Social Comparisons and Optimal Taxation in a Small Open Economy*

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Abstract
In this paper, we analyze how international capital mobility affects the optimal labor and capital income tax policy in a small open economy when consumers care about relative consumption. The main results crucially depend on whether the government can tax returns on savings abroad. If the government can use flexible residence-based capital income taxes, then the optimal policy rules from a closed economy largely carry over to the case of a small open economy. If it cannot, then capital income taxes become completely ineffective. The labor income taxes must then indirectly also reflect the corrective purpose that the absent capital income tax would have had.

Keywords: Capital mobility; optimal taxation; positional goods; relative consumption; small open economy
JEL classification: D03; D60; D62; F21; H21; H23

I. Introduction
People care about their relative consumption (i.e., how much they consume relative to what other people consume).1 While this insight has a long history, and was noted by the founding fathers of economics, including

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1For empirical evidence from research on happiness and from questionnaire-based experimental research, see, for example, Easterlin (1995, 2001), Johansson-Stenman et al. (2002), Blanchflower and Oswald (2004), Ferrer-i-Carbonell (2005), Solnick and Hemenway (2005), Carlsson et al. (2007), and Clark and Senik (2010).
Adam Smith and John Stuart Mill, the literature dealing with the optimal tax policy implications of relative consumption comparisons is more recent. Our paper contributes to this body of literature by considering an intertemporal model of a small open economy with a mobile capital stock, where the government redistributes and corrects for externalities by using nonlinear labor income and capital income taxes. We show that the optimal tax policy responses to relative concerns crucially depend on whether the government can observe and tax the returns on savings abroad through a flexible residence-based capital income tax. Under quite realistic assumptions, the optimal tax policy response can differ considerably from the tax policies prescribed by closed-economy models in earlier studies.

Most earlier studies dealing with the tax policy implications of social comparisons are based on static models of closed economies, and they do not address the potential role of capital income taxation. A major finding in this literature is that relative consumption comparisons typically imply much higher optimal marginal labor income tax rates than in standard economic models (without any social comparisons), because relative consumption concerns give rise to large negative externalities. The literature also explains how this corrective tax element will be modified when information asymmetries prevent redistribution through lump-sum taxes.\(^2\) To our knowledge, Aronsson and Johansson-Stenman (2010) were the first to analyze the role of capital income taxation in an economy where people care about relative consumption, and where the government can simultaneously use an optimal nonlinear labor income tax for purposes of redistribution and externality correction.\(^3\) They found that consumer preferences for relative consumption have important implications for capital income taxation even when the labor income tax is optimal, because the positional externalities that consumers impose on one another can vary both over the individual life cycle and over time in general. The more (less) positional people become over time, the stronger will typically be the argument for taxing (subsidizing) savings at the margin.\(^4\)


\(^3\)See also Aronsson and Johansson-Stenman (2014a) for a generalization, in particular with respect to the nature of the social comparisons. See Abel (2005) for a study of first-best optimal capital income taxation in a representative-agent economy (without any labor income tax), where the representative consumer has preferences for relative consumption.

\(^4\)For instance, if people become more positional when their income increases, as suggested by empirical evidence in Clark et al. (2008), there is an incentive to tax capital income at the margin in a growing economy where people become more positional over time. Similarly, if the young are more positional than the old, which is consistent with some empirical evidence (Pingle and
However, the studies on optimal taxation referred to above, and indeed almost all previous studies in the policy-oriented literature on relative consumption, are based on closed-model economies. This is problematic when dealing with capital taxation as most (if not all) developed countries are open to capital mobility. Our main contribution in this paper is that we generalize the setting of Aronsson and Johansson-Štěnman (2010) to a small open economy with capital mobility where individuals can invest their savings either domestically or abroad. This generalization is clearly important because capital mobility can seriously restrict the use of capital income taxation as a means of correction and redistribution.

The point of departure is the optimal income tax model with overlapping generations (OLG) developed by Aronsson and Johansson-Štěnman (2010), where (realistic) information asymmetries prevent the government from using type-specific lump-sum taxes for purposes of redistribution. Here, this model is augmented with an international capital market, and it is embedded into the framework of a small open economy. A small open economy is here meant to imply that the country is small enough for its government to treat the world market interest rate as exogenous – a realistic assumption for many (if not most) countries. Nevertheless, at the end of Section III, we comment on how the results would change if the economy were large in the sense that the government is able to (strategically) affect the world market interest rate.

The scope for capital income taxation will, of course, depend on whether all capital income is observable to the government. Following the terminology in the literature on capital income taxation in open economies, we refer to “source-based” capital income taxation when the capital income is taxed at the source (i.e., imposed by the country where this income is generated, irrespective of whether the income earner is a domestic or foreign resident). In contrast, “residence-based” capital income taxation means that the tax is levied on the citizens of a particular country, irrespective of whether they earn their income domestically or abroad. An individual who

Mitchell, 2002; Johansson-Štěnman and Martinsson, 2006), it is, for this reason, desirable to subsidize capital income at the margin.

To our knowledge, the only exceptions are Aronsson and Johansson-Štěnman (2014b), with an examination of the optimal provision of public goods, and Aronsson and Johansson-Štěnman (2015), dealing with optimal income taxation in two-country economies with social comparisons within as well as between countries.

Many earlier studies have examined the implications of international capital mobility for revenue collection and provision of public goods at the national level in contexts without relative consumption comparisons; see, for example, Zodrow and Mieszczkowski (1986), Wilson (1986), Bucovetsky and Wilson (1991), and Huber (1999). See also Aronsson and Sjögren (2014), who analyze the tax policy implications of quasi-hyperbolic discounting in an economy with international capital mobility.

lives in, for example, the UK and who saves domestically will then be taxed by the UK government for the savings returns based on both the sourced-based tax (as the saving is undertaken in the UK) and the residence-based tax (as the saving is done by a UK citizen). If the same individual instead saves in Switzerland, then the UK government will only tax the individual through the residence-based tax, while the Swiss government might tax the individual through the source-based tax in Switzerland.

Throughout the paper, we assume that the government can perfectly observe, and hence tax, the returns on capital within its own country; thus, it can impose source-based taxes without restrictions. We also assume, as is commonly done in the literature, that capital is perfectly mobile between countries while people are immobile, and that the governments in different countries do not coordinate their capital tax policies. The possibility of taxing the returns on savings abroad through a flexible residence-based capital income tax constitutes a natural reference case, in the sense of allowing for a second-best optimal resource allocation (conditional on the assumption that all tax policies are decided at the national level). Thus, this is the open-economy analogue to the second-best optimal tax policy problem of a closed economy examined in Aronsson and Johansson-Stenman (2010). However, the possibility of observing the returns on savings abroad, and hence implementing residence-based capital income taxation, is far from obvious in practice. Here, we analyze two extreme cases: one in which the government has access to a flexible residence-based capital income tax, and one in which no such residence-based tax is available.

If the government can perfectly observe the returns on savings abroad, and if it can use a flexible nonlinear residence-based capital income tax, then we show, in Section III, that the optimal marginal tax policy rules derived for a closed economy by Aronsson and Johansson-Stenman (2010) largely carry over to the small open economy analyzed here. We also show that there would be no role for a source-based capital income tax as such a tax would induce people to move their savings abroad to escape this part of the capital tax (other small open economies would have no source-based taxes, for the same reason).

However, if the government cannot observe (and tax) the returns on savings abroad, the tax policy rules will be dramatically different, as shown

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7Of course, none of these assumptions is strictly fulfilled in reality; there are still some transaction costs associated with international capital mobility, and people do move between countries. Yet, capital is certainly much more mobile than people.

8Access to general labor income and capital income taxes would allow the government of a closed economy to control the capital stock. This is not the case in an open economy, where the domestic capital stock also depends on the tax policies decided on in other countries. Therefore, the tax policy rules we derive in Section III are not identical to those of the closed economy in Aronsson and Johansson-Stenman (2010).

in Section IV. Yet, here too, the source-based capital income tax will be completely ineffective for the same reason as above, meaning that the government lacks a direct instrument for influencing the individual’s trade-off between present and future consumption. Instead, the labor income tax must indirectly, and imperfectly, also reflect the corrective purpose that the absent capital income tax would otherwise have had. We show that the optimal marginal labor income tax rate implemented for any ability type can, in this case, be written as a weighted sum of two components: (i) the policy rule for marginal labor income taxation that the government would have used had the residence-based capital income tax instrument been available, and (ii) the policy rule for marginal capital income taxation that the government would have used had the residence-based instrument been available. In a simplified version of the model, where the self-selection constraint does not bind and the individuals’ utility functions are additive and linear in the measures of relative consumption, we show that if a compensated measure of saving is increasing (decreasing) in the marginal wage and if the average degree of positionality is increasing over time, then the implemented marginal labor income tax exceeds (falls short of) the tax that the government ideally would have preferred had a full set of tax instruments been available.

In brief, our contribution in addition to Aronsson and Johansson-Stenman (2010) is thus threefold. First, we take a much broader perspective of capital income taxation by considering capital mobility in combination with different tax principles. Second, we consider an open-economy analog to their second-best problem by analyzing how a government equipped with a full set of flexible tax instruments would respond to relative consumption concerns. This is clearly relevant in the sense of pinpointing conditions under which the tax policy implications of such concerns are similar (albeit not identical) in closed and open economies. Third, we examine how an arguably realistic restriction of the residence-based tax instrument influences the use of the other tax instruments – an issue never addressed before in economies with status consumption.

Although one can question the extreme case where the residence-based capital tax instrument cannot be used at all, it is arguably realistic that such a tax instrument cannot be used to its full potential as this would require a perfect international information-sharing system where all relevant source countries assist the domestic government in the collection of revenue. In principle, therefore, it suffices that one of the source countries does not assist the domestic government for a scenario with a restricted residence-based tax to be relevant. Nevertheless, we can of

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9See also Baccetta and Espinosa (1995) and Eggert and Kolmar (2002), who have studied this information-exchange problem.
course think of intermediate cases where there is some role for residence-based capital income taxation, but where it still cannot be fully used. We show in our Online Appendix that the policy rule for marginal labor income taxation derived without the residence-based capital tax instrument continues to apply with minor modifications for any exogenous residence-based capital income tax. Furthermore, the source-based tax remains equal to zero irrespective of whether the residence-based instrument is restricted.

The paper proceeds as follows. In Section II, we present the basic structure of the model. In Section III, we analyze the benchmark scenario with a full set of flexible tax instruments (including a flexible residence-based capital income tax), while we address the implications of taking away the residence-based capital income tax instrument in Section IV. We provide some concluding remarks in Section V.

