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CONSUMPTION AND LEISURE EXTERNALITIES, ECONOMIC GROWTH AND EQUILIBRIUM EFFICIENCY*

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Abstract.

This paper analyzes the effects of consumption and leisure externalities on growth and welfare in a two-sector endogenous growth model with human capital accumulation. Both types of externalities are shown to affect the long-run equilibrium and optimal growth rates in a rather different way. The relationship between the steady state of the market and the centrally planned economy is also analyzed. The optimal growth path can be decentralized by resorting to consumption or labor income taxation, whereas capital income should be untaxed. Numerical simulations suggest that growth and welfare effects of mild consumption and leisure externalities may be quantitatively important.

Keywords: Endogenous growth, Optimal policy, Externalities, Leisure.

JEL Classification Numbers: O41, E62.

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1. Introduction

Several authors have considered the presence of externalities in endogenous growth models with human capital accumulation. A partial list includes Lucas (1988), Chamley (1993), Benhabib and Perli (1994), Benhabib et al. (2000), Mino (2001) and Gómez (2004). Nonetheless, their attention has been restricted to the possibility that the technology at the level of the aggregate economy may differ from the technology faced at the individual level, what can be categorized as production externalities. However, other types of external effects affecting the individual utility are also conceivable. Actually, consumption externalities have been widely considered in the literature. For example, Abel (1990) and Galí (1994) study the effects on asset pricing; Carroll et al. (1997, 2000) and Álvarez-Cuadrado et al. (2004) examine the dynamics of the AK and the neoclassical growth models with consumption externalities and habit formation; and Dupor and Liu (2003) define different forms of consumption externalities and explore their relationship with equilibrium over-consumption.

In contrast, leisure externalities have been largely ignored. However, they are entirely plausible as well since it can be argued that the satisfaction we get from our free time usually depends on sharing leisure activities with others. Indeed, many activities are impossible without others. Thus, time spent in social interaction and entertainment (e.g., visiting friends, eating out), and some active leisure activities (e.g., playing sports) and passive leisure activities (e.g., talking on phone) that involve other people represent a high fraction of total leisure time (e.g., Juster and Stafford, 1991). Hamermesh (2002), for USA, Hallberg (2003), for Sweden, and Jenkins and Osberg (2005), for Great Britain, report evidence that couples arrange their work schedules to allow time for leisure that they consume jointly. Costa (2000) argues that the compression in the length of the work day distribution over the last century could be partly explained by the increasing co-ordination of work activities within and across firms and by the increasing synchronization of leisure time activities with those of relatives and friends. Jenkins and Osberg (2005) also report estimates indicating that propensities to engage in associative activity depend on the availability of suitable leisure companions outside the household. This evidence suggests that an increase in the average leisure hours of everyone else may have a positive external effect on the marginal utility of each person's leisure.

This paper analyzes the effects on growth and welfare of externalities affecting both consumption and leisure in a two-sector endogenous growth with human capital accumulation. Agents derive utility both from consumption and leisure, and individual preferences are subject to spillovers from average consumption and average leisure. In the presence of externalities, optimal growth paths and competitive equilibrium paths may not coincide. Thus, we analyze the efficiency of the competitive equilibrium and design a tax policy capable of decentralizing the optimal growth path. Numerical results are presented to illustrate the magnitude of the growth and welfare effects involved by the externalities, and the optimal taxes needed to correct for the distortions that they may cause.

Related work has been recently made. García-Castrillo and Sanso (2000) and Gómez (2003, 2005) devise optimal fiscal policies in the Lucas (1988) model with production externalities. However, they do not examine the effect of utility externalities arising from consumption and leisure, and labor supply is assumed to be inelastic. Although a number of authors have analyzed the equilibrium efficiency in models with consumption externalities, the analysis has been mostly confined to the Ramsey exogenous growth model or the simplest one-sector endogenous growth model. Ljungqvist and Uhlig (2000) consider a model without capital accumulation. Fisher and Hof (2000), Alonso-Carrera et al. (2004), and Liu and Turnovsky (2005) analyze a Ramsey model, and Alonso-Carrera et al. (2005), a one-sector endogenous growth model. Furthermore, most of these works consider that labor supply is inelastic, an even when labor supply is assumed to be endogenous, as in Ljungqvist and Uhlig

(2000) and Liu and Turnovsky (2005), none of these works consider the presence of external effects associated to leisure.

Externalities affect the long-run equilibrium and optimal growth rates in a rather different way. In the market economy, consumption externalities affect long-run growth through their impact on the effective elasticity of intertemporal substitution. This measure, introduced by Fisher and Hof (2000), modifies the usual definition of the elasticity of intertemporal substitution to take account of the impact of consumption externalities. Intuitively, the lower (higher) is the effective elasticity intertemporal of substitution, the less (more) willing are agents to substitute intertemporally so that the more (less) consumption is shifted from the future to the present, and so, the lower (higher) is the long-run equilibrium growth rate. We show that a positive consumption externality has a negative (positive) impact on the effective elasticity of intertemporal substitution if the standard elasticity of intertemporal substitution is lower (greater) than unity, and so, has a negative (positive) impact on the long-run growth rate. These effects should be reversed for the case of a negative externality.

In the centrally planned economy, there are instead two channels through which consumption externalities may affect long-run growth: the impact on the effective elasticity of intertemporal substitution, as in the market economy, and the impact on the efficient marginal rate of substitution between consumption and leisure, which is absent in the market economy. Intuitively, a positive (negative) consumption externality decreases (increases) the efficient marginal rate of substitution between consumption and leisure, which has a negative (positive) effect on leisure and, therefore, a positive (negative) effect on growth. We show that if the standard elasticity of intertemporal substitution is greater than unity, positive (negative) consumption externalities have a positive (negative) impact on the long-run optimal growth rate through both channels. However, if the standard elasticity of intertemporal substitution is lower than unity, both channels may have opposite signs, and therefore, the overall effect on growth is ambiguous. The effect on the marginal rate of substitution between consumption and leisure is also the channel through which leisure externalities affect long-run growth in the centrally planned economy. A positive (negative) leisure externality affects adversely (positively) the long-run optimal growth rate, because it increases (decreases) the efficient marginal rate of substitution between consumption and leisure and, therefore, increases (decreases) the long-run value of time devoted to leisure activities. This channel is absent in the market economy, and so, leisure externalities do not affect the long-run equilibrium growth rate.

We also analyze the relationship between the steady state of the market and the centrally planned economies. If the elasticity of average consumption is higher (lower) than the elasticity of average leisure time in utility, the long-run equilibrium growth and interest rates are lower (higher) than their long-run optimal values, and the long-run equilibrium leisure value is higher (lower) than its long-run optimal value. The intuition is simple: The efficient marginal rate of substitution between consumption and leisure would be lower (higher) than the competitive one.

If the elasticities of average consumption and average leisure in utility coincide, the competitive equilibrium is efficient both at the steady state and off the steady state. Otherwise, the competitive equilibrium is inefficient because of the divergence between the competitive and the efficient marginal rates of substitution between consumption and leisure. There is a degree of arbitrariness in the tax policy designed to decentralize the optimal growth path as it can be achieved by taxing (or subsidizing) consumption or labor income, whereas capital income should be kept free of taxation. The numerical simulations performed suggest that the effects of mild consumption and leisure externalities on growth and welfare may be quantitatively important.

