# TAX INCIDENCE IN A MODEL WITH EFFICIENCY WAGES AND UNEMPLOYMENT

by

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**Abstract**

The purpose of the present paper is to examine the effects of taxation on income distribution in a model with *efficiency wages* and *involuntary unemployment*. Central to the efficiency-wage theory is the hypothesis that firms may set wages above market-clearing levels, whenever the productivity of labor depends positively on the real wage paid by the firm. Within a two sector general equilibrium model we study the incidence of factor and commodity taxes on income distribution. Our findings are quite different from the results derived by the traditional neoclassical analysis, originally developed by Harberger.

Key words: tax incidence, efficiency wages

JEL classification: J3, H22

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## 1. Introduction

It is generally recognized by now that the simple two-sector general equilibrium model has been a very useful tool in analyzing tax incidence[1]. Most of the analyses, however, have been conducted under the assumption that perfect competition prevails in all markets, and as a result there is no unemployment. It is, of course, true that some authors have relaxed the assumptions of perfect competition in the product or labor markets, but still in most of these studies the distortions are exogenous rather than derived from the optimizing behavior of agents.[2] To overcome this shortcoming, Davidson and Matusz (1988) introduced an explicit search theory of *voluntary* unemployment into the two-sector model, and showed how endogenously derived frictions affect income distribution and the other variables of the model.

Later, Agell and Lundborg (1992) extended the two-sector model by introducing a fair wage hypothesis and, therefore, allowing for *involuntary* unemployment. The authors, following the gift/exchange model developed by Akerlof (1982), examine the effects of various policy instruments, such as taxation and unemployment benefits, on income distribution, resource allocation and unemployment. With regard to the effects of taxation, the results of the above paper are not very different, at least qualitatively, from those derived by the classic article of Harberger (1962), but we can obtain some interesting insights about the role of taxation not only on income distribution but also on unemployment.

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[1] For a recent and quite comprehensive review of the literature on tax incidence, see (Fullerton and Metcalf).

[2] See, for example, Anderson and Ballentine (1976), Atkinson and Stiglitz (1980), and Davidson, Martin, and Matusz (1988) who relax the assumption of perfect competition in the product markets. Jones (1971), Johnson and Mieszkowski (1970) and Imam and Whalley (1985) have focused on labor market features like unemployment and wage rigidities. Of particular interest is the work of Lockwood (1990) who introduces imperfections in both product and labor markets.

The purpose of the present paper is to examine the effects of taxation on income distribution in a model with *efficiency wages* and *involuntary unemployment*. Central to the efficiency-wage theory is the hypothesis that firms may set wages above market-clearing levels, whenever the productivity of labor depends positively on the real wage paid by the firm.[3] In what follows we adopt the efficiency-wage hypothesis, and specify worker's effort norm as a function of real wages and unemployment.

From a methodological point of view, our approach is very close to that of Agell and Lundborg (1994), with one basic difference. Agell and Lunborg assume that worker's effort function depends on unemployment and a fair wage, the latter being defined as the ratio of wages received by the workers and the returns to capital owners in the firm. Our approach, however, assumes that workers' effort depends on the real wage as defined by the nominal wage divided by a price index. In other words, we argue that workers' effort function depends not on the wage-profit differential and unemployment, as in Agell and Lundborg (1994), but on the real reward of their effort and the level of unemployment. The efficiency wage hypothesis is much more usual in the literature and is considered as more realistic than the fair wage hypothesis.

A theoretical explanation for this approach is provided in the second part of this paper. In the third part, the efficiency-wage hypothesis is incorporated into the simple two-sector model, and the basic relations of the model are derived. In the fourth part, we examine the effects of factor and commodity taxes on income distribution, on resource allocation and unemployment. In the last section, we summarize the main results of our analysis and compare our findings with those of Agell and Lundborg, but also with those derived by the standard analysis of tax incidence as developed, for example, by Atkinson and Stiglitz (1980).

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[3] For the microfoundations of the efficiency-wage theories, the interested reader can consult a large number of papers, for example, Solow (1979), Akerlof (1982), Stiglitz (1986), Weiss (1990). For the macroeconomic implications of the efficiency-wage theories a very useful survey is provided by Fischer (1989).

