<a> Economic determinants of sport performance

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<b> Introduction

Several variables can be mobilised when explaining sport performance. The set of explanatory variables is different when dealing with individual sport performance as against looking for the determinants of macro-sport performance, that is, either team sport performance or a series of national team performances including individual and team sports (such as the Olympics medal totals). Looking for the determinants of each individual sport performance typically calls for skills and experiences existing in sports sciences such as physiology, biology, biomechanics engineering, medicine, psychomotricity, psychology and neurology. The knowledge collected through these scientific disciplines is crucial to the athlete, their trainers and coaches and sport managers. However, explanatory variables of each individual sport performance, such as an athlete's height, weight, body mass, blood pressure, speed, fitness, dexterity, training and talent, even aggregated for all athletes selected in a national team, are rather short for providing a substantial insight into why, say, the French team regularly wins less Olympic medals than the Chinese or United States (US) team (M. Andreff, W. Andreff and Poupaux 2008).

Thus, when it comes to analysing the determinants of sport performance at a macro-social level (e.g. national level), we have to turn to social sport sciences such as sociology, demography, history, political science, sport management and sport economics. Indeed, team performance does not only rely on individual talent, fitness and so on but also on the athlete's environment. This includes coordination efficiency between athletes within the team and with trainers and coaches and the socio-economic environment of the athlete. The latter refers to athlete education and training conditions, the availability of more or less suitable and comfortable sporting equipment and facilities, the quantity and quality of team management and of monetary and non-monetary incentives sent to the athletes. In other words, the athlete's environment is heavily conditioned by the human and economic resources they are supplied with. In economic terms, a nation's overall human resources boil down to its population and its total economic resources are usually assessed by its gross domestic product

(GDP). A team's human resources can be assessed by its players' roster and its staff (or its payroll) and its economic resources by its overall revenues (budget). Consequently, sports economics is useful to understand macro-social sport performance as defined above and nearly useless to explain one specific individual athlete performance. Therefore, the present chapter exclusively focuses on the determinants of (national or clubs') team sport performance.

Explaining national team sport performance is not a new train of thought in sports economics. This kind of research started as early as 1972, with a focus on the Olympic Games (Ball 1972; Novikov and Maximenko 1972). Research exploring the economic determinants of sport performance achieved by national men's football teams started 30 years later (Hoffmann, Ging and Ramasamy 2002; Houston and Wilson 2002), and even later for national women's football teams (Hoffmann, Ging, Matheson and Ramasamy 2006). These studies explained the differences in sport performance across countries. Such differences can also be encapsulated in a single indicator through a metrics of competitive balance in a sport contest. Indeed, competitive balance assesses the degree of sporting equilibrium or disequilibrium between playing strengths on the pitch that compete against each other in a sporting contest. Therefore, looking for the determinants of competitive balance is equivalent to searching for the determinants of differences in sport performance between competitors. This is the rationale underlying this chapter.

In the following sections, the authors exhibit what has motivated them to develop research on economic determinants of sport performance, before providing their theoretical and methodological framework and then the current state of knowledge they have reached so far. The chapter ends with an overview of the impact of their research.

<b> Why are economic determinants of sport performance looked for?

Our most recent research, together with three co-authors, looked for economic determinants of sport performance at Summer Olympic Games from 1992 to 2016, with the objective of forecasting national medal totals at Tokyo 2020 (W. Andreff, Scelles, Bonnal, M. Andreff and Favard 2019; Scelles, W. Andreff, Bonnal, M. Andreff and Favard 2020), and later at the 2024 Paris Games. It is not the first research conducted by the two authors together on economic determinants of sport performance as shown below.

Wladimir Andreff's interest in analysing economic determinants of macro-sport performance emerged when he was supervising Sandrine Poupaux's PhD dissertation, passed at the

University Paris 1 Panthéon-Sorbonne (Poupaux 2006). The thesis statistically confirmed that former communist countries were winning a greater number of Olympic medals than it could be expected from observing their population and level of economic development (using GDP per inhabitant as a proxy). Then, following Bernard and Busse (2004), a first modelling was attempted to explain the distribution of Olympics medal totals across countries participating in the Summer Games, including why communist countries were outliers. The explanatory variables mobilised were population, GDP per inhabitant, a host country effect (upgrading the host country's medal total) and a dummy variable for being a communist or post-communist nation.