This paper is organized as follows. Section 2 presents the model. Section 3 analyzes the equilibrium dynamics of the decentralized economy, and Section 4, the optimal growth path attainable by a central planner. Section 5 compares the steady state of the decentralized and the centrally planned economies. Section 6 devises a tax policy capable of decentralizing the optimal growth path. Section 7 presents some numerical results. Section 8 concludes.

2. The model

Consider an economy populated by a large number of identical infinitely-lived representative agents who derive utility from the consumption of a private consumption good, c, and leisure time, l. For simplicity, we assume that population is constant and normalized to one. The intertemporal utility derived by the agent is represented by

$$\int_0^\infty \mathrm{e}^{-\rho t} U(c, C, l, L) dt, \tag{1a}$$

where the instantaneous utility function is

$$U(c, C, l, L) = \frac{(cC^\mu (l L^\psi)^\eta)^{1-\sigma} - 1}{1-\sigma} \qquad \rho > 0,\ \sigma > 0. \tag{1b}$$

Here, $1/\sigma$ is the elasticity of intertemporal substitution (EIS), and ρ, the rate of time preference. The term C is the average consumption, and expresses externalities in utility arising from consumption. Following Dupor and Liu (2003), we may say that the utility function exhibits jealousy if $\mu < 0$, and admiration if $\mu > 0$ when other agents' consumption increases. When $\mu < 0$ agents are jealous because average consumption reduces agent's utility for a given level of own consumption. When $\mu > 0$ agents are admiring since average consumption increases agent's utility for a given level of own consumption. The term L is the average level of leisure in the economy at large, and expresses externalities in utility associated to leisure. If $\psi < 0$, then average leisure reduces agent's utility for a given level of own leisure, and so, it has a negative external effect on utility. If $\psi > 0$, average leisure has a positive external effect. We impose the conditions $\mu + 1 > 0$, $\psi + 1 > 0$ and $\sigma + \mu(\sigma - 1) > 0$, that mean that either the externality augments the direct effect, or it is dominated by the own effect.[1] Following Fisher and Hof (2000), we define

$$\varepsilon = 1/(\sigma + \mu(\sigma - 1))$$

as the "effective" elasticity of intertemporal substitution (effective EIS).

The agent is endowed with one unit of time per period which can be allocated to work, u, learning, z, or leisure, l. The time constraint is then

$$1 = u + z + l \,. \tag{2}$$

Human capital, h, is accumulated according to the dynamic equation

$$\dot{h} = \delta(zh) \qquad \delta > 0 \,. \tag{3}$$

The rate of return on physical capital is denoted r, and the wage rate, w. The government taxes physical capital income at a constant rate τ_k, labor income at a constant rate τ_h, and consumption at a constant rate τ_c. The income raised is rebated to the consumers as lump-sum transfers, s. In absence of depreciation of physical capital, the agent's budget constraint is

$$\dot{k} = (1 - \tau_k) rk + (1 - \tau_h) wuh - (1 + \tau_c) c + s \,. \tag{4}$$

Output, y, is produced with the constant returns-to-scale Cobb-Douglas technology

$$y = F(k, uh) = A k^{\alpha} (uh)^{1-\alpha} \qquad A > 0, \quad 0 < \alpha < 1 \,. \tag{5}$$

Profit maximization by competitive firms implies that labor and capital are used up to the point at which marginal product equates marginal cost:

$$r = \alpha y / k \,, \tag{6a}$$

$$w = (1 - \alpha) y / (uh) \,. \tag{6b}$$

We shall assume that the government runs a balanced-budget:

$$\tau_k rk + \tau_h wuh + \tau_c c = s \,. \tag{7}$$

[1] This is similar to assumption 1 in Liu and Turnovsky (2005).

Following Ladrón-de-Guevara et al. (1999), we also impose the condition[2]

$$\delta(1+\mu)(\sigma-1)+\rho>0\,. \tag{8}$$

Throughout the paper, U_x and F_x will denote the partial derivative of U and F, respectively, with respect to the variable x.

3. The decentralized economy

A competitive equilibrium for this economy is defined as a set of market-clearing prices and quantities such that i) the consumer's choice of c, k, h, u, z and l maximizes (1) subject to the constraints (2), (3) and (4), given the initial endowments of physical capital, k_0, and human capital, h_0, and taking as given the path of factor returns and fiscal policy variables; ii) the firm's choice of physical capital, k, and effective labor, uh, maximizes profits, and iii) the government obeys its budget constraint (7).

Let J be the current value Hamiltonian of the household's optimization problem, and let λ and θ be the multipliers for the constraints (4) and (3), respectively:

$$J=\frac{(cC^{\mu}(l\,L^{\psi})^{\eta})^{1-\sigma}-1}{1-\sigma}+\lambda\,((1-\tau_k)rk+(1-\tau_h)wuh-(1+\tau_c)c+s\,)+\theta\,\delta\,(1-u-l)h\ ,$$

where (2) has been used to substitute z for $1 - u - l$ and eliminate it from the problem.

The first-order conditions for an interior optimum are

$$\partial J/\partial c=c^{-\sigma}C^{\mu(1-\sigma)}l^{(1-\sigma)\eta}L^{(1-\sigma)\eta\psi}-(1+\tau_c)\lambda=0\,, \tag{9a}$$

$$\partial J/\partial u=\lambda(1-\tau_h)wh-\theta\delta h=0\,, \tag{9b}$$

$$\partial J/\partial l=\eta\, c^{1-\sigma}C^{\mu(1-\sigma)}l^{(1-\sigma)\eta-1}L^{(1-\sigma)\eta\psi}-\theta\delta h=0\,, \tag{9c}$$

$$\dot{\lambda}=(\rho-(1-\tau_k)r)\lambda\,, \tag{9d}$$

$$\dot{\theta}=(\rho-\delta(1-u-l))\theta-\lambda(1-\tau_h)wu\,, \tag{9e}$$

[2] This is similar to the transversality condition imposed in Uzawa (1965) (see also Caballé and Santos, 1993).

plus the transversality condition

$$\lim_{t\to\infty} \lambda k e^{-\rho t} = \lim_{t\to\infty} \theta h e^{-\rho t} = 0 . \tag{9f}$$

Hereafter, let $\gamma_x = \dot{x}/x$ denote the growth rate of the variable *x*. In what follows, the symmetry conditions $C=c$ and $L=l$ will be imposed, and the expressions (6a)-(6b) for *r* and *w* will be taken into account. We shall express the dynamics of the economy in terms of the variables *r*, *l* and $q=c/k$, which are constant in the steady state.

