ECONOMICS BULLETIN

Status, environmental externality, and optimal tax programs

Ronald Wendner
Department of Economics, Graz University, Austria

Abstract

This paper studies the designs of optimal tax programs in OLG economies when first, consumption of one household lowers (status) utility of others, and second, consumption harms the environment. Status seeking raises optimal consumption tax rates, and lowers optimal tax rates on capital income.

I am grateful to an anonymous referee. Further, I am indebted to Kurt Annen, Nicolas Guigas, and Tetsuo Ono for insightful debates on a former version of this paper.
Citation: Wendner, Ronald, (2003) "Status, environmental externality, and optimal tax programs." *Economics Bulletin,* Vol. 8, No. 5 pp. 1−10
Submitted: November 7, 2002. **Accepted:** January 30, 2003.
URL: http://www.economicsbulletin.com/2003/volume8/EB−02H20005A.pdf

1 Introduction

This paper examines optimal tax programs that aim to internalize two externalities: a status externality and an environmental externality.

In an insightful article, Ono (1996) investigates two optimal tax programs in an overlapping generations (OLG) economy where consumption of finitely lived generations causes a negative environmental externality. Consumption in period t causes the environment to deteriorate as of period $t+1$. While households derive utility from the environment, the old generation has no incentive to care for environmental quality in future periods. Ono (1996) demonstrates that the externality can be internalized by both a consumption tax program with a higher consumption tax rate for old than for young households, and a second tax program with a uniform consumption tax together with a capital income tax.

In the present paper households gain utility not only from environmental quality. They also derive utility from the status achieved by consuming at above-average levels. Striving for status, however, leads to overconsumption and overuse of the environment. Thus, the desire to keep up with the Joneses has to be considered in the design of an optimal tax program.

It is important to consider the interactions between the status externality and the environmental externality for the following reasons. First, status seeking has an impact on optimal tax *levels*. The desire for status raises the optimal levels of consumption taxes and lowers the optimal level of a capital income tax. This result represents a new and different rationalization of an extensively discussed tax reform proposal according to which the tax base should be switched from (capital) income to consumption. Second, status seeking has an impact on the optimal tax *structure*. In a framework where overlapping generations live for two periods each, the desire for status lowers the optimal tax rate of second period consumption relative to the optimal tax rate of first period consumption. In the case of a uniform consumption tax, the desire for status lowers the optimal capital income tax rate relative to the optimal consumption tax rate.

In addition to Ono (1996), there are several models in the literature that are related to the model in this paper. Ono (2002) analyzes the impact of habitual consumption on the environment in a similar OLG framework. He shows that consumption habits are potentially harmful to the environment. Ng and Wang (1993) show that status seeking leads to overconsumption. Both papers, however, do not look at optimal tax programs. Howarth (1996) also analyzes status effects and environmental externalities. He derives efficient consumption and pollution tax rates. His model, however, is static. Therefore, in contrast to the present note, Howarth (1996) does not consider capital income taxes.

Section 2 of this note presents the OLG model and shows the social optimum. Section 3 discusses competitive equilibria with taxes and transfers and demonstrates that the social optimum can be achieved by two different optimal tax programs. Section 4 concludes the note.

2 The Social Optimum

We consider a fully competitive economy where economic activity is performed over infinite discrete time. In each period there are two identical overlapping generations, one young and one old. Each generation endures for two periods and exhibits preferences for consumption in both periods, c^1 and c^2, and for environmental quality, which is measured by an index E. Superscripts 1 and 2 refer to the first and second period of life respectively. Each young household is endowed with L_t units of labor. For the sake of simplicity, we assume a zero growth rate of the population, $n = 0$, and set $L_t = L_0 = 1$.

Preferences of a generation born in period t are given by the utility function[1]

$$U_t = u(\hat{c}_t^1,\, \hat{c}_{t+1}^2,\, E_{t+1})\,. \tag{1}$$

The variable $\hat{c}^1$ denotes *effective* consumption in the first period of life: $\hat{c}^1 \equiv c^1 - \gamma^1 C$, where $C \geq 0$ is average consumption across all households.[2] The parameter $\gamma^1 \in [0, 1)$ determines the relative importance of average consumption. It indexes the desire of young households for status. The higher γ^1 is, the more young households care for status and for the consumption level of their peers. Similarly, $\hat{c}^2 \equiv c^2 - \gamma^2 C$, where $\gamma^2 \in [0, 1)$. If $\gamma^1 > 0$ and $\gamma^2 > 0$ a household not only derives utility from absolute consumption but also from consumption relative to average consumption (status).

