conditions of interior solutions are

$$\Pi_S = t[(1-p) - pf'(tS)] = 0, \quad [5]$$

$$\Pi_L = (1-t)(R' - w) = 0, \quad [6]$$

where $\Pi_S = \partial\Pi/\partial S$ and $\Pi_L = \partial\Pi/\partial L$. We note that the employment level, L, does not enter into eq. [5], which implies the firm's tax evasion is separable from the employment decision. Equation [6] implies the firm's employment choice only depends on wage rate if wage bargaining is unavailable (a given wage). This is because $(1-t)(R' - w)$ can be reduced to $R' = w$. This is consistent with the findings of Wang and Conant (1988) and Yaniv (1995). From eq. [6], we can derive the following comparative static effects

$$L^\star_w = \frac{\partial L^\star}{\partial w} = \frac{1}{R''} < 0, \quad [7]$$

$$\frac{\partial L^\star}{\partial t} = 0. \quad [8]$$

Equation [7] implies that an increase in the wage rate leads to a decrease in the employment level. In addition, eq. [8] indicates that the change of tax rate has no impact on $L^\star$.

Step 1: Wage bargaining

Anticipating the outcomes from the firm setting labor demand and tax evasion, a trade union and firm solve the following problem:

$$\max_{w} \Psi = (U - U^0)^\theta \Pi^{1-\theta}, \quad [9]$$

where Ψ denotes a Nash product of the bargaining,[13] and $0 \le \theta \le 1$ is the relative bargaining power of the union with a lager value of θ denoting a greater bargaining power. Using $V = U - U^0$, the first-order condition with respect to wage is

$$\Psi_w = 0 \Leftrightarrow \theta \frac{V_w}{V} + (1-\theta)\frac{\Pi_w}{\Pi} = 0$$

13 See Nash (1950) for a Nash product treatment.

where $V_w = \varphi'(w)L + (\varphi(w) - \varphi(b))L_w$ and $\Pi_w = -(1-t)L$ by the envelope theorem. Note that the term V_w can be interpreted as the marginal benefit from a higher wage from the union's standpoint and Π_w can be interpreted as the marginal cost from a higher wage from the firm's standpoint. We make use of the explicit form of the first-order condition, which can be written as

$$\Psi_w = \theta V_w \Pi - (1-\theta)(1-t)LV = 0. \quad [10]$$

We assume that the second-order sufficient condition ($\Psi_{ww} < 0$) is fulfilled and $V_w > 0$ in order to guarantee an interior solution. With regard to V_w, except for $\theta = 1$,[14] we assume $V_w > 0$ throughout the paper. In eq. [10], $\theta V_w \Pi$ and $(1-\theta)(1-t)LV$ represent the marginal benefit and the marginal cost in bargain from the increasing w, respectively. The optimal wage rate w^* is therefore the solution in which the marginal benefit equals to the marginal cost.

In line with most of the literature referred to in the introduction, we address the following two questions: (i) whether profit taxes are neutral, and (ii) whether the firm's production and tax evasion decisions are separable. The answers to these questions hinge critically on the presence of wage bargaining.

First, if the union has no bargaining power at all ($\theta = 0$), then from eq. [9] we would obtain

$$\frac{\partial \Pi}{\partial w} = -(1-t)L < 0. \quad [11]$$

Equation [11] shows that it is optimal for the firm to set the lowest possible wage rate. Intuitively, the reason for this is that if the union has no bargaining power at all ($\theta = 0$), the firm leaves no rent for the union, and the wage rate is cut down by the firm. This result indicates that the firm's optimal wage level is independent of its optimal choice of tax evasion S^* and the profit tax t. Thus, tax evasion and profit tax cannot indirectly affect the wage rate and employment level (output). That is, the firm's production and tax evasion decisions are separable from each other and profit tax is neutral in this case.

