COMMODITY TAXES, WAGE DETERMINATION AND PROFITS

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September 1998

Abstract

We examine the effects of two different types of commodity taxation, specific and ad valorem, on wages and profits. We analyze two models of wage determination, one with efficiency wage setting and one with bargaining between a union and a firm. In the former, a (locally) revenue-neutral shift from specific to ad valorem taxation leads to an increase in both employment and wages, and a reduction in profitability. In the bargaining case however, the effect on wages and profits may be reversed: predominantly ad valorem taxation raises employment but lowers wages, and under certain circumstances, the net effect can lead to an increase in profits.

JEL Classification: H2, H32, J41, J5

Keywords: Commodity taxation, specific tax, ad valorem tax, efficiency wage, bargaining.

Acknowledgements: We would like to thank Owen O'Donnell and Andy Dickerson for helpful comments.

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1. Introduction

Most recent developments in the theory of commodity tax incidence look at how imperfect competition in product markets and the choice of tax (specific or ad valorem) affect the impact of taxes on prices and profits. For example, Delipalla and Keen (1992) compare the effects of ad valorem and specific taxation in an oligopolistic product market and show that a shift from specific to ad valorem taxation is associated with a relatively lower consumer price and lower profits. However, the interaction between the product and labour markets has been ignored in much of the literature. As we show below, extending the model to incorporate different wage-setting theories leads to new insights on the relative effects of the two forms of taxation.

The importance of the employer's performance in the product market for wage and employment outcomes has long been recognised in the theoretical literature, dating back to post-war labour economists, and in particular in empirical studies (see, for example, Carruth and Oswald, 1989). But, there seems to be little systematic investigation of how the interaction between imperfectly competitive product and labour markets affects the impact of taxes on the economy (Lockwood, 1990). Moreover, to the best of our knowledge, no study looks at the relative effects of different commodity taxes on the labour market. Johnson and Layard (1986), Pisauro (1991), and Petrucci (1994), using different versions of efficiency wage models, examine the relative effects of ad valorem and specific labour taxes on wage and employment, but commodity taxation is ignored.

The purposes of this paper are, first, to look at the (relative) effects of specific and ad valorem commodity taxation on wages and employment. Then, to examine how the interaction between wages and prices affects the tax impact on a firm's profits. As we see below, the tax effect on wages is model-dependent. Moreover, changing the mixture of taxes in favour of ad valorem may actually increase firm's profits, contrary to one of the results in Delipalla and Keen (1992), where the labour market is not considered. This is interesting given that tobacco multinationals often lobby for specific taxation.

We employ two popular models, one with efficiency wages and one with a bargaining structure, to analyse the effects of commodity taxation on wage and employment. For analytical simplicity and to focus on the purpose in hand, we assume no labour taxes. In the efficiency wage model, predominantly ad valorem taxation implies relatively higher industry output and employment. With a relative decrease in the industry unemployment, wages must rise, as otherwise workers would exert less effort and "shirk" on the job. With relatively lower prices and higher wages, not surprisingly, profits fall. In the bargaining model however, the outcome is determined by factors such as the degree of union power, and the extent of collusion among firms. Interestingly, in such a model predominantly ad valorem taxation may increase a firm's profits.

The structure of the paper is as follows. The efficiency wage model is presented and comparative statics of wage and employment with respect to specific and ad valorem taxes are analysed in section 2. The relative effects of the two types of taxes on wage, employment and profits are systematically examined. Section 3 presents and analyses the wage-bargaining model. Section 4 discusses the results derived in the two models employed, and concludes.

