Employment Double Dividend and Wage Determination

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Résumé : L'objet de notre article est de proposer un cadre unifié pour établir des résultats les plus généraux possibles et répondre aux doutes exprimés par certains quant à l'éventualité d'un double dividende en terme d'emploi comme en terme d'efficacité. Nous raisonnons dans un cadre d'équilibre général en concurrence imparfaite sur le marché des biens, où trois types d'agents sont distingués : les salariés, les chômeurs et les rentiers. Deux modes de formation non concurrentielle des salaires sont envisagés (les négociations salariales et le salaire d'efficience), ainsi que différents modes d'indexation des allocations chômage. Nous montrons alors qu'un second dividende en termes d'emploi ne peut apparaître dans le cas où seules les entreprises sont soumis à l'écotaxe. Par ailleurs, lorsque tous les agents sont taxés, le double dividende est d'autant plus facilement réalisable que le degré de concurrence sur le marché des biens est faible et que les salariés ont la possibilité de reporter la charge fiscale sur les autres agents. En outre, la réforme fiscale conduit plus aisément à un double dividende dans le cas des négociations salariales que dans celui du modèle de salaire d'efficience. Enfin, il existe un taux de taxe initial maximal des taxes environnementales pour obtenir un dividende d'emploi et il dépend du mode d'indexation des allocations-chômage.

Mots clés: Taxe environnementale - Double dividende - Chômage - Négociations salariales - Salaire d'efficience.

Abstract : This paper investigates te double dividend issue in a general equilibrium model of a closed economy in which polluters are firms and households, and firms are monopolistic competitors on the non polluting good market. We compare the effects of the reform on employment for two non-competitive labor-market scenarios: a wage bargaining model and an efficiency wage model. Moreover, three characteristics of the unemployment benefits are considered: fixed in real terms, indexed to production price or fixed replacement ratio. It is shown that if environmental taxes preexist, such a reform can boost employment if and only if at least households energy consumption is taxed regardless the unemployment scenario. Moreover the reform yields more easily a second dividend if wages are negociated than in efficiency wage model. Finally, the maximum level of initial environmental taxes rate compatible with an employment dividend depends on the characteristics of the unemployment benefits.

Key words: Environmental tax - Double dividend - Unemployment - Bargaining wage model - Efficiency wage model.

JEL classification: D60 - D62 - E62 - H23 - Q28

1. Introduction

In 1991, David Pearce argued that using the revenues from environmental taxation to reduce preexisting distortionary taxes may overcompensate for negative costs of the environmental policy, i.e.e, this can lead to an improvement of environmental quality associated with a more efficient fiscal system. This strong form of the so-called double dividend hypothesis has been criticized by a number of authors (Bovenberg and de Mooij [1994a], [1994b] and [1997], Goulder [1995], Bovenberg and Goulder [1996]). Using a theoretical general equilibrium framework in which all markets clear, including the labor market, they show that the strong form of the double dividend fails to arise. In these models, welfare grows with labor supply. But environmental taxation raises the consumption price and reduces labor supply. The double dividend could be reached if and only if labor supply elasticity were negative. On the other hand, empirical works with neo-keynesian macroeconometric models, in which there is some involuntary unemployment, conclude to an improvement of growth and employment by using the revenues form environmental taxation to reduce wage taxes (EC [1992] and [1994], Beaumais and Godard [1994], Lemiale and Zagamé [1998]).

More recently, these differences have led some authors to deal with involuntary unemployment in the double dividend debate. Nevertheless, labour market imperfections are rather different across papers, so comparative results are quite difficult to obtain. Bovenberg and van der Ploeg [1994a, b] and [1996] and Bovenberg [1997] conduct an analysis in a framework in which unemployment is due to matching frictions. Schneider [1997] uses an efficiency model. Most of the studies use a wage bargaining model (Brunello [1996], Koskela and Schöb [1999], Bayindir-Upmann and Raith [1997], Marsiliani and Renström [1997], Pfüger [1997], Holmlund and Kolm [1997], De Mooij [1999]). Despite the differences in the modelling approaches, a general result seems to emerge: when labor market does not clear, the double dividend is more likely to occur. They all show that employment can rise if the tax burden is shifted from workers to unemployed. Hence, these results depend crucially on the characteristics of unemployment benefits.

The aim of this paper is to clarify the debate on the employment dividend in a unified framework. We assume a closed economy *à la* Blanchard and Kiyotaki [1987]. Hence, we consider imperfect competition in the product market. In contrast with Koskela and Schöb [1999] and Pfüber [1997], firms and households consume energy. Therefore all agents will face the environmental policy. The characteristics of the economy are described in section 2. In section 3, we assume different specifications of the labor market: wage bargaining and an efficiency wage model. In each model, we assume different characteristics of unemployment benefits (indexation to the consumption price, to the aggregate production price, or exogenous replacement ratio). Section 4 examines the sensitivity of unemployment and wages to an increase in environmental tax rate and to a cut in labour tax regardless the budget neutrality. It turns out that an environmental fiscal reform cannot reduce unemployment if the replacement ratio is fixed and if wages are negotiated, which is a standard result in equilibrium unemployment models. However, this is no more the case in an efficiency wage model and moreover, in a bargaining framework, a cut in personal income tax always reduces unemployment. For the other characteristics of the unemployment benefits, it is shown that an increase in employment could be more easily achieved in a bargaining model than in an efficiency wage. The reason is, that in the efficiency wage model, the environmental tax always raises the wage because, by reducing the expected utility of work, it induces the worker to shirk.

After having linearized the reduced form of our model around the steady state in section 5, the section 6 explores the effects of a revenue neutral environmental tax reform when the environmental taxes are recycled in lower wage tax. We show that an environmental policy bearing only on firms cannot boost employment. The reform reduces unemployment if households also face an increase in their energy prices. If both agents face an increase in energy consumption price, the fiscal reform reduces unemployment when there are no initial tax, if and only if the product market is not competitive. When, initially, an environmental policy is already enforced, employment can increase depending on the initial level of the energy tax. It is then possible to range the conditions for a second dividend depending on the characteristics of the labour market and the unemployment benefits.

2. The model

We study the steady-state of a closed economy whose characteristics are close of those of Blanchard and Kiyotaki [1987]. Two sectors are modelled: one producing consumption goods and one producing energy.

2.1. The households

The total number of households is $M = H + N$, who are workers (L), or unemployed $(H - L)$, or N firms' owners who are assumed not to be active. They all have the same preferences. The workers earn wages , the unemployed perceive unemployment benefits and the firms' owners collect profits. The utility function of household m is:

$$U_m = \left(\frac{C_m}{1-\sigma}\right)^{1-\sigma} \left(\frac{E_m}{\sigma}\right)^{\sigma} - D(\overline{E}) \tag{2.1}$$

where C_m is her aggregate consumption of goods and E_m her consumption of energy. $\overline{E}$ is the total consumption of energy of both consumers and firms (which is considered as the global level of pollution), and $-D(\overline{E})$ represents then the disutility of pollution.

The aggregate consumption of goods is modelled by a CES function of the goods produced by the economy (Dixit and Stiglitz [1977]).

$$C_m = N^{\frac{1}{1-\theta}} \left(\sum_{i=1}^{N} c_{im}^{\frac{\theta-1}{\theta}} \right)^{\frac{\theta}{\theta-1}} \tag{2.2}$$

where c_{im} stands for the consumption by agent m of good i, θ ($\theta > 1$) for the elasticity of substitution between the differentiated goods, and N for the number of produced goods.
The representative consumer's budget constraint is:

$$PC_m + P_{em}E_m = R_m \tag{2.3}$$

where P and P_{em} are respectively the aggregate price (after tax) of the consumption of non-polluting goods and the price of energy for the households. Assume $P_{em} = (1 + t_d)\, e$ with e the energy price and t_d the tax rate on energy purchased by the households. R_m is their revenue: $R_m = (1 - t_L)w$ for a worker, with t_L the income-tax rate (assumed to be constant) and w the gross wage rate, $R_m = B$ for an unemployed, where B stands for the unemployment benefits and $R_m = \Pi_i$ for the owner of firm i.
The household's program leads to:

$$c_{im} = (1-\sigma)\frac{R_m}{NP}\left(\frac{P_i}{P}\right)^{-\theta} \qquad i = 1..N \tag{2.4}$$

The aggregate price of consumption is:

$$P = \left(\frac{1}{N} \sum_{i=1}^{N} P_i^{1-\theta} \right)^{\frac{1}{1-\theta}} \tag{2.5}$$

The indirect utility of the consumer can then be expressed as:

$$V(R_m) = \frac{R_m}{P_c} - D(\overline{E}) \tag{2.6}$$

where $P_c = P^{1-\sigma}P_{em}^{\sigma}$ is the aggregate consumption price index.

2.2. The energy sector

As in Marsiliani and Renström [1997], we assume that energy can be produced by competitive firms using an aggregate of consumption goods, through a linear transformation process:

$$E_s = \phi X_e \qquad \text{with} \quad X_e = N^{\frac{1}{1-\theta}} \left(\sum_{i=1}^{n} x_i^{\frac{\theta-1}{\theta}} \right)^{\frac{\theta}{\theta-1}} \tag{2.7}$$

Minimizing the expenditures of this sector leads to the factor demands:

$$x_i = \frac{X_e}{N}\left(\frac{P_i}{P}\right)^{-\theta} \qquad i = 1..N \tag{2.8}$$

Given this peculiar specification, the price of X_e equals the aggregate consumption price index P, which implies that the real price of energy is constant and equal to ϕ.