II. The Model

Following Aronsson and Johansson-Stenman (2010), we consider an OLG economy and we assume that each individual lives for two periods, working in the first and retired in the second. Individuals are of two types, where the low-ability type (type 1) is less productive in the labor market – and consequently earns a lower before-tax wage rate – than the high-ability type (type 2). Those entering the economy in period \( t \) (who are active in the labor market in period \( t \) and retired in period \( t + 1 \)) are referred to as generation \( t \); \( n_{t,i} \) similarly denotes the number of individuals of ability-type \( i \) (for \( i = 1, 2 \)) in generation \( t \).

Individual Preferences, Constraints, and Choices

Individuals derive utility from their absolute consumption when young, \( c_{t,i} \), and old, \( x_{t,i+1} \), and use of leisure when young, \( z_{t,i} = 1 - l_{t,i} \), where \( l \) denotes working hours and the time endowment has been normalized to one. The utility also depends on the individual’s relative consumption when young and old.\(^{10}\) We model relative consumption as the difference between the individual’s own consumption and a measure of reference consumption. Using a bar symbol for reference consumption, we can then express the relative consumption of an individual of type \( i \) who is young in period \( t \) as \( \Delta_{t,i}^c = c_{t,i} - \bar{c}_t \). The relative consumption of the same individual when old can similarly be written as \( \Delta_{t,i+1}^x = x_{t,i+1} - \bar{c}_{t+1} \). Throughout the paper,

\(^{10}\) The limited empirical evidence available suggests that individuals are much less positional in terms of leisure than in terms of visible consumption goods, such as houses and cars, and income (Alpizar et al., 2005; Solnick and Hemenway, 2005; Carlsson et al., 2007).

we follow convention in assuming that the reference consumption in each period can be defined as the average consumption in the economy as a whole, such that

\[ \tilde{c}_t = \frac{n_{1,t}c_{1,t} + n_{2,t}c_{2,t} + n_{1,t-1}x_{1,t} + n_{2,t-1}x_{2,t}}{N_t}, \] (1)

where \( N_t = n_{1,t} + n_{2,t} + n_{1,t-1} + n_{2,t-1} \) denotes the total population in period \( t \). The lifetime utility function facing any individual of ability-type \( i \) and generation \( t \) can then be written as

\[ U_{i,t} = u_{i,t}(c_{i,t}, z_{i,t}, x_{i,t+1}, \Delta c_{i,t}, \Delta x_{i,t+1}). \] (2)

This utility function is assumed to be increasing in each argument and strictly quasi-concave.

We follow Johansson-Stenman et al. (2002) in defining the “degree of positionality” as a measure of the extent to which the marginal utility of consumption is driven by concerns for relative consumption. Because each individual lives for two periods, we can distinguish between the degree of positionality when young and when old. For any individual of ability-type \( i \) and generation \( t \), these two measures can be written as

\[ \alpha_{i,t}^c = \frac{\partial u_{i,t}/\partial c_{i,t}}{\partial u_{i,t}/\partial c_{i,t} + \partial u_{i,t}/\partial x_{i,t}}, \]

\[ \alpha_{i,t+1}^x = \frac{\partial u_{i,t}/\partial x_{i,t+1}}{\partial u_{i,t}/\partial x_{i,t+1} + \partial u_{i,t}/\partial x_{i,t+1}}. \] (3)

Here, \( \alpha_{i,t}^c \) can be interpreted as the fraction of the utility gain of an additional dollar spent on consumption that is due to increased relative consumption when young in period \( t \). In the extreme case where \( \alpha_{i,t}^c \) approaches one, only relative consumption matters (i.e., the marginal utility of absolute consumption is zero), whereas the mirror case where \( \alpha_{i,t}^c \) approaches zero reflects the conventional assumption where relative consumption does not matter at all. Note that \( \alpha_{i,t+1}^x \) has an analogous interpretation when old in period \( t + 1 \).

Each individual has the option of investing savings at home or abroad. Let \( \bar{r}_t^m \) denote the foreign rate of return before any residence-based capital income tax (although after source-based taxation). The after-tax rate of return on a domestic investment is given by \( r_{i,t}^m = (1 - \theta_{i,t}^m)(1 - \theta_{i,t})r_t \), where \( \theta_{i,t}^m \) denotes the residence-based marginal capital income tax rate facing ability-type \( i \), \( \theta_{i,t} \) denotes the source-based tax rate, \( r_t \) denotes the domestic before-tax interest rate, and the total marginal capital income tax

rate can be calculated as $\theta_{i,t} = \theta_{i,t}^n + \theta_{i,t}^r - \theta_{i,t}^p \theta_{i,t}$.\footnote{Note that all individuals face the same source-based tax rate.\footnote{We assume that capital is perfectly mobile, which means that the following equilibrium condition applies (as the residence-based rate cancels out on both sides):}}\footnote{Note that all individuals face the same source-based tax rate.\footnote{We assume that capital is perfectly mobile, which means that the following equilibrium condition applies (as the residence-based rate cancels out on both sides):}} x_{i,t} = (1 - \theta_{i,t}^p) r_t, \tag{4}

Let $\tau_{i,t}$ denote the marginal labor income tax rate, $w_{i,t}$ the before-tax wage, $w_{i,t}^n = (1 - \tau_{i,t}) w_{i,t}$ the after-tax marginal wage rate, and $s_{i,t}$ savings. The budget constraint facing any individual of ability-type $i$ and generation $t$ can then be summarized by the following two equations:\footnote{The marginal tax rates and lump-sum components, and measures of reference consumption as exogenous. The individual first-order conditions for work hours and saving can then be written as}
\begin{align}
\frac{\partial U_{i,t}}{\partial c_{i,t}} \frac{w_{i,t}^n}{\bar{w}_{i,t}} - \frac{\partial U_{i,t}}{\partial z_{i,t}} &= 0, \tag{6a} \\
\frac{\partial U_{i,t}}{\partial x_{i,t+1}}(1 + r_{i,t+1}^n) - \frac{\partial U_{i,t}}{\partial c_{i,t}} &= 0, \tag{6b}
\end{align}

where $T_{i,t}$ and $\Phi_{i,t+1}$ are lump-sum components of the tax system.\footnote{This is based on Aronsson and Sjögren (2014). Another formulation would be to assume $\theta_{i,t} = \theta_{i,t}^c + \theta_{i,t}^r$. This formulation is more restrictive, as the capital market equilibrium condition would then imply $\theta_{i,t} = \theta_{i,t}`, in which case the government does not have a fully flexible capital income tax. The type-specific residence-based marginal tax rates are possible here because capital mobility places a restraint on the source-based (not the residence-based) tax rate according to equation (4) in combination with the assumption that income is observable at the individual level.\footnote{It would be very difficult for the government to differentiate the source-based tax rate among the different consumer types, as those facing the higher rate would invest their savings abroad instead of at home.\footnote{This way of formulating the budget constraint with optimal nonlinear income taxes is chosen for analytical convenience. It is equivalent to a formulation where both types in each time period face the same general, nonlinear labor income and capital income taxation tax functions (e.g., Aronsson and Johansson-Stenman, 2010, 2014a).}}\footnote{One way to interpret these lump-sum components is in terms of intercepts of locally linearized budget constraints (i.e., adjustments due to inframarginal units of income not being taxed at the marginal rates).}}

\footnote{The editors of The Scandinavian Journal of Economics 2018.
and

\[
\frac{\partial U_{i,t}}{\partial x_{i,t+1}} = \frac{\partial u_{i,t}}{\partial x_{i,t+1}} + \frac{\partial u_{i,t}}{\partial \Delta x_{i,t+1}}.
\]

Equations (5) and (6) implicitly define the following labor supply and saving functions:

\[
l_{i,t} = l_{i,t}(w_{i,t}^{n}, r_{i,t+1}^{n}, T_{i,t}, \Phi_{i,t+1}, \bar{c}_{i}, \bar{c}_{t+1}),
\]

\[
s_{i,t} = s_{i,t}(w_{i,t}^{n}, t_{i,t+1}^{n}, T_{i,t}, \Phi_{i,t+1}, \bar{c}_{i}, \bar{c}_{t+1}),
\]

for \( i = 1, 2 \).

**Production and Equilibrium**

We assume that the production technology is characterized by constant returns to scale. Identical, competitive firms produce a homogeneous good, and we normalize their number to one for notational convenience. Let \( F(L_t, K_t) \) be the production function, where \( L_t \) denotes effective labor and \( K_t \) is the capital stock used in the domestic production. The marginal product of each factor is positive and diminishing. In turn, effective labor is given by \( L_t = a_1 L_{1,t} + a_2 L_{2,t} \), where \( 0 < a_1 < a_2 \) are fixed parameters, while \( L_{i,t} = n_{i,t} l_{i,t} \) denotes the total number of work hours by type \( i \) in period \( t \). The necessary conditions equate marginal products and factor prices such that

\[
a_1 \frac{\partial F_t}{\partial L_t} - w_{1,t} = 0, \quad a_2 \frac{\partial F_t}{\partial L_t} - w_{2,t} = 0, \quad \frac{\partial F_t}{\partial K_t} - r_t = 0.
\]

In the equilibrium, equation (4) implicitly defines \( r_t \) as a function of \( \theta_t^s \); \( r_t = r_t(\theta_t^s) \). By substituting \( r_t(\theta_t^s) \) into the third equation in equation (8) while using the fact that \( L_{i,t} = n_{i,t} l_{i,t} \) for \( i = 1, 2 \), we can solve for \( K_t \) as a function of \( \theta_t^s, l_{1,t} \), and \( l_{2,t} \); \( K_t = K_t(\theta_t^s, l_{1,t}, l_{2,t}) \). If we substitute the latter function into the first and second equations in (8), respectively, we obtain \( w_{i,t} \) (for \( i = 1, 2 \)) as a function \( w_{i,t} = w_{i,t}(\theta_t^s, l_{1,t}, l_{2,t}) \). Finally, let \( Q_t \) denote the part of the aggregate savings invested abroad in period \( t \). It follows from the national accounts that

\[
K_t + Q_t = \sum_{i=1,2} n_{i,t-1} s_{i,t-1}.
\]

Substituting \( K_t(\theta_t^s, l_{1,t}, l_{2,t}) \) into equation (9) produces \( Q_t = Q_t(\theta_t^s, l_{1,t}, l_{2,t}, s_{1,t-1}, s_{2,t-1}) \). In all these equations, the exogenous variables \( a_i, n_{i,t} \), and \( r_t^p \) have been suppressed to avoid unnecessary notation.

The Government

We begin by formulating the optimal tax problem for our benchmark scenario where the government has a full set of tax instruments, including a flexible residence-based capital income tax. In Section III, we address the optimal tax policy corresponding to this problem, while in Section IV we analyze the technically more restrictive version of the model where the residence-based tax instrument is absent.