The index of environmental quality, E, evolves according to

$$E_{t+1} = (1 - b)E_t - \beta(c_t^1 + c_t^2) + \delta\, m_t\,. \tag{2}$$

Without economic activity, E tends to an autonomous level of zero, where the parameter $b \in (0, 1)$ determines the speed of adjustment. Environmental quality is negatively affected by consumption if $\beta > 0$ and positively affected by maintenance investment, m, if $\delta > 0$.

[1]The assumption that only E_{t+1} is considered in the utility function follows the work of John and Pecchenino (1994) as well as that of Ono (1996).

[2]This formulation of status, or relative consumption, is equal to the keeping up with the Joneses formulation used in Ljungqvist and Uhlig (2000).

Production of a single commodity follows a production function $f(k)$ that is homogeneous of degree one, where k is capital intensity. Output is allocated to consumption, capital accumulation, and maintenance investment. Let us assume that capital depreciation is complete. Then the resource constraint becomes

$$f(k_t) - k_{t+1} - c_t^1 - c_t^2 - m_t = 0\,. \tag{3}$$

For all $t \geq 0$, a social planner chooses c_t^1, c_t^2, k_t, m_t (and implicitly E_t), where k_0 and E_0 are given. She takes into account (i) the resource constraint (3), (ii) the environmental constraint (2), and (iii) the average consumption level $C_t = (L_t\, c_t^1 + L_{t-1}\, c_t^2)/(L_t + L_{t-1}) = (c_t^1 + c_t^2)/2$ in each period t. The social planner discounts future generations' utilities. This case gives rise to a Bergsonian social welfare function

$$W = \sum_{t=-1}^{\infty} \rho^t\, U_t\,, \tag{4}$$

where $0 < \rho < 1$ denotes the social discount factor. The time index starts with -1 because the generation born in -1 still consumes in period 0. The case where the social planner does not discount future generations' utilities is shortly discussed in the Appendix.

A social optimum, in a steady state, is the tuple $\mathbf{SO} = \{c^1,\, c^2,\, k,\, m,\, E\}$ which follows from:

$$u_1(\hat{c}^1,\, \hat{c}^2,\, E) = \frac{2(\beta+\delta)}{(2-\gamma^1-\gamma^2)[1-\rho\,(1-b)]}\, u_3(\hat{c}^1,\, \hat{c}^2,\, E)\,, \tag{5}$$

$$u_2(\hat{c}^1,\, \hat{c}^2,\, E) = \frac{2\,\rho\,(\beta+\delta)}{(2-\gamma^1-\gamma^2)[1-\rho\,(1-b)]}\, u_3(\hat{c}^1,\, \hat{c}^2,\, E)\,, \tag{6}$$

$$f'(k) = 1/\rho\,, \tag{7}$$

$$f(k) = c^1 + c^2 + k + m\,, \tag{8}$$

$$E = -\beta\,(c^1 + c^2)/b + \delta\, m/b\,, \tag{9}$$

where $u_i(\hat{c}^1,\, \hat{c}^2,\, E)$ denotes the partial derivative of $u(\hat{c}^1,\, \hat{c}^2,\, E)$ with respect to the i-th argument. Details of the derivation of these conditions are provided in the Appendix.

3 Competitive Equilibria with Taxes and Transfers

Each young household inelastically supplies its labor endowment to the labor market in the first period of life, and receives, in return, a wage rate $w =$

$f(k) - k\,f'(k)$ per unit of labor. Wage income is allocated to savings, s, consumption, and maintenance investment. Once the household becomes old and enters period 2, both savings and interest income $R\,s = f'(k)\,k$ are fully consumed.[3]

Let us consider consumption taxes, τ_{c^1}, τ_{c^2}, lump-sum taxes and transfers, t, and a tax on capital income, τ_k. Then the first- and second-period budget constraints are:

$$c_t^1(1+\tau_{c^1}) + s_t + m_t = w_t - t_t^1\,, \quad c_{t+1}^2(1+\tau_{c^2}) = R_{t+1}\,s_t(1-\tau_k) + t_{t+1}^2\,. \tag{10}$$

Variable t^1, if positive, represents a lump-sum tax. The government budget constraint is: $t_{t+1}^2 = \tau_{c^1}\,c_{t+1}^1 + \tau_{c^2}\,c_{t+1}^2 + R_{t+1}\,s_t\,\tau_k + t_{t+1}^1$.