2.3. The capital sector

We assume also that capital can be produced by competitive firms using an aggregate of consumption goods, through a linear transformation process:

$$K_s = \varphi X_k \qquad \text{with} \quad X_k = N^{\frac{1}{1-\theta}} \left(\sum_{i=1}^{n} x_i^{\frac{\theta-1}{\theta}} \right)^{\frac{\theta}{\theta-1}} \tag{2.9}$$

Minimizing the expenditures of this sector leads to the factor demands:

$$x_i = \frac{X_k}{N} \left(\frac{P_i}{P} \right)^{-\theta} \qquad i = 1..N \tag{2.10}$$

Given this peculiar specification, the price of X_k equals the aggregate consumption price index P, which implies that the real price of energy is constant and equal to φ.

2.4. The government

To simplify, we assume that the public expenditures G, are of the same form as the consumption:

$$G = N^{\frac{1}{1-\theta}} \left(\sum_{i=1}^{N} g_i^{\frac{\theta-1}{\theta}} \right)^{\frac{\theta}{\theta-1}} \tag{2.11}$$

The minimization of expenditures leads to the following demand of good i:

$$g_i = \frac{G}{N} \left(\frac{P_i}{P_g} \right)^{-\theta} \qquad i = 1..N \tag{2.12}$$

The price of public expenditures is obtained as an aggregation of the consumption goods prices and, given the specific form of the aggregate expenditures, equals P.

The government finances its expenditures and the unemployment benefits with four distortionary taxes[3]: the energy taxes, t_e paid by the firms and t_d by the consumers, a wage tax t_w paid by the firms and the income-tax t_L. The government's budget constraint can then be written as[4]:

$$PG = t_w w L + t_L w L + e t_d E^M + e t_e E^N - B(H - L) \tag{2.13}$$

where E^M et E^N stand respectively for the total energy demands of consumers and firms.

[3] We do not include capital taxation beause in this kind of model the effects are the same as in Bovenberg and de Mooij [1996].

[4] As we intend to explicitly analyze the energy taxation on households under alternative rules of indexation of unemployment benefits, we introduce benefits in the government constraint. Other studies suppose that unemployment utility is derived from housekeeping activities as in de Mooij [1999] for example. Hence it appear neither in the government budget constraint, nor in the households budget constraint. As there is then work sharing, it is easier to conclude on the environmental dividend.

2.5. The aggregate demand

The demand addressed to firm i can then be written as:

$$d_i = \sum_{m=1}^{M} c_{im} = \frac{(1-\sigma)}{N}\frac{R}{P}\left(\frac{P_i}{P}\right)^{-\theta} + \frac{G}{N}\left(\frac{P_i}{P}\right)^{-\theta} + \frac{X_e}{N}\left(\frac{P_i}{P}\right)^{-\theta} + \frac{X_k}{N}\left(\frac{P_i}{P}\right)^{-\theta}$$

where R is the aggregate consumers revenue.

This leads to the total demand:

$$PD = \sum_{i=1}^{N} p_i d_i = (1-\sigma)R + PG + PX_e + PX_k \tag{2.14}$$

The demand addressed to firm i then writes:

$$Y_i = \frac{D}{N}\left(\frac{P_i}{P}\right)^{-\theta} \tag{2.15}$$

2.6. The firms

There are N identical firms which produce imperfect substitutes. Each firm monopolizes its market. Each firm is price-taker on the energy-market and either price-taker or price-maker on the labor market, depending on the way wages are determined. It is also assumed that each firm is so small that it takes as exogenous the aggregate price and demand.

The technology of firm i is represented through a Cobb-Douglas function with constant returns to scale combining *three* inputs: efficient labor L_i, capital K_i and energy E_i.

$$Y_i = F(L_i, K_i, E_i) = (L_i)^{\alpha} K_i^{\beta} E_i^{1-\alpha-\beta} \tag{2.16}$$

Each firm maximizes its profit, for given levels of global production and aggregate price level. This leads, in symmetric equilibrium, to the following rule of price determination, the labor demand, the energy demand and aggregate profits:

$$\left\{\begin{array}{ll} 1 = & \tau C \left(\frac{W}{P}\right)^{w_l} \left(\frac{r}{P}\right)^{w_k} \left(\frac{P_{en}}{P}\right)^{w_e} \\ L = & \alpha C \left(\tau C\right)^{-\theta} \left(\frac{W}{P}\right)^{\epsilon_{ll}} \left(\frac{r}{P}\right)^{\epsilon_{lk}} \left(\frac{P_{en}}{P}\right)^{\epsilon_{le}} D \\ K = & \beta C \left(\tau C\right)^{-\theta} \left(\frac{W}{P}\right)^{\epsilon_{kl}} \left(\frac{r}{P}\right)^{\epsilon_{kk}} \left(\frac{P_{en}}{P}\right)^{\epsilon_{ke}} D \\ E = & (1-\alpha-\beta)\, C \left(\tau C\right)^{-\theta} \left(\frac{W}{P}\right)^{\epsilon_{el}} \left(\frac{r}{P}\right)^{\epsilon_{ek}} \left(\frac{P_{en}}{P}\right)^{\epsilon_{ee}} D \\ \frac{\Pi}{P} = & C^{(1-\theta)} \tau^{-\theta} \left(\tau - 1\right) \left(\frac{W}{P}\right)^{\epsilon_{\pi l}} \left(\frac{r}{P}\right)^{\epsilon_{\pi k}} \left(\frac{P_{en}}{P}\right)^{\epsilon_{\pi e}} D \end{array}\right. \tag{2.17}$$

where $W_i = (1+t_w)\, w_i$ stands for the labor cost; $P_{en} = (1+t_e)e$ for the energy cost for firms where t_e is the energy tax rate levied on firms and r the capital cost; $\tau = \frac{\theta}{\theta-1}$ the mark-up rate of firms and $C = \alpha^{-\alpha}(1-\alpha)^{-(1-\alpha)}$. ϵ_{ij} stands for price elasticity of factor demand and w_i the factor share in production costs. The table 2.1 gives the expressions of these elasticities:

Tableau 2.1: **Allen price elasticicties**

	L	E	K
L	$-\theta w_l - (1-w_l)$	$w_e(1-\theta)$	$w_k\,(1-\theta)$
E	$w_l\,(1-\theta)$	$-(1-w_e) - w_e\theta$	$w_k\,(1-\theta)$
K	$w_l\,(1-\theta)$	$w_e(1-\theta)$	$-(1-w_k) - w_k\theta$
Π	$w_l\,(1-\theta)$	$w_e(1-\theta)$	$w_k\,(1-\theta)$
	$w_l = \alpha$	$w_e = 1-\alpha-\beta$	$w_k = \beta$

2.7. The equilibrium

Adding the consumers' budget constraint, the government's budget constraint, and the profit definitions for the three sectors yields the following equilibrium relation:

$$PY = PC + PG + PX_e + PX_k \tag{2.18}$$

2.8. The *Price Setting* curve

The price-setting curve is represented by the factor-price frontier for firms:

$$\frac{w}{P} = (\tau C)^{-\frac{1}{w_l}}\, \varphi^{-\frac{w_k}{w_l}}\, \phi^{-\frac{w_e}{w_l}}\, (1+t_e)^{-\frac{w_e}{w_l}}\, (1+t_w)^{-1} \tag{2.19}$$

In our case of constant returns to scale, this curve alone determines the equilibrium wage rate; and in no way does it depend on the unemployment rate.

An increase of the energy tax rate paid by firms increases production costs, reduces the use of energy and incites to substitute labor for energy. A reduction of the labor cost appears necessary to compensate for the reduction of the labor productivity. This may be obtained through two different mechanisms: either a reduction of the real wage rate (production falls and therefore reduces the use of labor) or a reduction of the wage tax.

3. The determination of wages

We will consider in turn a bargaining model and an efficiency wage model[5].

[5] For an overview of wage formation see Layard, Nickell and Jackman [1991] or Cahuc and Zylberberg [1996]

3.1. Wage bargaining

One consider a canonical model of right to manage (Nickell and Andrews [1983]), where the trade-union and the firm i bargain on wages only, the firm being free to adapt afterwards its labor demand, given the negotiated wage.

The firm i maximizes its real profit $\frac{\Pi_i}{P}$ and the trade-union maximizes the expected utility of its membership, which consists of both employed and unemployed (Oswald [1985]):

$$\Omega_i = L_i V\left(\frac{(1-t_L)w_i}{P_c}\right) - (\frac{H}{N} - L_i)V\left(\frac{R_u}{P_c}\right) \tag{3.1}$$

where R_u denotes the expected revenue of an unemployed agent, which is considered as exogenous by the trade-union.

Wage bargaining is apprehended by a Nash criterion. This latter requires to specify the threat points of the different agents, which describe their outside opportunities. The union threat point consists of the expected utility of an unemployed $\frac{H}{N}V\left(\frac{R_u}{P_c}\right)$, and the firm threatpoint equals rK_i.

The bargaining program then writes:

$$\underset{\{\frac{w_i}{P}\}}{Max} \qquad \Psi_i = L_i\left(\frac{W_i}{P_c}\right)^{(1-\rho)}\left(V\left(\frac{(1-t_L)w_i}{P_c}\right) - V\left(\frac{R_u}{P_c}\right)\right)^{(1-\rho)}\left(\frac{\Phi_i}{P}\right)^{\rho}$$

where $1-\rho$ denotes the union bargaining power and $\Phi_i = \Pi_i - rK_i$.

The expected revenue of an unemployed agent is:

$$\frac{R_u}{P_c} = (1-u)\frac{w_{-i}}{P_c} + u\frac{B}{P_c} \tag{3.2}$$

where w_{-i} stands for the wage opportunities in other firms. An agent who is not hired by the firm i can be hired by another firm, with probability equal to $(1-u)$ or she may stay unemployed, with probability u, and therefore collect an unemployment benefit B.