Second, if $\theta = 1$, i. e., in the presence of a monopoly union, then from eq. [9] we would obtain

$$V_w = \varphi'(w)L + (\varphi(w) - \varphi(b))L_w = 0. \quad [12]$$

Equation [12] shows that the monopoly union's optimal wage level is independent of the firm's choice of tax evasion S^* and the profit tax t. Thus, the neutrality and separability results of the profit taxes are quite robust in a monopoly union model.

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14 Please see eq. [12].

The present paper assumes that the firm and the union bargain over the wage only and the firm unilaterally sets the employment level in a profit-maximizing way, it can be obviously seen that eq. [10] could no longer be reduced into eqs [11] and [12] since $0 < \theta < 1$. We note that the wage rate w and employment level L do not enter into eq. [5]. That is, the extent of the firm's tax evasion is decided separately from the wage and employment decisions. However, eqs [6] and [10] simultaneously solve the optimal wage level w^*, and optimal employment level L^*. It is worth noting that w^* and L^* are determined by S^*, but S^* does not depend upon w^* and L^*. This demonstrates that tax evasion does affect employment when wage bargaining is available, i. e. the separability result and tax neutrality will not hold. Notice that if wage bargaining is unavailable ($\theta = 0$ or $\theta = 1$), eq. [10] will reduce to eq. [11] or eq. [12]. Thus, tax evasion does not have an effect on employment, i. e. the separability result holds and profit taxes are neutral.

To proceed further with the analysis, we need to answer the connection between tax evasion, wage rate, and output. We do so by comparing the wage rate in the presence of tax evasion with that in the absence of tax evasion. Without tax evasion the terms tS and $f(tS)$would no longer be present in eqs [1] and [2] respectively, and the first-order condition for eq. [10] would be reduced to

$$\tilde{\Psi}_w = \theta V_w (1-t)\pi - (1-\theta)(1-t)LV = 0, \qquad [13]$$

where $\theta V_w (1-t)\pi$ and $(1-\theta)(1-t)LV$ represent respectively the marginal benefit and the marginal cost in bargain from increasing w. Let $\tilde{w}$ satisfy eq. [13].

To compare w^* in eq. [10] to $\tilde{w}$ in eq. [13], evaluating eq. [10] at $w = \tilde{w}$ and using eq. [13] yield[15]

$$\Psi_{w=\tilde{w}} = \theta V_w [\Pi - (1-t)\pi] = \theta V_w [(1-p)tS - pf(tS)]. \qquad [14]$$

Since $V_w > 0$ and $0 < \theta < 1$ by assumption, the sign of eq. [14] depends on the sign of $(1-p)tS - pf(tS)$. If $(1-p)tS - pf(tS) > 0$, then tax evasion takes place and the sign of eq. [14] is positive. Thus, we obtain that w^* is greater than $\tilde{w}$. This is because the firm is better off from evading taxes (i. e. enjoys a higher rent), the union will receive a share of this improvement of the firm's rent via higher wages. This result is different from that of Goerke (2003), who has shown that the existence of individual tax evasion opportunities lowers wages. In addition, an increase in wage rate leads to a reduction in employment level. Therefore, tax evasion exerts indirect influence on output level by increasing the wage rate.

We can then summarize the finding into:

Proposition 1: In a right-to-manage model, we find that (i) tax evasion has a positive effect on the wage rate and a negative effect on output, and (ii) if wage bargaining is available ($0 < \theta < 1$), then profit taxes are not neutral, and the firm's

tax evasion decision and its production decision are not separable. Contrarily, if wage bargaining is unavailable, then profit taxes are neutral, and the firm's tax evasion decision and its production decision are separable.

