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When Samuelson Met Veblen Abroad: National and Global Public Good Provision when Social Comparisons Matter

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This paper derives Pareto-efficient provision rules for national and global public goods in a two-country world, where each individual cares about his or her relative consumption of private goods compared to other domestic and foreign residents. We contrast these rules with those following from a non-cooperative Nash equilibrium. Both national and global public goods are underprovided in Nash equilibrium under such relative consumption concerns. Finally, when individuals also care about the relative consumption of national public goods, based on between-country comparisons, the optimal provision rule depends on whether or not the national public goods are less positional than private consumption.

INTRODUCTION

We live in an increasingly globalized world. This is not least true for the environmental problem at the top of the political agenda worldwide, namely global warming, for which it essentially does not matter for the environment in a single country where in the world the emissions of, for example, CO_2 are released; see, for example, Stern (2007). It is also true culturally, since only half a century ago, a large part of the world's population had only vague perceptions about living conditions in countries other than their own, whereas today we know much more about our fellows in other countries as a result of increased travel and the technological advancements of television and other media.

Arguably, this cultural globalization also has implications for social comparisons. In recent years, an economics literature dealing with the importance of relative consumption concerns—i.e. that we tend to value not only absolute consumption but also our consumption relative to that of others—has grown rapidly, in part influenced by the large corresponding literatures in social psychology and sociology. The strong connection between individual wellbeing and the individual's relative consumption found in many earlier studies also provides important challenges for public policy. Earlier empirical analysis on relative consumption and wellbeing comes from several different research areas, such as happiness research (e.g. Easterlin 2001; Blanchflower and Oswald 2004; Ferrer-i-Carbonell 2005; Luttmer 2005; Clark and Senik 2010), questionnaire-based experiments (e.g. Johansson-Stenman *et al*. 2002; Solnick and Hemenway 2005; Carlsson *et al*. 2007; Corazzini *et al*. 2012) and brain science (Fliessbach *et al*. 2007; Dohmen *et al*. 2011), whereas the theoretical literature dealing with optimal policy responses to relative consumption concerns include Boskin and Sheshinski (1978), Layard (1980), Ng (1987), Blomquist (1993), Howarth (1996, 2006), Corneo and Jeanne (1997, 2001), Ireland (2001), Brekke and Howarth (2002), Dupor and Liu (2003), Abel (2005), Aronsson and Johansson-Stenman (2008, 2010, 2013), Wendner and Goulder (2008), Kanbur and Tuomala (2010) and Wendner (2010, 2011).

Yet both the empirical and the theoretical literature on relative consumption concerns have almost exclusively been concerned with consumption comparisons *within* countries, and have hence ignored *between*-country comparisons. Becchetti *et al*. (2010) constitute a

recent exception in the empirical literature. Their study examines the determinants of self-reported life satisfaction and is based on survey data for Western European countries from 1973 to 2002. By controlling for the determinants of subjective wellbeing discussed in earlier literature, such as conventional relative income measures (one's income relative to that observed in reference groups based on education, age and gender) and domestic GDP, the authors find that the distance between the domestic GDP and the GDP of the richest country in the data significantly reduces individual life satisfaction, and that the importance of such cross-country comparisons has increased over time. As such, increased globalization indeed seems to affect the social comparisons inherent in subjective wellbeing.

There is also more indicative evidence. Based on different kinds of evidence, e.g. from the sociological literature, James (1987) argues that people in poor countries are most likely affected by the consumption in rich countries. Also, Friedman (2005) argues—based on his interpretation of available happiness data across countries and over time together with the rapidly increased spread of television and other information technology—that the importance of cross-country consumption comparisons most likely increases over time, i.e. in line with the evidence presented by Becchetti *et al.* (2010). Consistent with this (although there are, of course, alternative explanations), Clark and Senik (2010) present evidence based on a recent survey of Europeans showing that respondents who did not have internet access were less subject to income comparisons. Similarly, Clark and Senik (2011) argue in a recent survey of the happiness–consumption relationships that if the development of information and communication technologies allows 'the inhabitants of low-income countries to be aware of the lifestyle and consumption possibilities of high-income country citizens, this is likely to generate feelings of relative deprivation'.

However, we are not aware of any study dealing with the policy implications of relative consumption concerns both within and between countries. The present paper aims to fill part of this gap by analysing the policy incentives underlying public good provision. To be more specific, the purpose is to analyse the Pareto-efficient provision of national and global public goods in a world where people are concerned with consumption comparisons both with others in their own country and with people in other countries, and also to compare the policy rules for efficient public provision with those that follow in a non-cooperative Nash equilibrium. As such, the present paper generalizes insights from Ng (1987), Brekke and Howarth (2002), Aronsson and Johansson-Stenman (2008), and Wendner and Goulder (2008), who all study public good provision under relative consumption concerns in the context of one-country model economies, to a world with more than one country; see also Howarth (1996, 2006), who examines the related problem of dealing with environmental externalities in a one-country economy with relative consumption comparisons.

Why is this generalization interesting? First, as referred to above, evidence suggests that between-country comparisons have become increasingly important for individual wellbeing. Yet there are no earlier studies (at least not to our knowledge) dealing with the policy implications of such comparisons. As we will show below, within- as well as between-country comparisons affect the incentives underlying the provision of *both* national and global public goods. Second, it is particularly interesting to analyse the efficient provision of *global* public goods in such contexts due to the increased attention paid to global public goods in recent decades, where the global climate is the prime example. To implement the efficient provision of such public goods in real-world economies, the policy incentives facing governments at the national level must also be addressed, which

further motivates the distinction between the Pareto-efficient allocation and a non-cooperative Nash equilibrium.

In Section I, we present the basic model. To keep the analysis as simple as possible, while still being able to analyse the main mechanisms involved, we assume a world with two countries, which may or may not be identical. Individuals derive utility from their own consumption of private and public goods, where the latter comprise both national and global public goods, as well as from their own private consumption relative to that of other people in their own country and abroad, respectively. By national public goods, we simply mean public goods with no international spillovers, such that people derive utility from these goods solely within the country that provides them, whereas global public goods can be benefited from in all countries.