At a symmetric equilibrium, wages are identical in all firms which leads to the following aggregate equation for the negotiated wage (*wage setting* schedule):

$$\frac{w(1-t_L)}{P} = \frac{Mu}{1-M(1-u)}\frac{B}{P} \qquad \text{with} \quad M = \left(1 + \frac{(1+\beta(\theta-1))(1-\rho)}{\alpha(\theta-1)}\right) > 1 \tag{3.3}$$

The equilibrium wage increases with the mark-up rate of the trade-unions and decreases as the unemployment rises, since the threat of unemployment moderates the wage claims. The wage also increases with the replacement revenue because it improves the union threatpoint: the insiders agents value their position towards the unemployed agents. Let us notice some important mechanisms:

- When the unemployment benefits are indexed to the aggregate price index, $B = Pa$, wages are independent of all consumption taxes, including the environmental one, because the environmental tax do not reduce the relative position of the workers with respect to the unemployed.

$$\frac{w(1-t_L)}{P} = \frac{Mub}{1-M(1-u)} \tag{3.4}$$

- When the employment benefits are instead indexed to the aggregate consumption price index ($B = P_c a$), any increase of the energy tax enhances the wage claims and the wage relation becomes:

$$\frac{w(1-t_L)}{P} = \frac{Mub}{1-M(1-u)} \left(\frac{P_{em}}{P}\right)^{\sigma} \tag{3.5}$$

- The income tax do not affect wages unless the unemployed are not taxed (or taxed at a lower rate).

- Lastly, when unemployment benefits are indexed to the wage rate ($B = aw$), the WS curve alone determines the unemployment rate, which is not affected by the consumption taxes, but only by the income tax if the unemployed are taxed at a lower rate than the workers. In this case, the equilibrium unemployment rate can be written as:

$$u^* = \frac{(1-t_L)(M-1)}{M\left[(1-t_L)-b\right]} \tag{3.6}$$

3.2. Efficiency wage

The efficiency wage model assumes that the household's utility function depends on her effort at work:

$$U^m = \left(\frac{C_m}{1-\sigma}\right)^{1-\sigma} \left(\frac{E_m}{\sigma}\right)^{\sigma} - D(\overline{E}) - Z(\chi) \tag{3.7}$$

χ stands for the effort level of agent m which is $\chi = 0$ when the worker does not make any effort but $\chi = 1$ when she makes an effort and $Z(\chi)$ is the disutility of effort. We assume that $Z(0) = 0$ and $Z(1) = Z$.

Our shirking model is inspired from that of Shapiro and Stiglitz (1984), where the wage is unilaterally determined by the firm in order to incite the worker to produce the required effort.

Efforts are assumed to be imperfectly monitored by firms: the probability for a shirking worker to be detected equals $d \in]0,1[$. All workers who are caught shirking are immediately fired[6].

The expected utility of a non-shirker is given by her indirect utility for her net wage rate (équation 2.6)[7]:

$$V_e = V\left(\frac{w(1-t_L)}{P_c}\right) - Z \tag{3.8}$$

[6] We then suppose that worker are monitored in the beginning of the period.

[7] We can supress the desutility of pollution because it enters additatively in utility. So, it vanishes in the incentive and participation constraints. Finally, desutility of pollution does not enter in wage formation.

The expected utility of a shirker is:

$$V_s = (1-d)V\left(\frac{w(1-t_L)}{P_c}\right) + dV_u \tag{3.9}$$

A typical worker will not shirk if and only if her expected utility V_e exceeds the utility obtained without any effort. The incentive condition writes:

$$V_e \geqslant V_s \Leftrightarrow V\left(\frac{w(1-t_L)}{P_c}\right) \geqslant \frac{Z}{d} + V_u \Leftrightarrow V_e - V_u \geqslant (1-d)\frac{Z}{d} \tag{3.10}$$

On the other hand, the worker will accept a job if and only her utility as employed is higher than that of an unemployed (participation condition):

$$V_e \geqslant V_u \tag{3.11}$$

Thus, in order to hire a worker and encourage her to make an effort, the firm must meet the two constraints 3.10 and 3.11. The firm chooses the lowest wage which fulfill both conditions:

$$V_e - V_u = (1-d)\frac{Z}{d} \tag{3.12}$$

Any unemployed agent may be hired with probability $(1-u)$ and thus obtain the expected utility V_e or she may remain unemployed with probability u (where u is the unemployment rate), and thus perceive unemployment benefits B. Her expected utility then expresses as:

$$V_u = (1-u)V_e + uV(\frac{B}{P_c}) \tag{3.13}$$

Combining 3.12 with 3.13 and the formulas of the expected utilities of a worker and of an unemployed (at the steady state) leads to the following expression of the wage rate (wage setting schedule for the efficiency wage model)

$$\frac{w(1-t_L)}{P} = \frac{B}{P} + \left(\frac{1-d}{d}\frac{Z}{u} + Z\right)\left(\frac{P_{em}}{P}\right)^{\sigma} \tag{3.14}$$

Results are different from those of the bargaining model. Here, the environmental tax and the income tax always affect the wage level because these taxes always reduce the expected utility of work. Hence an increase of the environmental tax enhances the wage level, in all cases: employers have to increased wage to meet the non-shirking condition (equation 3.10). The second dividend becomes more difficult to obtain.

- When the unemployment benefits are indexed to the aggregate price index, $B = Pa$, then

$$\frac{w(1-t_L)}{P} = b + \left(\frac{1-d}{d}\frac{Z}{u} + Z\right)\left(\frac{P_{em}}{P}\right)^{\sigma} \tag{3.15}$$

- When the employment benefits are instead indexed to the aggregate consumption price index ($B = P_c a$), then

$$\frac{w(1-t_L)}{P} = \left[b + \left(\frac{1-d}{d}\frac{Z}{u} + Z\right)\right]\left(\frac{P_{em}}{P}\right)^{\sigma} \tag{3.16}$$

- Lastly, when the unemployment benefits are indexed to the wage rate ($B = aw$), the WS curve is no more vertical. The unemployment rate is still affected by the consumption taxes and by the income tax, whatever the income tax rate for the unemployed. Under the assumption that the unemployed bear the same income tax rate than the workers, one can obtain the following WS curve:

$$\frac{w(1-t_L)}{P} = \frac{\left(\frac{1-d}{d}\frac{Z}{u} + Z\right)}{(1-b)(1-t_L)}\left(\frac{P_{em}}{P}\right)^{\sigma} \tag{3.17}$$

4. Sensitivity to the different tax rates

The equations WS and PS determine together the equilibrium levels of wage and of unemployment u^*, which can be calculated by the following implicit equation:

$$u^* \quad t.q. \quad U(u, t_e, t_w, t_L) = PS(t_e, t_w) - WS(u, t_d, t_L) = 0 \tag{4.1}$$

The aim of this paragraph is to qualify the tax rate changes which might induce a decrease of the unemployment rate. At his stage, the government's budget constraint is not imposed. We will distinguish several cases depending on the wage formation mechanism and on the environmental policy:

1. different indexation cases for the unemployment benefits:
   - Case **A**: perfect indexation of the unemployment benefits to the consumption price;
   - Case **B**: perfect indexation of the unemployment benefits to the production price;
   - Case **C**: exogenous replacement ratio.
2. different environmental policies:
   - Case **F**: the environmental policy bears only on firms ($dt_d = 0$);
   - Case **H**: the environmental policy bears only on households ($dt_e = 0$);
   - Case **T**: the environmental policy bears both on firms and households ($dt_e = dt_d$);.

The sensitivity of the *wage setting* curve (WS) and of the *price setting* curve (PS) to their arguments, for the different definitions of the unemployment benefits, is described in the two following Tables (Tables 4.1 and 4.2).

By differentiating the equation which implicitly defines the unemployment rate (equation 4.1), we obtain:

$$\frac{\partial PS}{\partial t_e}dt_e + \frac{\partial PS}{\partial t_w}dt_w = \frac{\partial WS}{\partial t_u}du + \frac{\partial WS}{\partial t_d}dt_d + \frac{\partial WS}{\partial t_L}dt_L \tag{4.2}$$

This equation can be used to calculate the change of the wage tax rate (or of the income tax rate) in response to a change of the environmental tax rate which ensures the obtention of an employment dividend. The results are given below for the different policies and compensation which can be considered. We here discuss the different mechanisms which operate in both models.

For firms, the energy tax reduces the labor productivity through the substitution effect between energy and labor. The production cost becomes then too high and the firms reduce their demand for labor: this raises the unemployment rate and allows for a reduction of the real wage. The workers can not refuse this loss of purchasing power because of the increase in unemployment.

When the tax bears on households, they try to maintain their real income by claiming a wage increase (in the case where unemployment benefits are indexed to the consumption price), in the bargaining model. In the efficiency wage model, the environmental tax paid by consumers urge firms to increase wages in order to maintain the incentives to work. In the short term, the real wage increases. Then firms reduce their labor demand and the unemployment rises. This leads the workers to accept wage cuts. In the long term, the labor cost is back to its initial level but the unemployment rate is higher.

When the environmental policy bears on both firms and consumers, the long term effect consists of a decrease in the real wage and an increase in unemployment.

In case of reduction of the wage tax, the effects are qualitatively the same but in the opposite direction: this leads to a decrease in unemployment and a raise in real wages.