The social objective function is assumed to be utilitarian:

\[
W = \sum_{t=0}^{\infty} \sum_{i=1,2} n_{i,t} U_{i,t}.
\]  

(10)

This specific functional form simplifies the calculations. It is not important for the efficiency conditions presented below. Indeed, the qualitative results would continue to hold for any social objective function that is increasing in the utility of each type in each time period. They would also continue to hold when the social objective is to obtain a Pareto-efficient allocation; that is, when the utility of a specific type in a specific time period is maximized, while the utility of the other type in the same time period, as well as the utility of both types in all other time periods, are held fixed.

The government is assumed to observe labor income and capital income at the individual level, whereas individual ability is private information. We also (and quite realistically) assume that the government wants to redistribute from the high-ability to the low-ability type. To eliminate the incentive for high-ability individuals to mimic the low-ability type in order to gain from this redistribution, the following self-selection constraint is imposed:

\[
U_{2,t} = u_{2,t}(c_{2,t}, z_{2,t}, x_{2,t+1}, \Delta_{2,t}^c, \Delta_{2,t+1}^x) \\
\geq u_{2,t}(c_{1,t}, \tilde{z}_{2,t}, x_{1,t+1}, \Delta_{1,t}^c, \Delta_{1,t+1}^x) = \tilde{U}_{2,t}.
\]  

(11)

The left-hand side of the weak inequality (11) is the utility of the true high-ability type, and the right-hand side the utility of the mimicker. A mimicker earns the same labor and capital income, and consumes as much in both periods, as the low-ability type. The variable \( \tilde{z}_{2,t} = 1 - \phi l_{1,t} \) denotes the time spent on leisure by the mimicker, where \( \phi = w_{1,t}/w_{2,t} = a_1/a_2 < 1 \) represents the relative wage rate. As the mimicker is more productive than the low-ability type, we have \( \tilde{z}_{2,t} = 1 - \phi l_{1,t} > z_{1,t} \).
With a full set of tax instruments, and by using \( r_{i,t} w_{i,t} = w_{i,t} - w_{i,t}^n \) and \( \theta_{i,t} r_{i,t} = r_t - r_{i,t}^n \), the public budget constraint can be written as

\[
\sum_{i=1,2} n_{i,t}[(w_{i,t} - w_{i,t}^n)i_{i,t} + T_{i,t}] + \sum_{i=1,2} n_{i,t-1}[\Phi_{i,t} + (r_t - r_{i,t}^n)s_{i,t-1}] = \theta_t^i r_t Q_t.
\]  

Equation (12) abstracts from public expenditure on public and private goods, which are of no concern in the analysis to follow.

The public decision problem is then to choose the policy vector \( (\theta_t^i, w_{i,t}^n, r_{i,t}^n, T_{i,t}, \Phi_{i,t}) \) for \( i = 1, 2 \) and all \( t \) to maximize the social welfare function given in equation (10) subject to the self-selection and budget constraints in equations (11) and (12), the private sector optimality conditions given in equations (6)–(8), and the equilibrium equations for \( r_t, K_t, w_{1,t}, w_{2,t}, \) and \( Q_t \) (which are defined in the paragraph following equation (9)). The Lagrangean can then be written as

\[
\mathcal{L} = \sum_{t=0}^{\infty} \sum_{i=1,2} n_{i,t} U_{i,t} + \sum_{t=0}^{\infty} \lambda_t(U_{2,t} - \bar{U}_{2,t})
+ \sum_{t=0}^{\infty} \mu_t \left[ \bar{c}_t - \sum_{i=1,2} \left( n_{i,t} c_{i,t} + n_{i,t-1} x_{i,t} \right) \right]
+ \sum_{t=0}^{\infty} \gamma_t \left\{ \sum_{i=1,2} n_{i,t}[(w_{i,t} - w_{i,t}^n)i_{i,t} + T_{i,t}] + \sum_{i=1,2} n_{i,t-1}[\Phi_{i,t} + (r_t - r_{i,t}^n)s_{i,t-1}] - \theta_t^i r_t Q_t \right\},
\]

where \( \lambda_t \) and \( \gamma_t \) are the Lagrange multipliers associated with the self-selection constraint and the budget constraint in period \( t \), respectively. The government attempts to redistribute and internalize the positional externality that the relative consumption concerns give rise to. Note that we have included equation (1), which shows how the reference consumption is determined, as an explicit constraint, where \( \mu_t \) denotes the associated Lagrange multiplier.

In Sections III and IV, we follow most earlier research on optimal taxation in characterizing the marginal tax policy based on first-order conditions (i.e., the first-order conditions implied by the decision problems

\[\footnote{Note that \( \sum_{i} n_{i,t-1}[\Phi_{i,t} + (r_t - r_{i,t}^n)s_{i,t-1}] \) overestimates the total revenue from capital income taxation, as \( (r_t - r_{i,t}^n)s_{i,t-1} = \theta_t r_t s_{i,t-1} \) measures the total marginal capital income tax rate times the capital income of an individual of ability type \( i \). Therefore, because the source-based tax is only paid on the domestic savings, we must subtract \( \theta_t^i r_t Q_t \) from \( \sum_{i} n_{i,t-1}[\Phi_{i,t} + (r_t - r_{i,t}^n)s_{i,t-1}] \) in order to arrive at the tax revenue collected from capital income taxation.} \]
facing the government and private agents). As it is well known (e.g., Lollivier and Rochet, 1983; Stiglitz, 1987) that one cannot *a priori* know whether the second-order conditions are also satisfied in optimal tax problems when the first-order conditions are satisfied, we cannot rule out that one has to make additional assumptions to guarantee that the latter conditions are also satisfied. Either way, we recognize these potential problems but we follow the common approach in the literature on optimal nonlinear taxation, and we simply assume that the second-order sufficient conditions are satisfied.

III. Optimal Tax Policy under Residence-Based Capital Income Taxes

We begin by discussing the second-best optimal marginal tax structure, which solves the optimal tax problem described above where the government has a full set of tax instruments, and we continue in Section IV with a restricted optimal tax problem without the residence-based capital income tax. Let

$$\tilde{\alpha}_t = \sum_{i=1,2} \frac{\alpha_{t,i}^{x} n_{i,t-1} + \alpha_{t,i}^{c} n_{i,t}}{N_t}$$

denote the average degree of positionality measured among those alive in period $t$. Because all individuals compare their own consumption with the average consumption, we can interpret the average degree of positionality as measuring the value of the marginal consumption externality per unit of consumption.\(^{16}\) Also, let $\tilde{\alpha}_{2,1}^{x}$ and $\tilde{\alpha}_{2,1}^{c}$ denote the degree of positionality of the young and old mimicker, respectively, of generation $t$, which are calculated as in equations (3) although based on the mimicker’s utility function.

The social shadow price of reference consumption, $\mu_t$, plays an important role in the tax policy described below. This shadow price reflects the welfare effect of a decrease in $\tilde{c}_t$, *ceteris paribus*, and is given as follows at the second-best optimum (see the Online Appendix):

\(^{16}\)The empirical literature has repeatedly found the average degree of positionality to be quite large, both for income (which can be seen as a summary measure of consumption in general) and for clearly visible goods, such as houses and cars. For instance, Alpizar et al. (2005) and Carlsson et al. (2007) find an estimate of around 0.4–0.5, whereas in their literature review, Wendner and Gould (2008) argue in favor of a slightly lower interval (i.e., 0.2–0.4). This suggests that positional externalities are associated with large welfare costs (see also Frank, 2005).
\[ \mu_t = N_t \gamma_t \frac{\tilde{\alpha}_t}{1 - \tilde{\alpha}_t} - \frac{1}{1 - \tilde{\alpha}_t} \left[ \lambda_{t-1} \frac{\partial \tilde{U}_{2,t-1}}{\partial x_{1,t}} (\tilde{a}_{2,t} - \alpha_{1,t}) + \lambda_t \frac{\partial \tilde{U}_{2,t}}{\partial c_{1,t}} (\tilde{a}_c - \alpha_{1,t}) \right]. \] (13)

Equation (13) takes the same form as the corresponding shadow price derived for a closed economy by Aronsson and Johansson-Stenman (2010). The first term on the right-hand side reflects the efficiency cost of the positional consumption externality, and it depends on the average degree of positionality. The intuition is that the larger the positional externality, the greater the welfare benefit of a decrease in \( \bar{c}_t \), which explains why this component works to increase the shadow price (i.e., making it more desirable to reduce \( \bar{c}_t \) from the perspective of the government). Yet, this is not the whole story, as can be seen from the second term, which depends on differences in the degree of positionality between the mimicker and the low-ability type. If the low-ability type is more positional than the mimicker both when young and when old, this effect also works to increase \( \mu_t \) as a decrease in \( \bar{c}_t \) will, in that case, lead to a relaxation of the self-selection constraint (in addition to the pure efficiency gain of a smaller externality). However, if the mimicker is more positional than the low-ability type, such that the expression in square brackets is positive, increased reference consumption instead contributes to a relaxation of the self-selection constraint. As such, in a second-best world with information asymmetries, we cannot a priori rule out that an increase in \( \bar{c}_t \) leads to higher welfare (even if this scenario does not appear very likely to us).

With equation (13) at our disposal, it is straightforward to show that the model set out above produces results similar to those derived for a closed economy by Aronsson and Johansson-Stenman (2010). Let \( MRS_{i,t}^{c,c} = (\partial U_{i,t}/\partial z_{i,t})/(\partial U_{i,t}/\partial c_{i,t}) \) denote the marginal rate of substitution between leisure and private consumption, and let \( MRS_{i,t}^{c,x} = (\partial U_{i,t}/\partial c_{i,t})/(\partial U_{i,t}/\partial x_{i,t+1}) \) denote the marginal rate of substitution between present and future consumption for ability-type \( i \) of generation \( t \), while \( MRS_{2,t}^{c,c} \) and \( MRS_{2,t}^{c,x} \) denote the corresponding marginal rates of substitution for the mimicker. We summarize the optimal tax policy in terms of the following proposition.

**Proposition 1.** The optimal second-best policy based on a full set of instruments satisfies \( \theta_i^* = 0 \) in combination with the following marginal labor income tax rates,

\[
\begin{align*}
\tau_{1t} &= \frac{\lambda_t}{w_{1,t} N_{1,t}} (MRS_{1,t}^{c,c} - \phi MRS_{2,t}^{c,c}) + \frac{MRS_{1,t}^{c,c}}{w_{1,t} N_{1,t}} \mu_t, \quad (14a) \\
\tau_{2t} &= \frac{MRS_{2,t}^{c,c}}{w_{2,t} N_{1,t}} \mu_t, \quad (14b)
\end{align*}
\]
where $\lambda^*_t = \lambda_t (\partial \tilde{U}_{2,t}/\partial x_{1,t})/\gamma_t$, and the following marginal capital income tax rates,

$$
\theta_{1,t+1} = \frac{\lambda_t (\partial \tilde{U}_{2,t}/\partial x_{1,t+1})}{\gamma_{t+1} r_{t+1} n_{t+1}} (MRS_{1,t}^{c,x} - MRS_{2,t}^{c,x})
$$

$$
- \frac{1}{\gamma_{t+1} r_{t+1}} \left( \frac{\mu_t}{N_{t}} - MRS_{1,t}^{c,x} \frac{\mu_{t+1}}{N_{t+1}} \right),
$$

$$
\theta_{2,t+1} = - \frac{1}{\gamma_{t+1} r_{t+1}} \left( \frac{\mu_t}{N_{t}} - MRS_{2,t}^{c,x} \frac{\mu_{t+1}}{N_{t+1}} \right),
$$

for all $t$.