Section II presents efficient public good provision rules, with a particular emphasis on the elicitation format of people's marginal willingness to pay (WTP), which is shown to be important for how these policy rules are related to the Samuelson condition. These provision rules are expressed in terms of degrees of positionality, i.e. the degree to which relative consumption matters compared to absolute consumption. Section III presents the non-cooperative Nash equilibrium and, in particular, examines the provision of national and global public goods in that context. It is concluded that both national and global public goods tend to be underprovided in Nash equilibrium under between-country relative consumption concerns. In Section IV, we extend the analysis to a framework where each individual also cares about the relative consumption of national public goods through between-country comparisons. This extension does not change the policy rules for public provision in the Nash equilibrium, while it modifies the condition for Pareto-efficient public provision of national public goods. The efficiency-based argument for overproviding the public good relative to the Samuelson condition, due to positional concerns for private consumption, is here counteracted by the between-country externality caused by the provision of national public goods. Section V concludes the paper.

I. The Model—Preferences and Concerns for Relative Consumption

The world consists of two countries, Country 1 and Country 2, each with a fixed population of n identical individuals (although the individuals in Country 1 may be different from those in Country 2). The assumption that the population is of equal size in both countries is made for analytical convenience, as it simplifies the analysis considerably with little loss of generality. As such, it has no important implications for our qualitative understanding of how relative consumption concerns affect the optimal provision of public goods. Each individual in Country i derives utility from private consumption, c^i, as well as from the consumption of a national public good, l^i, and a global public good, g. The global public good is, in turn, decomposed as $g = g^1 + g^2$, where g^i is the contribution to the global public good made by Country i (but hence enjoyed in both countries). In addition, the individual cares about his or her relative consumption of the private good through two different comparisons: relative consumption compared to others' consumption in the individual's own country, $R^i = r^i(c^i, \bar{c}^i)$, where $\bar{c}^i$ is average consumption in Country i; and relative consumption compared to people in the other country, $S^i = s^i(c^i, \bar{c}^j)$, where $\bar{c}^j$ is the average consumption in the other country, j. The functions $r^i(\cdot)$ and $s^i(\cdot)$ have the properties $r^i_{c^i} > 0$, $r^i_{\bar{c}^i} < 0$, $s^i_{c^i} > 0$ and $s^i_{\bar{c}^j} < 0$, where subscripts denote partial derivatives.

To begin with, the public goods are assumed to be completely non-positional, which is the conventional approach in earlier studies on public goods and relative consumption.

This assumption is relaxed in Section IV, where we introduce relative consumption concerns for the national public goods through between-country comparisons.

The utility function for an individual in Country i is then given by (for $i = 1, 2$)

$$U^i = v^i(c^i, l^i, g, R^i, S^i) = u^i(c^i, l^i, g, \vec{c}^i, \vec{c}^j), \tag{1}$$

where v^i and u^i are twice continuously differentiable. As mentioned, we assume that people care about relative consumption compared to others in their own country as well as in the other country, implying that $v^i_R, v^i_S > 0$, which also implies that people's utility will depend negatively on others' consumption such that $u^i_{\vec{c}^i}, u^i_{\vec{c}^j} < 0$. As before, subscripts denote partial derivatives.

The reason why we work with two different utility functions (following, for example, Aronsson and Johansson-Stenman, 2008, 2010) is presentational, where $u^i(\cdot)$ is written as a function of private and public consumption for given levels of others' consumption. As such, it constitutes the natural starting point for expressing people's marginal willingness to pay for the public good *ceteris paribus*, given by $u^i_{l^i}/u^i_{c^i}$ and $u^i_g/u^i_{c^i}$, respectively. These, in turn, constitute crucial elements of the optimal provision rules for the public goods. In addition, $u^i(\cdot)$ can be seen as a convenient reduced form of the more explicit $v^i(\,\cdot\,)$, used in some of the calculations below.

$v^i(\cdot)$, in contrast, is written as a function of private and public consumption and also explicitly of the different kinds of relative consumption. Therefore it constitutes the natural starting point for expressing measures of the extent to which relative consumption matters for the individual, an issue to which we will turn next. These measures, in turn, are crucial components of the optimal public good provision rules to be derived. Subsequently we will specify $v^i(\cdot)$ further in order to obtain provision rules that are straightforward to interpret.

Before we derive the efficient provision rules, we will thus—following, for example, Johansson-Stenman *et al*. (2002) and Aronsson and Johansson-Stenman (2008)—introduce measures of the extent to which relative consumption matters at the individual level, to be denoted *degrees of positionality*. Yet since we have two countries here, contrary to previous studies, we will have different measures for the extent to which relative consumption matters within the country and the extent to which relative consumption matters between countries.

Let us define *the degree of domestic positionality* for each resident in Country i as

$$\alpha^i = \frac{v^i_R r^i_{c^i}}{v^i_{c^i} + v^i_R r^i_{c^i} + v^i_S s^i_{c^i}}, \quad \text{for } i = 1, 2. \tag{2}$$

The variable α^i reflects the fraction of the utility increase from the last dollar consumed by residents in Country i that is due to the increased relative consumption compared to others in their own country. For example, if $\alpha^i = 0.4$ (which is roughly consistent with the average findings in Johansson-Stenman *et al*. 2002), then 40% of the utility increase from the last dollar consumed by an individual in Country i is due to the increased relative consumption compared to others in their own country. The remaining 60% of the utility increase is due to a combination of increased absolute consumption and increased relative consumption compared to the consumption level in the other country.

Similarly, we can define *the degree of foreign positionality* for each resident in Country i as

$$\beta^i = \frac{v^i_S s^i_{c^i}}{v^i_{c^i} + v^i_R r^i_{c^i} + v^i_S s^i_{c^i}}, \quad \text{for } i = 1, 2. \tag{3}$$

Hence β^i reflects the fraction of the utility increase from the last dollar consumed by residents in Country i that is due to the increased relative consumption compared to people in the other country. Finally, *the total degree of positionality* is then correspondingly defined as

$$\gamma^i = \alpha^i + \beta^i, \quad \text{for } i = 1, 2, \tag{4}$$

meaning that γ^i reflects the fraction of the utility increase from the last dollar consumed that is due to the increased relative consumption of any kind, i.e. including comparisons with people both within and outside the individual's own country. For example, if $\gamma^i = 0.6$, then 60% of the utility increase from the last dollar consumed is due to increased relative consumption, whereas the remaining 40% is due to the increased absolute consumption. Clearly, in conventional economics models where only the absolute consumption matters, we have $\alpha^i = \beta^i = \gamma^i = 0$. The other extreme case where only relative consumption matters for utility, and hence absolute consumption does not, implies that $\gamma^i = \alpha^i + \beta^i = 1$.