Tableau 4.1: **Sensitivity of the WS et PS curves to their arguments in the bargaining model**

	wage setting			*price setting*
	Case **A**	Case **B**	Case **C**	
Environmental tax	$\frac{\sigma w}{(1+t_d)P} > 0$	0	0	$-\frac{w_e}{w_l}\frac{w}{(1+t_e)P} < 0$
Wage tax	0	0	0	$-\frac{w}{(1+t_w)P} < 0$
Income tax	$\frac{w}{(1-t_L)P} > 0$	$\frac{w}{(1-t_L)P} > 0$	$\frac{M(M-1)b}{[M((1-t_L)-b)]^2} > 0$	0
Unemployment level	$\frac{M(u)\phi(1+t_d)^\sigma}{(1-t_L)} < 0$	$\frac{M(u)b}{(1-t_L)} < 0$	$-\infty$	0
with $M(u) = \frac{M(1-M)b}{(1-M(1-u))^2}$				

Case **A**: Perfect indexation of the unemployment benefits to consumption price
Case **B**: Perfect indexation of the unemployment benefits to production price
Case **C**: Exogenous replacement rate

4.1. Environmental tax compensated with a decrease of the wage tax

4.1.1. Bargaining model

The necessary ratios between the change of the wage tax rate and the change of the environmental tax rate which ensures the obtention of an employment dividend are shown in the following table ($\left|\frac{dt_w}{dt_e}\right|$ or $\left|\frac{dt_w}{dt_d}\right|$ depending on the case studied):

In case **C**, the fiscal reform cannot affect the equilibrium level of unemployment, for all policies studied: when the replacement rate is exogenous, any increase of an environmental tax, whether compensated or not with a reduction of the wage tax rate, has no effect on the rate of unemployment.

In case **F**, where the environmental policy bears only on firms, the unemployment rate can only be reduced if and only if the decrease of the wage tax compensate for the increase of the production cost.

In case **H**, where the environmental policy bears only on households, the unemployment rate will always be reduced if the unemployment benefits are not indexed to the consumption price (case **B**). When these unemployment benefits are indeed indexed to the consumption price (case **A**), the workers only bears the environmental tax. They try to maintain their real wage by claiming for wage increases: the unemployment will be reduced if and only if the decrease of the wage tax compensate for the wage claims.

In fact, the unemployment rate may decrease only when both workers and unemployed bear the fiscal

Tableau 4.2: **Sensitivity of the WS et PS curves to their arguments in the efficiency wage model**

	wage setting			*price setting*
	Case **A**	Case **B**	Case **C**	
Environmental tax	$\sigma \frac{w}{P} \frac{1}{1+t_d} > 0$	$\sigma \left(\frac{w}{P} - \frac{B}{P} \right) \frac{1}{1+t_d} > 0$	$\sigma \frac{w}{P} \frac{1}{1+t_d} > 0$	$-\frac{w_e}{w_l} \frac{w}{P} \frac{1}{1+t_e} < 0$
Wage tax	0	0	0	$-\frac{w}{P} \frac{1}{1+t_w} < 0$
Income tax	$\frac{w}{P} \frac{1}{1-t_L} > 0$	$\frac{w}{P} \frac{1}{1-t_L} > 0$	$\frac{w}{P} \frac{1}{1-t_L} > 0$	0
Unemployment level	< 0	< 0	< 0	0

Case **A**: Perfect indexation of the unemployment benefits to consumption price
Case **B**: Perfect indexation of the unemployment benefits to production price
Case **C**: Exogenous replacement rate

Tableau 4.3: **Necessary ratios between the change in the labor tax rate and the change in the environmental tax rate which ensures the obtention of an employment dividend**

	Case **F**	Case **H**	Case **T**
Case **A**	$\frac{w_e}{w_l} \frac{1+t_w}{1+t_e}$	$\sigma \frac{1+t_w}{1+t_d}$	$\left(\sigma + \frac{w_e}{w_l} \right) \frac{1+t_w}{1+t_d}$
Case **B**	$\frac{w_e}{w_l} \frac{1+t_w}{1+t_e}$	0	$\frac{w_e}{w_l} \frac{1+t_w}{1+t_d}$
Case **C**	–	–	–

burden of the environmental policy because, in this bargaining model, the important point is the relative position of workers and unemployed.

In case **T**, where both firms and households are affected by the environmental policy, the reduction of the wage tax rate necessary to obtain an employment dividend is greater in case **A** (when the consumption price influences the determination of wages) than in case **B**. The double dividend assumption will therefore be more difficult to achieve.

4.1.2. Efficiency wage model

The same analysis as above leads here to the following results (Table 4.4):

Tableau 4.4: **Necessary ratios between the change in the labor tax rate and the change in the environmental tax rate which ensure the obtention of an employment dividend**

	Case **F**	Case **H**	Case **T**
Case **A**	$\left(\frac{w_e}{w_l}\right)\frac{1+t_w}{1+t_e}$	$\sigma\frac{1+t_w}{1+t_d}$	$\left(\sigma+\frac{w_e}{w_l}\right)\frac{1+t_w}{1+t_d}$
Case **B**	$\left(\frac{w_e}{w_l}\right)\frac{1+t_w}{1+t_e}$	$\left[\sigma\left(1-\frac{B}{w}\right)\right]\frac{1+t_w}{1+t_d}$	$\left[\sigma\left(1-\frac{B}{w}\right)+\frac{w_e}{w_l}\right]\frac{1+t_w}{1+t_d}$
Case **C**	$\left(\frac{w_e}{w_l}\right)\frac{1+t_w}{1+t_e}$	$\sigma\frac{1+t_w}{1+t_e}$	$\left(\sigma+\frac{w_e}{w_l}\right)\frac{1+t_w}{1+t_d}$

As $\left(1-\frac{B}{w}\right)<1$, because the unemployment benefits are assumed to be less than the wage rate, the double dividend will, in case **B**, be more difficult to obtain in an efficiency wage model than in a bargaining model. On the opposite, an employment dividend could be obtained when the replacement rate is exogenous (case **C** for all policies).

4.2. Environmental tax compensated with a decrease in the income tax

Taking the same line as above, the same results are obtained, except in case **C** (exogenous replacement rate) for the bargaining model, in which a decrease of the income tax rate always reduces the unemployment rate, whether the agents bear the environmental tax or not.

4.3. The conditions for a second dividend

The above discussion gives, in different cases, the wage tax cut necessary to reduce unemployment. Its extent depends on two factors: the ratio of the shares of energy and labor $\left(\frac{w_e}{w_l}\right)$ and the elasticity of the real wage in respect to the environmental tax (σ).

The higher is the energy share in comparison with the labor share, the higher the wage tax cut has to be to compensate for the cost increase, positively related to the energy share. The labor cost reduction necessary to restore the factor price frontier is then higher.

The elasticity of the real wage to the environmental tax has an impact in all cases in the efficiency wage model but only in the case where the unemployment benefits are indexed to consumption prices in the bargaining model. In all these situations, an increase in the environmental tax induces a wage rise, either by wage claims or by effect of the incentive constraint. The wage tax cut has to be higher to restore the equality between the marginal labor productivity and the labor cost.

Lastly, it is worth pointing out that a second dividend is at least as difficult to obtain in an efficiency wage model as in a bargaining model, but for one case (case **C**, for a wage tax cut). In all other cases, the necessary conditions to achieve a double dividend are either equally or more restrictive than in the bargaining model.

However, the size of the feasible tax cuts depends on the government's budget constraint. The additional revenue obtained through any environmental tax reform results from two conflicting effects: a direct increase (*ex ante* effect), but also an erosion effect of the different fiscal bases (*ex post* effect). The revenues to be recycled depend on the relative magnitude of these two effects:

- the raise of the revenue of an energy tax depend on the energy share in consumption and in production. The higher this share, the higher the *ex ante* revenue;
- on the other hand, the *ex post* recycling possibilities are reduced by the depressive effect of the tax which erodes the fiscal revenues through different ways:
  - the depressive effects increase the rate of unemployment and reduce the equilibrium real wage; the fiscal revenues decrease because of the fall in the labor tax revenue (through both the volume effect and the price effect) and of the rise in unemployment benefits which are all the more large since they are indexed to the consumption price;
  - the energy consumptions and therefore the energy tax revenue are reduced both by a substitution effect and by the effect of activity contraction.

5. Linearization of the model

We will, in this part, linearize the model around the steady state. Variables $\tilde{x}$ then denote relative change. We will now consider only real terms, $\omega = \frac{w}{P}$ standing for the real wage and $b = \frac{B}{P}$ for real unemployment benefits. The above discussion shows that the results are equivalent in both cases of recycling the environmental tax revenue, with a wage tax cut or with an income tax cut, but for the case where the unemployment benefits are an exogenous proportion of the wage rate. From now on we will consider only one recycling way, by a wage tax rate. The income tax rate (t_L) disappears now from our discussion. The model in linearized form is presented in Table 5.3. We present in more details the linearization of the wage curve which plays an important role in the analysis.

Differentiating the wage equations 3.3 and 3.14, we arrive to a unique quasi labor supply curve encompassing both wage formation:

$$\widetilde{\omega} = \xi_u \tilde{u} + \xi_b \widetilde{b} + \xi_{t_d} \tilde{t}_d \tag{5.1}$$

where $\xi_x = \frac{\partial WS}{\partial x} \frac{x}{\omega}$ with $x = u, b, t_d$ stands respectively for the elasticity of the real wage (or of the labor quasi-supply) to the unemployment rate, to the real unemployment benefits and to the environmental tax rate which are presented in Table 5.1.

