Economic Incentives of the Olympic Games

Alexander Matros and Soiliou Daw Namoro*

University of Pittsburgh

January 21, 2004

Abstract

We provide a game-theoretic analysis of countries' strategic allocations of resources to different sports and athletes performance at Olympic Games. Individuals are assumed to face opportunity costs of spending efforts to become elite athletes and countries are assumed to be medal number maximizers. We test the predictions of the model using Olympics data covering eleven Olympic Games (1960-2000).

1 Introduction

According to the International Olympic Committee (IOC), the supreme authority of the Olympic Movement:

> "*The Olympic Games are competitions between athletes in individual or team events and not between countries.*" [1]

*We thank Olivier Armantier, Andreas Blume, Dave DeJong, Ariel Pakes, In Uck Park, Ted Temzelides, Lise Vesterlund, and the seminar participants at the University of Pittsburgh for their valuable comments and informal discussions.

[1] See http://www.olympic.org/uk/organisation/missions/games_uk.asp. The Olympic Movement regroups the IOC, Organizing Committees of the Olympic Games (OCOGs), the National Olympic Committees (NOCs), the International Federations (IFs), the national associations, clubs, and the athletes.

This paper disentangles the extent to which, this goal is undermined by (i) economic differences among countries and (ii) countries' strategic behavior in terms of budget allocation among sports. The first of these two factors is in the preoccupation of the IOC, which has initiated costly programmes of assistance to developing National Olympic Committees (NOC's).[2] The second factor can explain the observed differences in Olympics performances between economically and demographically similar countries.

In a context of political and ideological competition, countries or interest groups might be tempted to use the Olympic Games as a propaganda tool.[3] As a matter of fact, countries' are in rivalry in virtually all aspects of the Games. Besides, sport, in many countries, is a big business, which involves both public and private funding. Hogan and Norton (2000) reported, in a study of spending pattern to elite sports programs in Australia, that funding (in 1998 dollars), jumped from about \$1.2 million in 1976/77 to \$106 million in 1997/98. The authors further compared \$.918 billion dollars spending on elite athletes, to the 115 total Olympic medals (of which, 25 gold) won by Australia in the period 1980-96 and concluded that approximately \$37 million were spent per gold medal and \$8 million per medal in general. Few countries can afford such colossal investments. In fact, given the external

[2]The IOC generates more than \$900 million a year in television rights, corporate sponsorships and other income. Nearly 3% (\$25000000) of this money was used to fund the Olympic Solidarity Scholarship Program, launched in 1998. The program targeting the Sydney 2000 summer games. It awarded 632 scholarships to "athletes practising an individual Olympic sport who demonstrated considerable potential and who did not have the possibility of receiving adequate training or of taking part in international competitions owing to lack of financial means." (Olympic Solidarity, Nov. 2000). Of these grantees, 472 (75%) participated in the Sydney games, and 61 of the latter (13%) won a total of 70 medals of which more than a third where gold medals.

[3]Examples of political use of the Olympics are the killings of Israeli athletes by Palestinian terrorists at Munich in 1972, the boycott of Moscow games in 1980 by several countries to protest against the Soviet invasion of Afghanistan, the retaliation of the Soviet bloc four years later at Los Angeles etc.

Table 1: Olympic Performances of Similar Countries

Country	Gold	Silver	Bronze	GDP/cap(1995US$)	Population (million)
Singapore	0	0	0	26868.18	4.13
New-Zealand	25	11	26	18425.17	3.85
Greece	12	13	18	13669.44	10.59
Portugal	3	3	5	13108.96	10.02
Switzerland	11	24	18	47064.41	7.23
Luxembourg	0	0	0	56381.98	0.44
China	80	78	65	878.42	1271.85
India	2	1	5	480.47	1032.36

debts that many countries face, their freedom to allocate high portions of their income to sport events is severely constrained. For instance, while the costs of staging the Millennium Games at Sydney were estimated at 2.6 billion Australian dollars (.19% of the country's GDP), the World Bank recently raised concern about the spending of $300 millions by Nigeria (.26% of the country's GDP) to host the 2003 African games.[4] According to the fundamental thesis that "Competition works best when all the participants are similar" (Nalebuff and Stiglitz ,1983), and given the very different economic environments in which athletes are trained and prepared for the Olympic Games, one is tempted to conclude that it is countries, not individuals, that compete against one another. Note that this medal-for-money theory implicitly downplays the possibility that potential athletes in different countries may respond differently to similar incentives provided by the sport authorities of these countries. Table 1 shows the year 2001 GDP per capita and the population of eight countries along with their Olympic Games performances in terms of medals won in the period 1960-2000. A pairwise comparison can

[4]See http:www.olympics.org.ukthegamespastsydney.asp
and http:news.bbc.co.uk1hiworldafrica3181336.stm

be made between Singapore and New Zealand, Greece and Portugal, Luxembourg and Switzerland, or China and India. As one can observe, the table 1 shows in each case a striking difference in the Olympic Games performances of the two countries despite the fact that they have similar economic and demographic profiles. A possible explanation of these patterns is that athletes might face country-specific and sport-specific costs that influence their participation and performance in the diverse sports. Further, the structure of funding allocation to different competing sports may be of a strategic nature.