3.2 Comparative Statics

In this subsection, assuming a solution exists, the analysis goes on to investigate how the optimal wage rate is affected by changes in various policy parameters. With the implicit function theorem applied to eq. [10], the effect of a change in any parameter $\beta \in \{t, p, b, \theta\}$ on w^* is given by

$$\frac{\partial w^*}{\partial \beta} = \frac{-\Psi_{w\beta}}{\Psi_{ww}}, \tag{15}$$

where $\Psi_{w\beta} = \partial \Psi_w / \partial \beta$. Differentiating eq. [10] with respect to β yields

$$\Psi_{wt} = -\theta V_w[\pi - (1-p)S + pSf'] + (1-\theta)LV > 0, \tag{16}$$

$$\Psi_{wp} = -\theta V_w(tS + f(tS)) < 0, \tag{17}$$

$$\Psi_{wb} = -\theta \Pi \varphi'(b) L_w + (1-\theta)(1-t)\varphi'(b)L^2 > 0, \tag{18}$$

$$\Psi_{w\theta} = V_w \Pi + (1-t)LV > 0. \tag{19}$$

The signs of eqs [17], [18] and [19] are easy to obtain clear-cut results. However, eq. [16] needs to be explained more. By using eqs [5] and [10], we obtain respectively $(1-p) = pf'(tS)$ and $(1-\theta)LV = \theta V_w \Pi/(1-t)$. Substituting these terms into eq. [16] yields the positive sign.

From eqs [16]–[19] and $\Psi_{ww} < 0$, we put forward:

Proposition 2: In the presence of tax evasion, we find that first, if the firm is risk neutral, an increase in the profit tax has a positive effect on the wage rate. Second, an increase in the detection probability has a negative effect on the wage rate. Third, increases in both the unemployment benefit and the relative bargaining power of the union have a positive effect on the wage rate.

The rationale underlying this result is as follows. First, due to the existence of tax evasion, an increase in the profit tax enhances the marginal benefit of wage rate. This provides the firm with a greater incentive to raise wage rate. Consequently, an increase in the profit tax leads to a positive effect on the wage rate. Note that with the firm's fallback level set at zero, if the firm tax evasion is absent, our result would be the same as the one presented by Goerke (1996): profit tax has no impact on wage rate.

Secondly, a higher detection probability, threatening to reduce the gain from tax evasion, may also force the firm to secure profits by lowering wage rate. Thirdly, as the unemployment benefit increases, the union has a weaker incentive to bargain with the firm. The firm will push a higher wage to reach agreement with the union if profitable tax evasion is possible. Finally, if the union has larger bargaining power, it can strive for a higher wage rate.

Interestingly, in this paper, firms use lower wages as a substitute for less profitable tax evasion. Similarly in the context of a Cournot oligopoly model with an endogenous number of firms and evasion of indirect taxes, Goerke and Runkel (2011) have show that firms use tax evasion as a substitute for the loss in market power.

4 The Efficient Bargain Model

4.1 Characterization of the Solution

The assumptions and notations in this section are similar to those in Section 3 except that we assume both wage and employment are the subjects of the bargain.[16] Therefore, by differentiating eq. [9] with respect to w and L, we have

$$\Psi_w = \theta V_w \Pi + (1-\theta)\Pi_w V = 0, \tag{20}$$

$$\Psi_L = \theta V_L \Pi + (1-\theta)\Pi_L V = 0, \tag{21}$$

where $V_w = \varphi'(w)L > 0$,[17] $\Pi_w = -(1-t)L < 0$, $V_L = \varphi(w) - \varphi(b) > 0$ and $\Pi_L = (1-t)(R' - w)$. Let $(\hat{w}, \hat{L})$ represent the solutions to eqs [20] and [21]. Division of eqs [20] and [21] shows that

$$\frac{\varphi'(\hat{w})\hat{L}}{\varphi(\hat{w}) - \varphi(b)} = -\frac{(1-t)\hat{L}}{(1-t)(R' - \hat{w})}, \tag{22}$$

or

$$R' = \hat{w} - \frac{[\varphi(\hat{w}) - \varphi(b)]}{\varphi'(\hat{w})}. \tag{23}$$

