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An Olympic Level Playing Field? The Contest for Olympic Success as a Public Good

LOEK GROOT[†]

ABSTRACT

This article considers the performance of countries at the Olympic Games as a public good. Firstly, it is argued that, at the national level, Olympic success meets the two key conditions of a public good: non-rivalry and non-excludability. Secondly, it is demonstrated that standard income inequality measures, such as the Lorenz curve and the Gini index, can successfully be applied to the distribution of Olympic success. The actual distribution of Olympic success is compared with alternative hypothetical distributions, among which the noncooperating Nash-Cournot distribution, the distribution according to population shares and the one favoured by a social planner. By way of conclusion, it is argued, based on the Olympic Charter, that instruments to make the distribution of Olympic success more equitable are warranted to realize the true Olympic spirit as symbolized by the Olympic rings and the Parade of athletes.

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[†] Economics of the Public Sector, Utrecht University School of Economics. Correspondence address: P.O. Box 80125, 3508 TC Utrecht, The Netherlands. Email: L.F.M.Groot@uu.nl.

1 INTRODUCTION

At the Summer Olympics Games 2008 in Beijing, more than eleven thousand athletes from over 200 countries competed for medals in 302 different sport events. Overall, a total of 958 medals were distributed.[1] More than half (56%) of all medals, and 65% of all gold medals, were collected by the Top 10 countries, which comprise slightly above one third of the world population.[2] Only one in four participating countries succeeded in winning at least one gold medal, whilst half of the participating countries failed to win any medal.

At face value, these figures do not show that the medal tally is (un)equally distributed over countries. Whether or not the medal tally is (un)evenly distributed depends on the criteria used. With a few exceptions, the economic literature on Olympic performance concentrates on explaining the performance of countries at the Olympic games by identifying relevant factors like population size, GDP and GDP per capita, hosting and neighbouring countries and socialist background. Bernard and Busse (2004: 417) deploy their favourite model to an out-of-sample prediction for the medal tally of the Summer Olympics of 1996 and attain an R^2 of 96%. Apart from the specific econometric techniques, the main difference of the model of Bernard and Busse from other conventional models explaining the medal tally (e.g. Bian 2005, Hoffmann et al. 2002; 2004, Lui and Suen 2008, Luiz and Fadal 2010, Matros and Namoro 2004, Mitchell and Stewart 2007, Oyeyinka 2007 and Tcha 2004) is the inclusion of a variable representing the lagged medal share. This variable stands for the 'time to build'-effect: investments for one Olympics increase the winning odds in subsequent Olympic Games. Past success turns out to be a strong predictor of current success, indicating that (investments in) Olympic success (hereafter abbreviated as OS) can be seen as a kind of durable capital good bearing fruit over several Olympic cycles.

[1] The total medal count is more than three times the number of disciplines, because sometimes medal-winning athletes end exactly equal, in which case a double bronze, silver of golden medal is awarded (see http://en.beijing2008.cn/).

[2] Exclusion of China from the Top 10 gives that the other 9 countries, with a world population share of only 14%, capture almost half of all gold medals. For the Olympics 2004 and 2000, the Top 10 had a gold share of 60% and 66% respectively, against population shares of 33%. In 1996 it was 65% against 34%, in 1992 78% against 34% and in 1988 81% against 14%.

This suggests that one may expect a different medal allocation for new Olympic sport events, but it is difficult to explore this issue empirically. Johnson and Ali (2004: 982-8) attain similar figures for the out-of-sample predictions for the number of participants and the gold medal count per country at the Winter Olympics 2002 in Salt Lake City ($R^2 = 0.96$ and 0.85 respectively) and at the Summer Olympics 2000 in Sydney ($R^2 = 0.95$ and 0.85 respectively). The predictions of Kuper and Sterken (2008) for the last olympic cycle attain a similar explanatory power. Much more challenging is to explain which countries will win which medals. Tscha and Pershin (2003) started this project by applying the analysis of comparative advantages in international trade theory to the country's performances in each sport, e.g. countries with a long coastline are expected to have a comparative advantage in sailing or rich countries have a comparative advantage in the expensive equestrian sport events. In contrast to this strand of research, the purpose of this article is not to explain which factors determine the Olympic medal tally. Instead of taking an explanatory or descriptive perspective, I deliberately adopt a normative perspective. There are several reasons why a normative perspective regarding the contest for OS between countries may be interesting.

Firstly, the distribution of Olympic medals is a fixed sum game. By definition, the number of different events is limited and fixed *ex ante*, and per event only three medals can be assigned. Therefore, any country trying to or succeeding in getting a larger share in the medal count imposes a negative externality on all other competing countries. From a normative perspective, it can be desirable to change the incentives in such a way that relatively (un)successful countries become (more) less successful.

Secondly, the former socialist countries have shown that, at least to some extent, OS can be manufactured. At the Olympic Summer Games of Seoul 1988, just prior to the fall of the Wall in 1989, the People's Republic of Germany DDR with only 17 million inhabitants won more gold medals than the USA with a population of nearly 250 million. More than 55% of all gold medals went to the socialist countries. Five formerly socialist countries (USSR, DDR, Hungary, Bulgaria and Romania) were in the Top 10, together comprising only 4.1% of the world population, but winning nearly half of all gold medals. Although doping definitely played a role, these countries have shown that a strong governmental sport policy can breed OS. That the distribution of OS is strongly biased towards the rich countries and countries which attach a high political preference for OS is probably to a large part due to governmental support of top sport in these countries. In other words, there is no such thing as a natural distribution of OS.

After the demise of nearly all the socialist countries in 1989, and with it their superior international sport performance, it has become more attractive for other countries all over the world to pursue an active policy of their own in order to share as much as possible in the OS. To an increasing extent, countries embark in a rat race to compete for OS by means of government expenditures exclusively allocated to stimulate professional sport, whereas these scarce resources could also be allocated to sport activities in general. From a normative perspective, it might be preferable to allocate more of the national sport budget to promote amateur sport, instead of the significantly higher expenditures allocated to top sport.[3]

Thirdly, as in trade, some countries have comparative advantages in some sports. One of the best examples is Kenya, with a population of only 28 million, but the world leader of distance running. Barra (*Wall Street Journal*, 20 September 2000) argues that 'based on population percentages alone, the odds of Kenya dominating these events would be one in 1.6 billion'.[4] If it is indeed the case that countries have comparative advantages in some sports, for example due to the genetic endowments of their population, then it is efficient that they specialize in these sports rather than in others. Specialization is more efficient than when (too) many countries compete for success in the same discipline. During the era of the cold war, the USA, USSR and DDR shared the podium much less than could be expected from their overall performance, suggesting that in the past they strategically and tacitly divided the market for medals.