Tables 2-4 show for each Olympic Game, the number of times that two of the three biggest Olympic Games medal winners during the period 1960-1996 - USA, USSR, and East Germany (DDR)- shared a podium. It results from the tables that the each of the three countries shared a podium with one of the two other rival countries only in about 30 percent of its victories. This may suggest that these countries strategically and tacitly avoided competing against each other.

Table 2: Podium Shares by USA and USSR

Games	USA	USSR	PODIUM SHARES		
			Frequency	%USA	% USSR
Rome 1960	71	103	22	30.98	21.35
Tokyo 1964	90	96	23	25.55	23.95
Mexico City 1968	107	91	24	22.42	26.37
Munich 1972	95	99	24	25.26	24.24
Montreal 1976	94	126	33	35.10	26.19
Moscow 1980		195			
Los Angeles 1984	175				
Seoul 1988	94	135	30	31.91	22.22
Barcelona 1992	109	114	33	30.27	28.94
Average	94.28571	109.1429	27	28.63	24.73

Table 3: Podium Shares by USA and East Germany

Games	USA	DDR	PODIUM SHARES		
			Frequency	% USA	% DDR
Rome 1960	71				
Tokyo 1964	90				
Mexico City 1968	107	25	17	15.88	68.00
Munich 1972	95	66	22	23.15	33.33
Montreal 1976	94	89	25	26.59	28.08
Moscow 1980		126			
Los Angeles 1984	175				
Seoul 1988	94	102	31	32.97	30.39
Barcelona 1992	109				
Average	94.28571	81.6	23.75	25.18	29.10

Table 4: Podium Shares by USSR and East Germany

Games	USSR	DDR	PODIUM SHARES		
			Frequency	% USSR	% DDR
Rome 1960	103				
Tokyo 1964	96				
Mexico City 1968	91	25	10	10.98	40.00
Munich 1972	99	66	32	32.32	48.48
Montreal 1976	126	89	39	30.95	43.82
Moscow 1980	195	126	92	47.17	73.01
Los Angeles 1984					
Seoul 1988	135	102	44	32.59	43.13
Barcelona 1992	114				
Average	119.875	81.6	43.4	36.20	53.18

In this paper, we emphasize two important aspects of the Games that have not been considered in the previous literature. The first is that athletes do face country-specific individual "opportunity costs" of investing a substantial part of their physical and intellectual resources in elite sport with the goal of becoming national champions. These costs determine, along with the prevailing competitive environment, what we call the "hardness" of becoming a national champion in a given sport. We argue that this "hardness" index might be one of the country-specific unobserved factors that influence the winning of medals.

The strategic allocation of the sport budget of a country among different competing sports is the other important factor, which arguably influences Olympic Games participation and performance. Our contention is that the structure of the sport budget allocation plays a distinct and important role that is at least as important as the size of the budget.

We develop this argument by proposing a theoretical model which we test using Olympic Games data on the period 1960-2000. An important consequence of our theory is that country-specific factors, which we relate to individual costs and countries' strategic allocation of budget, should explain an important part of the variation in the observed performance, and should not be correlated with the proxies for the size of the sport budgets. We test empirically these two predictions and we propose variables to account for the unobserved heterogeneity among countries. A summary of the results is is provided in the following section. The next two sections present a literature review and the theoretical model. Section five describes the econometric model, the data and the empirical results. The last section is devoted to the conclusion and some further remarks.

2 Overview of the results

2.1 The Theoretical Model

The model to be described more in detail below explicitly assumes that countries have strong motivations to win olympic medals and, therefore, allocate strategically their resources among the diverse sports in order to achieve this goal.[5] It involves different countries allocating their internal (i.e., national) limited resources among a given set of sports, and it predicts the reactions of the potential athletes to these allocations. These reactions concern individuals' decisions to enroll in some particular subset of sports, and the effort levels that they will invest in these sports, given that effort

[5] As a further motivation of that assumption, we note for instance that in a report about the Sydney summer games, the Director of the French most important training institution (the INSEP) recommends among others things to the French government, "a political orientation of exchanges toward strategically interesting countries". A popular example of patriotic bias on the Olympic Games is in figure skating. Fenwick and Chatterjee (1981) and Campbell and Galbraigth (1996), e.g., found that judges tend to give higher scores to contestants from their own country.

spending is individually costly. We describe how each particular allocation of resources among the sports induces a game among potential athletes within a country, which in turn results in an optimal participation rate in each sport, and a configuration of effort across sports in that country. We assume that national sport policy makers are aware of that input-output process. Under this assumption, the competition among countries for medals is described as a simple game in which, relatively higher effort in one particular sport is likely to result in the winning of a medal in that sport. A common-sense feature of the within-country equilibrium is that the participation rate and the level of effort spent in one sport are directly proportional to the amount of resources allocated to that sport. This equilibrium can be given the intuitive interpretation that in each sport, the relative benefit to the national champion exactly compensates the "difficulty" of becoming champion in that sport. This difficulty index is a function of the individual costs (tangible and intangible) supported by the national champion.