For simplicity, we also assume a linear technology and perfect competition, implying zero profits. The national resource constraint can then be written as (for $i = 1, 2$)

$$y^i = nc^i + p^l l^i + p^g g^i, \tag{5}$$

where y^i is the (fixed) gross national income produced in Country i, which is used for private and public consumption. Since the technology is linear, the prices p^l and p^g are interpretable in terms of the marginal rate of transformation between the associated public good and the private consumption good.

II. Pareto-Efficient National and Global Public Good Provision

In this section we will derive the efficient provision rules, i.e. we will maximize the utility of individuals in Country 1 while keeping it fixed for people in Country 2, subject to an overall resource constraint. We will not address the related question of implementation, i.e. how coalitions that lead to a Pareto-efficient resource allocation are formed in practice. See Lange and Vogt (2003) for a study on the formation of coalitions under environmental externalities, where the utility faced by each agent depends both on the agent's absolute payoff (as in conventional models of coalition formation) and on the relative payoff comparison with other agents.

The Lagrangian associated with the maximization problem can then be written as

$$L = U^1 + \lambda(U^2 - \hat{U}^2) + \mu\left[\sum\nolimits_{i=1}^{2} (y^i - nc^i - p^l l^i) - p^g g\right], \tag{6}$$

where $\hat{U}^2$ is the fixed minimum utility level for residents in Country 2, whereas λ and μ are Lagrange multipliers. If expressed in terms of the reduced form utility function $u^i(\cdot)$ defined in equation (1), the first-order conditions with respect to private consumption in Countries 1 and 2, global public good provision, and national public good provision in Countries 1 and 2, are given by

$$u^1_{c^1} + u^1_{\bar{c}^1} + \lambda u^2_{\bar{c}^1} - \mu n = 0, \tag{7}$$

$$u^1_{\bar{c}^2} + \lambda u^2_{c^2} + \lambda u^2_{\bar{c}^2} - \mu n = 0, \tag{8}$$

$$u^1_g + \lambda u^2_g - \mu p^g = 0, \tag{9}$$

$$u^1_{l^1} - \mu p^l = 0, \tag{10}$$

$$\lambda u^2_{l^2} - \mu p^l = 0. \tag{11}$$

So far, we have expressed our first-order conditions, which characterize the efficient provision rules, in terms of a rather general utility function. To obtain simple provision rules that are straightforward to interpret in terms of relative consumption concerns, we make some further assumptions about the utility function and measures of relative consumption.

First, we assume *difference* comparison forms, such that $R^i = r^i(c^i, \bar{c}^i) = c^i - \bar{c}^i$ and $S^i = s^i(c^i, \bar{c}^i) = c^i - \bar{c}^i$. The difference comparison form is very common in earlier studies; see, for example, Akerlof (1997), Corneo and Jeanne (1997), Ljungqvist and Uhlig (2000), Bowles and Park (2005), Carlsson *et al*. (2007) and Aronsson and Johansson-Stenman (2008, 2010). Alternative approaches include ratio comparisons (Boskin and Sheshinski 1978; Layard 1980; Abel 2005; Wendner and Goulder 2008) and comparisons of ordinal rank (Frank 1985; Hopkins and Kornienko 2004, 2009). Although it is difficult to formally discriminate between different comparison forms, our choice is governed by two basic observations. (i) Corazzini *et al*. (2012) find that absolute differences, and not only rank, matter; (ii) Aronsson and Johansson-Stenman (2013) show that the optimal tax policy implications of relative consumption concerns do not depend qualitatively on whether these comparisons take the difference or ratio form—an insight that applies here as well. As a consequence, we settle with difference comparisons, as this formulation is slightly more convenient from a technical point of view.

Second, we make additional assumptions regarding the structure of the utility functions in order to ensure that the positionality degrees are the same in both countries, as follows:

$$U^i = V^i((1-\alpha-\beta)c^i + \alpha R^i + \beta S^i, l^i, g) = V^i(c^i - \alpha\bar{c}^i - \beta\bar{c}^i, l^i, g). \tag{12}$$

Therefore the function $V^i(\cdot)$ is interpretable as a slightly more restrictive version of $v^i(\cdot)$ in equation (1), where it is straightforward to show that α, $\beta > 0$ can be interpreted as the domestic and foreign positionality degrees, as defined by equations (2) and (3), respectively. Thus these positionality degrees are constant and the same for both

countries, such that $\alpha^1 = \alpha^2 = \alpha$ and $\beta^1 = \beta^2 = \beta$, and then of course also $\gamma^1 = \gamma^2 = \gamma$. These assumptions simplify the analytical expressions considerably without any important loss of generality; the main mechanisms shown are more robust and do not depend on these assumptions. In the Appendix, along with the proofs of the propositions below, we also derive efficient provision rules for the more general case where the positionality degrees are not the same in both countries. Yet as is evident from equation (12), people in different countries need not be identical regarding the underlying income levels, consumption levels or preferences.

It is now time to present the optimal public good provision rules. Let us use the short notation

$$MRS^i_{lc} = \frac{u^i_{l^i}}{u^i_{c^i}}$$

for the marginal rate of substitution between the national public good and private consumption. Then the following result can be shown.

Proposition 1. The efficient provision of the national public good in Country i is given by (for $i = 1, 2$)

$$n\, MRS^i_{lc} = p^l(1 - \alpha - \beta) = p^l(1 - \gamma). \tag{13}$$

Proof. See the Appendix.

