# (OLYMPIC) GAMES AND ECONOMIC BEHAVIOR

Wing Suen*

University of Hong Kong

(August 1994)

* Sports commentators at ATV and TVB offered invaluable insights. They are not responsible for my errors, and vice versa.

The study of games has become a popular sport among economists (Fisher 1989). In this field theory leads empirics by a wide margin. To redress the imbalance and bring some competitiveness back into the sport, this paper presents an econometric study of a real life game: the 1992 Summer Olympics. Using a reduced form model in the spirit of the structure-conduct-performance paradigm, the performance of national teams are found to be closely related to three variables: population, income, and political structure. In fact these three variables alone explain more than thirty percent of the variation in the number of medals won by different teams.

## I. Model

Existing literature on the game-theoretic aspect of sports games is sparse. Meschler (1967) describes hockey with a model of a differential game of goal-keeping and scoring. However, the present author does not have the math skills of a hockey player to solve the game using dynamic programming techniques. Keller (1973) uses the laws of physics to develop a theory of competitive running that fits Olympic records rather well. Unfortunately since the theory ignores strategic interactions (pulling shirts) and costly information (looking back), it cannot be any good. In the absence of comprehensive theory, two remedies are often attempted. (1) Assume some parameter values for the athletes' ergonomics and simulate the games numerically. (2) Ask college undergraduates to perform experimental runs. For lack of research grants, I resort to a third alternative: examine the records in the 1992 Olympic Games. The Olympics being a world class event, the results are expected to suffer the sample selection bias problem. However this approach is preferable to experimental studies since gold and silver are at stake.[1]

Several structural factors affect the performance of a national team. On the demand side, sport is a normal good. One may even venture to conjecture that it is a superior good. The higher the income, the greater the demand for sports, both as a way of keeping

[1] Dr. Siegel demonstrated that gold could do wonders in a classic experimental study on sympathy. See Stigler (1984).

fit and as a form of entertainment. For spectator sports, a large market (in value terms) is especially important since its production involves increasing returns (Rosen 1981). These considerations suggest that countries with high income are likely to perform better in the Olympics, with an elasticity that may exceed unity.

On the supply side, income is again an important factor. Physical prowess depends on nutrition, and nutrition is a function of income. Another factor on the supply side is the size of the population. Since athletes are chosen from national tournaments to represent their countries, and since the expected values of rank order statistics are non-decreasing functions of sample size, an athlete chosen from a large country to is expected to swim faster or jump higher than one from a small country.

While economists are not used to thinking about competition in terms of rivalry, competition *is* rivalry in sports. People often view excellence in competitive sports as a source of national pride. Since winning the running race is easier than winning the standard of living race, communist governments seem to have a greater derived demand for sports as propaganda than other governments. Moreover communism seems to have a comparative advantage in producing athletes (relative to producing, say, pop singers) than other forms of economic organization such as the market. In the production of commodities, Lindsay (1976) suggests that government enterprises tend to overproduce attributes that are easily measurable and underproduce attributes that are less easy to measure. Performance in sports is usually defined in a limited number of dimensions such as time and distance with definite criteria of winning, whereas success in pop songs, say, is much more elusive absent the market test. The state-directed production of athletes in communist countries then explains their superior performance in the Olympic Games.

Measuring performance in the Olympic Games is as problematic as measuring performance in an industry. Fortunately recent advances in game theory offer some guidance. Using the Intuitive Criterion (Cho and Kreps 1987), I define the total number of medals won by a team as the dependent variable.[2] On second thought, however, my intuition

[2] The perfectness concept of equilibrium is ruled out because too few gymnasts and divers scored the perfect ten. The trembling hand concept does not seem to be quite appropriate either especially for combative sports or relay races. The reader, however, is invited to apply the Divine Equilibrium

suggests awarding different weights to gold (3), silver (2) and bronze (1) medals. Both performance measures will be used in the subsequent analysis.

## II. Data

The most convenient source of internationally comparable income statistics is the Penn World Table (Mark 5). Since the dataset contains only four observations on planned economies, it is augmented by the unpublished (and lower-quality) data in Appendix B of Summers and Heston's (1991) paper. I used the variables POP and RGDP in 1988 to measure population (in hundred millions) and per capita real income (in ten thousand dollars). For a number of countries, only the figures in 1985 are available. These figures are then updated by applying the world average rates of population and income growth between 1985 and 1988. Since the production of world class athletes is a very time-consuming process, not having the most up-to-date numbers on population and income is unlikely to be an important problem.

