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Comparing Tennis Success Among Countries

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Abstract

Elite sport is 'citius, altius, fortius' by definition. In tennis, as in most sports, effective sports policy is now more important than ever. This article analyses the notion of 'success in tennis' and international comparison. We discuss how the existing ATP- and WTP-rankings can be used to generate indicators of absolute success. We identify major determinants of tennis success and present a method that allows identification of successful countries while controlling for the impact of socio-economic determinants. Tennis is taken as a case study in order to propose a method for determining relative success of countries. This method allows us to place countries in more equal positions when they are compared.

Introduction

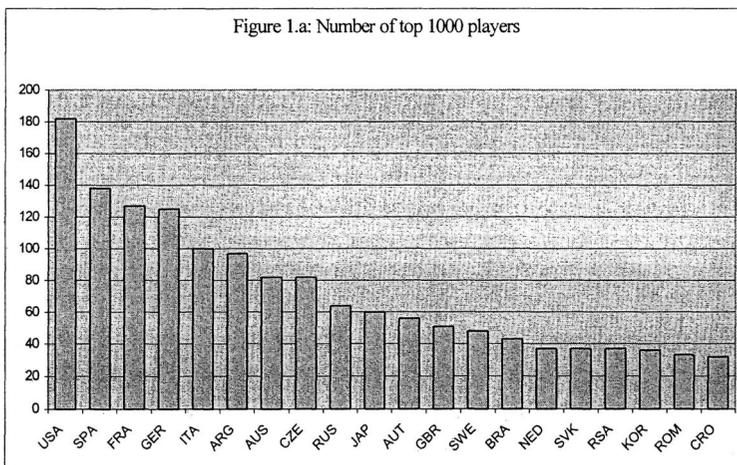
Over the last century, sports have become ever more competitive. At the same time, increased (media) attention and popularity of major sports events have given sports the status of an issue of 'national importance'. In this process of systematically trying to outperform competitors, governments play a crucial role. An efficient and effective sports policy has become more important than ever. Politics and a lack of effective sports policies are often blamed for inferior achievements in sport. Still, it is not unambiguously clear what the nature of efficient sports policies is. Even more, it is not even clear how to distinguish successful from unsuccessful countries in a given discipline or in sports in general. A first aim of this paper is to do just that. Using tennis as a case study, we demonstrate how different parameters for a country's success can be built. Typically, success is expressed in *absolute* terms. The number of medals in Olympic Games, the number of top 20 players in tennis and so on provide an indication of a country's success. Still, it goes without saying that such comparisons are biased by structural differences in the countries' socio-economic situation. It does not come as a surprise if one observes that a large and rich country such as the USA wins more medals in the Olympics than smaller or poorer countries like Zimbabwe or Ecuador. As such, indicators of absolute success carry little information on how successful or efficient countries 'really' are in allocating their (often scarce) resources. Such information can only be given through indicators of *relative* success. We offer a method to measure *relative* success of countries by making abstraction of the macro-economic determinants. As such, countries are put into *comparable* positions with regard to top-level performance in sports. By controlling for exogenous influences on success, the methodology allows identifying successful countries and effective sports policies. This identification is a second aim of our work. While our focus is on tennis, the method proposed has a much wider applicability. Tennis was

selected as a case study to determine the importance of an efficient and effective sports policy for international success. Tennis is an interesting sport to compare international performances, because of the ranking system of players that allows an objective system to measure success of countries. Furthermore tennis is a popular sport, played and developed in many countries (van Bottenburg, 1994).

In the first section we discuss the measurement of *absolute* success in tennis. Different indicators based on the individual ranking of players are considered. Having observed important differences in how successful countries are, in section two we discuss the potential underlying determinants of these differences. Insight into these determinants allows us to build *relative* indicators of tennis success, which is discussed in section three. By controlling for the influence of socio-economic differences between countries we are able to identify the 'really' successful countries.

The Absolute Success of Countries in Tennis

In order to compare international success of countries it should be clear what is meant by 'success'. This is not self-evident. To construct indicators for countries' successes in tennis the logical place to look is at the existing indicators for successes of individual players. Such indicators exist formally: the Association of Tennis Professionals (ATP) and Women's Tennis Association (WTA) rankings. To measure national success, one should then 'just' aggregate these rankings over countries. This is not, however, a trivial exercise. One may argue that the fact that in women's tennis five out of ten players are from the USA, should be taken to suggest that this country is successful. Still, an alternative view may be that one has to consider not only top ten players, but rather top 100 or top 1000. All these indicators capture 'some' notion of 'success'. Figure 1a illustrates countries' absolute success in tennis. Success is here defined as the number of top 1000 players (male and female) at 8 October 2001. Figure 1b gives similar information, but only considers the top 100 players.



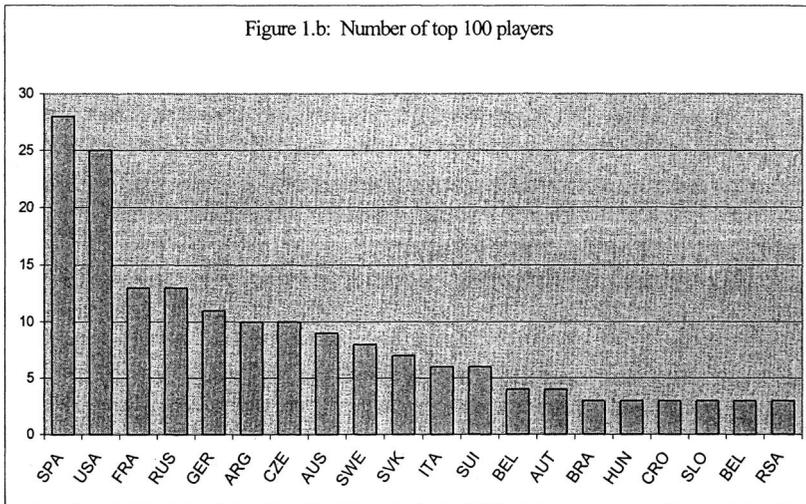


Figure 1a (unsurprisingly) identifies the USA as the most successful country with 182 players being represented in the top 1000 of the ATP or WTP rankings. While 82 countries have one or more players in the top 1000, Figure 1a suggests that success is indeed concentrated in a limited number of countries. Five countries (Spain, France, Germany, USA) have together no less than 672 players out of the 2000 players considered.