## 2. An efficiency-wage model in which real wage matters

We assume that the representative worker in firm $i$ maximizes a utility function that is separable in commodity and effort arguments. Following Levine (1989) and Agell and Lundborg (1992), the effort arguments are represented by utility $u_i^e$, which includes the individual's effort $e_i$. We assume, in particular, that the effort function depends on the cost to workers of losing their jobs. The cost of job loss depends in turn on the expected duration of unemployment, and the difference between the current real wage and the unemployment benefit and the wage expected at the next job. An intuitive explanation for this function could be the following. If a worker is fired and the unemployment spell is long, or the unemployment benefits are far below current pay, or if pay in other jobs is far below the current pay, then she/he is expected to work very hard. Assuming further that all workers and firms are identical, that the unemployment benefits are exogenously set, and that the duration of unemployment is positively associated with the economy-wide level of unemployment, we can postulate effort as a function of real wage ($w/P$) and unemployment $U$. Utility also depends on the quantities consumed of the goods produced in the two sectors of the economy according to the function $u_i^q$. The utility of an employed is assumed to be strictly higher than the utility of an unemployed. It is in this framework that the representative worker maximizes his utility, and firms maximize their profits. We, therefore, have the following effort function for the representative worker.[4]

$$e = e(\frac{w}{P}), U \tag{2.1}$$

where $e$ is the supply of effort, $w$ is the wage rate and $P$ is a price index. A unique optimum requires effort to be a continuous strictly concave function, with $e_1>0$, $e_2>0$, $e_{11}<0$, $e_{22}<0$. For

[4] It is rather easy to provide some theoretical underpinnings for this equation, if we follow the approach suggested by Agell and Lundborg (1992) or Akerlof (1982).

analytical convenience, we also assume that the effort function is separable in its arguments, and thus $e_{12} = 0$. Moreover, to ensure an interior solution we assume that $e$ is negative whenever $w$ is zero.

Equation (2.1) is crucial to the firm's optimization problem. We assume that firms in either of the two sectors face the same effort function e, and that they set their wages in such a way as to minimize the *effective* wage cost per worker. With the assumption that there is competition in the labor markets and perfect intersectoral mobility, the wage rate is the same for all firms. Thus, the effective wage cost can be written as $v \equiv w/e$. Formally, the optimization problem for the representative firm is the following:

$$Min \quad v = w/[(\frac{w}{P}), U] \tag{2.2}$$

subject to

$e<0$ *for* $w = 0$

Solving (2.2) gives the following first order condition:

$$e - (\frac{w}{P})e_1 = 0 \tag{2.3}$$

which can be rewritten as

$$\varepsilon_1 \equiv \frac{e_1}{e}(\frac{w}{P}) = 1 \tag{2.4}$$

This relationship states that the optimal wage is set such that the elasticity of the effort function with respect to the real wage rate is equal to unity. So, equation (2.4) is the traditional Solow condition (Solow 1979).

Totally differentiating equation (2.3) and with the assumption that $e_{12} = 0$, we obtain after some manipulations the following relationship:

$$\hat{U} = \frac{\varepsilon_{11}}{\varepsilon_2}(\hat{w} - \hat{P}) \tag{2.5}$$

where an caret (^) indicates the percentage change in a variable, $\varepsilon_{11} = (e_{11}/e_1)(w/P)$, and $\varepsilon_2 = (e_2/e)U$. Since $e_2>0$, we also have that $\varepsilon_2 >0$, which is the elasticity of effort with respect to the unemployment. Also, by the concavity of the effort function we have that $e_{11}<0$ which implies that $\varepsilon_{11}<0$.

An important parameter in the following analysis is the elasticity $\varepsilon_{11}$ . It measures the concavity of the effort function with respect to $w/P$. In economic terms, we may think of $\varepsilon_{11}$ as measuring the rate at which workers get satisfied with real wages. When $\varepsilon_{11}$ is small, the effort function is close to linear, and marginal effort $e_1$ is a slowly declining function of $w/P$; when $\varepsilon_{11}$ is large, $e_1$ declines rapidly with $w/P$.

