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Keeping up with the Joneses, the Smiths and the Tanakas: On international tax coordination and social comparisons☆

Thomas Aronsson [a,*], Olof Johansson-Stenman [b]

[a] Department of Economics, Umeå School of Business and Economics, Umeå University, SE – 901 87 Umeå, Sweden
[b] Department of Economics, School of Business, Economics and Law, University of Gothenburg, SE – 405 30 Gothenburg, Sweden

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ABSTRACT

Recent evidence suggests that social comparisons between people in different countries have become more important over time due to globalization. This paper deals with optimal nonlinear income taxation in an international setting, where consumers derive utility from their relative consumption compared both with other domestic residents and people in another country. The optimal tax policy in our framework reflects both correction for positional externalities and redistributive aspects of such correction due to the incentive constraint facing each government. If the national governments behave as Nash competitors to each other, the resulting tax policy only internalizes the externalities that are due to within-country comparisons, whereas the tax policy chosen by the leader country in a Stackelberg game also to some extent reflects between-country comparisons. We also derive globally Pareto-efficient tax policies in a cooperative framework, and conclude that there are potentially large welfare gains of international tax policy coordination.

1. Introduction

The issue of international tax coordination has recently gained much attention, largely due to the work by Piketty (2014). His central policy recommendation in order to deal with growing inequalities is international tax policy coordination, in particular with respect to capital taxes and progressive income taxes, where the need for tax coordination is motivated primarily by international capital mobility. In the present paper we analyze another potentially powerful motive for international tax coordination, namely international social comparisons. Our motivation and approach are outlined below.

The globalization process has implied that information about people and their living conditions in other parts of the world has increased rapidly in recent decades. Indeed, the technological advancement of TV, Internet, and social media together with increased traveling have resulted in much better knowledge of the living conditions of others, and of some people in particular (such as the rich and famous), than was the case only a couple of decades ago. This suggests that people's reference consumption is increasingly determined by consumption levels in other countries than their own. The present paper examines such between-country comparisons and identifies the corresponding implications for optimal income tax policy, which to our knowledge have not been addressed before.

A rapidly growing literature deals with optimal tax policy implications of relative consumption concerns based on *one-country* models; see, e.g., Boskin and Sheshinski (1978), Oswald (1983), Frank (1985a, 2005, 2008), Tuomala (1990), Persson (1995), Corneo and Jeanne (1997), Ljungqvist and Uhlig (2000), Ireland (2001), Dupor and Liu (2003), Abel (2005), Aronsson and Johansson-Stenman (2008, 2010), Wendner (2010, 2014), Alvarez-Cuadrado and Long (2011, 2012), Eckerstorfer and Wendner (2013), and Kanbur and Tuomala (2014). Our paper extends this literature to a *two-country* framework, where each individual derives utility from his/her relative consumption

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* Corresponding author.
E-mail addresses: Thomas.Aronsson@econ.umu.se (T. Aronsson), Olof.Johansson@economics.gu.se (O. Johansson-Stenman).

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compared both with other domestic residents and people in the other country. More specifically, the main purpose is to examine the implications for optimal income taxation of such a broader framework for social comparisons. In doing so, we analyze the tax policy outcome of Nash and Stackelberg competition between national governments as well as characterize the Pareto efficient marginal income tax structure for the global economy as a whole.

Much of the empirical happiness and questionnaire-based research dealing with individual well-being and relative consumption is silent about the role of cross-country comparisons, which is not surprising given the difficulties of measuring such effects.[1] Yet, several authors have recently suggested that such comparisons have most likely become more important over time (e.g., Friedman, 2005; Zhang et al., 2009; Clark and Senik, 2011; Becchetti et al., 2013).[2] For example, Becchetti et al. (2013) examine the determinants of self-reported life satisfaction using survey-data for countries in Western Europe from the early 1970s to 2002. To be able to assess the effects of cross-country comparisons and whether these effects have changed over time, the authors control for determinants of subjective well-being discussed in earlier literature, including relative income measures based on national comparisons (across education, age, and gender groups) as well as domestic GDP. Interestingly, the results show that the distance between the GDP of the individual's own country and the GDP of the richest country in the data reduces individual life satisfaction, and that the contribution of such cross-country comparisons to well-being increased over the study period. A possible interpretation is that the increased globalization through technological advancements in recent decades has meant that social comparisons between countries now have a greater influence on individual well-being than before.[3]

Moreover, Piketty (2014) argues that cross-country social comparisons seem to constitute an important part of the motivation behind Thatcher's and Reagan's drastic income tax reductions in the early 1980s. At that time, both the US and the UK had seen lower growth rates than other Western European countries and Japan for several decades and hence experienced that other countries were catching up. According to Piketty (2014, 509): “For countries as well as individuals, the wealth hierarchy is not just about money; it is also a matter of honor and moral values.”

The policy implications of social comparisons between countries remain largely unexplored. To our knowledge, the only exception is Aronsson and Johansson-Stenman (2014), who analyze the optimal provision of national and global public goods in a two-country setting where each individual derives well-being from his/her relative private consumption through within- and between-country comparisons, as well as from the relative consumption of national public goods through between-country comparisons. However, their study does not address optimal taxation but implicitly assumes that each government can raise sufficient revenue for public provision through lump-sum taxation, implying that both externality-correcting and redistributive roles of the tax system are ignored.

The present study adds at least two important new dimensions. First, since all previous studies on tax policy and relative consumption that we are aware of are based on one-country model economies, the policy incentives associated with between-country comparisons, as well as those resulting from interaction between such comparisons and the (conventional) within-country comparison, remain to be explored. Arguably, this is empirically relevant for the reasons mentioned above. Second, since between-country comparisons give rise to international externalities, the tax policies decided by national governments are no longer necessarily efficient at the global level. This leads to the question of tax policy coordination and cooperation among countries. There are of course other well-known arguments for coordinated tax policy, including cross-country environmental externalities as well as international labor and capital mobility; see, e.g., Carraro and Siniscalco (1993), Huber (1999), Aronsson and Blomquist (2003), Keen and Konrad (2013), and Bierbrauer et al. (2013). Yet, the issue of between-country comparisons has been neglected so far in the study of tax policy under social interaction. Since the aim is to better understand the mechanisms of social interaction and their tax policy implications, we will throughout the paper ignore these other motives for policy coordination. This does not reflect a belief that these other motives are less important, but rather that they are well understood from earlier research.

Section 2 presents the basic model of a two-country economy, where individual utility depends on the individual's own consumption of goods and leisure as well as on the individual's relative consumption based on within-country and between-country comparisons, respectively. Section 3 deals with optimal income taxation for a baseline case where individuals are identical within each country (although not necessarily between the countries). This model implies that income taxation has no redistributive purpose and is motivated solely by the desire to internalize the positional externalities. As such, it generalizes results derived by, e.g., Persson (1995), Ljungqvist and Uhlig (2000), and Dupor and Liu (2003) to a two-country setting. We start with the non-cooperative Nash solution, where each country takes the behavior of the other country as given. Each government will then fully internalize the positional externalities affecting people within its own country, but completely ignore the externalities affecting the other country. These externality-correcting taxes are expressed in terms of (empirically estimable) *degrees of positionality*, i.e., the degree to which relative consumption matters compared with absolute consumption.

However, while Nash competition is a common assumption in earlier literature on international externalities, it is not always the most realistic one since the ability to commit to public policy may differ among countries (e.g., due to differences in resources, size, and opportunities). Therefore, we also analyze a Stackelberg equilibrium where one country is acting leader and the other is a follower. While the policy incentives faced by the follower are analogous to those in the Nash equilibrium, we show that the leader will also take into account the externalities it causes to the follower country. The reason is, of course, that the leader recognizes the behavioral responses of the follower and adapts its tax policy accordingly. If the preferences of the individuals in the follower country are characterized by a keeping-up-with-the-Joneses property, such that they prefer to consume more (and hence use less leisure) when individuals in the leader country consume more, ceteris paribus, then this constitutes a reason for the government of the leader country to increase the marginal income tax rate beyond the Nash equilibrium rate, and vice versa.

Section 4 analyzes the potential for cooperative behavior. First, we show that there is scope for Pareto improvements through a small coordinated increase in the marginal income tax rates, if the economy is in Nash or Stackelberg equilibrium. Second, we consider a framework where each government can pay the other country for increasing its marginal income tax rates. We then obtain a globally Pareto-efficient allocation implying that each government will fully internalize all positional externalities associated with private consumption, including those imposed on the other country. This is in the symmetric case

[1] See, e.g., Easterlin (2001), Johansson-Stenman et al. (2002), Blanchflower and Oswald (2004), Ferrer-i-Carbonell (2005), Solnick and Hemenway (2005), Carlsson et al. (2007), Clark et al. (2008), Senik (2009), Clark and Senik (2010), and Card et al. (2012). This literature typically assumes that relative consumption concerns are driven by within-country comparisons (based on various reference groups) or does not specify relative consumption in a jurisdictional context. Evidence for relative consumption concerns can also be found in literature on brain science (Fliessbach et al., 2007; Dohmen et al., 2011) and in experimental work on productivity (Cohn et al., 2014), and there are also plausible evolutionary explanations for such concerns; see, e.g., Rayo and Becker (2007) and Wolpert (2010).

[2] See also James (1987) for an early discussion of how tastes (including positional concerns) are transferred from developed to developing countries. Friehe and Mechtel (2014) analyze how the political regime affects preferences for conspicuous consumption based on data for East and West Germany after the reunification.

[3] Arguably, this interpretation presupposes that relative consumption concerns are not independent of access to social media. Indeed, in a recent survey of Europeans, Clark and Senik (2010) found that people without access to the Internet are less concerned with their relative consumption than people with such access.

accomplished through a simple Pigouvian tax based on the sum of the marginal willingness to pay of all individuals, within as well as between the countries, to avoid the externality. In turn, this corrective tax depends on the extent to which relative consumption is important for individual well-being both in the domestic and foreign dimensions. Section 5 acknowledges the fact that some goods tend to be more positional than others, and then outlines the implications in terms of differential consumption taxation in a two-country world.

Section 6 generalizes the model used in Sections 3–4 to the more realistic case where there are also redistributional concerns within each country, and where the government has to rely on distortionary taxation for this redistribution due to asymmetric information. This generalization is clearly relevant from a practical policy perspective, and also because earlier literature shows that the optimal tax policy responses to relative consumption concerns in second-best economies may differ substantially from the policy responses typically derived in a full information context (see, e.g., Oswald, 1983; Tuomala, 1990; Ireland, 2001; Aronsson and Johansson-Stenman, 2008, 2010).

As the basic work horse in Section 6, we use an extension of the two-type model developed by Stern (1982) and Stiglitz (1982), where the government in each country can use nonlinear income taxes but cannot tax leisure or ability directly. This two-type model provides a useful framework for characterizing how corrective and redistribution motives for taxation jointly contribute to policy incentives. From a practical policy perspective, this model obviously gives a highly simplified picture of society.[4] However, the purpose here is not to determine the appropriate marginal tax levels but rather analyze how social comparisons modify the policy rules for marginal income taxation. These modifications would be very similar if they were instead based on a much less tractable model with many ability types.[5] Based on such two-type models, we then show that the basic findings obtained in Sections 3–4 continue to hold under certain conditions, but that interactions between externality correction and redistribution through the self-selection constraint may also have important implications for optimal taxation.

Section 7 concludes that international social comparisons have important implications for optimal income tax policy and that they also constitute a potentially important reason for international tax policy coordination — a reason that will most likely become even more important over time as globalization continues. Proofs of the propositions are presented in the Appendix.

2. Preferences and individual behavior

In this section, we outline the basics of our model assuming that people have preferences for relative consumption both within and between countries. We have no ambition to explain *why* people derive utility from their relative consumption. An alternative approach would be to start from conventional preferences where relative consumption has a purely instrumental value (see, e.g., Cole et al., 1995, for arguments in favor of this approach and Bilancini and Boncinelli, 2014, for an interesting application in terms of matching). Yet, while we certainly share the view that there are important instrumental reasons underlying why relative consumption matters, we see two main reasons for simply imposing such concerns directly into the utility function in the present paper. First, the fact that there has been an important evolutionary value to have more wealth than others provides an obvious reason for why selfish genes would prefer to belong to people with preferences for relative wealth and status (just as they would prefer to belong to people with preferences for having sex and against eating poisoned food); cf., Frank (1985b), Samuelson (2004), and Rayo and Becker (2007).[6] Second, the shortcut to ignore instrumental reasons in the model, and hence focus solely on effects through the utility function, makes the model comparable to much earlier literature on public policy and relative consumption as well as more tractable and suitable for analyzing the optimal tax problems at stake.

The model consists of two countries with fixed populations.[7] To begin with, we assume that the population in each country consists of a fixed number of identical individuals normalized to one. This assumption is relaxed in Section 6 below, where we introduce differences in ability (productivity) between individuals and assume that this ability is private information. Each individual in country i derives utility from his/her absolute consumption of goods, c^i, and use of leisure, z^i, and also from his/her relative consumption compared with other people. The latter is of two kinds: relative consumption compared with other people in the individual's own country, R^i, and relative consumption compared with people in the other country, S^i. Relative consumption of the first kind can then be written as $R^i = r^i(c^i, \bar{c}^i)$, where $\bar{c}^i$ is average consumption in country i. Correspondingly, we can write relative consumption of the second kind, i.e., compared with people in the other country k, as $S^i = s^i(c^i, \bar{c}^k)$. To simplify the analysis, we follow many previous studies in assuming a convenient difference comparison form,[8] such that $r^i(c^i, \bar{c}^i) = c^i - \bar{c}^i$ and $s^i(c^i, \bar{c}^k) = c^i - \bar{c}^k$.