Figure 1b gives a slightly different picture, however. When considering only top 100 players, it appears that the USA is no longer the most successful country. Indeed, Spain has more top 100 players than the USA (28 versus 25). Also other 'reversals' take place between Figures 1a and 1b: for example, Russia ranks ninth when top 1000 players are considered while it ranks fourth when we restrict ourselves to top 100. On the other hand, Italy scores better under the top 1000 (5th) than under the top 100 (11th). While, of course, the 'general' picture remains the same, these differences suggest that what is measured by these success-indicators is different. From a policy perspective, these differences may be highly relevant. For example, it may be the case that the top 1000 indicator primarily gives information on the available resources to send players to international competitions, on the extent of selection criteria and on the popularity of the sport. At the same time, the top 100 indicator may be a better parameter for measuring efficiency and effectiveness of sports policy as an instrument to 'make' international successes at the highest level. Therefore both types of parameter will be used and compared in this study.

Of course, the information in Figures 1a and 1b is, to say the least, rudimentary. It is built on a number of implicit assumptions that need not be compatible with the very notion of tennis success for which one aims. For example, by just counting the number of players (and, thus, giving each player equal weight) one introduces a very specific, though implicit,

interpretation of the notion of 'success'. The very notion of individual success based on WTA or ATP rankings implies that a higher ranking reflects more success for the individual tennis player. As such, it makes sense to take this ranking into account when measuring countries' successes. The issue is, of course, not unique to tennis. The literature on sporting success has concentrated mainly on the Olympic successes of countries. Here, typically the total number of medals is counted, and weighting systems are often used (for example, a gold medal = 3 points, silver = 2 points and bronze = 1 point). Different authors have, however, shown that there is a high correlation between a weighting system for medals and total medal counts (den Butter & van der Tak, 1995; Hoffmann, 2001; Levine, 1974; Novikov en Maximenko, 1972; van Bottenburg, 2000). Studies of the Olympic Games have a limitation because only the absolute top is regarded as successful. Only the best three of a competition are winners. The others are often forgotten. Some studies use the first six or eight places (Kiviahho & Mäkelä, 1978; Condon et al., 1999; Stamm & Lamprecht, 2001).

Availability of official rankings in tennis provides a very detailed source of information to make international comparisons. By their very nature, the existing rankings allow a weighing of the individual successes. Several aggregation methods are possible. A straightforward choice is to add, by country, the scores of individual players in the top 1000 singles ranking system of the WTA and ATP. The country of the first ranked player gets 1000 points, for the second ranked player: 999 points and so on up to player 1000 with one point. Using this method to rank countries (data for rankings of 8 October 2001) are in Table 1, last column. The first columns in Table 1 give similar data, but only take the top 100 players into account.

In both rankings in Table 1, the USA is identified as the most successful country, followed by Spain and France. The order of countries in Table 1 is very much in line with the corresponding orders in Figures 1a and 1b where just the number of players is counted. Again, we observe some notable changes between the top 100 and the top 1000 indicators. These are also very much in line with what we found on the number of players (note the positions discussed earlier of Russia and Italy). Belgium ranks 12th under the AS-100 indicator while not being successful under AS-1000 (ranked 52). Japan shows the opposite of the Belgian situation. Japan is ranked 11th under AS-1000 while not being among the top-20 countries under AS-100. These changes again illustrate the intrinsic difference in the nature of the success that is measured.

Table 1: 20 Absolute Success (AS) best performing countries in tennis, for top 100 (AS-100) and top 1000 (AS-1000)

Country	AS-100	Country	AS-1000
1. United States	1483	1. United States	97554
2. Spain	1396	2. Spain	74220
3. France	852	3. France	70782
4. Russia	781	4. Germany	62623
5. Germany	527	5. Italy	51392
6. Argentina	475	6. Czech	48861
7. Australia	455	7. Argentina	46799
8. Sweden	415	8. Australia	41476
9. Czech	399	9. Russia	37242
10. Italy	281	10. Austria	27560
11. Switzerland	278	11. Japan	25396
12. Belgium	263	12. Great-Britain	24692
13. Slovakia	261	13. Sweden	24394
14. South-Africa	211	14. Slovakia	22316
15. Croatia	205	15. Netherlands	20796
16. Great Britain	182	16. Brazil	18712
17. Brazil	142	17. South-Africa	18004
18. Morocco	133	18. Croatia	16631
19. Austria	125	19. Romania	16003
20. Belarus	102	20. Switzerland	15781

Factors Determining Success in Tennis

Performances in top-level tennis, as in top-level sports in general, are a combination of genetic qualities and the environmental and physical circumstances in which people live. Genetic qualities between people can explain differences between men and women, between young and old people, and between tall and small people. They cannot, however, explain why Norwegians are more active skiers (Seppänen, 1981). As such, non-genetic factors can explain differences in sports successes within a set of countries. Importantly, there is a view that such factors gain importance:

Originally talent was a sufficient condition to be successful in international sporting competitions. A simple comparison of the performances of individual athletes was a reasonably precise measure of success. Today a variety of economic, political and social conditions influence the level of athletic achievement reached (Colwell, 1982: 101).