Differentiating totally (2.1) yields:

$$\hat{e} = \hat{w} - \hat{P} + \varepsilon_2\hat{U} \tag{2.6}$$

which says that positive changes in the real wage and/or the unemployment increase the work effort. From (2.5) and (2.6) we obtain that:

$$\hat{e} = (1+\varepsilon_{11})(\hat{w} - \hat{P}) \tag{2.7}$$

$$\hat{v} = \hat{w} - \hat{e} = \hat{P}(1+\varepsilon_{11}) - \varepsilon_{11}\hat{w} \tag{2.8}$$

Having established the basic relationships regarding the behavior of the firm and the workers, we can proceed to the analysis of the tax incidence. However, in order to simplify things we shall assume for the rest of our analysis that $\varepsilon_{11} = -1$. Although this assumption is rather strong and implies that the work effort does not change with respect to the real wage, i.e. that work effort changes only as unemployment changes, we shall adhere to it because the main results of our analysis do not change significantly, but our analysis is made much more tractable.

## 3. The two-sector model with efficiency-wages and taxation

Consider an economy with two sectors of production in which two commodities are produced in quantities $X$ and $Y$. There two factors of production, capital ($K$) and labor ($L$), which are intersectorally mobile, and in fixed total supply. Product markets are perfectly competitive, while in the labor market firms in the two sectors set wages according to the efficiency-wage hypothesis. Production functions are assumed to be linearly homogeneous into which capital, $K_i$, and labor in efficiency units, $E_i$, enter as arguments.

$$X = F_X(E_X, K_X) \tag{3.1}$$

$$Y = F_Y(E_Y, K_Y) \tag{3.2}$$

We have $E_i = e(w/P,\ U)L_i$, where $L_i$ is the amount of labor used in sector $i$. As we mentioned earlier, the number of workers, $L$, is fixed to the economy, while total labor in efficiency units, $e(...)L$, is determined endogenously.

In the following analysis, we shall examine only two taxes: A capital income tax in sector $X$, and a consumption tax on good $X$. With these taxes, the dual total cost functions, $C_X$ and $C_Y$, to the production functions become:

$$C_X = C_X(\frac{w}{e}, r_X)X \tag{3.3}$$

$$C_Y = C_Y(\frac{w}{e}, r_Y)Y \tag{3.4}$$

where $r_X = (1+t_{KX})r = T_{KX}r$, $r$ is the net rate of return to capital and $t_{kx}$ is the tax rate on the return to capital in the $X$ sector. With perfect factor mobility, the net returns to capital and labor will be equalizes across sectors. Assuming that $C_i$ is twice differentiable, we can obtain the following equilibrium conditions in factor markets:

$$C_{EX} X + C_{EY} Y = e(L - U) \tag{3.5}$$

$$C_{KX} X + C_{KY} Y = K \tag{3.6}$$

where $C_{ij}$ are the derivatives of the minimum unit cost functions in the two sectors with respect to (effective) factor prices. The LHS of (3.5) specifies the total demand for efficiency labor units of the two production sectors, while the RHS defines the effective labor supply in efficiency units corrected for the unemployment and multiplied by the economy-wide effort level.

Perfect competition in product markets implies the following zero profit conditions:

$$C_{EX} v + C_{KX} r_X = p_X \tag{3.7}$$

$$C_{EY} v + C_{KY} r = p_Y \tag{3.8}$$

where $p_i$ is the producer price of commodity $i$, ($i$=$X,Y$). Differentiating totally equations (3.5)-(3.8), and denoting changes in variables with a caret, we can obtain, after some manipulations the following relationships, assuming that $\hat{L} = \hat{K} = 0$

$$\lambda_{EX}\hat{X} + \lambda_{EY}\hat{Y} = -(\lambda_{EX}\hat{C}_{EX} + \lambda_{EY}\hat{C}_{EY}) - \frac{U}{L-U}\hat{U} \tag{3.9}$$

$$\lambda_{KX}\hat{X} + \lambda_{KY}\hat{Y} = -(\lambda_{KX}\hat{C}_{KX} + \lambda_{KY}\hat{C}_{KY}) \tag{3.10}$$

$$\theta_{EX}\hat{w} + \theta_{KX}\hat{r} = \hat{p}_X - \theta_{KX}\hat{T}_{KX} \tag{3.11}$$

$$\theta_{EY}\hat{w} + \theta_{KY}\hat{r} = \hat{p}_Y \tag{3.12}$$

where

$\lambda_{EX} \equiv C_{EX}X/e(L\text{-}U)$ is the share of *efficient* labor used in sector X

$\lambda_{EY} \equiv C_{EY}Y/e(L\text{-}U)$ is the share of *efficient* labor used in sector Y