Eventually this research led to elaborating an econometric model that slightly improved Bernard and Busse's model (Andreff et al. 2008). Once carefully tested with required data, this model was used to forecast the distribution of medal totals across participating nations at the 2008 Beijing Games. On the request of the French National Institute for Sports (INSEP), a paper was written after the Games to check how much the model forecasts were different from actual sporting outcomes (observed medal totals) achieved by each participating national team in Beijing. It appeared that the model exactly forecast 70 per cent of countries' medal totals and, with accepting a two-medal error margin, the model performance was up to forecasting 88 per cent of overall medal distribution (Andreff 2009).

The previous model was then adapted to forecast the outcome of Winter Olympic Games by adding two new variables describing each participating nation's level of snow coverage and its endowment in winter sport resorts and facilities (Andreff 2013). After successful econometric testing, the explanatory model was used for forecasting the 2014 Sochi Games distribution of medal totals across countries. One surprising result was that the model did not predict the Russian team as the biggest winner in terms of medals: Russia was ranked fourth in the forecast. However, since the model does not take on board a variable for doping, it recently became a natural experiment of doping practices in the Russian Olympic winter sports team (Andreff 2019). Since 2014, 11 participants of the Russian Olympic winter sports team were disqualified for doping so that Russia is now ranked back to its predicted rank after disqualifications (11 medals 'lost'). This is called a natural experiment of doping impact on sporting outcome.

Finally, it was attempted to use a similar model for explaining and forecasting sport performance in the final stage of the FIFA World Cup which is played, in its first part, as a round robin tournament and then, in its second part, as a knock-out sport contest. The model

aims to explain which four teams had qualified for the World Cup semi-finals, and then forecast the semi-finalists for the next Cup (M. Andreff and W. Andreff 2015). In addition to population, GDP per inhabitant and host country effect, the model takes on board four additional variables specific to football: an historical variable of former semi-final participations, current team FIFA ranking, a regional variable grouping countries in FIFA's continental federations (such as UEFA, CONCACAF, CONMEBOL, etc.), and the number of registered football players divided by population in each country. Once econometrically tested, the model poorly performs in forecasting only 50 per cent of future semi-finalists[1], namely at the 2010 FIFA World Cup. Two lessons are drawn from this failure: (1) when a sport contest encompasses a knock-out stage the outcome uncertainty (and the randomness of actual sporting result) is higher than in a round robin and may dilute the impact of explanatory macro-variables, such as population and GDP per inhabitant; and (2) due to higher randomness, a number of surprising outcomes are likely to emerge during the knock-out stage with a favourite (in macroeconomic terms) being defeated by an underdog. A typical case of this was at the 2010 FIFA World Cup when the Ghanaian team won (2-1) against the US team in the round of 16. Such an unforeseeable outcome (by the model) obviously distorted all the forecasts of further knock-out stages (quarter-finals, semi-finals and the final).

When participating in Nicolas Scelles's PhD viva voce (Scelles 2009, 2010), Wladimir Andreff expressed the view that the competitive intensity concept and its metrics are extremely appealing and can probably be fruitful for studying the determinants of sport performance[2]. This was confirmed later with cooperation between the two authors of the present chapter, starting in 2014, as described below.

Nicolas Scelles started working on economic determinants of sport performance after having read the 2012 version of *Soccernomics* (Kuper and Szymanski 2012). In this book, chapters 15 and 17 describe the regression applied by the authors for explaining goal difference in games played by national men's football teams over the 1980-2001 period. Towards the end of 2013, Stefan Szymanski tweeted about an update of the dataset used for the new edition of the book, with an observation period running until 2010. Following this tweet, Nicolas Scelles decided to conduct similar research for the 2011-2013 period, with the idea of including new determinants and using the results obtained to forecast the 2014 FIFA men's World Cup outcome prior to the event. He liaised with Wladimir Andreff on this project,

resulting in a number of published research articles (Scelles and Andreff 2014a, 2014b, 2015, 2017, 2019).