2.2 The Empirical Tests

The above characterization of the equilibrium suggests an empirical model that we now describe. We use the total number of medals won by a country as a proxy to the total relative benefit to national champions in all sports. We assume that the difficulty index is constant across sports within a country and differs among countries. We then use, in a first step, country-specific effects to capture the unobserved heterogeneity among countries. We control for the total amounts invested in elite sport by using GDP per capita as instrument for these amounts. Other included regressors are demographic variables and variables that capture countries' experience in hosting Olympic Games, the home advantage conferred to a country by hosting the Game and the political regime in each country. The resulting model is in the spirit of the reduced form models that have been previously used to predict a number of winning Olympic medals for every country. We then test and reject the hypothesis that there is a correlation between the unobserved heterogeneity factors among countries and the other covariates. This rejection is an evidence against the all-money theory of Olympic Games. It can also mean, for instance, that observable policy variables that influence the medal winning process might not be the sole determinants of the unobservable comparative advantages to countries which are sometime seen as cultural factors.[6] We then substitute for the countries' unobserved effect in the regression, additional variables, which may be seen as related to individual costs and countries' strategic behavior. We provide an extensive discussion of the relevance of these variables in this context.

3 A Brief Literature Review

This paper shares a similar empirical framework with a few previous papers. These are Johnson and Ali (2000), Bernard and Busse (2000), Sterken and Kuper (2001), and Hoffmann et al. (2002). All these papers are devoted to the empirical identification of the determinants of Olympic Games medal winning. None of these paper does provide, as we do in this paper, an explicit economic model to shade light on the possible interactions among these determinants, however. The first three papers model both participation and performance. We do not follow this line because in our model, a country which does not participate in the Olympic Games but is allowed to do so, has simply not invest enough in sports. Such a decision is not qualitatively different from investing enough to participate in the games but not enough to put the country's athletes into the position to win medals. The previous studies have identified some determinants of performance and the choice of regressors to control for in our empirical model is directly influenced by

[6] Hoffmann et al., (2002) contend that "Nations whose cultures emphasize sport are more likely to generate and support athletes."

these findings. These determinants are essentially demographic (the size of the population), economic (income per capita), political (communist or not), and also include the “home advantage” stemming from hosting of the games, and hard-to-measure cultural factors. Hoffman et al. (2002) also consider geographic factors such as the average temperature in each country.

4 The Model

We assume that there are N countries and every country pursues the goal of winning (through the performance of its athletes) a maximum number of medals (gold, silver or bronze) on the Olympic Games. Although, we shall assume that countries value gold more than silver and silver more than bronze, this aspect is not essential in the description of the main features of the model. Each country selects the best athletes for a medal competition within S given sports events on the Olympic Games. The best athletes are the winners of the qualification tournaments in the country. The problem which each country faces is how to allocate a given fixed amount of resources (typically a certain fraction of its GDP) among different sports in order to maximize the total number of medals on the Olympic Games. Each allocation of resources in a country results in a number of athletes and the effort spent by them in each sport. Athletes are assumed to incur a cost upon spending effort. Countries then confront their best athletes in each sport on the Olympic Games. Higher within-country effort in a given sport gives higher probability to win an Olympic medal in that sport. Countries differ in their resources and costs of effort. We describe the within-country reactions of potential athletes to a given resource allocation in the following subsection.

4.1 Within-Country Participation Rates and Effort Levels

Let us consider a country i. Each sport in the country is to be viewed as a qualification tournament. Individuals in each country are assumed to be risk-neutral and to live only two periods. In the first period of her life, an individual chooses to enter a sport $s \in \{1, ..., S\}$ or to stay outside of the sport arena. If an athlete wins the qualification tournament, she is promoted in the second period to represent country i in the sport event s on the Olympic Games.

We assume that every qualification tournament is a winner-take-all tournament: the winner - the best country i's athlete - receives all the money/resources M_s, which the country i invests in sport s; all other athletes in this sport in the country i get nothing. Note that our model allows private investments as well. If a private institution makes an investment in sport s, then the total amount of money in this sport becomes a sum of the private and governmental investments. Even though in some popular sports, the funding is mainly private, in most of the Olympic sports, the funding is mostly public. Since only the government cares about the total number of medals in all sports, the government faces an allocation problem, given private investments in some of the sports. To simplify the exposition, we assume that private investments are zero.

