The determinants of international football success: A panel data analysis of the Elo rating*

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Abstract

Objectives. This paper investigates the determinants of football[1] success at international level. We introduce three innovations as a) we apply the model developed by Bernard and Busse (2004) to football. b) We consider a wide panel of countries over a 33 years period and c) we supplement FIFA's classification with the Elo rating system. *Methods.* We estimate a dynamic panel model using Blundell and Bond's (1998) System-generalised method of moments (GMM) estimator. *Results.* The results are robust to several sensitivity analyses, show that economics, demographics, weather, geography and football institutions are good indicators of football success at international level. Besides, the Elo rating is a better alternative indicator that the FIFA ranking, *Conclusions*. Elo rating it may be used in the academic works that wish analyse football success over a long period of time.

JEL codes: C33, C53, L83
Key words: Elo rating, football success, dynamical panel model, FIFA ranking

I Introduction

Football is a sport that moves masses[2], creating joy and disappointment in almost equal measure (Kerr et al., 2005 and Jones et al., 2012), and generating billions worldwide[3]. In many countries football has become a religion, a way of life and of feeling part of society. Such is the impact of football that according to the FIFA 3,200 million people watched the South African World Cup (FIFA, 2010). The importance of football is so great that it can even be used as a development indicator (Gásquez and Royuela, 2014). Given the importance of football in society today and its impact on the economy, efforts have been

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made to study the determinants of football success at the international level. This paper improves previous works and contributes to the literature in three ways:

a. We apply to football a theoretical framework, which is based on the work of Bernard and Busse (2004) developed originally for determining country success at the Olympic Games.
b. In addition, we expand the traditional cross-section analyses reported in the literature by considering a panel of 180 countries[4] for the period 1980-2012.
c. We use as our world-wide indicator of football performance the Elo rating, an alternative indicator (and less problematic) to FIFA's more traditional classification.

The paper addresses these tasks in the following six sections. Section II reviews the literature on the topic. Section III introduces the theoretical analytical framework used in this research. Section IV presents the data sources. Section V sets out the empirical model and presents the estimation results, several additions to the model and a sensitivity analysis and robustness checks. Finally, section VI offers some conclusions.

II Literature review

The study of the determinants of the success of national football teams (based on analyses of the FIFA classification and its resulting ranking) is a relatively modern field, but a number of findings have already been reported. Below we review chronologically the papers published to date that analyse the determinants of the football performance of national football teams[5].

1. Hoffman et al. (2002) is considered the pioneering study of the determinants of international football performance. Drawing on studies of the determinants of success at the Olympic Games, the authors apply an empirical methodology to the analysis of the explanatory variables showing a significant relation to FIFA's world ranking points. To do so, they estimate a cross-section for 76 countries for the year 2000. The explanatory variables are: GNP per capita, GNP per capita squared, temperature, share of world population, host dummy (if the World Cup has been held previously in a given country), and a Latin dummy variable (it is noted that the largest countries in terms of population - China, India, Indonesia - are not the most successful at football, and so the authors include an interaction term between Latin cultural origin and population size). Their findings indicate that economic, demographic, cultural and climate

variables are important. They also identify an inverted U-shape relationship for temperature and per capita wealth. Finally, the authors find that the interaction between population size and Latin culture is significant, while separately these variables are insignificant.

2. Houston and Wilson (2002) analyse FIFA's ranking points as a proxy of the proficiency of leisure. The estimation was conducted using a cross-section of 179 countries for 1999. Interestingly, the authors incorporate control variables hitherto not considered, including, the number of years as a member of FIFA (a proxy of football institutions). The findings show that leisure proficiency on an aggregate level (FIFA points ranking) is positively associated with income and increases at a decreasing rate. As such, their results are consistent with Hoffman et al. (2002).
3. In three separate studies Benno Torgler analyses the determinants of football performance. Torgler (2004a) examines the determinants of the success of national teams in the 2002 FIFA World Cup. The study uses a dummy variable as the dependent variable (winning a match=1 vs. not winning a match=0) and FIFA's points ranking as an explanatory variable, together with related variables of game performance: shots on goal, possession, sending-offs, corner kicks, etc. (determinants of success during a game). The author reports a cross-section probit estimate for 126 observations[6] and finds that FIFA's points ranking is not a good predictor for determining which team will win a match.

   Torgler (2004b) examines the determinants of the FIFA women's world ranking and also the FIFA classification. The estimation is made for a cross-section of 99 countries in 2009. The explanatory variables are similar to those selected in previous studies: GDP, tradition, population and temperature. In addition, he uses the success of national football teams over time as a proxy of football tradition among women. The main contribution of the study is the author's attempt to control for geography using football regions (confederations). In line with Hoffman et al. (2002), the author finds that economy, demography and tradition are important. However, he fails to find the same inverted U-shape relationship with per capita wealth. Moreover, Torgler finds regional differences (geography) to be relatively small.

   Finally, Torgler (2004c) constructs a model where previous World Cup final tournament performance (1930 to 2002) is the dependent variable[7] for studying the determinants of success in such tournaments. Although he analyses the success of national football teams over time, he considers average values. In the case of his economic and demographic explanatory variables he uses averages for 1960 to 2001. He thus estimates a cross-sectional model applied to 60 countries[8]. Once more, wealth is positively associated with a national team's performance,

population size only affects countries of Latin origin and there is strong evidence of the importance of football tradition[9]. By contrast, temperature does not affect football performance.

