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Income and Emission Taxation in a Model of Economic Development, Population Growth and the Environment*

Von Burkhard Heer

1. Introduction

Population Growth and degradation of the environment are known to be two of the most serious problems of mankind. Population pressure significantly contributes to environmental deterioration as natural resources are used more intensively. However, the literature on economic growth and environment assumes population either to be constant or to grow at a constant exogenous rate. The empirical evidence, though, suggests that fertility depends on income and other variables like the wage rate or female education [see Wahl (1985), Barro/Lee (1994), Schultz (1989) and (1994), Rosenzweig (1990) or Wang et al. (1994)]. The model set up in this paper studies the interdependence between population, economic growth and the environment and takes the empirical results on fertility into account. For this reason, the fertility decision of the household is endogenous. Fertility decreases with higher wages and higher education as suggested by the empirical studies. There are two external effects on the environment in the market equilibrium. First, firms do not internalize the environmental damage caused by production. Second, households do not consider that having more children puts higher pressure on the natural ressources and the environment.

Recently, the trade-off between environmental care and economic growth has received increasing interest in the academic literature. The intertemporal allocation of resources and accumulation of capital is studied either in an OLG model or in a Ramsey model. If environmental damage is caused by the use of physical capital in production and a larger stock of capital leads to higher pollution, environmental care necessitates a higher social interest rate. Therefore, the optimal capital intensity and consumption levels are lower in the Ramsey model with

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exogenous economic progress, while the socially optimal growth rate is unaffected.[1] In the elementary 'Ak'-model with endogenous growth as described by Rebelo (1991), increasing preferences for the environment, however, reduce the optimal growth rate which depends positively on the rate of interest [Gradus/Smulders (1993)]. If human capital accumulation is the engine of growth, on the contrary, the optimal growth rate might even be higher. The reason is simple. Higher environmental care does not affect the human capital accumulation directly. If there is any effect on the growth rate, it is through the environment's impact on individuals' learning abilities. If less pollution makes learning a more productive activity, the growth rate, of course, increases with higher concern for the environment.

In recent policy proposals on tax reforms, the 'double dividend hypothesis' has been discussed lively and has received increasing public attention. The double dividend hypothesis states that the substitution of environmental taxes for income taxes yields two dividends. The first dividend is a cleaner environment. The second dividend is a less distortionary tax system.[2] If the double dividend hypothesis holds, the implications for fiscal policies are straightforward: Income taxes should be reduced while pollution taxes should be increased. If the double dividend hypothesis does not hold, instead, policy recommendations are hard to formulate as the welfare gain from a cleaner environment has to be estimated explicitly. Bovenberg/van der Ploeg (1994) and Bovenberg/de Mooij (1994) find that environmental taxes typically render the tax system less efficient. For this reason, they study a second-best general equilibrium model where the government has to finance its spendings by distortionary taxes and cannot rely on lump-sum taxation. In their model, labour income decreases as environmental taxes are increased. As a consequence, the labour income tax base is reduced and tax revenues from labor income might fall by more than the revenues generated by the environmental tax. As a consequence, the government might have to raise the labour tax rate increasing the distortions in the economy.

In this paper, economic development and environmental quality are studied in a model of endogenous growth. Human capital accumulation is the engine of growth. The population is growing at an endogenous rate and intensifies the pressure on the environment. The impact of labour income taxation and emission taxation on the population, the economic growth rate and the environment is analyzed for a market equilibrium. As a result, a rise in both tax rates increases population growth and reduces economic growth. The effect on the environment depends on the size of the government sector. However, one might not preclude that a higher environmental tax will improve the environment only in the short run but not in the long run. Furthermore, the double dividend hypothesis is

1 An extensive overview on how pollution can be integrated in the standard Ramsey model is provided by van der Ploeg and Whithagen (1991).

2 For the various definitions of the double dividend hypothesis that exist in the academic literature the reader is referred to Goulder (1994).

examined for a growing economy. It is shown that switching to environmental taxes does give a second dividend, i.e. the economic growth rate increases while population growth declines.

The paper is organized as follows. In section 2, the model of economic development and the environment is introduced. In section 3, the equilibrium and steady state conditions are derived. Furthermore, existence and stability of the growth equilibrium are established. The effects of income and emission taxation are studied in section 4. In particular, the double dividend hypothesis is proven. Section 5 concludes.