More recently, Nicolas Scelles searched for economic determinants of sport performance in international women's football (Valenti, Scelles and Morrow 2020). This research was part of his former PhD student (and now colleague) Maurizio Valenti's dissertation on the development of women's football in Europe. Nicolas Scelles wanted to conduct such research on women's football based on quantitative data over a long span of time but the paucity of such data in the past hindered him from doing so. Fortunately, more quantitative data have become available, enabling Nicolas Scelles, when he had his tenure at the University of Stirling (Scelles 2015), to suggest a PhD proposal on women's football that Maurizio Valenti has conducted to its end.

Nicolas Scelles also conducted research on economic determinants of sport performance over the recent period in European men's football first tiers. With co-authors, he looked at determinants of international performance in UEFA competitions (Scelles, François and Dermit-Richard 2020a) as well as at those of competitive balance across European men's football first tiers over the 2006-2017 (Scelles, François et al. 2020a) and 2006-2018 periods (Scelles, François et al. 2020b).

At the time of writing the chapter, Nicolas Scelles is conducting further research looking at the determinants of the evolution of competitive balance in the FIFA women's World Cups (Scelles 2020). This research is not discussed later in this chapter because it does not use econometric testing.

<b> Econometric testing and theoretical underpinnings

As regards the methodology in sport economics, econometric testing of the determinants of sport performance relies on multiple linear regressions. That is, a statistical technique using several explanatory variables (determinants) to explain then predict the outcome on a response variable (sport performance), based on quantitative data collected from different sources (usually available online) requiring sometimes further calculations (e.g. indicators of competitive balance). An econometric model will differentiate from another one by the choice of the explained variable (e.g. Olympic medals totals, World Cup semi-finalists, goal difference, FIFA points) and then by testing various sets of supposedly explanatory variables (e.g. population, GDP per capita, host country effect). Within a given set of data, some variables will successfully pass the econometric test (their coefficients will appear to be

statistically significant at a 1 per cent, 5 per cent or 10 per cent threshold) while other variables will fail to be statistically significant. The former will be kept in the explanatory econometric model whereas the latter will be rejected.

Consequently, two econometric models attempting to explain the same variable, such as the Olympic medal totals distribution, can find different and sometimes even contradictory results (there are some cases in point mentioned in this chapter) depending on the set of explanatory variables taken on board, the number (or period) of observations, the country sample and the econometric technique used. In this respect, in most econometric modelling and testing of economic determinants of sport performance a Tobit model technique has been implemented. However, some exceptions consist in complementing the Tobit with a Logit (Andreff et al. 2008) or a Hurdle model (Andreff et al. 2019; Scelles, W. Andreff et al. 2020).

It can be seen that the two authors look for economic determinants of sport performance with econometric testing in five cases: (1) national medal totals at the Olympic Games, (2) goal difference in games played by national men's football teams, (3) FIFA points gained by national women's football teams, (4) international performance of European men's football first tiers, and (5) competitive balance in European men's football first tiers. The first three cases relate to national teams while the last two cases relate to domestic leagues. Although some differences can be drawn between both types, the starting assumption in all cases is that population and GDP per capita drive the talent pool, which in turn drives sport performance.

<b> Economic determinants of sport performance in most recent researches

Although this chapter's title is 'Economic determinants of sport performance', the range of determinants tested with an econometric methodology to explain sport performance goes beyond economic variables, such as population and GDP, as already noted above (e.g. host country, regional or historical variables, sport rankings are taken into account).

The main difference between national teams and domestic leagues is that the former relies on domestic players (although a national team can field naturalised foreign players) while the latter can rely on both domestic and foreign players. Scelles, François et al. (2020a) argued that the ability of a domestic league to attract the best foreign players while retaining the best domestic players depends in part on the GDP of the country where the league is played. Therefore, GDP would be a more appropriate predictor of sport performance than population and GDP per capita in the case of domestic leagues.