Fourthly, the celebration of OS is essentially a public good, because the pleasure created by an athlete winning gold is truly a non-excludable and non-rival good. The enjoyment of one passive spectator seeing his fellow country(wo)man win a medal does not exclude the

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[3] For instance, The Netherlands has spent about €80 million, a quarter of the entire governmental sport budget, for the last Olympic cycle Beijing 2008 to realize its ambition of a place among the Top 10.

[4] A better example still is the inhabitants of the Nandi district in Kenya, with 500,000 people holding about 20% of the world distant records in running in 2000.

enjoyment of another spectator from the same country: one's consumption does not reduce the consumption of others and all can consume OS at the level of its total supply. Nor is it possible to exclude some citizens from passively sharing in the success of its country. Therefore, the passive enjoyment of OS meets the two key conditions of a pure public good. Since it is non-excludable, private markets may not generate the optimal amount of OS. As far as I know, the public good nature of OS, because of the non-exclusion and non-rivalry attributes, has never been addressed in the economic literature. As with other public goods, there is a *prima facie* case for the government to intervene in the provision of this good.

Finally, the Olympics are advertised as a feast of brotherhood of mankind. According to Coubertin, the founder of the modern Olympics, the Olympic rings symbolizes the union between men. Also the parade of athletes at the opening ceremony of the Games suggests that the Olympics are really global. However, despite this rhetoric, rich countries and some other countries that strive for OS for mainly political reasons, are far more successful than other countries. The normative issue here is whether the Olympic movement should take more action to 'encourage and support the development of sport for all' (Olympic Charter, p. 15), that is, to establish a level playing field, to live up and compete according to its own fundamental principles of Olympism.

Admittedly, there are also good reasons to evaluate the premise of this article, that is to arrive at a distribution of OS that is more just or results in higher social welfare, as highly questionable. First of all, the purpose of the Games is to single out the winners; that is to say that the best must win, irrespective whether the overall distribution of OS is in (dis)agreement with some kind of pattern based on justice or social welfare. Secondly, there are huge differences between countries, not only in the genetic endowments of its population and natural environment, but also in culture and preferences.[5] These differences influence each country's chances for OS, but also affect the value attached to OS. Maybe successful countries care more about OS than relatively unsuccessful countries. If so, then a social welfare function should take these differences into account. Admittedly, these

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[5] India is a notorious underperformer at the Olympics, but it is very strong in cricket, which is not an Olympic sport. The same goes for Latin American countries, where soccer is by far the most popular sport, for which only one Olympic medal can be won.

objections, as well as others, to apply standard social welfare functions to sport contests may make this analysis a non-starter. In principle, however, the analysis may be interesting in its own right: it can be read as an investigation into the forces determining alternative distributions of absolutely scarce goods at the global level, e.g. paintings of old masters, which is rival in consumption across nations but a public good within nations.

2 THE ACTUAL DISTRIBUTION OF OLYMPIC SUCCESS

In what follows it is heuristically assumed that (*i*) the Olympic Games are truly global (in the sense that citizens in all countries have identical utility functions for OS); (*ii*) the distribution of OS is not a kind of natural distribution but rather already manufactured to a considerable extent by top sport policies adopted by national governments and international governing bodies; (*iii*) all disciplines are equally important (so, a gold medal in obscure sports as fencing, archery or skeet shooting is as important as one in track and field) and (*iv*) for simplicity, we concentrate on the distribution of gold medals only.

In table 1, the countries are ranked in descending order according to population shares (column 2). Column 3 gives the actual gold medal tally of Beijing 2008, and column 4 the gold medal share. If gold medals were distributed in proportion to population shares, as in column 5, then China would receive even eleven medals more; India would win 51 instead of one gold medal; whilst the USA only retains 14 gold medals. Comparing columns 3 and 5, it are mainly the rich countries (USA, Germany, UK, France, Italy and Japan) which capture a much larger share of medals than would follow if medals were distributed according to population shares. These six rich countries comprise only 10.9% of the world population, but hold three of every ten gold medals (31.5%), and so capturing an 'excessive share' of 20.6%. Due to the fixed sum game of Olympic medals, the higher than proportional share of some countries has as mirror image that other countries receive less than their proportional share. The lower than proportional shares of populous India (with no gold and only a silver medal in 2004 and only one gold in 2008), together with China, more or less compensate the higher than proportional share of gold medals of the above mentioned six rich countries.

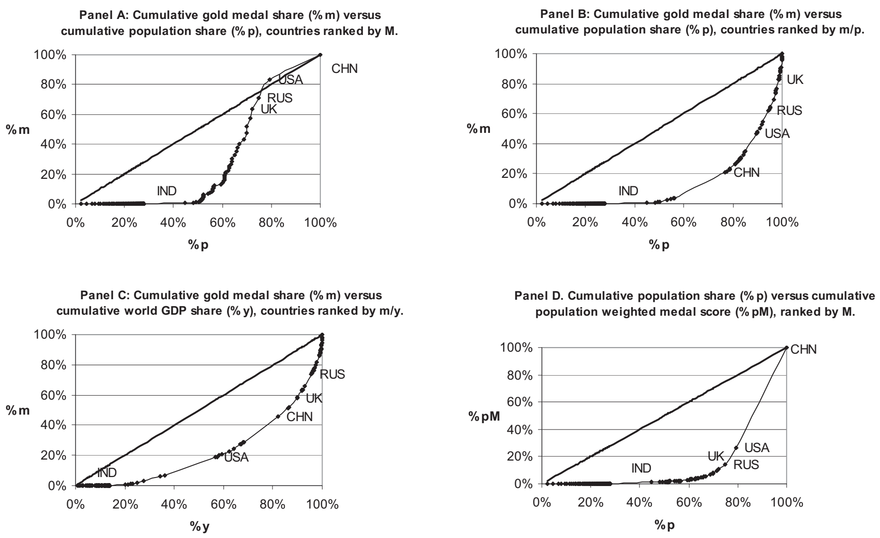
Table 1. Different distributions of Olympic success