From (9a), (9b) and (9c), we can derive the following expression for *u*:

$$u(r,q,l) = \frac{(1-\alpha)(1-\tau_h)rl}{\alpha\eta(1+\tau_c)q} . \tag{10}$$

Using (9a) and (9e), we can obtain

$$\gamma_\theta = \rho - \delta(1-l) . \tag{11}$$

Log-differentiating (9a), and using (9d), we find the Euler equation:

$$-(\sigma + \mu(\sigma-1))\gamma_c + \eta(1-\sigma)(1+\psi)\gamma_l = \rho - (1-\tau_k)r . \tag{12}$$

Denoting $\zeta = \lambda/\theta$, (9d) and (11) imply that

$$\gamma_\zeta = \delta(1-l) - (1-\tau_k)r . \tag{13}$$

Log-differentiating (6a) and (9b) we obtain, respectively,

$$\gamma_r = (1-\alpha)(\gamma_u + \gamma_h - \gamma_k) , \tag{14}$$

$$\gamma_\zeta = \alpha(\gamma_u + \gamma_h - \gamma_k) . \tag{15}$$

Using (6a), (6b) and (7), the overall resources constraint (4) can be expressed as

$$\gamma_k = y/k - c/k = r/\alpha - q . \tag{16}$$

The growth rate of human capital (3) can be rewritten as

$$\gamma_h = \delta(1-u-l) . \tag{17}$$

Log-differentiating $q=c/k$ and (10) with respect to time yields, respectively,

$$\gamma_q = \gamma_c - \gamma_k . \tag{18}$$

$$\gamma_u = \gamma_l + \gamma_r - \gamma_q . \tag{19}$$

Solving the system (12)-(19) for γ_u, γ_ζ, γ_c, γ_k, γ_h, γ_r, γ_q and γ_l, we find, in particular, the system that drives the dynamics of the market economy in terms of r, q and l:

$$\gamma_r = -\frac{1-\alpha}{\alpha}((1-\tau_k)r - \delta(1-l)) , \tag{20a}$$

$$\gamma_q = (1-\tau_k)r - \frac{1}{\alpha}r - \frac{(1+\mu)(\sigma-1)(1-\tau_k)r + \delta(\sigma-1)\eta(1+\psi)u(r,q,l) + \rho}{\sigma + (\mu+\eta(1+\psi))(\sigma-1)} + q \ , \tag{20b}$$

$$\gamma_l = \frac{(1-\sigma)(1+\mu)(1-\tau_k)r + \delta(\sigma+\mu(\sigma-1))u(r,q,l) - \rho}{\sigma + (\mu+\eta(1+\psi))(\sigma-1)} , \tag{20c}$$

where $u(r,q,l)$ is given by (10).

A hat "^" over a variable will denote its steady-state value in the market economy.[3] The steady state can be computed as follows.[4] Equating (13) to zero, we get that at the steady state

$$(1-\tau_k)r = \delta(1-l) . \tag{21}$$

Since $\gamma_l = 0$ at the steady state, (12) entails that the long-run growth rate, γ, is given by

$$\gamma = \varepsilon((1-\tau_k)r - \rho) = \delta(1-u-l) , \tag{22}$$

where the last equality follows from (17). Using (21) to eliminate r from (22), we find the following expression for the work time, u:

$$u = g_D(l) = 1 - l - \frac{\varepsilon(\delta(1-l)-\rho)}{\delta} = \frac{\delta(1+\mu)(\sigma-1)(1-l)+\rho}{\delta(\sigma+\mu(\sigma-1))} . \tag{23}$$

The long-run growth rate can also be expressed, recalling (16) and (17), as

$$\gamma = r/\alpha - q = \delta(1-u-l) . \tag{24}$$

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[3] Ladrón-de-Guevara et al. (1999) show that there exists the possibility of multiple balanced growth paths, and conclude that it seems difficult to state a set of necessary and sufficient conditions for this possibility to occur. We address to this reference for a detailed analysis of the dynamics of this class of models.

[4] We follow a procedure similar to that used by De Hek (forthcoming) to examine the growth effects of taxes.

Using (10) and (21) to eliminate q and r from (24), we find that the work time, u, has to satisfy the quadratic equation

$$au^2 + bu + d = 0\,, \tag{25}$$

with the coefficients $d = (1-\alpha)(1-\tau_h)(1-l)l > 0$, $b = -(1-(1-\tau_k)\alpha)\eta(1+\tau_c)(1-l) < 0$, and $a = -\alpha(1-\tau_k)(1+\tau_c)\eta < 0$. Since $d > 0$ and $a < 0$, the discriminant $\Delta_D = b^2 - 4ad$ is positive:

$$\Delta_D = \eta(1+\tau_c)(1-l)\,[(1-(1-\tau_k)\alpha)^2\eta(1+\tau_c)(1-l) + 4\alpha(1-\alpha)(1-\tau_k)(1-\tau_h)l\,] > 0\,. \tag{26}$$

Hence, (25) has two real solutions, one positive and one negative. The positive one is

$$u = f_D(l) = \frac{-(1-(1-\tau_k)\alpha)\eta(1+\tau_c)(1-l) + \Delta_D^{1/2}}{2\alpha(1-\tau_k)(1+\tau_c)\eta}\,. \tag{27}$$

The steady state values of l and u are obtained from the intersection of the functions $g_D(l)$ defined by (23) and $f_D(l)$ defined by (27). In order to the steady state be feasible, it must also be satisfied that $z = 1-u-l > 0$; i.e., the solution must lie below the line $u = p(l) = 1-l$.

The function $g_D(l)$ is linear, with $g_D(0) = \varepsilon(\delta(1+\mu)(\sigma-1)+\rho)/\delta > 0$ from (8), and $g_D(1) = \varepsilon\rho/\delta > 0$. Since $f''_D(l) = -2(1-\tau_k)(1-\tau_h)^2(1+\tau_c)(1-\alpha)^2\alpha\eta/\Delta_D^{3/2} < 0$, the function $f_D(l)$ is strictly concave, with $f_D(0) = 0$ and $f_D(1) = 0$. As a strictly concave function has at most two intersections with a convex function, there exist at most two solutions to the equation $f_D(l) = g_D(l)$. We shall assume that there exists one feasible interior steady state $\hat{l} \in (0,1)$ such that $0 < \hat{u} = f_D(\hat{l}) = g_D(\hat{l}) < 1$ and $0 < \hat{z} = 1-\hat{u}-\hat{l} < 1$. Eqs. (21) and (10) entail that $\hat{r} > 0$ and $\hat{q} > 0$, and so, the steady state is feasible.[5] The transversality condition (9f) can be easily shown to be satisfied as well. Using (21) and (22), the long-run growth rate of

[5] It should be noted that, since $\lim_{l\uparrow 1} f'_D(l) = -\infty < -1 = p'(1)$, if there are two interior solutions $0 < \hat{l}_1 < \hat{l}_2 < 1$ to the equation $f_D(l) = g_D(l)$ with $0 < \hat{u}_1 = f_D(\hat{l}_1) < 1$ and $0 < \hat{u}_2 = f_D(\hat{l}_2) < 1$, and one of them is not feasible because the constraint $z = 1-u-l > 0$ is violated, the unfeasible solution must be the one associated with the greatest value of leisure time, $\hat{l}_2$.

output, physical and human capital, and consumption is

$$\hat{\gamma} = \delta(1-\hat{u}-\hat{l}) = \varepsilon(\delta(1-\hat{l})-\rho) = \hat{\gamma}_k = \hat{\gamma}_h = \hat{\gamma}_c = \hat{\gamma}_y \,. \tag{28}$$

Eq. (28) shows that long-run growth and long-run leisure are negatively related. As Milesi-Ferretti and Roubini (1998) argue, the fraction of human capital corresponding to the fraction of time devoted to leisure activities is unemployed, and the less (more) human capital is unemployed the higher (lower) are the incentives to accumulate human capital.