The factors determining top-level success can be classified into three levels:

- 1) *Micro-level*: the individual athletes (genetic qualities) and their close environment (parents, friends, coach).
- 2) *Meso-level*: sports policies and politics. This is the level where well-considered sports policies may influence long-term performance.
- 3) *Macro-level*: the social and cultural context people live in: economic welfare, population, geographic and climatic circumstances.

In this study, national successes of countries are compared and not individual successes of athletes. Therefore, this study is situated on the *macro*- and *meso*-levels. Nevertheless, these three levels will undeniable interact and no factor can be totally isolated from its social context.

While our prime interest is success in tennis, an exploration of possible determinants of this success in the literature involves looking at sporting success in more general terms. Indeed, to our knowledge, literature trying to disentangle macro- and meso-determinants of tennis success is lacking. Still, such literature on other sports – notably on the Olympic Games – can be a useful starting point for our own analysis. In what follows, we discuss what macro- and meso-determinants have been identified in the literature and – where possible – relate these to the specific context of tennis.

Macro Level

During the 1970s factors determining Olympic success were discussed in many studies and these have begun to be re-explored. Predictions of Olympic performance were made based on factors mainly falling within the macro-level. The underlying assumption of these studies is that there is an equal

distribution of talent throughout the world. Every country has equal opportunities to produce good athletes (Levine, 1974; Grimes et al., 1974; Kiviaho et al., 1978). Excluding this factor of talent distribution, many studies point out a connection between two independent macro-economic variables: the gross national product of a country and its population (Jokl, 1964; Johnson & Ayfer, 2002; Novikov & Maximenko, 1972; Levine, 1974; Kiviaho & Mäkelä, 1978; Bernard & Busse, 2000; van Bottenburg, 2000). Daniel Johnson and Ayfer Ali (2002) come to the conclusion that these factors not only determine Olympic success, but also participation in the Olympics and that international success is to a large extent determined by participation. Less consensus exists on the influence of other factors such as the area, the political system, the religion or the degree of urbanization, etc. In a recent example of this literature Maarten van Bottenburg (2000) shows that 63 per cent of the medals won during Olympic Games is 'determined' by four macro-economic factors: GDP, population, area and degree of urbanization. This means that 'at least' 37 per cent of sports performance is determined by other factors, situated at micro- or meso-level. 'At least', because there is an undeniable interaction between these factors. GNP by itself determines fifty per cent of the performances. All these determinants of Olympic success are potential determinants of success in tennis. We discuss each of the main determinants in turn.

Population Size

Population size is an obvious potential determinant of success in tennis. The larger the population, the larger the pool for detection of talent and the more possibilities to organize training and competition. The latter argument, that population size affects training quality, relates to the observation that sports often are 'joint products'. The success of an individual is based on his or her intrinsic qualities. But developing these qualities is facilitated if the athlete can train together with highly talented partners. It is a mere statistical fact that such partners will be easier to find if the population is larger. The argument is especially valid at the beginning of players' careers. Then, it is fair to say that the quality of training partners (as well as the quality of the local competitions) can be expected to be higher, as the pool of potential players is larger.

Economic Welfare

Economic welfare may explain absolute tennis success for several reasons. First, playing tennis is only possible if the individual has the means to at least buy a racket and pay membership dues to the local tennis club. As such, economic welfare is an indirect determinant of participation. The pool of tennis players is likely to be larger in countries where tennis is 'affordable'. Second, economic welfare is likely to have an effect over and above the effect at the individual level. Wealthier countries have more possibilities to invest in sports facilities, talent development systems and other forms of infrastructure.

Degree of Urbanization

The influence of degree of urbanization is connected with the fact that sports are typically an urban activity (Adelman, 1986; van Bottenburg, 1994). There are more facilities and better accessibility for elite athletes. The 'joint product' argument already given is, of course, related. Indeed, possibilities to organize higher quality training and competition with a given population increase if the area and thus travel distances are smaller. The area can be important to certain sports for a second reason. Indeed, some sports require specific geographic circumstances. Large countries have larger climatologic and geographic diversities and thus more physical advantages in practicing certain sports.

Political Systems

The influence of political systems on international success shows that there is a very thin or even not existing borderline between the macro- and the meso-level. Former state socialist countries were successful at the Olympic Games. Still, Robert Hoffman, Lee Chew Ging and Bala Ramasamy (2000) show that it is not the political system as such that explains the difference. Former socialist countries have been more successful, not because of their communist regime, but because this regime promoted large investments in sports in order to obtain international prestige.

Religion

Some studies found the religion of countries as a predictor for international success. Günther Lüschen (1972) found that protestant countries have won more than half of all the Olympic medals, while only eight per cent of the world population is Protestant. Gillis (1980) confirmed this and also found that Muslim countries were less successful than Catholic and Protestant countries. Interesting in this study is the explanation for this phenomenon by the achievement-oriented values that are typical of a protestant education. The values that contribute to sport achievement are communicated through the religious institution and appear to be reflected in sport performance. In particular, striving for excellence, discipline and systematic training are encouraged in the Protestant ethic and contribute to the sport success.