Each generation chooses consumption, savings, and maintenance investment in order to maximize utility (1), subject to the budget constraints (10) and to the environmental constraint (2). In contrast to the social planner, households consider average consumption C as given. A competitive equilibrium with taxes and transfers, in a steady state, is a tuple $\mathbf{CET} = \{c^1,\, c^2,\, k,\, m,\, E\}$ that follows from:

$$u_1(\hat{c}^1,\, \hat{c}^2,\, E) = [\beta + \delta(1+\tau_{c^1})]\,u_3(\hat{c}^1,\, \hat{c}^2,\, E)\,, \tag{11}$$

$$u_2(\hat{c}^1,\, \hat{c}^2,\, E) = \frac{\delta\,(1+\tau_{c^2})}{f'(k)\,(1-\tau_k)}\,u_3(\hat{c}^1,\, \hat{c}^2,\, E)\,, \tag{12}$$

$$c^1\,(1+\tau_{c^1}) = f(k) - k\,f'(k) - k - m - t^1\,, \tag{13}$$

$$c^2\,(1+\tau_{c^2}) = f'(k)\,k\,(1-\tau_k) + t^2\,, \tag{14}$$

$$E = -\beta\,(c^1 + c^2)/b + \delta\,m/b\,, \tag{15}$$

$$\tau_{c^1},\ \tau_{c^2},\ \tau_k,\ t^1 \text{ given.}$$

Assign two different sets of instruments to the government. *Regime A:* The government imposes two consumption taxes, τ_{c^1}, and τ_{c^2}, and there is no capital income tax. *Regime B:* The government imposes a uniform consumption tax, τ_c, and a capital income tax, τ_k.

Proposition 1 (Tax Regime A) *There exists an optimal tax program, such that* $\mathbf{SO} = \mathbf{CET}$*, with*

$$\tau_{c^1} = \frac{(\beta+\delta)\,[\gamma^1 + \gamma^2 + (1-b)\rho\,\Gamma]}{\delta\,\Gamma\,[1-\rho(1-b)]}\,, \quad \tau_{c^2} = \tau_{c^1} + \frac{\beta}{\delta},$$

$$t^1 = f(k) - (1+\rho)/\rho\,k - m - c^1\,(1+\tau_{c^1}), \quad \Gamma \equiv (2 - \gamma^1 - \gamma^2)\,.$$

[3]Since the rate of depreciation of capital equals unity, the interest factor R equals $f'(k)$.

Proof. The optimal consumption tax rate τ_{c^1} follows from equating the first order conditions (5) and (11), and solving for τ_{c^1}. Similarly, τ_{c^2} follows from equating the first order conditions (6) and (12). The level of the lump-sum tax, t^1, is chosen such that $f'(k) = 1/\rho$. Q.E.D.

Notice that the higher β is, the larger are the optimal consumption tax rates. I.e., the parameter β indexes the strength of the negative externality of consumption on environmental quality. Proposition 1 shows that $\tau_{c^2} > \tau_{c^1}$ whenever $\beta > 0$. While the young generation considers the impact of its consumption on environmental quality at least for the period that follows, the old generation does not consider the impact of its consumption on environmental quality at all. Thus, the optimal tax rate on c^2 must be higher than on c^1 in order to internalize these externalities. If $\gamma^1 = \gamma^2 = 0$, and $\rho = 1$, Ono's (1996, p. 286) optimal tax scheme follows.

Proposition 2 *An increase in the desire for status, γ^1 or γ^2, implies a rise in both the optimal consumption tax rates and the optimal ratio τ_{c^1}/τ_{c^2}.*

Suppose, first, that $\gamma^1 = \gamma^2 = \gamma$. In this case $\partial\,\tau_{c^1}/\partial\,\gamma = \partial\,\tau_{c^2}/\partial\,\gamma = (\beta + \delta)/[(1 - \rho(1 - b))\,\delta(-1 + \gamma)^2] > 0$. The higher the status parameter the higher are both optimal tax rates. Each unit of consumption of one household causes an external cost for all other households in terms of status loss. The optimal tax program accounts for this negative externality by a rise in consumption tax rates.