2. *The Model*

I will consider a simple extension of the standard overlapping generations model à la Diamond (1965) to an endogenous growth model. Growth depends on time people spend on human capital accumulation similar to Lucas (1988). There are three sectors in the economy: the households, the firms and the government sector. Households maximize their utility which is a function of consumption, environmental pollution and the number of children. Firms maximize profits and produce output with the help of labour and capital. Further, production is assumed to have a polluting effect on environmental quality. This negative effect on household's utility is not internalized by the firm owners. The government collects revenues from taxes on labour income and on emissions by the firms. The tax revenues are transferred to the households as a lump sum.

2.1 *Households*

The economy consists of N_t identical individuals born at time t. Individuals live two periods. They work in the first period of their life earning the wage rate w_t and retire in the second period of their life. An individual born at time t consumes c_{1t} when he is young and c_{2t+1} when he is old. Therefore, part of the first-period income is saved in order to finance the second-period consumption.

The number of households N_t is growing at the rate $n_t - 1$, $N_{t+1} = n_t N_t$. Utility is a function of the number of children n_t.[3] As a simple justification of this assumption, parents might derive pleasure from their children. Alternatively, children can be interpreted as a necessary input into home production. E.g., children in rural areas of developing countries might collect firewood, fetch water or graze cattle [Dasgupta (1992), Dasgupta (1994)]. As a consequence, children do increase parents' utility by allowing for a higher comsumption of home goods. For simplicity, it is assumed that utility from children does only depend on the

3 For empirical evidence on the endogenity of the fertility decision, the reader is referred to Wang et al. (1994).

number of children n_t and not on the quality of the children like in Becker/Barro (1989) or Becker et al. (1990). Utility is also a function of the pollution level P_t and P_{t+1} in the two periods of life. For analytical convenience, utility is assumed to be additive in its arguments:

$$(1) \qquad u_t = \ln c_{1t} + \frac{1}{1+\theta} \ln c_{2t+1} + \phi \ln n_t + \upsilon(P_t, P_{t+1}),\ \phi,\theta > 0,\ \upsilon' < 0.$$

The parameter θ denotes the subjective discount rate, and $\upsilon(.,.)$ denotes the disutility from pollution in period t and $t+1$. Parents are non-altruistic and, consequently, do not account for the utility of their children.

The households face two kinds of constraints: a time constraint and a budget constraint. Each individual is endowed with one unit of time in each period. When young, the household can either work, raise children or spend time on learning activities. The time necessary for raising the children increases with the number of children n_t. Each child takes κ units of time.[4] The household can also allocate time h_t on learning activities which will determine her human capital H_t. The remaining time, $1 - \kappa n_t - h_t$, is supplied as labour. The household also faces a budget constraint as she cannot spend more than her income:

$$(2) \qquad (1-\tau)(1-\kappa n_t - h_t) H_t w_t + T_t = c_{1t} + \frac{c_{2t+1}}{1+r_{t+1}}.$$

Her gross wage income is given by the product of the wage rate w_t, her working time, $1 - \kappa n_t - h_t$, and her human capital H_t. The tax rate on labour income is denoted by τ. The household also receives transfers from the government at the amount of T_t. The income is spent on her intertemporal consumption $\{c_{1t}, c_{2t+1}\}$. The consumption in the second period c_{2t+1} is financed from savings s_t which receive interest at the rate r_{t+1}: $c_{2t+1} = (1 + r_{t+1})s_t$.

As is obvious from (2), children generate opportunity costs proportional to the wage income of the parents. The higher the fertility n_t of households, the more time people spend raising the children foregoing income. There are no goods' costs of children in this model. This assumption is only justified for medium- to high-income countries. In the early stage of development, consumption per child is an important cost component to the parents. E.g., parents have to provide food and clothing to the children. Thus, for very poor countries, fertility might increase initially with rising income. For medium- and high-income countries, the time costs of children are more important to the households' fertility decision and, consequently, fertility is a negative function of income. According to empirical findings of Barro/Sala-I-Martin (1995), the latter countries are characterized by

4 The functional form of the time spent on raising children, κn_t, need not be linear for the theoretical results of this paper to hold but only increasing in the number of children n_t. It is merely assumed in order to derive closed-form solutions for the endogenous variables.

a GDP per capita exceeding $ 800 (in 1985 US dollars). The model concentrates on the medium- and high-income countries where time opportunity costs of children are the predominant determinant of the fertility decision. The countries who display a negative correlation of fertility and income also represent the majority of countries worldwide.