Cultural and Social Values

Furthermore, there are the culture and social values of countries, which are undoubtedly important factors for success. We can distinguish effects of general culture and elite sports culture. In contrast to the aforementioned factors, the culture of countries cannot easily be measured or quantitatively expressed. This is one of the basic reasons of problems associated with comparative research. It is clear that the national sports system generally reflects the overall social philosophy of the country under study. In this connection, it is reasonable to assume that a uniform pattern does not exist (Semotiuk, 1981). Whatever pattern exists, one can conclude that the system of sports is a product of the society in which it is found. Therefore, it is

difficult, not to say impossible, to explain international success by differences in culture. They cannot directly be observed. But they need to be described, analysed and taken into account in every cross-cultural study.

Meso Level

Although certain socio-economic circumstances of a country can have a positive influence on its sporting success, such circumstances are not a sufficient condition for that success. Economic conditions provide a necessary basis for sports activity but they do not give any guarantee for how these conditions are used for advancing sports. On an individual level this becomes even more obvious. The richest man is hardly the best in sport, even when only the richest man has sufficient conditions for effective physical activity (Seppänen, 1981). Indeed, while being able to buy a racket may be a prerequisite for becoming a top tennis player, it is certainly not a sufficient condition.

There are few literary references to the efficiency and effectiveness of sports policies and sport investments. This is probably due to the difficulty in measuring these effects. National sports organizations worldwide spend large sums of money in the quest for superior sport performance. Although little is known on the reason why some nations excel in some specific sporting events, administrators and researchers have sought to identify the winning factors for decades (Larose & Haggerty, 1996). Notwithstanding the fact that no one doubts the importance of good sports policies, knowledge on the impact of governmental or private investment in sports is minimal. Out of all the above-mentioned factors determining success, those on the meso-level are the only that can actively be influenced. This makes it particularly interesting to examine the effects of elite sports policies.

According to responsible experts of elite sport divisions in 21 countries' national tennis federations, the five most important factors on the meso-level for international success in tennis were (De Bosscher, 2002):

- Professionalism of the federation.
- Structural aspects: the cooperation of the federation with regional departments and clubs.
- The coaches education system.
- Training facilities for elite tennis.
- Total budget of the federation and budget for elite sport, which influences support for athletes, talent development system.

Given the complexity of the problem of identifying factors that affect international success and the lack of data analysis methods, the most suitable method is to analyse the processes particular to good and poorly

performing countries. The only way to demonstrate that a given phenomenon causes another is to compare the cases in which they are simultaneously present or absent, to see if the variations they present in these different combinations of circumstances indicate that one depends on the other (Arts & Halman, 1999). According to Pooley (1988) three fundamental questions are associated with comparative research:

1. How are two or more phenomena similar or different?
2. Under what conditions are they similar or different?
3. Why are they similar or different?

The method presented in this study tries to eliminate some of the differences between countries on the macro-level, which are of major significance in comparing international success. We could refer to the metaphor stated by Geert Hofstede (1998) that every comparison between values and norms between countries is in one way a comparison between apples and oranges. It is important to find a common language for those factors that can be compared:

Popular wisdom deems that one cannot compare apples with oranges. But what do we mean by 'compare'? Scientifically speaking, apples and oranges come under the general category of 'fruits' and can be compared on many criteria, such as availability, price, color, vitamin content or keeping quality. Comparing apples with oranges, cross-cultural psychologist Harry Triandis once said, is okay as long as we possess a fruitology, a theory of fruits (Hofstede, 1998: 16).

Relative Success in Tennis

According to Levine (1974), one can conceive of two broad approaches for looking at the question of effectiveness of sport systems. The first examines differences between nations, so as to isolate national characteristics of Olympic success, while the second examines specific countries in order to understand mechanisms of sport structure and how these interact with particular groups. The former macro-perspective isolates generalities across nations, while the latter looks at specific processes of sport development. The method in this article, focuses on the first approach. To examine the effect of sports policy on national sporting success, external factors should be eliminated as much as possible. As seen in the previous section, many studies have explained Olympic success through macro-economic determinants. These studies can be used to explain differences between countries. The same method can be used in tennis. This allows us to construct indicators for relative success, that is success-indicators that control for exogenous macro-influences. Formally, the method corresponds to an analysis of regression residuals in an OLS (ordinary least squares) model.

The residuals – the unexplained variation – are taken to be an indicator of this relative success, and as such are considered a more efficient measure for sports successes. The higher efficiency results from the fact that the method boils down to controlling for the systematic influences of macro-determinants. We proceed as follows: we discuss briefly the basic estimation equation and analysis of residuals followed by a summary of exploratory data analysis that focuses on simple correlation between the dependent variable - absolute tennis success – and the respective explanatory variables from the model. Finally, we give estimation results as well as the implied indicator for relative tennis success before concluding with a brief discussion.