Proof: See the Appendix. □

Note first that the source-based capital income tax rate is zero because capital is perfectly mobile into and out of the country. Therefore, because the government of the small open economy treats the world market interest rate as exogenous, it will not use the source-based tax.

Equations (14a), (14b), (15a), and (15b) take the same general form as their counterparts derived for a closed economy by Aronsson and Johansson-Stenman (2010), and the interpretations are the same as in their study. Nevertheless, it is worthwhile to discuss the insights from the proposition, as these insights will be useful in the analysis to follow. The first term on the right-hand side of equations (14a) and (15a) represents the policy rule that would be implemented for the low-ability type without any tax response to relative consumption concerns (i.e., the marginal tax policy rules derived from a standard model of optimal income taxation). There is no corresponding term in equations (14b) and (15b), meaning that the marginal labor and capital income tax rates implemented for the high-ability type would be zero in that case. All remaining terms are proportional to $\mu$ (measured either at $t$ or $t+1$), and therefore represent policy adjustments.

17A difference compared with the closed economy analyzed by Aronsson and Johansson-Stenman (2010) is that the condition for intertemporal production efficiency, $\gamma_t / \gamma_{t+1} = (1 + r_{t+1})$, is not necessarily satisfied here. However, by adding the assumption that the domestic government can borrow and lend at the foreign interest rate (measured net of source-based taxation), $r^*_t$ for all $t$, and because the domestic source-based tax is zero, the condition for intertemporal production efficiency will be satisfied here as well.

18If all individuals share a common utility function, and if leisure is weakly separable from the other goods in the utility function, then the first term on the right-hand side of equation (15a) is zero. Therefore, if the social cost of relative consumption does not change over time (such that the right-hand side of equation (15b) and the second term on the right-hand side of equation (15a) are zero), this would reproduce the result in the leading contribution by Ordover and Phelps (1979) for when there is no need to supplement an optimal labor income tax with marginal capital income taxation.

to relative concerns. Note that the higher $\mu_t$ is (i.e., the larger the marginal social value of a decrease in $\bar{c}_t$), \textit{ceteris paribus}, the higher the marginal labor income tax rates implemented for both ability types.\footnote{Based on the estimates of the average degree of positionality referred to in footnote 16, we would typically expect that relative consumption concerns imply much higher marginal labor income tax rates than standard economic models (where such concerns are absent). This is also verified by recent numerical simulations that show that relative concerns might motivate much higher marginal labor income tax rates (e.g., Kanbur and Tuomala, 2013; Aronsson and Johansson-Stenman, 2018).} As explained in the context of equation (13), a high value of $\mu_t$ can reflect either that the positional externality (as measured by the average degree of positionality) is large, and/or that the low-ability type (the mimicked agent) is more positional than the mimicker. Finally, note that the marginal capital income tax rates depend on the difference between $\mu_t$ and $\mu_{t+1}$; the greater this difference, the larger the welfare cost of consumption in period $t$ compared with period $t + 1$, \textit{ceteris paribus}, and consequently the lower the optimal marginal capital income tax rates.

Note, finally, that the policy rules for marginal taxation in equations (14) and (15) would also remain valid if we were to relax the “small open economy assumption” and instead assume a large open economy where the government is able to influence the world market interest rate. In a large open economy, whose government recognizes that the world market interest rate is a function of the net capital export, the results would change in two ways compared with Proposition 1. First, the optimal source-based capital income tax would no longer be equal to zero; instead, it would follow an inverse elasticity rule based on the relationship between the world market interest rate and the net capital export. Second, the residence-based marginal capital income tax policy would have to be adjusted in response to the source-based tax such that the total marginal capital income tax rates would satisfy equations (15a) and (15b).\footnote{Aronsson and Sjögren (2014) present an analogous comparison between a small and large open economy when the government attempts to correct for a self-control problem generated by quasi-hyperbolic discounting.} In qualitative terms, the tax policy response to relative consumption concerns would be exactly the same as in the small open economy characterized in Proposition 1.

IV. Optimal Tax Policy without Residence-Based Capital Income Taxes

The analysis in the preceding section presupposes that the government has access to a residence-based capital income tax. Even if the capital income taxes used in many countries share elements of both the residence and the
source principles, we argued in the introduction that a flexible residence-based tax requires a global information-sharing system, which is likely to be difficult to implement in practice (even if steps in that direction have recently been taken). Without such a residence-based tax, Proposition 1 will no longer apply. It is thus interesting to analyze how the optimal use of the other tax instruments will change if the government is not able to freely use the residence-based tax. Here, we take this argument to its extreme by considering a scenario where the government is unable to use residence-based capital income taxation.

Without the residence-based tax, the model set out above will change in two ways. First, if \( \theta^n_i \equiv 0 \), then \( \theta^n_{i,t} = \theta^n_i \) for \( i = 1, 2 \) and the after-tax interest rate facing domestic residents is fixed at the world market interest rate, that is, \( r^n_{i,t} = r_t (1 - \theta^n_i) = \tilde{r}^n_t \) according to equation (4). Second, the government’s budget constraint changes to

\[
\sum_{i=1,2} n_{i,t} [(w_{i,t} - w^n_{i,t})h_{i,t} + T_{i,t}] + \sum_{i=1,2} n_{i,t-1} \Phi_{i,t} + (r_t - \tilde{r}^n_t)K_t = 0. \tag{16}
\]

because the tax base for the source-based tax is the domestic capital stock and not the domestic savings.

The optimal tax problem is to choose the policy vector \((\theta^n_i, w^n_{i,t}, T_{i,t}, \Phi_{i,t})\) for \( i = 1, 2 \) and all \( t \) to maximize the social welfare function in equation (10) subject to the self-selection and budget constraints in equations (11) and (16), respectively, subject to equations (6)–(8), as well as subject to the equilibrium equations for \( r_t, K_t, w_{1,t}, w_{2,t}, \) and \( Q_t \). In doing so, the government recognizes that \( r^n_{i,t} = \tilde{r}^n_t \) is exogenous. The Lagrange function is given by

\[
\mathcal{L} = \sum_{t=0}^{\infty} \sum_{i=1,2} n_{i,t} U_{i,t} + \sum_{t=0}^{\infty} \lambda_t (U_{2,t} - \bar{U}_{2,t}) \\
+ \sum_{t=0}^{\infty} \mu_t \left[ \tilde{c}_t - \sum_{i=1,2} \frac{(n_{i,t}c_{i,t} + n_{i,t-1}\lambda_{i,t})}{N_t} \right] \\
+ \sum_{t=0}^{\infty} \gamma_t \left[ \sum_{i=1,2} n_{i,t} [(w_{i,t} - w^n_{i,t})h_{i,t} + T_{i,t}] \right] \\
+ \sum_{i=1,2} n_{i,t-1} \Phi_{i,t} + (r_t - \tilde{r}^n_t)K_t .
\]

We start by presenting the policy rules for marginal income taxation, and then we continue with the partial welfare effect of decreased reference consumption (i.e., the shadow price of the externality), when the residence-based capital income tax instrument is absent.

Marginal Income Taxation: Policy Rules

For presentational convenience, we make use of the second-best optimal tax formulas derived in Section III through the following short notation:

\[
\tau^*_{1,t} = \frac{\lambda_{t}}{w_{1,t}n_{1,t}} \left( MRS^C_{1,t} - \phi MRS^C_{2,t} \right) + \frac{MRS^C_{1,t}}{w_{1,t}N_t} \mu_{t}, \quad (17a)
\]

\[
\tau^*_{2,t} = \frac{MRS^C_{2,t}}{w_{2,t}N_t} \mu_{t}, \quad (17b)
\]

\[
\theta^*_{1,t+1} = \frac{\lambda_{t}}{\gamma_{t+1}r_{t+1}n_{1,t}} \left( MRS^C_{1,t} - MRS^C_{1,t} \right) \left( \frac{\mu_{t}}{N_t} - MRS^C_{1,t} \frac{\mu_{t+1}}{N_{t+1}} \right), \quad (18a)
\]

\[
\theta^*_{2,t+1} = -\frac{1}{\gamma_{t+1}r_{t+1}} \left( \frac{\mu_{t}}{N_t} - MRS^C_{2,t} \frac{\mu_{t+1}}{N_{t+1}} \right). \quad (18b)
\]

Equations (17) and (18) take the same form as their counterparts in equations (14) and (15), with the only difference that equations (17) and (18) are evaluated in the equilibrium examined here, which the superscript * serves to indicate. Thus, equations (17) and (18) can be interpreted in terms of the policy rules for marginal taxation of labor and capital income, respectively, that the government ideally would have preferred had it had access to a full set of tax instruments.

To shorten the notation below, it is convenient to introduce the following compensated labor supply and saving responses to a change in the marginal wage rate:

\[
\frac{\partial \tilde{l}_{i,t}}{\partial w_{i,t}} = \frac{\partial l_{i,t}}{\partial w_{i,t}} + \frac{\partial l_{i,t}}{\partial T_{i,t}} > 0
\]

and

\[
\frac{\partial \tilde{s}_{i,t}}{\partial w_{i,t}} = \frac{\partial s_{i,t}}{\partial w_{i,t}} + \frac{\partial s_{i,t}}{\partial T_{i,t}}.
\]

The optimal tax policy is characterized in Proposition 2.

**Proposition 2.** Without the residence-based capital income tax instrument, the optimal tax policy satisfies \( \theta^*_{1} = 0 \) in combination with the following marginal labor income tax rates:

\[
\tau_{i,t} = \tau^*_{i,t} + \theta^*_{t+1} \frac{\gamma_{t+1}r_{t+1}}{\gamma_{t}w_{i,t}} \frac{\partial \tilde{s}_{i,t}}{\partial w_{i,t}} \frac{\partial \tilde{l}_{i,t}}{\partial w_{i,t}} \quad (19)
\]

for \( i = 1, 2 \) and all \( t \).
Proof: See the Appendix.