The effect of consumption externalities on the long-run growth rate can be deducted by differentiating totally the equation $f_D(l)-g_D(l)=0$ with respect to μ and evaluating at $l=\hat{l}$, which yields

$$(f_D'(\hat{l})-g_D'(\hat{l}))\frac{\partial \hat{l}}{\partial \mu}+\frac{\partial f_D(\hat{l})}{\partial \mu}-\frac{\partial g_D(\hat{l})}{\partial \mu}=(f_D'(\hat{l})-g_D'(\hat{l}))\frac{\partial \hat{l}}{\partial \mu}+\frac{(\delta(1-\hat{l})-\rho)}{\delta}\frac{\partial \varepsilon}{\partial \mu}=0\,.$$

Thus, we obtain

$$\frac{\partial \hat{l}}{\partial \mu}=-\frac{(\delta(1-\hat{l})-\rho)}{\delta(f_D'(\hat{l})-g_D'(\hat{l}))}\frac{\partial \varepsilon}{\partial \mu}=\frac{(\sigma-1)\hat{\gamma}}{\delta(\sigma+\mu(\sigma-1))(f_D'(\hat{l})-g_D'(\hat{l}))}, \tag{29}$$

where it has been used that $\partial\varepsilon/\partial\mu=-(\sigma-1)/(\sigma+\mu(\sigma-1))^2$.

Differentiating (28) with respect to μ and evaluating at $l=\hat{l}$, we get

$$\frac{\partial \hat{\gamma}}{\partial \mu}=-\varepsilon\,\delta\,\frac{\partial \hat{l}}{\partial \mu}+(\delta(1-\hat{l})-\rho)\frac{\partial \varepsilon}{\partial \mu}=-\frac{\delta}{\sigma+\mu(\sigma-1)}\frac{\partial \hat{l}}{\partial \mu}-\frac{(\sigma-1)\hat{\gamma}}{\sigma+\mu(\sigma-1)}\,. \tag{30}$$

If there is a unique interior steady state, since $g_D(0)>0=f_D(0)$, $g_D(l)$ intersects $f_D(l)$ from above, implying that $f_D'(\hat{l})-g_D'(\hat{l})>0$. Examination of (29) and (30) shows that three cases may arise. If $\sigma>1$, then $\partial\hat{l}/\partial\mu>0$ and $\partial\hat{\gamma}/\partial\mu<0$, and so, an increase in the elasticity of average consumption in utility, μ, provokes an increase in leisure time and a decrease in the long-run growth rate. If $\sigma<1$, then $\partial\hat{l}/\partial\mu<0$ and $\partial\hat{\gamma}/\partial\mu>0$, and so, an increase in the elasticity of average consumption in utility, μ, provokes a decrease in leisure time and an increase in the long-run growth rate. If $\sigma=1$, then $\partial\hat{l}/\partial\mu=\partial\hat{\gamma}/\partial\mu=0$, and so, consumption externalities do not affect the long-run equilibrium.

Eq. (30) shows that consumption externalities have a direct effect on the growth rate through their impact on the effective EIS, ε, and an indirect effect through their impact on long-run leisure which, in turn, is affected by the impact on the effective EIS (see Eq. (29)). Intuitively, the lower is the effective EIS, the more anxious are agents to smooth their consumption over time and, therefore, the more consumption is shifted from the future to the present. As a consequence, the long-run leisure increases, and so, both the direct and the indirect effect have an adverse impact on the long-run growth rate. As (29) and (30) show, both the direct and the indirect effect have the same sign, which depends on consumption externalities provoking an increase or a decrease in the effective EIS which, in turn, depends on the standard EIS being higher or lower than unity. If $\sigma > 1$ (i.e., EIS < 1), the higher is μ, the lower is the effective EIS, and therefore, the higher is long-run leisure and the lower is the long-run growth rate. If $\sigma < 1$ (i.e., EIS > 1), the effects are reversed: the higher is μ, the higher is the effective EIS and, therefore, the lower is long-run leisure and the higher is the long-run growth rate. If $\sigma = 1$ (i.e., EIS = 1), consumption externalities do not affect the long-run equilibrium: the effective EIS remains constant.[6]

Differentiating totally the equation $f_D(l)-g_D(l)=0$ and (28) with respect to ψ, and evaluating at $l=\hat{l}$, since (23) and (27) do not depend on ψ, we find that

$$\partial\hat{\gamma}/\partial\psi = \partial\hat{l}/\partial\psi = 0. \tag{31}$$

Hence, leisure externalities do not affect the steady state of the market economy, and so,

[6] If there were two feasible interior solutions $0<\hat{l}_1<\hat{l}_2<1$, the effects just discussed would be applicable to the one associated with the lowest leisure time, $\hat{l}_1$. For the steady state associated with the greatest leisure time, $\hat{l}_2$, $g_D(l)$ intersects $f_D(l)$ from below, implying that $f'_D(\hat{l}_2)-g'_D(\hat{l}_2)<0$ and, therefore, the sign of the effects discussed above should be reversed.

economies with different degrees of leisure externalities will display the same long-run equilibrium values.[7] Using the previous results, we can state the following Proposition.

Proposition 1. *Let a unique interior steady state exist.*

i) A positive (negative) consumption externality causes a decrease (increase) in the long-run growth rate of the market economy if $\sigma > 1$ (i.e., EIS < 1); causes an increase (decrease) in the long-run growth rate if $\sigma < 1$ (i.e., EIS > 1), and does not affect the long-run equilibrium if $\sigma = 1$ (i.e., EIS = 1).

ii) Leisure externalities do not affect the steady state of the market economy.

4. The centrally planned economy

The central planner possesses complete information and chooses all quantities directly, taking all the relevant information into account. She maximizes (1) subject to (2), (3) and

$$\dot{k} = F(k,uh) = Ak^{\alpha}(uh)^{1-\alpha} - c\,. \tag{32}$$

Let $\bar{J}$ be the current value Hamiltonian of the planner's problem, and let $\bar{\lambda}$ and $\bar{\theta}$ be the multipliers for the constraints (32) and (3), respectively:

$$\bar{J} = \frac{(c^{1+\mu} l^{\eta(1+\psi)})^{1-\sigma} - 1}{1-\sigma} + \bar{\lambda}\,(Ak^{\alpha}(uh)^{1-\alpha} - c) + \bar{\theta}\delta(1-u-l)h\ ,$$

where (2) has been used to substitute z for $1 - u - l$ and eliminate it from the problem.