2. An Efficiency Wage Model

The framework is based on Delipalla and Keen (1992), amended for the purpose in hand. For ease of comparison similar notation is used. There are *n* identical firms in the industry and each firm *i* sells its product at price *P*. The representative firm's production function is $x = f(e(w,u)\ell)$, where e is the effort put in by its typical employee and ℓ is firm's employment; that is, we make the conventional assumption that effort and labour are multiplicative (see, for example, Solow, 1979). Following much of the efficiency wage literature, effort is assumed to be a positive function of both the wage (*w*) and the unemployment rate (*u*), with $e_{uu} < 0$ and $e_{ww} < 0$.[1] Workers elsewhere receive wage $\overline{w} \leq w$. For the representative firm, profits are:

$$\pi = \{(1-t_v)P(X) - t_s\} f(e\ell) - w\ell \tag{2.1}$$

where t_v and t_s are the ad valorem and specific tax rates respectively; $f' > 0$, $f'' < 0$. We assume each firm forms a conjecture about how the industry output (*X*) responds to a change in its own output. That is, $dX/dx = \lambda$, where $\lambda \in (0, n]$ is assumed constant throughout. Analogously, each firm forms a conjecture about how the industry's unemployment rate, $u = 1 - (L/L^*)$, where L^* and L are the industry labour force and total employment respectively, responds to a change in its own employment. That is, $du/d\ell = \beta$, where $\beta \in [-n/L^*, 0)$ is also assumed fixed.

Then the first-order conditions for profit maximisation are:

$$\pi_w = [(1-t_v)(P + fP_X\lambda) - t_s] f' \ell e_w - \ell = 0 \tag{2.2}$$

and

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[1] The sign of e_{wu} is unclear *a priori*; for simplicity, we assume it is equal to zero.

$$\pi_{\ell} = [(1-t_v)(P + fP_X\lambda) - t_s] f'(e + \ell e_u \beta) - w = 0, \tag{2.3}$$

where subscripts denote derivatives. Dividing (2.2) by (2.3), and rearranging, yields the modified Solow condition[2]

$$e_w w - e - \ell e_u \beta = 0. \tag{2.4}$$

The corresponding second-order conditions are

$$\pi_{ww} = [(1-t_v)(P + f\lambda P_X) - t_s][f''(\ell e_w)^2 + f'\ell e_{ww}] + (1-t_v)(f'\ell e_w)^2 \lambda[2P_X + f\lambda P_{XX}] < 0 \tag{2.5}$$

$$\begin{aligned}\pi_{\ell\ell} = {} & [(1-t_v)(P + fP_X\lambda) - t_s][f''(e + \ell e_u\beta)^2 + f'(2e_u\beta + \ell e_{uu}\beta^2)] + \\ & (1-t_v)(f')^2(e + \ell e_u\beta)^2\lambda[2P_X + f\lambda P_{XX}] < 0\end{aligned} \tag{2.6}$$

and

$$\pi_{ww}\pi_{\ell\ell} > (\pi_{w\ell})^2 \tag{2.7}$$

where, making use of (2.2) divided by ℓ,

$$\pi_{w\ell} = (e + \ell e_u\beta)\ell e_w\{[(1-t_v)(P + fP_X\lambda) - t_s]f'' + (1-t_v)(f')^2\lambda[2P_X + \lambda P_{XX}]\} \tag{2.8}$$

We will also rely on the stability condition that perceived marginal revenue for a firm is a decreasing function of the other firms' output,

$$P_X + \lambda f P_{XX} < 0 \tag{2.9}$$

for signing our comparative statics results; see Seade (1980). Noting that $X = nx$ and $u = 1 - (n\ell / L^*)$ under symmetry, we use (2.2) and (2.4) to derive our comparative statics results. Perturbing (2.2) we get

$$A dw + B d\ell = f'e_w(P + \lambda P_X f)dt_v + f'e_w dt_s, \tag{2.10}$$

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[2] Note that equation (2.4) implies a wage at which the elasticity of effort with respect to the wage is less than one.

where

$$A = \frac{f'e_{ww} + \ell(e_w)^2 f''}{f'e_w} + \ell(1-t_v)(f'e_w)^2[(n+\lambda)P_X + n\lambda f P_{XX}] \tag{2.11}$$

and

$$B = [e + e_u(u-1)]\left(\frac{f''}{f'} + (1-t_v)(f')^2 e_w[(n+\lambda)P_X + n\lambda f P_{XX}]\right). \tag{2.12}$$

Assuming the stability condition (2.9) holds, $A < 0$. B is also negative if $e + e_u(u-1) > 0$, which is reasonable to assume.[3]