2.2 *Human Capital Accumulation*

In recent contributions to the theory of endogenous growth, human capital accumulation has been emphasized as a major engine of growth, e.g. Lucas (1988), Lucas (1990), and Grüner/Heer (1994). Empirical support for the hypothesis that knowledge is a major contribution to growth has been provided by Adams (1990), Barro (1991) or Levine/Renelt (1992) among others. In this kind of model, the time people spend on accumulating human capital determines the economic growth rate. The following model builds on the work of Lucas (1988). It is assumed that human capital depends on the learning effort of an individual and is produced with constant returns to scale. In particular, human capital H_t is accumulated according to:

$$H_t = (Ah_t + 1)H_{t-1}, \tag{3}$$

where A denotes the productivity of the individual's learning effort.[5]

2.3 *Production*

Firms act competitively and use labour L_t and physical capital K_t as inputs into production of the good Y_t. Labour L_t is measured in efficiency units and is the product of the working time, the number of people and their human capital, $L_t \equiv (1 - \kappa n_t - h_t)H_t N_t$. Production uses the public good environment as an input, e.g. in the form of water or air. The use of the natural resource is assumed to cause proportional costs to the producer at the amount of δ. For example, the firm might have to pump the water to the plant or build a stack in order to dispose of the polluted air. In addition, the government raises a tax π on emissions P_t.[6] Firms can use labour and capital for abatement activities and, this way, reduce

5 According to equation (3), human capital is produced only with labour but not with capital. Alternatively, one could include physical capital as a second factor of production in (3). However, this would not change the results as long as the production of human capital is relatively intensive in human capital compared to the production of goods. Further, allowing for depreciation of the human capital stock H_t does not change the qualitative results either as long as people spend nonnegative time on learning, $h_t > 0$.

6 π might be interpreted in many ways. E.g., in many developing countries, the use of energy is subsidized by the government. A cut in energy subsidises is equivalent to a rise in π.

emissions P_t. Of course, allocating more labour and capital to the reduction of pollution decreases the use of these inputs in the production of the output good Y_t. As a consequence, labour L_t, capital K_t and the emission of pollutants P_t are substitutes in production.[7] For analytical convenience, suppose that the production function of output Y_t is Cobb-Douglas:

$$(4) \qquad Y_t = F(K_t, L_t, P_t), = K_t^{\alpha} P_t^{\beta} L_t^{1-\alpha-\beta},$$

or

$$(5) \qquad y_t = k_t^{\alpha} p_t^{\beta}, \quad \text{with} \quad y_t \equiv \frac{Y_t}{L_t}, p_t \equiv \frac{P_t}{L_t}, k_t \equiv \frac{K_t}{L_t}.$$

Firms maximize profits so that factors are rewarded with their marginal products. The marginal product of labour, measured in efficiency units, equals the wage rate w_t, the one of capital equals the interest rate r_t, and the one of pollutants is equal to the sum of the emission tax rate π and the pollution costs δ:

$$(6) \qquad w_t = (1 - \alpha - \beta) k_t^{\alpha} p_t^{\alpha},$$

$$(7) \qquad \pi + \delta = \beta k_t^{\alpha} p_t^{\beta - 1},$$

$$(8) \qquad r_t = \alpha k_t^{\alpha - 1} p_t^{\beta}.$$

2.4 Government

The government receives income from the emission tax, πP_t, and the income tax, $\tau(1 - \kappa n_t - h_t) w_t H_t N_t$. The government budget is balanced in all periods and tax revenues are transferred to the households lump-sum:

$$(9) \qquad T_t = \tau(1 - \kappa n_t - h_t) w_t H_t + \pi \frac{P_t}{N_t}.$$

Let ψ_t denote the size of the government sector in period t and be defined as total government revenues in relation to total output, $\psi_t \equiv \frac{T_t N_t}{Y_t}$. With the help of (5), (6) and (7), the governmental size ψ_t can be expressed as a function of the two tax rates τ and π:

$$(10) \qquad \psi(\tau, \pi) = \tau(1 - \alpha - \beta) + \pi \frac{\beta}{\pi + \delta}.$$

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7 Likewise, high pollution might indicate inefficient use of energy. If, for example, an engine is not burning fuel efficiently because the machine is of low quality (K_t is small), the emission of pollutants P_t is high.