Equation (13) can be compared to the basic Samuelson (1954) rule where we instead have $n\, MRS^i_{lc} = p^l$. The modifying factor $(1 - \alpha - \beta) = (1 - \gamma)$ can be seen as the 'degree of non-positionality'. If every person in each country receives one additional dollar, then their relative consumption is clearly held constant. What then remains is the absolute, or non-positional, utility effect. For the public good, there is by definition no such leakage. This also explains why between-country comparisons of private consumption will affect the efficient provision of national public goods, despite the fact that these goods (by the assumptions made earlier) have no spillover effects across jurisdictions. As such, the policy rule for efficient provision of national public goods derived by Aronsson and Johansson-Stenman (2008) for an economy without between-country comparisons, i.e. $n\, MRS^i_{lc} = p^l(1 - \alpha)$, implies underprovision in the present context.

As noted by Aronsson and Johansson-Stenman (2008), when people care about relative consumption, it will matter for the interpretation of the Samuelson rule how people's marginal WTP for the public good is measured. In equation (13), MRS^i_{lc} reflects an individual's marginal WTP for an increased national public good provision *ceteris paribus*, i.e. given that others' consumption is held constant. Alternatively, in the stated preference literature, one often uses a so-called referendum payment vehicle; see, for example, Arrow *et al*. (1993). In that case, people are basically asked whether they would vote yes or no in a referendum implying not only a public good increase and that they would have to pay a certain amount (in terms of private consumption) for that increase, but also that other people in society would have to pay the same amount. In a conventional model where only absolute consumption matters, in principle it does not matter whether people's marginal WTP is elicited *ceteris paribus* or is conditional on others

having to pay too. Yet when relative consumption matters, this distinction is important: when others too have to pay, there is an additional benefit to the individual, as an individual's relative consumption increases when others' consumption decreases.

Therefore consider such a referendum payment vehicle for eliciting the marginal WTP for the national public good. Based on this idea, one can define a measure of marginal WTP for the national public good at the individual level, given that all persons in the individual's own country will have to pay the same amount for the public good at the margin, as follows:

$$CMRS^i_{lc} = \frac{u^i_{l^i}}{u^i_{c^i} + u^i_{\bar{c}^i}},$$

where $CMRS$ denotes this *conditional MRS*, i.e. individual MRS conditional on that all others in the individual's own country will also have to pay the same amount on the margin for the public good increase. As such, this measure of MRS is elicited with R^i held constant. Based on equation (1) and the definitions of within-country and between-country positionality, we obtain

$$\frac{u^i_{\bar{c}^i}}{u^i_{c^i}} = -\alpha \text{ and } \frac{u^i_{\bar{c}^j}}{u^i_{c^i}} = -\beta.$$

We can then write the relationships between our marginal WTP measures as follows:

$$CMRS^i_{lc} = \frac{MRS^i_{lc}}{1-\alpha}. \tag{14}$$

Using this in equation (13), we obtain the following result.

Corollary 1. The efficient provision of the national public good in Country i can be expressed in terms of marginal WTP based on a referendum payment vehicle as follows (for $i = 1, 2$):

$$n\, CMRS^i_{lc} = p^l \frac{1-\alpha-\beta}{1-\alpha} = p^l\left(1 - \frac{\beta}{1-\alpha}\right). \tag{15}$$

This result means that the Samuelson rule expressed in terms of marginal WTPs elicited with the referendum method, $n\, CMRS^i_{lc} = p^l$, still implies an underprovision of the public good compared to the efficient rule in equation (15). This can be compared to the corresponding finding in the one-country case analysed by Aronsson and Johansson-Stenman (2008). In that case, it followed that utilizing a referendum-type payment vehicle implies that we return to the basic Samuelson rule, i.e. that the sum of marginal WTPs equals the marginal rate of transformation between the national public good and the private consumption good. Here, in contrast, although we move in the same direction, the Samuelson rule will still imply an underprovision compared to the efficiency rule. The reason is that people in the other country will obviously not have to pay for the public good increase; hence a public good increase

will be accompanied by reduced relative consumption compared to people in the other country.

Let us now turn to the efficient provision rule for the global public good, and use the short notation

$$MRS^i_{gc} = \frac{u^i_g}{u^i_{c^i}}.$$

Proposition 2. The efficient provision of the global public good is given by

$$n\,MRS^1_{gc} + n\,MRS^2_{gc} = p^g(1-\alpha-\beta). \tag{16}$$

Proof See the Appendix.

As can be seen, this efficiency rule is equivalent to the one for the national public good, with the only difference that we here have a positive marginal WTP for the public good in both countries. The logic behind the modifying factor due to relative consumption concerns, i.e. $(1-\alpha-\beta)$, is the same as for the national public good.

Here too we can define a corresponding marginal WTP measure for the global public good when this marginal WTP is elicited under the assumption that all others in the individual's own country also have to pay the same amount at the margin:

$$CMRS^i_{gc} = \frac{u^i_g}{u^i_{c^i} + u^i_{\bar{c}^{\bar{i}}}} = \frac{MRS^i_{gc}}{1-\alpha}. \tag{17}$$

This together with equation (16) implies the following result.

Corollary 2. The efficient provision of the global public good can be expressed in terms of marginal WTP based on a referendum payment vehicle as follows:

$$n\,CMRS^1_{gc} + n\,CMRS^2_{gc} = p^g\frac{1-\alpha-\beta}{1-\alpha} = p^g\left(1-\frac{\beta}{1-\alpha}\right). \tag{18}$$

Hence the global Samuelson rule expressed in terms of marginal WTPs elicited with the referendum method, $n\,CMRS^1_{gc} + n\,CMRS^2_{gc} = p^g$, will imply an underprovision of the efficient amount of the global public good.

Yet with a global public good, it makes sense also to consider a developed version of the national referendum payment vehicle, as follows. Assume that people are asked to vote yes or no to a referendum where a global public good increase is associated with a consumption decrease for all people, i.e. in both countries. The corresponding marginal WTP measure can then be expressed as

$$GMRS^i_{gc} = \frac{v^i_g}{v^i_{c^i}} = \frac{u^i_g}{u^i_{c^i} + u^i_{\bar{c}^{\bar{i}}} + u^i_{\bar{c}^{\bar{j}}}} = \frac{MRS^i_{gc}}{1-\alpha-\beta}, \tag{19}$$

where *GMRS* can be thought of as the *globally* conditional *MRS*, i.e. individual *MRS* conditional on that all others globally will also have to pay the same amount at the margin for the public good increase. In other words, this global referendum payment vehicle means that individual *MRS* for the global public good is measured with both R^i and S^i held constant. By combining equations (16) and (19), we obtain the following result.