Perturbing (2.4) we get

$$C dw + D d\ell = 0 \tag{2.13}$$

where

$$C = w e_{ww} < 0 \tag{2.14}$$

and

$$D = -\left(\frac{u-1}{\ell}\right)(e_u + \beta\ell e_{uu}) - \beta e_u > 0. \tag{2.15}$$

Then (2.10) and (2.13) give

$$\begin{bmatrix} C & D \\ A & B \end{bmatrix}\begin{bmatrix} dw \\ d\ell \end{bmatrix} = \begin{bmatrix} 0 & 0 \\ f'e_w(P + fP_X\lambda) & f'e_w \end{bmatrix}\begin{bmatrix} dt_v \\ dt_s \end{bmatrix} \tag{2.16}$$

[3] As Pisauro (1991, p. 337) notes, $d(eL)/dL = e + e_u(u-1) > 0$ implies that firms, by hiring a new worker, will not decrease the amount of labour input in efficiency units. Also, this condition can be written as $u > (1-u)\varepsilon_{eu}$, where ε_{eu} is the elasticity of effort with respect to unemployment. Using British firm-level data and aggregate unemployment, Wadhani and Wall (1991) estimate this to be 0.05. If this is also the industry elasticity, then the condition holds if unemployment is greater than 5%.

where the determinant of the matrix on the left-hand side is $\Delta = CB - AD > 0$. This leads us to our first proposition.

Proposition 1: In the efficiency wage model specified here, taxes affect wages as

$$\frac{dw}{dt_s} = -\frac{f' e_w D}{\Delta} < 0 \tag{2.17}$$

and

$$\frac{dw}{dt_v} = (P + fP_X \lambda)\frac{dw}{dt_s} < 0. \tag{2.18}$$

They affect employment as

$$\frac{d\ell}{dt_s} = \frac{f' e_w C}{\Delta} < 0 \tag{2.19}$$

and

$$\frac{d\ell}{dt_v} = (P + fP_X \lambda)\frac{d\ell}{dt_s} < 0. \tag{2.20}$$

Proof: Equations (2.17) - (2.20) follow immediately from (2.16).□

Commodity taxes have a negative effect on both employment and wages. The intuition is that they increase the price of the good and hence reduce demand and output, and so employment falls. Since unemployment rises, effort also increases and firms can compensate at the margin by reducing the wage.

We turn now to the explicit comparison of ad valorem and specific taxation. As in Delipalla and Keen (1992), we consider a *P*-shift, that is, a tax change of the form

$$Pdt_v = -dt_s > 0 \qquad (2.21)$$

which tilts the balance towards ad valorem taxation whilst leaving total tax revenue unchanged at the initial equilibrium price.

Before we look at the effect of such a *P*-shift on wage and employment, we examine whether the Delipalla and Keen result, that a *P*-shift from specific to ad valorem taxation reduces both price and profits, still holds in our model.

Proposition 2: A P-shift from specific to ad valorem taxation leads to a reduction in

(a) consumer price, and

(b) profits.

Proof: (a) Noting that $X = nf[e(w,u(\ell))\ell]$, we derive

$$\frac{dX}{dt_s} = nf'\left((e + \ell e_u(-\frac{n}{L^*}))\frac{d\ell}{dt_s} + \ell e_w \frac{dw}{dt_s}\right) < 0 \qquad (2.22)$$

and

$$\frac{dX}{dt_v} = (P + fP_X \lambda)\frac{dX}{dt_s} < 0. \qquad (2.23)$$

Using (2.23) and the fact that $dP/dt_s = P_X(dX/dt_s)$ and $dP/dt_v = P_X(dX/dt_v)$, a *P*-shift as defined by (2.21) leads to

$$dP = (fP_X \lambda)\left(\frac{dP}{dt_s}\right)dt_v < 0. \qquad (2.24)$$

(b) From

$$\Pi = n\pi = [(1-t_v)P - t_s]nf[e(w,u(\ell))\ell] - nw\ell \qquad (2.25)$$

we derive

$$\frac{d\Pi}{dt_s} = n(w\frac{d\ell}{dt_s} + \ell\frac{dw}{dt_s})[(1-t_v)(1-\gamma)XP_X f'e_w] - X \tag{2.26}$$

