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# Green Tax Reform, marginal revenue of wage income taxes, and the wage curve: A brief note

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## 1. Introduction

Schneider (1997) showed that the success of a green tax reform depends crucially on a small slope of the wage curve of an efficiency wage model in which production occurs using a second factor E, energy or emissions. Scholz (1998) revealed that there is a second necessary condition that the marginal revenue of the wage income tax is negative. In this note we show that (i) these two conditions are not independent, but rather depend both on the slope of the wage curve; and (ii) if Schneider's condition of a sufficiently flat wage curve is fulfilled, marginal revenue of wage income taxes must be negative. By implication, both the green tax reform and the sign of the marginal revenue of wage income taxes depend on the slope of the wage curve which allows to distinguish three cases of a tax reform: a) a double dividend for a very small slope of the wage curve (Schneider's case); b) failure of unemployment reduction (Scholz' case) for a very steep wage curve; c) failure of emission reduction for an intermediate case of a wage curve slope.

## 2. Old and new results of the model

Scholz (1998) considers the reduced form of Schneider's model using her definition of symbols and derives three essential results:

$$\hat{T} / \hat{G} = \beta_u / DET$$

$$\hat{u} / \hat{p} = \frac{\sigma / s}{DET} (\theta_E / \theta_L)$$

$$\hat{E} / \hat{p} = \frac{\sigma / s}{DET} \alpha$$

Here  $DET = \{\beta_u (1-\tau) \theta_L - \varepsilon \theta_E - \varepsilon \tau \theta_L\} / s$  is the determinant of the reduced form of the model;  $\alpha = \tau \varepsilon - (1-\tau) \beta_u$ . With all parameters but  $DET$  and  $\alpha$  defined in a way that they are positive, Scholz shows that Schneider's results not only require  $\alpha > 0$  but also  $DET < 0$ . The latter condition implies that the marginal revenue of wage income taxes, the first of the three results, must be negative.

We show now, that the sign of  $DET$  also depends on the slope of the wage curve in a way that  $\alpha > 0$  implies  $DET < 0$ , but not vice versa.

From the definitions of  $DET$  and  $\alpha$  given above one can see that

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<sup>1</sup> I am grateful for useful comments to Dieter Imboden, Hans Nutzinger, and to Kerstin Schneider also for providing the graphs, which I have modified only slightly. Responsibility is entirely mine.

DET >(<) 0 exactly if  $\beta_u > (<) \frac{\varepsilon\theta_E/\theta_L + \varepsilon\tau}{1-\tau}$  and

$\alpha > (<) 0$ , exactly if  $\beta_u < (>) \frac{\tau\varepsilon}{1-\tau}$ .

From the right-hand sides of the inequalities one can see that the fraction of the inequality derived from *DET* is larger than the fraction of the inequality derived from  $\alpha$  because in the first of these a term is added to  $\varepsilon\tau$  in the numerator. Therefore we can distinguish three cases:

1.  $\beta_u > \frac{\varepsilon\theta_E/\theta_L + \varepsilon\tau}{1-\tau} > \frac{\tau\varepsilon}{1-\tau}$ , implies  $DET > 0$ ,  $\alpha < 0$ ,  $\hat{E} < 0, \hat{u} > 0, \hat{T}/\hat{G} > 0$ . (Employment failure)

An increase of the energy or emissions tax reduces energy use and emissions, but increases unemployment. Marginal revenue of wage income taxes is positive.

2.  $\frac{\varepsilon\theta_E/\theta_L + \varepsilon\tau}{1-\tau} > \beta_u > \frac{\tau\varepsilon}{1-\tau}$ , implies  $DET < 0$ ,  $\alpha < 0$ ,  $\hat{E} > 0, \hat{u} < 0, \hat{T}/\hat{G} < 0$ . (Emission failure)

The energy or emissions tax increases employment but also energy use. Marginal revenue of wage income taxes is negative.

3.  $\frac{\varepsilon\theta_E/\theta_L + \varepsilon\tau}{1-\tau} > \frac{\tau\varepsilon}{1-\tau} > \beta_u$ , implies  $DET < 0$ ,  $\alpha > 0$ ,  $\hat{E} < 0, \hat{u} < 0, \hat{T}/\hat{G} < 0$ . (Double dividend)

This is the case of a flat wage curve. Unemployment and emissions are both reduced and a double dividend can be reaped. These results can be summarized as follows.

**Proposition:** A sufficiently flat wage curve implies negative marginal revenue of wage income taxes and the conditions for a double dividend are not independent of each other.

**Corollary:** Schneider's condition  $\alpha > 0$  implies the one revealed by Scholz,  $DET < 0$ , i.e., a negative marginal revenue of wage income taxes, but not vice versa.