Corollary 3. The efficient provision of the global public good can be expressed in terms of marginal WTP based on a global referendum payment vehicle as follows:

$$n\,GMRS^1_{gc} + n\,GMRS^2_{gc} = p^g. \tag{20}$$

Corollary 3 thus implies that the Samuelson rule expressed in terms of marginal WTP based on a global referendum payment vehicle, such that all people in both countries will have to pay for a public good increase, is identical to the efficient rule.

III. Non-Cooperative Nash Equilibrium

So far, we have solely been concerned with a Pareto-efficient allocation. However, since national governments typically play a fundamental role for the provision of national as well as global public goods, a natural next step is to consider the behaviour of each government based on a non-cooperative Nash equilibrium, such that each national government contributes to the public goods while treating the contributions made by the other government as exogenous at the equilibrium. Since we focus solely on economic efficiency in the present paper, and hence do not analyse distributional issues, we also (implicitly) assume that each government can raise lump-sum taxes to finance the public good provision. The corresponding Lagrangian for Country i can then be written

$$U^i + \sigma^i(y^i - nc^i - p^l l^i - p^g g^i), \tag{21}$$

where σ^i is the Lagrange multiplier associated with the national resource constraint. The associated first-order conditions with respect to the private consumption, the contribution to the global public good, and the provision of the national public good, respectively, in Country i are given by

$$u^i_{c^i} + u^i_{\vec{c}^i} - \sigma^i n = 0, \tag{22}$$

$$u^i_g - \sigma^i p^g = 0, \tag{23}$$

$$u^i_{l^i} - \sigma^i p^l = 0. \tag{24}$$

By combining equations (22) and (24), we immediately obtain the following result.

Proposition 3. The non-cooperative Nash equilibrium implies the following rule for provision of a national public good in Country i (for $i = 1, 2$):

$$(25) \qquad n\, MRS^i_{lc} = p^l(1-\alpha),$$

implying an underprovision compared to the efficient provision rule in Proposition 1.

The derivation of equation (25) is analogous to the derivation of equation (13). Note that this underprovision result holds despite the fact that the government takes into account relative consumption effects (within the country), and also despite the fact that we are dealing with a national public good, i.e. a good that individuals in Country j do not derive any utility from. The intuition for the underprovision is instead based on the fact that the government in Country i will not take into account that the reduced private consumption in Country i that will follow from increased public provision implies a benefit to individuals in Country j, i.e. a benefit that is not taken into account in the Nash equilibrium.

We can also note that a government that wants to implement the Nash equilibrium can do so simply by applying the Samuelson rule expressed in terms of marginal WTPs based on a referendum payment vehicle. That is, it can use a payment vehicle such that individual WTP is measured conditional on that all others in the individual's home country will also have to pay the same amount for the public good increase, such that

$$(26) \qquad n\, CMRS^i_{lc} = p^l.$$

Finally, turning to the national contribution to the global public good, we combine equations (22) and (23) to obtain the following result.

Proposition 4. The non-cooperative Nash equilibrium implies the following rule for contribution to a global public good in Country i (for $i = 1, 2$):

$$(27) \qquad n\, MRS^i_{gc} = p^g(1-\alpha),$$

implying an underprovision compared to the efficient provision rule in Proposition 2.

Equation (27) is derived in the same general way as equation (16). By comparing equations (16) and (27), we can conclude that this underprovision result follows for two different reasons. First, and most straightforwardly, there is an underprovision due to free riding, i.e. each country will not take into account the benefit that the public good gives people in the other country. Second, there is a benefit through the same mechanism as described above for the national public good, namely that Country i will not take into account that the reduction in the domestic private consumption needed to finance the contribution to the global public good leads to increased relative consumption in Country j, a benefit of public provision that is not taken into account in the Nash equilibrium. As a consequence, the underprovision problem associated with national contributions to global public goods is more severe when individuals have positional preferences than in a standard model where utility is determined solely by the absolute consumption.

IV. Extension: Allowing for Between-country Comparisons of the National Public Goods

In this section, we extend the analysis by also allowing for between-country comparisons of the national public goods. Thus we allow for the possibility that citizens in

one country derive utility from having access to a larger national public good than do citizens in the other country. As such, we will add a new element in the utility function, $T^i = t^i(l^i, l^j)$, reflecting the provision of the national public good in Country i relative to that in Country j.

The utility function for an individual in Country i is then given by (for $i = 1, 2$)

$$U^i = v^i(c^i, l^i, g, R^i, S^i, T^i) = u^i(c^i, l^i, l^j, g, \bar{c}^i, \bar{c}^j). \tag{28}$$

In addition to the assumptions already made with respect to the utility function in equation (1), we assume that $v^i_T > 0$, $t^i_{l^i} > 0$, $t^i_{l^j} < 0$, and, as a consequence, $u^i_{l^j} < 0$. In other words, people prefer high relative provision of the national public good, which also implies that utility depends negatively on the provision of the national public good in the other country.

Let us next provide a measure of how much people care about the relative provision of the national public good. Define *the degree of national public good positionality* for each resident in Country i as

$$\tau^i = \frac{v^i_T t^i_{l^i}}{v^i_{l^i} + v^i_T t^i_{l^i}}, \quad \text{for } i = 1, 2. \tag{29}$$

The variable τ^i reflects the fraction of the utility increase from the last unit of the national public good in Country i that is due to the increased relative public good provision compared to the public good provision in the other country. The extreme case where τ^i approaches zero reflects the conventional case where only absolute levels of the public good provision matter. The other (perhaps unrealistic) extreme case, where τ^i approaches unity, implies that the absolute level of the public good provision does not matter at all, and all that matters is the relative provision.