It can be argued that GDP is simply population x GDP per capita. However, choosing to have both population and GDP per capita or only GDP as economic determinants of sport performance refers to two different rationales. In the first case of national teams relying on domestic players, the assumption is that a larger population is likely to result in a larger talent pool of which quality depends on whether players are well fed, can train in good infrastructure and so on, all elements that are driven in part by GDP per capita. The rationale in the second case of national leagues is the one argued by Scelles, François et al. (2020a), as mentioned above. Nevertheless, there is a need for further explanations as to why GDP should impact competitive balance.

Scelles, François et al. (2020b) provide the following rationale: competitive balance may be impacted by the talent pool, also impacting international performance, with more talented players beneficial to more clubs and consequently a better competitive balance (Berri, Brook, Frick, Fenn and Vicente-Majoral 2005; Flores, Forrest and Tena 2010; Schmidt and Berri 2003). However, the literature on the determinants of international performance shows that some other factors are at play. One can assume that some other factors impact on international performance because they affect the quality of those players who are part of the talent pool and, as a consequence, they should also affect competitive balance if a domestic league mainly relies on domestic players. The latter hypothesis may be disputed in European men's football where, due to the globalisation of the market for talent, leagues can (sometimes heavily) recruit foreign players and/or struggle to retain their best domestic players. A league's ability in attracting the best foreign players and retaining its best domestic players depends on its economic power, hence GDP impacting competitive balance.

<c> *The determinants of national teams' sport performance in international sport contests*

In the above Cases 1, 2, and 3 related to national teams, population or talent pool (or population and percentage of football players in overall population[3]) and GDP per capita appear as two explanatory variables that need to be included in any model looking for economic determinants of sport performance. However, it is worth noting that Scelles and Andreff (2014b) found a significant negative impact of GDP per capita in the specific case of European men's football national team performance from August 2012 to December 2013, contrary to expectations and results exhibited in other research. An explanation of this different result may be that most European countries have a GDP per capita high enough for their inhabitants to be sufficiently fed and in good physical shape, which is consistent with playing football at the highest level. At the same time, the incentive to make a decent living

by earning money from football may be higher for players from European countries with lower GDP per capita.

In the first two cases, looking for the determinants of sport performance in a specific event or game hosted in a given country, one needs also to include a host country/home advantage effect in the explanatory modelling. In the case of Olympic Games, Andreff et al. (2019) show that it is not only being host country in the current event that has a significant positive impact on sport performance as a consequence of the specific preparation and investment made to perform well at home. Being host country four years earlier and four years later have also a significant positive impact on sport performance. The impact of specific preparation and investment made four years earlier is still present during the current Olympic Games, whereas the impact of specific preparation and investment made to perform well at home in the current Games lasts and is still present at the next Games four years later.

Climate was also taken on board, although it was found to be a non-significant variable at Summer Olympic Games by Andreff et al. (2019). In football, climate corresponds to $(\text{temperature} - 14)^2$, 14 degrees Celsius having been tested as the optimal temperature for playing football (Hoffmann et al. 2002). This means that an actual temperature higher than $(\text{temperature} - 14)^2$ translates into lower sport performance.

Political variables also have to be included in sport performance modelling, such as political regime (Andreff et al. 2008 and Andreff et al. 2019) or a democracy index, although the latter has been found to be non-significant in women's football (Valenti et al. 2020). A higher democracy index translates into lower sport performance in games played by national men's football teams but not in FIFA rankings. According to Scelles and Andreff (2019), an explanation could be that democracy has a significant negative impact mainly on games that do not allocate a large number of FIFA points (e.g. friendly games against teams ranked 150th and below).

Region or football confederation dummy variables are also to be considered, with different impacts at Summer Olympic Games and in men's football. Econometric results witnessed for such variables exhibit that North America is the best performer as regards the Olympics, while South America is the best performer in world men's football.