1	2	3	4	5	6	7	8
Country	p	M	m	M_p	M_y	M_N	SP I
China	20.7%	51	16.9%	62.4	41.4	22.0	160.1
India	16.9%	1	0.3%	51.1	18.6	12.9	107.4
USA	4.7%	36	11.9%	14.1	62.8	29.0	8.1
Indonesia	3.4%	1	0.3%	10.3	4.1	4.7	4.4
Brazil	2.8%	3	1.0%	8.5	7.7	7.2	3.0
Pakistan	2.3%	0	0.0%	7.1	1.8	2.7	2.0
Russia	2.3%	23	7.6%	7.0	8.0	7.4	2.0
Bangladesh	2.2%	0	0.0%	6.6	1.5	2.4	1.8
Nigeria	2.1%	0	0.0%	6.5	0.7	1.4	1.7
Japan	2.1%	9	3.0%	6.2	20.2	13.6	1.6
Mexico	1.6%	2	0.7%	4.9	5.3	5.6	1.0
Germany	1.3%	16	5.3%	4.0	12.8	10.0	0.7
Vietnam	1.3%	0	0.0%	3.9	1.3	2.1	0.6
Philippines	1.3%	0	0.0%	3.9	2.1	3.0	0.6
Turkey	1.1%	1	0.3%	3.4	2.9	3.7	0.5
Ethiopia	1.1%	4	1.3%	3.3	0.3	0.8	0.4
Egypt	1.1%	0	0.0%	3.2	1.5	2.4	0.4
Iran	1.1%	1	0.3%	3.2	2.8	3.6	0.4
Thailand	1.0%	2	0.7%	3.0	2.7	3.5	0.4
France	1.0%	7	2.3%	2.9	9.3	8.1	0.3
UK	1.0%	19	6.3%	2.9	9.5	8.3	0.3
Italy	0.9%	8	2.6%	2.8	8.5	7.7	0.3
Congo (DR)	0.8%	0	0.0%	2.5	0.2	0.7	0.3
Burma	0.8%	0	0.0%	2.4	0.5	1.1	0.2
Ukraine	0.8%	7	2.3%	2.4	1.7	2.6	0.2
Other countries	24.3%	111	36.8%	73.5	74.0	135.4	3.1
Total	100%	302	100%	302	302	302	302

Notes: Income data from the World Bank (WDI), population data from the U.S. Energy Information Administration (EIA).

The distribution of OS can be nicely illustrated by means of the Lorenz curve (see figure 1, Panel A-D). To visualize the inequality in the *income distribution* using the Lorenz curve, individuals are ranked according to income from lowest to highest. Treating OS as a public good, the strict parallel of the income-based Lorenz curve applied to OS requires that we rank countries according to their gold medal score: each citizen in a country 'consumes' the medal score of its country. If we rank the countries according to gold medal score (M), the countries with zero medals are situated at the left of the Lorenz curve and those with the highest scores (Russia, USA and China) at the right. Moving from left to right, the horizontal axis registers the cumulative share of the world population (% p), while the vertical axis registers the cumulative share in the world gold medal score (% m).

Figure 1: Lorenz curves for the distribution of Olympic gold medals in 2008



As Panel A shows, this ranking results in an awkwardly shaped Lorenz curve. The slope of the Lorenz curve does not increase monotonously. Compare Russia with China. Russia accounts for only 2.3 percent of the world population, but holds 23 gold medals, corresponding to 8 percent of the world gold medal score. China accounts for more than 20 percent of the world population, but holds 51 gold medals, which is only 17 percent of all gold medals. Because countries are ranked according to gold medal score, China is located at the right of Russia.

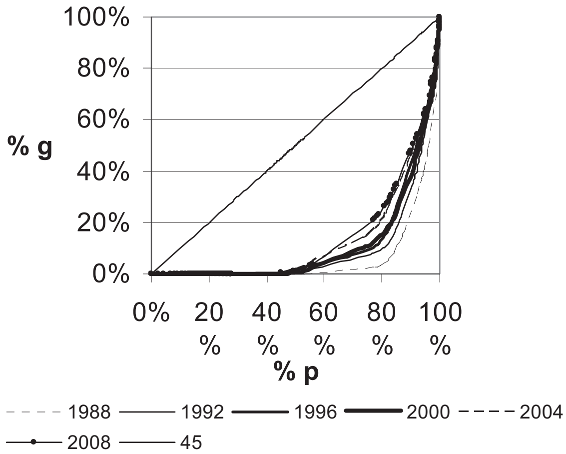
Since the slope of the Lorenz curve is the ratio of the gold medal share and population share, for Russia this ratio is 3.3, against 0.8 for China, which implies that the Lorenz curve flattens when China is entering the scene after Russia. The same phenomenon explains the steep part in the middle, which contains all moderately populated but rich countries with medal shares much higher than their world population shares. Therefore, to get a properly shaped Lorenz curve, we have to rank countries according to the ratio of medal share and population share, as is done in Panel B. Now we see that China is situated more at the left side of the Lorenz curve, since its medal share is less than its population share, while Russia and the UK move further to the right. The further the curve lays from the diagonal, the greater the disproportion between medals shares and population shares. The Lorenz curve shows that almost half of the world population has a zero medal share and that 80% of the world population has a medal share of only 20%.