3. Steady State

In equilibrium, factor markets clear and the factor prices equal their respective marginal products as given by (6)–(8). The households maximize their utility (1) subject to their time and budget constraint (2) and their human capital (3). The first-order conditions are given by:

$$\text{(11)} \qquad \frac{c_{1t}}{c_{2t+1}} = \frac{1+\theta}{1+r_{t+1}},$$

$$\text{(12)} \qquad n_t = \frac{\phi}{\kappa} \frac{c_{1t}}{(1-\tau)w_t H_t},$$

$$\text{(13)} \qquad h_t = \frac{1}{2} - \frac{1}{2A} - \frac{\kappa n_t}{2}.$$

The necessary conditions (11)–(13) are easy to interpret. The optimal intertemporal consumption allocation is given by (11). The marginal rate of substitution equals one plus the interest rate. Further, the marginal utility from having more children, ϕ/n_t, equals the opportunity costs of raising children, $\kappa(1-\tau)w_t H_t/c_{1t}$. Finally, according to (13), the individual allocates her time on learning h_t in order to maximize her income as given in (2). Her intertemporal consumption allocation (11) together with the budget constraint (2) and the government transfers (9) imply savings s_t:

$$\text{(14)} \qquad s_t = \frac{1}{2+\theta}\left[1-\alpha-\beta+\pi\frac{\beta}{\pi+\delta}\right]\left(\frac{\beta}{\pi+\delta}\right)^{\frac{\beta}{1-\beta}}(1-\kappa n_t - h_t)H_t k_t^{\frac{\alpha}{1-\beta}}.$$

In capital market equilibrium, savings equal investments:

$$\text{(15)} \qquad s_t N_t = K_{t+1}.$$

The first-order conditions (11)–(13), the factor market equilibrium (6)–(8), and the capital market equilibrium (15) can be solved to give a difference equation system in the three endogenous variables n_t, k_t and h_t, which completely describe the dynamics of the economy:

$$\text{(16)} \qquad n_t = \frac{\frac{1}{2}+\frac{1}{2A}}{\kappa\left(\frac{1}{2}+\frac{1-\tau}{\phi}\frac{2+\theta}{1+\theta}\frac{1-\alpha-\beta}{1-\alpha-\beta+\pi\frac{\beta}{\pi+\delta}}\right)},$$

(17) $$h_t = \frac{1}{2} - \frac{1}{2A} - \frac{\kappa n_t}{2},$$

(18) $$k_{t+1} = \frac{1}{2+\theta} \frac{(1-\kappa n_t - h_t)(1-\alpha-\beta+\pi\frac{\beta}{\pi+\delta})}{(1-\kappa n_{t+1} - h_{t+1})(Ah_{t+1}+1)n_t} \left(\frac{\beta}{\pi+\delta}\right)^{\frac{\beta}{1-\beta}} k_t^{\frac{\alpha}{1-\beta}}.$$

A steady state is characterized by a constant capital intensity k, a constant population growth rate n and a stationary time allocation. As a consequence, the economic growth rate of per capita output g equals the growth rate of human capital, and is constant, too:

(19) $$g \equiv \frac{K_{t+1}/N_{t+1}}{K_t/N_t} = \frac{Y_{t+1}/N_{t+1}}{Y_t/N_t} = Ah + 1.$$

Notice that capital K_t, effective labour L_t, and production Y_t all grow at the same rate. In a market equilibrium, firms do not internalize the negative external effect of production on individuals' utility such that total pollution P_t will also grow at the same rate as output Y_t:

(20) $$g_P \equiv \frac{P_{t+1}}{P_t} = (Ah+1)n.$$

As is evident from equations (16)–(18), a steady state (n, h, k) characterized by non-negative growth of per-capita output, $g > 0$, exists if and only if the productivity of the education sector is sufficiently large:

(21) $$A > 1 + \frac{\phi}{1-\tau} \frac{1+\theta}{2+\theta} \cdot \frac{1-\alpha-\beta+\pi\frac{\beta}{\pi+\delta}}{1-\alpha-\beta}.$$

Accordingly, for a large government sector ψ, and, therefore, high tax rates τ and π, the productivity of the education sector A has to increase in order to ensure human capital accumulation to take place. In the following, condition (21) is assumed to hold.
Besides the existence of the steady state, one also has to check for its stability in order to get meaningful results. The following proposition establishes local stability.