We assume that the Olympic Games take place every second period. In each country, every individual in the young generation observes the government money allocation to different sports after the Olympic Games and decides to enter or to stay outside of the sport arenas and, if the decision is to enter, which sport to enter during her first live period. We also assume that the sports markets are perfectly competitive, with the consequence that every individual has zero expected utility/payoff. The outside sport option gives zero payoff to an individual. We make the following assumption on the cost induced by effort spending $C(e)$:

$$A1. \ C(e) \geq 0, \ C'(e) > 0, \ C''(e) > 0. \tag{1}$$

An individual j, who is an athlete in sport s, solves the following problem

$$\max_{e_j} u(e_j) = \max_{e_j} \left[\frac{f(e_j)}{\sum_{l=1}^{N_s} f(e_l)} M_s - C(e_j) \right], \tag{2}$$

where

$$A2. \ f(x) > 0, \ f'(x) > 0, \ f''(x) < 0. \tag{3}$$

The first term in (2) is individual j's expected probability to win the qualification tournament times the money which the government puts in sport s. The second term is the cost to exert effort e_j. N_s is the total number of athletes in sport s. N_s and e_j are to be determined in equilibrium. For simplicity we assume that there is no time discount.

We show first that there exists a symmetric equilibrium in pure strategies. The properties of the symmetric equilibrium are analyzed after that.

Proposition 4.1 *Suppose that assumptions (1) and (3) hold. Then there exists a symmetric equilibrium in pure strategies.*

Proof By assumptions (1) and (3), the continuous payoff function $\left[\frac{f(e_j)}{\sum_{l=1}^{N_k} f(e_l)} M_s - C(e_j) \right]$ is quasi-concave in e_j. It means that we can apply Kakutani's fixed-point theorem. The fixed point is a symmetric equilibrium in pure strategies. **End of proof.**

We now analyze some properties of the symmetric equilibrium in pure strategy that exists by Proposition 4.1. The first-order condition of the maximization problem (2) is

$$\frac{f'(e_j) \sum_{l \neq j} f(e_l)}{\left[\sum_{l=1}^{N_s} f(e_l) \right]^2} M_s = C'(e_j).$$

In symmetric equilibrium, it must be that all athletes in sport s exert the same effort $e_j = e_s^*$.Thus the first order condition (FOC) for effort is:

$$\frac{(N_s - 1)}{N_s^2} \frac{f'(e_s^*)}{f(e_s^*)} M_s = C'(e_s^*) . \tag{4}$$

Athletes' individual rationality (IR) constraint must be satisfied in all sports:

$$u(e_s^*) \geq 0 \text{ for any } s \in \{1, ..., S\} .$$

Assuming that there is perfect competition in the sports markets, the (IR) constraint is binding:

$$u(e_s^*) = 0,$$

or

$$u(e_s^*) = \left[\frac{f(e_s)}{\sum_{l=1}^{N_s} f(e_l)} M_s - C(e_s) \right] = \frac{M_s}{N_s} - C(e_s^*) = 0. \tag{5}$$

It gives the following condition between money in the sport and a number of individuals and their effort for that sport:

$$N_s C(e_s^*) = M_s. \tag{6}$$

Define the elasticity of the cost function as

$$\varepsilon_C(e) = C'(e) \frac{e}{C(e)},$$

the elasticity of the function f as

$$\varepsilon_f(e) = f'(e) \frac{e}{f(e)},$$

and

$$\varepsilon(e) \equiv \frac{\varepsilon_C(e)}{\varepsilon_f(e)}.$$

Note that equation (4) can be rewritten as

$$\frac{(N_s - 1)}{N_s} \left[f'(e_s^*) \frac{e_s^*}{f(e_s^*)} \right] = C'(e_s^*) \frac{e_s^*}{C(e_s^*)}$$

or

$$\left(1 - \frac{1}{N_s}\right) \varepsilon_f = \varepsilon_C. \tag{7}$$

We can state the main result of this subsection now.