The utility function faced by the representative individual in country i is given by[9]

$$\begin{aligned} U^i &= v^i\left(c^i, z^i, R^i, S^i\right) = v^i\left(c^i, z^i, r^i\left(c^i, \bar{c}^i\right), s^i\left(c^i, \bar{c}^k\right)\right) \\ &= v^i\left(c^i, z^i, c^i - \bar{c}^i, c^i - \bar{c}^k\right) = u^i\left(c^i, z^i, \bar{c}^i, \bar{c}^k\right) \end{aligned}, \quad (1)$$

where $v^i(\cdot)$ and $u^i(\cdot)$ are twice continuously differentiable. The function $v^i(\cdot)$ is assumed to be increasing in each argument and strictly quasi-concave, and describes the individual's utility as a function of his/her own consumption and use of leisure, respectively, as well as of his/her relative consumption compared with others. The function $u^i(\cdot)$ is a convenient reduced form allowing us to shorten some of the notations below. For further use, we summarize the relationships between $u^i(\cdot)$ and $v^i(\cdot)$ as follows: $u^i_c = v^i_c + v^i_R + v^i_S$, $u^i_z = v^i_z$, $u^i_{\bar{c}^i} = -v^i_R$, and $u^i_{\bar{c}^k} =$

[4] For instance, results derived for the high-ability type in such a framework would only be valid for the highest ability type in a model with more than two types. Indeed, the optimal tax policy implemented for the high-ability type in a two-type model tends to provide a bad approximation of the optimal tax policy for almost all ability levels in more realistic models based on a continuous ability distribution. Yet, again, this does not affect the insights provided in the present paper.

[5] Another alternative would be to consider a linear tax problem. However, results based on models restricted to linear tax instruments are typically much harder to interpret since they, in addition to the inherent second-best problem due to information limitation, also reflect the rather arbitrary linearity restriction.

[6] One might object that the evolutionary arguments are stronger for social comparisons within small groups than between countries, just as the evolutionary arguments for pro-social behavior are stronger within small groups. While agreeing in principle, we still have two counter-arguments: First, there is compelling evidence in favor of what Singer (1983) denotes *the expanding circle* with respect to pro-social behavior and ethics, i.e., that human beings over time tend to take into account consequences for larger and larger groups of people; see in particular Pinker (2012). Second, we are not biologically well adapted to recent technological developments, implying, e.g., that we may emotionally perceive people on TV to be closer to us than most people who live on the same block.

[7] In a working paper version, Aronsson and Johansson-Stenman (2015), we show that most results would carry over to an economy with n (instead of two) countries.

[8] Although flexible functional forms are preferable to more restrictive formulations, ceteris paribus, it is of no great importance for the qualitative results whether the analysis is based on difference comparisons (such as in Akerlof, 1997; Corneo and Jeanne, 1997; Ljungqvist and Uhlig, 2000; Bowles and Park, 2005; Carlsson et al., 2007) or ratio comparisons (such as in Boskin and Sheshinski, 1978; Layard, 1980; Abel, 2005; Wendner and Goulder, 2008). Mujcic and Frijters (2013) compare models based on difference comparisons, ratio comparisons, and rank comparisons without being able to discriminate between them, whereas Corazzini et al. (2012) find that absolute differences, and not only rank, matter, suggesting that models based solely on rank comparisons are more restrictive than the other formulations. Aronsson and Johansson-Stenman (2013b) show that the optimal tax policy implications of relative consumption concerns tend to be qualitatively similar regardless of whether these comparisons take the difference or ratio form.

[9] Following most previous comparable literature, we assume that leisure is completely non-positional, meaning that people only care about the absolute level of leisure. Aronsson and Johansson-Stenman (2013a) analyze a model of optimal taxation where the consumers have positional preferences with respect to both private consumption and leisure.

$-v_S^i$, where subscripts denote partial derivatives, i.e., $u_c^i = \partial u^i/\partial c^i$, $v_c^i = \partial v^i/\partial c^i$, $v_R^i = \partial v^i/\partial R^i$, and $v_S^i = \partial v^i/\partial S^i$, and similarly for the other partial derivatives. Note also that people in the different countries need not be identical regarding consumption levels or preferences.

The government in country i can tax private income (and hence consumption) by utilizing an income tax t^i and distribute back the revenues in lump-sum form, such that each individual receives a lump-sum payment, τ^i, regardless of behavior. For simplicity we assume a linear technology and perfect competition, implying zero profits, and that productivity is fixed with before-tax wage rates w^i. The individual budget constraint can then be written as

$$w^i\left(\Omega - z^i\right)\left(1 - t^i\right) + \tau^i = c^i, \tag{2}$$

where Ω is the total time available (i.e., 24 hours a day).

Although the measures of reference consumption facing the representative consumer in country i, i.e., $\bar{c}^i$ and $\bar{c}^k$, are endogenous in our model, we assume that each individual treats them as exogenous. This reflects the idea that each individual is small relative to the economy as a whole, which is the conventional assumption in models with externalities. The individual first-order condition regarding the consumption-leisure tradeoff then becomes

$$u_c^i w^i\left(1 - t^i\right) = u_z^i, \tag{3}$$

where (as before) subscripts denote partial derivatives.

2.1. Degrees of positionality

The optimal tax policy presented below depends on *the extent* to which relative consumption matters at the individual level (and not just on *whether or not* it matters). Following Johansson-Stenman et al. (2002) and Aronsson and Johansson-Stenman (2014), we introduce the concept of "degrees of positionality" as reflections of the extent to which relative consumption matters for the marginal utility of consumption. Since we have two countries, we will have different measures for the extent to which relative consumption matters within the country and the extent to which it matters between countries.

Let us define *the degree of domestic positionality* as

$$\alpha^i = \frac{v_R^i r_c^i}{v_c^i + v_R^i r_c^i + v_S^i s_c^i} = \frac{v_R^i}{v_c^i + v_R^i + v_S^i}, \tag{4}$$

where the last formulation follows due to our difference comparison form. The variable α^i thus reflects the fraction of the overall utility increase from the last dollar consumed that is due to the increased relative consumption compared with other people in the individual's own country. Similarly, we can define *the degree of foreign positionality* as

$$\beta^i = \frac{v_S^i s_c^i}{v_c^i + v_R^i r_c^i + v_S^i s_c^i} = \frac{v_S^i}{v_c^i + v_R^i + v_S^i}, \tag{5}$$

which reflects the fraction of the overall utility increase from the last dollar consumed by the representative consumer in country i that is due to the increased relative consumption compared with people in the other country. *The total degree of positionality* is then correspondingly defined as

$$\rho^i = \alpha^i + \beta^i, \tag{6}$$

meaning that ρ^i reflects the fraction of the utility increase from the last dollar consumed that is due to increased relative consumption of any kind, i.e., including comparisons with people both within and outside the individual's own country.

3. Optimal tax policy and noncooperative behavior

We start in Subsection 3.1 by considering the policy implications of a Nash equilibrium such that each national government treats the decisions made in the other country as exogenous. In Subsection 3.2, we consider a Stackelberg equilibrium, where one of the countries is acting as leader and the other as a follower.

3.1. Nash competition

The decision-problem of the government in country i implies the maximization of U^i, where the externalities that each domestic resident imposes on other domestic residents are taken into account, while the externalities imposed on the other country remain uninternalized. Thus, the government in country i recognizes that $\bar{c}^i$ is endogenous, while it treats $\bar{c}^k$ as exogenous. By using that the tax revenue is returned lump-sum to the consumer, the resource constraint for country i is given by

$$w^i\left(\Omega - z^i\right) = c^i. \tag{7}$$

For presentational convenience, we follow convention in the literature on optimal nonlinear taxation in writing the public decision-problem in country i as a direct decision problem, which is solved by choosing c^i and z^i to maximize the utility function in Eq. (1) subject to the resource constraint and $c^i = \bar{c}^i$, while treating $\bar{c}^k$ as exogenous. Based on the utility formulation $u^i(\cdot)$ in Eq. (1), the Lagrangean can be written as

$$L^i = u^i\left(c^i, z^i, \bar{c}^i, \bar{c}^k\right) + \gamma^i\left(w^i\left(\Omega - z^i\right) - c^i\right). \tag{8}$$

The corresponding first-order conditions are given by

$$u_c^i + u_{\bar{c}^i}^i = \gamma^i, \tag{9}$$

$$u_z^i = \gamma^i w^i. \tag{10}$$

A Nash equilibrium in this economy is an allocation such that Eqs. (3), (7), (9), and (10) are satisfied simultaneously for both countries. Since our model is based on the general utility functions given in Eq. (1), rather than a specific functional form, we are of course not able to derive closed form solutions for the variables involved. However, such explicit solutions are not required for a general characterization of the marginal income tax rates implicit in Nash equilibrium, which is our concern here. By using Eqs. (9) and (10) and the private first-order condition for labor supply given by Eq. (3), we obtain the following result:

Proposition 1. *In Nash equilibrium, the marginal income tax rate facing the representative consumer in country i is given by* $t^i = \alpha^i$.

Hence, the marginal tax is simply given by the sum of people's marginal willingness to pay for an individual to reduce his/her consumption, where the sum of the marginal willingness to pay is measured *within the individual's own country* and equals the degree of domestic positionality. This means that each government will fully internalize the positional externalities within its own country, but will not at all internalize the positional externalities imposed on the other country.[10] Therefore, it should be clear that the tax formula in Proposition 1 does not implement a global welfare optimum, since transnational positional externalities are ignored.

[10] Thus, the corrective tax derived here resembles Nash equilibrium tax formulas in the literature on environmental policy (e.g., van der Ploeg and de Zeeuw, 1992; Aronsson and Löfgren, 2000).

3.2. Country i is a Stackelberg leader

Assume now instead that country i is a Stackelberg leader in relation to country k, a Stackelberg follower. While the government in country k will then behave as in the Nash equilibrium, the optimization problem for country i is modified. This is because i will take into account welfare effects on i caused by the changed actions in k that choices by i induce. As a consequence, the government in country i will not take the consumption in country k as given (as in the Nash equilibrium case) but rather let it be a function of its own consumption, such that $\bar{c}^k = \bar{c}^k(\bar{c}^i)$. The following characterization will be used for this relationship:

Definition 1. *The consumption in country k is characterized by a cross-country keeping-up-with-the-Joneses (staying-away-from-the-Joneses) property with respect to the consumption in country i if*

$$\frac{\partial \bar{c}^k}{\partial \bar{c}^i} > 0\,(<0).$$

To examine when this condition is fulfilled, let $SMRS^k_{cz} = (u^k_c + u^k_{\bar{c}^k})/u^k_z$ denote the social marginal rate of substitution between private consumption and leisure from the point of view of country k, whose government treats $\bar{c}^i$ as exogenous. In other words, $SMRS^k_{cz}$ reflects the marginal rate of substitution between private consumption and leisure in country k for a given relative consumption within the country (but not between the countries). We can then derive the following result:

Lemma 1.

$$\frac{\partial \bar{c}^k}{\partial \bar{c}^i} > 0(<0) \;\; iff \;\; \frac{\partial SMRS^k_{cz}}{\partial \bar{c}^i} > 0(<0).$$

A Stackelberg equilibrium is in this model an allocation where the leader-country satisfies the optimality conditions (3), (7), and (10) as before, but where Eq. (9) is replaced with

$$u^i_c + u^i_{\bar{c}^i} + u^i_{\bar{c}^k}\frac{\partial \bar{c}^k}{\partial \bar{c}^i} = \gamma^i. \tag{9a}$$

whereas the follower satisfies the same optimality conditions as in the Nash equilibrium case. Using Definition 1 and Lemma 1, we are now ready to analyze the optimal tax policy implicit in the Stackelberg game equilibrium:

Proposition 2. *The optimal marginal income tax formula in country k, where the government is a Stackelberg follower, is the same as in the Nash equilibrium. The optimal marginal income tax in country i, where the government is a Stackelberg leader vis-à-vis country k, is given by*

$$t^i = \alpha^i + \frac{\partial \bar{c}^k}{\partial \bar{c}^i}\beta^i.$$

Conditional on α^i, therefore, the optimal marginal income tax rate facing the Stackelberg leader is larger (smaller) than the optimal rate implied by the Nash equilibrium formula if the utility function in country k is such that

$$\frac{\partial SMRS^k_{cz}}{\partial \bar{c}^i} > 0(<0),$$

meaning that the consumption in country k is characterized by a cross-country keeping-up-with-the-Joneses (staying-away-from-the-Joneses) property with respect to the consumption in country i.

Thus, the optimal marginal income tax rate in country i, the Stackelberg leader, is larger than the rate corresponding to optimal taxation in the Nash equilibrium if consumption becomes more valuable relative to leisure on the margin in country k due to a consumption increase in country i, ceteris paribus. Intuitively, if increased consumption in country i induces people to consume more in country k, and hence causes larger negative externalities on country i, this constitutes a reason to reduce the consumption in country i, and hence to increase the marginal income tax.

4. Cooperative solutions

4.1. The scope for a Pareto-improving tax reform

We showed in Section 3 that each government in the Nash equilibrium will only internalize the positional externalities caused in its own country. The same applies to the follower in the Stackelberg case, while the leader will also add a component related to induced consumption changes in the other country due to transnational keeping-up-with-the-Joneses effects. Thus, there is scope for Pareto-improving tax reforms:

Proposition 3. *Based on either the Nash equilibrium or Stackelberg equilibrium, there is scope for Pareto-improving tax reforms through small increases in the marginal income tax rates.*

Given that a Pareto improvement is possible, it is natural to ask how much the government in country i would be willing to pay country k for a small increase in t^k, and how this marginal willingness to pay depends on the strength of the relative consumption concerns in country i. Suppose that the countries are in Nash equilibrium and let M^{ik} denote government i's marginal willingness to pay for an increase in the marginal income tax in country k, such that

$$M^{ik} = \frac{u^i_{\bar{c}^k}}{u^i_c + u^i_{\bar{c}^i}}\frac{\partial \bar{c}^k}{\partial t^k}.$$

By using Eqs. (1), (4), and (5) to derive $u^i_{\bar{c}^k}/u^i_c = -\beta^i$ and $u^i_{\bar{c}^i}/u^i_c = -\alpha^i$, we can rewrite this expression as

$$M^{ik} = -\frac{\beta^i}{1-\alpha^i}\frac{\partial \bar{c}^k}{\partial t^k} > 0, \tag{11}$$

where the inequality holds provided that the consumption in country k decreases (and leisure increases) when the marginal income tax in country k increases. Eq. (11) indicates that the (partial) degree of foreign positionality plays a key role for tax coordination, as it directly affects how much the government in country i is willing to pay for a small decrease in the consumption in country k, ceteris paribus.[11] Note also that an algebraic expression similar to Eq. (11) holds if the pre-reform equilibrium is instead based on a Stackelberg game where i is leader (as in subsection 3.2), with the only difference being that $1-\alpha^i$ should then be replaced by $1-\alpha^i-\beta^i(\partial_c^{-k}/\partial_c^{-i})$.