The optimal source-based capital income tax also remains equal to zero when the residence-based instrument is absent. This is because the capital stock is still perfectly elastic from the point of view of the government, whereas the labor income tax base is not. As a consequence, only the labor income tax will be used in response to the externalities that relative consumption concerns give rise to.\footnote{An immediate objection to Propositions 1 and 2 is, of course, that small open economies often use capital income taxes despite the fact that capital is (at least close to) perfectly mobile. Therefore, we would like to emphasize that the policy incentives characterized in equation (19) remain valid as long as the residence-based capital income tax is not flexible in the sense described in Section III. For instance, with a positive, yet suboptimal, residence-based capital income tax, the optimal labor income tax can still be written in a way similar to equation (19), with the modification that $\theta^*_{t,t+1}$ is replaced with $\theta^*_{t,t+1} - \theta_{t+1}$, where $\theta_{t+1}$ is the actual marginal capital income tax rate facing ability-type $t$ of generation $t$. See the Online Appendix.}

Note that, in this case, the optimal marginal labor income tax can be interpreted as a weighted sum of the policy rules for marginal labor and capital income taxation that the government would ideally have preferred. We can thus think of $\tau^*_t$ and $\theta^*_{t,t+1}$ in terms of latent optimal tax policy rules, while the formula for $\tau_{t,t}$ is the actual policy rule for marginal labor income taxation when the government is constrained to the more limited set of tax instruments considered here. Therefore, $\tau_{t,t}$ is given by a weighted average of $\tau^*_t$ and $\theta^*_{t,t+1}$, with the relative weight given by the ratio between compensated savings and labor supply responses to an increase in the marginal wage rate. The understanding is that when the residence-based capital income tax instrument is absent, the marginal labor income tax will be used to correct for the effects of relative consumption concerns on two margins: the atemporal consumption–leisure margin (as before) and the intertemporal consumption margin that a residence-based capital income tax would otherwise have targeted.

Although the labor income tax is a direct instrument for influencing the atemporal consumption–leisure trade-off, it is only an indirect (and imperfect) instrument for affecting the intertemporal consumption trade-off. Therefore, whether the labor income tax is a useful instrument for influencing people’s saving behavior depends on how the saving responds to a budget neutral change in marginal labor income tax, which hints at the role of the multiplier $((\partial \tilde{h}_{t,t}/\partial w^0_{t,t})/(\partial \tilde{h}_{t,t}/\partial w^1_{t,t})$ attached to $\theta^*_{t,t+1}$ in equation (19). The reason why the multiplier is based on the compensated – instead of uncompensated – labor supply and saving responses to an increase in the marginal wage rate is that we have combined the social first-order conditions for the marginal wage rate, $w^0_{t,t}$, and the lump-sum
tax element, $T_{i,t}$, implemented for ability-type $i$ in period $t$ to derive equation (19). The economic intuition is that a general income tax (which contains a lump-sum element) separates revenue collection from tax wedges, giving the government an option to compensate each consumer type for a tax-induced distortion of the labor supply and saving behavior. We can see that the larger (smaller) this multiplier is, the larger the relative weight attached to $\hat{\theta}^*_{i,t+1} (\tau^*_{i,t})$ will be. Economic theory gives no clear guidance regarding the sign of this multiplier. Whereas the compensated labor supply is increasing in the marginal net wage rate, the corresponding compensated saving response can be either positive or negative, although a positive sign appears to us as the most likely outcome.\(^{22}\)

**Examples Based on a Simplified Model**

To facilitate the interpretation of Proposition 2, we consider a simplified version of the model by adding two quite restrictive assumptions: (i) the self-selection constraint does not bind (such that $\lambda_t = 0$ for all $t$); (ii) the individuals’ lifetime utility functions are additive and linear in the two measures of relative consumption. The second assumption means that equation (2) simplifies to

$$U_{i,t} = u_i(c_{i,t}, z_{i,t}, x_{i,t+1}) + k^c \Delta c^c_{i,t} + k^x \Delta x^x_{i,t+1}, \tag{20}$$

for $i = 1, 2$ and all $t$, where $k^c > 0$ and $k^x > 0$ are fixed parameters. This functional form implies that the labor supply and saving functions become $l_{i,t} = l_i(w^n_{i,t}, r^n_t, T_{i,t}, \Phi_{i,t+1})$ and $s_{i,t} = s_i(w^n_{i,t}, r^n_t, T_{i,t}, \Phi_{i,t+1})$, respectively, which do not directly depend on the reference consumption levels. Furthermore, under assumptions (i) and (ii), it is straightforward to derive $\mu_t = \tilde{\alpha}_t \gamma_t N_t / (1 - \tilde{\alpha}_t) > 0$, which reflects that a *ceteris paribus* decrease in the level of reference consumption constitutes a pure efficiency gain through a smaller positional externality.\(^{23}\) Based on these additional assumptions, equation (19) reduces to (for $i = 1, 2$)

\[^{22}\text{As long as the utility function is overall concave in consumption such that}
\]

$$\frac{\partial^2 u_{i,t}}{\partial c^2_{i,t}} + \frac{\partial^2 u_{i,t}}{\partial (\Delta c^c_{i,t})^2} + 2 \frac{\partial^2 u_{i,t}}{\partial c_{i,t} \partial (\Delta c^c_{i,t})} < 0,$$

\[^{23}\text{See the proof of Proposition 3 in the Online Appendix.}\]

\[ \tau_{t,t} = \frac{\text{MR}^{\text{Sc}^c}_{i,t}}{w_{t,t}} \tilde{\alpha}_t - \frac{\tilde{\alpha}_t}{1 - \tilde{\alpha}_t} \left( M\text{RS}^{\text{Sc}^c,x} y_{t+1} \right) \gamma_t + \frac{\tilde{\alpha}_{t+1}}{1 - \tilde{\alpha}_{t+1}} \]

\[ \times \frac{1}{w_{t,t}} \frac{\partial \tilde{s}_{t,1}}{\partial w_{t,t}, \partial \tilde{l}_{t,1}}. \]

(21)

Note also that if the government can borrow/lend in the international capital market at interest rate \( \tilde{r}^n_t \), then \( \gamma_t = (1 + \tilde{r}^n_t) \gamma_{t+1} \), which in turn implies that \( M\text{RS}^{\text{Sc}^c,x} y_{t+1} / \gamma_t = 1 \). We can then rewrite equation (21) as

\[ \tau_{t,t} = \frac{\text{MR}^{\text{Sc}^c}_{i,t}}{w_{t,t}} \tilde{\alpha}_t - \frac{\tilde{\alpha}_t}{1 - \tilde{\alpha}_t} \left( M\text{RS}^{\text{Sc}^c,x} y_{t+1} \right) \gamma_t + \frac{\tilde{\alpha}_{t+1}}{1 - \tilde{\alpha}_{t+1}} \]

\[ \times \frac{1}{w_{t,t}} \frac{\partial \tilde{s}_{t,1}}{\partial w_{t,t}, \partial \tilde{l}_{t,1}}. \]

(22)

Equation (22) implies the following corollary to Proposition 2.2.

**Corollary 1.** Consider the special case where the utility function takes the form of equation (20), the self-selection constraint does not bind, and the government can borrow/lend abroad at interest rate \( \tilde{r}^n_t \). Equation (22) then implies the following:

(a) if \( \partial \tilde{s}_{t,1}/\partial w_{t,t} > 0 \), then \( \tau_{t,t} > \tau^*_t \), iff \( \tilde{\alpha}_{t+1} < \tilde{\alpha}_t \), and \( \tau_{t,t} < \tau^*_t \), iff \( \tilde{\alpha}_{t+1} > \tilde{\alpha}_t \).

(b) if \( \partial \tilde{s}_{t,1}/\partial w_{t,t} < 0 \), then \( \tau_{t,t} < \tau^*_t \), iff \( \tilde{\alpha}_{t+1} > \tilde{\alpha}_t \), and \( \tau_{t,t} > \tau^*_t \), iff \( \tilde{\alpha}_{t+1} < \tilde{\alpha}_t \).

(c) if \( \tilde{\alpha}_{t+1} = \tilde{\alpha}_t \), then \( \tau_{t,t} = \tau^*_t \).

We base most of the interpretation below on the case where the multiplier \( \partial \tilde{s}_{t,1}/\partial w_{t,t} \) is positive. Let us first observe that if the self-selection constraint does not bind and the utility functions are given as in equation (20), we have (as long as \( \gamma_t = (1 + \tilde{r}^n_t) \gamma_{t+1} \))

\[ \text{sign} \theta^*_{t+1} = \text{sign} (\tilde{\alpha}_{t+1} - \tilde{\alpha}_t). \]

Therefore, \( \tilde{\alpha}_{t+1} > \tilde{\alpha}_t \) means that the government would ideally have preferred to implement a positive marginal capital tax in order to reduce saving, as the marginal positional externality increases over time (i.e., the positional externality is larger in period \( t + 1 \) than in period \( t \)). However, as this option is not available by assumption, the government uses the labor tax as an indirect (and imperfect) instrument to deter saving. If the compensated saving measure increases in response to an increase in the marginal wage rate, which is the case addressed in Corollary 1(a), then this is accomplished through a higher marginal labor income tax rate. The case where \( \tilde{\alpha}_{t+1} < \tilde{\alpha}_t \) correspondingly implies an incentive for the government to induce individuals to save more, which is accomplished through a lower marginal labor income tax rate.
The interpretation of Corollary 1(b) is analogous, except that this case is based on the assumption that \( \partial \bar{s}_{i,t} / \partial w_{i,t} > 0 \). The qualitative implications for policy will then be the opposite of those just described. Turning finally to Corollary 1(c), \( \bar{x}_{t+1} = \bar{x}_t \) means \( \theta^*_{i,t+1} = 0 \). In other words, because the marginal positional externality does not change between periods \( t \) and \( t + 1 \), the desire to correct for positional externalities provides no incentive for the government to modify the intertemporal consumption trade-off faced by the consumers. As a consequence, the absence of the residence-based capital income tax instrument does not lead to any modification of the policy rule for marginal labor income taxation.