An increase in the status parameter γ also implies a rise in the optimal tax ratio τ_{c^1}/τ_{c^2}. According to Proposition 1, $\tau_{c^1}/\tau_{c^2} = \tau_{c^1}/(\tau_{c^1} + \beta/\delta)$. Thus, $\partial\,(\tau_{c^1}/\tau_{c^2})/\partial\,\gamma = (\tau_{c^2})^{-2}\,\beta/\delta\,(\partial\,\tau_{c^1}/\partial\,\gamma) > 0$. As a result of status seeking, the tax burden shifts more to the young consumers. Notice that in the limit, as γ approaches unity, $\tau_{c^1} \rightarrow \tau_{c^2}$.

If $\gamma^1 \neq \gamma^2$, similar results hold. For the same reasons as above $\partial\,\tau_{c^i}/\partial\,\gamma^1 = \partial\,\tau_{c^j}/\partial\,\gamma^2 > 0$, $i = 1, 2;\ j = 1, 2$, and $\partial\,(\tau_{c^1}/\tau_{c^2})/\partial\,\gamma^1 = \partial\,(\tau_{c^1}/\tau_{c^2})/\partial\,\gamma^2 > 0$.

Under regime A, there are differing consumption tax rates for young and old generations. There are two arguments, motivating this tax regime. First, Ono (1996) used a similar tax program, and the present paper extends the results obtained by Ono (1996). Second, Erosa and Gervais (2002) demonstrate, for life-cycle economies, it is optimal to tax consumption goods uniformly over the lifetime of an individual only when the optimal τ_k is zero. However, below it is shown that the optimal τ_k is positive. Hence, *optimal* consumption tax rates must differ among individuals belonging to different generations.

If consumption tax rates cannot be conditioned on age in practice[4], the

[4] A referee rightly pointed out that it is hard to think of the implementation of non-

tax program must be implemented by an *equivalent* tax program for which tax rates can be conditioned on age. One such tax program is one with a uniform consumption tax plus a tax on labor income that exactly mimics the age-conditioned consumption tax rates.[5]

Proposition 3 (Tax Regime B) *There exists an optimal tax program, such that* **SO** = **CET**, *with*

$$\tau_c = \frac{(\beta+\delta)}{\delta}\left\{\frac{2}{\Gamma\,[1-\rho(1-b)]}-1\right\}, \quad \tau_k = \frac{\beta}{2\,(\beta+\delta)}\left\{\Gamma\,[1-\rho(1-b)]\right\},$$
$$t^1 = f(k)-(1+\rho)/\rho\, k - m - c^1\,(1+\tau_c)\,.$$

As before, the optimal tax rates follow from the first order conditions of both the social optimum (5) and (6) and the competitive equilibrium with taxes and transfers (11) and (12). As a special case, if $\gamma^1 = \gamma^2 = 0$, and $\rho = 1$, Ono's (1996, p. 288) optimal tax scheme follows.

For the optimal tax program with differentiated consumption taxes it was shown that $\tau_{c^2} > \tau_{c^1}$. Here, in the optimal tax program with a capital income tax there is a uniform tax rate on consumption: $\tau_{c^1} = \tau_{c^2} = \tau_c$. Thus, the social optimum requires a lowering of second period consumption by $\tau_k > 0$.

Proposition 4 *An increase in the desire for status implies a rise in the optimal consumption tax rate and a decline in the the optimal capital income tax rate.*

Suppose that $\gamma^1 = \gamma^2 = \gamma$. A rise in γ leads to higher consumption in the competitive equilibrium (without taxes and transfers). Thus, the optimal consumption tax rate increases: $\partial\,\tau_c/\partial\,\gamma = (\beta+\delta)/[[1-\rho(1-b)]\,\delta(1-\gamma)^2] > 0$. Moreover, a rise in γ also leads to a lower optimal tax rate on capital income: $\partial\,\tau_k/\partial\,\gamma = -[1-\rho(1-b)]\,\beta/(\beta+\delta) < 0$. For the tax program with differentiated consumption tax rates it was shown that an increase in γ lowers the optimal tax ratio τ_{c^2}/τ_{c^1}. Here, in this tax program, $\tau_{c^1} = \tau_{c^2} = \tau_c$. Thus, effective taxation on consumption of the old generation needs to be lowered as γ rises. This is achieved by lowering the capital income tax τ_k. Therefore,

---

uniform consumption tax rates in practice. How should one stop young people from buying for old people (arbitrage)?