and

$$\frac{d\Pi}{dt_v} = P\frac{d\Pi}{dt_s} + nfP_X\lambda(w\frac{d\ell}{dt_s} + \ell\frac{dw}{dt_s})[(1-t_v)(1-\gamma)XP_X f'e_w], \tag{2.27}$$

where use has been made of the first-order conditions and (2.22), and denoting $\gamma = \lambda / n$. Then, using (2.26) and (2.27), a *P*-shift implies

$$d\Pi = nfP_X\lambda(w\frac{d\ell}{dt_s} + \ell\frac{dw}{dt_s})(1-t_v)(1-\gamma)XP_X f'e_w < 0. \tag{2.28}$$

So industry profits fall (and so do firm profits), except in the special case of joint collusion $(\gamma = 1)$, in which case they are unaffected.□

But what is the effect of a *P*-shift on wages and employment? The next proposition looks at this, and helps us see why a *P*-shift reduces profits.

Proposition 3: In the efficiency wage model specified, a P-shift from specific to ad valorem taxation leads to an increase in both wages and employment.

Proof: The effect on wage of an arbitrary tax reform is given by

$$dw = \left(\frac{\partial w}{\partial t_v}\right)dt_v + \left(\frac{\partial w}{\partial t_s}\right)dt_s. \tag{2.29}$$

Substituting into (2.29) for the particular reform given by (2.21) and using (2.18) gives

$$dw = (fP_X \lambda)\left(\frac{dw}{dt_s}\right)dt_v > 0, \tag{2.30}$$

since $dw/dt_s < 0$ and $dt_v > 0$. Then, a similar argument to the above gives

$$d\ell = (fP_X \lambda)\left(\frac{d\ell}{dt_s}\right)dt_v > 0, \tag{2.31}$$

where use has been made of (2.19) and (2.20).□

Note here that since the number of firms is fixed, total industry employment increases. The intuition underlying Proposition 3 is analogous to the one for a rise in output discussed in Delipalla and Keen (1992): under ad valorem taxation, but not under specific, output expansion becomes profitable since part of the implied reduction in sales revenue on intra-marginal units is borne by the Exchequer rather than the firm. So at the margin, a *P*-shift gives firms an incentive to raise output and hence employment. However, with a fall in unemployment, firms have an incentive to raise the wage in order to mitigate the consequent reduction in effort.

3. A Wage Bargaining model

We turn now to a model where the production function of a representative firm is $x = f(\ell)$ and each firm in the industry has to bargain with its workers, who have formed a union. For analytical convenience, we assume that the union is risk-neutral and cares only about the wage. Hence, $U(.) = w$. Although rather extreme, the assumption that the union is indifferent to the level of employment can be justified when there is majority voting in the union and layoffs are determined by seniority (Oswald, 1993).[4] We assume that the actual outcome is

[4] This also implies that wage-employment outcomes on the labour demand curve are efficient.

determined by a Nash-bargain, where the union's fall-back utility is b (representing strike pay or casual work wages), assumed constant throughout, and the firm's fall-back profit is 0. Then, the equilibrium outcome is given by the solution to the problem

$$\max_{w,\ell} G = \mu \log(w-b) + (1-\mu)\log \pi \tag{3.1}$$

subject to the constraint that bargains are on the firm's labour demand curve. Here μ represents the union's bargaining power, $0 \le \mu \le 1$, and

$$\pi = \{(1-t_v)P(X) - t_s\} f(\ell) - w\ell \tag{3.2}$$

The first-order conditions are

$$G_w = \frac{\mu}{(w-b)} - \frac{(1-\mu)\ell}{\pi} = 0 \tag{3.3}$$

and

$$G_\ell = (1-\mu)\frac{1}{\pi}\{[(1-t_v)P - t_s]f' - w + (1-t_v)P_X \lambda f f'\} = 0. \tag{3.4}$$