The diagonal in Panel B corresponds to the situation where each country's gold medal share is equal to its world population share, so along this 45^{o} line every world citizen has the same chance of success, irrespective of political regime, income per capita, race or religion. At the left side in Panel B - as long as the slope of the curve is less than the slope of the diagonal (which has a slope of 1) - are all countries which have a lower than proportional medal score (alternatively, these are the countries for which the ratio between the medal share and population share is less than 1). On this segment, besides all countries without any medals, India and China are located. Predominantly, these countries are Second or Third World countries (with the exceptions of Hong Kong, Taiwan, Ireland and Sweden with no gold medals). Argentina is the country situated most nearly to the point where the Lorenz curve is perpendicular to the diagonal. To the right of this point, where the slope of the curve is higher than of the diagonal, countries are located with higher medal shares than population share. On this segment all rich countries are located, along with countries with a strong sport culture (Russia and former socialist countries) or definite comparative advantages in particular sports (notably some African countries such as Kenya and Ethiopia). At the far right, there are two outliers: Mongolia (2 gold, with a ratio of 23) and Jamaica (6 gold, a ratio of 66).

From table 1 and the Lorenz curve in Panel B we already noticed that with only a few exceptions the medals shares of the rich countries are higher than their population shares. Instead of using the cumulative population shares, we may also put the cumulative world income share on the horizontal axis. To get a smooth Lorenz curve and a meaningful Gini-index, countries must be ranked according to the ratio of world share in gold medals and share in world income (m_i/y_i). In Panel C, the horizontal axis now measures the cumulative share of the *world income* and the vertical axis again the cumulative share of gold medals. The diagonal obtains when medals are distributed proportional to world GDP shares (see column 6 of table 1). Contrary to Panels A and B, the USA is now situated more to the left: its GDP accounts for more than 20 percent of world output, against a gold medal share of only 11.9 percent. Interestingly, comparing Panels B and C shows that OS is much less unequally distributed if pitched against cumulative world income shares rather than cumulative population shares. The degree of inequality depicted by the Lorenz curve can be expressed as the Gini coefficient. The Gini coefficient is graphically the ratio of the area in between the diagonal and the curve and the triangle below the diagonal. The Gini in Panel C is 55.1 percent (52.7 for 2004), against 72.7 percent (74.7) for the latter.

Summarizing, to get a properly shaped Lorenz curve, countries have to be ranked according to the ratio of the variable whose cumulative fraction is measured on the vertical axis and the variable whose cumulative fraction is measured on the horizontal axis. In Panel A, countries were ranked according to absolute gold medal score instead of according to the ratio of gold medal share and population share, as in Panel B. However, a properly shaped Lorenz curve can be drawn using the ranking of countries according to the absolute gold medal score if we draw a *generalized* Lorenz curve, with world population share on the horizontal axis and the cumulative share in the population weighted gold medal score on the vertical axis. In drawing the generalized Lorenz curve of Panel D, with the same ranking of countries as in Panel A, for each country the product of the medal score and world population share is calculated, which is used to obtain the cumulative fractions, which adds up to a population weighted average medal score of 14.3. To illustrate, the population share of the USA is 4.6 percent and its medal score is 36, so its contribution to the population weighted average medal score is 1.66; for China, with a population share of 21 percent and a medal score of 51, the contribution is 10.55. The vertical axis of Panel D simply gives the cumulative contributions, divided by the population weighted average medal score.[6] The Gini-coefficient for this curve is 69.3 percent (66.8 in 2004).

Figure 2. The distribution of Olympic success, 1988-2008



Finally, figure 2 gives an overview of the Lorenz curve for the last five Olympic Games. For every Olympic cycle, countries are ranked according to the ratio of medal and population share, as in Panel B of figure 1. Clearly, there is a modest but steady inward shift of the Lorenz curve over time, which suggests that the distribution of medal shares becomes more in line with the distribution of population shares over time.

3 THE NASH-COURNOT DISTRIBUTION OF OLYMPIC SUCCESS

In this section the distribution of OS is derived when all countries follow Nash-Cournot strategies: they maximize the utility function of a representative citizen with respect to public investments in OS, taking the investments of other countries as given. Consider the world with countries indexed by $i = 1, 2, \ldots, n$, with P_i the population in country i and $p_i = P_i / N$ the world population share of country i, where N is the world population. The representative citizen in a country has a twice

[6] The diagonal represents the state of affairs where the ratio of the contribution of each country to the population weighted gold medal score and its population share is equalized, which implies an equal medal score for each country.

continuously differentiable utility function U_i that is increasing in per capita income for consumption Y_i^c and the medal score M_i:

$$U_i = U_i(Y_i^c, M_i) \tag{1}$$

Each country faces a budget constraint where per capita income available for consumption is per capita income Y_i^b minus the per capita cost $C(M_i) / P_i$ of medal production as a public good:

$$Y_i^c = Y_i^b - C(M_i) / P_i \tag{2}$$

According to Equation (2), the production of OS is considered as a public good at the country level, so the cost of medal production is shared over the entire population P_i of the country, where $C(M_i) / P_i$ expresses the per capita cost of medal production. Equation (3) specifies a standard contest function, also known as the proportionate sharing rule (see e.g. Congleton 1984: 203-4 and Lockard 2006), where each country's share in OS is proportional to its share in world wide investment in OS:

$$M_i = \frac{C_i}{\sum_{j=1}^{n} C_j} M_t \tag{3}$$

where M_t denotes the total number of medals (M_{-i} denotes the number of medals hold by all other countries than i). Equation (3) ensures that the sum of all medals won is equal to the total number of medals available. Note that there is a link here with the rent-seeking literature where players invest effort in order to gain a prize. In standard rent-seeking models the total investments are considered as rent dissipation and a social waste, whereas one might argue that in case of OS more training effort by athletes is something to be welcomed.[7] The model here focuses on government investment in top sport and abstracts from training effort by individual athletes (see Matros and Namoro 2004 for a simultaneous approach to optimal allocation of a given budget over

[7] Shughart and Tollison (1993: 266) argue that the contest model can explain the decline in Olympic performance by former socialist countries in the early 1990s because athletes "... could no longer expect to capitalize their medals into lives of socialist indulgence. With economic systems in collapse, neither could they expect to garner commercial fame and forture ... "

sports and the number and effort of athletes at the country level to achieve OS).