Tableau 5.1: **Elasticities**

Elasticity of the real wage to:	Bargaining model	Wage efficiency model
Unemployment rate (ξ_u)	$\dfrac{1-M}{1-M(1-u)} < 0$	$-\dfrac{(1-d)}{d}\dfrac{Z}{u}\dfrac{(\phi(1+t_d))^\sigma}{\omega} < 0$
Unemployment benefits (ξ_b)	1	$\dfrac{b}{\omega} < 1$
Unvironmental tax rate (ξ_{t_d})	0	$\sigma\left(1-\dfrac{b}{\omega}\right) > 0$

The relative change of the unemployment benefits can be expressed, in the different cases, as:

$$\widetilde{b} = \xi_{bt}\widetilde{t}_d \qquad \text{with } \xi_{bt} = \begin{cases} \sigma & \text{case } \mathbf{A} \\ 0 & \text{case } \mathbf{B} \\ \dfrac{\widetilde{\omega}}{\widetilde{t}_d} & \text{case } \mathbf{C} \end{cases}$$

The linearization of the labor market equilibrium, in the different cases of wage formation models and of determination of the unemployment benefits, is given in the following (table 5.2) :

Tableau 5.2: **Linearization of the labor demand and supply curves**

	Bargaining model $\xi_b = 1 \qquad \xi_{t_d} = 0$	Wage efficiency model $0 < \xi_b < 1 \qquad 0 < \xi_{t_d} < 1$
Labor demand curve (*price setting*)		
	$\widetilde{\omega} = -\dfrac{w_e}{w_l}\tilde{t}_e - \tilde{t}_w$	$\widetilde{\omega} = -\dfrac{w_e}{w_l}\tilde{t}_e - \tilde{t}_w$
Labor quasi-supply curve (*wage setting*)		
Case **A**	$\tilde{u} = -\xi_w\left(\widetilde{\omega} - \sigma\tilde{t}_d\right)$	$\tilde{u} = -\xi_w\left(\widetilde{\omega} - \left(\sigma\xi_b + \xi_{t_d}\right)\tilde{t}_d\right)$
Case **B**	$\tilde{u} = -\xi_w\widetilde{\omega}$	$\tilde{u} = -\xi_w\left(\widetilde{\omega} - \xi_{t_d}\tilde{t}_d\right)$
Case **C**	$\tilde{u} = 0$	$\tilde{u} = -\xi_w(1-\xi_b)\widetilde{\omega} + \xi_w\xi_{t_d}\tilde{t}_d$

$\omega = w/P \qquad b = B/P$

$w_l = \dfrac{(1+t_l)wL}{C(Y)} \qquad w_k = \dfrac{(1+t_k)rK}{C(Y)} \qquad w_e = \dfrac{(1+t_e)eE}{C(Y)}$

$w_l + w_k + w_e = 1 \quad \widetilde{t}_i = \dfrac{dt_i}{1+t_i} \qquad \forall i = w, e, d$

where $\xi_w = \dfrac{1}{\xi_u}$ is the elasticity of the labor quasi supply to the real wage

The results concerning the unemployment rate can be summarized by the following general expressions:

$$\tilde{u} = -\xi_w\frac{\omega_e}{\omega_L}\tilde{t}_e - \xi_w\left(\xi_b\xi_{bt} + \xi_{t_d}\right)\tilde{t}_d - \xi_w\tilde{t}_w \tag{5.2}$$

The Table 5.3 contains the linearized form of the model.

Tableau 5.3: **Model in relative change**

Firms	
Production	$\widetilde{Y} = \tau\Omega_l\widetilde{L} + \tau\Omega_k\widetilde{K} + \tau\Omega_e\widetilde{E}$
Labor demand	$\widetilde{L} = \epsilon_{ll}\left(\widetilde{\omega} + \widetilde{t}_w\right) + \epsilon_{le}\widetilde{t}_e + \widetilde{D}$
Capital demand	$\widetilde{K} = \epsilon_{kl}\left(\widetilde{\omega} + \widetilde{t}_w\right) + \epsilon_{ke}\widetilde{t}_e + \widetilde{D}$
Energy demand	$\widetilde{E}^N = \epsilon_{ee}\widetilde{t}_e + \epsilon_{el}\left(\widetilde{\omega} + \widetilde{t}_w\right) + \widetilde{D}$
Profit	$\widetilde{\pi} = \epsilon_{\pi e}\widetilde{t}_e + \epsilon_{\pi l}\left(\widetilde{\omega} + \widetilde{t}_w\right) + \widetilde{D}$
Pricing rule	$\widetilde{\omega} = -\frac{w_e}{w_l}\widetilde{t}_e - \widetilde{t}_w$
Unemployment	$\tilde{u} = -\xi_w\left(\widetilde{\omega} + \left(\xi_b\xi_{bt} + \xi_{t_d}\right)\tilde{t}_d\right)$
Consumers	
Consumption goods demand	
Workers	$\widetilde{C}_s = \widetilde{\omega} + \widetilde{L}$
Firms'owners	$\widetilde{C}_R = \widetilde{\pi}$
unemployers	$\widetilde{C}_u = \widetilde{b} + \widetilde{u}$
Total	$\widetilde{C} = \frac{\Omega_s}{\Omega_s + \Omega_\pi + \Omega_u}\widetilde{C}_s + \frac{\Omega_\pi}{\Omega_s + \Omega_\pi + \Omega_u}\widetilde{C}_R + + \frac{\Omega_u}{\Omega_s + \Omega_\pi + \Omega_u}\widetilde{C}_u$
Energy demand	
Workers	$\widetilde{E}_s = \widetilde{\omega} + \widetilde{L} - \widetilde{t}_d$
Firms'owners	$\widetilde{E}_R = \widetilde{\pi} - \widetilde{t}_d$
unemployers	$\widetilde{E}_u = \widetilde{b} + \widetilde{u} - \widetilde{t}_d$
Total	$\widetilde{E}^M = \frac{\Omega_s}{\Omega_s + \Omega_\pi + \Omega_u}\widetilde{E}_s + \frac{\Omega_\pi}{\Omega_s + \Omega_\pi + \Omega_u}\widetilde{E}_R + \frac{\Omega_u}{\Omega_s + \Omega_\pi + \Omega_u}\widetilde{E}_u$
Government budget constraint	
	$\Omega_l\widetilde{t}_w + \Omega_e\widetilde{t}_e + \sigma\left(\Omega_s + \Omega_\pi + \Omega_u\right)\widetilde{t}_d + \theta_l\Omega_l\widetilde{\omega}$
	$+\theta_l\Omega_l\widetilde{L} + \theta_e\Omega_e\widetilde{E}^N + \sigma\theta_d\Omega_s\widetilde{E}_s + \sigma\theta_d\Omega_\pi\widetilde{E}_R + \sigma\theta_d\Omega_u\widetilde{E}_u - \Omega_u\widetilde{b} - \Omega_u\widetilde{u} = 0$

$\pi = \frac{\Pi}{P}$	$\theta_i = \frac{t_i}{1+t_i} \quad \forall i = w, e, d$	$\tilde{t}_i = \frac{dt_i}{1+t_i} \quad \forall i = w, e, d$
$\Omega_l = \frac{(1+t_l)wL}{PY} = \frac{w_l}{\tau}$	$\Omega_e = \frac{(1+t_e)eL}{PY} = \frac{w_e}{\tau}$	$\Omega_u = \frac{B(H-L)}{PY}$
$\Omega_\pi = \frac{\Pi}{PY}$	$\Omega_s = \frac{wL}{PY}$	$\Omega_\pi = \frac{\tau - 1}{\tau} = \frac{1}{\theta}$
$\Omega_l + \Omega_k + \Omega_e + \Omega_\pi = 1$		

6. Fiscal reform and employment dividend

In this section, we will analyze the employment effect of an environmental fiscal reform[8]. The reform consists of an increase of energy taxes recycled by a cut in wage tax. The reduced form of some equations are reported in table 6.1. In order to simplify the discussion, we study the effects of a fiscal reform by distinguishing different cases depending on the type of agents bearing the cost of the environmental policy (cases **F**, **H** and **T**).

Tableau 6.1: **Reduced form of the model**

Unemployment and revenu

$$\begin{aligned}
\Lambda_w \widetilde{u} = \; & \xi_w^* \{\theta_e \Omega_e F_{ee} + \sigma \theta_d \Omega_\pi F_{\pi e}\} \widetilde{t}_e \\
& + \xi_w^* \{(\xi - \sigma)\Omega_s + \Omega_u(\xi_{bt} - \sigma) - \sigma\Omega_\pi - \sigma\theta_d((\xi - 1)\Omega_s + \Omega_u(\xi_{bt} - 1) - \Omega_\pi)\} \widetilde{t}_d \\
\Lambda_w \widetilde{\omega} = \; & - \{\theta_e \Omega_e F_{ee} + \sigma \theta_d \Omega_\pi F_{\pi e}\} \widetilde{t}_e \\
& + \{\xi \Lambda_w + (\sigma - \xi)\Omega_s + \Omega_u(\sigma - \xi_{bt}) + \sigma\Omega_\pi + \sigma\theta_d((\xi - 1)\Omega_s + \Omega_u(\xi_{bt} - 1) - \Omega_\pi)\} \widetilde{t}_d \\
\Lambda_w \widetilde{\pi} = \; & - \{\Lambda_w F_{\pi e} + \theta_u \xi_w^* (\theta_e \Omega_e F_{ee} + \sigma \theta_d \Omega_\pi F_{\pi e})\} \widetilde{t}_e \\
& - \theta_u \xi_w^* \{(\xi - \sigma)\Omega_s + \Omega_u(\xi_{bt} - \sigma) - \sigma\Omega_\pi - \sigma\theta_d((\xi - 1)\Omega_s + \Omega_u(\xi_{bt} - 1) - \Omega_\pi)\} \widetilde{t}_d
\end{aligned}$$