By implication, Schneider's case is not weakened but rather we have the empirical question how flat the wage curves are. Authors providing support for a double dividend view tend to use horizontal labour supply or wage curve (besides Schneider 1997, see Nielsen et al. 1995 and Koskela et al. 2001). Otherwise the success of a green tax reform depends on having a labour cost reduction that does not benefit the unemployed or black market workers (Bovenberg and van der Ploeg 1998, Koskela and Schöb 1999). As in most countries institutional arrangements are such that the unemployed would also benefit from a labour tax reduction (see Koskela and Schöb

1999), either institutional change is required or this latter way does not work and the slope issue of the Schneider paper remains crucial.

### 3. Some 'back –on-the-envelop' empirics

If a politician wants to know whether or not unemployment and emissions will increase or decrease after the introduction of an eco-tax (s)he needs to know the value of Beta relative to the other terms. This will be very difficult for two reasons.

*First*, the wage curve replaces the textbook labour-supply curve in the model, which is structurally very similar. Labour supply curves are normally expected to be very steep. Bovenberg (1995) reports that an increase of wages by 1% increases labour supply by 0.02%. This is an almost vertical function, which comes very close to an exogenous labour supply. If the wage curve replaces the labour-supply function, the question is whether or not empirical results can differ very much from those of a labour supply function. The structural equations, which have to be estimated for different models are always very similar to each other (see Pissarides 1998). This view would support the assumption of a very high value of Beta, which in turn would support the view that an eco-tax increases unemployment. On the other hand, this latter result of an increase in unemployment could be an optimum because it buys an improvement of the environment (see Schneider 1997, section IV). One may doubt however, that voters and politicians have the individual welfare or utility function, which drives this policy result, because results based on questionnaires show a huge priority for employment (see Böhringer und Vogt 2001). In sum, it is not surprising, that scientific support for a green tax reform has been based on models with fixed wages and the implied *horizontal* labour supply curve (see Nielsen et al. 1995 and Koskela et al. 2001).<sup>2</sup>

*Second*, the term  $\alpha = -\beta_u / T + (1-1/T)\epsilon$  must be positive.  $1-1/T$  is the percentage tax rate on gross wages and  $1/T$  is the percentage that remains after taxes. Graafland and Huizinga (1999) estimate an equation similar to a wage curve – derived from a bargaining model - and obtain a semi-elasticity ( $-\partial w/w/\partial u$ ) between 1.5 for the second half of the 1970s and 3.0 for the beginning of the 1990s. In order to make these values comparable with Beta, the semi-elasticity can be multiplied with the European unemployment rates of the corresponding time periods: the first number with the unemployment rate of about  $u=5\%$  and the second with  $u=10\%$ . This yields values for Beta of 0.075 and 0.3. The higher the unemployment rate is, the higher the elasticity. This method clearly differs from a constant elasticity approach. Each figure shows two surfaces. The *flat* one is the benchmark-value of Beta as derived from the Graafland-Huizinga semi-elasticities, assuming for illustrative purposes that they are more generally valid than just for the Netherlands. The *bended* curve shows values for the right-hand side of the inequality  $\beta_u < u(T-1)/(1-u) \equiv \beta$  called 'beta' on the vertical axis of the graph, which are calculated for alternative values of the unemployment rate  $u$  and the tax factor  $t=1/T$ , which is the percentage of the gross wage, which the employee gets. The lower this percentage and the higher the rate of unemployment the larger is the right-hand side of the inequality. In the case of the higher elasticity  $\beta_u = 0.3$ , the after-tax percentage, which the employee gets has to be fairly low (below 40%) for all unemployment rates below 15% in order to get a double dividend. In the case of the lower elasticity  $\beta_u=0.075$ , however, a large right-hand side is much more easy to get. Therefore one cannot derive a clear-cut answer to the question whether or not the wage curve is flat enough to guarantee a double dividend or predict increasing emissions or unemployment.

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<sup>2</sup> Other support has been based on bargaining models in which the revenues of a green tax reform are used to improve the situation of working people compared to those not working.

#### 4. Conclusion

We have shown that the condition of a flat wage curve as revealed by Schneider (1997) and the condition of negative marginal revenue of wage income taxes are not independent of each other. But rather a sufficiently steep (flat) wage curve implies positive (negative) marginal revenue of wage income taxes. The dismissal of negative marginal revenue of wage income taxes is premature unless one can prove that wage curves are not sufficiently flat. So far flat and steep curves are used in the literature. Our back-on-the-envelope calculations do not allow excluding any of the cases.

