Money illusion and the double dividend in the short run

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Abstract

In their seminal paper, Bovenberg and De Mooij (1994) elucidate why an ecological tax reform will not yield a double dividend, i.e. fails to increase the efficiency of the tax system. The present paper slightly modifies the Bovenberg and De Mooij model by introducing money illusion. With this modification, an environmental tax reform that raises the price level may generate a double dividend, since the additional tax on the dirty good does not reduce labor supply. A prerequisite for the double dividend to occur is a sufficiently small elasticity of substitution between clean and dirty consumption. Moreover, accounting for money illusion always reduces the intertemporal gross cost of the tax reform.

Keywords: Environmental tax reform, money illusion, double dividend

JEL classification: E60, H21, Q28

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1 Introduction

The notion of the double dividend goes back to Goulder (1994). It says that ”the revenue neutral substitution of the environmental tax for *typical* or *representative* distortionary taxes involves a zero or negative gross cost”[1]. The idea that such a tax reform renders a more efficient tax system without taking account of potential environmental benefits was seriously challenged by Bovenberg and De Mooij (1994). In a very simple general equilibrium model, they show that increasing the tax on dirty goods and using the revenue to cut labor taxes reduces the real after-tax wage. In their model, taxing labor is second-best. Therefore, a substitution of a narrow-based consumption tax on the dirty good for a broad-based labor tax cannot yield a double dividend.

The present paper modifies the model by Bovenberg and De Mooij by introducing money illusion. With money illusion, labor supply depends on nominal rather than on real wages as in the fully rational model. In such a setting, a price increase of the dirty good does not reduce labor supply while the labor tax cut enhances it. Hence, the environmental tax reform may yield a double dividend.

The relevance of money illusion is part of an ongoing discussion on the neutrality of money that is often obscured by ideological positions. Moreover, the validity of its empirical test is restricted by the basic problem of measuring unobservable variables, i.e. the perception of price changes. However, recent studies by Shafir et al. (1997) and by Fehr and Tyran (2001), the former based on review questions and the later on experimental design, come to the conclusion that people respond to nominal rather than to real price changes and therefore are subject to money illusion at least in the short run.

This paper introduces the modified Bovenberg/De Mooij model and derives its reduced forms in section 2. Section 3 discusses the scope for a double dividend and section 4 concludes.

2 The Model and its Reduced Forms

In order to present the consequences of money illusion in the most straightforward way, we only slightly change the Bovenberg/De Mooij model, by making labor supply depend on nominal wages. Furthermore, we do not include environmental quality in the household’s utility function as this is not crucial for analyzing the double-dividend hypothesis. The model is presented in table 1.

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[1] *Goulder* (1995), p. 4.

Table 1: The model in levels

Production	$hNL = NC + ND + G$	I.1
Utility	$U = U(G, H(V, Q(C, D)))$	I.2
Budget constraint	$C + (1 + t_D)D = h(1 - t_L)(1 - V)$	I.3
Government	$t_D ND + t_L hNL = G$	I.4
Labor supply	$L = L(W)$	I.5

Notation:

h : labor productivity
L : labor
C : consumption of clean good
D : consumption of dirty good
G : consumption of public good
N : number of households
V : leisure
t_D : tax rate on dirty good
t_L : tax rate on labor
W : nominal wage rate

The production function (I.1) describes a linear technology with labor as the only production factor. The utility function (I.2) depicts the nested structure of the household's preferences, with the public good being weakly separable from the private goods and the subutility Q assumed to be homothetic. The household's budget constraint (I.3) displays the two imposed taxes on the dirty good and on labor respectively. The government (I.4) uses the tax revenue to finance a given amount of the public good. Finally, as already mentioned, labor supply (I.5) is a function of the nominal wage.

The effect of a tax reform that - marginally - raises the tax on the dirty good and uses the revenue to cut the labor tax, can best be analyzed by log-linearizing the model. We normalize around the price of the untaxed clean good[2]. Within a fully rational model, such a normalization is of no relevance to the result because only relative prices matter. However, in the presence of money illusion, nominal values matter and the choice of normalization is not just a technical issue. When the relative price of the dirty good rises with the environmental tax and the price of the clean good remains unchanged, the price level will increase. Our normalization, therefore, assumes that the central bank accommodates the price level increase initiated by the tax rise on the dirty good[3]. This assumption seems plausible, since, without accommodation, a sticky price of the clean good would cause involuntary unemployment in the short run.

Table 2 presents those log-linearized functions that are required to derive the reduced forms. A tilde denotes a relative change, except where indicated otherwise. Dirty good demand (II.1) is presented as the sum of an income and a substitution effect, where σ stands for the

[2] With constant productivity, this is equivalent to normalizing around the before-tax wage.
[3] The monetary side is not explicitly modeled since it does not render more insight to the results presented here.

elasticity of substitution between the dirty and the clean good. The government budget (II.2) shows that the labor tax depends on the environmental tax and on the general equilibrium effects of the tax reform on the tax bases. Labor supply (II.3) exhibits the – nominal – wage elasticity θ_l. The difference between the real and the nominal after-tax wage (II.4 and II.5) equals the price level increase due to the environmental tax.