The first-order necessary conditions for an interior solution are

$$\partial\bar{J}/\partial c = (1+\mu)c^{-\sigma+\mu(1-\sigma)} l^{(1-\sigma)\eta(1+\psi)} - \bar{\lambda} = 0\,, \tag{33a}$$

$$\partial\bar{J}/\partial u = \bar{\lambda}(1-\alpha)Ak^{\alpha}u^{-\alpha}h^{1-\alpha} - \bar{\theta}\delta h = 0\,, \tag{33b}$$

$$\partial\bar{J}/\partial l = \eta(1+\psi)c^{(1+\mu)(1-\sigma)} l^{(1-\sigma)\eta(1+\psi)-1} - \bar{\theta}\delta h = 0\,, \tag{33c}$$

[7] Leisure externalities do affect the transition path of the variables as it results evident from the examination of the dynamic system (20a)-(20c).

$$\dot{\bar{\lambda}} = (\rho - \alpha A k^{\alpha-1} (uh)^{1-\alpha}) \bar{\lambda} \,, \tag{33d}$$

$$\dot{\bar{\theta}} = (\rho - \delta(1-u-l))\bar{\theta} - \bar{\lambda}(1-\alpha) A k^{\alpha} u^{1-\alpha} h^{-\alpha} \,, \tag{33e}$$

plus the usual transversality condition.

Recalling that $r = \alpha A k^{\alpha-1}(uh)^{1-\alpha}$, (33d) can be expressed as

$$\gamma_{\bar{\lambda}} = \rho - r \,, \tag{34}$$

and using (33e) and (33b), we can obtain

$$\gamma_{\bar{\theta}} = \rho - \delta(1-l) \,. \tag{35}$$

Proceeding in the same manner as in the case of the market economy, we can express the dynamics of the centrally planned economy in terms of the variables *r*, *q*, and *l*, which are constant in the steady state:

$$\gamma_r = -\frac{1-\alpha}{\alpha}(r - \delta(1-l)) \,. \tag{36a}$$

$$\gamma_q = r - \frac{1}{\alpha} r - \frac{(1+\mu)(\sigma-1) r + \delta(\sigma-1)\eta(1+\psi) u(r,q,l) + \rho}{\sigma + (\mu + \eta(1+\psi))(\sigma-1)} + q \,, \tag{36b}$$

$$\gamma_l = \frac{(1-\sigma)(1+\mu) r + \delta(\sigma + \mu(\sigma-1)) u(r,q,l) - \rho}{\sigma + (\mu + \eta(1+\psi))(\sigma-1)} \,, \tag{36c}$$

where $u(r,q,l)$ is given by

$$u(r,q,l) = \frac{(1-\alpha)(1+\mu) r}{\alpha\eta(1+\psi) q} l \,. \tag{37}$$

A bar "¯" over a variable will denote its steady-state value in the centrally planned economy.[8] Proceeding in the same manner as in the case of the decentralized economy, we find that at the steady state the following condition, identical to (23), must be satisfied:

$$u = g_C(l) = 1 - l - \frac{\varepsilon(\delta(1-l) - \rho)}{\delta} = \frac{\delta(1+\mu)(\sigma-1)(1-l) + \rho}{\delta(\sigma + \mu(\sigma-1))} \,. \tag{38}$$

[8] As in the case of the market economy (see fn. 3), we address to Ladrón-de-Guevara et al. (1999) for a detailed analysis of the equilibrium dynamics of this class of models.

The work time, u, also has to satisfy the quadratic equation $au^2+bu+d=0$, where $d=(1-\alpha)(1+\mu)(1-l)l/(1+\psi)>0$, $b=-(1-\alpha)\eta(1-l)<0$, and $a=-\alpha\eta<0$, so that the discriminant is positive:

$$\Delta_C=b^2-4ad=(1-\alpha)\eta(1-l)\left((1-\alpha)\eta(1-l)+\frac{4\alpha(1+\mu)l}{1+\psi}\right)>0. \tag{39}$$

Now, the positive root is given by

$$u=f_C(l)=\frac{-(1-\alpha)\eta(1-l)+\Delta_C^{1/2}}{2\alpha\eta}. \tag{40}$$

It can be easily shown that $f_C(l)$ is strictly concave, with $f_C(0)=0$ and $f_C(1)=0$. Hence, there exist at most two solutions to the equation $f_C(l)=g_C(l)$. Again, we shall assume that there exists one feasible interior steady state $\bar{l}\in(0,1)$ such that $0<\bar{u}=f_C(\bar{l})=g_C(\bar{l})<1$ and $0<\bar{z}=1-\bar{u}-\bar{l}<1$. Eqs. (16) and (21) entail that $\bar{r}>0$ and $\bar{q}>0$, and so, the steady state is feasible.[9] The transversality condition can be easily shown to be satisfied as well. The long-run growth rate is

$$\bar{\gamma}=\delta(1-\bar{u}-\bar{l})=\varepsilon(\delta(1-\bar{l})-\rho)=\bar{\gamma}_y=\bar{\gamma}_k=\bar{\gamma}_h=\bar{\gamma}_c. \tag{41}$$

The effect of consumption externalities on the long-run growth rate can be obtained by differentiating totally the equation $f_C(l)-g_C(l)=0$ with respect to μ and evaluating at $l=\bar{l}$, which yields

$$(f_C'(\bar{l})-g_C'(\bar{l}))\frac{\partial\bar{l}}{\partial\mu}=\frac{\partial g_C(\bar{l})}{\partial\mu}-\frac{\partial f_C(\bar{l})}{\partial\mu}=-\frac{(\delta(1-\bar{l})-\rho)}{\delta}\frac{\partial\varepsilon}{\partial\mu}-\frac{(1-\alpha)(1-\bar{l})\bar{l}}{(1+\psi)\Delta_C^{1/2}}, \tag{42a}$$

which, using that $\partial\varepsilon/\partial\mu=-(\sigma-1)/(\sigma+\mu(\sigma-1))^2$, entails that

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[9] As discussed for the case of the market economy (see fn. 5), since $\lim_{l\uparrow1} f_C'(l)=-\infty<-1=p'(1)$, if there are two interior solutions $0<\bar{l}_1<\bar{l}_2<1$, and one of them is not feasible because the constraint $z=1-u-l>0$ is violated, the unfeasible solution must be the one associated with the greatest value of leisure time, $\bar{l}_2$.

$$\frac{\partial \bar{l}}{\partial \mu} = \frac{1}{f_C'(\bar{l}) - g_C'(\bar{l})} \left(\frac{(\sigma-1)\bar{\gamma}}{\delta(\sigma+\mu(\sigma-1))} - \frac{(1-\alpha)(1-\bar{l})\bar{l}}{(1+\psi)\Delta_C^{1/2}} \right), \tag{42b}$$

where Δ_C is also evaluated at $l=\bar{l}$. Differentiating (41) with respect to μ, we get

$$\frac{\partial \bar{\gamma}}{\partial \mu} = -\frac{\delta}{\sigma+\mu(\sigma-1)} \frac{\partial \bar{l}}{\partial \mu} + (\delta(1-\bar{l}) - \rho) \frac{\partial \varepsilon}{\partial \mu} = -\frac{\delta}{\sigma+\mu(\sigma-1)} \frac{\partial \bar{l}}{\partial \mu} - \frac{(\sigma-1)\bar{\gamma}}{\sigma+\mu(\sigma-1)}. \tag{43}$$