Energy

$$\begin{aligned}
\Lambda_w \widetilde{E}^N = \; & - \{\Lambda_w F_{ee} + \theta_u \xi_w^* (\theta_e \Omega_e F_{ee} + \sigma \theta_d \Omega_\pi F_{\pi e})\} \widetilde{t}_e \\
& - \theta_u \xi_w^* \{(\xi - \sigma)\Omega_s + \Omega_u(\xi_{bt} - \sigma) - \sigma\Omega_\pi - \sigma\theta_d((\xi - 1)\Omega_s + \Omega_u(\xi_{bt} - 1) - \Omega_\pi)\} \widetilde{t}_d \\
\Lambda_w \widetilde{E}_s = \; & - (1 + \theta_u \xi_w^*) \{\theta_e \Omega_e F_{ee} + \sigma \theta_d \Omega_\pi F_{\pi e}\} \widetilde{t}_e + \\
& \{(\xi - 1)\Lambda_w + (1 + \theta_u \xi_w^*)[(\sigma - \xi)\Omega_s + \Omega_u(\sigma - \xi_{bt}) + \sigma\Omega_\pi + \sigma\theta_d((\xi - 1)\Omega_s + \Omega_u(\xi_{bt} - 1) - \Omega_\pi)]\} \widetilde{t}_d \\
\Lambda_w \widetilde{E}_R = \; & - \{\Lambda_w F_{\pi e} + \theta_u \xi_w^* (\theta_e \Omega_e F_{ee} + \sigma \theta_d \Omega_\pi F_{\pi e})\} \widetilde{t}_e \\
& - \{\Lambda_w + \theta_u \xi_w^* [(\xi - \sigma)\Omega_s + \Omega_u(\xi_{bt} - \sigma) - \sigma\Omega_\pi - \sigma\theta_d((\xi - 1)\Omega_s + \Omega_u(\xi_{bt} - 1) - \Omega_\pi)]\} \widetilde{t}_d \\
\Lambda_w \widetilde{E}_u = \; & \xi_w^* \{\theta_e \Omega_e F_{ee} + \sigma \theta_d \Omega_\pi F_{\pi e}\} \widetilde{t}_e \\
& + \{(\xi_{bt} - 1)\Lambda_w + \xi_w^* [(\xi - \sigma)\Omega_s + \Omega_u(\xi_{bt} - \sigma) - \sigma\Omega_\pi - \sigma\theta_d((\xi - 1)\Omega_s + \Omega_u(\xi_{bt} - 1) - \Omega_\pi)]\} \widetilde{t}_d
\end{aligned}$$

$$\xi = \xi_b \xi_{bt} + \xi_{t_d} \qquad \theta_u = \frac{u}{1-u} \qquad F_{ee} = \frac{\Omega_e + \Omega_l}{\Omega_l} \qquad F_{\pi e} = \frac{\Omega_e}{\Omega_l}$$

$$\xi_w^* = \begin{cases} \xi_w & \text{in cases } \mathbf{A} \text{ and } \mathbf{B} \\ \xi_w (1 - \xi_b) & \text{in case } \mathbf{C} \text{ for efficiency wage model only} \end{cases}$$

$$\Lambda_w = (1 - \theta_l)\Omega_l - \sigma\theta_d\Omega_s - \xi_w [(1 - \sigma\theta_d\Omega_u) + \theta_u(\theta_l\Omega_l + \theta_e\Omega_e + \sigma\theta_d\Omega_s + \sigma\theta_d\Omega_\pi)] > 0$$

[8] The environmental dividend (first dividend) is presented in section 7

6.1. Case F: the environmental policy bears only on firms ($\widetilde{t_d} = 0$)

As households do not bear the environmental policy, only firms decisions are affected. The wage curve does not move.

Introducing an energy tax for firms only reduces the demand for energy and thereby labor productivity. In the long run, after-tax wage is reduced to equalize labor productivity and wage costs. Workers accept this income reduction because unemployment increases. When energy tax is recycled in a cut in labor tax, differences between labor productivity and labor costs can be partially offset. This offsetting will depend on the government capacity to levy revenue. This is the so called *tax-burden effect*, which denotes the erosion of the tax base.

It happens that the employment cannot increase which such a reform. The reason is that this reform increases production cost and reduces activity. Given constant expenditures and a balanced government budget[9], the labor tax cut cannot make up for the extra costs because of the depressive effect. The erosion effect of the fiscal base (for all taxes, including the environmental taxes) happens to be too large.

Consider first the case where there are no prior environmental taxes ($\theta_e = \theta_d = 0$). The first row of Table 5.2 shows that unemployment is not affected by the reform. The cut in labor tax exactly offsets the adverse effect of environmental tax. Without prior environmental taxes there is no erosion of the tax base.

When θ_e and θ_d are positive, the negative effect of unemployment comes about because the reduction in the labor tax cannot fully compensate firms for the loss in labor productivity. The environmental tax reduces energy demand from firms and reduces profits (recall that F_{ee} and $F_{\pi e}$ are positive). The reduction in firms' owners revenue reduces their energy consumption. These two effects erode the tax base, therefore government is not able to reduce sufficiently labor costs.

The magnitude of the adverse effect on the tax base depends on the size of prior energy taxes and the general equilibrium elasticities of profit and energy demand to the environmental tax (F_{ee} and $F_{\pi e}$). The higher the elasticities, the more energy demand and profit are reduced. Finally, the tax burden effect depends on the share of energy consumption in firms' owners decision (σ).

Proposition 6.1. *When environmental policy bears only on firms, unemployment cannot be reduced whatever the wage formation and the competition on consumption goods.*

[9] What is kept constant is public consumption and not public expenditure as in Marsiliani and Renström [1997]. Hence, unemployment benefits can vary.

6.2. Case H: the environmental policy bears only on households ($\widetilde{t}_e = 0$)

In this subsection, the policy bears only on households, ($\widetilde{t}_e = 0$). Our analysis will begin with the bargaining model and consider afterwards the efficiency wage case. In each case, we will distinguish the different indexation rules of unemployment benefits presented in section 3. This reform modifies firms decisions through the cut in labor tax and households decisions through the wage formation mechanism. Then, both pricing rule and wage curve will move.

6.2.1. Wage bargaining model ($\xi_b = 1, \xi_{t_d} = 0$)

If wages are the outcome of a bargaining process between workers and firms, Table 5.2 reveals that the elasticity of unemployment rate to benefits is unity ($\xi_b = 1$) and that of environmental tax on household is 0 ($\xi_{t_d} = 0$). In that case, environmental policy impacts wage formation only through the indexation of unemployment benefits.

If unemployment benefits are perfectly indexed to consumer price (case **A**, *i.e.* $\xi_{bt} = \sigma$), the mechanisms at work in such a policy are the following. This indexation fully compensates unemployed for the loss of income. It then reduces workers income as compared to those of unemployed, strengthening the bargaining position of unions. In the short run, wage claim push up after-tax wages. In the long run, employment (and wages) increases if firms can be fully compensated for the increase in wage cost through cut in labor tax.

In the absence of prior environmental tax on households ($\theta_d = 0$), first column of Table 6.2 reveals that unemployment always decreases if profits are positive, hence if there is imperfect competition on the goods market. The government is able to fully compensate firms for wage claim because tax is not only borne by labor but also by profits. So the tax base of the environmental tax is larger than the base of wage tax.

In fact there are two opposite mechanisms: the *tax shifting effect* (which is represented by the first term in square bracket) which shifts the burden of taxation form workers and unemployed to profits , and the *tax burden effect* which erodes the tax base. The latter is at work only if prior environmental taxes are positive. Hence unemployment decreases only if the former effect is greater than the latter. It is possible to compute the threshold value of environmental tax on households which leaves employment unchanged. This critical value is defined as $\overline{\theta}_d^{WN_A}$. It depends positively on the share of profit in the economy and therefore on the competition degree. But it is decreasing in the indexation rule of unemployment benefits. Indeed, fully compensating the unemployed for policy has two opposite effects: first it maintains unemployed energy consumption so the fiscal base, but it has a negative impact on government revenue. It can be shown than the second effect is greater than the first.

$$\overline{\theta}_d^{WN_A} = \frac{\Omega_\pi}{\Omega - \sigma\Omega_{su}}$$

.

Tableau 6.2: **Tax on energy consumption of households in a wage bargaining model**

	Case **A** ($\xi_{bt} = \sigma$)	Case **B** ($\xi_{bt} = 0$)
$\Lambda_w \widetilde{u} =$	$-\xi_w \left\{\sigma\Omega_\pi - \sigma\theta_d \left[\Omega - \sigma\Omega_{su}\right]\right\}$	$-\xi_w \sigma \left(1 - \theta_d\right) \Omega$
$\Lambda_w \widetilde{\omega} =$	$\sigma \left(\Lambda_w + \Omega_\pi\right) - \sigma\theta_d \left[\Omega - \sigma\Omega_{su}\right]$	$\sigma \left(1 - \theta_d\right) \Omega$
$\Lambda_w \widetilde{\pi} =$	$\theta_u \xi_w \left\{\sigma\Omega_\pi - \sigma\theta_d \left[\Omega - \sigma\Omega_{su}\right]\right\}$	$\theta_u \xi_w \sigma \left(1 - \theta_d\right) \Omega$
	$\Omega_{su} = \Omega_s + \Omega_u$	$\Omega = \Omega_s + \Omega_u + \Omega_\pi$
$\Lambda_w = \left(1 - \theta_l\right) \Omega_l - \sigma\theta_d\Omega_s - \xi_w \Gamma > 0$		
with $\Gamma = \left(1 - \sigma\theta_d\Omega_u\right) + \theta_u \left(\theta_l\Omega_l + \theta_e\Omega_e + \sigma\theta_d\Omega_s + \sigma\theta_d\Omega_\pi\right)$		

Case **A**: Perfect indexation of the unemployment benefits to consumption price
Case **B**: Perfect indexation of the unemployment benefits to production price

The second column of Table 6.2 reveals that, when unemployment benefits are indexed to production price, employment increases unambiguously. In that case, real income of unemployed is unchanged relatively to that of workers. Hence wages are unaffected through the bargaining process. The *tax shifting effect* is always greater than the *tax burden effect*. Indeed, the burden of taxation is borne by all agents and the tax cut benefits only to workers. Hence the base tax base of the environmental tax is greater than that of labor tax. The positive employment effect comes about because firms benefit from cut in labor tax without support wage claim (the wage curve does not move rightward).