Table 2: The model in relative changes

Dirty good demand	$\tilde{D} = \tilde{L} + \tilde{w} - (1-\phi_D)\sigma\tilde{t}_D$	II.1
Government budget	$\tilde{t}_L = -\frac{t_L\tilde{L} + t_D a_D \tilde{D}}{1-t_L} - \phi_D \tilde{t}_D$	II.2
Labor supply	$\tilde{L} = \theta_l \tilde{W}$	II.3
Real after-tax wage rate	$\tilde{w} = -\tilde{t}_L - \phi_D \tilde{t}_D$	II.4
Nominal after-tax wage rate	$\tilde{W} = -\tilde{t}_L$	II.5

Notation:

Parameters:

σ : substitution elasticity between clean and dirty consumption

θ_l : uncompensated wage elasticity of labor supply

Taxes:

$\tilde{t}_D = \frac{dt_D}{1+t_D}$, $\tilde{t}_L = \frac{dt_L}{1-t_L}$

Shares:

$a_D = \frac{D}{hL}$: output share of the dirty good

$\phi_D = \frac{(1+t_D)D}{C+(1+t_D)D}$: expenditure share of dirty consumption

From table 2 we first derive the reduced form for labor:

$$\Delta\tilde{L} = [-\theta_l t_D a_D (1-\phi_D)\sigma + \theta_l \phi_D (1-t_L - t_D a_D)]\tilde{t}_D \qquad (1)$$

with: $\Delta \equiv 1-(t_L + t_D a_D)(1+\theta_l) > 0$[4].

The first term in brackets of equation (1) corresponds to the result presented by Bovenberg and De Mooij[5]. With a positive elasticity of labor supply, the term is negative. We may call it the tax erosion effect, because it shows that, due to the erosion of the dirty-good tax base, the additional revenue is smaller than the amount that is needed to compensate the household for the price increase. The second term in brackets is positive[6] and describes the money illusion effect, since it reflects the non-perception of the fall in real wages. The money illusion effect is positively related to the expenditure share of dirty consumption ϕ_D because, with a higher

[4] The condition is required for stability reasons. It ensures an upward-sloping Laffer curve (see Bovenberg and De Mooij, p. 1087).

[5] Bovenberg and De Mooij (1994), p. 1087.

[6] $1-t_L - a_D t_L$ corresponds to the positive output share of the private goods.

expenditure share, the tax on the dirty good raises the general price level more and increases the discrepancy between nominal and real wage.

From equation (1), we can deduce the condition for the money illusion effect to outweigh the tax erosion effect:

$$\tilde{L} > 0 \Leftrightarrow \sigma < \frac{1 + t_D(1-\phi_D)}{t_D(1-\phi_D)}. \tag{2}$$

It can be shown that condition (2) implies an upward-sloping Laffer curve in the dirty good market. In this case, higher taxation of the dirty good generates additional revenue which can be used to reduce the tax on labor.

To save on notation, the result referring to the equilibrium on the dirty good market is presented conditional on labor:

$$\tilde{D} = \frac{\tilde{L} - (1-\phi_D)\sigma(1-t_L)\tilde{t}_D}{1 - t_L - t_D a_D}. \tag{3}$$

The second term of the nominator of equation (3) is negative and represents the substitution effect conditional on labor. Therefore, the conditions for dirty good consumption to increase are more stringent than for labor. Note, however, that with the substitution elasticity σ converging to zero, the substitution and, consequently, the tax erosion effect vanish. In this case, labor as well as dirty good consumption increase.

3 The Double Dividend

The money metric welfare effect of a budget-neutral tax reform is calculated in terms of the share of total household income. With λ denoting marginal utility of income, we arrive at equation (4), which displays the double dividend as the sum of distortions in the two taxed markets:

$$\frac{dU}{\lambda(1-t_L)hL} = \frac{t_L\tilde{L} + t_D a_D \tilde{D}}{1 - t_L}. \tag{4}$$

Substituting (3) into (4) yields a semi-reduced form of the double dividend:

$$\frac{dU}{\lambda(1-t_L)hL} = \left[\frac{t_L}{1-t_L} + \frac{t_D a_D}{(1-t_L)(1-t_L-t_D a_D)}\right]\tilde{L} - \frac{t_D a_D}{1-t_L}\frac{(1-\phi_D)\sigma(1-t_L)}{1-t_L-t_D a_D}\tilde{t}_D. \tag{5}$$

Provided that labor increases, only the last term on the r.h.s. of equation (5) is negative. It describes the additional distortion of the consumption decision arising from the substitution of the clean for the dirty good. The smaller the substitution elasticity is, the weaker the distortion. Moreover, with little substitution of the clean for the dirty good the tax base erodes

only slightly and labor increases strongly. Therefore, with a sufficiently small elasticity of substitution, the reduction of the distortion in the labor market is large enough to compensate for the additional distortion in the dirty good market, resulting in a double dividend. To give an illustrative example, if we set $\theta_l = t_L = t_D = 0.2$ and $\phi_D = 0.5$, welfare would break even at a substitution elasticity of 0.8, i.e. any elasticity below 0.8 would produce a double dividend.

4 Conclusions

Recent surveys and experimental studies come to the conclusion that people are subject to money illusion in the short run. If we integrate money illusion in the simple model that Bovenberg and De Mooij used to analyze environmental tax reform, the result changes dramatically. With money illusion, an environmental tax reform that raises the price level may yield a double dividend. This result hinges on the fact that people do not perceive the reduced purchasing power caused by the price increase of the dirty good. On the contrary, they interpret the labor tax cut as a rise in real wages and supply more labor, which reduces the existing distortion in the labor market. With a sufficiently small elasticity of substitution between dirty and clean consumption, the welfare gain due to increased labor outweighs the additional distortion of the consumption decision.

The misperception of nominal for real wages and, hence, the potential for a double dividend will not persist forever. However, if we change from a static to a dynamic perspective, the inclusion of money illusion always reduces the reforms cost-integral over time, because, as long as misperception lasts, the distortion in the labor market is diminished.

The result can be applied more generally. If an expansion of the money supply leads to an equivalent increase in all prices and wages, the money illusion effect alleviates the tax distortion in the labor market without causing negative substitution and tax erosion effects. In this case, welfare always increases. This generalization points to the crucial role of the central bank, which must accommodate the environmental tax rise so that money illusion can occur.

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