$\lambda_{KX} \equiv C_{KX}X/K$ is the share of capital used in sector X

$\lambda_{KY} \equiv C_{KY}Y/K$ is the share of capital used in sector Y

$\theta_{Ei} \equiv wC_{Ei}/eP_i$ is the share of *effective* labor cost in producing commodity i,

$\theta_{Ki} \equiv rC_{Ki}/P_i$ is the share of capital cost in producing commodity i,

From the fact that the unit cost functions are homogeneous of degree zero in factor prices, we also have:

$$\hat{C}_{EX} = -\theta_{KX}\sigma_X(\hat{w} - \hat{r} - \hat{T}_{KX}) \tag{3.12}$$

$$\hat{C}_{KX} = \theta_{KX}\sigma_X(\hat{w} - \hat{r} - \hat{T}_{KX}) \tag{3.13}$$

$$\hat{C}_{EY} = -\theta_{KY}\sigma_Y(\hat{w} - \hat{r}) \tag{3.14}$$

$$\hat{C}_{KY} = \theta_{EY}\sigma_Y(\hat{w} - \hat{r}) \tag{3.15}$$

By making use of (3.12) - (3.15), we can rewrite equations (3.9) and (3.10) as follows:

$$\lambda_{EX}\hat{X} + \lambda_{EY}\hat{Y} = \lambda_{EX}\theta_{KX}\sigma_X(\hat{w} - \hat{r} - \hat{T}_{KX}) + \lambda_{EY}\theta_{KY}\sigma_Y(\hat{w} - \hat{r}) - \frac{U}{L-U}\hat{U} \tag{3.16}$$

$$\lambda_{KX}\hat{X} + \lambda_{KY}\hat{Y} = -\lambda_{KX}\theta_{EX}\sigma_X(\hat{w} - \hat{r} - \hat{T}_{KX}) + \lambda_{KY}\theta_{EY}\sigma_Y(\hat{w} - \hat{r}) \tag{3.17}$$

where $\sigma_I$ is the elasticity of substitution between capital and labor in efficiency units in the ith sector.

From equations (3.16) and (3.17) we can obtain:

$$\lambda(\hat{X} - \hat{Y}) = (\delta_X + \delta_Y)(\hat{w} - \hat{r}) - \frac{U}{L-U}\hat{U} \tag{3.18}$$

where

$\lambda = \lambda_{EX}-\lambda_{KX}=\lambda_{KY}-\lambda_{EY}$

$\delta_X \equiv (\lambda_{EX}\theta_{KX} + \lambda_{KX}\theta_{EX})\sigma_X$

$\delta_Y \equiv (\lambda_{EY}\theta_{KY} + \lambda_{KY}\theta_{EY})\sigma_Y$

In proceeding to our analysis we shall assume that commodity $Y$ is taken as the numeraire, and therefore its price $p_Y = 1$. If we define the price index $P$ to be equal to a weighted average of the consumer prices of the two commodities, i.e. $P = q_X^{\gamma} + q_Y^{1-\gamma}$ where $q_i$ is the consumer price of commodity i, and $\gamma$ and $1\text{-}\gamma$ are the weights of commodity $X$ and $Y$ respectively in the index, then

$$\hat{P} = \gamma\hat{q}_X + (1-\gamma)\hat{q}_Y \tag{3.19}$$

Let us assume that a commodity tax is imposed on $X$ at a rate $\tau_X$ so that $q_X = p_X(1+ \tau_X) = p_X T_X$. Since no tax is imposed on $Y$, $q_Y = p_Y = 1$. Therefore, the price index reduces to $\hat{P} = \gamma\hat{q}_X$ . For simplicity, we shall assume, without any loss of generality, that

$$\hat{P} = \hat{q}_X \tag{3.19a}$$

Making use of (2.5), (3.11), (3.18), and (3.19a) we obtain:[5]

$$\lambda(\hat{X}-\hat{Y}) = (\delta_X + \delta_Y + \frac{U\theta_{KX}}{(L-U)\varepsilon_2})(\hat{w}-\hat{r}) - \frac{U}{(L-U)\varepsilon_2}\hat{T}_X - [\delta_X + \frac{U\theta_{KX}}{(L-U)\varepsilon_2}]\hat{T}_{KX} \tag{3.20}$$

On the consumption side, we assume that consumers have identical and homothetic preferences, so that relative demand for the two commodities depends on relative prices only,

[5] For more details see appendix.

i.e. $D_X/D_Y = f\,(q_X/q_Y)$.[6]

Given that we assume a closed economy, $D_X = X$, and $D_Y = Y$, total differentiation yields.[7]

$$(\hat{X} - \hat{Y}) = -\sigma_D\, \hat{q}_X \tag{3.21}$$

where $\sigma_D$ is the elasticity of substitution between $X$ and $Y$ in consumption.