Proposition 1: Local Stability
The steady state, characterized by $k_t = k$, $n_t = n$ and $h_t = h$ for all periods t, is locally stable.
Proof: According to (16) and (17), fertility n_t and time spent on learning activities h_t instantaneously take their steady state values n and h, respectively. For local stability, thus, a sufficient and necessary condition is given by $|dk_{t+1}/dk_t| < 1$,

where the derivative is evaluated at the steady state (n, h, k). It is easy to see from (18) that this condition is equivalent to $\alpha+\beta<1$ for $k_{t+1}=k_t=k$. However, this is the case for the production function (4).

4. *Steady State Responses to Tax Changes*

In this simple model, a change in the two tax rates affects the decision of the representative household and the firms. The mechanism is the same for both tax rates. Increasing the income tax rate τ decreases the opportunity costs of children and, in this section, it is shown that higher income taxation increases fertility and reduces growth. Similarly, following higher emission taxation, firms decrease the use of natural resources in production and P_t declines relative to K_t and L_t. As a consequence, the marginal product of labour as given by (6) is reduced, and economic growth will decline, too. The growth rate of pollutants as given by (20) may either decline or increase depending on the size of the government sector ψ. The result is stated in proposition 2. In this section, a differential tax incidence analysis is also effectuated. The reduction of labour income taxes accompanied by an equivalent increase in pollution taxation is proven to increase economic growth giving support to the double dividend hypothesis. This result is stated in proposition 3.

Proposition 2

A rise in the income tax rate τ or the emission tax rate π reduces economic growth g and increases population growth n in the steady state. The growth rate of pollution g_P increases if and only if

$$\text{(22)}\qquad \frac{1+\theta}{2+\theta}\frac{\phi}{2}\frac{1}{1-\tau}\frac{1-\alpha-\beta+\pi\frac{\beta}{\theta+\delta}}{1-\alpha-\beta}<1.$$

Proof: With (16) and $n_t=n$, $\frac{\partial n}{\partial \tau}>0$ and $\frac{\partial n}{\partial \pi}$.
Together with $h_t=h$ and equation (17), this also implies $\frac{\partial h}{\partial \tau}<0$ and $\frac{\partial h}{\partial \pi}$. As the growth rate of output per capita is given by (19), economic growth declines as well. Finally, condition (22) implies

$$\text{(23)}\qquad \frac{dg_P}{d\tau}=(Ah+1)\frac{dn}{d\tau}+An\frac{dh}{d\tau}>0.$$

Similarly, $\frac{dg_P}{d\pi}>0$ if (22) holds.

The second result of proposition 2 is rather surprising. Taxing pollution might eventually harm the environment. The reason is the endogenity of the fertility decision. If the emission tax rate π increases, economic growth decreases as people spend less time learning. In this simple model, less economic growth corresponds to less pollution for constant population growth rate n as the pollution growth rate $g_P = (Ah + 1)n$ goes down. However, as the opportunity costs of children decreases as well, fertility n increases and this effect might even dominate the output reduction effect if condition (22) holds.

Of particular importance, of course, is the question how an increase of the emission tax combined with an equivalent decrease in the income tax does affect growth and the environment. As a higher pollution tax rate π decreases the growth rate g while a lower income tax rate τ increases the growth rate g, the net effect on economic growth is a priori unclear. Proposition 3 summarizes the results from this differential tax incidence analysis.

Proposition 3

For a constant size of the government sector ψ, an increase of the emission tax rate π combined with a reduction in the income tax rate τ increases economic growth and also decreases population growth. It positively affects the environment, i.e. the growth rate of pollutants g_P decreases, if and only if condition (22) holds.

Proof: In order to keep the government size ψ constant in the steady state, an increase of π has to be offset by a decrease in income taxation:

$$(24) \qquad \frac{d\tau}{d\pi} = -\frac{\beta\delta}{(\pi + \delta)^2(1 - \alpha - \beta)}.$$

It is easy to show from (16) that $\frac{dn}{d\pi} < 0$ for constant ψ. Similarly, human capital accumulation h and the growth rate g increase.

$\frac{dn}{d\pi} < 0$ and $g_P = (Ah + 1)n = (\frac{A+1-\kappa n}{2})n$ further imply that $\frac{dg_P}{d\pi} < 0$ if (22) holds.