Finally, we must mention some interesting results gained in the recent literature about the socio-economic determinants of Olympic medal totals. Forrest, Sanz and Tena (2010) found that the level of public expenditure on recreational, cultural and religious affairs (including

sport) and being future hosts of the Games had a significant positive impact on the shares of medals for the 1992-2004 Olympics. They also attempted to forecast national team medal totals at the 2008 Beijing Olympics under the assumption that extra medals attributable to the past political regime in post-communist economies will fade away over time, which is empirically observed by Forrest, McHale, Sanz and Tena (2017) and Noland and Stahler (2017).

Blais-Morisset, Boucher and Fortin (2017) attempted to explain a nation's medals total for the 1992-2012 Olympics by again testing the impact of the level of public expenditure on recreational, cultural and religious affairs. They found that it is a better indicator of Olympic performances than GDP per capita. The authors interpret their results as public investment in sports being a better targeted governmental policy tool in view to gaining a nation's successes at the Olympics. Extremely topical and interesting, such a result is to be taken with a pinch of salt due to a serious limitation: a sample of 53 nations was used, which is roughly one-quarter of all participating nations in the last Olympics.

Leeds and Leeds (2012), Trivedi and Zimmer (2014), and Lowen, Deaner and Schmidt (2016) looked at the impact of gender (for the first two) or gender inequalities (for the latter). More exactly, Leeds and Leeds (2012) included four variables related to gender: the fertility rate of a country (the authors' hypothesis being that, as the fertility rate falls in a country, the overall status of women, and their likelihood of sport success, increases); the year in which women in a given country attained the right to vote; the ratio of the labor force participation rate for women to the labor force participation rate for men; and a regional dummy variable that denotes whether a country is in the Arab World (based on the fact that women's empowerment is a particular problem in the Arab World). All these variables had a significant impact on sport performance for women (negative impact, except the ratio of the labor force participation rate for women to the labor force participation rate for men, which has a positive impact). The first two variables had also a significant negative impact on sport performance for men. Trivedi and Zimmer (2014) included the ratio country's female athletes divided by country's total athletes and a regional dummy variable that denotes whether a country has Islamic status. They found contrasted results depending on whether they included the ratio country's athletes divided by total athletes in their models (positive impact for female share when this variable was included but negative otherwise, no significant impact for Islamic status when the athlete share is included but negative otherwise). Lowen et al.

(2016) found that greater gender equality (measured using the Gender Inequality Index) is associated with higher medal counts (for both females and males).

Otamendi and Doncel (2018) raised the issue of whether the medal win distribution is better anticipated by forecasting models or by sports experts who have a deep knowledge of the different Olympic sport disciplines. They compared five expert predictions published in the press with three forecasting models used for the 2010 Vancouver Winter Olympics, the 2012 London Summer Olympics, and the 2014 Sochi Winter Games. They concluded that sports experts' predictions are more accurate as regards the detailed medal distribution within a given sport discipline while econometric models perform better when it comes to medal wins distribution across participating nations. They suggested that expert forecasts are more useful to sport punters, whereas econometric forecasts are more useful for designing public sport policies.

Beyond the variables presented so far, some sporting variables are specific to given sports and thus must also be taken on board. For example, this could include the number of participating athletes in each Olympic national team, experience or tradition (number of games played by a national team in its past history), players' quality (number of players from best clubs) or FIFA points in men's football, coaching provision (senior national team coach license UEFA Pro in the European case) and men's football legacy (FIFA men's points) in women's football. All these variables have been tested with a significant positive impact on sport performance.

In games played by national men's football teams, the nature of the sporting prizes at stake is also to be taken into account. Scelles and Andreff (2019) found a significant positive impact on goal difference of being the favourite team whatever the nature of sporting prizes. However, they discovered a hierarchy as to the extent of favourite team advantage depending on the nature of sporting prizes: the favourite team has a higher advantage when it has something to compete for while this is no longer the case for an underdog. The hierarchy between different sporting prizes then corresponds to the following ranking: (1^{st}) the favourite team has nothing to compete for anymore while the underdog has, (2^{nd}) both teams have something to compete for, ($3^{rd)}$ both teams have nothing to compete for any longer in a competitive game, and ($4^{th)}$ the game is a friendly game.