The list of teams in the 1992 Barcelona Olympics is matched to the list of countries in the Summers and Heston dataset. The breakup of the Soviet Union and of Yugoslavia necessitates some adjustments to the data. Based on the population and income shares of the former Soviet republics (Economist Intelligence Unit 1992), I apportioned the population and income figures of the former Soviet Union to the Unified Team and to the three Baltic teams. Similar calculations using White (1990) give an estimate of the population and per capita income for the three break-away Yugoslav republics: Slovenia, Croatia and Bosnia-Hercegovina. Finally I also merged the relevant population and income figures in the Summers and Heston dataset to reflect political unification in Germany and in Yemen. After these adjustments the total number of observations used in the analysis is 149.

Political upheavals in Europe leave very few communist countries in the world. However most of the athletes in former communist countries were trained under a regime quite different from that of market economies. To analyze the effect of different forms of

---

solution to capture the divine moments of Olympic triumph.

organizing the production of athletes, I assign the variable COMMY (for COMmunist dumMY) a value of 1 to countries that were designated planned economies in 1988 according to the Summers and Heston classification. One problem remains: the German and the Yemen teams were formed by the merger of communist and market economies. For these two countries I take the unusual step of assigning a value of .5 to the COMMY variable. The reader can be assured that none of the results in the subsequent analysis are materially affected by such a choice.

Game theory predicts that the structure of information is a crucial determinant of the outcome of a game. The empirical measurement of information in asymmetric information games still awaits more diligent researchers. Thus I simply assume the Olympics is a symmetric information game. With this assumption, I can assign each team an equal value of 1 to the variable INFORMATION.[3] This variable can alternatively be called INTERCEPT.

Information on the medals won by various teams was obtained from the *International Herald Tribune* (August 10, 1992). Two measures of performance are used in the analysis: MEDAL (total number of medals) and MEDAL2 (weighted number of medals). It turns out that the simple correlation coefficient between the two variables is .998. The two measures of performance give coefficient estimates that are identical for all practical purposes. To save paper only the regressions using MEDAL as the dependent variable are reported.

**III. Results**

A simple least squares fit to the data yields the following regression equation:

$$\begin{array}{llllll} \text{MEDAL} = & -3.10 & + \; 5.43 & \text{POP} + 11.08 & \text{RGDP} + \; 9.28 & \text{COMMY.} \\ & (-1.87) & (5.67) & (4.66) & & (2.94) \end{array}$$

The numbers in parenthesis are $t$-statistics. The standard error of estimate is 13.31. Variations in independent variables account for 32 percent of the variation in the total number of medals won. This $R^2$ value compares favorably with most inter-industry

[3] As a testimony to the importance of information structure in the study of games, note that all coefficient estimates will be biased if the INFORMATION variable were not included in the regressions.

studies of profitability differences (e.g., Schmalensee 1985). Clearly economic forces influence performance in the Olympic Games.[4]

Lest the referee cries foul at the simple-minded OLS regression, Table 1 shows the estimation results of a number of other specifications. Column (1) gives the Tobit estimates of the data.[5] As expected, the estimated coefficients are larger than their OLS counterparts. Column (2) of Table 1 shows the Tobit estimates after controlling for continental dummy variables. These continental dummies are individually and jointly insignificant at the 5 percent level, while POP, RGDP, and COMMY remain highly significant. Column (3) uses the logarithms of POP and RGDP as independent variables. This specification gives a better fit—the squared correlation between the observed and the predicted value of the dependent variable is .68—but the basic pattern is the same. The Tobit specification also allows me to calculate the elasticities of the expected number of medals with respect to the independent variables. Using the logarithmic specification, the elasticities are 1.17 for the population variable and 1.66 for the income variable. Thus there are increasing returns to scale in the production of Olympic medalists. In the last column (4) of Table 1, the Tobit regression was estimated using the number of medals per capita as the dependent variable. Except for the increased noise, the results are not materially affected. Large countries win proportionately more medals than small countries. As is common in game-theoretic models, this model makes bold predictions about imaginary cases. For example the model predicts that rich communist countries—assuming they exist—will win more medals than poor capitalist countries.