[5] Arbitrage can be ruled out for this equivalent tax program, as labor income tax rates can easily be set on an individual level, e.g., according to age. In particular, consider a uniform consumption tax rate τ_c plus a tax on labor income, τ_w, in (10). Set τ_c equal to τ_{c^1}, and set $\tau_w = \beta\, c^2/(R\, w\, \delta)$. Then, the tax program with the uniform consumption tax τ_c plus the tax on labor income τ_w is equivalent to the program with age-conditioned consumption tax rates.

an increase in the desire for status shifts the tax burden from capital income to consumption.

Consider an increase in γ^1 *or* in γ^2 with the other status parameter held constant. Then the consumption tax rate rises by less compared to the case where both γ^1 and γ^2 rise by the same amount: $(\partial\,\tau_c/\partial\,\gamma^i - \partial\,\tau_c/\partial\,\gamma)|_{\gamma^1=\gamma^2=\gamma} = -(\beta+\delta)/[2\,[1-\rho(1-b)]\,\delta(1-\gamma)^2] < 0$. The optimal consumption tax rate rises by less because the status externality is lower compared to the case where both γ^1 *and* γ^2 rise. As τ_c rises by less, the optimal capital income tax rate declines by less: $(|\partial\,\tau_k/\partial\,\gamma^i| - |\partial\,\tau_k/\partial\,\gamma|)|_{\gamma^1=\gamma^2=\gamma} = -[1-\rho(1-b)]\,\beta/[2(\beta+\delta)] < 0$.

4 Conclusions

The present paper investigates optimal tax schemes in the presence of two consumption externalities. On the one hand consumption degrades the environment. On the other hand, as households exhibit a desire for (consumption) status, consumption of one household lowers utility of all other households. The paper shows that both a consumption tax program with a higher tax rate for old-age consumption and a consumption tax plus interest income tax program internalize the externalities. An increase in the desire for status first, raises consumption tax rates, second, lowers the extent by which the optimal consumption tax rates differ, and third, lowers the optimal tax rate on capital income.

The discussion presented here is related to the literature on double dividends (see Goulder 1995) by the fact that the tax programs offer an additional dividend. Reducing the environmental externality also reduces the status externality ("third dividend"). However, there is no swap of environmental taxes for distortionary taxes. Thus the tax programs discussed here do not reduce the distortionary cost of an existing tax system (second dividend). Whether the "third dividend" suffices to support the claim of an "Intermediate Form" or "Strong Form" (Goulder 1995) of double (triple) dividend, however, clearly is a question of future research.

Appendix: The Social Optimum Reconsidered

The Discounted Optimum. Let the social planner discount future generations' utilities by a social discount factor $0 < \rho < 1$. Then the planner optimization problem is:

$$\max_{\{c_t^1, c_t^2, k_t, m_t, E_t\}} \mathcal{L} = \sum_{t=-1}^{\infty} \rho^t \{u(\hat{c}_t^1,\, \hat{c}_{t+1}^2,\, E_{t+1}) + \lambda_t\,(f(k_t) - k_{t+1} - c_t^1 - c_t^2 - m_t)$$
$$+\mu_t\,(E_{t+1} - (1-b)E_t + \beta(c_t^1 + c_t^2) - \delta\, m_t)\}\,,$$
$$\text{where } c_{-1}^1,\, c_{-1}^2,\, m_{-1},\, k_{-1},\, k_0,\, E_0 \text{ are exogenously given}\,.$$

Consider $\partial\,\mathcal{L}/\partial\, k_{t+1} = 0$, and insert λ_t and λ_{t+1} from $\partial\,\mathcal{L}/\partial\, m_t = 0$ and $\partial\,\mathcal{L}/\partial\, m_{t+1} = 0$. This gives μ_t as a function of μ_{t+1}. Next, Consider $\partial\,\mathcal{L}/\partial\, E_{t+1} = 0$, and insert μ_t. The resulting equation together with the first order conditions $\partial\,\mathcal{L}/\partial\, k_t = 0$, $\mathcal{L}/\partial\, m_t = 0$, and $\mathcal{L}/\partial\, E_t = 0$ give:

$$\lambda_t = -\frac{\delta\, f'(k_{t+1})\, u_3(\hat{c}_t^1,\, \hat{c}_{t+1}^2,\, E_{t+1})}{1 - b - f'(k_{t+1})}\,, \quad \lambda_{t+1} = \frac{\lambda_t}{\rho\, f'(k_{t+1})} \tag{16}$$

$$\mu_t = \frac{f'(k_{t+1})\, u_3(\hat{c}_t^1,\, \hat{c}_{t+1}^2,\, E_{t+1})}{1 - b - f'(k_{t+1})}\,, \quad \mu_{t+1} = \frac{\mu_t}{\rho\, f'(k_{t+1})}\,. \tag{17}$$