Proposition 6.2. *A neutral environmental tax reform on household when wage formation is a bargaining process always reduces unemployment if unemployment benefits are indexed to production price. If the rule of indexation is the consumer price, unemployment decreases only if the product market is imperfectly competitive and if the initial tax rate on households is not too high.*

6.2.2. The efficiency wage model ($0 < \xi_b < \sigma$ et $0 < \xi_{t_d} < 1$)

In case of an efficiency wage model, Section 3 showed that wages are always affected by environmental tax whatever the rule of indexation of unemployment benefits ($0 < \xi_{t_d} < 1$). Indeed, an increase in the tax rate always increases the expected utility of shirkers. Therefore wages need to be pushed up to meet the incentive constraint. Hence, an employment dividend is less likely to occur. Table 6.3 shows the reduced form of unemployment, after-tax wage and profits for the wage efficiency model. Here, contrary to the wage bargaining model, an exogenous replacement ratio affects unemployment.

Tableau 6.3: **Tax on energy consumption of housholds in an efficiency wage model**

	Case **A** ($\xi_{bt} = \sigma$)	Case **B** ($\xi_{bt} = 0$)	Case **C**
$\Lambda_w \widetilde{u} =$	$-\xi_w \{\sigma\Omega_\pi$	$-\xi_w \left\{\sigma\Omega - \xi_{t_d}\Omega_s\right.$	$-\xi_w (1-\xi_b) \{\sigma\Omega_\pi$
	$-\sigma\theta_d [\Omega - \sigma\Omega_{su}]\}$	$\left.-\sigma\theta_d \left[\Omega - \xi_{t_d}\Omega_s\right]\right\}$	$-\sigma\theta_d [\Omega - \sigma\Omega_{su}]\}$
$\Lambda_w \widetilde{\omega} =$	$\sigma (\Lambda_w + \Omega_\pi)$	$\xi_{t_d}\Lambda_w + \sigma\Omega - \xi_{t_d}\Omega_s$	$\sigma (\Lambda_w^c + \Omega_\pi)$
	$-\sigma\theta_d [\Omega - \sigma\Omega_{su}]$	$-\sigma\theta_d \left[\Omega - \xi_{t_d}\Omega_s\right]$	$-\sigma\theta_d [\Omega - \sigma\Omega_{su}]$
$\Lambda_w \widetilde{\pi} =$	$\theta_u \xi_w \{\sigma\Omega_\pi$	$-\theta_u \xi_w \left\{\sigma\Omega - \xi_{t_d}\Omega_s\right.$	$\theta_u \xi_w (1-\xi_b) \{\sigma\Omega_\pi$
	$-\sigma\theta_d [\Omega - \sigma\Omega_{su}]\}$	$\left.-\sigma\theta_d \left[\Omega - \xi_{t_d}\Omega_s\right]\right\}$	$-\sigma\theta_d [\Omega - \sigma\Omega_{su}]\}$
$\Omega_{su} = \Omega_s + \Omega_u \qquad \Omega = \Omega_s + \Omega_u + \Omega_\pi$			
$\Lambda_w = (1-\theta_l)\,\Omega_l - \sigma\theta_d\Omega_s - \xi_w\Gamma > 0$			
$\Lambda_w^c = (1-\theta_l)\,\Omega_l - \sigma\theta_d\Omega_s + (\sigma\theta_d - 1)\,\Omega_u - \xi_w (1-\xi_b)\,\Gamma$			
with $\Gamma = (1 - \sigma\theta_d\Omega_u) + \theta_u (\theta_l\Omega_l + \theta_e\Omega_e + \sigma\theta_d\Omega_s + \sigma\theta_d\Omega_\pi)$			

Case **A**: Perfect indexation of the unemployment benefits to consumption price
Case **B**: Perfect indexation of the unemployment benefits to production price
Case **C**: exogenous replacement rate

Table 6.3 reveals that, if unemployment benefits are indexed to consumer price, the unemployment effect is equivalent to that of the wage bargaining model. Then, unemployment decreases if and only if the tax rate on households is not too high. The critical value of this tax is

$$\overline{\theta}_d^{EW_A} = \frac{\Omega_\pi}{\Omega - \sigma\Omega_{su}}$$

The second column of Table 6.3 (case **B**) tells us that unemployment depends on two opposite effects as in case **A**, namely the *tax shifting effect* and the *tax burden effect*. The former is different from that of case **A**. Indeed, if unemployment benefits are indexed to production price, the tax is borne by firms' owners and unemployed. Hence, this effect is greater than the one of case **A** (recall that $\xi_{t_d} < \sigma$). Therefore, an employment dividend is more likely to occur but at the cost of less equity. The environmental tax reduces real income of unemployed. Nevertheless, the second dividend is not always reached, as it depends on the magnitude of the tax burden. The critical value of the initial environmental tax now writes:

$$\overline{\theta}_d^{EW_B} = \frac{\sigma\Omega - \xi_{t_d}\Omega_s}{\sigma\left(\Omega - \xi_{t_d}\Omega_s\right)}$$

When the rule of indexation is an exogenous replacement rate (case **C**, third column of table 6.3), the mechanisms are the same as in case **A**, but the effect on unemployment is smaller because the effective elasticity of unemployment to wages in that case is $\xi_w (1 - \xi_b) < \xi_w$. Nevertheless, the critical value of the initial tax remains unchanged. So $\overline{\theta}_d^{EW_C} = \overline{\theta}_d^{EW_A}$

Proposition 6.3. *When wage formation is set accordingly to the efficiency wage theory, an employment dividend can be achieved only if there is the product market is imperfectly competitive and if the initial tax rates on households are not too high.*

6.3. Case T: the environmental policy bears both on firms and households

In this section, we present the critical value of initial environmental tax rate, when the reform bears on all agents. We assume here that $\theta_e = \theta_d$. These critical values are detailed in Table 6.4. They all are smaller than those obtained when only households bear the reform. Indeed, if firms are taxed, they reduce their energy demand, increasing the *tax burden effect*. Hence the second dividend is more likely to occur when only households are taxed.

Proposition 6.4. *When initially both firms and households bear the same environmental taxes, an increase in this common tax rate reduces the unemployment rate, if and only if there is imperfect competition in the product market and the initial tax rate is below a threshold rate $\overline{\theta}_d$ which depends on the wage formation model and on the indexation scheme of the unemployment benefits, as shown in the following table.*

Corollaire 6.5. *In the very long run, profits vanish, and the second dividend occurs only if the tax is shifted to unemployed, that is, if unemployment benefits are indexed to production price.*

Tableau 6.4: **Values of $\overline{\theta}_d^*$ depending on the wage detemination and the unemployment benefits indexation rule**

	Case **A**	Case **B**	Case **C**
Wage bargaining model	$\dfrac{\sigma\Omega_\pi}{\sigma\Omega - \sigma\Omega_{su} + \frac{\Omega_e}{\Omega_l}\Omega^*}$	$\dfrac{\sigma\Omega}{\sigma\Omega + \frac{\Omega_e}{\Omega_l}\Omega^*}$	–
Efficiency wage model	$\dfrac{\sigma\Omega_\pi}{\sigma\Omega - \sigma\Omega_{su} + \frac{\Omega_e}{\Omega_l}\Omega^*}$	$\dfrac{\left(\sigma - \xi_{t_d}\right)\Omega_s + \sigma\left(\Omega_u + \Omega_\pi\right)}{\sigma\left(\Omega - \xi_{t_d}\Omega_s\right) + \frac{\Omega_e}{\Omega_l}\Omega^*}$	$\dfrac{\sigma\Omega_\pi}{\sigma\Omega - \sigma\Omega_{su} + \frac{\Omega_e}{\Omega_l}\Omega^*}$
$\Omega^* = \Omega_l + \Omega_e + \sigma\Omega_\pi$	$\Omega = \Omega_l + \Omega_e + \Omega_\pi$	$\Omega_{su} = \Omega_s + \Omega_u$	

Case **A**: Perfect indexation of the unemployment benefits to consumption price
Case **B**: Perfect indexation of the unemployment benefits to production price
Case **C**: exogenous replacement rate

7. The environmental dividend

We assumed pollution being generated by the total energy consumption $\overline{E}$, which is the sum of households' consumption (E_M) and firms consumption (E_N), $-D(\overline{E})$ standing then for the pollution disutility. Therefore, the fiscal reform would lead an environmental dividend if and only if energy consumption, and therefore global pollution decrease. The relative energy consumption change $\widetilde{E}$ writes as:

$$\begin{aligned} \widetilde{E}_M = & \frac{\Omega_s}{(\Omega_s+\Omega_u+\Omega_\pi)}\widetilde{E}_s + \frac{\Omega_\pi}{(\Omega_s+\Omega_u+\Omega_\pi)}\widetilde{E}_R + \frac{\Omega_u}{(\Omega_s+\Omega_u+\Omega_\pi)}\widetilde{E}_u \\ \widetilde{E} = & = \Lambda_M\ \widetilde{E}_M + (1-\Lambda_M)\ \widetilde{E}_N \qquad \text{avec} \qquad \Lambda_M = \tfrac{E_M}{E_M+E_N} \end{aligned}$$

7.1. Case F: the environmental policy bears only on firms ($\widetilde{t_d} = 0$)

We showed in section 6.1 that, in this case where the firms bear alone the fiscal reform, one can not obtain any employment dividend. Yet it is clear that in such a case, the environmental dividend may be unambiguously obtained, whatever the wage determination and the indexation of the unemployment benefits would be. Indeed, the additional environmental tax decreases the energy consumption of firms, depress the activity, increases unemployment and thus reduces income as well as energy consumption of the households.