Since we consider population shares and per capita incomes as given, per capita consumption depends only on the chosen investment levels or cost of medal production, so equation (1) can also be written as $U_i = U_i(Y_i^c(C_i), M_i(C_i))$. Direct substitution of the budget constraint (2) and the contest function (3) in the utility function gives:

$$U_i(Y_i^c, M_i) = U_i(Y_i^b - \frac{C_i}{P_{i\,i}}, \frac{C_i}{\sum_{j=1}^{n} C_j} M_t) \tag{4}$$

The noncooperative Nash-Cournot strategy followed by each country – maximization of U_i with respect to the amount of investment in OS (C_i) taking the investments of other countries (C_{-i}) as given – can be derived by differentation of (4) with respect to C_i:

$$\frac{-U_{Y_i^c}}{P_i} + U_{M_i} \frac{C_{-i}}{(C_i + C_{-i})^2} M_t = 0 \tag{5}$$

Note that rewriting equation (3) as $C_i = (M_i C_{-i}) / (M_t - M_i)$ and differentiation with respect to M_i gives that the marginal cost of medal production ($\partial C_i / \partial M_i$) is equal to $(C_i + C_{-i})^2 / (C_{-i} M_t)$. Substitution of this expression in equation (5) results in the Samuelson rule $P_i(U_{M_i} / U_{Y_i^c}) = \partial C_i / \partial M_i$ for the optimal provision of the public good at the country level. In other words, each country invests in OS up to the point where the marginal costs (dependent on the investments of other countries) are equal to the private national marginal benefits. Inspection of the Samuelson rule learns us that given the (world) marginal cost of medal production[8], the larger the population of a country and the lower its marginal utility of per capita income, the lower the marginal utility of OS must be, which implies that the more rich and/or populous a country, the higher its level of OS (that is, a high medal score, and therefore a lower marginal utility of OS).

[8] Using equation (3), the marginal cost can also be written as C_t / M_{-i}, which implies that the marginal cost of medal production for all countries with a low medal score (so $M_{-i} \approx M_t$) is approximately equal to the world average cost of medal production.

Solving equation (5) for C_i gives the following equation for the Nash reaction curve:[9]

$$C_i = -C_{-i} + \sqrt{S_i C_{-i}} \tag{6}$$

with $S_i = P_i \frac{U_{M_i}}{U_{Y_i^c}} M_t$ a measure for the sum of marginal utility of OS at the country level expressed in terms of marginal utility of per capita consumption. According to equation (6), how much one country invests depends on the welfare benefits of OS for that country as measured by S_i and on how much all other countries invest. From equation (6) it also follows that C_i will only be positive if $S_i = P_i(U_{M_i} / U_{Y_i^c})M_t > C_{-i}$. This implies that for many small and/or poor countries it is optimal not to invest in OS: they will invest only if S_i is at least as high as the total investments made by all other countries in the world. The intuition behind this result is that (i) for a small country the investment cost can only be shared among relatively few people, (ii) the total benefits, since OS is a public good at the country level, are modest because population size is small and (iii) for a poor country, the opportunity cost of investment in OS is high, because the marginal utility of income is high, which lowers the value of S_i. Likewise, the rich and/or populous countries will have a strong incentive to invest in OS, the former because the marginal utility of per capita consumption is low, the latter because P_i is high, both which make the value of S_i high and reduces the par capita cost of investments in OS. In addition, countries that attach a higher relative importance to OS will also invest more. This result of a threshold value for the benefits of OS is a direct consequence of the contest function, where each country's share in OS is proportional to its share in world investments in OS and no specialization (see Box 1) is yet accounted for. In other words, by using equation (3), countries can only compete for a share in OS taken as a fixed stock (M_t), where this stock is distributed according to the proportionate share rule.

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[9] The same result can be obtained by maximizing the Lagrange function:

$$L(Y_i^c, M_i, C_i, \mu, \lambda) = U_i(Y_i^c, M_i) - \mu[M_i - \frac{C_i}{(C_i + C_{-i})} M_t] - \lambda[Y_i^b - Y_i^c - \frac{C_i}{P_i}]$$

Given the contest function of equation (3) and the Nash reaction function of equation (6), the resulting Nash-Cournot distribution of OS is determined by the following set of n equations:

$$\frac{M_i}{M_j} = \frac{P_i \frac{U_{M_i}}{U_{y_i}}}{P_j \frac{U_{M_j}}{U_{y_j}}} \quad \forall i, j = 1,2,..,n \quad \sum_{i=1}^{n} M_i = M_t \tag{7}$$

To illustrate, assume for simplicity an additively separable utility function and the Atkinson iso-elasticity specification for marginal utilities,[10] $U_{M_i} = 1/M_i^{\varepsilon}$ and $U_{y_i} = 1/y_i^c$, so the operationalization of equation (7) becomes:

$$\frac{M_i}{M_j} = \frac{P_i \frac{y_i^c}{M_i^{\varepsilon}}}{P_j \frac{y_j^c}{M_j^{\varepsilon}}} \Rightarrow \frac{M_i}{M_j} = \left(\frac{P_i y_i^c}{P_j y_j^c}\right)^{1/(1+\varepsilon)} \tag{8}$$

Together with the overall medal constraint, equation (8) stipulates that the Nash equilibrium medal shares are determined by relative world GDP shares. This is in line with the empirical literature on the distribution of OS, where among the set of explanatory variables including host country, population, socialist background etcetera (all not included in the model here), GDP is invariably the most important factor. The Nash distribution of OS for $\varepsilon = 0$ coincides with the distribution strictly according to GDP shares, given in column 6 of table 1. The distribution for $\varepsilon = \frac{1}{2}$ is given in column 7 of table 1. India is always underperforming, while for China and Russia the actual medal scores are higher than the Nash medal scores.