Proposition 4.2 *If $\varepsilon(e)$ is an increasing function of effort such that $\varepsilon(0) = 0$, and $lim_{e\to\infty}\varepsilon(e) > 1$, then, in the symmetric equilibrium, more resources allocated to a sport induces more athletes entering that sport and more effort spent by athletes in that sport.*

Proof The assumption that ε is an increasing function and the relation (7) imply that the number of potential athletes N_s is an increasing function of the effort, e. Since the cost is also an increasing function of effort, then the equation (6) implies that upon increasing the amount of resources M_s allocated to sport s, both the optimal equilibrium effort e and the participation N_s must increase. Note that we have also proved the existence and uniqueness of an equilibrium under the assumptions of proposition 4.2. **End of proof.**

4.2 The Between-Country Game

As we have seen in the previous subsection every resource allocation $(M_{c1}, ..., M_{cS})$ among different S sports in the country c gives a unique configuration of effort allocation $e_c \equiv (e_{c1}, ..., e_{cS})$ in the different sports. Let

$$P_{cs} \equiv \frac{g(e_{cs})}{\sum_{j=1}^{N} g(e_{js})} \tag{8}$$

stand for the probability that country c wins the Olympics gold medal in sport s. Country c's expected total number of gold medals is, therefore, equal to $P_c \equiv \sum_{s=1}^{S} P_{cs}$. The function g is assumed to be such that:

$$A3.\ \ g(x) > 0,\ \ g'(x) > 0,\ \ g''(x) < 0. \tag{9}$$

A country c has to decide how to allocate the sport budget M_c in order to maximize the expected number of Olympic medals. The strategy set for each country is compact and from Kakutani fixed point theorem the between-country game has a pure-strategy equilibrium. Therefore, the whole game (within and between countries) has an equilibrium. In this equilibrium, countries first choose their allocations of the sport budgets, then the potential athletes choose their participation and the optimal effort levels. In fact the equilibrium of the game also determines countries' relative probabilities of winning in each sport. Since the between-country game may have several equilibria, it is not clear which of these equilibria actually occurs. As table 2-4 suggest, the biggest Olympic medal winners (USA, USSR, DDR) split the market for Olympic medals in equilibrium in the following sense. They appear to invest in different sports. We now proceed with the empirical implications of the model.

5 Econometric Framework

5.1 The Model

Our empirical test of the above model will be based on equations (6) and (7). We first write (7) as follows:

$$\frac{N_s - 1}{N_s} = \varepsilon(e). \tag{10}$$

Then, multiplying both the numerator and the denominator of the left-hand side of (10) by $C(e)$ and using (6), we obtain the equality:

$$\frac{M_s - C(e)}{M_s} = \varepsilon(e). \tag{11}$$

The left-hand side of the equation (11),

$$B_s \equiv \frac{M_s - C(e)}{M_s},$$

is interpretable as the net relative benefit to the national winner of the competition in sport s. Indeed, multiplied by 100, it represents the net benefit (prize minus cost) as a percentage of the prize, i.e., the resource amount allocated to sport s. The ratio at the right-hand side, $\varepsilon(e)$, can be interpreted as the extent to which, it is difficult to win the national competition in sport s. Indeed, it shows by how much percentage the cost must increase for each percentage increase in the effort contribution to the probability of wining. It follows from the above that the equilibrium condition (11) simply says that the net relative benefit to the national champion in sport s must exactly compensate the hardness of becoming a national champion in that sport. For example, if f is of constant elasticity and C is exponential, then the fraction $\frac{\varepsilon_C}{\varepsilon_f}$ is proportional to optimal the level of effort e.

Since we shall now focus on the comparisons among countries, we shall emphasize in relation (11), the dependence of all the variables on the country:

$$\frac{M_{s,c} - C_c(e_{s,c})}{M_{s,c}} = \varepsilon(e_{s,c}). \qquad (12)$$

Note that, since for a given sport the benefits for two different countries are dimension-free, they can be compared. Relation (12) can now be aggregated over sports at country level as follows:

$$\sum_{s=1}^{S} \left(\frac{M_{s,c}-C_c(e_{s,c})}{M_{s,c}}\right) \frac{M_{s,c}}{\sum_{s=1}^{S} M_{s,c}} = \sum_{s=1}^{S} \left(\frac{\varepsilon_{C_c(e_{s,c})}}{\varepsilon_{f_c(e_{s,c})}}\right) \frac{M_{s,c}}{\sum_{s=1}^{S} M_{s,c}} \qquad (13)$$

$$\Leftrightarrow$$

$$\frac{M_c-C_c}{M_c} = \sum_{s=1}^{S} \left(\frac{\varepsilon_{C_c(e_{s,c})}}{\varepsilon_{f_c(e_{s,c})}}\right) \frac{M_{s,c}}{M_c}, \qquad (14)$$

where $M_c \equiv \sum_{s=1}^{S} M_{s,c}$ and $C_c \equiv \sum_{s=1}^{S} C_{s,c}$. The left-hand size of the relation (14) is interpreted as the average (over all sports) relative net benefit to a champion within country c. This quantity is equal, in the equilibrium, to the average difficulty of becoming a champion in country c, where the latter is expressed by the right-hand size of (14). Note that this average index of difficulty depends on three things: the *structure* of the sport budget, the sport-dependent elasticity of the cost function with respect to the effort spent, and the sport-dependent elasticity of the function f with respect to the effort spent. In particular, this index does not depend directly on the size of the sport budgets.