Proposition 7.1. *When the environmental fiscal reform bears only on firms, there is an environmental dividend in any case.*

7.2. Case H: the environmental policy bears only on households ($\widetilde{t_e} = 0$)

In case **A**, where unemployment benefits are perfectly indexed to consumer price, the bargaining model and the efficiency model result both in the same equation:

$$\Lambda_w \widetilde{E} = -\Lambda_M \Lambda_w \left(1 - \sigma \tfrac{\Omega_{su}}{\Omega}\right) + \left[\Lambda_M \tfrac{\Omega_s}{\Omega} + \theta_u \xi_w \left(1 - \Lambda_M \tfrac{\Omega_u}{\Omega} \tfrac{(1+\theta_u)}{\theta_u}\right)\right] \Delta$$

$$\text{avec } \Delta = \sigma \Omega_\pi - \sigma \theta_d \left[(1-\sigma)\,\Omega_{su} + \Omega_\pi\right]$$

The necessary and sufficient existence condition of the environmental dividend is hardly readable. Thus, we will limit the discussion to sufficient conditions for pollution decrease. As $\sigma < 1$ et $\frac{\Omega_{su}}{\Omega} < 1$, the first term is always negative. The environmental dividend will be obtained if the second term is also negative. The term Δ is positive if and only if

$$\theta_d < \frac{\Omega_\pi}{\Omega_\pi + (1-\sigma)\,\Omega_{su}}$$

This condition is the same than the existence condition of the employment dividend. Finally, the term within brackets is negative if and only if:

$$\theta_u \xi_w \Lambda_M \frac{\Omega_u}{\Omega} \frac{(1+\theta_u)}{\theta_u} > 1 + \Lambda_M \frac{\Omega_s}{\Omega} \Leftrightarrow \theta_u < \frac{\Lambda_M \left(\frac{\Omega_u}{\Omega}\xi_w - \frac{\Omega_s}{\Omega}\right)}{\left(1 - \Lambda_M \frac{\Omega_u}{\Omega}\right)\xi_w}$$

In case **B**, when the unemployment benefits are indexed to the aggregate price index, we need again to distinguish between the wage determination models. In the wage bargaining model, the derived condition is very close to the one which was obtained in case **A**:

$$\Lambda_w \widetilde{E} = -\Lambda_M \Lambda_w + \theta_u \xi_w \sigma (1-\theta_d) \Omega \left(1 - \Lambda_M \frac{\Omega_u}{\Omega} \frac{(1+\theta_u)}{\theta_u}\right)$$

This sufficient condition is formally analogous to the one of case **A**:

$$\Lambda_M \frac{\Omega_u}{\Omega} \frac{(1+\theta_u)}{\theta_u} > 1 \Leftrightarrow \theta_u < \frac{\Lambda_M \frac{\Omega_u}{\Omega}}{1 - \Lambda_M \frac{\Omega_u}{\Omega}}$$

Even though the necessary and sufficient conditions are difficult to formally compare, one could think intuitively that the environmental dividend might be easier to obtain when the unemployment benefits are indexed to the aggregate production price rather than to the consumption price index.
For the efficiency model, the sufficient existence condition for the environmental dividend turns to be exactly the same for case **B** as for case **A**. Indeed, the relative energy consumption change $\widetilde{E}$ writes as:

$$\begin{aligned} \Lambda_w \widetilde{E} &= -\Lambda_M \Lambda_w \left(1 - \sigma \frac{\Omega_{su}}{\Omega}\right) + \left[\Lambda_M \frac{\Omega_s}{\Omega} + \theta_u \xi_w \left(1 - \Lambda_M \frac{\Omega_u}{\Omega} \frac{(1+\theta_u)}{\theta_u}\right)\right] \Delta' \\ \text{with } \Delta' &= \sigma \Omega - \xi_{td} \Omega_s + \sigma \theta_d \left[\xi_{td} \Omega_s - \Omega\right] \end{aligned}$$

Here again, Δ' is positive if and only if there is an employment dividend.

In case **C**, where the unemployment benefits are determined by an exogenous replacement rate, we showed at section 5 that the employment dividend can not be obtained in the wage bargaining case. In this case by contrast, it is easy to see that the environmental dividend is warranted for all initial tax rates, because

$$\Lambda_w \widetilde{E} = -\Lambda_M \Lambda_w \Omega_{su} (1-\sigma)$$

It will be greater as the income share of workers and unemployed is grater and the substitution elasticity is weaker.

Finally, in case **C** for the efficiency wage model, the relative energy consumption change $\widetilde{E}$ writes as:

$$\begin{aligned} \Lambda_w \widetilde{E} &= -\Lambda_M \Lambda_w^c \left(1 - \sigma \frac{\Omega_{su}}{\Omega}\right) + \left[\Lambda_M \frac{\Omega_{su}}{\Omega} + \theta_u \xi_w (1-\xi_a) \left(1 - \Lambda_M \frac{\Omega_u}{\Omega} \frac{(1+\theta_u)}{\theta_u}\right)\right] \Delta \\ \text{avec } \Delta &= \sigma \Omega_\pi - \sigma \theta_d \left[(1-\sigma) \Omega_{su} + \Omega_\pi\right] \end{aligned}$$

and the sufficient existence condition of the environmental dividend is the following one:

$$\theta_u < \frac{\Lambda_M \left(\frac{\Omega_u}{\Omega} \xi_w (1-\xi_a) - \frac{\Omega_{su}}{\Omega}\right)}{\left(1 - \Lambda_M \frac{\Omega_u}{\Omega}\right) \xi_w (1-\xi_a)}$$

This limit value is less than in cases **A** et **B**: the environmental dividend will be more difficult to achieve in the case of an exogenous replacement rate than when the unemployment benefits are indexed to prices.

The 7.1 summarizes the sufficient existence conditions of a double dividend in the different cases.

Tableau 7.1: **Values of θ_u and θ_d depending on the wage detemination and the unemployment benefits indexation rule**

	Bargaining	Efficiency wage
Case **A**	2nd dividend if and only if $\theta_d < \frac{\Omega_\pi}{\Omega - \sigma\Omega_{su}}$ 1st dividend if $\theta_u < \frac{\Lambda_M\left(\frac{\Omega_u}{\Omega}\xi_w - \frac{\Omega_s}{\Omega}\right)}{\left(1-\Lambda_M\frac{\Omega_u}{\Omega}\right)\xi_w}$	2nd dividend if and only if $\theta_d < \frac{\Omega_\pi}{\Omega - \sigma\Omega_{su}}$ 1st dividend if $\theta_u < \frac{\Lambda_M\left(\frac{\Omega_u}{\Omega}\xi_w - \frac{\Omega_s}{\Omega}\right)}{\left(1-\Lambda_M\frac{\Omega_u}{\Omega}\right)\xi_w}$
Case **B**	2nd dividend **always** obtained 1st dividend if $\theta_u < \frac{\Lambda_M\frac{\Omega_u}{\Omega}}{1-\Lambda_M\frac{\Omega_u}{\Omega}}$	2nd dividend if and only if $\theta_d < \frac{\sigma\Omega - \xi_{t_d}\Omega_s}{\sigma\left(\Omega - \xi_{t_d}\Omega_s\right)}$ 1st dividend if $\theta_u < \frac{\Lambda_M\left(\frac{\Omega_u}{\Omega}\xi_w - \frac{\Omega_s}{\Omega}\right)}{\left(1-\Lambda_M\frac{\Omega_u}{\Omega}\right)\xi_w}$
Case **C**	2nd dividend **never** obtained 1st dividend **always** obtained	2nd dividend if and only if $\theta_d < \frac{\Omega_\pi}{\Omega - \sigma\Omega_{su}}$ 1st dividend if $\theta_u < \frac{\Lambda_M\left(\frac{\Omega_u}{\Omega}\xi_w(1-\xi_a) - \frac{\Omega_{su}}{\Omega}\right)}{\left(1-\Lambda_M\frac{\Omega_u}{\Omega}\right)\xi_w(1-\xi_a)}$

Case **A**: Perfect indexation of the unemployment benefits to consumption price
Case **B**: Perfect indexation of the unemployment benefits to production price
Case **C**: Exogenous replacement rate

Proposition 7.2. *When the environmental fiscal reform bears only on firms, in all cases but case **C** for the bargaining model (where the first dividend will always be obtained but never the second one), one can simultaneously obtain an environmental dividend and an employment one if the initial environmental tax rate and the unemployment rate are low enough.*

7.3. Case T: the environmental policy bears both on firms and households

It is clear that, when the increase of the environmental tax bears on households and also on firms, the environmental dividend is more likely because the firms decrease their energy consumption, through the substitution effect, in response to the rise in the energy price.

8. Concluding remarks

This paper analyzes the question whether a revenue neutral environmental tax reform can yield benefits in the form of an employment gain, within a general equilibrium framework *a la* Blanchard-Kiyotaki [1987] for various non-competitive labor-market scenarios. Important features of the model are, i) households and firms consume polluting goods; ii) firms are monopolistic competitors; iii) unemployment is due to wage-bargaining process or efficiency wage model; and iv) three different characteristics of the unemployment benefits are considered (unemployment benefits are either fixed in real terms or indexed to producer price, and fixed replacement ratio). Results can be summarized as follows. First, a revenue neutral environmental tax reform cannot yield an employment dividend if only polluting goods consumed by firms are taxed. The only way to obtain an employment gain is to tax at least households. In that case, a decrease in the unemployment rate can be obtained with such a reform regardless of the non-competitive labor-market scenario. Second, the reform yields a second dividend more easily if wages are negotiated than in efficiency wage model. The reason is that in the efficiency model, the environmental tax always reduces the expected utility of effort, so induce workers to shirk unless wage increases. Finally, the maximum initial environmental tax rate depends on the characteristics of the unemployment benefits. The more the benefits are indexed to consumer price index, the smaller the initial tax rate to obtain an employment dividend.

9. References

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