If there is a unique interior steady state, since $g_C(0) > 0 = f_C(0)$, $g_C(l)$ intersects $f_C(l)$ from above, implying that $f_C'(\bar{l}) - g_C'(\bar{l}) > 0$. Now, if $\sigma > 1$, the two right-hand side terms in expression (42b) have opposite signs and, therefore, the sign of $\partial \bar{l}/\partial \mu$ is ambiguous. If it turns out to be non negative, $\partial \bar{l}/\partial \mu \geq 0$, then (43) entails that $\partial \bar{\gamma}/\partial \mu < 0$. However, if $\partial \bar{l}/\partial \mu < 0$, then (43) shows that the sign of $\partial \bar{\gamma}/\partial \mu$ is ambiguous.[10] If $\sigma \leq 1$, then $\partial \bar{l}/\partial \mu < 0$ and $\partial \bar{\gamma}/\partial \mu > 0$. Hence, an increase in the elasticity of average consumption in utility causes a decrease in long-run leisure time and an increase in the long-run growth rate.[11]

The effect of leisure externalities can be deducted by differentiating totally the equation $f_C(l) - g_C(l) = 0$ with respect to ψ, and evaluating at $l = \bar{l}$, which yields

$$(f_C'(\bar{l}) - g_C'(\bar{l})) \frac{\partial \bar{l}}{\partial \psi} = \frac{\partial g_C(\bar{l})}{\partial \psi} - \frac{\partial f_C(\bar{l})}{\partial \psi} = \frac{(1-\alpha)(1+\mu)(1-\bar{l})\bar{l}}{(1+\psi)^2 \Delta_C^{1/2}}. \tag{44}$$

Differentiating (41) with respect to ψ, we get

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[10] For example, Section 7 shows a calibration for which increasing μ increases the long-run optimal growth rate (see Table 2). Considering, for instance, the parameter values $A = 1$, $\alpha = 0.4$, $\delta = 0.25$, $\sigma = 3$, $\eta = 1$, $\rho = 0.02$, $\psi = 0$ and $\mu = 0$, the long-run optimal growth rate is $\bar{\gamma} = 0.0336$. Increasing μ to 0.1 reduces the long-run optimal growth rate to $\bar{\gamma} = 0.0328$, and increasing μ to 0.2, reduces long-run growth further to $\bar{\gamma} = 0.0320$.

[11] If there were two (feasible) interior solutions $0 < \bar{l}_1 < \bar{l}_2 < 1$, the effects just discussed would be applicable to the one associated with the lowest leisure time, $\bar{l}_1$. For the steady state associated with the greatest leisure time, $\bar{l}_2$, $g_C(l)$ intersects $f_C(l)$ from below, implying that $f_C'(\bar{l}_2) - g_C'(\bar{l}_2) < 0$ and, therefore, the sign of the effects discussed above should be reversed.

$$\frac{\partial \bar{\gamma}}{\partial \psi} = -\frac{\delta}{\sigma + \mu(\sigma - 1)} \frac{\partial \bar{l}}{\partial \psi}. \tag{45}$$

Hence, an increase in the elasticity of average leisure in utility causes an increase in leisure time, $\partial \bar{l} / \partial \psi > 0$, and a subsequent reduction in the long-run growth rate, $\partial \bar{\gamma} / \partial \psi < 0$. Using the former results, we can state the following Proposition.

Proposition 2. *Let a unique interior steady state exist.*

i) A positive (negative) consumption externality causes an increase (decrease) in the long-run optimal growth rate if $\sigma \leq 1$ (i.e., EIS ≥ 1), whereas its effect is ambiguous if $\sigma > 1$ (i.e., EIS < 1).

ii) A positive (negative) leisure externality causes a decrease (increase) in the long-run optimal growth rate.

These results differ markedly from those obtained for the marked economy summarized in Proposition 1. In the market economy, using (9a)-(9c) to eliminate λ, the competitive marginal rate of substitution (MRS) between consumption and leisure satisfies that

$$\frac{U_l}{U_c} = \frac{(1-\tau_h)}{1+\tau_c} F_{uh} h, \tag{46a}$$

This condition is not affected by the presence of externalities. In contrast, using (33a)-(33c), the efficient MRS satisfies that

$$\frac{U_l + U_L}{U_c + U_C} = F_{uh} h, \tag{46b}$$

which is affected by both consumption and leisure externalities.

As in the market economy, Eq. (43) shows that consumption externalities have a direct effect on the growth rate through their impact on the effective EIS, and an indirect effect through their impact on leisure. In the centrally planned, there are two channels through which consumption externalities may affect long-run leisure: the impact on the effective EIS, as in the market economy, and the impact on the (efficient) MRS between consumption and leisure, which is absent in the market economy. These two channels are reflected in (42a). The total effect would be the sum of both partial effects. First, the lower (higher) is the effective EIS, the more (less) anxious are agents to smooth their consumption over time, which has a positive (negative) effect on long-run leisure. Second, the lower (higher) the efficient MRS between consumption and leisure, the lower (higher) is the agent's willingness to substitute consumption for leisure. This has a negative (positive) effect on leisure. Both effects may have the same or opposite signs, and therefore, the overall effect might be ambiguous.

Three cases may arise. If $\sigma > 1$ (i.e., EIS < 1), the higher is μ, the lower is the effective EIS, which has a positive effect on leisure, and the lower is the efficient MRS between consumption and leisure, which has a negative effect on leisure. The overall effect on leisure is ambiguous. If the overall effect on leisure is positive (or zero), both the direct and indirect effects on growth would be negative, and so, the higher is μ, the lower is the long-run growth rate. But, if the overall effect on leisure turns out to be negative, the indirect effect on growth would be positive whereas the direct effect is negative: the overall effect on growth would be ambiguous. If $\sigma < 1$ (i.e., EIS > 1), the higher is μ, the higher is the effective EIS and the lower is the efficient MRS between consumption and leisure, and so, the lower is long-run leisure. Now both the direct and the indirect effect on the growth rate are positive and, therefore, the higher is μ, the higher is the long-run growth rate. If $\sigma = 1$ (i.e., EIS = 1), the higher is μ, although the effective EIS remains constant, the lower is the efficient MRS between consumption and leisure, and so, the lower is long-run leisure. Hence, the indirect channel is operative, and so, the higher is μ, the higher is the long-run growth rate. The effect on the efficient MRS is also the channel through which leisure externalities affect long-run growth in the centrally planned economy. Intuitively, the higher is ψ, the higher is the efficient MRS between consumption and leisure so that the higher is long-run leisure and, therefore, the lower is long-run growth.