We shall use as a proxy for the net benefit, the total number of medals (of a given color) won by a country. This choice is motivated by the assumption that the higher is the average relative net benefit, the higher a champion in country c will will perform at the international level. The average difficulty of becoming a champion in country c will be treated as an unobserved heterogeneity factor, and we shall use country-specific dummy as a proxy for it. Since in the theoretical model, the total investment in all sports in a country (the sport budget) is assumed to be determined by a mechanism that is exogenous to the model, we shall control for this in the empirical model by using the country GDP per capita as a proxy for it. Assuming that the unit of observation is the country at a specific Olympic Game, we end up with the following empirical model

$$Y_{ct} = \alpha_c + X_{tc}\beta + u_{tc}, \qquad (15)$$

where Y_{tc} is the total number of medals (of a given color) won country by c at the Olympic games t, α_c is country c's specific effect, and X_{tc} is a vector of characteristics including GDP per capita. The vector β contains some of the parameters of the model. The regressors considered in the model are suggested to us by the previous literature. Given the structure of the model, we expect the fixed effects estimates to significantly influence the total number of medals won by a country at each Game after controlling for the other regressors, in particular the per capita GDP. In fact, to assess the independent character of the above influence, we also expect the specific effects to be uncorrelated with the per capita GDP.

5.2 Empirical Analysis

We now investigate and discuss the determinants of Olympic performance as suggested by our theoretical model. The emphasis will be put here on variables that may be seen as related to individual costs and countries' strategic behavior.

As mentioned in the preceeding sections, previous papers have identified a set of variables that are correlated with the number of medals won by countries or the probability to win medals, or to participate in the Games. These variables are essentially economic (e.g. per capita GDP), demographic (e.g. population), political (e.g. communist vs non-communist regimes) or historical and cultural (e.g. sporting culture, game hosting experience and advantage) etc. Before presenting our empirical findings, we first discuss the variables that we propose as additional determinants of the Olympic performance and how they relate to the previous ones.

5.2.1 Fertility Rate (*fertility*)

Previous studies have suggested that a larger population is more likely to contain gifted athletes. Given the livable area of a country and assuming constant mortality rate, it is clear, however, that a high fertility rate influences both the population size and the living conditions in the country. The fertility rate is considered here beside the population to capture the pressure that it may put on the individuals. The underlying assumption here is that fertility rate acts at family or household level and, therefore, is more or less related to the individual costs that an athlete may be facing in engaging herself elite sports. The obligation to contribute to the family's living conditions for instance may prevent an individual from engaging in time consuming sport training, especially for women in some areas. Our fertility data is collected from the Worldbank online database "WDI Online."

5.2.2 Age at first Marriage (*agemarr*)

Olympic athlete rather young in the majority of sports. Marriage decisions, given the time constraints that they imply, are natural rivals of the decisions to engage in elite sports. Both decisions are in fact risky in that they may lead to unsuccessful outcomes and, therefore, to regret. If the first marriage occurs in a country at a relatively earlier stage than in a rival country, it is not clear, however, that an athlete will face higher opportunity costs in the first country than in the second, when choosing to engage in elite sports, even if their sport careers are expected to be equally successful. Indeed, a postponing of the marriage decision may lead to a smaller choice set of the partner, but the set may also be relatively big for a successful athlete. We consider here the age at first marriage for men (*agemarr_m*) and the age difference between men and women (*diffagemarr*) at their first marriage as components of the individual costs. The data on these variables are collected from the U.N. report on world marriage (UN 2000).

5.2.3 Ethnic Fractionalization (*ethnfrac*)

The way in which national pride is boosted in a country by the performance of its athletes in international tournaments depends on the extent to which individual identifies their private and group interests with the countries' interest in such occasions. An athlete's performance may for example mean much more for the particular ethnic or social group to which the athlete belongs than to the country as a whole, despite the advertising of this event in the media as a national event. It may also have different meanings for the social group and the national authorities. The anti-racial segregation demonstration by the American athletes Tommy Smith and John Carlos at Mexico City in 1968 offers an example of such situations. This difference in the perception of "national success" may act as a stimulating or a discouraging factor at the individual level, depending partly on how much is expected socially and individually from the winning of an olympic medal in a country. Ethnic fractionalization is used in many studied in political science to capture the risk of social unrest in a country. Here, we view that variable as a component of the non-tangible costs faced by individual athletes. The fractionalization data was collected from two different sources:

Alesina et al. (2003) and Matthew Krain's Data Page.