4.2. A globally efficient allocation and the implicit marginal tax rates

Consider the (somewhat extreme) case where both countries can negotiate with each other about tax policy without transaction costs. Country i would then be willing to buy a further marginal tax increase in country k as long as the welfare cost to i of paying k is lower than the welfare gain to i of the associated reduced consumption in k. Let us also assume that the countries succeed in finding an agreement such that no Pareto improvements are possible. This means that the

[11] We can also observe that the government's marginal willingness to pay increases with the degree of domestic positionality. The intuition is that the larger α^i is, the larger will be the discrepancy between the government's and the consumers' assessment of the marginal utility of private consumption. Therefore, $1 - \alpha^i$ serves to transform the consumers' marginal willingness to pay into a measure of marginal willingness to pay for the government.

marginal income tax rates will be (globally) Pareto efficient. An alternative interpretation of such a resource allocation is that it corresponds to the outcome of a global social planner aiming to obtain a globally Pareto-efficient allocation through maximization of utility for one of the countries subject to a minimum utility restriction for the other country and an overall resource constraint. A third interpretation, suggested to us by one of the referees, is that an efficient outcome may be the result of a dynamic negotiation process in the framework of infinitely repeated games. Based on such a process, an efficient tax policy that internalizes all positional externalities might be self-sustained due to the Folk theorem, in which case there is no need to refer to a global social planner or an explicit negotiation process. In either case, the optimal marginal income tax rates needed in each country to obtain such an efficient allocation can be derived as follows:

Proposition 4. *The globally Pareto-efficient marginal income tax rate for country i is given by*

$$t^i = \alpha^i + \frac{1-\alpha^i+\beta^i}{1-\alpha^k+\beta^k}\beta^k > 0.$$

Thus, the globally Pareto-efficient marginal income tax rate looks almost like a conventional Pigouvian tax based on the sum of all people's (including people from the other country) marginal willingness to pay for reducing consumption by an individual in country i, which would be given by

$$t^i = -\frac{u^i_{\bar{c}^i}}{u^i_c} - \frac{u^k_{\bar{c}^i}}{u^k_c} = \alpha^i + \beta^k.$$

Yet, the second term in the tax formula in Proposition 4, related to the sum of the marginal willingness to pay by residents in the foreign country, $u^k_{\bar{c}^i}/u^k_c$, has a modifying factor attached to it. We will return to this factor and the intuition behind Proposition 4. Let us first present the more straightforward results from the symmetric case where the positionality degrees are identical in both countries:

Corollary 1. *If $\alpha^i = \alpha^k = \alpha$ and $\beta^i = \beta^k = \beta$, the globally Pareto-efficient marginal income tax rate for country i is given by*

$$t^i = \alpha^i + \beta^k = \alpha + \beta = \rho > 0.$$

Hence, the Pareto-efficient marginal income tax rate in the symmetric case is a simple Pigouvian tax given by the aggregate global marginal willingness to pay for reduced consumption by an individual in country i. In turn, this sum equals the total degree of positionality, ρ. Basically, the tax reflects the part of consumption that is waste, due to zero-sum relative comparison effects, whereas leisure is purely non-positional (by assumption). Corollary 1 provides a straightforward generalization of the efficient tax policy derived in the context of one-country economies in, e.g., Ljungqvist and Uhlig (2000), and Dupor and Liu (2003).

When interpreting Corollary 1, recall that $\alpha^i, \alpha^k, \beta^i$ and β^k are not exogenous parameters but rather endogenous variables in the model. Consequently, for the conditions on which Corollary 1 is based to hold generally, i.e. for all levels of consumption and leisure, one would have to impose very strong restrictions on the underlying utility functions. This will be further discussed in Section 6. However, note that for Corollary 1 to hold it is sufficient that $\alpha^i = \alpha^k$ and $\beta^i = \beta^k$ *in the Pareto efficient equilibrium*, irrespective of whether these conditions are also satisfied outside this equilibrium. Moreover, even if these conditions do not strictly hold in the equilibrium either, the case when they do hold may still constitute a reasonable approximation and natural benchmark case.

Let us now turn to the modifying factor in the non-symmetric case, i.e.,

$$\frac{1-\alpha^i+\beta^i}{1-\alpha^k+\beta^k}.$$

Suppose first that the β-factors are small, such that the modifying factor can be approximated by $(1-\alpha^i)/(1-\alpha^k)$. Then, if $\alpha^i > \alpha^k$, the modifying factor for the marginal income tax rate in country i becomes less than unity. The intuition is that $\alpha^i > \alpha^k$ implies that the efficient marginal income tax in country i is larger than in country k. In turn, this means that a larger fraction of an income increase in country i is taxed away, such that a smaller fraction of this income increase causes a negative consumption externality. In the more general case where the β - factors are not small, also these factors will affect how much of an income increase that will be taxed away. A large β in country i then implies that a larger fraction will be taxed away in country k, and vice versa. Consequently, the relative weight given to domestic externality correction is reduced in country i. This also explains why the β - factors affect the modifying factor in the opposite direction compared with the α - factors.

5. Differential consumption taxes and positional goods

In other parts of this paper we follow most of the earlier literature in considering an economy without differential consumption taxes. Yet, as Frank (1985a, b) and others have noted, in reality some goods are most likely more positional than other goods. For example, Alpizar et al. (2005) found that cars and housing are much more positional than insurances. Let us here consider the case with m different consumption goods in each country. We assume that the governments can use income taxes as before, but also differential consumption taxes. That is, the government in each country is free to use different percentage consumption taxes for each good such that the consumer price of good h ($h = 1,\ldots,m$) is now equal to $1 + t^i_h$ (instead of 1) for individuals in country i. The utility of a representative individual in country i is then given by

$$\begin{aligned} U^i &= v^i\left(c^i_1,\ldots,c^i_m,z^i,R^i_1,\ldots,R^i_m,S^i_1,\ldots,S^i_m\right) \\ &= v^i\left(c^i_1,\ldots,c^i_m,z^i,r^i_1\left(c^i_1,\bar{c}^i_1\right),\ldots,r^i_m\left(c^i_m,\bar{c}^i_m\right),s^i_1\left(c^i_1,\bar{c}^k_1\right),\ldots,s^i_m\left(c^i_m,\bar{c}^k_m\right)\right) \\ &= v^i\left(c^i_1,\ldots,c^i_m,z^i,c^i_1-\bar{c}^i_1,\ldots,c^i_m-\bar{c}^i_m,c^i_1-\bar{c}^k_1,\ldots,c^i_m-\bar{c}^k_m\right) \\ &= u^i\left(c^i_1,\ldots,c^i_m,z^i,\bar{c}^i_1,\ldots,\bar{c}^i_m,\bar{c}^k_1,\ldots,\bar{c}^k_m\right) \end{aligned} \tag{12}$$

This enables us to define good-specific positionality measures. The partial degrees of domestic and foreign positionality for good h in country i are then given by

$$\alpha^i_h = \frac{v^i_{R_h}}{v^i_{C_h}+v^i_{R_h}+v^i_{S_h}},$$
$$\beta^i_h = \frac{v^i_{S_h}}{v^i_{C_h}+v^i_{R_h}+v^i_{S_h}},$$

respectively, where $v^i_{C_h} = \partial v^i/\partial c^i_h$, $v^i_{R_h} = \partial v^i/\partial R^i_h$, and $v^i_{S_h} = \partial v^i/\partial S^i_h$. α^i_h can then be interpreted as the fraction of the utility increase from the last dollar spent on good h that is due to the increased relative consumption of good h compared with other people in the individual's own country; β^i_h can be interpreted correspondingly with respect to people in the other country.

If we otherwise make the same assumptions as before, and disregard possible practical problems with implementing differential commodity taxation, we obtain the following result:

Proposition 5. *The optimal consumption tax on good h facing the representative consumer in country i in Nash equilibrium is given by*

$$t_h^i = \frac{\alpha_h^i - t^i}{1-\alpha_h^i}.$$

Note that t^i denotes the marginal income tax rate in country i as before. We can immediately see that consumption taxes are redundant if and only if the degrees of positionality are the same for all goods. In that case, the positional externalities that each individual imposes on other domestic residents are perfectly internalized by an income tax equal to the degree of domestic positionality of each good, which would then also equal the degree of domestic positionality of the aggregate consumption. In all other cases we need differential consumption taxes. The reason why the optimal consumption taxes depend on the marginal income tax, in addition to the good-specific positionality degrees, is that the system is over-identified with both marginal income and consumption taxes present. Any combination of taxes that fulfills Proposition 5 implies an optimal allocation from the perspective of the government in country i. For example, when $t^i = 0$ it follows that $t_h^i = \alpha_h^i/(1-\alpha_h^i)$.

Consider next the case where the countries can negotiate without transaction costs, or for any other reason obtain a globally Pareto-efficient allocation. Using the short notation

$$\Gamma^i = \frac{1-\alpha_h^k + \beta_h^k}{1-\alpha_h^i + \beta_h^i}, \tag{13}$$

we obtain the following result:

Proposition 6. *The globally Pareto-efficient consumption tax on good h facing the representative consumer in country i is given by*

$$t_h^i = \frac{\alpha_h^i + \Gamma^i\beta_h^k - t^i}{1-\alpha_h^i - \Gamma^i\beta_h^k} > \frac{\alpha_h^i - t^i}{1-\alpha_h^i}.$$

In the symmetric case where $\alpha_h^i = \alpha_h^k = \alpha_h$ and $\beta_h^i = \beta_h^k = \beta_h$, such that $\Gamma^i = 1$, this policy rule reduces to read

$$t_h^i = \frac{\alpha_h + \beta_h - t^i}{1-\alpha_h - \beta_h} = \frac{\rho_h - t^i}{1-\rho_h} > \frac{\alpha_h - t^i}{1-\alpha_h}. \tag{14}$$

The modifying factor, Γ^i, has a similar interpretation as its counterpart derived in the context of optimal income taxation in Section 4. Comparing Propositions 5 and 6, we can conclude that the argument for international tax coordination based on cross-country positional externalities is in principle equally strong for consumption taxes as for income taxes.

6. Distributional concerns and asymmetric information

So far, we have assumed that people are identical within each country, and that the only reason for using income taxes is to correct for positional externalities. In reality, however, taxation has many purposes, a central one being to redistribute income. In this section, we generalize the model to encompass heterogeneity and distributional concerns within each country. As a work horse, we utilize a modified version of the Stern–Stiglitz optimal nonlinear income tax model based on a self-selection approach with two ability types in each country.

Each country is characterized by asymmetric information between the government and the private sector, such that the government can observe (and hence tax) income but not ability and leisure. Furthermore, we assume (as we did above) that the population in each country is fixed; this simplifies the analysis and allows us to abstract from the implications of labor mobility for redistributive policy at the national level.

There are two ability types in each country and n_j^i individuals of ability type j in country i. Each such individual faces the following utility function:

$$\begin{aligned} U_j^i &= v_j^i\left(c_j^i, z_j^i, R_j^i, S_j^i\right) = v_j^i\left(c_j^i, z_j^i, r_j^i\left(c_j^i, \overline{c}^i\right), s_j^i\left(c_j^i, \overline{c}^k\right)\right) \\ &= v_j^i\left(c_j^i, z_j^i, c_j^i - \overline{c}^i, c_j^i - \overline{c}^k\right) = u_j^i\left(c_j^i, z_j^i, \overline{c}^i, \overline{c}^k\right) \end{aligned}, \tag{15}$$

for $j = 1, 2$. Eq. (15) allows for the same between-country differences in preferences as Eq. (1); yet, it also allows the two ability types in the same country to have different preferences and make different relative consumption comparisons. All notations are the same as in the previous sections, with the exception that the variables are both ability-type specific and country specific here (and not just country specific as above).

The individual budget constraint is given by

$$w_j^i l_j^i - T^i\left(w_j^i l_j^i\right) = c_j^i, \tag{16}$$

where $l_j^i = \Omega - z_j^i$ denotes the number of work hours by ability type j in country i, and $T^i(\cdot)$ is a nonlinear income tax decided by the government in country i. The corresponding first-order condition for the consumption-leisure tradeoff becomes

$$u_{j,c}^i w_j^i\left(1 - T^{i\,\prime}\left(w_j^i l_j^i\right)\right) - u_{j,z}^i = 0, \tag{17}$$

where $u_{j,c}^i = \partial u_j^i/\partial c_j^i$ and $u_{j,z}^i = \partial u_j^i/\partial z_j^i$, while $T^{i\,\prime}(w_j^i l_j^i)$ denotes the marginal income tax rate facing ability type j in country i.

The positionality degrees are defined in the same general way as in the representative-agent framework set out above. Hence, the partial degrees of domestic and foreign positionality for an individual of ability type j in country i are given by

$$\alpha_j^i = \frac{v_{j,R}^i}{v_{j,c}^i + v_{j,R}^i + v_{j,S}^i} \text{ and } \beta_j^i = \frac{v_{j,S}^i}{v_{j,c}^i + v_{j,R}^i + v_{j,S}^i},$$

respectively. Since the utility functions may differ between types, the positionality degrees may differ too for that particular reason (and, of course, also because the two ability types face different constraints). The interpretations are the same as before, with the only exception that the degrees of positionality are ability-type specific here. The total degree of positionality for an individual of ability type j in country i is then defined as $\rho_j^i = \alpha_j^i + \beta_j^i$. For further use, we also calculate the corresponding average degrees of positionality in country i as

$$\overline{\alpha}^i = \frac{n_1^i\alpha_1^i + n_2^i\alpha_2^i}{n_1^i + n_2^i}, \tag{18a}$$

$$\overline{\beta}^i = \frac{n_1^i\beta_1^i + n_2^i\beta_2^i}{n_1^i + n_2^i}, \tag{18b}$$

where $n_1^i + n_2^i$ denotes the total population in country i.

6.1. The second-best problem of the government

Let type 1 be the low-ability type and type 2 the high-ability type, which means that $w_2^i > w_1^i$. The objective of the government in each county is again to obtain a Pareto-efficient resource allocation, which can be accomplished by maximizing the utility of the low-ability type subject to a minimum utility restriction for the high-ability type, as well as subject to a self-selection constraint and the budget constraint.