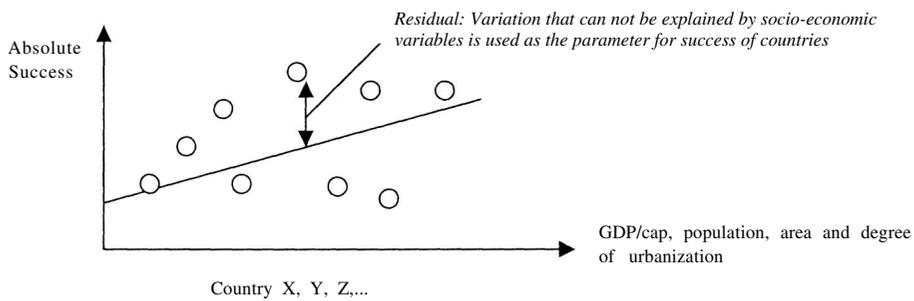
Estimation Equation and Analysis of Residuals

The starting point for our empirical work is a simple OLS estimation of a reduced form model that captures the main macro-determinants of *absolute* tennis success. Given the discussion above on the different underlying notions of success, we operate with two dependent variables in parallel. To be more precise, we estimate the regressions using AS-1000 and AS-100 (as defined in table 1) successively as dependent variables. The basic estimation equation for AS-1000 is:

$$\text{AS-1000} = \beta_0 + \beta_1 \text{POP} + \beta_2 \text{GDPCAP} + \beta_3 \text{AREA} + \beta_4 \text{URB} + \beta_5 \text{RELI} + \beta_6 \text{GOV} + \varepsilon$$

Where AS-1000 is the absolute tennis success of country i (indices are left out for convenience), measured as the sum of all the country's players points in the ATP- and WTP-rankings. POP is population size, GDPCAP is per capita GDP, AREA is the country's area, and URB is the degree of urbanization of a country. RELI and GOV are vectors. RELI is a three element-vector with the percentage of the population that is Muslim, Catholic and Protestant respectively. GOV indicates the political system. It takes the value 1 to 6 depending on whether the country is a republic (parliamentary and democratic), (parliamentary) democracy, communism, federation, monarchy (constitutional and traditional) and others. Otherwise, the vector elements take the value 0. β_0 to β_6 are the coefficients to be estimated and, finally, ε is the regression residual (see Figure 3).² The latter residual - the variation in AS-1000 *not* explained by our model - is further used as an indicator of relative tennis success. Larger positive values for this residual indicates that the country under consideration has a value for AS-1000 (or AS-100) that is higher than could be expected on its population size, per capita GDP, and soon.

Figure 3: regression analysis to determine relative success of countries



Our sample consists of countries that had at least one top 1000 tennis player in either the ATP or WTP rankings. Two countries – China and India – have been removed from the list of countries as outliers (due to their extremely high population). A final observation on the estimation equation is that this is in line with a standard specification on all dimensions but one. Indeed, many authors have preferred to use GDP instead of per capita GDP as an indicator of wealth (De Butter & van der Tak, 1995; Levine, 1974; Seppänen, 1981; van Bottenburg, 2000). Still, we did not follow this route as it would imply that wealth-effects (in our model captured by GDPCAP) and scale-effects (in our model captured by POP) are actually amalgamated. Given that wealth and size are expected to have distinct influences on tennis success, including both separately seemed the logical thing to do.

Simple Correlations

As a first step, we calculate correlation coefficients (spearman's rho) between the AS-1000 (AS-100) and the respective explanatory variables in the estimation equation. Table 2 summarises the results. The table below gives an overview of the socio-economic factors that correlate with international success in tennis.

Table 2: Correlation between socio-economic determinants of countries and international success in tennis

Spearman's rho		GDP CAP	AREA	URB	MUSL	CATH.	PROT.	GOV.
Top 100 of players Absolute success	Correlation Coefficient	,357**	,348**	,212	,199	-,005	,145	,245*
	Sig. (2-tailed)	,001	,001	,055	,074	,966	,193	,027
	N	82	82	82	82	82	82	82
Top 1000 of players Absolute success	Correlation Coefficient	,438**	,404**	,247*	,247*	-,167	,167	,317**
	Sig. (2-tailed)	,000	,000	,025	,025	,134	,133	,004
	N	82	82	82	82	82	82	82

** Correlation is significant at the.01 level (2-tailed), * Correlation is significant at the.05 level (2-tailed)
 pop = population; urb. = urbanization; mosl. = Muslim; Cath. = Catholic-roman; gov. = government type

There are some small differences in the correlation between the top 1000 and top 100 in tennis. Top 1000 in tennis is strongly correlated to five socio-economic factors of population, wealth, area and urbanization and Protestantism. Four factors agree with van Bottenburg's study (2000). Success in tennis is also correlated with countries with a high protestant population, as was also found in earlier studies on the Olympics (Gillis, 1982; Lüschen, 1980; Seppänen, 1981). The top 100 in tennis is only correlated to wealth, population and Protestantism. Of note is also that the correlation with population and GDP/cap are lower for AS-100 than AS-1000.

Multivariate Estimation and Analysis of Residuals

A step-by-step regression analysis is used to explore a causal relation between the dependent and independent variables (Ottoy, Van Vooren & Hughe, 1993), however, 'causal' should always be carefully interpreted when no experiment is done. 'Association' is a more precise term (De Pelsmacker & Van Kenhove, 1999). The regression analysis gives information to what extent absolute success is explained by macro (economic) determinants. Although some determinants did not positively correlate, all will be used, as some factors might reinforce each other.

Table 3: Regression analysis: explaining variance for international success in tennis (top 1000 and 100)

Dependent variable	Independent variables	t-value	Level of significance	Adjusted R square	Std. Error of the estimate
AS-1000	Population	4.76	.000	0.21	16843
	Population	5.02	.000	0.36	15117
	GDP/cap	4.51	.000		
	Population	5.6	.000	0.39	14840
	GDP/cap	3.73	.000		
Muslim	-2.47	.016			
AS-100	Population	4.62	.000	0.20	240
	Population	4.71	.000	0.30	224
	GDP/cap	3.49	.001		
	Population	2.74	.008	0.33	219
	GDP/cap	3.40	.001		
Area	2.24	.029			

Table 3 shows that 21 per cent of the variation in absolute tennis success (AS-1000) can be attributed to the differences in population size. Wealth (per capita GDP) and population together explain 36 per cent. Similar results are obtained when explaining the AS-100. This allows us to conclude that population size and wealth are the main determinants of tennis success. The larger pool of talent and the availability of financial resources to develop this are clearly crucial determinants of success. While the main message from Table 3 is similar for AS-100 and AS-1000, there are some notable differences too. First of all, it should be noted that the model performs marginally better for AS-1000. This is likely to be attributed to the larger variation in the dependent variable. Second, and more fundamental, we find that religion has an impact on AS-1000 while being insignificant in the AS-100 regression and while the opposite is true for AREA.