5.2.4 Results

We consider all the summer Olympic games that took place between 1960 and 2000. We thus have a total of 11 games - Rome (1960), Tokyo (1964), Mexico City (1968), Munich (1972), Montreal (1976), Moscow (1980), Los Angeles (1984), Seoul (1988), Barcelona (1992), Atlanta (1996), and Sydney (2000). We have an unbalanced panel data of size 977 in which, each individual observation is indexed both by the country and the Game. The lack of balance of the panels is due to newly formed states and countries that no longer exist. We have also limited the investigation to countries who have ever won an olympic medal. This choice is motivated by the assumption that these countries are thought to share the common feature that they have shown enough interest in the Olympic Games and they have invested enough in at least one sport, to be considered as valid players in the game described in section 4. Some countries which were colonies at the time they won a medal where also eliminated from the sample. The reason is that these countries' performances can be viewed as reflecting the investment decisions of the colonizing country.

Tables 5 describes the linear random-effect regression of the total number of medals won by a country (*allmedals*) on a the per-capita GDP (*gdp-percapita*), the log-population (*logpop*), a variable indicating whether the country has ever hosted a communist regime (*ever_com*) and two variables indicating whether the country had ever hosted Olympic games (*ever_hosted*) and whether the country is currently hosting the Game (*homeadvantage*).

These variables have been identified as the determinants of olympic performance in the previous literature. A country, which has ever hosted the Olympic games or is currently hosting these games is thought to have higher chances to perform well. Indeed, such a country has probably accumulated a sport experience that can increase its potential of winning medals. Finally, the rush of former socialist countries for Olympic medals (probably for ideological reasons), and their relatively high performance motivate the consideration of the variable (*ever_com*). The impact of all these variables is well documented in the previous studies described in section 3.

The dependent variable (*allmedals*), was constructed using the database Oly2001. The data on the regressors where collected from the database "WDI Online." (*gdppercatita* and *population*) and from the web site of the International Olympic Committee. For some countries like Cuba, the series was approximated using information from Cata (1995), Mesa-Lago (2002). For other countries such as the former European socialist countries, the series were approximated using the Penn World Tables.

Regression 1 confirms the important findings of the previous literature in that the wealth of a nation, its population, its political institutions, and its experience in hosting Olympic games as well as the home advantage have all a positive influence on the winning of medals.

Further, Regression 1 shows that the contribution of country-specific effects to the overall variance of the error term (Var.Contribution) is above 70 percent. The p-value in the Hausman test of absence of correlation between the country-specific effects and the other regressors leads to the non-rejection of the absence of correlation. The p-value for the Breusch-Pagan test of absence of country-specific effect (BP) also shows a strong presence of these effects in both regression. Changing the dependent variable to the number of gold, silver or bronze medals did not change substantially the results.

These results are supportive of the contentions made in the introduction of the paper: not only do the country-specific effects strongly contribute to the observed variation in the Olympics performances but they also are not correlated to the wealth and other budget-related variables.

In table 6, we include in a second regression as explanatory variables the

Table 5: Regression 1: dependent=allmedals

allmedals	Coef.	Std. Err.	p-value
gdppercapita	0.0003275	0.0000636	0.000
ever_com	15.84458	2.812844	0.000
ever_hosted	16.098	3.595707	0.000
homeadvant e	27.83401	2.500737	0.000
logpop	2.14665	0.6193473	0.001
cons	-21.06045	5.706316	0.000
Var. Contribution	0.72666071		
Hausman	0.373		
BP	0.000		

costs-related variables discussed above. This regression shows first a fit that is comparable to the one obtained in the random-effect regression (with an adjusted R^2 of about .43). As one can see from the table 6, mens' age at first marriage and ethnic fractionalization both have a positive significant effect on the number of medal won by a country. Fertility and the age difference at first marriage have, in contrast, no significant effect on the dependent variable. The positive effect of the age at first marriage may be interpreted as follows: if marriage occurs at relatively later age, athletes face less pressure on their time spent in elite sports before marriage. The positive effect of ethnic fractionalization may be seen as surprising since it suggests that ethnic diversity is likely to stimulate Olympic effort. These results suggest all together that the country individual effects may be accounted for, at least to some extent,by the proposed variables. The above arguments downplay the fact that the fixed effects are in fact endogenous in the original model. To account for this, we performed the fixed effect versions of the previous

Table 6: Regression 2: dependent=allmedals

allmedals	Coef.	Std. Err.	P¿t
gdppercapita	0.0002988	0.0000645	0.000
ever_com	19.07407	1.506232	0.000
ever_hosted	11.05705	1.559274	0.000
homeadvant e	40.72437	4.384885	0.000
logpop	2.866578	0.3237174	0.000
fertility	-0.0755814	0.342112	0.825
agemarr_m	0.8590596	0.228676	0.000
diffagemarr	-0.2461001	0.4192319	0.557
ethnfrac	6.436522	2.213568	0.004
cons	-52.04972	8.178991	0.000

panel data regression. Indeed the bias introduced by the endogenous fixed effects are removed by the first differentiation process. The variables *evercommunist* and *everhosted*, which describe countries' political status and experience in hosting Olympic games are correlated in the sample with the country dummies and, therefore dropped. The population is also no longer significant. This results are not included here but are available upon request.