5. Comparison of steady state equilibria

This section compares the steady state of the centrally planned economy and the market economy with no government intervention; i.e., with $\tau_k = 0$, $\tau_h = 0$ and $\tau_c = 0$. Comparison of (23) and (38) reveals that $g_C(l) = g_D(l)$, whereas comparing (27) and (40) it can be easily shown that $\text{sgn}\,(f_C(l) - f_D(l)) = \text{sgn}\,(\mu - \psi)$. Thus, if $\mu > \psi$, then $f_C(l) > f_D(l)$, and so, the long-run value of leisure time in the centrally planned economy is lower than its counterpart in the market economy, $\bar{l} < \hat{l}$. If $\mu < \psi$, then $f_C(l) < f_D(l)$, and so, $\bar{l} > \hat{l}$. If $\mu = \psi$, then $f_C(l) = f_D(l)$, and so, $\bar{l} = \hat{l}$. Comparing (28), (21) and (23) with their counterparts in the centrally planned economy (41), $\bar{r} = \delta(1 - \bar{l})$, and (38), respectively, we obtain that

$$\hat{\gamma} - \bar{\gamma} = \varepsilon\,\delta(\bar{l} - \hat{l}),$$

$$\hat{r} - \bar{r} = \delta(\bar{l} - \hat{l}),$$

$$\hat{u} - \bar{u} = \varepsilon(1 + \mu)(\sigma - 1)(\bar{l} - \hat{l}).$$

Hence, we can state the following Proposition.

Proposition 3. *Let a unique interior steady state exist for both the market and the centrally planned economies.*

i) If $\mu > \psi$, the equilibrium leisure is higher than its long-run optimal value ($\bar{l} < \hat{l}$);the equilibrium growth rate and interest rate are lower than their respective long-run optimal values ($\bar{\gamma} > \hat{\gamma}$, $\bar{r} > \hat{r}$), and the equilibrium labor supply is lower than its long-run optimal value ($\bar{u} > \hat{u}$) if $\sigma > 1$, is greater than its long-run optimal value ($\bar{u} < \hat{u}$) if $\sigma < 1$, and is equal to its optimal long-run value ($\bar{u} = \hat{u}$) if $\sigma = 1$.

ii) If $\mu < \psi$, the relationships described in i) should be reversed.

iii) If $\mu = \psi$, the steady state of the market and the centrally planned economies coincide.

If the elasticity of average consumption in utility, μ, is higher (lower) than the elasticity of average leisure time, ψ, the long-run equilibrium growth and interest rates are lower (higher) than their long-run optimal values, and the long-run equilibrium value of leisure time is higher (lower) than its long-run optimal value. The intuition is simple: The efficient MRS between consumption and leisure would be lower (higher) than the competitive one, as can be deducted from (46a) and (46b). If the elasticities of average consumption and average leisure are equal, the efficient and the competitive MRS between consumption and leisure coincide and, therefore, so do the steady state of the decentralized and the centrally planned economies.[12]

6. Optimal tax policy

This section analyzes the efficiency of the competitive equilibrium and, when it is not efficient, designs a tax policy capable of decentralizing the optimal growth path attainable by a central planner. To this end, the tax rates must be chosen so as to the time paths of *c*, *k*, *h*, *l* and *u* in the decentralized economy replicate those of the centrally planned economy.

Comparison of (9a) and (9c) with (33a) and (33c) reveals the decentralization of the optimal growth path requires that $\lambda = a\overline{\lambda}$ and $\theta = b\overline{\theta}$, where *a* and *b* are arbitrary constants; i.e., $\gamma_{\lambda} = \gamma_{\bar{\lambda}}$ and $\gamma_{\theta} = \gamma_{\bar{\theta}}$. Comparing (9d) with its counterpart (34) in the centrally planned economy we find that the return on capital income must be untaxed

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[12] If there were two (feasible) interior solutions for both the market and the centrally planned economies, $0<\hat{l}_1<\hat{l}_2<1$ and $0<\bar{l}_1<\bar{l}_2<1$, respectively, the effects just discussed would be applicable to the ones associated with the lowest leisure time, $\hat{l}_1$ and $\bar{l}_1$. For the steady states associated with the greatest leisure time, $\hat{l}_2$ and $\bar{l}_2$, the sign of the effects discussed above should be reversed (see fns. **¡Error! Marcador no definido.** and 11).

$$\tau_k = 0\,. \tag{47}$$

Eqs. (9a)-(9c) entail that the competitive MRS between consumption and leisure satisfies that (see Eq. (46a))

$$\frac{U_l}{U_c} = \frac{(1-\tau_h)F_{uh}\,h}{1+\tau_c}\,,$$

whereas (33a)-(33c) entail that the efficient MRS satisfies a similar condition (see Eq. (46b)):

$$\frac{U_l + U_L}{U_c + U_C} = F_{uh} h\,.$$

Comparing (46a) and (46b), we can observe that inefficiency may arise because of the divergence between the before-tax MRS of the competitive economy and the corresponding one of the centrally planned economy. Thus, in order to correct for the inefficiency caused by the externalities, consumption and labor income taxes must be set so that

$$\frac{(1+\tau_c)}{(1-\tau_h)}\frac{U_l}{U_c} = \frac{U_l + U_L}{U_c + U_C}\,, \tag{48}$$

or, equivalently,[13,14]

$$(1-\tau_h) = (1+\tau_c)\frac{1+\mu}{1+\psi}\,. \tag{49}$$

The intuition for (49) is simple. If the MRS between consumption and leisure of the decentralized economy evaluated along the optimal growth path is lower than the MRS of the centralized economy, the individuals' willingness to substitute consumption for leisure would be too low. In this case, the optimal growth path can be reached by the market economy through a consumption tax that increases the price of consumption or by means of a tax on labor income that reduces the opportunity cost of leisure. On the contrary, if the MRS of the market economy along the optimal growth path turns out to be larger than that of the

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[13] A similar result has been derived by Liu and Turnovsky (2005) in a Ramsey model without leisure spillovers.

[14] Another way to derive the optimal fiscal policy would be to compute the tax rates such that system (20) that drives the dynamics of the market economy replicates that of the centrally planned economy given by (36).

centralized economy, then consumption or labor income should be subsidized. The MRS of the market and the centralized economies coincide if and only if the elasticities of average consumption and average leisure in utility coincide; i.e., $\mu = \psi$. In this case, the competitive equilibrium is efficient both at the steady state and off the steady state.[15]

Eq. (49) shows that one tax can be arbitrarily chosen, and so, there is a degree of arbitrariness in the optimal tax policy. In particular, this arbitrariness entails that income from physical and human capital could be treated uniformly, i.e., be untaxed. Thus, the market failure caused by externalities could be corrected by resorting to a consumption tax only. When there are no external effects from leisure ($\psi = 0$), the consumption tax, $\tau_c = -\mu/(1+\mu)$, is positive (negative) if utility exhibits jealousy (admiration) about consumption. When there are no consumption externalities ($\mu = 0$), the consumption tax, $\tau_c = \psi$, is positive (negative) if leisure spillovers are positive (negative). Alternatively, a tax on labor income could be used, keeping consumption untaxed. When there are no leisure externalities ($\psi = 0$), a consumption externality may be corrected by taxing (subsidizing) labor income at a rate $\tau_h = -\mu$ when utility exhibits jealousy (admiration) about consumption. When there are no consumption externalities ($\mu = 0$), a positive (negative) leisure externality can be corrected by taxing (subsidizing) labor income at a rate $\tau_h = \psi/(1+\psi)$.