From (16) it follows:

$$\frac{u_3(\hat{c}_{t+1}^1,\, \hat{c}_{t+2}^2,\, E_{t+2})}{u_3(\hat{c}_t^1,\, \hat{c}_{t+1}^2,\, E_{t+1})} = \frac{1 - b - f'(k_{t+2})}{\rho\, f'(k_{t+2})[1 - b - f'(k_{t+1})]}\,. \tag{18}$$

The remaining intertemporal first order conditions follow from $\partial\,\mathcal{L}/\partial\, c_t^1 = 0$, and $\partial\,\mathcal{L}/\partial\, c_t^2 = 0$ by taking (16) and (17) into account.

In a steady state (18) becomes: $f'(k) = 1/\rho$. By setting $k_t = k$, and $E_t = E$, the remaining steady state conditions (5) to (9) follow immediately.

The Undiscounted Optimum. Let the social planner treat all generations symmetrically: $\rho = 1$. Then (4) is no longer bounded, and social welfare is evaluated according to the *long-run average criterion*:

$$W' = \lim_{T\to\infty} \frac{1}{T} \sum_{t=0}^{T-1} U_t\,. \tag{19}$$

Dutta (1991, p.75) shows in Theorem 3 that as $\rho \to 1$ the limit of the solution to the social planner's problem with $\rho < 1$ equals the solution to the social planner's problem when $\rho = 1$ (long-run average problem) whenever "value-boundedness" in Dutta's (1991) sense (which holds in the present case) holds.

For this reason, we find the first order conditions simply by setting $\rho = 1$ in (5) to (9), and the social planner chooses c^1, c^2, m, k, E such that the following conditions hold:

$$u_1(\hat{c}^1,\, \hat{c}^2,\, E) = u_2(\hat{c}^1,\, \hat{c}^2,\, E) = \frac{2(\beta+\delta)}{b(2-\gamma^1-\gamma^2)}\, u_3(\hat{c}^1,\, \hat{c}^2,\, E)\,,$$
$$f'(k) = 1\,,$$
$$f(k) = c^1 + c^2 + k + m\,,$$
$$E = -\beta\,(c^1+c^2)/b + \delta\, m/b\,.$$

References

[1] Dutta, P.K. (1991) "What do Discounted Optima Converge to?: A Theory of Discount Rate Asymptotics in Economic Models" *Journal of Economic Theory* **55**, 64–94.

[2] Erosa, A. and M. Gervais (2002) "Optimal Taxation in Life-Cycle Economies" *Journal of Economic Theory* **105**, 338–369.

[3] Goulder, L.H. (1995) "Environmental Taxation and the 'Double Dividend:' A Reader's Guide" *International Tax and Public Finance* **2**(2), 157–183.

[4] Howarth, R.B. (1996) "Status Effects and Environmental Externalities" *Ecological Economics* **16**, 25–34.

[5] John, A. and R. Pecchenino (1994) "An Overlapping Generations Model of Growth and the Environment" *The Economic Journal* **10**, 1393–1410.

[6] Ljungqvist, L. and H. Uhlig (2000) "Tax Policy and Aggregate Demand Management Under Catching Up with the Joneses" *American Economic Review* **90**, 356–366.

[7] Ng, Y.K. and J. Wang (1993) "Relative Income, Aspiration, Environmental Quality, Individual and Political Myopia: Why may the Rat Race for Material Growth be Welfare-reducing?" *Mathematical Social Sciences* **26**, 3–23.

[8] Ono, T. (1996) "Optimal Tax Schemes and the Environmental Externality" *Economics Letters* **53**, 283–289.

[9] Ono, T. (2002) "Is Habitual Consumption Harmful to the Environment?" *Economics Bulletin* **17** (1), 1–10.