<c> *The determinants of sport performance across domestic leagues*

In above Cases 4 and 5 related to domestic leagues, GDP appears as an explanatory variable that needs to be included in any model looking for economic determinants of sport performance across countries. Nevertheless, Scelles, François et al. (2020a, 2020b) did not identify any research having taken it on board prior to them except Peeters (2011). They did not mention any research that has looked at the determinants of international performance across domestic leagues. Instead, Scelles, François et al. (2020a) reviewed the literature on the determinants of national team performance as a way to identify potential determinants of cross-national performance across domestic leagues.

Scelles, François et al. (2020a, 2020b) identified four main publications explaining competitive balance across domestic leagues. First, Flores et al. (2010) investigated the impact on competitive balance of widening the pool of players from which clubs are permitted to recruit through the case of the liberalisation of football player labour markets associated with the Bosman Ruling of 1995[4]. Across 17 European men's football leagues, they found an improvement in within-season (but not cross-season) competitive balance following Bosman. Second, Peeters (2011) argued that, in the 32 European men's football leagues studied, collective sales do not increase competitive balance as compared to individual sales. Further, he demonstrated the negative effect of the UEFA Champions League and the beneficial effect of a more equal distribution of drawing power and a larger domestic market size on competitive balance. Third, Peeters and Szymanski (2014) analysed the financial and sporting impact of UEFA Financial Fair Play (FFP) regulations in four major European men's football leagues (England, France, Italy and Spain). They showed how the break-even constraint embedded in FFP could substantially reduce average payrolls and wage-to-turnover ratios, while strengthening the position of the traditional top teams. And fourth, Rocaboy (2017) proposed a microeconomic framework to model the trade-off between national competitive balance and international performance of the national representative club. He argued that if a non-cooperative game exists among the national league governing bodies, this game would result in inefficient redistributive policies. He found 'soft' empirical evidence of such a competition among the big 5 men's football leagues in Europe. That is, the four studied by Peeters and Szymanski (2014) and Germany.

As an alternative to GDP, Scelles, François et al. (2020a, 2020b) tested previous year attendance as an economic variable more specific to sport. Scelles, François et al. (2020a) found that those models explaining international performance and competitive balance have a better explanatory power (higher R^2) when mobilising previous year attendance rather than

GDP. By contrast, Scelles, François et al. (2020b) exhibited no significant impact of previous year attendance on competitive balance while a significant impact of GDP still holds.

Scelles, François et al. (2020a) considered that the number of clubs in a domestic league could also affect international performance. More clubs in a league result in more fixtures and more games, which boil down to more revenues and a better ability to pay for high-performing players. Nevertheless, domestic leagues with fewer clubs potentially can still arrange the same number of games as leagues with a bigger number of clubs. Besides, having more clubs at the highest domestic tier drives players' distribution and revenue-sharing between more clubs, with potentially fewer highly performing players per club. In particular, for those clubs taking part in European competitions, this could eventually have a negative impact on international performance. It must be noted that the optimal number of clubs in a league depends on its potential. For example, 20 clubs in the English Premier League may be appropriate while the same number in the Scottish Premiership may not be appropriate due to its market being smaller. Thus, it appears relevant to use the variable number of clubs / GDP as an indicator of entry barrier. Scelles, François et al. (2020a) tested a significant negative impact of this variable on international performance.

The same variable can be used to explain competitive balance. As stated by Scelles, François et al. (2020a, 2020b), it enables the testing of the idea that 'a fixed number of places on professional teams is to be filled from an eligible playing population' (Flores et al. 2010, p. 547), as well as the subsequent hypothesis of a negative impact on competitive balance from having too high a number of clubs to be able to ensure that all of them have a sporting level credible enough at the highest tier. Both Scelles, François et al. (2020a, 2020b) found no significant impact.