The corresponding second-order conditions are

$$G_{ww} = -\frac{\mu}{(w-b)^2} - \frac{(1-\mu)\ell^2}{\pi^2} < 0, \tag{3.5}$$

$$G_{\ell\ell} = \frac{(1-\mu)}{\pi}\{[(1-t_v)P - t_s + (1-t_v)P_X \lambda f] f'' + 2(1-t_v)P_X \lambda (f')^2 + (1-t_v)P_{XX}\lambda^2 f(f')^2\} < 0 \tag{3.6}$$

and

$$G_{ww}G_{\ell\ell} > (G_{w\ell})^2, \tag{3.7}$$

where, making use of (3.4),

$$G_{w\ell} = -\frac{(1-\mu)}{\pi}. \tag{3.8}$$

Solving (3.3) for w and using (3.2), we get

$$w = \frac{\mu}{\ell}[(1-t_v)P - t_s]f + (1-\mu)b. \tag{3.9}$$

Substituting (3.9) into (3.4),

$$[(1-t_v)P - t_s][f' - \frac{\mu f}{\ell}] - (1-\mu)b + (1-t_v)P_X \lambda f f' = 0 \tag{3.10}$$

and perturbing gives

$$\begin{aligned}&\{[((1-t_v)P - t_s) + (1-t_v)P_X \lambda f]f'' + (1-t_v)(n+\lambda)P_X(f')^2 \\ &+ (1-t_v)P_{XX} n\lambda f(f')^2 - ((1-t_v)P - t_s)\mu\left(\frac{f'\ell - f}{\ell^2}\right) - (1-t_v)P_X nf'\frac{\mu f}{\ell}\}d\ell \\ &-[P(f' - \frac{\mu f}{\ell}) + P_X f\lambda f']dt_v - [f' - \frac{\mu f}{\ell}]dt_s = 0.\end{aligned} \tag{3.11}$$

Then, denoting the term in brackets in front of $d\ell$ by E, comparative statics analysis leads to

Proposition 4: In the wage-bargaining model, taxes affect employment as

$$\frac{d\ell}{dt_s} = \frac{\left(f' - \frac{\mu f}{\ell}\right)}{E} \tag{3.12}$$

and

$$\begin{aligned}\frac{d\ell}{dt_v} &= \frac{\left[P\left(f' - \frac{\mu f}{\ell}\right) + P_X \lambda f f'\right]}{E} \\ &= P\frac{d\ell}{dt_s} + \frac{P_X \lambda f f'}{E}\end{aligned} \tag{3.13}$$

Proof: Equations (3.12) and (3.13) are immediate from (3.11).□

Equation (3.10) establishes that the numerators in (3.12) and (3.13) are positive. But, the sign of E is ambiguous unless certain circumstances hold. It can be shown that E is definitely negative when the union has no bargaining power, that is $\mu = 0$ (in which case it is immediate from (3.9) that $w = b$), or when there is joint collusion among all the firms in the industry, that is $\lambda = n$. In the first case, E is negative given the first-order condition (3.4) and Seade's stability condition (see Section 2) are satisfied. In the second case, E is negative given the second-order conditions are satisfied. To see this, using (3.6) and then (3.2), (3.9) and (3.10), E can be written as

$$E = G_{\ell\ell}\frac{\pi}{(1-\mu)} + \frac{\mu\pi}{\ell^2} = \frac{\pi}{(1-\mu)}[G_{\ell\ell} + \frac{\mu(1-\mu)}{\ell^2}], \tag{3.14}$$

which can be shown to be negative if (3.7) is satisfied.

For the remainder of the paper, we assume that the condition $E < 0$ holds. Then, the effect of commodity taxes is to reduce employment. Note from (3.9) that

$$\frac{dw}{d\ell} = \frac{\mu}{\ell}\{[(1-t_v)P - t_s](f' - \frac{f}{\ell}) + (1-t_v)P_X nff'\} < 0. \tag{3.15}$$

Using $dw/dt_s = (dw/d\ell)(d\ell/dt_s)$ and $dw/dt_v = (dw/d\ell)(d\ell/dt_v)$, it is obvious that the effects of taxes on wages and employment have opposite signs.

Turning now to the effects of a P-shift, as defined in (2.18), on profits, we get

Proposition 5: A P-shift from specific to ad valorem taxation has an ambiguous effect on profits. But

(a) it reduces profits, if the union has no bargaining power, and

(b) it increases profits, if there is joint collusion.