From (3.11) and (3.12), we can also obtain that:

$$\theta(\hat{w} - \hat{r}) = \hat{p}_X - \hat{T}_{KX} \tag{3.22}$$

We have thus established the basic relations of our model, (3.20)-(3.22), which can be solved for $(\hat{w} - \hat{r})$, $(\hat{X} - \hat{Y})$, and $\hat{p}_X$, unemployment and real wages.

## 4. The incidence of factor and commodity taxes

### 4.1. The incidence of a factor income tax

We shall examine first the incidence of a tax on capital in the X-sector. By setting $T^*_X = 0$, we obtain by solving simultaneously equations (3.20)-(3.22), the following relationships:

$$\hat{w} - \hat{r} = \frac{1}{\Delta}\left(-\lambda\theta_{KX}\sigma_D + \delta_X + \frac{U\theta_{KX}}{(L-U)\varepsilon_2}\right)\hat{T}_{KX} \tag{4.1}$$

$$\hat{X} - \hat{Y} = -\frac{\sigma_D}{\Delta}\left[\left(\delta_X + \frac{U\theta_{KX}}{(L-U)\varepsilon_2}\right)\theta_{KY} + \theta_{KX}\delta_Y\right]\hat{T}_{KX} \tag{4.2}$$

$$\hat{p}_X = \frac{1}{\Delta}\left(\theta_{KY}\delta_X + \theta_{KX}\delta_Y + \frac{U\theta_{KX}\theta_{KY}}{(L-U)\varepsilon_2}\right)\hat{T}_{KX} \tag{4.3}$$

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[6] The assumption of homothetic preferences is rather usual in the theory of tax incidence. For further details, see for example, Atkinson and Stiglitz (1980).

[7] With some rather minor changes the analysis could be easily extended for an open economy.

$$\hat{U} = \frac{\theta_{KX}}{\Delta\varepsilon_2}(\lambda\theta_{KY}\sigma_D + \delta_Y)\hat{T}_{KX} \tag{4.4}$$

$$\hat{w} - \hat{P} = -\frac{\theta_{KX}}{\Delta}(\lambda\theta_{KY}\sigma_D + \delta_Y)\hat{T}_{KX} \tag{4.5}$$

where $\Delta = \lambda\theta(\sigma_D+\sigma_s)$, and $\sigma_s$ is the supply-elasticity of substitution between $X$ and $Y$ in the production, and it is positive.[8] Assuming that there are no other distortions in the economy, before the imposition of the factor tax, it can be shown that $\Delta$ is positive.[9]

Let us consider first the effects of taxation on relative factor prices, and compare our results with those derived by Harberger (1962), in his classic treatment of the incidence of the corporate income tax. The change in the wage-rental ratio depends on three effects, the *output effect* ($-\lambda\theta_{KX}\sigma_D$), the *factor substitution effect* ($\delta_X$) and the *unemployment effect* $U\theta_{KX}/(L-U)\varepsilon_2$. Comparing this formula with the corresponding formula of Harberger, we observe that the only difference between the two is the unemployment effect.[10] The factor substitution effect and the unemployment effect are positive, while the sign of the output effect is ambiguous depending on the sign of $\lambda$. If the X-sector is relatively capital intensive $\lambda$ is negative and the output effect positive. If on the other hand, the X-sector is labor intensive $\lambda$>o, and the output effect is negative. The effects of the output and substitution effects have been analyzed extensively (e.g. Atkinson and Stiglitz 1980), and thus we shall limit our analysis to the influence of the unemployment effect. Since it is positive, it works in favor of labor. To see this more clearly, we can examine two extreme cases under the assumption that the X-sector is relatively labor intensive, i.e. $\lambda>0$.

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[8] For the exact definition of $\sigma_s$ see appendix.

[9] For more details see Atkinson and Stiglitz (1980) or Neary (1978).

[10] The distinction in output and substitution effects was originally made by Mieszkowski (1967).