Scelles, François et al. (2020a, 2020b) took on board tradition and, in Scelles, François et al. (2020a), its square to capture a negative effect after having reached an optimum. These two new variables explain both international performance and competitive balance. In addition, sporting prizes explain competitive balance, similarly to the result shown with explanatory models of national football team performance. Scelles, François et al. (2020a) found a significant positive impact of tradition on international performance and competitive balance (not confirmed by Scelles, François et al. (2020b) for the latter), and a significant negative impact of its square on international performance but no significant impact on competitive balance.

Scelles, François et al. (2020a, 2020b) also suggested to include a dummy variable that captures whether the league is played from summer to spring (i.e. is aligned with the continental competitions) and found a significant positive impact on international performance but no significant impact on competitive balance.

For the model explaining competitive balance, Scelles, François et al. (2020a, 2020b) suggested that the differences in drawing power should be taken on board. Following Peeters (2011), the latter are approximated by the coefficient of variation of average clubs' attendances per game over the period studied. Average attendances over the period are retained rather than attendance for a specific season in view of avoiding endogeneity (i.e. a situation where we explain a variable *Y* by a variable *X* that is itself explained by the variable *X*). Indeed, the sporting performance of different clubs affects both competitive balance and their respective attendances. Consistent with expectations, the authors found a significant negative impact of the differences in drawing power on competitive balance.

In both models, Scelles, François et al. (2020a, 2020b) suggested taking on board a dummy variable that captures whether UEFA FFP is enforced (which is so since 2011). They found no significant impact on international performance, except in Germany where a significant negative impact is witnessed. The authors recommend being cautious about this result. For sure, Germany has the highest GDP and average attendance per game in Europe, but the German Bundesliga is not yet the wealthiest league. Although using these variables as proxies for economic power is the most appropriate among the data available, this remains an imperfect option which, in some instances such as Germany, may deliver misleading results. The observed result may simply counterbalance the excessive economic power allocated to Germany based on its GDP and average attendance per game.

Eventually, international performance and competitive balance may mutually explain each other. Indeed, domestic clubs performing well in international competitions earn more money that they can invest in players, therefore increasing their competitive advantage compared to other domestic clubs (i.e. a better international performance in the previous year leads to a deterioration of competitive balance in the current year). A domestic league may also implement less equalitarian revenue sharing schemes that trigger lower competitive balance in view to improving its international performance. These interpretations are partially confirmed by econometric results exhibited in Scelles, François et al. (2020a, 2020b), although Scelles, François et al. (2020a) found no significant impact of international

performance in the previous year on competitive balance in the current year (contrasting with Scelles, François et al. 2020b).

<b> Resulting explanation of sport performance and recommendations

The main result of the aforementioned research basically consists of providing a macro and economic explanation of sport performance through mobilising variables that go beyond the micro characteristics of each individual athlete/player. This is a value added by sport economics and its capacity of modelling to the wide knowledge already accumulated about sport performance by other sport sciences.

A major impact of the authors' research comes from forecasts achieved by means of econometric modelling macro-(team)-sport performance. Such forecasting capacity obviously draws attention from the government and sport governing bodies. Explaining then predicting the distribution of medal totals at the 2008 Summer Olympics triggered a demand from the French National Institute of Sports for a comparison between the model forecasts and actual medal distribution observed two months later in Beijing (in particular, with regards to medals won by French Olympic team).

In September 2017, when Paris won the right to host the 2024 Summer Olympics, the incumbent French Minister of Sports expressed her very optimistic wish that the French Olympic team should double the number of its medal total (i.e. 80 medal wins in 2024 instead of 42 at the 2016 Rio Games). One consequence of such wishful thinking was that the Ministry of Sports convened an expert group to scientifically estimate a plausible range of medal wins by the French Olympic team in 2024. An intermediary by-product of the expert group's work is the forecast elaborated on for the 2020 Tokyo Summer Olympics (Andreff et al., 2019). Recently, this study attracted a wider interest from the newly-created scientific body focused on sport (GDR CNRS Sport et Activité Physique) belonging to the National Centre for Scientific Research (CNRS) and from the newly-launched National Agency of Sports (ANS), a department that is in charge of high-level sport performance in the perspective of the 2024 Summer Olympics. An article derived from this research has been published in an academic journal (Scelles, W. Andreff et al. 2020).