By using eq. [23], we can rewrite eq. [20] as

16 See McDonald and Solow (1981) and Grandner (2006).

17 Note that V_w in the efficient bargain model is different from V_w in the right-to-manage model.

$$\hat{w} = \frac{\theta \Pi}{(1-\theta)(1-t)\hat{L}} + R'. \quad [24]$$

According to eq. [24]), we obtain $\Pi_L = (1-t)(R'-w) < 0$. Equation [23] shows the optimal employment rule for efficient bargain, implying that the marginal product of labor should be less than the per worker wage $\hat{w}$. Equation [24] states that the wage in the efficient bargain model is determined by the marginal product of labor (R'), the bargaining power of the union (θ), the profit tax (t), tax evasion (S), and the expected profit of the firm (Π). Notice that, from eq. [5], the optimal tax evasion (S^*) does not depend upon $\hat{w}$ and $\hat{L}$. However, eqs [23] and [24] are determined simultaneously and depend upon the optimal tax evasion (S^*) and the profit tax t. Thus, both the tax evasion S^* and the profit tax t can affect the wage rate and employment level. This immediately implies that the neutrality and separability results will not hold.

Notice that if $\theta = 0$ or $\theta = 1$, we can get the same result as in eqs [11] and [12], i. e., profit taxes are neutral, and the firm's tax evasion decision and its production decision are separable.

Above results bring us to the following proposition:

Proposition 3: In an efficient bargaining framework where both wage and employment are negotiated, we find that, profit taxes in general are not neutral, and the firm's tax evasion decision and its production decision are not separable.

It is worthwhile to note that Proposition 1 and 3 are based on profit tax evasion. In addition to profit tax evasion, the conclusions in Proposition 1 and 3 can also apply to payroll or revenue tax evasion as discussed by Yaniv (1995) and Marrelli (1984).

4.2 Comparative Statics

Applying the implicit function theorem to eqs [20] and [21], the effect of a change in any parameter $\beta \in \{t, p, b, \theta\}$ on $\hat{w}$ and $\hat{L}$ is given by:

$$\frac{\partial \hat{w}}{\partial \beta} = \frac{\Psi_{wL}\Psi_{L\beta} - \Psi_{w\beta}\Psi_{LL}}{H}, \quad [25]$$

$$\frac{\partial \hat{L}}{\partial \beta} = \frac{\Psi_{wL}\Psi_{w\beta} - \Psi_{L\beta}\Psi_{ww}}{H}, \quad [26]$$

where $H \equiv \Psi_{ww}\Psi_{LL} - (\Psi_{wL})^2 > 0$, $\Psi_{ww} = \partial\Psi_w/\partial w < 0$, $\Psi_{LL} = \partial\Psi_L/\partial L < 0$, $\Psi_{wL} = \partial\Psi_w/\partial L$, $\Psi_{L\beta} = \partial\Psi_L/\partial\beta$ and $\Psi_{w\beta} = \partial\Psi_w/\partial\beta$. Because H is positive, the direction

of the effect of a change in any parameter $\beta \in \{t, p, b, \theta\}$ on $\hat{w}$ and $\hat{L}$ is the same as the sign of the numerators of eqs [25] and [26]. Since Ψ_{wL} is a key factor in determining the signs of eqs [25] and [26], we are interested in knowing the sign of Ψ_{wL}. To this end, differentiating eq. [20] with respect to L yields

$$\Psi_{wL} = \theta(V_{wL}\Pi + V_w\Pi_L) + (1-\theta)(\Pi_{wL}V + \Pi_w V_L),$$

where $V_{wL} = \varphi'(w) > 0$, $\Pi_{wL} = -(1-t) < 0$. By using eq. [20], it will simplify Ψ_{wL} and we obtain $\Psi_{wL} = \theta V_w \Pi_L + (1-\theta)\Pi_w V_L$. Since $V_w > 0$, $\Pi_L < 0$, $\Pi_w < 0$ and $V_L > 0$, the sign of Ψ_{wL} is negative. In addition, differentiating eqs [20] and [21] with respect to β yields