The assumptions behind Corollary 1 are useful as they allow us to relate the relationship between \( r_{1,t} \) and \( r_{2,t} \) to the core mechanisms of externality correction. An important question is whether these insights carry over to a second-best scenario with a binding self-selection constraint. It turns out that they do, albeit with some modification. If we continue to assume that the lifetime utility functions are linear in the measures of relative consumption, while at the same time assuming that the self-selection constraint binds, it turns out that the social shadow price of a decrease in the level of reference consumption takes the form of equation (13). In other words, it takes the same form as it would have taken had the government had a full set of tax instruments. If we follow Aronsson and Johansson-Stenman (2010) and define the following summary measure of differences in the degree of positionality between the mimicker and the low-ability type in period \( t \),

\[
\alpha^d_t = \frac{1}{\gamma_t N_t} \left[ \lambda_{t-1} \frac{\partial \tilde{U}_{2,t-1}}{\partial X_{1,t}} (\tilde{\alpha}^x_{2,t} - \alpha^x_{1,t}) + \lambda_t \frac{\partial \tilde{U}_{2,t}}{\partial c_{1,t}} (\tilde{\alpha}^x_{2,t} - \alpha^x_{1,t}) \right],
\]

then this shadow price can then be written as

\[
\mu_t = \frac{N_t \bar{\alpha}_t - \alpha^d_t}{1 - \bar{\alpha}_t}.
\]

Therefore, Corollary 1 continues to remain valid for the high-ability type with the only modification that the relevant difference in positionality over time is now measured by

\[
(\tilde{\alpha}_{t+1} - \alpha^d_{t+1})/(1 - \tilde{\alpha}_{t+1}) - (\tilde{\alpha}_t - \alpha^d_t)/(1 - \tilde{\alpha}_t),
\]

instead of by \( \bar{\alpha}_{t+1} - \bar{\alpha}_t \). The reason is, of course, that the social marginal benefit of decreased reference consumption at any time \( t \) will now also depend on whether mimickers are predominantly more \( (\alpha^d_t > 0) \) or less \( (\alpha^d_t < 0) \) positional than low-ability individuals. Corollary 1(a), which is based on the assumption that \( \partial \bar{s}_{i,t} / \partial w_{i,t} > 0 \), will then be modified as follows for the high-ability type: \( r_{2,t} > (\leq) r^*_{2,t} \) iff equation (25) is positive.

(negative). The modifications of Corollary 1(b) and 1(c) are analogous. For the low-ability type, it is not equally straightforward to adjust Corollary 1 to a second-best economy with a binding self-selection constraint, as \( \theta^*_{1,t+1} \) now also depends on whether the marginal rate of substitution between present and future consumption facing the low-ability type exceeds, or falls short of, the corresponding marginal rate of substitution facing the mimicker. Therefore, to generalize the corollary for the low-ability type, we would also have to add \( MRS_{c_t}^{x} < (>)MRS_{z_t}^{x} \) to the other conditions required for \( \tau_{1,t} > (\leq)\tau^*_i, \)

**Social Marginal Value of \( \tilde{c}_t \)**

In the examples based on the simplified model, where the utility function is separable and linear in the measures of relative consumption, the social shadow price of the externality takes the same form as in equation (13), that is, \( \mu_t = N_t \gamma_t (\tilde{a}_t - \tilde{a}^2_t) / (1 - \tilde{a}_t) \). However, an important difference is that equation (13) was derived based on a general, non-separable utility function in a case where the government has access to a full set of tax instruments (including a flexible residence-based capital income tax). However, the analogous shadow price formula in equation (24), which is derived without the residence-based tax instrument, no longer applies if the separability and linearity assumptions are relaxed. Therefore, the social value of a decrease in the level of reference consumption generally depends on the tax instruments that the government has at its disposal. Therefore, let us now return to the general, non-separable utility function.

By using the following short notations for compensated labor supply and saving responses to an increase in the level of reference consumption,

\[
\begin{align*}
\frac{\partial L_{i,t}}{\partial \tilde{c}_t} &= \frac{\partial l_{i,t}}{\partial \tilde{c}_t} - \alpha^x_{i,t} \frac{\partial l_{i,t}}{\partial \Phi_{i,t}}, \\
\frac{\partial s_{i,t}}{\partial \tilde{c}_t} &= \frac{\partial s_{i,t}}{\partial \tilde{c}_t} - \alpha^x_{i,t} \frac{\partial s_{i,t}}{\partial \Phi_{i,t}}, \\
\frac{\partial L_{i,t-1}}{\partial \tilde{c}_t} &= \frac{\partial l_{i,t-1}}{\partial \tilde{c}_t} - \alpha^x_{i,t} \frac{\partial l_{i,t-1}}{\partial \Phi_{i,t}}, \\
\frac{\partial s_{i,t-1}}{\partial \tilde{c}_t} &= \frac{\partial s_{i,t-1}}{\partial \tilde{c}_t} - \alpha^x_{i,t} \frac{\partial s_{i,t-1}}{\partial \Phi_{i,t}},
\end{align*}
\]

Proposition 3 characterizes the social shadow price of the externality.

Proposition 3. Without the residence-based capital income tax instrument, the social shadow price of reference consumption becomes

\[
\mu_t = \frac{\gamma_t N_t (\tilde{a}_t - \alpha_t^d)}{1 - \tilde{a}_t} - \frac{1}{1 - \tilde{a}_t} \sum_{i=1}^{2} \left( \gamma_t n_{i,t} w_{i,t} \Delta \tau_{i,t} \frac{\partial \tilde{l}_{i,t}}{\partial \tilde{c}_t} + \gamma_{t-1} n_{i,t-1} w_{i,t-1} \Delta \tau_{i,t-1} \frac{\partial \tilde{l}_{i,t-1}}{\partial \tilde{c}_t} \right) \\
- \frac{1}{1 - \tilde{a}_t} \sum_{i=1}^{2} \left( \gamma_{t+1} r_{i,t+1} n_{i,t+1} \Delta \theta_{i,t+1} \frac{\partial \tilde{s}_{i,t}}{\partial \tilde{c}_t} + \gamma_t r_{i,t} n_{i,t} \Delta \theta_{i,t} \frac{\partial \tilde{s}_{i,t}}{\partial \tilde{c}_t} \right),
\]

for all \( t \), where \( \Delta \tau_{i,t} = \tau_{i,t} - \tau_{i,t}^* \) and \( \Delta \theta_{i,t} = \theta_{i,t} - \theta_{i,t}^* = -\theta_{i,t}^* \).

Proof: See the Online Appendix. \( \square \)

The first component on the right-hand side of equation (26) coincides with the shadow price derived under a full set of tax instruments given in equation (13), where \( \alpha_t^d \) is the measure of difference in the degree of positionality between the mimicker and the low-ability type defined in equation (23). As such, this component can be interpreted in the same general way as in the previous section. However, the second and third components on the right-hand side of equation (26) are novel and did not appear in equation (13). The reason they were not present in equation (13) is that \( \Delta \tau_{i,t} = \Delta \theta_{i,t} = 0 \) for all \( t \) if the government has a full set of tax instruments, in which case the actual policy rules coincide with the latent rules ideally preferred by the government. In a second-best optimum based on a full set of tax instruments, the labor supply and saving behavior will be chosen to maximize the social welfare (which the government induces the individuals to do through tax policy). This explains why a change in the level of reference consumption did not have any welfare effects via the labor supply and saving functions in Section III. However, when this is no longer the case (i.e., when the tax instruments are not flexible enough to allow the government to exercise perfect control over the labor supply and saving), a change in the level of reference consumption will typically affect the shadow price also via the induced responses in the individuals’ labor supply and saving behavior.

The terms in parentheses in the second and third parts of equation (26) are reminiscent of tax revenue effects. They depend on discrepancies between the actual marginal tax rate and the marginal tax rate ideally preferred (i.e., the marginal tax policy that the government would choose if equipped with a full set of instruments). The reason why the labor supply and saving responses are compensated instead of uncompensated is that the lump-sum elements in the tax are optimally chosen, and the first-order
conditions for these lump-sum components are used in the calculation of equation (26).

To give a more thorough interpretation, consider the second part of equation (26) and suppose that $\Delta \tau_{i,t}$ is positive, such that the actual marginal labor income tax rate exceeds the rate implied by the government’s ideal policy rule. This would typically imply that individuals of ability-type $i$ and generation $t$ supply fewer hours of work than ideally preferred, in which case an increase in the hours of work would be welfare improving. Thus, if an increase in $\bar{c}_t$ leads to an increase in the hours of work (which is reasonable, as one would expect people prone to conspicuous consumption to work more than they would otherwise have done) such that $\partial \bar{L}_{i,t}/\partial \bar{c}_t > 0$, then this contributes to a decrease in the social marginal cost of the externality, and thus to a lower $\mu_t$. The interpretation of the case where $\Delta \tau_{i,t}$ is negative is analogous, yet with effects opposite of those just described. Note, finally, that $\bar{c}_t$ also affects generation $t-1$, meaning that the expression proportional to $\partial \bar{L}_{i,t-1}/\partial \bar{c}_t$ in the second part of equation (26) can be interpreted in a similar way.

The third part of equation (26) appears because a change in the level of reference consumption affects the saving behavior, and the terms in brackets are interpretable in the same general way as the second part. To exemplify, consider the first term in parentheses, which is proportional to $\Delta \theta_{i,t+1}$. If $\Delta \theta_{i,t+1} > 0$, the actual marginal capital income tax rate – which is zero here – exceeds the rate implied by the policy rule ideally preferred by the government in equations (18a) and (18b). This typically implies that individuals of ability-type $i$ and generation $t$ save less than the government would have liked them to, ceteris paribus, meaning that increased saving would lead to higher welfare. Therefore, if an increase in the level of reference consumption contributes to less saving in the sense that $\partial \tilde{s}_{i,t}/\partial \bar{c}_t < 0$ (which seems plausible to us), then this effect contributes to increase the social marginal cost of the externality; this, in turn, implies a higher $\mu_t$. By analogy, if $\Delta \theta_{i,t+1} < 0$ while the other conditions remain as above, the first term in brackets in the third row would instead reduce the social marginal cost of the externality and, therefore, contribute to a lower $\mu_t$.

V. Conclusions

As far as we know, with this paper, we are the first to analyze optimal capital and labor income taxation in an economy that is open to capital mobility and where people are concerned with their relative consumption. The framework is one of a small open economy where capital is perfectly mobile while people (in the form of overlapping generations) are immobile, and
where the government uses nonlinear taxation for purposes of redistribution and correction for positional externalities.

The take-home message of this paper is that the tax policy response to relative consumption concerns crucially depends on whether the government can perfectly observe (and hence tax) returns on savings abroad, such that residence-based capital income taxes can be used to their full potential. With a full set of tax instruments, including a flexible residence-based capital income tax, marginal income tax policies derived for a closed economy largely carry over to the small open economy analyzed here. In contrast, when returns on savings abroad cannot be observed, the optimal tax policy rules become very different. In this case, capital income taxes on domestic savings will also be completely ineffective, as such taxes would induce the consumers to move their savings abroad. As a consequence, there is no longer room for capital income taxation, and the labor income tax must therefore indirectly also reflect the corrective purpose that the absent capital income tax would otherwise have had. The policy rules for marginal labor income taxation then become rather complex in the sense of reflecting both the conventional second-best problem due to asymmetric information (as the ability type cannot be observed directly) and another second-best problem due to the fact that capital income taxation cannot be used. Among other results, we show that the optimal marginal labor income tax rate implemented for any ability type can then be written as a weighted sum of two components: (i) the policy rule for marginal labor income taxation that the government would have implemented had the residence-based capital income tax instrument been available (without restrictions); (ii) the policy rule for marginal capital income taxation that the government would have chosen had the residence-based instrument been available. The compensated saving response to an increase in the marginal labor income tax rate largely determines the effectiveness of the labor income tax as an (indirect) instrument to correct for intertemporal positional externalities.