Box 1: Specialization

At the opening ceremony of the Olympics we see that almost all countries are sending athletes. Apparently, all countries, however small or poor, invest in OS. This can be explained by the fact that the analysis so far has ignored the effects of specialization and comparative advantages. By specialization, a country chooses a subset of M_t, say M^*, for which it wants to compete for a medal. In the limit, M^* includes only one event. Contrary to equation (6), with specialization all the investments done by other countries outside the subset of M^*

[10] E. g. a Cobb-Douglas type after utility function and then hard return $U_i = (Y_i^c)^{\alpha}(M_i^{\varepsilon})^{\beta}$, so $\ln U_i = \alpha \ln(Y_i^c) + \beta \ln(M_i^{\varepsilon})$.

are not relevant. For simplicity, suppose only two countries compete for the hegemony in one sport event, so the contest function[11] can be expressed as:

$$\mathrm{Pr}_{M^*} = \frac{rC_1}{(rC_1 + C_2)} \tag{B1}$$

with Pr the probability for country 1 to win the medal M^* and $r > 1$ a measure of the relative comparative advantage of country 1 in winning this event, e.g. because it happens to have a great talented athlete. The Nash reaction functions (see Congleton 1984: 204 for similar reaction functions in case of award-seeking efforts) become:

$$C_1 = (-C_2 + \sqrt{rS_1C_2}) / r \tag{B2}$$

$$C_2 = -rC_1 + \sqrt{rS_2C_1}$$

and the Nash equilibrium (C_1^*, C_2^*) is given by:

$$C_1^* = \frac{rS_1^2S_2}{(rS_1 + S_2)^2} \tag{B3}$$

$$C_2^* = \frac{rS_1S_2^2}{(rS_1 + S_2)^2}$$

thus a comparative advantage of one country affects the investments of both countries in a symmetrical way. The derivative of investments with respect to the comparative advantage parameter r is positive if $S_2 > r\ S_1$. This case applies when a small and/or poor country has a comparative advantage, but the larger and/or richer country has a considerable higher 'willingness to pay' for the medal, expressed in S_2. From equations (B3) it also follows that $C_1^* \big/ C_2^* = S_1 \big/ S_2$, which is equivalent to the proposition of Nti (1999: 419) that both players allocate the same fraction of their valuations to the contest. If both countries value OS in this event equally ($S_1 = S_2 = S$), then $C_1 = C_2 = rS/(1+r)^2$ and the probability to win for country 1 is $r/(1+r)$, which is r-times as large as the probability to win for country 2. For $r = 1$, $C_1 =$

[11] The contest function can be generalized by raising the investments in equation (B1) to the power of a so called 'mass effect parameter', which is a measure how sensitive the winning probability is to changes in investment (see e.g. Hirsleifer 1989).

$C_2 = S/4$ and total investments are $S/2$, a well-known result in the rent-seeking literature (see e.g. Katz et al. 1990: 52). Additionally, substitution of Eqs. (B3) in (B1) gives that $\Pr_{M^*} = rS_1 \big/ (rS_1 + S_2)$, so the probability to win is a function of both relative marginal benefits attached to OS and the comparative advantage. If the comparative advantage is due to superior inborn talent, then the country with that talent will only be favourite to win the medal if $rS_1' > S_2'$. In practical terms, the talented athlete must be sufficiently supported by her country to appear as the favourite at the start, because an athlete from a rival country can compensate lower talent by more investments in training(facilities), counselling and coaching. Not the most talented athlete invariably wins, but the one equipped with the right mix of talent, training and facilities.

4 SOCIAL PLANNER: ZERO COST FUNCTIONS

It is interesting to see whether the noncooperating Nash outcome differs from the one imposed by a hypothetical social planner. Many different types of social planners can be imagined, depending on the powers bestowed upon them (e.g. the power of lump sum taxation, or the power to force countries to take negative externalities imposed on other countries into account). I will consider only one type, with the power to forbid government investments in top sport facilities in order to gain more OS.[12] This amounts to imposing zero cost functions in the model. To find the optimum for the social planner, world welfare is

[12] The distribution of OS of a social planner with only the power to prevent that countries spend more or less than is optimal for them is the same as the Nash distribution because each country faces the same overall medal constraint as the social planner does. Also the budget constraints do not differ: under Nash behaviour, each country has its own budget constraint, while the social planner includes all budget constraints separately into its Lagrangian function. It can also be shown that the resulting distribution of OS of a social planner with the power to forbid investments in OS beyond the point where the net welfare benefit of one country is higher than the negative externalities imposed on the other countries under the assumption of the zero Nash conjecture $(\partial C_j \big/ \partial C_i = 0)$ is identical to the social planner in the main text, because the optimum is that no costs are made. Starting from a situation of zero cost, a small country investing in OS will capture all medals, so definitely imposing negative externalities on all others. But even the net welfare gain for the largest country of investing in OS is less than the total welfare of the no cost distribution.

simply set equal to the sum of welfare over all countries, $W = \sum_{i=1}^{n} W_i = \sum_{i=1}^{n} P_i U_i(Y_i^c, M_i)$ and the optimum condition is:

$$\frac{\partial W_i}{\partial M_i} = \frac{\partial W_j}{\partial M_j} = \mu \tag{9}$$

According to (9), in the optimum allocation, the marginal contribution to world welfare must be equalized across countries and equal to the fixed medal constraint multiplier (see Box 2 below). In a two country world, due to the fixed medal constraint $\partial M_i = -\partial M_j$, so equation (9) can be rewritten as:

$$\begin{aligned} \frac{\partial W_1}{\partial M_1}\Big/ N &= p_1 U_{M_1} - p_2 U_{M_2} = \frac{\partial W_2}{\partial M_2}\Big/ N \\ &= -p_1 U_{M_1} + p_2 U_{M_2} \Rightarrow \frac{U_{M_1}}{U_{M_2}} = \frac{p_2}{p_1} \end{aligned} \tag{10}$$

According to equation (10), a social planner will allocate more medals to the more populous countries. What the social planner is doing is to minimize the sum of negative externalities imposed by countries capturing one more medal on all other countries. Starting from scratch and assume one country is small and the other large, if a small country wins the first medal, it imposes a large negative externality (welfare loss) on the large country, but if the large countries wins, it imposes only a small negative externality on the small country. Initially, the first medals will therefore go to the large country, until the point is reached where the gain in welfare of even more medals for the large country, due to a declining marginal utility of OS, becomes equal to the negative externality imposed on the small country, which of course is equal to the gain in welfare for the small country to win a first medal, etc.