We follow the standard approach in assuming that the government wants to redistribute from the high-ability to the low-ability type, and also assume that a self-selection constraint must be imposed to prevent the high-ability type from mimicking the low-ability type.[12] This self-selection constraint can be written as

$$U_2^i = u_2^i\left(c_2^i, z_2^i, \bar{c}^i, \bar{c}^k\right) \geq u_2^i\left(c_1^i, \Omega - \frac{w_1^i}{w_2^i} l_1^i, \bar{c}^i, \bar{c}^k\right) = \hat{U}_2^i. \tag{19}$$

The expression on the left-hand side of the weak inequality is the utility of the high-ability type, whereas the right-hand side denotes the utility of the mimicker; the hat symbol (^) denotes mimicker variables. A mimicking high-ability individual faces the same before-tax income (and in this case also consumption) as the low-ability type; yet, since the mimicker is more productive than the low-ability type, he/she can reach this income with less effort.

As we are considering a pure redistribution problem under positional externalities, it follows that the government's overall resource constraint can be written as

$$n_1^i\left(w_1^i l_1^i - c_1^i\right) + n_2^i\left(w_2^i l_2^i - c_2^i\right) = 0, \tag{20}$$

i.e., overall production equals overall consumption.

The public decision-problem will be written as a direct decision-problem, as we also did in the representative-agent models analyzed in Sections 2–5. Therefore, and by analogy with earlier literature based on the self-selection approach to optimal income taxation (e.g., Stiglitz, 1982; Boadway and Keen, 1993), the marginal income tax rates can be derived implicitly by comparing the social and private first-order conditions for the number of work hours and private consumption, respectively, for each ability type in each country.[13] From the perspective of the national government, the social first-order conditions are derived based on the following Lagrangean for an arbitrary country i:

$$\begin{aligned} L^i &= U_1^i + \delta^i\left(U_2^i - \overline{U}_2^i\right) + \lambda^i\left(U_2^i - \hat{U}_2^i\right) \\ &\quad + \gamma^i\left(n_1^i\left(w_1^i l_1^i - c_1^i\right) + n_2^i\left(w_2^i l_2^i - c_2^i\right)\right). \end{aligned} \tag{21}$$

In Eq. (21), δ^i, λ^i, and γ^i are Lagrange multipliers corresponding to the constraints.

6.2. Optimal tax policy in the Nash-competition case

In the Nash equilibrium, the government in country i treats consumption (and hence average consumption) in the other country as exogenous, and vice versa. Let

$$\hat{u}_{2,c}^i = \frac{\partial u_2^i\left(c_1^i, \Omega - \frac{w_1^i}{w_2^i} l_1^i, \bar{c}^i, \bar{c}^k\right)}{\partial c_1^i}$$

denote the mimicker's marginal utility of consumption based on the utility formulation $u_j^i(\cdot)$ in Eq. (15). We can then define the following measure of difference in the partial degree of domestic positionality between the mimicker and the low-ability type:

$$\alpha^{id} = \frac{\lambda^i}{\gamma^i} \frac{\hat{u}_{2,c}^i}{n_1^i + n_2^i}\left(\hat{\alpha}_2^i - \alpha_1^i\right). \tag{22}$$

To simplify the tax formulas, we use the short notation σ_j^i for the part of the optimal marginal income tax rate for type-j individuals in country i that would be present also in a standard model where people are not concerned with their relative consumption; see Eqs. (A42) and (A43) in the Appendix. The marginal income tax policy in Nash equilibrium can then be characterized as follows:

Proposition 7. *In Nash equilibrium, the optimal marginal income tax rate facing individuals of ability type j in country i is given by (for j = 1,2)*

$$T^{i\prime}\left(w_j^i l_j^i\right) = \sigma_j^i + \bar{\alpha}^i\left(1 - \sigma_j^i\right) - \left(1 - \bar{\alpha}^i\right)\left(1 - \sigma_j^i\right)\frac{\alpha^{id}}{1 - \alpha^{id}}.$$

In what follows, we will not focus on the interpretation of σ_1^i and σ_2^i, except noting that $\sigma_2^i = 0$, as these effects are well understood and explained elsewhere (e.g., Stiglitz, 1982). The second term reflects the incentive facing the domestic government to correct for positional externalities and depends on the average degree of domestic positionality. If $\sigma_1^i > 0$ (as in the standard optimal income tax model where the consumers share a common utility function), this corrective component is smaller for the low-ability type than for the high-ability type. The third term reflects an incentive for the government to relax the self-selection constraint by exploiting that the mimicker and the low-ability type may differ in terms of positional concerns. Consider first the case where $\hat{\alpha}_2^i > \alpha_1^i$, such that $\alpha^{id} > 0$. This means that an increase in the average domestic consumption (with the average consumption in the other country held constant) will cause a larger utility loss, in monetary terms, for the mimicker than for the low-ability type. Hence, an increase in $\bar{c}^i$ makes it less attractive to become a mimicker, implying that the self-selection constraint is relaxed. This is clearly beneficial from a social point of view and implies a corresponding reason for reducing the marginal income tax rate. The intuition for the opposite case where $\alpha^{id} < 0$ is analogous. Note also that the result in Proposition 5 resembles the tax policy implications of positional concerns derived for a one-country economy by Aronsson and Johansson-Stenman (2008). This is so because all positional externalities caused to the other country are ignored by the Nash-competing national governments.

6.3. Optimal tax policy in the Stackelberg-competition case

Let us again assume, as we did in Subsection 3.2, that country i is a Stackelberg leader in relation to country k, a Stackelberg follower. As in Subsection 3.2 above, we focus on the policy incentives facing the Stackelberg leader; the policy incentives facing the follower are analogous to those facing the governments in the Nash game analyzed in Subsection 6.2. Hence, the government in country i will treat the average consumption in country k as a function of the average consumption in country i.

Before presenting the results, let us introduce the following measure of difference in the partial degree of foreign positionality between the mimicker and the low-ability type:

$$\beta^{id} = \frac{\lambda^i}{\gamma^i} \frac{\hat{u}_{2,c}^i}{n_1^i + n_2^i}\left(\hat{\beta}_2^i - \beta_1^i\right), \tag{23}$$

and also introduce the following short notations:

$$\bar{\psi}^i = \bar{\alpha}^i + \bar{\beta}^i \frac{\partial \bar{c}^k}{\partial \bar{c}^i} \text{ and } \psi^{id} = \alpha^{id} + \beta^{id} \frac{\partial \bar{c}^k}{\partial \bar{c}^i}.$$

[12] In a more general framework, there will be a corresponding self-selection constraint on the low-ability type to prevent each such individual from mimicking the high-ability type. Yet, both self-selection constraints cannot bind at the same time, and the assumed redistribution profile suggests that the self-selection constraint (19) is the relevant one. This also means that our study follows earlier literature based on the self-selection approach to optimal taxation, making it easy to compare our results with findings in other studies. In a richer framework, e.g., where individuals differ not only in ability but also in wealth such as in Cremer et al. (2001), the choice of binding self-selection constraint would be less obvious.

[13] See the Appendix for details.

We can think of $\overline{\psi}^i$ and ψ^{id} as measuring the "average degree of effective positionality" and the "difference in the degree of effective positionality between the mimicker and the low-ability type," respectively, from the point of view of the government in country i, which is acting as a Stackelberg leader vis-à-vis country k. In particular, note that these measures also reflect the partial degrees of foreign positionality (in addition to the partial degrees of domestic positionality), since the government in country i may exploit the relationship between $\overline{c}^i$ and $\overline{c}^k$ for purposes of externality correction and redistribution.

Noting that $\overline{\beta}^i > \beta^{id}$ means that the welfare in country i decreases in response to an increase in $\overline{c}^k$, ceteris paribus, the marginal income tax policy can now be characterized as follows:

Proposition 8.

(i) *The optimal marginal income tax rate for individuals of ability type j in country i, where the government is a Stackelberg leader vis-à-vis country k, is given by (for j = 1,2)*

$$T^{i\prime}\left(w_j^i l_j^i\right) = \sigma_j^i + \left(1-\sigma_j^i\right)\overline{\psi}^i - \left(1-\sigma_j^i\right)\left(1-\overline{\psi}^i\right)\frac{\psi^{id}}{1-\psi^{id}}.$$

(ii) *Given the levels of σ_j^i, $\overline{\alpha}^i$, α^{id}, $\overline{\beta}^i$, and β^{id}, and if $\overline{\beta}^i > \beta^{id}$, the optimal marginal income tax rates chosen by the Stackelberg leader are larger (smaller) than the Nash equilibrium rates if the consumption in country k is characterized by a cross-country keeping-up-with-the-Joneses (staying-away-from-the-Joneses) property with respect to the consumption in country i such that*

$$\frac{\partial \overline{c}^k}{\partial \overline{c}^i} > 0\ (<0).$$

The marginal income tax formula implemented by the Stackelberg leader takes the same general form as that implemented by a follower. The difference is that the Stackelberg leader behaves as if ψ is the appropriate measure of positionality, whereas the follower behaves as in the Nash game, where α is the appropriate measure of positionality. Therefore, if the consumption of the Stackelberg follower is characterized by the keeping-up-with-the-Joneses property discussed above, the policy decided by the Stackelberg leader may be closer to a globally optimal policy than that implemented by the follower. We will return to this comparison below.

Note also that the interpretation of Proposition 8 is close – yet not equivalent – to the interpretation of Proposition 7, due to that the magnitudes (and possibly also the signs) of $\overline{\psi}^i$ and ψ^{id} depend on the reaction function $\overline{c}^k(\overline{c}^i)$. If $\partial\overline{c}^k/\partial\overline{c}^i > 0$, which appears to be a plausible assumption, the incentives to correct for positional externalities are stronger for a government acting as a Stackelberg leader than for a Nash competitor, whereas these incentives instead are weaker if $\partial\overline{c}^k/\partial\overline{c}^i < 0$ (in fact, if $\overline{\beta}^i$ is sufficiently large, we cannot rule out the possibility that $\overline{\psi}^i < 0$, although this outcome appears very unlikely). Similarly, the interpretation of the variable ψ^{id} is more complex than the interpretation of α^{id}, as ψ^{id} reflects differences in the degree of positionality between the mimicker and the low-ability type in two dimensions. The practical importance of Propositions 7 and 8 is, nevertheless, clear: the two propositions show exactly what information the national policy maker (who acts as a Nash competitor and Stackelberg leader, respectively) needs in order to implement the desired resource allocation through tax policy in a decentralized setting.

6.4. The scope for international cooperation

We showed in Subsection 4.1 that each government in the Nash equilibrium and Stackelberg equilibrium, respectively, is willing to pay a positive amount to the other country for it to increase its marginal income taxes. Hence, there exists a Pareto-improving tax reform. The situation in the more general second-best case is similar. That there are two types of individuals in each country does not matter *per se*, since it would be beneficial for the other country if the marginal income tax rates were increased for both types. Yet, what is crucial is that welfare in one country is affected negatively by increased consumption in the other country, i.e., the mimicker must not be so much more positional than the low-ability type that the welfare loss due to the direct positional externality is fully offset by a welfare benefit of increased reference consumption through the self-selection constraint. To be more specific, we have the following result:

Proposition 9. *Based on either the Nash equilibrium or the Stackelberg equilibrium, there is scope for Pareto-improving tax reforms through small increases in the marginal income tax rates, provided that the direct positional externality dominates the self-selection effect in the sense that $\overline{\beta}^i > \beta^{id}$.*

This is analogous to the results derived above. Consider next, as in Subsection 4.2, the case where the countries can negotiate with each other about the tax policy without transaction costs, or for any other reason obtain a globally Pareto-efficient allocation. Country i would then be willing to buy a further tax increase in country k as long as the welfare cost for country i of paying country k is smaller than the welfare gain of the reduced consumption in country k. This means that country k will take into account the welfare effects caused to country i, and vice versa.

Without loss of any important insight, let us simplify by focusing on a symmetric equilibrium where the two countries are identical in the sense of the following assumption:

A1. $\overline{\alpha}^i = \overline{\alpha}^k = \overline{\alpha}, \overline{\beta}^i = \overline{\beta}^k = \overline{\beta}, \alpha^{id} = \alpha^{kd} = \alpha^d, \beta^{id} = \beta^{kd} = \beta^d$, and $n_1^i + n_2^i = n_1^k + n_2^k$.

Note that these assumptions do not mean that the two countries are identical also in other respects; they may still differ in terms of wage and population distributions and preferences for leisure and private consumption. By using $\overline{\rho} = \overline{\alpha} + \overline{\beta}$ and $\rho^d = \alpha^d + \beta^d$, we can then derive the following result:

Proposition 10. *The globally Pareto-efficient marginal income tax rate under assumption A1 for individuals of ability type j in country i is given by (for j = 1,2)*

$$T^{i\prime}\left(w_j^i l_j^i\right) = \sigma_j^i + \overline{\rho}\left(1-\sigma_j^i\right) - (1-\overline{\rho})\left(1-\sigma_j^i\right)\frac{\rho^d}{1-\rho^d}.$$

Proposition 10 generalizes the Pareto-efficient optimal tax structure derived by Aronsson and Johansson-Stenman (2008) for a one-country economy to a two-country economy with international positional externalities. It shows that an increase in the average degree of total positionality (which is here given by the average degree of domestic positionality in country i plus the average degree of foreign positionality in country k) contributes to increase the marginal income tax rates implemented for the residents of country i. Furthermore, if the mimicker is more (less) positional than the low-ability type, here measured in terms of the total degree of positionality, there is an incentive to relax the self-selection constraint through a lower (higher) marginal income tax rate for each ability type.