$$\Psi_{wt} = -\theta V_w[\pi - (1-p)S + pSf'] + (1-\theta)LV > 0, \quad [27]$$

$$\Psi_{wp} = -\theta V_w(tS + f(tS)) < 0, \quad [28]$$

$$\Psi_{wb} = -(1-\theta)\Pi_w\varphi'(b)L > 0, \quad [29]$$

$$\Psi_{w\theta} = V_w\Pi - \Pi_L V > 0, \quad [30]$$

$$\Psi_{Lt} = -\theta V_L[\pi - (1-p)S + pSf'] - (1-\theta)(R'-w)V > 0, \quad [31]$$

$$\Psi_{Lp} = -\theta V_L(tS + f(tS)) < 0, \quad [32]$$

$$\Psi_{Lb} = -\varphi'(b)[\theta\Pi + (1-\theta)\Pi_L L], \quad [33]$$

$$\Psi_{L\theta} = V_L\Pi - \Pi_L V > 0. \quad [34]$$

Since $\Pi > 0$ and $\Pi_L < 0$, the sign of Ψ_{Lb} is ambiguous. In addition, by using eq. [21], we obtain $\Psi_{Lt} > 0$. The eqs [27]–[34] have clear-cut signs except Ψ_{Lb}.

We find that when $\Psi_{wL} < 0$, the comparative static results are uncertain. This is because the numerators of eqs [25] and [26] include two terms. With two decision variables, a parameter change alters the marginal effect for each decision variable, termed the direct effect. There is also an indirect effect, which implies a parameter shift indirectly affects the one decision variable via altering the other decision variable. The first term in the numerators on the right-hand side of eqs [25] and [26] represents the indirect effect, while the second term represents the direct effect. Under $\Psi_{wL} < 0$, we find that the direct effect counteracts the indirect effect. Hence, changes in policy parameters have an ambiguous effect on the wage rate and the employment level.

For reasons of concreteness and tractability, we then provide some numerical examples to illustrate the comparative static results. We assume a linear demand function $p(L) = a - L$, with $a > 0$, and convex penalty functions $f(tS) = (tS)^2/2$. In addition, we suppose that the worker's utility functions are $\varphi(w) = \ln w$ and $\varphi(b) = \ln b$. Also, it is assumed that the baseline parameters are $a = 5$, $t = 0.1$, $p = 0.1$, $\theta = 0.1$, and $b = 0.1$. From eq. [5], we then get the equilibrium

values $S = (1-p)/pt^2$. By using this term and solving the simultaneous eqs [23] and [24], we obtain the equilibrium values $\hat{w} = 2.9614$ and $\hat{L} = 6.0357$. We then present comparative statics by varying t, p, b, and θ as shown in Figures 1–4. Figures 1 and 2 show that higher values of t and p lead to smaller wage rate and employment. Figures 3 and 4 reveal that higher values of b and θ lead to greater

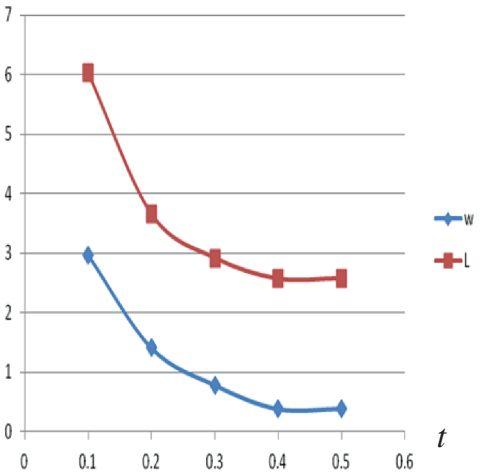

Figure 1: Extents of w and L for varying t.