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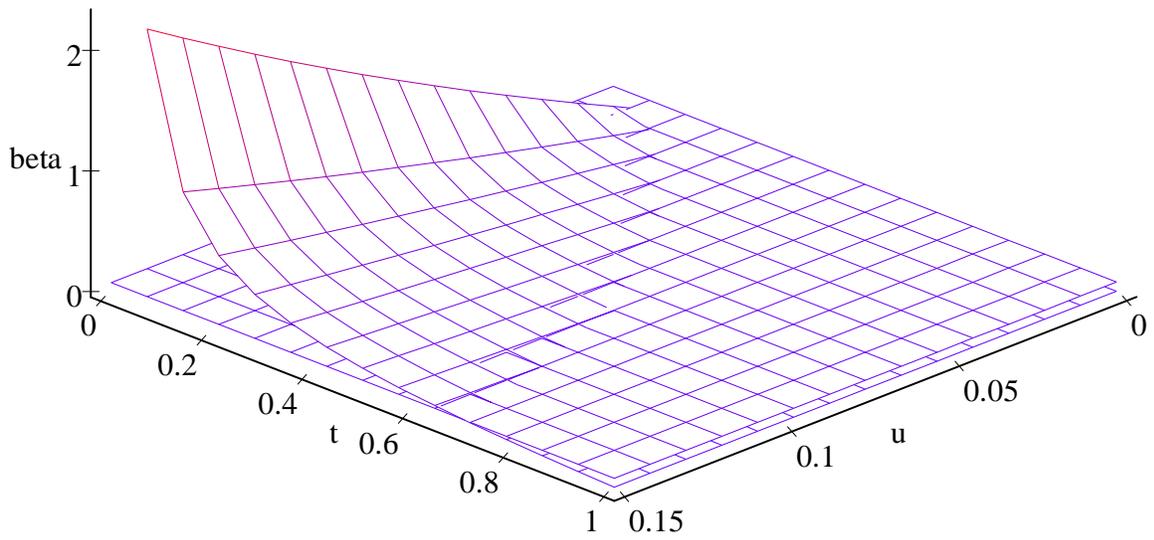


Figure 1  
High values of the unemployment rate and low values of the after-tax factor allow for a double dividend if the wage curve has an elasticity of 0.075

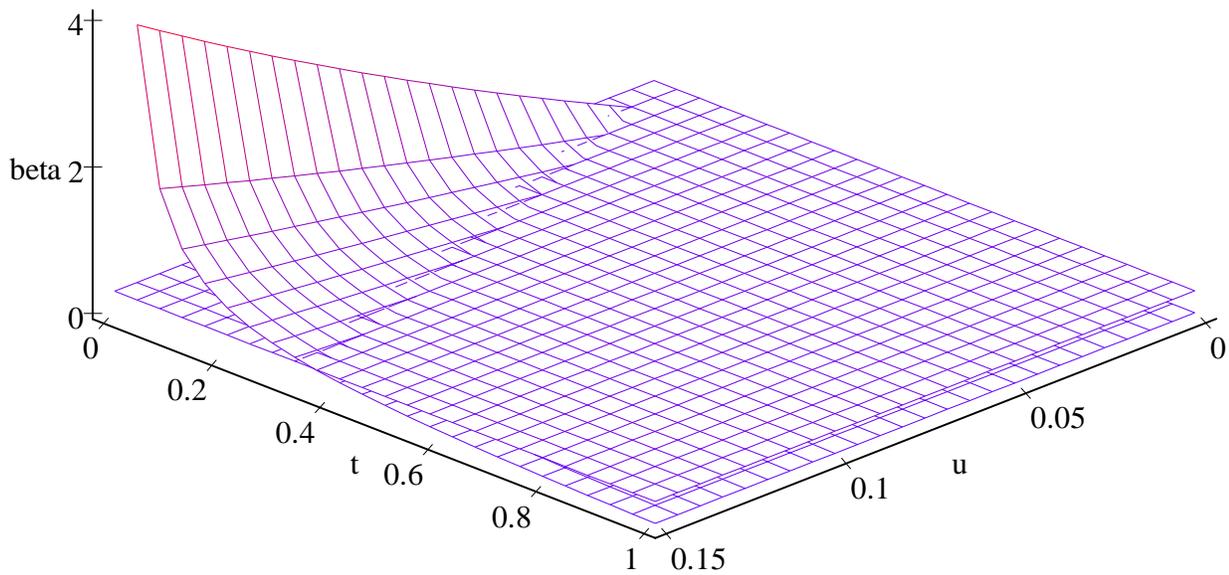


Figure 2  
 Only very high values of the unemployment rate and very low values of the after-tax factor allow for a double dividend if the wage curve has an elasticity of 0.3