Note once again that all degrees of positionality are endogenously determined within the model. It is therefore sufficient that assumption A1 holds in the globally Pareto efficient equilibrium for Proposition 10 to apply. It may nevertheless be illuminating to consider a more restrictive version of the model where assumption A1 holds generally, i.e., for all levels of consumption and leisure time, which would be the case if (i) $n_1^1 = n_1^2 = n_1$ and $n_2^1 = n_2^2 = n_2$, and (ii) the utility functions take the following form (for $j = 1, 2$):

$$U_j^i = f_j^i\left((1-a_j-b_j)c_j^i + a_j\left(c_j^i-\bar{c}^i\right) + b_j\left(c_j^i-\bar{c}^k\right), z_j^i\right), \\ = f_j^i\left(c_j^i-a_j\bar{c}^i-b_j\bar{c}^k, z_j^i\right) \tag{24a}$$

$$U_j^k = f_j^k\left((1-a_j-b_j)c_j^k + a_j\left(c_j^k-\bar{c}^k\right) + b_j\left(c_j^k-\bar{c}^i\right), z_j^k\right) \\ = f_j^k\left(c_j^k-a_j\bar{c}^k-b_j\bar{c}^i, z_j^k\right), \tag{24b}$$

where a_j and b_j are fixed (yet type-specific) parameters. It follows immediately that $\overline{\alpha}^i = \overline{\alpha}^k = (n_1a_1 + n_2a_2)/(n_1 + n_2)$ and $\overline{\beta}^i = \overline{\beta}^k = (n_1b_1 + n_2b_2)/(n_1 + n_2)$ are also fixed parameters, and $\alpha^{id} = \alpha^{kd} = \beta^{id} = \beta^{kd} = 0$.[14] In other words, assumption A1 always applies, irrespective of differences in consumption levels and use of leisure between ability-types and across countries. Note also that the utility functions (Eqs. (24a) and (24b)) are allowed to differ both between ability-types and countries, although the functional form assumption will, of course, imply severe restriction compared to the general model.

In the symmetric case where assumption A1 holds in the Pareto efficient equilibrium, we can obtain a straightforward relationship between the socially efficient marginal income tax rates and the rates implemented in the non-cooperative regimes (addressed in Propositions 7 and 8). Let $T_N^{i\prime}(w_j^il_j^i)$, $T_S^{i\prime}(w_j^il_j^i)$, and $T_C^{i\prime}(w_j^il_j^i)$ denote the marginal income tax rate implemented for ability type j when the government in country i acts as a Nash competitor, Stackelberg leader, and in accordance with the cooperative game set out here, respectively. The following result is an immediate consequence of Propositions 7, 8, and 10:

Corollary 2. *Under assumption A1, and given the levels of $\sigma_j^i, \overline{\alpha}, \overline{\beta}, \alpha^d$, and β^d, we have*

$$T_N^{i\prime}\left(w_j^il_j^i\right) < T_S^{i\prime}\left(w_j^il_j^i\right) < T_C^{i\prime}\left(w_j^il_j^i\right) \text{ for } j = 1, 2,$$

if (i) $\overline{\beta} > \beta^d$ and (ii) $\partial\bar{c}^k/\partial\bar{c}^i \in (0, 1)$.

Clearly, $\overline{\beta} > \beta^d$ means that the marginal income tax rate implemented in the non-cooperative Nash equilibrium falls short of the socially efficient rate, i.e., $T_N^{i\prime}(w_j^il_j^i) < T_C^{i\prime}(w_j^il_j^i)$. The second condition then means that the marginal income tax rate decided by the Stackelberg leader falls between these two extremes. Note that this ranking applies when the values of σ_j^i, $\overline{\alpha}$, $\overline{\beta}$, α^d, and β^d are the same in these three equilibria. While this is not likely to be the case in general, there are no a priori reasons to believe that any of these variables would be larger in one particular equilibrium compared to another, suggesting that Corollary 2 still constitutes an important benchmark case.

Overall, we conclude that the scope for international tax policy coordination due to cross-country social comparisons remains large also in a second-best world without the possibility of using non-distortionary taxation. As an indication of the social value of tax coordination, let us finally examine the difference in marginal income taxation between the cooperative regime and the Nash-equilibrium under the assumptions in Corollary 2. To simplify the analysis, we assume that the mimicker and the low-ability type are always equally positional, such that $\alpha^d = \rho^d = 0$. By comparing Propositions 7 and 10, we obtain the difference between the globally efficient marginal tax rate and the Nash rate as follows (for both ability types):

$$\Delta T^{i\prime}\left(w_j^il_j^i\right) = (\overline{\rho}-\overline{\alpha})\left(1-\sigma_j^i\right) = \overline{\beta}\left(1-\sigma_j^i\right). \tag{25}$$

This measure can be interpreted as the part of the overall positional externality in a second-best economy that is not internalized by the national governments in Nash equilibrium. Unfortunately, as noted in the introduction, there is little empirical evidence regarding $\overline{\beta}$. Let us nevertheless make some illustrative conjectures. According to questionnaire-experimental research (e.g., Johansson-Stenman et al., 2002; Alpizar et al., 2005; Carlsson et al., 2007), some 30–50% of an individual's utility gain from increased consumption may be due to increased (within-country) relative consumption. Similarly, happiness-based studies often find that a dominating share of consumption-induced well-being in industrialized countries is due to relative effects (e.g., Easterlin, 2001; Luttmer, 2005). Thus, one might conjecture $\overline{\beta}$ to be in the order of magnitude of 0.2, at least in some countries in a near future. If we also assume that the optimal marginal income tax rate in the absence of any relative consumption comparisons (i.e., σ_j^i) is equal to 50%, it follows that $\Delta T^{i\prime}(w_j^il_j^i) = 0.1$. This example means that the uninternalized positional externalities correspond to some 10 percentage points of the marginal income tax rates. Such orders of magnitude may reflect substantial welfare gains of tax coordination.

7. Discussion

Cross-country social comparisons have most likely become more important over time. This is both intuitively plausible and consistent with empirical evidence suggesting that increased globalization in recent decades has influenced the social comparisons inherent in individual well-being. In the present paper, we take this evidence seriously and analyze optimal income taxation under relative consumption concerns in a two-country framework, where each individual in each country compares his/her own consumption both with that of other domestic residents and with that of people in the other country. Furthermore, our framework allows for differences in relative consumption concerns, depending on whether they refer to within-country or between-country comparisons, as well as for differences in preferences for relative consumption between individuals and across countries.

There are for sure many existing papers dealing with strategic interaction and the potential for policy coordination between governments due to environmental externalities as well as international labor and capital mobility. Yet, in the present paper we explicitly disregard each of these other reasons and show that international social comparisons alone constitute an important reason for strategic interaction, and that there may be large social values of international tax policy coordination. In doing this we distinguish between the tax policy implicit in non-cooperative regimes where the national governments act as Nash competitors to one another or engage in Stackelberg competition, and the tax policy implicit in a cooperative regime where the countries can negotiate over tax policy. Our choice to focus on international social comparisons does not reflect a belief that other motives for international tax coordination are unimportant. Rather, the results should be interpreted as further strengthening the case for such coordination, as recently suggested by Piketty (2014) and others.

We start by examining a simple framework where each country is modeled as a representative-agent economy, which means that we disregard distributional concerns within each country. If the national governments behave as Nash competitors, the resulting tax policy only internalizes the externalities that are due to within-country comparisons, meaning that the optimal marginal income tax rate in each country reflects the degree of domestic positionality. The tax policy chosen by the leader country in a Stackelberg game reflects between-country comparisons as well. Furthermore, if the residents of the Stackelberg follower country are characterized by cross-country keeping-up-with-the-Joneses preferences, then the marginal income tax implemented by the leader country in the Stackelberg game typically exceeds that implemented by the follower, as well as exceeds the marginal income tax rates implicit in the Nash equilibrium. We also derive the globally

[14] Utility functions implying fixed (i.e., parametric) degrees of positionality can also be found in some earlier studies on optimal taxation under relative consumption comparisons in one-country models (e.g., Ljungqvist and Uhlig, 2000; Dupor and Liu, 2003; Aronsson and Johansson-Stenman, 2010).

Pareto-efficient tax structure in the cooperative regime and show that cooperation typically leads to higher marginal income tax rates than implicit in the non-cooperative Nash equilibrium, and under certain (fairly reasonable) conditions also higher marginal income tax rates than implemented by the leader country in the Stackelberg game. We also show how the optimal marginal income tax rates in the cooperative regime reflect domestic as well as foreign degrees of positionality. Taken together, this implies clear arguments for international tax coordination, which are shown to apply also to the case with several consumption goods where differential consumption taxes are needed.

In the second part of the paper, we extend the analysis by allowing the consumers in each country to differ in ability (productivity) and assume that this ability is private information. This is well motivated because earlier research based on second-best analysis of one-country models shows that the policy implications of positional concerns may differ substantially from those that follow from representative-agent models. Once again, we compare the three regimes mentioned above. In general, these comparisons give ambiguous results, as externality correction may either tighten or relax the self-selection constraint. However, under a relatively mild additional assumption, namely that the difference in the degree of foreign positionality between the mimicker and the low-ability type is not too large, the qualitative results for the representative-agent framework referred to above will continue to hold also in the second-best setting.

We believe that the insights from the present paper, and in particular the scope for international tax coordination, will grow more important over time. This is because we anticipate that the globalization process will continue and that cross-country social comparisons will correspondingly further increase in importance.

Appendix A

Proof of Proposition 1. Combining Eqs. (9) and (10) gives

$$u_z^i = w^i\left(u_c^i + u_{\bar{c}^i}^i\right). \tag{A1}$$

Using $u_c^i w^i t^i = u_c^i w^i - u_z^i$ from Eq. (3), substituting into Eq. (A1), and solving for t^i yields

$$t^i = -\frac{u_{\bar{c}^i}^i}{u_c^i}. \tag{A2}$$

Finally, using Eqs. (1) and (4), we can rewrite Eq. (A2) in terms of the degree of domestic positionality. Since $u_c^i = v_c^i + v_R^i + v_S^i$ and $u_{\bar{c}^i}^i = -v_R^i$, we have

$$t^i = \frac{v_R^i}{v_c^i + v_R^i + v_S^i} = \alpha^i. \tag{A3}$$

QED

A.1. Comparative statics in subsection 3.2

The social first-order condition for work hours in country k can be written as

$$\left(u_c^k + u_{\bar{c}^k}^k\right)w^k - u_z^k = 0. \tag{A4}$$

By total differentiation, while recognizing that $c^k = \bar{c}^k$, we have

$$\begin{aligned}&\left(\left(u_{cc}^k + u_{\bar{c}^k c}^k\right)w^k - u_{zc}^k\right)dc^k + \left(\left(u_{\bar{c}^k c}^k + u_{\bar{c}^k\bar{c}^k}^k\right)w^k - u_{z\bar{c}^k}^k\right)dc^k\\ &+\left(\left(u_{cz}^k + u_{\bar{c}^k z}^k\right)w^k - u_{zz}^k\right)dz^k = -\left(\left(u_{c\bar{c}^i}^k + u_{\bar{c}^k\bar{c}^i}^k\right)w^k - u_{z\bar{c}^i}^k\right)d\bar{c}^i\end{aligned}. \tag{A5}$$

Next, use the resource constraint in country k,

$$w^k\left(\Omega - z^k\right) - c^k = 0,$$

to derive

$$\frac{dz^k}{dc^k} = -\frac{1}{w^k}. \tag{A6}$$

Substituting Eq. (A6) into Eq. (A5) and solving for $dc^k/d\bar{c}^i$ gives

$$\frac{dc^k}{d\bar{c}^i} = \frac{\left(u_{c\bar{c}^i}^k + u_{\bar{c}^k\bar{c}^i}^k\right)w^k - u_{z\bar{c}^i}^k}{\Phi/w^k}, \tag{A7}$$

where

$$\Phi \equiv -\left(u_{cc}^k + u_{\bar{c}^k c}^k\right)\left(w^k\right)^2 - \left(u_{\bar{c}^k c}^k + u_{\bar{c}^k\bar{c}^k}^k\right)\left(w^k\right)^2 + 2\left(u_{cz}^k + u_{\bar{c}^k z}^k\right)w^k - u_{zz}^k > 0$$

from the second-order conditions. Therefore, the right-hand side of Eq. (A7) is positive if $(u_{c\bar{c}^i}^k + u_{\bar{c}^k\bar{c}^i}^k)w^k - u_{z\bar{c}^i}^k > 0$ and vice versa. Now, differentiate $SMRS_{cz}^k = (u_c^k + u_{\bar{c}^k}^k)/u_z^k$ with respect to $\bar{c}^i$ to get

$$\frac{\partial SMRS_{cz}^k}{\partial\bar{c}^i} = \frac{\left(u_{c\bar{c}^i}^k + u_{\bar{c}^k\bar{c}^i}^k\right)w^k - u_{z\bar{c}^i}^k}{u_c^k + u_{\bar{c}^k}^k},$$

where we have used $w^k = u_z^k/(u_c^k + u_{\bar{c}^k}^k)$. We can then rewrite Eq. (A7) such that

$$\frac{dc^k}{d\bar{c}^i} = \frac{u_z^k}{\Phi}\frac{\partial SMRS_{cz}^k}{\partial\bar{c}^i}. \tag{A8}$$

Therefore, $dc^k/d\bar{c}^i > 0$ (<0) if $\partial SMRS_{cz}^k/\partial\bar{c}^i > 0$ (<0). QED

Proof of Proposition 2. We can write the Lagrangean of the Stackelberg leader as

$$L^i = u^i\left(c^i, z^i, \bar{c}^i, \bar{c}^k\left(\bar{c}^i\right)\right) + \gamma^i\left(w^i\left(\Omega - z^i\right) - c^i\right). \tag{A9}$$

The first-order conditions become

$$u_c^i + u_{\bar{c}^i}^i + u_{\bar{c}^k}^i\frac{\partial\bar{c}^k}{\partial\bar{c}^i} = \gamma^i, \tag{A10}$$

$$u_z^i = \gamma^i w^i. \tag{A11}$$

Combine Eqs. (A10) and (A11) to derive

$$u_z^i = w^i\left(u_c^i + u_{\bar{c}^i}^i + u_{\bar{c}^k}^i\frac{\partial\bar{c}^k}{\partial\bar{c}^i}\right). \tag{A12}$$

Next, combining Eqs. (3) and (A12) and solving for t^i gives

$$t^i = -\frac{u_{\bar{c}^i}^i + u_{\bar{c}^k}^i\dfrac{\partial\bar{c}^k}{\partial\bar{c}^i}}{u_c^i}. \tag{A13}$$