So far, n has denoted the number of children. The result of propositions 2 and 3 can also be interpreted in a different way. Assume population N_t to be constant. For $\kappa = 1$, let n denote the leisure time. In this case, individuals derive utility as given by (1) from leisure rather than from children. An increase in the two tax rates reduces the opportunity costs of leisure as the wage rate w_t falls. As a consequence, both labour supply and time spent on learning decrease. Thus, if labour supply is endogenous both taxes reduce growth even for countries characterized by a small elasticity of fertility with regard to income. Furthermore, proposition 3 implies that the double dividend also holds in the case of endogenous labour supply. In the present model, a switch from income taxation to emission taxation which keeps the government size constant increases growth unambigously.

5. Conclusion

I have described a model with endogenous growth. The environment is a public good which is used as an input into production. Growth is stimulated by the accumulation of human capital. Endogenizing the household's fertility decision provided interesting and surprising results. In accordance with other models of endogenous growth like Barro (1990) or Barro/Sala-I-Martin (1992), income taxation is found to reduce the growth rate, even though the mechanism is a different one. Similar results are derived for an emission tax. Emission taxation, even though it has a positive level effect on the environmental quality, is likely to increase the rate of pollution growth and, hence, might even be disadvantageous to the environment in the long run. As a second result, I showed that, for given size of the government sector, a switch from income to emission taxation increases the growth rate confirming the double dividend hypothesis.

The results have to be interpreted carefully since my analysis disregarded any governmental expenditures on the environment. Also, pollution is caused by the production of the firms only and not by consumption. However, the purpose of my analysis only was to illustrate one potential adverse effect of emission and income taxation, namely that a reduction in the wage rate net of taxes implies higher population growth and, hence, less economic growth. The extent of this effect, of course, depends on the sensitivity of the fertility decison on income which is an empirical question. Accordingly, my results emphasize the necessity to combine fiscal policy with population policies in developing countries. A reduction of labour income should be compensated for by alternative policy measures in order to reduce population growth, e.g. with the help of family planning programs or female and male education programs. In particular, the opportunity costs of women's time in childbearing should be increased.

Finally, I would like to mention another caveat of my analysis regarding the effects of income and emission taxation. In the real world, the input factor labour is not homogenous as assumed in this paper. One might distinguish skilled and unskilled labour. Furthermore, I did not account for technical progress. An emission tax will give incentives to intensify research in abatement technologies and will promote environmental technical progress. The higher research effort will increase demand for skilled labour endowed with high human capital. Consequently, the wage of skilled workers will rise relatively to the wage of the unskilled workers and, as a consequence, individuals will try to acquire more skills and to build up more human capital. This growth-enhancing effect of emission taxation will not occur in the case of income taxation.[8]

In conclusion, two directions of future research on economic development and the environment seem worth mentioning to me. First, one might analyze a general

8 Bovenberg/Smulders (1995) incorporate pollution-augmenting technological change in a model of economic growth and establish that higher pollution taxes increase long-run growth.

equilibrium model of endogenous growth with two kinds of technical progress, one environmental and one labour-augmenting. On the one hand, the government might engage or subsidize abatement activities and environmental technical progress. On the other hand, a private research & development sector might engage in innovative activites like in Grossman/Helpman (1991) or Aghion/Howitt (1992). Of course, a fundamental problem of such an analysis would consist in specifying the positive external effects of knowledge flowing between the two reserarch sectors. Second, utility, in this paper, is assumed to depend exclusively on the number of children and not the 'quality' of the children. Utility could be modelled as a function of both the number of children and the human capital per child, thus introducing an additional trade-off between population growth and economic growth. Similar to the analysis of Becker et al. (1990), one might end up with the possibility of a poverty trap characterized by high growth rates of both population and pollution.

Zusammenfassung

Der Einfluß einer Einkommens- und Umweltbesteuerung auf die wirtschafliche Entwicklung und die Umwelt wird für das Konkurrenzgleichgewicht eines endogenen Wachstumsmodells untersucht. Wachstum wird durch die Akkumulation von Humankapital hervorgerufen, und die Fertilitätsentscheidung der Haushalte erfolgt endogen. Unter der Annahme, daß die Erziehung der Kinder Zeit benötigt und vom Lohn abhängige Opportunitätskosten beinhaltet, erhöhen sowohl eine Lohnsteuer als auch eine Umweltsteuer das Bevölkerungswachstum und beeinträchtigen das Wirtschaftswachstum. Eine aufkommensneutrale Senkung der Einkommensteuer bei gleichzeitiger Erhöhung der Umweltsteuer erhöht die Wachstumsrate des Sozialproduktes und bestätigt die *,Double-Dividend' Hypothese.*

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