In an *n*-country world, the effect of a change in the number of medals of one country on the medal tally of other countries is more complicated. If all other *n*-1 countries are equally affected in their medal score, so $\partial M_j = -\partial M_i / (n-1)$, then equation (10) still holds, because:

$$\left.\frac{\partial W_i}{\partial M_i}\right/ N = p_i U_{M_i} + \sum\nolimits_{k \neq i}^{n} p_k U_{M_k}$$
$$= p_i U_{M_i} - p_j U_{M_j} / (n-1) - \sum\nolimits_{k \neq i,j}^{n} p_k U_{M_k} / (n-1) \tag{11}$$

$$\left.\frac{\partial W_j}{\partial M_j}\right/ N = p_j U_{M_j} + \sum\nolimits_{k \neq j}^{n} p_k U_{M_k}$$
$$= p_j U_{M_j} - p_i U_{M_i} / (n-1) - \sum\nolimits_{k \neq i,j}^{n} p_k U_{M_k} / (n-1)$$

and using (9) again gives $U_{M_i} \big/ U_{M_j} = p_j \big/ p_i$. However, it is more probable that countries with a high medal tally will be affected more. The expected change in the number of medals of country *j* because of a marginal change in the number of medals of country *i* can be expressed as $\partial M_j = -(M_j / (M_t - M_i))\partial M_i$, in which case the optimum condition becomes:

$$\frac{U_{M_i}}{U_{M_j}} = \frac{p_j}{p_i} \frac{[1 + M_j / (M_t - M_i)]}{[1 + M_i / (M_t - M_j)]} \tag{12}$$

Although equation (12) is theoretically to be preferred for the simulation, we will use the more simple expression of equation (10) or (11) that $U_{M_i} \big/ U_{M_j} = p_j \big/ p_i$. Using again the Atkinson specification of $U_{M_i} = 1 \big/ M_i^{\varepsilon}$, it follows that $M_j = (p_j \big/ p_i)^{1/\varepsilon} M_i$. Summing both sides over $j = 1, 2, \ldots, n$ gives:

$$M_i^{SP\ I} = \frac{p_i^{1/\varepsilon} M_t}{\sum_{j=1}^{n} p_j^{1/\varepsilon}} \tag{13}$$

The optimal distribution of medals for $\varepsilon = \frac{1}{2}$ is given in the final column of table 1. Note that for $\varepsilon = 1$, the distribution according to population shares of column 5 results, which can be seen as the optimal distribution if governments do not spend anything to raise its level of OS beyond what arises spontaneously in a situation where Olympic talent is randomly distributed. As said, these welfare optimal distributions of medals abstracts from production costs of OS and is more biased towards the more populous countries, the lower the decline in marginal utility of OS as measured by ε. For $\varepsilon = 0.5$, China and India would capture more than half of all medals. The USA, currently holding 36 gold medals, qualifies for 14 medals according to its population share (see column 5 of table 1). If the declining marginal utility of OS is taken into account, favouring China and India at the expense of all other countries, this number further decreases to only 8 medals. Japan retains only 2 of its actual 16 gold medals. Even more dramatic are Germany, France, the UK and Italy. Their actual numbers of gold medals vary between 9 and 14, they qualify for at most 5 medals each according to population shares and if the declining marginal utility is accounted for, they qualify for less than half a medal each.[13]

Box 2. The meaning of the fixed medal constraint multiplier

In equation (9), the optimum condition states that the marginal contributions of world welfare must be equalized across countries and the marginal contribution of each country is equal to μ. To appreciate where μ stands for, the maximization problem for the social planner has to be given in the Lagrangian form:

$$L(M_1 \ldots M_n, \mu) = \sum_{i=1}^{n} p_i U_i(Y_i^c, M_i) - \mu[(\sum_{i=1}^{n} M_i) - M_t]$$

where the Lagrange multiplier μ measures the change in the optimal value of the objective function ($\mathrm{d}W$) with respect to a unit or infinitesimal increase in the constraint ($\mathrm{d}M_t$), so $\mu = \mathrm{d}W/\mathrm{d}M_t$. The first order conditions are:

$$\frac{\partial L}{\partial M_i} = p_i U_{M_i} - \mu = 0 \quad \forall\, i = 1, 2, \ldots, n$$

giving the same result as Eqs. (9) and (10), so the optimal distribution is the one characterized by $p_i U_{M_i} = \mu$. In a way, μ is a summary statistic which measures the global equilibrium value of OS, or the world shadow price of OS.[14] If this global value is high, each country will experience that producing OS is more difficult than when this value is low. Since μ is given for an individual country, the more populous, the lower the marginal utility of OS, so the higher the medal tally for that country.

[13] For $\varepsilon = \frac{1}{2}$, marginal utility of OS declines rather slowly. Given the assumption of OS as a public good, the social planner will allocate most medals to the most populous countries, with the result that small countries will have nearly zero medal scores.

[14] If there would be a transfer market, like in football, for caliber athletes by changing nationality, this parameter would be a good predictor of the transfer price for an athlete with a near 100 percent chance of winning a gold medal.

The fixed sum medal constraint (M_t) can eventually be relaxed by introducing more Olympic events. However, the more the constraint is relaxed – that is, the higher the total number of medals – the stronger the inflationary pressure on the value of any medal. This may explain why the IOC is rather reserved with enlisting new sports events. The optimum for the IOC, in charge of expanding or contracting the list of Olympic sport events – that is varying the number of gold medals - is to increase the number of events up to the point where the gain in welfare by granting one more medal (one more sport event on the programme) is equal to the welfare loss of inflation in the value of the other medals.[15]

One must keep in mind that the medal constraint is different in nature than a standard resource constraint in an optimization problem. To fully appreciate this fact requires a slightly different model, where both the value and the cost of OS is also dependent on the total number of medals. In the utility and cost function it was implicitly assumed that ‘a medal is a medal’. The utility derived from or the cost incurred to achieve a particular medal score was independent of the total number of medals. However, if gold medals are disbursed to anyone who takes the trouble to show up at the Olympics, then both the value and the cost of medals dwindles to zero.