It is most often assumed that public goods are less positional than private goods or income. While we generally share this judgment, to our knowledge no studies have attempted to quantify the positionality degree for public goods, and the indications from existing studies are mixed; see Solnick and Hemenway (2005), Grolleau and Said (2008) and Hillesheim and Mechtel (2011). Moreover, it is reasonable to believe that some national public goods (e.g. those that give rise to sport or cultural achievements) are much more positional than others.

To derive the efficient provision rules, we will, as before, maximize the utility of individuals in Country 1 while keeping it fixed for people in Country 2, subject to an overall resource constraint. The Lagrangian associated with this problem will still be given by equation (6), and the first-order conditions with respect to private consumption in both countries as well as the provision of the global public good, i.e. equations (7) to (9), will also continue to hold. The first-order conditions with respect to the national goods in both countries will be modified as follows:

$$u^1_{l^1} + \lambda u^2_{l^2} - \mu p^l = 0 \tag{30}$$

$$\lambda u^2_{l^2} + \lambda u^1_{l^1} - \mu p^l = 0. \tag{31}$$

To be able to compare the results with those derived in earlier sections, we will specify the utility function in a way similar to equation (12). As a consequence, we consider a case where also the between-country comparisons with respect to national public goods take the difference form such that $T^i = t^i(l^i, l^j) = l^i - l^j$, and where the degree of positionality for the national public good is the same in both countries. The utility function can then be written as

$$\begin{aligned} U^i &= V^i((1-\alpha-\beta)c^i + \alpha R^i + \beta S^i, (1-\tau)l^i + \tau T^i, g) \\ &= V^i(c^i - \alpha\bar{c}^i - \beta\bar{c}^j, l^i - \tau l^j, g), \end{aligned} \tag{32}$$

where it is straightforward to show that the degrees of national public good positionality, as defined by equation (29), are given by τ, i.e. that $\tau^1 = \tau^2 = \tau$.

By using the short notation

$$\phi_{ji} = \frac{MRS^j_{lc}}{MRS^i_{lc}}$$

for the ratio between the marginal WTP for the national public good by each individual in Country j and the corresponding marginal WTP by each individual in Country i, the following result can be shown.

Proposition 5. When people also care about the relative provision of national public goods, then the efficient provision of such a good in Country i is given by (for $i = 1, 2$, $i \neq j$)

$$n\,MRS^i_{lc} = \frac{1-\alpha-\beta}{1-\phi_{ji}\tau}p^l = \frac{1-\gamma}{1-\phi_{ji}\tau}p^l. \tag{33}$$

Proof. See the Appendix.

The difference between equations (13) and (33) is that the modifying factor in relation to the Samuelson rule in equation (33), i.e.

$$\frac{1-\alpha-\beta}{1-\phi_{ji}\tau} = \frac{1-\gamma}{1-\phi_{ji}\tau},$$

is not necessarily below unity. Let us start by ignoring the factor ϕ_{ji} (i.e. assume that it is equal to 1). Then whether the efficient amount of national public goods exceeds or falls short of the amount given by the Samuelson rule depends on whether the private good is more or less positional than the national public good. This is intuitive since the spending on the national public good implies a waste due to the negative positional externality involved, while increased public expenditure also counteracts the positional externalities associated with private consumption (by reducing the amount of resources available for such consumption). From an efficiency point of view, it is the relative magnitude of these losses that matters.

Let us return to the intuition behind the factor ϕ_{ji}. This component arises because the marginal WTP for the national public good may differ among citizens in different countries, despite that the degree of positionality with respect to the national public good is assumed to be the same. To be more specific, when we consider the optimal provision of a national public good for a particular country, say Country 1, this implies that there are negative externalities for the other country, i.e. Country 2. Since the degree of national public good positionality is the same in both countries ($\tau^1 = \tau^2 = \tau$), there is symmetry in the externalities expressed *in terms of national public goods*. However, the externalities measured *in terms of private money* may still not be symmetric since the national public goods may be valued differently in the two countries. For example, if national public goods are valued much higher in Country 2 than in Country 1 (and the degrees of positionality with respect to the national public good are the same), then the welfare loss in monetary terms for Country 2 due to increased provision of the national public good in Country 1 will exceed the corresponding welfare loss for Country 1 of an increase in the national public good in Country 2. As a consequence, this discrepancy works to reduce the efficient provision of national public goods in Country 1 relative to the efficient provision in Country 2 through the factor $\phi_{21} > \phi_{12}$ in equation (33).

To eliminate ϕ_{ji} from the provision rule, such that the policy rule for efficient provision is governed by the simpler expression

$$nMRS^i_{lc} = \frac{1-\alpha-\beta}{1-\tau}p^l = \frac{1-\gamma}{1-\tau}p^l,$$

we need to make further strong assumptions of the utility functions such that we can write

$$\begin{aligned} U^i &= V^i((1-\alpha-\beta)c^i + \alpha R^i + \beta S^i + \omega((1-\tau)l^i + \tau T^i), g) \\ &= V^i(c^i - \alpha\bar{c}^i - \beta\bar{c}^j + \omega(l^i - \tau l^j), g), \end{aligned}$$

where $\omega > 0$ is a constant.

Let us also consider the case where the efficiency rule is defined based on a referendum payment vehicle such that each individual's marginal WTP for the national public good is determined given that all others in the individual's own country will have to pay the same amount for the public good at the margin. The relation between this conditional marginal WTP and the unconditional marginal WTP will be the same as in the previous analysis, i.e. equation (14) continues to hold. Therefore by using equations (14) and (33), we can derive the following result.

Corollary 4. When people also care about the relative provision of national public goods, then the efficient provision of the national public good in Country i can be expressed in terms of marginal WTP based on a referendum payment vehicle as follows (for $i = 1, 2$):

$$n\,CMRS^i_{lc} = \frac{1-\alpha-\beta}{(1-\alpha)(1-\phi_{ji}\tau)}p^l = \frac{1-\alpha-\beta}{1-\alpha-\phi_{ji}\tau(1-\alpha)}p^l. \tag{34}$$

Thus the national public good should be overprovided relative to the Samuelson rule, elicited based on the referendum method such that $n\ CMRS^i_{lc} = p^l$ if $\beta > \phi_{ji}\tau(1 - \alpha)$, and it should be underprovided if $\beta < \phi_{ji}\tau(1 - \alpha)$. The intuition is similar as for the case without between-country comparisons in national public goods. The government will internalize the within-country positional externality directly through the payment mechanism. Whether or not it is optimal to overprovide the public good relative to the Samuelson condition will then depend on the relative size of the between-country externalities through private and public consumption.