The authors' research on national men's football team performance responds to multifaceted vested interest in the football industry. First, international contests (events) organisers could take into consideration some explanatory macro-variables of sport performance in view to better formatting their football contests and improving their seeding schemes, better

balancing their competitions and, consequently, attracting wider attendance and TV viewership (and eventually higher TV rights revenues). Second, domestic (English, French, other) first-tier professional leagues should be interested in the results of our econometric modelling, in particular the role of variables such as the league format (number of clubs, potential sporting prizes), competitive balance, international performance and UEFA financial fair play rules. Finally, sport performance forecasts may be used as a basis for football fans' wagers. Thus, football punters are likely to be a group of interested readers and Scelles and Andreff (2017) do suggest some options that may help football punters' decision making for their future bets.

In the foreseeable future, an unexpected windfall benefit of this kind of research on economic determinants of sport performance may become an assessment of how much doping actually impacts sporting outcomes. If one takes those forecasts delivered by our economic modelling of sport performance as kind of benchmark for each national team's potential performance, then natural experiments of doping – as the one we have observed with the Sochi Games – can be created by comparing medal forecasts with medals actually won by each team and, finally, with the final medal total obtained by each team once some doped athletes have been disqualified[5]. This approximation of the doping impact on sport performance is all the more appealing because there is no complete data set on how much various athletes resort to performance-enhancing substances in sports contests (Andreff et al. 2008; Andreff 2019).

<b> Conclusion

This chapter has outlined the authors' expertise as regards economic determinants of sport performance. After introducing the contribution of sport economics to understanding the determinants of sport performance, the authors have described in the first section what motivated them to research on the topic. Wladimir Andreff started when supervising Sandrine Poupaux's PhD thesis (Poupaux 2006), while Nicolas Scelles began around a decade later, in collaboration with Wladimir Andreff and other researchers (Scelles and Andreff 2014a, 2014b). The second section explained what econometric testing is all about – a methodology used by the two authors and more generally sport economists to identify economic determinants of sport performance – and its theoretical underpinnings. Then the third section has provided the most recent results found by the authors with regards to economic determinants of sport performance. A distinction has been made between the determinants of national teams' sport performance in international sport contests and those of sport performance in domestic leagues. It has highlighted some determinants that are significant in

both cases (e.g. population and GDP per capita or GDP) while others are specific to one particular case. In the fourth section, the authors have underlined their overall resulting explanation of sport performance and some recommendations that can be derived for governments, sport governing bodies and leagues. Last, the authors have suggested an avenue for further research corresponding to an assessment of how much doping actually impacts sporting outcomes, doping being currently a key issue not yet well captured among the determinants of sport performance.

<b> Notes

[1] Most existing econometric models of this kind are not able to predict more than two out of four semi-finalists. Different modelling must be adopted to take into account the highest randomness of the knock-out stage of the tournament.

[2] Nicolas Scelles conducted a PhD dissertation on competitive intensity in professional team sports leagues. The idea underlying the competitive intensity concept is that clubs and fans are interested in sporting prizes distributed in a league (Kringstad and Gerrard, 2004). It may be argued that clubs' interest in such sporting prizes is due to their economic significance and, as such, they may be considered as economic determinants of sport performance. In this chapter, we consider sporting prizes as sport rather than economic determinants. The issue of competitive intensity per se is not tackled here. The impact of economic and financial rewards associated to distributed sporting prizes on competitive intensity in a league remains a very interesting avenue for further research.

[3] Talent pool is more specific than population since it captures the actual number of players in the country as opposed to the potential number of players as proxied by population. Including both variables usually captures redundant information because a country with a larger population is more likely to have a larger number of players than another country with a smaller population, even if the percentage of players in overall population is higher in the latter. An alternative is to include both population and the percentage of players in overall population.

[4] Judicial ruling delivered by the European Court of Justice in December 1995 leading to measures easing nationality restrictions.

[5] With the current WADA rules, an athlete can be tested and disqualified for doping up to ten years after the Games he/she has participated in.

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