5 LEVELLING THE OLYMPIC PLAYING FIELD?

So far, we have seen four different medal tallies in this article, which can roughly be divided into two pairs: one pair, the actual medal tally and the Nash equilibrium medal tally, biased towards the rich countries and the other pair, the medal tally proportional to population shares and the one envisaged by a hypothetical social planner, biased towards the populous (and mostly poor) countries. The bottom line of the story outlined in section 2 by means of Lorenz curves is that the actual distribution of OS is highly unequal, biased heavily towards rich countries and predominantly former socialist countries. This stands in sharp contrast with the idea behind the Olympic movement, that all world citizens really have the opportunity

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[15] At the Paralympics, the number of medals is much higher than for the regular Olympics, mainly because for each sport event there are separate competitions for different handicaps, which increases the number of medals per sport event to about a factor five. Despite the limited number of different sport events, at the Paralympics of Beijing, 471 gold medals can be won.

to participate. In *The Olympic Charter* one can find statements such as: "The practice of sport is a human right. Every individual must have the possibility of practising sport, without discrimination of any kind and in the Olympic spirit, which requires mutual understanding with a spirit of friendship, solidarity and fair play" (4th fundamental principle of Olympism, p. 11); "to cooperate with the competent public or private organizations and authorities in the endeavour to place sport at the service of humanity and thereby to promote peace" (4th role in the mission of the IOC, p. 14); "to encourage and support the development of sport for all" (12th role in the mission of the IOC, p. 15).[16] By and large these statements can be taken as a plea for equality of opportunity in the sense that for everyone in the world talent and willingness to use that talent rather than social circumstances should be decisive for OS. My claim is that the IOC, embodied with supranational authorities, sometimes even superseding policy preferences by individual NOCs, is capable of regulating international sport affairs in a more equitable way. It can devise a policy to soften the most grinding disadvantages for some countries to obtain OS.

One possibility is redistribution of sponsor, merchandizing and TV revenues of the Olympics towards poor countries, with the per capita subsidy higher, the lower per capita income. It has the advantage that it is simple in its idea and practically feasible if only the political will would be there. As noted in the introduction, approximately eleven thousand athletes participated in the last Games. If these eleven thousand entries to the Games were proportional to population shares, then India would have to send 1859 athletes and Germany 143, whereas the actual numbers are 57 for India and 463 for Germany. By redistributing revenues, the IOC has to monitor that the redistributed revenues are earmarked and really used to improve the sporting infrastructure of the benefiting countries. The revenues spent on sport facilities in poor countries will remove the major obstacle - money to buy sport equipment and top sporting knowledge on the market - why these countries perform relatively under the mark at the Olympics. The ultimate goal is that poor countries would be equally capable of breeding calibre athletes as rich countries and the parade of athletes in

[16] Moreover, in the chapter 'Olympic Solidarity' one can find statements as "The aim of Olympic Solidarity is to organise assistance to NOCs, in particular those which have the greatest need of it" (p. 18) and "To urge governments and international organizations to include sport in official development assistance" (10th objective of Olympic Solidarity, p. 19).

the stadium at the opening ceremony would be a true reflection of the world population.

Even apart from the practical feasibility, there are a few downsides to this proposal. First, poor countries might still prefer to cash in the revenues and spent it on other purposes. However, since the money is earmarked, they can only spend it to promote sport. The only way the revenues distort the allocation of resources at the national level is that these revenues may partly or fully replace the national sport budget. In any case, since these countries are poor, in principle at least the 'deadweight' costs will be minor, if not negative (this would be the case if because of the inflow of revenues the national sport budget money is redirected to other, more beneficial programs for the country).

Rich countries pay the lion share of the revenues of the Olympics in terms of broadcast and sponsor fees. One may inclined to think that since they are paying more, they are also entitled to capture a larger share of OS. I think this argument is a non-starter. As soon as other countries become more successful, their home markets will also be prepared to pay more to broadcast, sponsor and merchandize the Olympics. Moreover, it goes strongly against the idea of the Olympics, the brotherhood of mankind. Redistribution of revenues, or any more practical alternative,[17] might help to make the Olympic Games truly a feast of brotherhood of (wo)mankind around the world, always leaving

[17] A market-based solution would be to auction the limited number of entry tickets. As noted in the introduction, approximately eleven thousand athletes participated in the last Games. Suppose the IOC distributed these eleven thousand entries according to population shares; thus China would receive approximately 2266 entry rights, India 1859, USA 506 and Germany 143, and so on. India, with only 57 calibre athletes, would be willing to sell a large share of their entry rights, whereas USA and Germany would be eager to buy additional entry rights. If the auction works well, a uniform equilibrium price will result. India, and other countries with a relatively low sport profile, would earn revenues, paid for by countries with a relatively high sport profile. Although for all countries the opportunity cost of sending athletes to the Olympics is increased by the equilibrium price of entries at the auction, the net effect is a redistribution of money from countries with a ratio of medal share and population share higher than one towards countries with a ratio of medal share and population share lower than one. Recall the Lorenz curve drawn in figure 1, Panel B of section 2: the more a country is situated at the far left (like India and many other poor countries), the more it benefits from such a scheme, while the more a country is situated at the far right (almost all rich countries, as well as some former socialist countries), the more it is a net contributor to the scheme.

open the possibility that in the distant future the Games are really global, indiscriminate to sex, race, religion and income.[18]

A second possibility is a change in the bidding strategies of countries that try to organize the Games and in the policy of countries that have won the bidding. In the bid, there should be a proposal to sponsor sport facilities in third world countries, e.g. financed by including sport in their government development aid programs. In addition, the country that actually wins the bid should not so much go for its own OS success by investing heavily in its own athletes, but rather invest in sport infrastructure in countries that are notorious underachievers. Doing so would convey the message to the world that the organizing country first of all wants to be a good host and not so much trying to show-off how good they are in sport. This strategy will not only create much goodwill in the world and help to make the Olympics more global, but is also squarely in the spirit of the Olympic movement.

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[18] Suppose, for convenience, that by adopting this system in the end all world citizens have access to the same facilities to breed their sport talents. The medal tally that results will reflect which countries have comparative advantages or strong preferences to excel in particular sports, e.g. Kenya in distance running and Australia in swimming (my rough guess is that we hardly know yet which countries have comparative advantages in particular sports - maybe Tanzanians are great surfers). This distribution will be different from the one which maximizes world welfare; at best it strikes some sort of balance between the welfare optimal and the default just distribution. Still, it has the merit that it reveals who is really the best in its discipline worldwide, whereas in the present state the distribution is heavily biased towards the rich countries and countries with a strong political preference for OS.

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