6 Conclusion and Further Comments

In this paper, we offer an interpretation of the unobserved heterogeneity among countries in relation to countries' Olympics performances. More precisely, we add two factors that have not been consider previously to the traditional set of determinants of countries' Olympics performances. The first of these new factors is related to individual athletes within a country and is described as the “opportunity costs” faced by individuals in their effort to become elite athletes in their respective countries. The second factor concerns countries’ strategic behaviors implied by the allocation of their sport budgets among different and competing sports in order to achieve the highest possible performance in terms of medal winning. We build a game-theoretic model in which individuals respond optimally to countries strategic budget allocations by deciding the sports in which to participate (no participation is allowed) and the effort level to spend in these sports. We show that this game has (possibly non-unique) pure strategy equilibria and each of these equilibria implies that in a given sport, the effort levels within countries and the participation rates in the sport are both increasing in the money amount allocated to that sport. Since the costs and the strategic factors are unobservable to the econometrician, an independent effect of these factors on the total number of medals won by a country should translate itself into significants country-specific estimates that are also independent of the proxies to sport budgets. We carry out an empirical test that confirms this prediction. More importantly, we propose new costs-related variables to account for the unobserved country heterogeneity. Some of these variables are demographic (fertility rate in a country and age at first marriage) while the last is social-politic (ethnic fractionalization). It turn out that the age at first marriage and ethnic fractionalization both have a positive significant effect on countries’ Olympic performances and account to some extent for the unobserved heterogeneity. Our study also confirms the importance of previously identified factors of Olympics performance.

Many features of the actual equilibria of each Olympic Game, could in principle be described from the available data. An accurate description would necessitate a finer data than we used, however. Some of these aspects can already be seen from our data. For instance our data show that most countries win their medals in a small and stable set of sport events across Olympic

Games, and that poor countries put all their eggs in a small number of sports in which they eventually win a medal. We leave the investigation of these aspects for another project.

References

[1] Alesina A., A. Devleeschauwer, and S. Kurlat (2003): "Fractionalization," *Journal of Econonomic growth,* 8, 155-194.

[2] Bevilaqua, J. P. (2003) "Just Exactly What is Sports Marketing?" *The Sport Journal, Sport Supplement,* vol. 2011, No. 202.

[3] Andrew B. Bernard and Meghan R. Busse (2001): "Who Wins the Olympic Games: Economic Resources and Medal Totals".

[4] Campbell, B., J. W. Galbraith (1996): "Nonparametric Tests of the Unbiasedness of Olympic Figure-Skating Judgments, *The Statistician,* Vol. 45, No. 4., pp. 521-526.

[5] Hernandez-Cata, E. (1995): "Julio Carranza and Pedro Monreal on Economic Change in Cuba: A critique," *Cuba in Transition,* Vol.5, http://lanic.utexas.edu/la/cb/cuba/asce/cuba5

[6] Fenwick, I., and S. Chatterjee (1981): "Perception, Preference, and Patriotism: An Exploratory Analysis of the 1980 Winter Olympic Games" *The American Statistician,* Vol. 35, No. 3, pp.170-173.

[7] Hoffmann, R., Ging L.C., and B. Ramasamy (2002): "Public Policy and Olympic Success," *Applied Economic Letters,* 9, pp. 545-548. pp. 170-173.

[8] Hogan, K. and K. Norton (2000): "The 'Price ' of Olympic Gold," *The Journal of Science and Medecine in Sport,* Vol. 3(2), pp. 203-18.

[9] The International Olympic Committee (IOC): www.olympic.org.

[10] Johnson, D. K. N. and A. Ali (2000): "Coming to play or coming to win: participation and success at the olymptic games." Wellesley College Working Paper 2000-10.

[11] Krain M. http://www.wooster.edu/polisci/mkrain/Data.html

[12] Kuper, G. and E. Sterken (2001): "Olympic Participation and Performance since 1896," Mimeo. Department of Economics, University of Groningen.

[13] Mesa-Lago, C. (2002): "The Cuban Economy in 1999-2001: Evaluation of performance and Debate on the Future," in *Cuba in Transition*, Volume 11, Papers and Proceedings of the Eleventh Annual Meeting of the Association for the Study of the Cuban Economy (ASCE), Miami, Florida, August 2-4, 2001.

[14] Nalebuff, B.J. and J.E. Stiglitz (1983): "Prizes and Incentives: Towards a General Theory of Compensation and Competition," *The Bell Journal of Economics,* Vol. 14, No. 1, pp. 21-43.

[15] United Nations: (2000) "World Marriage Patterns 2000,"

http://www.un.org/esa/population/publications/ worldmarriage/worldmarriage.htm