The influence of countries with a high percentage of Muslims on AS-1000 tennis success is unexpected, as there was no significant correlation. We find a larger share of Muslims to have a negative effect on tennis success. Our finding that countries with a high percentage of Muslim inhabitants have a disadvantage in tennis may be explained by the lower sporting opportunities for Muslim women (Sfeir, 1985). Still, looking at the partial correlation for male and female tennis success does not seem to support this hypothesis. Indeed, looking at data for men only, we find a significant correlation between success and the presence of Muslim population ($r = -0.244$, $\sigma = 0.03$). For women's tennis, however, no significant correlation is observed ($r = -0.14$, $\sigma = 0.911$). This suggests that the explanation for the lower tennis success in Muslim countries is not merely a gender issue.

For the top 100, AREA is significant. Larger countries (in size) appear to be more successful. There is no straightforward explanation for this (we would have rather expected a negative sign as this would suggest that travel distances increase the cost of tennis education). A tentative explanation for the effect of AREA could be that area is a proxy for the climatologic heterogeneity of the country. Large countries are more likely to offer the possibility to play outdoor tennis. But, again, such an explanation is most tentative and demands further exploration.

As mentioned, a number of preceding studies used similar methods while focusing on Olympic successes. It is of note that the total explained variation in these models has been generally higher than what we find for tennis. This suggests that socio-economic determinants are more important for countries to achieve international success during the Olympic Games than for tennis. To the extent that Olympic results can be seen as an indicator of success in 'average sports', this implies that socio-economic determinants in tennis are less important than 'average'. It follows that the influence of other factors, such as those related to sports policy, are higher for tennis. At the more detailed level, we observe that the role of population size is more important in tennis than in the Olympic Games. The table below gives the correlation between success in tennis and the Olympics.

Table 4: Correlation between international success in tennis (top 1000 and 100) and Olympic Games

Spearman's rho		Success in tennis Top 1000	Success in tennis Top 100
Olympic Games (Sydney 2000) Absolute success (Medals: gold=3 points; silver=2 points; bronze=1 point)	Correlation Coefficient	.563**	.452**
	Sig. (2-tailed)	.000	.000
	N	61	61

From this table we can see that success of countries during Olympic Games correlates well to success in tennis. A regression analysis serves two purposes. First, it identifies the determinants for international success on the macro-level. Second, the analysis of the residuals allows us to compare countries on a *ceteris paribus* basis so that we can define relative success of countries. A case-by-case analysis for every country gives an objective answer to the question: 'what are successful countries controlling for socio-economic circumstances?'. This is the definition of *relative success*.

Table 5 highlights the differences between absolute and relative success for tennis, given by the residual: $R(\text{esidual}) = A(\text{bsolute}) - P(\text{redicted})$. Countries with a positive residual perform better than their predicted value and are in our view, the objective criterion for a successful country. These predictions are made for a success score (see method step 1), but also for the number of players.³ As we have seen, the number of players correlates strongly with the score based on the ranking of players. The table presents the values of the twenty most successful countries by top 1000 and top 100.

It is apparent from the above table that controlling for socio-economic determinants gives a different image of tennis success. A clear, though not unexpected, result is that the USA is no longer the most successful nation in tennis. Still, it should be noted that the USA is successful as 'despite' its wealth and large population it still has a positive residual. Irrespective of whether we use information on top 1000 or only top 100, it is Spain that is the most successful country. This indicates that given its population size, wealth, and so on, this country generates the most success in tennis. Considering top 1000 data, France, the Czech Republic, Argentina and Germany make up the top five tennis countries. Most interesting is that, in contrast to what we observed in Table 1 when considering absolute success, the ranking of countries differs considerably depending on whether we take into account top 100 or top 1000 players. Indeed, although in general the correlation between top 1000 and top 100 is 0.824 ($\sigma = 0.000$) there are some remarkable changes for some particular countries. For example, whereas the USA is only seventh in the Top-1000 relative ranking, it classifies third in the top 100 relative ranking.

Table 5: Relative success: residuals from AS-1000 and AS-100 regressions (Residual R).⁵

Country	AS-1000	AS-1000 ranking	R	Country	AS-100 ³	AS-100 ranking	R
1. Spain	74220	(2)	56244	1. Spain	1396	(2)	1223
2. France	70782	(3)	44500	2. France	852	(3)	594
3. Czech (rep.)	48861	(6)	39910	3. United States	1483	0)	555
4. Argentina	46799	(7)	33259	4. Czech (rep.)	399	(9)	326
5. Germany	62623	(4)	33150	5. Argentina	475	(6)	292
6. Italy	51392	(5)	27225	6. Sweden	415	(8)	258
7. United States	97554	(1)	25075	7. Germany	527	(5)	245
8. Australia	41476	(8)	22932	8. Slovakia	261	(13)	219
9. Slovakia	22316	(14)	16297	9. Croatia	205	(15)	2023
10. Croatia	16631	(18)	14235	10. Russia	781	(4)	111
11. Yugoslavia	12706	(23)	11974	11. Yugoslavia	91	(22)	106
12. Romania	16003	(19)	10479	12. Morocco	133	(18)	98
13. Austria	27560	(10)	9505	13. South Africa	211	(14)	94
14. Russia	37242	(9)	9482	14. Australia	455	(7)	88
15. Sweden	24394	(13)	8562	15. Belgium	263	(12)	87
16. Bulgaria	10307	(26)	7028	16. Ecuador	77	(26)	79
17. South Africa	18004	(17)	6856	17. Switzerland	278	(11)	78
18. Uruguay	2958	(50)	4402	18. Bulgaria	85	(23)	72
19. Hungary	10966	(25)	3371	19. Belarus	102	(20)	71
20. Mauritius	356	(75)	3005	20. Uzbekistan	78	(25)	61