Finally, since $u_c^i = v_c^i + v_R^i + v_S^i$ and $u_{\bar{c}^k}^i = -v_S^i$ as defined above, we obtain

$$t^i = \frac{v_R^i + v_S^i\dfrac{\partial\bar{c}^k}{\partial\bar{c}^i}}{v_c^i + v_R^i + v_S^i} = \alpha^i + \frac{\partial\bar{c}^k}{\partial\bar{c}^i}\beta^i. \tag{A14}$$

QED

Proof of Proposition 3. The welfare effect in country i if country k reduces its own consumption through a small increase in the marginal income tax rate is given by

$$u^i_{\bar{c}^k}\frac{\partial \bar{c}^k}{\partial t^k} > 0,$$

while the domestic welfare effect in country k is equal to zero (since each country has already made an optimal policy choice based on its own objective and constraints). This holds irrespective of whether the pre-reform equilibrium is based on the Nash or the Stackelberg game, and whether in the latter case i is the leader or the follower. QED

Proof of Proposition 4. The Lagrangean corresponding to the maximization of utility in country i subject to a constraint that utility is held fixed in country k and an overall resource constraint can be written as

$$L = U^i + \mu\left(U^k - \overline{U}^k\right) + \gamma\left(w^i\left(\Omega - z^i\right) - c^i + w^k\left(\Omega - z^k\right) - c^k\right), \tag{A15}$$

where $\bar{U}^k$ is the fixed minimum utility for country k. The corresponding first-order conditions can be written as

$$u^i_c + u^i_{\bar{c}^i} + \mu u^k_{\bar{c}^i} = \gamma, \tag{A16}$$

$$u^i_{\bar{c}^k} + \mu u^k_c + \mu u^k_{\bar{c}^k} = \gamma, \tag{A17}$$

$$u^i_z / w^i = \gamma, \tag{A18}$$

$$\mu u^k_z / w^k = \gamma. \tag{A19}$$

Eqs. (A18) and (A19) imply

$$\mu = \frac{u^i_z / w^i}{u^k_z / w^k} = \frac{u^i_z}{u^k_z}\frac{w^k}{w^i}. \tag{A20}$$

Combine Eqs. (A16) and (A17) and use Eq. (A20) to substitute for μ. This gives

$$\frac{u^k_z}{u^k_c} w^i\left(1 + \frac{u^i_{\bar{c}^i}}{u^i_c} - \frac{u^i_{\bar{c}^k}}{u^i_c}\right) = \frac{u^i_z}{u^i_c} w^k\left(1 + \frac{u^k_{\bar{c}^k}}{u^k_c} - \frac{u^k_{\bar{c}^i}}{u^k_c}\right), \tag{A21}$$

while Eqs. (A16), (A18), and (A20) can be combined in a similar way to give

$$\frac{u^k_z}{u^k_c} = \frac{\dfrac{u^i_z}{u^i_c}\dfrac{u^k_{\bar{c}^i}}{u^k_c} w^k}{\dfrac{u^i_z}{u^i_c} - w^i - \dfrac{u^i_{\bar{c}^i}}{u^i_c} w^i}. \tag{A22}$$

Substituting Eq. (A22) into Eq. (A21) and using the individual first-order condition $u^i_z / w^i = u^i_c[1 - t^i]$ imply

$$t^i = -\frac{u^i_{\bar{c}^i}}{u^i_c} - \frac{1 + \dfrac{u^i_{\bar{c}^i}}{u^i_c} - \dfrac{u^i_{\bar{c}^k}}{u^i_c}}{1 + \dfrac{u^k_{\bar{c}^k}}{u^k_c} - \dfrac{u^k_{\bar{c}^i}}{u^k_c}}\frac{u^k_{\bar{c}^i}}{u^k_c}. \tag{A23}$$

Finally, rewriting Eq. (A23) in terms of positionality degrees such that $u^i_{\bar{c}^i}/u^i_c = -\alpha^i$, $u^i_{\bar{c}^k}/u^i_c = -\beta^i$, $u^k_{\bar{c}^k}/u^k_c = -\alpha^k$, and $u^k_{\bar{c}^i}/u^k_c = -\beta^k$ gives the formula in Proposition 4. QED

Proof of Corollary 1. Follows directly from Proposition 4.

Proof of Proposition 5. The individual budget constraint can be written as

$$w^i\left(\Omega - z^i\right)\left(1 - t^i\right) + \tau^i = \sum\nolimits_{l=1}^m c^i_l\left(1 + t^i_l\right), \tag{A24}$$

and the Lagrangean corresponding the individual's decision problem is given by

$$U^i + \mu^i\left(w^i\left(\Omega - z^i\right)\left(1 - t^i\right) + \tau^i - \sum\nolimits_{l=1}^m c^i_l\left(1 + t^i_l\right)\right).$$

The individual first-order condition regarding the tradeoff between consumption of good h and leisure then becomes

$$\frac{u^i_{c_h}}{u^i_z} = \frac{1}{w^i}\frac{1 + t^i_h}{1 - t^i}. \tag{A25}$$

The governmental budget constraint is given by

$$w^i\left(\Omega - z^i\right) = \sum\nolimits_{l=1}^m c^i_l, \tag{A26}$$

implying the following Lagrangean associated with the Nash equilibrium:

$$U^i + \gamma^i\left(w^i\left(\Omega - z^i\right) - \sum\nolimits_{l=1}^m c^i_l\right). \tag{A27}$$

The government's first-order condition for consumption of good h in country i then becomes

$$u^i_{c_h} + u^i_{\bar{c}^i_h} = \gamma^i, \tag{A28}$$

whereas the optimum condition with respect to leisure is still given by Eq. (10). Combining Eqs. (A28) and (10) gives

$$u^i_z = w^i\left(u^i_{c_h} + u^i_{\bar{c}^i_h}\right). \tag{A29}$$

From Eq. (A25) we get $u^i_z = w^i u^i_{c_h}\frac{1 - t^i}{1 + t^i_h}$, which we can substitute into Eq. (A29) and solve for t^i_h to obtain

$$t^i_h = \frac{-u^i_{\bar{c}^i_h}/u^i_{c_h} - t^i}{1 + u^i_{\bar{c}^i_h}/u^i_{c_h}} = \frac{\alpha^i_h - t^i}{1 - \alpha^i_h}.$$

QED

Proof of Proposition 6. The Lagrangean corresponding to the maximization of utility in country i subject to a constraint that utility is held fixed in country k and an overall resource constraint can be written as

$$L = U^i + \mu\left(U^k - \overline{U}^k\right) + \gamma\left(w^i\left(\Omega - z^i\right) + w^k\left(\Omega - z^k\right) - \sum\nolimits_{l=1}^m\left(c^i_l + c^k_l\right)\right). \tag{A30}$$

We can then combine the first-order conditions in the same way as in the derivations of Eqs. (A21) and (A22) and obtain

$$\frac{u^k_z}{u^k_{c_h}} w^i\left(1 + \frac{u^i_{\bar{c}^i_h}}{u^i_{c_h}} - \frac{u^i_{\bar{c}^k_h}}{u^i_{c_h}}\right) = \frac{u^i_z}{u^i_{c_h}} w^k\left(1 + \frac{u^k_{\bar{c}^k_h}}{u^k_{c_h}} - \frac{u^k_{\bar{c}^i_h}}{u^k_{c_h}}\right), \tag{A31}$$

$$\frac{u^k_z}{u^k_{c_h}} = \frac{\dfrac{u^i_z}{u^i_{c_h}}\dfrac{u^k_{\bar{c}^i_h}}{u^k_{c_h}} w^k}{\dfrac{u^i_z}{u^i_{c_h}} - w^i - \dfrac{u^i_{\bar{c}^i_h}}{u^i_{c_h}} w^i}. \tag{A32}$$

Substituting Eq. (A32) into Eq. (A31) and using $\frac{u_z^i}{w^i} = \frac{1-t^i}{1+t_h^i} u_{c_h}^i$ imply

$$\frac{u^k_{\bar{c}^i_h}}{u^k_{c_h}}\left(1+\frac{u^i_{\bar{c}^i_h}}{u^i_{c_h}}-\frac{u^i_{\bar{c}^k_h}}{u^i_{c_h}}\right)=\left(1+\frac{u^k_{\bar{c}^k_h}}{u^k_{c_h}}-\frac{u^k_{\bar{c}^i_h}}{u^k_{c_h}}\right)\left(\frac{1-t^i}{1+t^i_h}-1-\frac{u^i_{\bar{c}^i_h}}{u^i_{c_h}}\right). \tag{A33}$$

Finally, using $\alpha_h^i = -u^i_{\bar{c}^i_h}/u^i_{c_h}$ and $\beta_h^i = -u^i_{\bar{c}^k_h}/u^i_{c_h}$ in Eq. (A33) and solving for t_h^i implies Proposition 6. QED.

Proof of Proposition 7. The first-order conditions for l_1^i, c_1^i, l_2^i, and c_2^i associated with the Lagrangean in Eq. (21) are given as follows:

$$-u^i_{1,z}+\frac{w^i_1}{w^i_2}\lambda^i\hat{u}^i_{2,z}+\gamma^i n^i_1 w^i_1=0, \tag{A34}$$

$$u^i_{1,c}-\lambda^i\hat{u}^i_{2,c}-\gamma^i n^i_1+\frac{\partial L^i}{\partial\bar{c}^i}\frac{n^i_1}{n^i_1+n^i_2}=0, \tag{A35}$$

$$-\left(\delta^i+\lambda^i\right)u^i_{2,z}+\gamma^i n^i_2 w^i_2=0, \tag{A36}$$

$$\left(\delta^i+\lambda^i\right)u^i_{2,c}-\gamma^i n^i_2+\frac{\partial L^i}{\partial\bar{c}^i}\frac{n^i_2}{n^i_1+n^i_2}=0, \tag{A37}$$

where

$$\frac{\partial L^i}{\partial\bar{c}^i}=u^i_{1,\bar{c}^i}+\left(\delta^i+\lambda^i\right)u^i_{2,\bar{c}^i}-\lambda^i\hat{u}^i_{2,\bar{c}^i}. \tag{A38}$$

Eq. (A38) thus measures the partial welfare effect for country i of an increase in $\bar{c}^i$, ceteris paribus, which we will refer to as the *within-country positionality effect* in what follows.

Consider first the marginal income tax rate implemented for the low-ability type. By combining Eqs. (A34) and (A35), we get

$$MRS^i_{1,zc}\left(\lambda^i\hat{u}^i_{2,c}-\frac{\partial L^i}{\partial\bar{c}^i}\frac{n^i_1}{n^i_1+n^i_2}\right)=\frac{w^i_1}{w^i_2}\lambda^i\hat{u}^i_{2,z}+\gamma^i n^i_1\left(w^i_1-MRS^i_{1,zc}\right). \tag{A39}$$

From Eq. (17) we have $w_1^i - MRS^i_{1,zc} = w_1^i T^{i\,\prime}(w_1^i l_1^i)$. Substituting into Eq. (A39) and solving for $T^{i\,\prime}(w_1^i l_1^i)$ gives

$$T^{i\prime}\left(w^i_1 l^i_1\right)=\frac{\lambda^i\hat{u}^i_{2,c}}{\gamma^i n^i_1 w^i_1}\left(MRS^i_{1,zc}-\frac{w^i_1}{w^i_2}M\hat{R}S^i_{2,zc}\right)-\frac{MRS^i_{1,zc}}{\gamma^i w^i_1\left(n^i_1+n^i_2\right)}\frac{\partial L^i}{\partial\bar{c}^i}. \tag{A40}$$

$MRS^i_{1,zc} = (\partial u_1^i/\partial z_1^i)/(\partial u_1^i/\partial c_1^i)$ denotes the marginal rate of substitution between leisure and private consumption for the low-ability type, and $M\hat{R}S^i_{2,zc}$ denotes the corresponding marginal rate of substitution for the mimicker. The result for the high-ability type is obtained equivalently by instead combining Eqs. (17), (A36), and (A37):

$$T^{i\prime}\left(w^i_2 l^i_2\right)=-\frac{MRS^i_{2,zc}}{\gamma^i w^i_2\left(n^i_1+n^i_2\right)}\frac{\partial L^i}{\partial\bar{c}^i}. \tag{A41}$$

Let us now introduce σ_j^i as a short notation for the optimal marginal income tax rate implemented for ability type j in country i in a standard two-type model without any direct policy adjustment to relative consumption concerns, i.e.,

$$\sigma^i_1=\frac{\lambda^i\hat{u}^i_{2,c}}{\gamma^i n^i_1 w^i_1}\left(MRS^i_{1,zc}-\frac{w^i_1}{w^i_2}M\hat{R}S^i_{2,zc}\right), \tag{A42}$$

$$\sigma^i_2=0. \tag{A43}$$

Using Eqs. (A42) and (A43) in Eqs. (A40) and (A41) we can, write the optimal marginal income tax rate for individuals of ability type j in country i in the following general form:

$$T^{i\prime}\left(w^i_j l^i_j\right)=\sigma^i_j-\frac{MRS^i_{j,zc}}{\gamma^i w^i_j\left(n^i_1+n^i_2\right)}\frac{\partial L^i}{\partial\bar{c}^i}. \tag{A44}$$

Let us next explore the within-country positionality effect. We start by re-expressing the terms of Eq. (A38). From the utility function (15) follows that

$$u^i_{j,\bar{c}^i}=-\alpha^i_j u^i_{j,c}. \tag{A45}$$

Substituting Eq. (A45) into Eq. (A38) gives

$$\frac{\partial L^i}{\partial\bar{c}^i}=-\alpha^i_1 u^i_{1,c}-\left(\delta^i+\lambda^i\right)\alpha^i_2 u^i_{2,c}+\lambda^i\hat{\alpha}^i_2\hat{u}^i_{2,c}. \tag{A46}$$

Now, Eqs. (A35) and (A37) can be rewritten as

$$u^i_{1,c}=\lambda^i\hat{u}^i_{2,c}+\gamma^i n^i_1-\frac{\partial L^i}{\partial\bar{c}^i}\frac{n^i_1}{n^i_1+n^i_2},$$
$$\left(\delta^i+\lambda^i\right)u^i_{2,c}=\gamma^i n^i_2-\frac{\partial L^i}{\partial\bar{c}^i}\frac{n^i_2}{n^i_1+n^i_2},$$

which if substituted into Eq. (A46) imply, after collecting terms and using Eq. (18a),

$$\frac{\partial L^i}{\partial\bar{c}^i}=-\gamma^i\left(n^i_1+n^i_2\right)\frac{\overline{\alpha}^i}{1-\overline{\alpha}^i}+\lambda^i\hat{u}^i_{2,c}\frac{\hat{\alpha}^i_2-\alpha^i_1}{1-\overline{\alpha}^i}. \tag{A47}$$