While this paper has taken large steps toward understanding optimal income taxation when the residents of a small open economy engage in status comparisons, there are several possible extensions for future research. First, we have assumed away labor mobility completely in order to keep the analysis as simple as possible. Although we conjecture that most qualitative results will continue to hold in a more general framework with imperfect labor mobility, such an extension would still be useful, not least as a basis on which to develop a numerical model of optimal taxation in an open economy. Second, we have focused only on a single country, and thus we have not addressed the welfare costs of strategic interaction or the scope for tax policy cooperation between different countries. Consequently, there is still room for much more work on redistributive taxation and public

expenditure in economies where people care about social comparisons of various kinds.

Appendix

Proof of Proposition 1: Proposition 1 addresses the optimal tax policy implemented for generation \( t \) when the government has access to a full set of tax instruments.

The Source-Based Capital Tax. The first-order condition for \( \theta_t^s \) can be written as

\[
\sum_{i=1,2} \left( \frac{\partial W_{i,t}}{\partial \theta_t^s} n_{i,t} l_{i,t} + \frac{\partial r_t}{\partial \theta_t^s} n_{i,t-1} s_{i,t-1} \right) - r_t Q_t - \theta_t^s \frac{\partial r_t}{\partial \theta_t^s} Q_t - \theta_t^s r_t \frac{\partial Q_t}{\partial \theta_t^s} = 0. \quad (A1)
\]

Substitute \( \sum_{i} n_{i,t-1} s_{i,t-1} = K_t + Q_t \) into equation (A1) and then use the fact that the zero-profit condition implies \( \sum_i (\partial w_{i,t}/\partial \theta_t^s) n_{i,t} l_{i,t} + (\partial r_t/\partial \theta_t^s) K_t = 0 \). The resulting equation is

\[
(1 - \theta_t^s) \frac{\partial r_t}{\partial \theta_t^s} Q_t - r_t Q_t - \theta_t^s r_t \frac{\partial Q_t}{\partial \theta_t^s} = 0. \quad (A2)
\]

Finally, because \( r_t^n \) is treated as exogenous by the government of the small open economy, equation (4) implies \( (\partial r_t/\partial \theta_t^s)(1 - \theta_t^s) = r_t \). Substituting into equation (A2) implies \( \theta_t^s = 0 \).

Marginal Labor and Capital Income Tax Rates. The first-order conditions for \( w_{1,t}^n, T_{1,t}, r_{1,t+1}^n \), and \( \Phi_{1,t+1} \), which are used to derive the optimal marginal income tax rates implemented for the low-ability type, can be written as follows if we use \( \theta_t^s = 0 \) and the equilibrium condition given by equation (4):

\[
\frac{\partial L}{\partial L_{1,t}} = n_{1,t} l_{1,t} \left( \frac{\partial U_{1,t}}{\partial C_{1,t}} - \gamma_t \right) + \gamma_t n_{1,t} (w_{1,t} - w_{1,t}^n) \frac{\partial l_{1,t}}{\partial w_{1,t}^n} + \gamma_t n_{1,t} (r_{1,t+1} - r_{1,t}^n) \frac{\partial s_{1,t}}{\partial w_{1,t}^n} - \mu_t \frac{\partial c_{1,t}}{\partial w_{1,t}^n} - \mu_{t+1} \frac{n_{1,t}}{N_t} \frac{\partial x_{1,t+1}}{\partial w_{1,t}^n} - \lambda_t \left[ l_{1,t} \frac{\partial \tilde{U}_{2,t}}{\partial C_{1,t}} + \left( w_{1,t}^n \frac{\partial \tilde{U}_{2,t}}{\partial C_{1,t}} - \phi \frac{\partial \tilde{U}_{2,t}}{\partial \omega_{2,t}} \right) \frac{\partial l_{1,t}}{\partial w_{1,t}^n} \right] - \lambda_t \left[ (1 + r_{1,t+1}^n) \frac{\partial \tilde{U}_{2,t}}{\partial x_{1,t+1}} - \left( \frac{\partial \tilde{U}_{2,t}}{\partial C_{1,t}} + \frac{\partial \tilde{U}_{2,t}}{\partial x_{1,t+1}} \right) \frac{\partial s_{1,t}}{\partial w_{1,t}^n} \right] = 0; \quad (A3a)
\]
\[
\frac{\partial L}{\partial T_{1,t}} = -n_{1,t} \left( \frac{\partial U_{1,t}}{\partial c_{1,t}} - \gamma_t \right) + \gamma_t n_{1,t} \left( w_{1,t} - w_{1,t}^n \right) \frac{\partial l_{1,t}}{\partial T_{1,t}} \\
+ \gamma_t n_{1,t} (r_{1,t+1} - \frac{r_{1,t+1}^n}{r_{1,t+1}}) \frac{\partial c_{1,t}}{\partial r_{1,t+1}} - \mu_t n_{1,t} \frac{\partial c_{1,t}}{\partial T_{1,t}} - \mu_t n_{1,t} \frac{\partial x_{1,t+1}}{\partial T_{1,t}} \\
- \lambda_t \left[ \frac{\partial U_{2,t}}{\partial c_{1,t}} + \left( \frac{w_{2,t}^n}{\partial c_{1,t}} - \phi \frac{\partial U_{2,t}}{\partial x_{1,t+1}} \right) \frac{\partial l_{1,t}}{\partial T_{1,t}} \\
- \frac{\partial U_{2,t}}{\partial x_{1,t+1}} - \frac{\partial U_{2,t}}{\partial \Delta_{t+1}} \right] \frac{\partial s_{1,t}}{\partial T_{1,t}} = 0; \quad (A3b)
\]

\[
\frac{\partial L}{\partial r_{1,t+1}^n} = n_{1,t} \left( \frac{\partial U_{1,t}}{\partial x_{1,t+1}} - \gamma_t + 1 \right) + \gamma_t n_{1,t} \left( w_{1,t} - w_{1,t}^n \right) \frac{\partial l_{1,t}}{\partial r_{1,t+1}^n} \\
+ \gamma_t n_{1,t} (r_{1,t+1} - \frac{r_{1,t+1}^n}{r_{1,t+1}}) \frac{\partial c_{1,t}}{\partial r_{1,t+1}} - \mu_t n_{1,t} \frac{\partial c_{1,t}}{\partial r_{1,t+1}} - \mu_t n_{1,t} \frac{\partial x_{1,t+1}}{\partial r_{1,t+1}} \\
- \lambda_t \left[ \frac{w_{1,t}^n}{\partial c_{1,t}} - \phi \frac{\partial U_{2,t}}{\partial x_{1,t+1}} \right] \frac{\partial l_{1,t}}{\partial r_{1,t+1}} + \frac{\partial s_{1,t}}{\partial r_{1,t+1}^n} \right] = 0; \quad (A3c)
\]

\[
\frac{\partial L}{\partial \Phi_{1,t+1}} = -n_{1,t} \left( \frac{\partial U_{1,t}}{\partial x_{1,t+1}} - \gamma_t + 1 \right) + \gamma_t n_{1,t} \left( w_{1,t} - w_{1,t}^n \right) \frac{\partial l_{1,t}}{\partial \Phi_{1,t+1}} \\
+ \gamma_t n_{1,t} (r_{1,t+1} - \frac{r_{1,t+1}^n}{r_{1,t+1}}) \frac{\partial c_{1,t}}{\partial \Phi_{1,t+1}} - \mu_t n_{1,t} \frac{\partial c_{1,t}}{\partial \Phi_{1,t+1}} \\
- \mu_{t+1} \frac{n_{1,t}}{N_{t+1}} \frac{\partial x_{1,t+1}}{\partial \Phi_{1,t+1}} - \lambda_t \left[ \frac{w_{1,t}^n}{\partial \Phi_{1,t+1}} - \phi \frac{\partial U_{2,t}}{\partial x_{1,t+1}} \right] \frac{\partial l_{1,t}}{\partial \Phi_{1,t+1}} - \frac{\partial s_{1,t}}{\partial \Phi_{1,t+1}} \right] = 0. \quad (A3d)
\]

In equations (A3a)–(A3d), we have used the following short notations:

\[
\frac{\partial c_{1,t}}{\partial w_{1,t}^n} = l_{1,t} + w_{1,t}^n \frac{\partial l_{1,t}}{\partial w_{1,t}^n} - \frac{\partial s_{1,t}}{\partial w_{1,t}^n},
\]

\[
\frac{\partial c_{1,t}}{\partial T_{1,t}} = -1 + w_{1,t}^n \frac{\partial l_{1,t}}{\partial T_{1,t}} - \frac{\partial s_{1,t}}{\partial T_{1,t}},
\]

\[
\frac{\partial c_{1,t}}{\partial r_{1,t+1}^n} = w_{1,t}^n \frac{\partial l_{1,t}}{\partial r_{1,t+1}^n} - \frac{\partial s_{1,t}}{\partial r_{1,t+1}^n}.
\]

\[ \frac{\partial c_{1,t}}{\partial \Phi_{1,t+1}} = w_{1,t}^{\alpha_t} \frac{\partial h_{1,t}}{\partial \Phi_{1,t+1}} - \frac{\partial s_{1,t}}{\partial \Phi_{1,t+1}}, \]
\[ \frac{\partial x_{1,t+1}}{\partial w_{1,t}^{\alpha_t}} = (1 + r_{1,t+1}^{n}) \frac{\partial s_{1,t}}{\partial w_{1,t}^{n}}, \]
\[ \frac{\partial x_{1,t+1}}{\partial T_{1,t}} = (1 + r_{1,t+1}^{n}) \frac{\partial s_{1,t}}{\partial T_{1,t}}, \]
\[ \frac{\partial x_{1,t+1}}{\partial r_{1,t+1}^{n}} = s_{1,t} + (1 + r_{1,t+1}^{n}) \frac{\partial s_{1,t}}{\partial r_{1,t+1}^{n}}, \]
\[ \frac{\partial x_{1,t+1}}{\partial \Phi_{1,t+1}} = -1 + (1 + r_{1,t+1}^{n}) \frac{\partial s_{1,t}}{\partial \Phi_{1,t+1}}. \]