This supports the view that both indicators do indeed measure different things. A similar result is found for Belgium. Under the top-1000 approach, this country is classified as poorly performing. Under top-100, however,

Belgium performs very well (of course mainly thanks to its two top-20 female players at that time, Kim Clijsters and Justine Henin-Hardenne, who by 2003 were in the top four with both reaching number one). Also Belgium has 27 players in the top 1000 whereas a regression of the type discussed (now using the number of top-1000 players as a dependent variable) suggests that the country would have 36 top-1000 players if it performed 'average'. So, considering the top 1000 Belgium again performs rather poorly (negative residual). Under the more selective criterion of top-100 players, we observe that Belgium has four top 100 players, making it a successful country. Comparable results are found for Belarus, Ecuador and Switzerland. This example proves that different aspects are measured when top-1000 or top-100 in tennis is used. From a policy perspective this is most relevant. Indeed, it is clear that a policy aimed at having as many players as possible in the top 1000 of the world is not identical to a policy that maximizes success at the highest possible level. While not disregarding the fact that top 100 players follow the same route (from no ranking, over top-1000 ranking to top-100 ranking) it should be recognised that there are indeed fundamental differences between top-1000 and top-100 players. These differences are not purely athletic. Indeed, while tennis is an expensive sport to practice at professional level it is well known that large financial gains are the privilege of a small set of top players. Practicing tennis is hardly self-supporting for lower ranked candidates. The implication is that the top-1000, in contrast to top-100 rankings reflect to some extent the policy choices aimed at supporting tennis players in their financial struggle to 'survive'. But the top 100 may reflect more the efficiency of talent identification and development policies, structural coordination of the tennis associations and personal guidance of athletes.

Conclusions and Recommendations

Comparing countries in terms of their successes at the tennis courts is no straightforward exercise. Of course, the initial approach, which is to look at absolute success defined as the number of top players or the joint ranking points per country, can be used. Still, it is obvious that this gives biased results. To measure tennis success in terms of the *efficient* use of local tennis talent implies that countries are put in comparable positions. To do this, it is necessary to control for the socio-economic determinants of success. Following the literature on the Olympic Games, we have presented a regression analysis that estimates a simple model of determinants of tennis success. We find that population size and per capita GDP (as a measure of wealth) are the major explanatory variables. While this result is in line with the findings on the Olympic Games, we find that the role of population size is relatively more important for tennis success, when compared to the role of wealth. Further a role for a country's religion as well as its area was found. A crucial finding was that results differed depending on the scope of the success variables. To be more precise, we found clear evidence that top-1000 success and top-100 success are really different.

Using analysis of residuals, we identify successful countries in *relative* terms, that is: controlling for the main socio-economic determinants. We found that, whereas the USA is the most successful tennis nation in absolute terms that Spain and France perform better once we control for socio-economic differences. This method to determine relative success of countries will be used for further research on the influence of sports policy to enhance international success. The effects of sports policy will be seen as a part of the residual. Identification of 'efficient' countries allows us to investigate their sports policies in more detail.

The model for explaining international success could still be refined. A major route for further research is to better take into account cultural effects. Sports and its organization remain specific to the respective culture, revealed in different ways. Culture is the mirror image of the respective social, moral concepts and cultural patterns (Heinemann, 1998). Cultures can be described, sometimes compared, but social phenomena such as sports cannot be understood without clear comprehension of culture. As such, the present model and analysis offers a basic framework to investigate cultural issues in more detail.

NOTES:

1. This method is highly correlated to other methods that have been tried out:
 - using a weighting system for players ranked 1-100, 101-200, 201-400, 401-1000. In a first method, every category got respectively 8/5/3/1 points, in a second method the mean of the ranking points was used ($r > 0.9$).
 - making the sum of single and double rankings ($r > 0.9$).
 - As seen from the figures and table, there is a high correlation ($r > 0.9$) with the number of players in the top 1000 or 100, which implies that the number of players as such is a good parameter for international success in tennis.
2. The regression line is the best fitting line through a typographical point system (Ottoy, Van Vooren, Hughe, 1993).
3. Results available from the authors upon request.
4. The socio-economic data where available from the World Fact book, 2001 (POP, GDP/CAP, Area, gov.) and from the website: www.worldpop.org (urbanization).
5. Because of the vagueness of Muslim effect for top 1000 and moreover because our prior interest is in sports policy effects, the religions were removed from the regression for comparing success of countries.