Using Eq. (22) in Eq. (A47) implies that we can write the within-country positionality effect as

$$\frac{\partial L^i}{\partial\bar{c}^i}=-\gamma^i\left(n^i_1+n^i_2\right)\frac{\overline{\alpha}^i-\alpha^{id}}{1-\overline{\alpha}^i}. \tag{A48}$$

Substituting Eq. (A48) into Eq. (A44), we obtain

$$\begin{aligned}T^{i\prime}\left(w^i_j l^i_j\right)&=\sigma^i_j+\frac{MRS^i_{j,zc}}{w^i_j}\left(\frac{\overline{\alpha}^i}{1-\overline{\alpha}^i}-\frac{\lambda^i\hat{u}^i_{2,c}}{\gamma^i\left(n^i_1+n^i_2\right)}\frac{\hat{\alpha}^i_2-\alpha^i_1}{1-\overline{\alpha}^i}\right)\\&=\sigma^i_j+\frac{MRS^i_{j,zc}}{w^i_j}\frac{\overline{\alpha}^i-\alpha^{id}}{1-\overline{\alpha}^i}\end{aligned}. \tag{A49}$$

Finally, using $MRS^i_{j,zc}/w_j^i = 1 - T^{i\,\prime}(w_j^i l_j^i)$ in Eq. (A49) and then solving for $T^{i\,\prime}(w_j^i l_j^i)$ gives

$$T^{i\,\prime}\left(w^i_j l^i_j\right)=\frac{1-\overline{\alpha}^i}{1-\alpha^{id}}\sigma^i_j+\frac{\overline{\alpha}^i-\alpha^{id}}{1-\alpha^{id}}, \tag{A50}$$

which can be re-arranged to give the tax formula in Proposition 7. QED

Proof of Proposition 8. Let us rewrite the Lagrangean in Eq. (21) to make the Stackelberg properties explicit:

$$\begin{aligned}L^i&=u^i_1\left(c^i_1,z^i_1,\bar{c}^i,\bar{c}^k\left(\bar{c}^i\right)\right)+\delta^i\left(u^i_2\left(c^i_2,z^i_2,\bar{c}^i,\bar{c}^k\left(\bar{c}^i\right)\right)-\bar{U}^i_2\right)\\&+\lambda^i\left(u^i_2\left(c^i_2,z^i_2,\bar{c}^i,\bar{c}^k\left(\bar{c}^i\right)\right)-\hat{u}^i_2\left(c^i_1,\Omega-\frac{w^i_1}{w^i_2}l^i_1,\bar{c}^i,\bar{c}^k\left(\bar{c}^i\right)\right)\right)\\&+\gamma^i\left(n^i_1\left(w^i_1 l^i_1-c^i_1\right)+n^i_2\left(w^i_2 l^i_2-c^i_2\right)\right)\end{aligned}. \tag{A51}$$

The first-order conditions with respect to the number of work hours for both ability types remain the same as in the Nash equilibrium case, i.e., as Eqs. (A34) and (A36), while the first-order conditions for c_1^i and c_2^i are given as

$$u_{1,c}^i - \lambda^i \hat{u}_{2,c}^i - \gamma^i n_1^i + \frac{\partial L^i}{\partial \bar{c}^i}\frac{n_1^i}{n_1^i + n_2^i} = 0, \tag{A52}$$

$$\left(\delta^i + \lambda^i\right) u_{2,c}^i - \gamma^i n_2^i + \frac{\partial L^i}{\partial \bar{c}^i}\frac{n_2^i}{n_1^i + n_2^i} = 0, \tag{A53}$$

in which

$$\frac{\partial L^i}{\partial \bar{c}^i} = u_{1,\bar{c}^i}^i + u_{1,\bar{c}^k}^i \frac{\partial \bar{c}^k}{\partial \bar{c}^i} + \left(\delta^i + \lambda^i\right) \times \left(u_{2,\bar{c}^i}^i + u_{2,\bar{c}^k}^i \frac{\partial \bar{c}^k}{\partial \bar{c}^i}\right) - \lambda^i \left(\hat{u}_{2,\bar{c}^i}^i + \hat{u}_{2,\bar{c}^k}^i \frac{\partial \bar{c}^k}{\partial \bar{c}^i}\right). \tag{A54}$$

By analogy to Eq. (A38), we can interpret Eq. (A54) as measuring the within-country positionality effect for the Stackelberg leader. The difference is that country *i* is here assumed to be first mover and will, therefore, also consider the indirect relationship between $\bar{c}^i$ and $\bar{c}^k$, which provides an additional channel through which the government may increase the domestic welfare. Since the social first-order conditions are analogous to those in the Nash equilibrium case, with the only exception that the expression for $\partial L^i/\partial \bar{c}^i$ takes a different form in (A52) and (A53) compared with (A35) and (A37), it follows that the optimal marginal income tax rates can be written as

$$T^{i\,\prime}\left(w_j^i l_j^i\right) = \sigma_j^i - \frac{MRS_{j,zc}^i}{\gamma^i w_j^i (n_1^i + n_2^i)}\frac{\partial L^i}{\partial \bar{c}^i}. \tag{A55}$$

Eq. (A55) takes the same general form as Eq. (A44). To be able to rewrite Eq. (A55) in terms of degrees of positionality, we will further explore the within-country positionality effect in the Stackelberg case. By using Eq. (15) and the definition of the partial degree of foreign positionality, we obtain

$$u_{j,\bar{c}^k}^i = -v_{j,S}^i = -\beta_j^i u_{j,c}^i. \tag{A56}$$

Substituting Eq. (A56) into Eq. (A54) gives

$$\frac{\partial L^i}{\partial \bar{c}^i} = -u_{1,c}^i\left(\alpha_1^i + \beta_1^i \frac{\partial \bar{c}^k}{\partial \bar{c}^i}\right) - u_{2,c}^i\left(\delta^i + \lambda^i\right)\left(\alpha_2^i + \beta_2^i \frac{\partial \bar{c}^k}{\partial \bar{c}^i}\right) + \lambda^i \hat{u}_{2,c}^i\left(\hat{\alpha}_2^i + \hat{\beta}_2^i \frac{\partial \bar{c}^k}{\partial \bar{c}^i}\right). \tag{A57}$$

Rewriting Eqs. (A52) and (A53) such that

$$u_{1,c}^i = \lambda^i \hat{u}_{2,c}^i + \gamma^i n_1^i - \frac{\partial L^i}{\partial \bar{c}^i}\frac{n_1^i}{n_1^i + n_2^i},$$
$$\left(\delta^i + \lambda^i\right) u_{2,c}^i = \gamma^i n_2^i - \frac{\partial L^i}{\partial \bar{c}^i}\frac{n_2^i}{n_1^i + n_2^i},$$

and then substituting into Eq. (A57) gives (after collecting terms)

$$\frac{\partial L^i}{\partial \bar{c}^i} = -\gamma^i\left(n_1^i + n_2^i\right)\frac{\bar{\alpha}^i + \bar{\beta}^i \frac{\partial \bar{c}^k}{\partial \bar{c}^i}}{1 - \bar{\alpha}^i - \bar{\beta}^i \frac{\partial \bar{c}^k}{\partial \bar{c}^i}} + \lambda^i \hat{u}_{2,c}^i \frac{\hat{\alpha}_2^i + \hat{\beta}_2^i \frac{\partial \bar{c}^k}{\partial \bar{c}^i} - \alpha_1^i - \beta_1^i \frac{\partial \bar{c}^k}{\partial \bar{c}^i}}{1 - \bar{\alpha}^i - \bar{\beta}^i \frac{\partial \bar{c}^k}{\partial \bar{c}^i}}. \tag{A58}$$

Using the definitions of α^{id} and β^{id}, Eq. (A58) can be written as

$$\frac{\partial L^i}{\partial \bar{c}^i} = -\gamma^i\left(n_1^i + n_2^i\right)\frac{\bar{\alpha}^i + \bar{\beta}^i \frac{\partial \bar{c}^k}{\partial \bar{c}^i} - \left(\alpha^{id} + \beta^{id}\frac{\partial \bar{c}^k}{\partial \bar{c}^i}\right)}{1 - \bar{\alpha}^i - \bar{\beta}^i \frac{\partial \bar{c}^k}{\partial \bar{c}^i}} = -\gamma^i\left(n_1^i + n_2^i\right)\frac{\bar{\psi}^i - \psi^{id}}{1 - \bar{\psi}^i}, \tag{A59}$$

where $\bar{\psi}^i = \bar{\alpha}^i + \bar{\beta}^i \frac{\partial \bar{c}^k}{\partial \bar{c}^i}$ and $\psi^{id} = \alpha^{id} + \beta^{id}\frac{\partial \bar{c}^k}{\partial \bar{c}^i}$. The equation in Proposition 8 then follows by analogy to the proof of Proposition 7 by replacing $\bar{\alpha}^i$ and α^{id} with $\bar{\psi}^i$ and ψ^{id}, respectively, in Eq. (A48).

To prove (*ii*), multiply and divide the second term on the right-hand side of the tax formula in the proposition by $1 - \psi^{id}$ and rearrange to derive

$$T^{i\,\prime}\left(w_j^i l_j^i\right) = \sigma_j^i + \frac{\left(1-\sigma_j^i\right)\left(\bar{\psi}^i - \psi^{id}\right)}{1-\psi^{id}} = \sigma_j^i + \frac{\left(1-\sigma_j^i\right)\left(\left(\bar{\alpha}^i - \alpha^{id}\right) + \left(\bar{\beta}^i - \beta^{id}\right)\frac{\partial \bar{c}^k}{\partial \bar{c}^i}\right)}{1 - \left(\alpha^{id} + \beta^{id}\frac{\partial \bar{c}^k}{\partial \bar{c}^i}\right)}. \tag{A60}$$

With $\bar{\beta}^i > \beta^{id}$, and if $\partial \bar{c}^k/\partial \bar{c}^i > 0$ (< 0), the right-hand side of Eq. (A60) is larger (smaller) than in the Nash case where all β − terms are absent. QED

Proof of Proposition 10. Consider the Lagrangean corresponding to the maximization of the utility facing the low-ability type in country *i*, while holding constant the utility of the high-ability type in country *i* and the utility facing both ability types in country *k* subject to a self-selection constraint in each country and an overall resource constraint:

$$L^i = U_1^i + \delta\left(U_2^i - \bar{U}_2^i\right) + \lambda\left(U_2^i - \hat{U}_2^i\right) + \omega\left(U_2^k - \hat{U}_2^k\right) + \mu\left(U_1^k - \bar{U}_1^k\right) + \upsilon\left(U_2^k - \bar{U}_2^k\right) + \gamma\left(n_1^i\left(w_1^i l_1^i - c_1^i\right) + n_2^i\left(w_2^i l_2^i - c_2^i\right) + n_1^k\left(w_1^k l_1^k - c_1^k\right) + n_2^k\left(w_2^k l_2^k - c_2^k\right)\right), \tag{A61}$$

where $\bar{U}_j^k$ for $j = 1,2$ denote the minimum utility levels for residents in country *k*. The first-order conditions with respect to leisure and consumption for the individuals in country *i* take the same general form as Eqs. (A34)–(A37), implying that Eq. (A44) holds here as well. Yet, the relevant positionality effect attached to $\bar{c}^i$ is now different and given by

$$\frac{\partial L^i}{\partial \bar{c}^i} = u_{1,\bar{c}^i}^i + (\delta + \lambda) u_{2,\bar{c}^i}^i - \lambda \hat{u}_{2,\bar{c}^i}^i + (\omega + \upsilon) u_{2,\bar{c}^i}^k - \omega \hat{u}_{2,\bar{c}^i}^k + \mu u_{1,\bar{c}^i}^k, \tag{A62}$$

since country *i* will, in this case, recognize the welfare effects it causes on country *k*. The corresponding social first-order conditions with respect to leisure and consumption for country *k* are given by

$$-\mu u_{1,z}^k + \omega \hat{u}_{2,z}^k \frac{w_1^k}{w_2^k} + \gamma n_1^k w_1^k = 0, \tag{A63}$$

$$\mu u_{1,c}^k - \omega \hat{u}_{2,c}^k - \gamma n_1^i + \frac{\partial L^i}{\partial \bar{c}^k}\frac{n_1^k}{n_1^k + n_2^k} = 0, \tag{A64}$$

$$-(\upsilon + \omega) u_{2,z}^k + \gamma n_2^k w_2^k = 0, \tag{A65}$$

$$(\upsilon + \omega) u_{2,c}^k - \gamma n_2^k + \frac{\partial L^i}{\partial \bar{c}^k}\frac{n_2^k}{n_1^k + n_2^k} = 0, \tag{A66}$$

and

$$\frac{\partial L^i}{\partial \bar{c}^k} = u^i_{1,\bar{c}^k} + \left(\delta^i + \lambda^i\right) u^i_{2,\bar{c}^k} - \lambda \hat{u}^i_{2,\bar{c}^k} + (\omega + \upsilon) u^k_{2,\bar{c}^k} - \omega \hat{u}^k_{2,\bar{c}^k} + \mu u^k_{1,\bar{c}^k}. \tag{A67}$$

Since the positionality effect for each country is now different compared with those associated with the non-cooperative regimes analyzed above, the optimal marginal income tax rates as expressed in terms of relative consumption comparisons will of course also be different. Substituting Eqs. (A34)–(A37) and (A63)–(A67) into Eq. (A62), and rearranging, gives

$$\begin{aligned}\frac{\partial L^i}{\partial \bar{c}^i} = & -\alpha^i_1\left(\lambda \hat{u}^i_{2,c} + \gamma n^i_1 - \frac{\partial L^i}{\partial \bar{c}^i}\frac{n^i_1}{(n^i_1+n^i_2)}\right) - \alpha^i_2\left(\gamma n^i_2 - \frac{\partial L^i}{\partial \bar{c}^i}\frac{n^i_2}{(n^i_1+n^i_2)}\right)\\ & -\beta^k_1\left(\omega \hat{u}^k_{2,c} + \gamma n^k_1 - \frac{\partial L^i}{\partial \bar{c}^k}\frac{n^k_1}{(n^k_1+n^k_2)}\right) - \beta^k_2\left(\gamma n^k_2 - \frac{\partial L^i}{\partial \bar{c}^k}\frac{n^k_2}{(n^k_1+n^k_2)}\right).\\ & +\lambda \hat{\alpha}^i_2 \hat{u}^i_{2,c} + \omega \hat{\beta}^k_2 \hat{u}^k_{2,c}\end{aligned} \tag{A68}$$