Proof: From (3.2), and using $X = nx$, the effect of a specific tax on profits is given by

$$\begin{aligned}\frac{d\pi}{dt_s} &= \{[(1-t_v)P - t_s + (1-t_v)P_X nf\,]\,f' - w - \ell\frac{dw}{d\ell}\}\frac{d\ell}{dt_s} - f \\ &= (1-\mu)\{(w-b) + (1-t_v)(n-\lambda)P_X\, ff' - b\}\frac{d\ell}{dt_s} - f\end{aligned} \tag{3.16}$$

where use has been made of (3.9) and (3.4). The effect of the ad valorem tax is given by

$$\frac{d\pi}{dt_v} = P\frac{d\pi}{dt_s} + (1-\mu)\{(w-b) + (1-t_v)(n-\lambda)P_X\, ff'\}\left(\frac{P_X \ell ff'}{E}\right) \tag{3.17}$$

where use has been made of (3.13). Then a *P*-shift implies

$$d\pi = (1-\mu)\{(w-b) + (1-t_v)(n-\lambda)P_X\, ff'\}\left(\frac{P_X \lambda ff'}{E}\right)dt_v. \tag{3.18}$$

Part (a) follows when $\mu = 0$ and $w = b$, and part (b) when $\lambda = n$.□

Proposition 5 highlights a contrast with the efficiency wage model: a shift towards ad valorem taxation may increase profits. Examining the effect of a *P*-shift on employment and wages helps understand why a shift towards ad valorem taxation might result in a different effect on profits in the two models.

Proposition 6: In the wage-bargaining model specified, a P-shift from specific to ad valorem taxation leads to an increase in employment (and hence a reduction in wages).

Proof: Proceeding as in Proposition 3, but now using (3.12) and (3.13),

$$d\ell = \left(\frac{P_X \lambda ff'}{E}\right)dt_v, \tag{3.19}$$

which is positive, given $E < 0$.□

As the number of firms is fixed, total employment (and output) in the industry increase. If the union has no bargaining power, a shift to ad valorem taxation reduces profits. So the Delipalla and Keen (1992) result holds in this case, since w is fixed. But if the union exercises some bargaining power, profits increase in the case of joint profit maximisation: the relative reduction in wages outweighs the price reduction and total profits increase.

4. Conclusions

Comparative statics analysis in an efficiency-wage and a wage-bargaining model, shows that a commodity tax effect on employment and wages is model-dependent. In the efficiency wage model, (specific and ad valorem) commodity taxes reduce both employment and wages. A locally revenue-neutral shift in the balance towards ad valorem taxation increases both. In the bargaining model, the tax effects on employment and wages go in opposite directions. It is this difference that gives rise to the interesting result that predominantly ad valorem taxation can be advantageous to the firm. Shifting the balance towards ad valorem taxation can increase employment and hence reduce wages. When firms are engaged in tacit collusion, the relative reduction in the wage outweighs the price reduction and profits increase.

The result is interesting because the prevailing view, in the theoretical literature and the business world, is that it is specific taxation that favours profits (see, for example, Keen, 1998, for an excellent survey on specific versus ad valorem taxation). Incorporating the labour market into the analysis, we show that this is not necessarily true. Depending on the labour and product market characteristics, predominantly ad valorem taxation can be favourable to profits. However, higher profits in our bargaining model come at the expense of lower wages for workers, and hence ad valorem taxes may encounter opposition from unions rather than firms.

It is worth noting that the results in this paper have been derived from simple models with very specific functional forms. The real world is far more complex and any policy conclusions drawn from the analysis must be tentative at best. In fact our main point in this paper is the effects of a shift from one form of commodity taxation to another are far from clear-cut, and that the interaction between the product and labour markets must be considered before policy decisions are made. There are also a number of ways in which this work can be extended which may generate further insight on the impact of commodity taxation: for example, by introducing labour income taxation and examining the optimal mix of direct and indirect taxes in different models of wage determination;[5] allowing free entry of firms, and possible collusion among different groups of workers; extending to an open economy. We plan to address some of these issues in future work.

[5] Chang (1995) looks at optimal rates of ad valorem taxes on commodities and labour in an efficiency-wage model.

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