First, assume that $\sigma_X = 0$, which implies that $\delta_X = 0$. In the standard Harbergerian model, where the unemployment effect is absent, the wage rate falls relative to the rental to capital. In the present model, however, there is also the unemployment effect which is positive and may even outweigh the negative output effect. So it is possible that the wage -rental ratio rises, and in any case it will be higher than in the simple Harbergerian model. Secondly, consider the case where $\lambda=0$, that is, both sectors have initially the same factor intensities, and $\sigma_X=0$. In the Harberger model, the wage-rental ratio remains unchanged. In our model, however, the wage-rental ratio rises. An intuitive explanation could be the following. In the Harbergerian approach, with the above assumptions, the imposition of the tax on capital in $X$ is equivalent to a tax on X, and raises the price of $X$ (see eq. 4.3) leading to a reduction in its demand. To accommodate this reduced demand the $X$ industry releases capital and labor in the proportion that these factors are used in the production of $X$. If the $Y$ industry uses these factors in the same proportions then it can expand its production to meet the increased demand. Since the capital/labor ratio in $Y$ is unchanged, the w/r ratio is also unchanged. Hence, w and r both fall relative to $p_X$ in the same proportion. In our model, however, the unemployment effect leads to an increase in the $w/r$ ratio. An explanation could be the following. With the above assumptions the real wage falls (see eq. 4.5), and unemployment rises so that the work-effort rises, as assumed. However, the higher the level of unemployment the lower the labor-capital ratio, and as a result the higher the marginal productivity of labor.

It is clear from the above analysis that the tax incidence may be quite different from the results derived by Harberger, not only quantitatively but also qualitatively. What is of particular interest is the presence of unemployment. As equation (4.4) reveals the effect of capital income taxation on unemployment depends on relative factor intensities. If the taxed sector is relatively labor intensive, i.e. $\lambda>0$, then unemployment will rise. If, on the other hand, the taxed sector is relatively capital intensive ($\lambda<0$), then the change in unemployment depends on the relative strength of the factor substitutability in the untaxed sector ($\delta_Y$). If it is small then unemployment will fall, while if it is large enough to outweigh the term $\lambda\theta_{KY}\sigma_D$ then unemployment will rise. The policy conclusion is, therefore, that a capital income tax may reduce unemployment as long as it is imposed on the relatively capital intensive sector of the economy and the factor substitutability in the untaxed sector is very low.

With regard to the effects of taxation on sectoral output composition and output prices, they are qualitatively the same with those derived from the standard Harbergerian analysis. What is worth examining is the supply of effective labor, which is variable, while in the analysis of Harberger, labor supply is fixed. Differentiating totally the effective labor supply function $E_s = e[(w/q), U](L-U)$, we obtain, after some manipulations that:

$$\hat{E}_S = (\hat{w} - \hat{p}_X)\frac{U}{L-U}\hat{T}_{KX} \tag{4.6}$$

Given that the real wage falls, it is clear that the effective labor supply falls as a result of the imposition of the capital income tax. Having examined the effects of capital income tax, we can turn now to the examination of the effects of a consumption tax on the output of sector *X*.

### 4.2 The incidence of a commodity tax

By assuming $\hat{T}_{KX} = 0$, and $\hat{T}_X > 0$, we have a difference between producer prices (p) and consumer prices (q), which is due to the commodity tax on X. Solving simultaneously equations (3.23)-(3.22), we obtain:

$$\hat{w} - \hat{r} = \frac{1}{\lambda\theta(\sigma_D + \sigma_S)}(-\lambda\sigma_D + \frac{U}{(L-U)\varepsilon_2})\hat{T}_X \tag{4.7}$$

$$\hat{p}_X = \frac{1}{\lambda(\sigma_D + \sigma_S)}(-\lambda\sigma_D + \frac{U}{(L-U)\varepsilon_2})\hat{T}_X \tag{4.8}$$

$$\hat{q}_X = \frac{1}{\lambda\theta\,(\sigma_D + \sigma_S)}(\delta_X + \delta_Y + \frac{U}{(L-U)\varepsilon_2})\hat{T}_X \tag{4.9}$$

$$\hat{U} = \frac{1}{\lambda\theta\,(\sigma_D + \sigma_S)\varepsilon_2}(\lambda\theta_{KY}\sigma_D + \delta_X + \delta_Y)\hat{T}_X \tag{4.10}$$