Using next the measures of average degrees of positionality defined in Eqs. (18a) and (18b) and rearranging gives

$$\begin{aligned}\frac{\partial L^i}{\partial \bar{c}^i}\left(1-\overline{\alpha}^i\right) = & -\gamma\left(n^i_1+n^i_2\right)\overline{\alpha}^i + \lambda \hat{u}^i_{2,c}\left(\hat{\alpha}^i_2 - \alpha^i_1\right) - \gamma\left(n^k_1+n^k_2\right)\overline{\beta}^k\\ & + \omega \hat{u}^k_{2,c}\left(\hat{\beta}^k_2 - \beta^k_1\right) + \overline{\beta}^k \frac{\partial L^i}{\partial \bar{c}^k}\end{aligned}. \tag{A69}$$

We can derive an analogous equation for $\bar{c}^k$:

$$\begin{aligned}\frac{\partial L^i}{\partial \bar{c}^k}\left(1-\overline{\alpha}^k\right) = & -\gamma\left(n^i_1+n^i_2\right)\overline{\beta}^i + \lambda \hat{u}^i_{2,c}\left(\hat{\beta}^i_2 - \beta^i_1\right) - \gamma\left(n^k_1+n^k_2\right)\overline{\alpha}^k\\ & + \omega \hat{u}^k_{2,c}\left(\hat{\alpha}^k_2 - \alpha^k_1\right) + \overline{\beta}^i \frac{\partial L^i}{\partial \bar{c}^i}\end{aligned}. \tag{A70}$$

Using the definitions of α^{id} and β^{id} and the corresponding measures α^{kd} and β^{kd}, substituting Eq. (A70) into Eq. (A69), and then using $\overline{\alpha}^i = \overline{\alpha}^k = \overline{\alpha}$, $\overline{\beta}^i = \overline{\beta}^k = \overline{\beta}$, $\alpha^{id} = \alpha^{kd} = \alpha^d$, $\beta^{id} = \beta^{kd} = \beta^d$, and $n^i_1 + n^i_2 = n^k_1 + n^k_2 = n_1 + n_2$, we obtain the positionality effect for the average consumption in country i as follows:

$$\frac{\partial L^i}{\partial \bar{c}^i} = -\gamma(n_1+n_2)\frac{\overline{\rho} - \rho^d}{1-\overline{\rho}}, \tag{A71}$$

where $\overline{\rho} = \overline{\alpha} + \overline{\beta}$ and $\rho^d = \alpha^d + \beta^d$. This positionality effect reflects the welfare effects of an increase in $\bar{c}^i$ facing both countries. This is also the reason why the positionality effect is governed by the average degree of *total* positionality, $\overline{\rho}$, and the difference in the degree of *total* positionality between the mimicker and the low-ability type, ρ^d, instead of the corresponding measures ($\overline{\alpha}$ and α^d) as in the non-cooperative Nash equilibrium. Using Eq. (A71) in Eq. (A44), Proposition 10 follows by analogy to the proofs of Propositions 7 and 8. QED

References

Abel, A.B., 2005. Optimal taxation when consumers have endogenous benchmark levels of consumption. Rev. Econ. Stud. 72, 1–19.

Akerlof, G.A., 1997. Social distance and social decisions. Econometrica 65, 1005–1027.

Alpizar, F., Carlsson, F., Johansson-Stenman, O., 2005. How much do we care about absolute versus relative income and consumption? J. Econ. Behav. Organ. 56, 405–421.

Alvarez-Cuadrado, F., Long, N.V., 2011. The relative income hypothesis. J. Econ. Dyn. Control. 35, 1489–1501.

Alvarez-Cuadrado, F., Long, N.V., 2012. Envy and inequality. Scand. J. Econ. 114, 949–973.

Aronsson, T., Blomquist, S., 2003. Optimal taxation, global externalities and labor mobility. J. Public Econ. 87, 2749–2764.

Aronsson, T., Johansson-Stenman, O., 2008. When the Joneses' consumption hurts: optimal public good provision and nonlinear income taxation. J. Public Econ. 92, 986–997.

Aronsson, T., Johansson-Stenman, O., 2010. Positional concerns in an OLG model: optimal labor and capital income taxation. Int. Econ. Rev. 51, 1071–1095.

Aronsson, T., Johansson-Stenman, O., 2013a. Conspicuous leisure: optimal income taxation when both relative consumption and relative leisure matter. Scand. J. Econ. 115, 155–175.

Aronsson, T., Johansson-Stenman, O., 2013b. Veblen's theory of the leisure class revisited: implications for optimal income taxation. Soc. Choice Welf. 41, 551–578.

Aronsson, T., Johansson-Stenman, O., 2014. When Samuelson met Veblen abroad: national and global public good provision when social comparisons matter. Economica 81, 224–243.

Aronsson, T., Johansson-Stenman, O., 2015. Keeping up with the Joneses, the Smiths and the Tanakas: on international tax coordination and social comparisons. Working paper no. 621. Department of Economics, University of Gothenburg.

Aronsson, T., Löfgren, K.-G., 2000. Green accounting and green taxes in the global economy. In: Folmer, H., Gabel, L., Gerking, S., Rose, A. (Eds.), Frontiers of Environmental Economics. Edward Elgar Publishing Limited.

Becchetti, L., Castriota, S., Giachin Ricca, E., 2013. Beyond the Joneses: inter-country income comparisons and happiness. J. Socio-Econ. 45, 187–195.

Bierbrauer, F., Brett, C., Weymark, J., 2013. Strategic nonlinear income tax competition with perfect labor mobility. Games Econ. Behav. 82, 292–311.

Bilancini, E., Boncinelli, L., 2014. Instrumental cardinal concerns for social status in two-sided matching with non-transferable utility. Eur. Econ. Rev. 67, 174–189.

Blanchflower, D.G., Oswald, A.J., 2004. Well-being over time in Britain and the USA. J. Public Econ. 88, 1359–1386.

Boadway, R., Keen, M., 1993. Public goods, self-selection and optimal income taxation. Int. Econ. Rev. 34, 463–478.

Boskin, M.J., Sheshinski, E., 1978. Individual welfare depends upon relative income. Q. J. Econ. 92, 589–601.

Bowles, S., Park, Y.-J., 2005. Inequality, emulation, and work hours: was Thorsten Veblen right? Econ. J. 15, F397–F413.

Card, D., Mas, A., Moretti, E., Saez, E., 2012. Inequality at work: the effect of peer salaries on job satisfaction. Am. Econ. Rev. 102, 2981–3003.

Carlsson, F., Johansson-Stenman, O., Martinsson, P., 2007. Do you enjoy having more than others? Survey evidence of positional goods. Economica 74, 586–598.

Carraro, C., Siniscalco, D., 1993. Strategies for the international protection of the environment. J. Public Econ. 52, 309–328.

Clark, A., Senik, C., 2010. Who compares to whom? the anatomy of income comparisons in Europe. Econ. J. 120, 573–594.

Clark, A.E., Senik, C., 2011. Will GDP growth increase happiness in developing countries? In: Peccoud, R. (Ed.), Measure For Measure: How Well Do We Measure Development?STIN, Paris

Clark, A.E., Frijters, P., Shields, M.A., 2008. Relative income, happiness and utility: an explanation for the easterlin paradox and other puzzles. J. Econ. Lit. 46, 95–144.

Cohn, A., Fehr, E., Herrmann, B., Schneider, F., 2014. Social comparison and effort provision: evidence from a field experiment. J. Eur. Econ. Assoc. 12, 877–898.

Cole, H.L., Mailath, G.J., Postlewaite, A., 1995. Incorporating concern for relative wealth into economic models. Fed. Reserv. Bank Minneapolis Q. Rev. 19, 12–21.

Corazzini, L., Esposito, L., Majorano, F., 2012. Reign in hell or serve in heaven? A cross-country journey into the relative vs absolute perceptions of wellbeing. J. Econ. Behav. Organ. 81 (3), 715–730.

Corneo, G., Jeanne, O., 1997. Conspicuous consumption, snobbism and conformism. J. Public Econ. 66, 55–71.

Cremer, H., Pestieau, P., Rochet, J.-C., 2001. Direct versus indirect taxation: the design of the tax structure revisited. Int. Econ. Rev. 42, 781–799.

Dohmen, T., Falk, A., Fliessbach, K., Sunde, U., Weber, B., 2011. Relative versus absolute income, joy of winning, and gender: brain imaging evidence. J. Public Econ. 95, 279–285.

Dupor, B., Liu, W.F., 2003. Jealousy and overconsumption. Am. Econ. Rev. 93, 423–428.

Easterlin, R.A., 2001. Income and happiness: towards a unified theory. Econ. J. 111, 465–484.

Eckerstorfer, P., Wendner, R., 2013. Asymmetric and non-atmospheric consumption externalities, and efficient consumption taxation. J. Public Econ. 106, 42–56.

Ferrer-i-Carbonell, A., 2005. Income and well-being: an empirical analysis of the comparison income effect. J. Public Econ. 89, 997–1019.

Fliessbach, K., Weber, B., Trautner, P., Dohmen, T., Sunde, U., Elger, C.E., Falk, A., 2007. Social comparison affects reward-related brain activity in the human ventral striatum. Science 318, 1305–1308.

Frank, R.H., 1985a. The demand for unobservable and other nonpositional goods. Am. Econ. Rev. 75, 101–116.

Frank, R.H., 1985b. Choosing the Right Pond: Human Behavior and the Quest for Status. Oxford University Press, New York.

Frank, R.H., 2005. Positional externalities cause large and preventable welfare losses. Am. Econ. Rev. 95, 137–141.

Frank, R.H., 2008. Should public policy respond to positional externalities? J. Public Econ. 92, 1777–1786.

Friedman, B.M., 2005. The Moral Consequences of Economic Growth. Alfred A. Knopf, New York.

Friehe, T., Mechtel, M., 2014. Conspicuous consumption and political regimes: evidence from East and West Germany. Eur. Econ. Rev. 67, 62–81.

Huber, B., 1999. Tax competition and tax coordination in an optimal income tax model. J. Public Econ. 71, 441–458.

Ireland, N.J., 2001. Optimal income tax in the presence of status effects. J. Public Econ. 81, 193–212.

James, J., 1987. Positional goods, conspicuous consumption and the international demonstration effect reconsidered. World Dev. 15, 449–462.
Johansson-Stenman, O., Carlsson, F., Daruvala, D., 2002. Measuring future grandparents' preferences for equality and relative standing. Econ. J. 112, 362–383.
Kanbur, R., Tuomala, M., 2014. Relativity, inequality, and optimal nonlinear income taxation. Int. Econ. Rev. 54, 1199–1217.
Keen, M., Konrad, K., 2013. In: Auerbach, A.J., Chetty, R., Feldstein, M., Saez, E. (Eds.), The Theory of International Tax Competition and CoordinationHandbook of Public Economics vol. 5. Elsevier, pp. 257–328.
Layard, R., 1980. Human satisfaction and public policy. Econ. J. 90, 737–750.
Ljungqvist, L., Uhlig, H., 2000. Tax policy and aggregate demand management under catching up with the Joneses. Am. Econ. Rev. 90, 356–366.
Luttmer, E.F.P., 2005. Neighbors as negatives: relative earnings and well-being. Q. J. Econ. 120, 963–1002.
Mujcic, R., Frijters, P., 2013. Economic choices and status: measuring preferences for income rank. Oxf. Econ. Pap. 65, 47–73.
Oswald, A., 1983. Altruism, jealousy and the theory of optimal non-linear taxation. J. Public Econ. 20, 77–87.
Persson, M., 1995. Why are taxes so high in egalitarian societies? Scand. J. Econ. 97, 569–580.
Piketty, T., 2014. Capital in the Twenty-First Century. Belknap Press, Cambridge, MA.
Pinker, S., 2012. The Better Angels of our Nature: Why Violence has Declined. Viking Books, New York.
Rayo, L., Becker, G.S., 2007. Evolutionary efficiency and happiness. J. Polit. Econ. 115, 302–337.
Samuelson, L., 2004. Information-based relative consumption effects. Econometrica 72, 93–118.
Senik, C., 2009. Direct evidence on income comparisons and their welfare effects. J. Econ. Behav. Organ. 72, 408–424.
Singer, P., 1983. The Expanding Circle: Ethics, Evolution, and Moral Progress. Princeton University Press.
Solnick, S., Hemenway, D., 2005. Are positional concerns stronger in some domains than in others? Am. Econ. Rev. Pap. Proc. 45, 147–151.
Stern, N.H., 1982. Optimum taxation with errors in administration. J. Public Econ. 17, 181–211.
Stiglitz, J.E., 1982. Self-selection and pareto efficient taxation. J. Public Econ. 17, 213–240.
Tuomala, M., 1990. Optimal Income Tax and Redistribution. Clarendon Press, Oxford.
van der Ploeg, F., de Zeeuw, A., 1992. International Aspects of Pollution Control. Environ. Resour. Econ. 2, 117–139.
Wendner, R., 2010. Conspicuous consumption and generation replacement in a model with perpetual youth. J. Public Econ. 94, 1093–1107.
Wendner, R., 2014. Ramsey, Pigou, heterogeneous agents, and non-atmospheric consumption externalities. J. Public Econ. Theory 16, 491–521.
Wendner, R., Goulder, L.H., 2008. Status effects, public goods provision, and the excess burden. J. Public Econ. 92, 1968–1985.
Wolpert, D., 2010. Why income comparison is rational. Games Econ. Behav. 69, 458–474.
Zhang, Y., Deng, J., Majumdar, S., Zheng, B., 2009. Globalization of Lifestyle: Golfing in China. In: Lange, H., Meier, L. (Eds.), The Middle Classes. Springer.