REFERENCES

- Adelman, M.L. (1986). *A Sporting Time. New York City and the rise of modern athletics, 1820-1870*. Urbana: University of Illinois Press.
- Arts, W. & Halman, L. (1999). New directions in quantitative comparative sociology: an introduction. *International Journal of Comparative Sociology*, 40, 1-12
- Bernard, A.B & Busse, M.R. (2000). Who wins the Olympic Games: economic development and medal totals. Retrieved December 2001 from the World Wide Web: <http://papers.ssrn.com>.
- Colwell, J (1982). Quantity or quality: non-linear relationships between extent of involvement and international sporting success. In A.O. Dunleavy, A. W. Miracle, and C.R. Rees (Eds), *Studies in the sociology of sport*. Forth Worth: Christian University Press.
- Condon, E.M., Golden, B.L., Wasil, E.A. (1999). Predicting the success of nations at the Summer Olympics using neural networks. *Computers & Operations Research*, 26, 1243-65.
- De Bosscher, V. & De Knop, P. (2002). *Factors determining success in tennis. International comparative study of top level sports and tennis policies. Working paper, 13 August*.
- De Butter, F. A.G. & Van der Tak, C.M. (1995). Olympic medals as an indicator of social welfare. *Social Indicators Research*, 35, 27-37
- De Pelsmacker, P., Van Kenhove, P. (1999). *Marktonderzoek: methoden en toepassingen. [Market research: methods and applications]*. Garant: Leuven-Apeldoorn.
- Heinemann, K. (Ed.) (1998). *Sports clubs in various European countries*. Series Club of Cologne. Vol 1, Stuttgart: Hofmann Verlag.
- Gartner, M. (1989). Socialist countries' sporting success before perestroika and after? *International Review for the Sociology of Sport*, 24, 283-97.
- Gillis, J.H. (1980). Olympic success and national religious orientation. *Review of Sport and Leisure*, 5, 1-20.
- Gleijser, H. (2002). Verdere bewijzen over het comparatief nadeel van kleine landen op het gebied van sport. *Nieuw Tijdschrift van de Vrije Universiteit Brussel*, 15(1), 82-91.
- Heinilä K. (1982). The totalization process in international sport: toward a theory of the totalization of competition in top-level sport. *Sportwissenschaft*, 3, 235-53.
- Hoffman, R., Ging, L.C. & Ramasamy, B. (2000). Public policy and Olympic success. The University of Nottingham in Malaysia Research Paper Series. Retrieved 10 November 2001 from the World Wide Web: <http://www.unim.nottingham.ac.uk/dbm/papers/2001-02.pdf>.
- Hofstede, G. (1998). A case for comparing apples with oranges: international differences in values. *International Journal of Comparative Sociology*, 39(1), 16-31.
- Johnson, K.N. & Ali, A. (2002). *A tale of two seasons: participation and medal counts at the Summer and Winter Olympic Games*. Wellesley College Working Paper. Retrieved January 2002 from the World Wide Web:

- http://www.wellesley.edu/economics/wkpapers/wellwp_0010.pdf.
- Jokl, E. (1964). Health, wealth, and athletics. In E. Simin (Ed.), *International research in sport and physical education* (pp. 218-22), Springfield: Thomas.
- Kiviaho, P. & Mäkelä, P. (1978). Olympic success: a sum of non-material and material factors. *International Review of Sport Sociology*, 2, 5-17.
- Larose, K. & Haggerty, T.R. (1996). *Factors associated with national Olympic success: an exploratory study*. Unpublished Master's thesis. University Brunswick (Canada).
- Levine, N. (1974). Why do countries win Olympic medals - some structural correlates of Olympic games success. *Sociology and Social Research*, 58(4), 353-60.
- Lüschen, G. (1972). The interdependence of sport and culture. In M.M. Hart (Ed.) *Sport in the socio-cultural process*. Dubuque, Iowa: Wm. C. Brown, 1972.
- Novikov, A.D. & Maximenko, A.M. (1972) The influence of selected socio-economic factors on the level of sports achievements in the various countries. *International Review of Sport Sociology*, 7, 22-44.
- Ottoy, Van Vooren, Hughe (1993). *Inleiding tot SPSS voor Windows*. Ghent: University Press.
- Oyen, E. (Ed.) (1990). *Comparative methodology: theory and practice in international social research* London: Sage.
- Pooley, J. (1988). The use and abuse of comparative physical education and sport. *Comparative Physical Education and Sport*, 5, 3-15.
- Scheuch, E.K. (1990). The development of comparative research: towards causal explanations. In E. Oyen (Ed.) *Comparative methodology: theory and practice in international social research* (pp. 19-37). London: Sage.
- Semotiuk, D.M. (1981). Motives for national government involvement in sport. *Journal of Comparative Physical Education and Sport*, 7(2), 13-23.
- Seppänen, P (1981) Olympic success: a cross-cultural perspective. In: G. Lüschen & G. Sage (Eds), *Handbook of social science of sport*. Champaign: Stipes.
- Sfeir, L. (1985) The status of Muslim women in sport: conflict between cultural tradition and modernization. *International Review for the Sociology of Sport*, 20(4), 283-304.
- Stamm, H., Lamprecht, M. (2001). *Sydney 2000 - The best games ever? World Sport and Relationships of Structural Dependency*. Summary of a paper presented at the 1st World Congress of the Sociology of Sport. Seoul, Korea. Retrieved January 2002 from the World Wide Web: http://www.lssfb.ch/download/ISSA_Seoul.pdf.
- Van Bottenburg, M. (1994). *Verborgene competitie, over de uiteenlopende populariteit van sporten*. Amsterdam: Bert Bakker.
- Van Bottenburg, M. (2000). *Het topsportklimaat in Nederland*. Onderzoek in opdracht van NOC*NSF en het ministerie van WVS. 's Hertogenbosch: Diopter-Janssens en van Bottenburg bv.