Let us finally compare the efficient provision rules with the policy rules associated with Nash equilibrium. In doing this, we can first conclude that the Nash equilibrium provision rules for both countries are unaffected by the relative comparisons of the national public goods. Intuitively, each government will not take into account the positional externalities due to the national public good provision that it inflicts on the other country. Hence equation (25) in Proposition 3 continues to hold. By comparing equations (25) and (33), we can then conclude that the Nash equilibrium implies an underprovision of the national public good in Country i, relative to the efficient provision, if $\beta > \phi_{ji}\tau(1 - \alpha)$, and an overprovision if $\beta < \phi_{ji}\tau(1 - \alpha)$. Intuitively, since the public good provision also implies between-country externalities, it is no longer obvious that the Nash equilibrium implies an underprovision of national public goods. Yet it is most often assumed in the literature that public goods are less positional than private goods, implying, if so, that the public good is correspondingly underprovided. It is also interesting to note that the condition for when the Nash equilibrium implies an efficient allocation is exactly the same as the condition for when the Samuelson rule implies an efficient allocation, namely that $\beta = \phi_{ji}\tau(1 - \alpha)$.

Neither the efficient provision rules nor the Nash equilibrium conditions for the global public good are affected by allowing for between-country comparisons of the national public good.

V. Conclusions

In this paper, we have derived Pareto-efficient rules for the provision of national as well as global public goods in a two-country world, where each individual cares about his or her relative private consumption compared to both other people in the same country and people in other countries. We have also compared the policy rules for efficient provision with those that follow in a non-cooperative Nash equilibrium, which is based on the assumption that each national government treats the public provision by the other country as exogenous.

We would like to emphasize three conclusions from the analysis. First, in the benchmark model where public goods are completely non-positional, the results show that not only global public goods are underprovided in Nash equilibrium (as in standard models without positional concerns); national governments also systematically underprovide national public goods in Nash equilibrium under relative consumption concerns. Furthermore, this holds despite our assumption that national public goods do not spill over across jurisdictions. The intuition is, instead, that an individual country does not take into account that the reduction in the domestic private consumption needed to finance the increased public provision leads to increased relative consumption in other countries.

Second, by introducing relative consumption concerns also for the national public good (such that each individual derives utility from the domestically provided

good relative to that provided in the other country), a counteracting mechanism arises. In this case, the efficient provision of national public goods must be designed to reflect both the positional consumption externalities and the positional public good externality. Furthermore, depending on whether the transboundary positional consumption externality exceeds or falls short of the transboundary positional public good externality, national public goods may be either underprovided or overprovided in Nash equilibrium. If one is willing to assume that public goods are less positional than private consumption—as is typically done in related literature—then the underprovision result discussed above is likely to carry over to the case where national public goods are subject to positional concerns.

Third, the underprovision problem associated with global public goods is more severe here than in the absence of relative consumption concerns. In light of the recent empirical evidence discussed in the Introduction, which suggests that between-country comparisons have increased in importance in recent decades, it is tempting to be provocative and argue that globalization in combination with relative consumption concerns has weakened the national incentives to contribute to global public goods. Yet we settle for a more modest conclusion that is fully supported by our analysis: that relative consumption concerns based on between-country comparisons imply underprovision of global public goods in Nash equilibrium even *in the absence of* the (well documented) free-rider problem associated with the public goods *per se*.

Finally, all theoretical results of course depend on the assumptions made. As far as we know, the present paper is the first to deal with international public good provision under relative consumption concerns. We encourage generalizations as well as alternative assumptions in future work. For example, we have formulated the decision problem faced by each national government as a 'planner problem', i.e. as if the national government directly chooses the national public good, the national contribution to the federal public good, as well as the private consumption for each domestic resident in order to obtain the Nash equilibrium provision rules. Given the assumptions on which the analysis is based, such a planner problem gives exactly the same policy rules for public good provision as those that would follow from a setting where the collection of public revenue through lump-sum taxes is modelled explicitly. However, governments of course have objectives other than public good provision and can generally not rely on non-distortionary taxation for raising revenue. The problem of deriving optimal public good provision rules under relative consumption concerns in a second-best one-country world has been analysed in terms of both linear taxes (Wendner and Goulder 2008) and non-linear taxes (Aronsson and Johansson-Stenman 2008). Our conjecture is that the main insights that relate to the second-best problem carry over from a one-country to a two- (or more) country setting; future research will presumably be able to judge whether or not this conjecture turns out to be justified. Yet it may be even more important to analyse the optimal income tax problem *per se* in an international second-best context, which is therefore a research task that we recommend for future research.

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APPENDIX

Proof of Proposition 1

Combining equations (7) and (8) gives

$$\lambda = \frac{u^1_{c^1} + u^1_{\bar{c}^1} - u^1_{\bar{c}^2}}{u^2_{c^2} + u^2_{\bar{c}^2} - u^2_{\bar{c}^1}}, \tag{A1}$$

while combining equations (7) and (10) implies

$$u^1_{c^1} + u^1_{\bar{c}^1} + \lambda u^2_{\bar{c}^1} = n u^1_{l^1}/p^l \tag{A2}$$

By substituting (A1) into (A2), we have

$$n\frac{u^1_{l^1}}{p^l} = u^1_{c^1} + u^1_{\bar{c}^1} + \frac{u^1_{c^1} + u^1_{\bar{c}^1} - u^1_{\bar{c}^2}}{u^2_{c^2} + u^2_{\bar{c}^2} - u^2_{\bar{c}^1}} u^2_{\bar{c}^1}. \tag{A3}$$