## IV. Confession

After digesting the impressive Tobit estimates, the reader may wonder what he has learnt from this exercise. After all, the author did have some casual familiarity with the Olympic results before constructing his model. Aren't the regressions just a for-

[4] The negative coefficient on INFORMATION suggests that better information results in poorer performance—not an uncommon result predicted by game theory. See also Gal-Or (1988) and Whittemore (1975).

[5] These alternative specifications do not address the question of reverse causality. See the vast literature distributed by sports centers and health clubs on the possibility that sports may promote population growth.

malization of what everybody knows? Shouldn't the model be tested on data that are independent of the initial set of observations that motivated the model? These are legitimate criticisms, and they pertain equally forcefully to the empirical as well as theoretical study of games. Tradition, however, dictates that I close the paper with a call for further games to be played.

**References**


Cho, I.K., and D.M. Kreps. "Signalling Games and Stable Equilibria." *Quarterly Journal of Economics 102* (1987): 179–221.

Economist Intelligence Unit. *Country Report: Commonwealth of Independent States*, No. 1, 1992. London: Business International Limited, 1992.

Fisher, F.M. "Games Economists Play: A Noncooperative View." *Rand Journal of Economics 20* (Spring 1989): 113–124.

Gal-Or, E. "The Advantages of Imprecise Information." *Rand Journal of Economics 19* (Summer 1988): 266–275.

Keller Joseph B. "A Theory of Competitve Runnig." *Physics Tody 26* (September 1973): 42–47.

Lindsay, Cotton M. "A Theory of Government Enterprise." *Journal of Political Economy 84* (October 1976): 1061–1077.

Meschler, P.A. "On a Goal-Keeping Differential Game." *IEEE Transactions on Automatic Control AC-12* (1967): 15–21.

Rosen, Sherwin. "The Economics of Superstars." *American Economic Review 71* (December 1981): 845–858.

Schmalensee, Richard. "Do Markets Differ Much?" *American Economic Review 75* (June 1985): 341–351.

Stigler, George. "Stigler's First Law of Sympathy." In *The Intellectual and the Marketplace,* enlarged edition. Cambridge: Harvard University Press, 1984.

Summers, Robert, and Alan Heston. "The Penn World Table (Mark 5): An Expanded Set of International Comparisons, 1950–1988." *Quarterly Journal of Economics 106* (May 1991): 327–368.

White, Stephen, ed. *Political and Economic Encyclopaedia of the Soviet Union and Eastern Europe*. Chicago: St. James Press, 1990.

Whittemore, L.H. *Peroff: The Man Who Knew Too Much.* New York: Morrow, 1975.

**Table 1**

Tobit Estimates of Olympic Medals Result

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| INTERCEPT | −27.75 | −24.86 | 31.86 | 66.58 |
| | (−7.40) | (−2.32) | (6.79) | (2.96) |
| POP | 7.71 | 8.52 | - | - |
| | (4.54) | (4.87) | | |
| log(POP) | - | - | 11.08 | 18.20 |
| | | | (7.89) | (3.02) |
| RGDP | 25.84 | 20.37 | - | - |
| | (5.55) | (3.72) | | |
| log(RGDP) | - | - | 15.68 | 67.37 |
| | | | (6.75) | (5.73) |
| COMMY | 19.86 | 14.65 | 20.53 | 89.10 |
| | (3.53) | (2.45) | (4.32) | (3.20) |
| AFRICA | - | −4.23 | - | - |
| | | (−.37) | | |
| AMERICAS | - | 3.77 | - | - |
| | | (.34) | | |
| ASIA | - | −7.22 | - | - |
| | | (−.64) | | |
| EUROPE | - | 10.13 | - | - |
| | | (.91) | | |
| log likelihood | −307 | −302 | −274 | −396 |
| standard error of estimate | 21.6 | 20.9 | 17.0 | 104.5 |
| squared correlation between observed and expected values | .32 | .39 | .68 | .15 |

Note: asymptotic $t$-statistics in parentheses