It is again clear that the unemployment effect may have important implications on income distribution and commodity prices. With regard to the wage/rental ratio, we observe that the unemployment effect may change the results of the standard model. Consider, for example, the case where $\sigma_D = 0$, (or that $\lambda=0$). In such a case, the w/r would remain unchanged in the standard model while in our model the wage rate would benefit in relation with the rental to capital. It is worth examining also what happens to the consumer and producer prices. The consumer price $q_X$ rises unambiguously, while the producer price of the taxed commodity $p_X$ may fall or rise depending not only on relative factor intensities, but also on the unemployment effect; and the unemployment effect works in favor of the producers. Finally, with regard to the unemployment, we observe that if the taxed sector is relatively capital intensive then the tax will lead to an increase in unemployment. If the taxed sector is relatively capital intensive, then unemployment may fall, if the elasticity of substitution between capital and labor in the two sectors is small.

## 5. Some concluding remarks

Most of the extensions of the classic model for tax incidence developed by Harberger were based on the assumption of full employment. In our analysis we have examined tax incidence in a model with efficiency wages. The introduction of efficiency wages makes effective labor supply endogenous, and as a result we can have *involuntary* unemployment. With the effort function depending on the real wage and unemployment, we derived a relationship between effort, real wage and unemployment. Assuming identical effort functions across the two sectors of a simple general equilibrium model, we are in a position to have the competitive model, with perfect competition in all markets, with unemployment.

In this framework, we analyze the effects of a corporate and a consumption tax on income distribution, prices, and unemployment. Our findings differ significantly from those derived by Harberger, but also the analyses, which extended the Harberger model.

When effort function depends on unemployment, a corporate income tax may lead to a reduction of unemployment, depending on the labor intensity of the taxed sector, and the level of unemployment. Moreover the distribution of income is also affected and the traditional results change not only quantitatively, but also qualitatively. Similarly a consumption tax may lead to a reduction in unemployment as long as it is imposed on the capital intensive commodity.

As our analysis has shown, the traditional general equilibrium model can be significantly enriched and become more realistic, with the introduction of efficiency wages. It also yields results that differ from those derived by the full employment neoclassical model, and can lead to policy recommendations for combating unemployment.

***Appendix***

Following Agell and Lunborg (1992) and Akerlof (1982), we can specify a utility function which is maximized by the representative employed worker as follows:

Max $U^e(e,U)U^q(X,Y)$ Subject to $w= P_X T_x X + P_Y T_Y Y=q_X X + q_Y Y,$

with $e = e\,[(w/P), U]$, and where $P_X, T_x, X, P_Y\ T_Y, Y, q_X, q_Y$, are defined in the paper.

The first order conditions become

$$\frac{\partial u^e}{\partial e} u^q(\ldots) = 0 \tag{A1}$$

$$\frac{\partial u^q}{\partial X} u^e(\ldots) - \lambda P_X T_X = 0 \tag{A2}$$

$$\frac{\partial u^q}{\partial Y} u^e(\ldots) - \lambda P_Y T_Y = 0 \tag{A3}$$

where λ is the Lagrange multiplier. Equation (A1) defines e as an implicit function of w/P, and U, i.e. we can write the effort function as

*e = e [(w/P), U], which is equation (2.1) of the text.*

To obtain (3.20), we substitute (2.5) into (3.18), which yields

$$\lambda(\hat{X} - \hat{Y}) = (\delta_X + \delta_Y)(\hat{w} - \hat{r}) - \frac{U}{L-U}(\frac{\varepsilon_{11}}{\varepsilon_2})(\hat{w} - \hat{P})$$ or

$$\lambda(\hat{X} - \hat{Y}) = (\delta_X + \delta_Y)(\hat{w} - \hat{r}) - \frac{U}{L-U}(\frac{\varepsilon_{11}}{\varepsilon_2})(\hat{w} - \hat{q}_X)$$ or

$$\lambda(\hat{X} - \hat{Y}) = (\delta_X + \delta_Y)(\hat{w} - \hat{r}) - \frac{U}{L-U}(\frac{\varepsilon_{11}}{\varepsilon_2})(\hat{w} - \hat{p}_X - \hat{T}_X)$$

Making use of (3.11), and setting $\varepsilon_{11} = -1$, yields (3.20).

Finally, $\sigma_s$ the supply-elasticity of substitution between X and Y in the production is defined as follows:

$$\sigma_S = \frac{1}{\lambda\theta}(\delta_X + \delta_Y + \frac{U}{(L-U)\varepsilon_2})$$

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