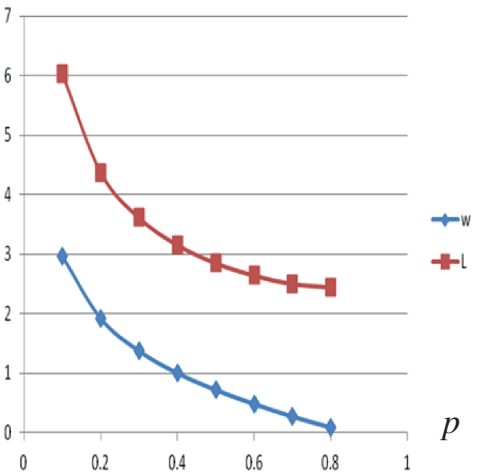

Figure 2: Extents of w and L for varying p.

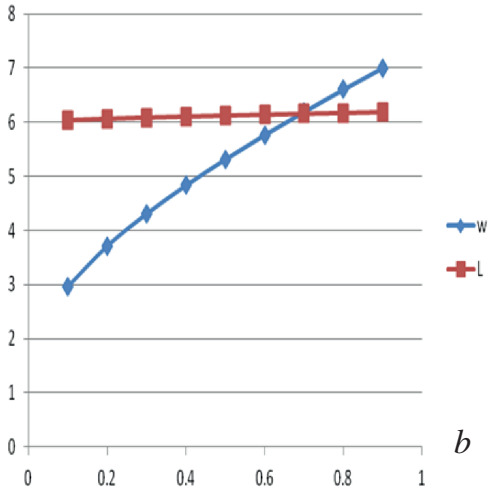

Figure 3: Extents of w and L for varying b.

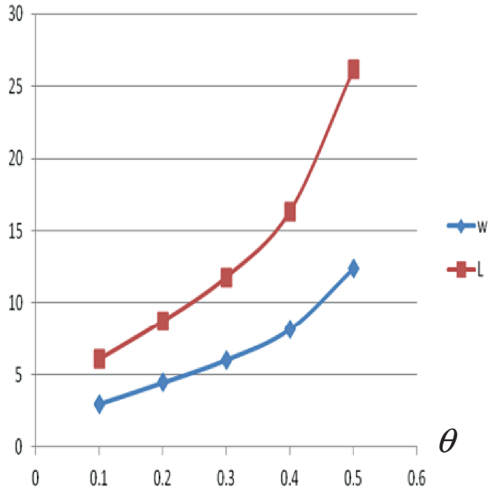

Figure 4: Extents of w and L for varying θ.

wage rate and employment. As a result, we can identify at least one example where the impact of t, p, b or θ has a non-zero impact on the wage and employment level in order to prove non-separability.[18]

18 We are grateful to a referee for pointing this out.

5 Optimal Taxation, Auditing and Unemployment Benefit

This section applies right-to-manage model to explore the optimal government policy.[19] According to Hashimzade, Huang, and Myles (2010), we assume that the aim of the government is to decide profit tax, enforcement policy and unemployment benefit to maximize the following expected net revenue function:

$$\max_{\{t,p,b\}} E[TR] = t(R(L) - wL) + pf(tS) - (1-p)tS - (N-L)b - C(p), \quad [35]$$

where $t(R - wL) + pf(tS) - (1-p)tS$ is the sum of the firm's expected tax and fine revenues, $(N-L)b$ is the total unemployment benefit, and $C(p)$ is the monitoring cost.

By using eqs [5] and [6], the necessary conditions for profit tax, enforcement policy, and unemployment benefit obtained from eq. [35] are

$$\frac{\partial E[TR]}{\partial t} = (R(L) - wL) - (tL - bL_w)\frac{\partial w}{\partial t}, \quad [36]$$

$$\frac{\partial E[TR]}{\partial p} = f(tS) + tS - (tL - bL_w)\frac{\partial w}{\partial p} - C_p, \quad [37]$$

$$\frac{\partial E[TR]}{\partial b} = -(tL - bL_w)\frac{\partial w}{\partial b} - (N-L), \quad [38]$$