The corresponding first-order conditions for \( w_{2,t}^{n}, T_{2,t}, r_{2,t+1}^{n}, \) and \( \Phi_{2,t+1} \), which are used to derive the marginal income tax rates implemented for the high-ability type, are written as

\[
\frac{\partial L}{\partial w_{2,t}^{n}} = \left[ (n_{2,t} + \lambda) \frac{\partial U_{2,t}}{\partial c_{2,t}^{n}} - n_{2,t} \gamma_{t} \right] + \gamma_{t} n_{2,t} (w_{2,t}^{n} - w_{2,t}^{n}) \frac{\partial l_{2,t}}{\partial w_{2,t}^{n}}
+ \gamma_{t+1} n_{2,t} (r_{t+1} - r_{2,t+1}^{n}) \frac{\partial s_{2,t}}{\partial w_{2,t}^{n}} - \mu_{t} \frac{n_{2,t}}{N_{t}} \frac{\partial c_{2,t}^{n}}{\partial w_{2,t}^{n}} - \mu_{t+1} \frac{n_{2,t}}{N_{t+1}} \frac{\partial x_{2,t+1}}{\partial w_{2,t}^{n}} = 0, \tag{A3e}
\]

\[
\frac{\partial L}{\partial T_{2,t}} = -\left[ (n_{2,t} + \lambda) \frac{\partial U_{2,t}}{\partial c_{2,t}^{n}} - \gamma_{t} \right] + \gamma_{t} n_{2,t} (w_{2,t}^{n} - w_{2,t}^{n}) \frac{\partial l_{2,t}}{\partial T_{2,t}}
+ \gamma_{t+1} n_{2,t} (r_{t+1} - r_{2,t+1}^{n}) \frac{\partial s_{2,t}}{\partial T_{2,t}} - \mu_{t} \frac{n_{2,t}}{N_{t}} \frac{\partial c_{2,t}^{n}}{\partial T_{2,t}} - \mu_{t+1} \frac{n_{2,t}}{N_{t+1}} \frac{\partial x_{2,t+1}}{\partial T_{2,t}} = 0, \tag{A3f}
\]

\[
\frac{\partial L}{\partial r_{2,t+1}^{n}} = s_{2,t} \left[ (n_{2,t} + \lambda) \frac{\partial U_{2,t}}{\partial x_{2,t+1}^{n}} - n_{2,t} \gamma_{t+1} \right] + \gamma_{t} n_{2,t} (w_{2,t}^{n} - w_{2,t}^{n}) \frac{\partial l_{2,t}}{\partial r_{2,t+1}^{n}}
+ \gamma_{t+1} n_{2,t} (r_{t+1} - r_{2,t+1}^{n}) \frac{\partial s_{2,t}}{\partial r_{2,t+1}^{n}} - \mu_{t} \frac{n_{2,t}}{N_{t}} \frac{\partial c_{2,t}^{n}}{\partial r_{2,t+1}^{n}}
- \mu_{t+1} \frac{n_{2,t}}{N_{t+1}} \frac{\partial x_{2,t+1}}{\partial r_{2,t+1}^{n}} = 0, \tag{A3g}
\]

\[
\frac{\partial L}{\partial \Phi_{2,t+1}} = - \left[ (n_{2,t} + \lambda t) \frac{\partial U_{2,t}}{\partial x_{2,t+1}} - n_{2,t} \gamma_{t+1} \right] + \gamma_{t+1} n_{2,t} (w_{2,t} - w_{2,t}^n) \frac{\partial l_{2,t}}{\partial \Phi_{2,t+1}} \\
+ \gamma_{t+1} n_{2,t} (r_{2,t+1} - r_{2,t+1}^n) \frac{\partial s_{2,t}}{\partial \Phi_{2,t+1}} - \mu_t n_{2,t} \frac{\partial c_{2,t}}{\partial \Phi_{2,t+1}} \\
- \mu_{t+1} n_{2,t} \frac{\partial x_{2,t+1}}{N_{t+1}} = 0, \text{ (A3h)}
\]

where

\[
\begin{align*}
\frac{\partial c_{2,t}}{\partial w_{2,t}^n} &= l_{2,t} + w_{2,t}^n \frac{\partial l_{2,t}}{\partial w_{2,t}^n} - \frac{\partial s_{2,t}}{\partial w_{2,t}^n}, \\
\frac{\partial c_{2,t}}{\partial T_{2,t}} &= -1 + w_{2,t}^n \frac{\partial l_{2,t}}{\partial T_{2,t}} - \frac{\partial s_{2,t}}{\partial T_{2,t}}, \\
\frac{\partial c_{2,t}}{\partial r_{2,t+1}^n} &= w_{2,t}^n \frac{\partial l_{2,t}}{\partial r_{2,t+1}^n} - \frac{\partial s_{2,t}}{\partial r_{2,t+1}^n}, \\
\frac{\partial c_{2,t}}{\partial \Phi_{2,t+1}} &= w_{2,t}^n \frac{\partial l_{2,t}}{\partial \Phi_{2,t+1}} - \frac{\partial s_{2,t}}{\partial \Phi_{2,t+1}}, \\
\frac{\partial x_{2,t+1}}{\partial w_{2,t}^n} &= (1 + r_{2,t+1}^n) \frac{\partial s_{2,t}}{\partial w_{2,t}^n}, \\
\frac{\partial x_{2,t+1}}{\partial T_{2,t}} &= (1 + r_{2,t+1}^n) \frac{\partial s_{2,t}}{\partial T_{2,t}}, \\
\frac{\partial x_{2,t+1}}{\partial r_{2,t+1}^n} &= s_{2,t} + (1 + r_{2,t+1}^n) \frac{\partial s_{2,t}}{\partial r_{2,t+1}^n}, \\
\frac{\partial x_{2,t+1}}{\partial \Phi_{2,t+1}} &= -1 + (1 + r_{2,t+1}^n) \frac{\partial s_{2,t}}{\partial \Phi_{2,t+1}}.
\end{align*}
\]

Consider, first, the marginal labor income and capital income tax rates implemented for the low-ability type. Multiply the right-hand side of equation (A3b) by \( l_{1,t} \) and add the resulting expression to the right-hand side of equation (A3a). After some manipulations, this gives

\[
\gamma_{t} n_{1,t} \Omega_{1,t} \left( \frac{\partial l_{1,t}}{\partial w_{1,t}^n} + \frac{\partial l_{1,t}}{\partial T_{1,t}} l_{1,t} \right) + \gamma_{t+1} n_{1,t} \Psi_{1,t} \left( \frac{\partial s_{1,t}}{\partial w_{1,t}^n} + \frac{\partial s_{1,t}}{\partial T_{1,t}} l_{1,t} \right) = 0, \text{ (A4)}
\]

where

\[
\Omega_{1,t} = \tau_{1,t} w_{1,t} - \frac{\lambda^*}{n_{1,t}} (MRS_{1,t}^{z,c} - \phi MRS_{2,t}^{z,c}) + \frac{MRS_{1,t}^{z,c} \mu_t}{N_t} \gamma_t \text{ (A5)}
\]

and
\[ \Psi_{1,t} = \theta_{1,t+1} r_{1,t+1} - \frac{\lambda_t (\partial \bar{U}_{2,t} / \partial x_{1,t+1})}{\gamma_{t+1} n_{1,t}} (MRS_{1,1,t}^{c,x} - MRS_{2,1,t}^{c,x}) \]
\[ + \frac{1}{\gamma_{t+1}} \left( \frac{\mu_t}{N_t} - MRS_{1,1,t}^{c,x} \frac{\mu_{t+1}}{N_{t+1}} \right). \]  
\( \text{(A6)} \)

Similarly, multiply the right-hand side of equation (A3d) by \( s_{1,t} \) and add the resulting expression to the right-hand side of equation (A3c). This gives
\[ \gamma_{t+1} n_{1,t} \Omega_{1,t} \left( \frac{\partial l_{1,t}}{\partial \mu_{1,t+1}} + \frac{\partial l_{1,t}}{\partial \Phi_{1,t+1}} s_{1,t} \right) + \gamma_{t+1} n_{1,t} \Psi_{1,t} \left( \frac{\partial s_{1,t}}{\partial \mu_{1,t+1}} + \frac{\partial s_{1,t}}{\partial \Phi_{1,t+1}} s_{1,t} \right) = 0. \]
\( \text{(A7)} \)

The system of equations (A4) and (A7) is solved by setting \( \Omega_{1,t} = 0 \) and \( \Psi_{1,t} = 0 \), which gives the marginal labor income and capital income tax rates for the low-ability type in equation (14a) and (14b), respectively. The marginal labor income and capital income tax rates implemented for the high-ability type can be derived in exactly the same way by using equations (A3e)–(A3h).

\[ \square \]

**Proof of Proposition 2**: Proposition 2 derives the marginal labor income tax rates and the source-based capital income tax in the case where the residence-based capital income tax instrument is absent, in which case \( r_{l,t+1} \) no longer constitutes a decision variable for the government. By using the same type of calculations as in equations (A1) and (A2), it follows that \( \theta_t^* = 0 \) in this case as well.

Turning to marginal labor income taxation, consider once again the formula implemented for the low-ability type. The first-order conditions for \( w_{1,t}, T_{1,t}, \) and \( \Phi_{1,t+1} \) take the same general form as in equations (A3a), (A3b), and (A3d), respectively, with the modification that \( r_{l,t+1} = \bar{r}_i \) for \( i = 1, 2 \). Because \( \theta_t^* = 0 \), this also means that \( r_t - r_{l,t+1} = 0 \) in equations (A3a), (A3b), and (A3d). The analogue to equation (A4) can thus be written as
\[ \gamma_{t+1} n_{1,t} \Omega_{1,t} \left( \frac{\partial l_{1,t}}{\partial w_{1,t}} + \frac{\partial l_{1,t}}{\partial T_{1,t}} I_{1,t} \right) + \gamma_{t+1} n_{1,t} B_{1,t} \left( \frac{\partial s_{1,t}}{\partial w_{1,t}} + \frac{\partial s_{1,t}}{\partial T_{1,t}} I_{1,t} \right) = 0, \]
\( \text{(A8)} \)

where \( \Omega_{1,t} \) is given by equation (A5) and
\[ B_{1,t} = -\frac{\lambda_t (\partial \bar{U}_{2,t} / \partial x_{1,t+1})}{\gamma_{t+1} n_{1,t}} \left( MRS_{1,1,t}^{c,x} - MRS_{2,1,t}^{c,x} \right) + \frac{1}{\gamma_{t+1}} \left( \frac{\mu_t}{N_t} - MRS_{1,1,t}^{c,x} \frac{\mu_{t+1}}{N_{t+1}} \right). \]

Using equation (A5) in equation (A8) and solving for \( \tau_{1,t} \) gives equation (19) for the low-ability type. The marginal labor income tax implemented for the high-ability type can be derived in exactly the
same way by using equations (A3e), (A3f), and (A3h) together with the additional restriction \( r_t - r_{z,t+1}^a = 0 \).

Supporting Information

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Online Appendix

References


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