The following Proposition summarizes the former findings.

Proposition 4. *i) The competitive equilibrium is efficient both at the steady state and off the steady state if and only if $\mu = \psi$.*

ii) If $\mu \neq \psi$, the market economy can attain the optimal growth path, both at the steady state and off the steady state, if physical capital income is untaxed and the tax rates on labor

[15] It can be easily shown that the systems (20), with no taxes, and (36) coincide if and only if $\mu = \psi$ (see fn. 14).

income and consumption are set so as to satisfy the condition

$$(1-\tau_h) = (1+\tau_c)\frac{1+\mu}{1+\psi}.$$

7. Some numerical results

This section briefly presents some simulation results to gain some insight on the magnitude of the growth and welfare effects of consumption and leisure externalities, and the optimal taxes needed to correct them. We begin by calibrating the model using the parameters representative of the US economy displayed in Table 1. As a benchmark, we consider an economy with no distortions, so that there are no external effects and no government intervention.

TABLE 1. Parametrization of the model

Predetermined parameters				
A	σ	α	μ	ψ
1	1.5	0.36	0	0
Data to match by the model				
γ	l	u	z	
0.02	0.71	0.17	0.12	
Fiscal policy parameters				
τ_k	τ_h	τ_c		
0	0	0		
Parameters obtained in the calibration				
δ	η	ρ		
0.1667	3.1408	0.0183		

The parameter A is simply normalized to unity. The elasticity of intertemporal substitution, $1/\sigma$, and the elasticity of physical capital in production, α, are standard (e.g., Jones et al., 1993, and Ortigueira, 1998). The remaining parameters, δ, η and ρ, are chosen so as to replicate the long-run growth rate, γ, the work time, u, and the time spent in human capital accumulation, z, which are taken from Jones et al. (1993).

TABLE 2. Long-run equilibrium and optimal growth rates (%)

	ψ					
	–0.2		**0**		**0.2**	
μ	Equilibrium	Optimal	Equilibrium	Optimal	Equilibrium	Optimal
–0.2	2.4082	2.4082	2.4082	1.4566	2.4082	0.6229
0	2.00	2.8130	2.00	2.00	2.00	1.3299
0.2	1.7033	3.0213	1.7033	2.2954	1.7033	1.7033

Table 2 shows the effect of consumption and leisure externalities on long-run growth.[16] The effects of externalities on the long-run equilibrium growth rate of the market economy are in accordance with the theoretical results derived in Section 3: i) the higher is the value of μ (for a constant value of ψ) the lower is the long-run growth rate; and ii) leisure externalities do not affect long-run growth. In a similar manner, the result obtained in Section 4 that the higher is the value of ψ (for a constant value of μ), the lower is the long-run optimal growth rate is also reflected in Table 2. Interestingly, we can observe that consumption externalities have opposite effects on the long-run equilibrium and optimal growth rates. As discussed in

[16] In all the simulations reported, there exists a unique (feasible) interior steady state for both the market and the centrally planned economies.

Section 3, an increase in μ, given that $\sigma > 1$, reduces the effective EIS, and so, causes a decrease in the long-run equilibrium growth rate of the market economy. As shown in Section 4, in the centrally planned economy there is one additional effect to consider, since an increase in μ decreases the MRS between consumption and leisure, which reduces the agent's willingness to substitute consumption for leisure. This has a negative effect on leisure and, therefore, a positive impact on growth. Given the calibration used, this positive effect turns out to be greater than the negative impact through the effective EIS. Hence, the long-run optimal growth increases as μ increases. The results displayed in Table 2 also suggest that the effect of mild utility externalities on long-run growth may be considerable.

TABLE 3. Optimal taxes and welfare gain (%)

	ψ								
	–0.2			**0**			**0.2**		
μ	τ_h	τ_c	κ	τ_h	τ_c	κ	τ_h	τ_c	κ
–0.2	0	0	0	20.0	25.0	3.810	33.33	50.0	14.705
0	–25.0	–20.0	3.410	0	0	0	16.67	20.0	2.800
0.2	–50.0	–33.33	11.909	–20.0	–16.67	2.571	0	0	0

Table 3 reports the value of the optimal labor income tax, τ_h, when consumption is kept untaxed ($\tau_c = 0$), and the optimal value of the consumption tax, τ_c, when labor income is kept untaxed ($\tau_h = 0$), needed to correct the market failure caused by utility externalities. It also reports the welfare gain, κ, of instituting the optimal tax policy, which is measured as the constant permanent percentage increase in consumption that leaves the agent indifferent between remaining in the (pre-tax-reform) competitive long-run equilibrium or undertaking the tax reform that leads to the optimal growth path.[17] Table 3 shows that the taxes (or subsidies) needed to decentralize the optimal growth path may be significant. Furthermore, it suggests that the effect of mild externalities on welfare may be important as well.

8. Conclusions

This paper has analyzed the effects of consumption and leisure externalities on growth and welfare in a two-sector endogenous growth model with human capital accumulation. We have shown that such externalities have rather different effects on the long-run competitive and optimal growth rates. In the market economy, consumption externalities affect long-run growth through their impact on the effective elasticity of intertemporal substitution. In the centrally planned economy, however, consumption externalities also affect long-run growth through their impact on the efficient marginal rate of substitution between consumption and leisure. If the (standard) elasticity of intertemporal substitution is lower than one –the most plausible case from an empirical viewpoint–, we show that a positive (negative) consumption externality affects negatively (positively) the long-run equilibrium growth rate of the market economy, whereas its effect on the long-run optimal growth rate is ambiguous. Leisure externalities affect long-run growth in the centrally planned economy through their impact on the marginal rate of substitution between consumption and leisure. Thus, a positive (negative) leisure externality causes a decrease (increase) in the long-run optimal growth rate. This channel is absent in the market economy, and so, leisure spillovers do not affect the long-run competitive equilibrium.

We have also analyzed the relationship between the long-run competitive equilibrium and the long-run optimal growth path. We showed that the long-run equilibrium growth rate

[17] We explicitly solve for the non-linear transitional dynamics by using the time elimination method (Mulligan and Sala-i-Martín, 1993).

is lower (higher) than the long-run optimal growth rate if the elasticity of average consumption in utility is higher (lower) than the elasticity of average leisure. Intuitively, the reason is that the efficient marginal rate of substitution between consumption and leisure would be lower (higher) than the competitive one. If both elasticities coincide, the efficient and the competitive marginal rates of substitution are equal, and so, the steady state of the market and the centrally planned economies coincide.

The presence of externalities raises the question of whether the competitive equilibrium is efficient and, when it is not so, calls for the design of an optimal tax policy capable of decentralizing the optimal growth path attainable by a central planner. If the elasticities of average consumption and average leisure in utility coincide, the competitive equilibrium is efficient both at the steady state and off the steady state. Otherwise, the competitive equilibrium is inefficient. The optimal tax policy shows a degree of arbitrariness because the optimal growth path can be decentralized by resorting to consumption or labor income taxation (or subsidy), whereas capital income should be untaxed. Numerical results have been presented that show that mild consumption and leisure externalities may have quantitatively significant effects on growth and welfare.

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