where $C_p = \partial C/\partial p > 0$. Because of $L_w < 0$ and $\partial w/\partial b > 0$ from Proposition 2, we then obtain $\partial E[TR]/\partial b < 0$, which implies b would necessarily be zero. If there are interior solutions for t $(0 < t < 1)$ and p $(0 < p < 1)$, then eqs [36] and [37] are satisfied with equality. Equations [36] and [37] simultaneously solve the optimal profit tax t^* and enforcement policy p^*. Note that if wage bargaining is unavailable ($\theta = 0$ or $\theta = 1$), we obtain $\partial w/\partial t = \partial w/\partial p = 0$ from eqs [11] and [12]. Therefore, eqs [36]–[38] reduce to

$$\frac{\partial E[TR]}{\partial t} = (R(L) - wL), \quad [39]$$

$$\frac{\partial E[TR]}{\partial p} = f(tS) + tS - C_p, \quad [40]$$

19 In this section, we ignore the governmental policy in the efficient bargain model. This is because the optimal solution in efficient bargain model is similar to that in the right-to-manage model. Also, the differences in both models for optimal policy are not significant. Readers interested in the calculation procedure can inquire the authors to offer.

$$\frac{\partial E[TR]}{\partial b} = -(tL - bL_w)\frac{\partial w}{\partial b} - (N - L). \quad [41]$$

Note that eq. [41] is analog to eq. [38] and $b = 0$. Due to a monopoly firm, we obtain $R(L) - wL > 0$, which implies that eq. [39] cannot be an equality. This indicates that it is optimal for the government to set the highest possible profit tax rate, i. e., $t^{**} = 1$. This is a very stylized result as shown by Hashimzade et al. (2010). In addition, if there is an interior solution for p $(0 < p < 1)$, then eq. [40] is satisfied with equality. By plugging $t = 1$ into eq. [40], we can obtain the optimal enforcement policy p^{**}. Note that, from eqs [39]–[41], we know that the optimal profit tax is independent of the audit strategy and the unemployment benefit. This result is similar to Hashimzade et al. (2010).

Comparing eq. [36] with eq. [39] shows $t^{*} < t^{**} = 1$. The reason for this result is that, under wage bargaining, an increase in profit tax will decrease profit tax revenue through increasing wage rate. Thus, the government has a weaker incentive to increase profit tax. On the other hand, to compare p^{*} in eq. [37] with p^{**} in eq. [40], evaluating eq. [37]) at $t = t^{**} = 1$ and $p = p^{**}$ and substituting from eq. [40] yield

$$\left.\frac{\partial E[TR]}{\partial p}\right|_{t = t^{**} = 1,\, p = p^{**}} = -L\frac{\partial w}{\partial p}. \quad [42]$$

Due to $\partial w/\partial p < 0$ from Proposition 2, the sign of eq. [42] is positive, which implies $p^{*} > p^{**}$. The reason underlying this result is that, under wage bargaining, an increase in the detection probability will increase profit tax revenue through decreasing wage rate. Thus, the government has a stronger incentive to increase the detection probability. To conclude, wage bargaining plays an important role in determining optimal profit tax and enforcement policy. Moreover, overlooking such a wage bargaining effect may result in misleading policymaking.

6 Concluding Remarks

This paper takes the interaction between profit tax evasion and wage bargaining into account and revisits the issue regarding how robust the neutrality of profit taxes and the separability of production and evasion decisions are in the presence of tax evasion.

This paper demonstrates that, in a right-to-manage collective bargaining setting, the level of tax evasion affects wages and employment, thereby altering output. This result implies that separability ceases to hold. Furthermore, in an

efficient bargaining context, tax evasion will also affect wages. Since employment will be determined jointly with wages, once again separability does not generally arise. This then leads to the question of what the impact of changes in profit taxes on wages and employment. We find that the profit tax with wage bargaining is smaller than that without wage bargaining, whereas the detection probability with wage bargaining is greater than that without wage bargaining.

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