Reorganizing equation (A3) and using the *MRS* definition implies

$$\text{(A4)} \qquad nMRS^1_{lc} = p^l \left(1 + \frac{u^1_{\bar{c}^1}}{u^1_{c^1}} + \frac{1 + \frac{u^1_{\bar{c}^1} - u^1_{\bar{c}^2}}{u^1_{c^1}} \frac{u^2_{\bar{c}^1}}{u^2_{c^2}}}{1 + \frac{u^2_{\bar{c}^2} - u^2_{\bar{c}^1}}{u^2_{c^2}} \frac{u^2_{\bar{c}^1}}{u^2_{c^2}}} \right).$$

From equation (1) we get that $u^i_{c^i} = v^i_{c^i} + v^i_R r^i_{c^i} + v^i_S s^i_{c^i}$ and $u^i_{\bar{c}^i} = v^i_R r^i_{\bar{c}^i}$, implying from equation (2) that

$$\text{(A5)} \qquad \alpha^i = -\frac{u^i_{\bar{c}^i}}{u^i_{c^i}}.$$

Similarly, we get from equation (1) that $u^i_{\bar{c}^j} = v^i_S s^i_{\bar{c}^j}$. The difference comparison assumption, i.e. that $S^i = s^i(c^i, \bar{c}^j) = c^i - \bar{c}^j$, then implies $s^i_{\bar{c}^j} = -1 = -s^i_{c^i}$, implying that $u^i_{\bar{c}^j} = -v^i_S s^i_{c^i}$. This together with the expression for $u^i_{c^i}$ above and equation (3) implies

$$\text{(A6)} \qquad \beta^i = -\frac{u^i_{\bar{c}^j}}{u^i_{c^i}}.$$

Substituting equations (A5) and (A6) into equation (A4) then implies

$$\text{(A7)} \qquad n\,MRS^1_{lc} = \left(1 - \alpha^1 - \frac{1 - \alpha^1 + \beta^1}{1 - \alpha^2 + \beta^2}\beta^2\right) p^l.$$

Equation (A7) gives the policy rule for efficient provision of the national public good in Country 1 in a general setting, where the degrees of positionality may differ between countries. Therefore using the more restrictive utility function in equation (12), implying that $\alpha^1 = \alpha^2 = \alpha$ and $\beta^1 = \beta^2 = \beta$, we obtain equation (13) in Proposition 1.

Proof of Proposition 2

By combining equations (7) and (9) we get

$$\text{(A8)} \qquad (u^1_{c^1} + u^1_{\bar{c}^1} + \lambda u^2_{\bar{c}^1}) p^g = (u^1_g + \lambda u^2_g) n.$$

It is easy to show from the positionality definitions and equation (A1) that $\lambda = u^1_{c^1}/u^2_{c^2}$. Substituting into equation (A8) and collecting terms implies

$$\text{(A9)} \qquad n\frac{u^1_g}{u^1_{c^1}} + n\frac{u^2_g}{u^2_{c^2}} = p^g \left(1 + \frac{u^1_{\bar{c}^1}}{u^1_{c^1}} + \frac{u^2_{\bar{c}^1}}{u^2_{c^2}}\right).$$

Using the *MRS* and positionality definitions then implies equation (16) in Proposition 2.

Proof of Proposition 5

Combining equations (7) and (30) implies

$$u^1_{c1} + u^1_{\bar{c}1} + \lambda u^2_{\bar{c}1} = (u^1_{l1} + \lambda u^2_{\bar{l}1})n/p^l. \tag{A10}$$

By substituting equation (A1), which still holds, into equation (A10), we get

$$u^1_{c1} + u^1_{\bar{c}1} + \frac{u^1_{c1} + u^1_{\bar{c}1} - u^1_{\bar{c}2}}{u^2_{c2} + u^2_{\bar{c}2} - u^2_{\bar{c}1}} u^2_{\bar{c}1} = \left(u^1_{l1} + \frac{u^1_{c1} + u^1_{\bar{c}1} - u^1_{\bar{c}2}}{u^2_{c2} + u^2_{\bar{c}2} - u^2_{\bar{c}1}} u^2_{\bar{l}1} \right) n/p^l. \tag{A11}$$

Using the MRS definition in equation (A11) and reorganizing implies

$$n\, MRS^1_{lc} \left(1 + \frac{MRS^2_{lc}}{MRS^1_{lc}} \frac{1 + \frac{u^1_{c1} - u^1_{c2}}{u^1_{c1}}}{1 + \frac{u^2_{c2} - u^2_{c1}}{u^2_{c2}}} \frac{u^2_{l1}}{u^2_{l2}} \right) = p^l \left(1 + \frac{u^1_{\bar{c}1}}{u^1_{c1}} + \frac{1 + \frac{u^1_{c1} - u^1_{c2}}{u^1_{c1}}}{1 + \frac{u^2_{c2} - u^2_{c1}}{u^2_{c2}}} \frac{u^2_{\bar{c}1}}{u^2_{c2}} \right), \tag{A12}$$

From equation (28) we get that $u^i_{li} = v^i_{li} + v^i_T t^i_{li}$ and $u^i_{lj} = v^i_T t^i_{lj}$. The difference comparison assumption, implying that $T^i = t^i(l^i, l^j) = l^i - l^j$, then implies $t^i_{lj} = -1 = -t^i_{li}$, such that $u^i_{lj} = -v^i_T t^i_{li}$. Substitution into equation (29) then implies, for $i \neq j$,

$$\tau^i = -\frac{u^i_{lj}}{u^i_{li}}, \tag{A13}$$

Substituting equations (A5), (A6) and (A13) into equation (A12) then implies

$$n\, MRS^1_{lc} = \frac{1 - \alpha^1 - \frac{1-\alpha^1+\beta^1}{1-\alpha^2+\beta^2}\beta^2}{1 - \frac{MRS^2_{lc}}{MRS^1_{lc}} \frac{1-\alpha^1+\beta^1}{1-\alpha^2+\beta^2}\tau^2} p^l. \tag{A14}$$

Equation (A14) provides the policy rule for efficient provision of the national public good in Country 1 in a general setting, corresponding to equation (A7), where the degrees of positionality may differ between countries. Using finally the more restrictive utility function in equation (32), implying that $\alpha^1 = \alpha^2 = \alpha$, $\beta^1 = \beta^2 = \beta$ and $\tau^1 = \tau^2 = \tau$, we obtain equation (33) in Proposition 5.