4. Hoffman et al. (2006) adopt a very similar approach to Torgler (2004b). They use a cross-section regression for 88 countries in 2002 for women's international football performance and compare it with that of their male counterparts. In so doing, they also incorporate political[10] and gender inequality variables. They find that while economic and demographic factors have the same impact on the men's and women's game, the political and cultural factors differ. Specifically, climate and Latin cultural origin only affect men's football performance, while the political system and gender inequality account for performance in the women's game. Thus, the authors find a differentiated set of determinants of football success for men and women.
5. Macmillan and Smith (2007) identify serious statistical problems in the pioneering work of Hoffman et al. (2002), including sample selection bias and abnormal errors. To overcome these problems, the authors add 100 countries to the sample and estimate a cross-section for the year 2000. As well as considering the same explanatory variables as in Hoffman et al. (2002), they take into account Houston and Wilson's (2002) study and introduce the importance of football tradition as a variable. Additionally, in line with Torgler (2004c), they also include football confederations as control variables[11]. The findings confirm that Hoffman et al. (2002) suffers from serious statistical problems. In line with earlier studies, a country's football tradition is a significant variable. However, they conclude that the size of the population is significant without the need to relate it directly to whether a country is of Latin origin or not. Indeed, these findings lead them to propose the use of an alternative indicator of population: a variable related to the number of football players, rather than the simple use of population. Finally, they consider that the FIFA ranking may not be a good indicator of the true level of competitiveness, as its calculation includes friendly matches in which national teams do not have the same incentives as in competitive matches. As a consequence, in addition to the FIFA ranking, they use an alternative indicator: the so-called Elephant ranking[12], and obtain similar results.
6. Gelade and Dobson (2007) estimate a cross-section for 201 countries for FIFA ratings between 2000 and 2005. Most interestingly they introduce new explanatory variables: the number of men who regularly play football (in line with Macmillan and Smith's suggestion) and the percentage of expatriate players in the national team. They find that the inclusion of these two variables (both significant) improves the explanation of the determinants of national football success - the models' overall explanatory power being 70%. They conclude that the

determinants of football success are highly inflexible, limiting the ability of policymakers to intervene; however, they believe policymakers can make a difference by encouraging more people to play football and by increasing the number of expatriate footballer's from the most competitive leagues in the national team.

7. Leeds and Leeds (2009) claim that success in football can be measured in one of two ways: by measuring the success of a national team over time (temporal), or by accounting for the number of FIFA points held by a nation at a particular point in time. They estimate a cross-section for 178 countries for 2006. In line with Torgler (2004b), the authors consider an alternative dependent variable, the FIFA classification (as opposed to FIFA points). The paper contributes to the literature by analysing the role of institutions in determining the success of national football teams. Thus, they analyse the impact of a nation's political regime, colonial heritage and political freedom (but find no significant relationships), as well as its football institutions: number of years as a member of FIFA (as in Houston and Wilson, 2002) and the international success of the country's club teams. The authors conclude that the stronger the country's domestic leagues is (measured by success in international club tournaments), the stronger the national team will be. Thus, investing in the domestic league is one way to improve a national team's performance.
8. Yamamura (2009) examines whether the mechanism of technology transfer from developed to developing countries can be applied to football. He observes that only 21% of players in the African national teams at the 1998 World Cup played in their corresponding domestic leagues. Consequently, he claims, the gap in competitive football between developed and developing countries should be closed quite quickly thanks to the importation of more advanced techniques. Indeed, he finds that the coefficient of variation of FIFA's ranking points system fell between 1993 and 1998. To test his reasoning, the author regresses the log of FIFA points for 156 countries over the period 1993-1998, making his the first study to use panel data. He justifies the use of this short period of time on the grounds of the methodological changes made in the computation of FIFA classification in 1999 and 2006. He concludes that the improved proficiencies of developing countries can be attributed to technology transfer and local information spillover. In a similar vein, Yamamura (2012) uses FIFA world ranking points to examine how linguistic heterogeneity impacts technology transfers from the most developed countries, finding that it has a detrimental effect in the case of developed countries but not in that of developing countries.
9. Binder and Findlay (2012) analyse the effects of the Bosman ruling on national and club teams in Europe. To our knowledge, this is the first paper that uses the Elo rating to measure the

national team strength. The authors show how the Elo rating is a better predictor of success in recent World Cups compared to the FIFA rating, although they do not discuss in depth the methodological advantages of such alternative. The application is devoted to fourteen European countries and finds that the Bosman ruling had, if any, a fairly small effect on national teams' performance.

10. Berlinschi et al. (2013) carry out a cross-sectional estimation for 202 countries for the year 2010, considering both FIFA points and the FIFA ranking (using a negative binomial regression). The authors study the impact of the migration of professional footballers on their countries of origin. They find that the migration of international football players improves performance, especially for countries with domestic leagues of lower quality. The authors conclude, in line with Gelade and Dobson (2007), that the migration of players to competitive leagues is one of the determinants of football success, especially for developing countries, in keeping with Yamamura's results on knowledge transfer by migration.
11. Allan and Moffat (2014) make a cross-sectional estimation for 179 countries for the year 2010, 2011 and 2012, considering FIFA points. The authors study the impact of the emigration of professional footballers and the manager immigration on the national football team. They find that player emigration has a positive impact on the performance of the national football team. Nevertheless, the manager immigration variable has a negative impact to the national football team. The author concludes that the national football sides should employ domestic managers.
12. Jacobs (2014) studies the determinants of women´s international football performance, such as Torgler (2004b) and Hoffman et al. (2006). This work emphasizes how four programme-level factors – governance, training, youth development and early initiation into football – are associated with a country's international performance. This study uses 2006 programme-level data from 139 FIFA member nations. The contemporaneous and longer-term associations between programme-level factors and FIFA ranking points are explored using ordinary least squares regressions. Controls for economic, gender equity, talent pool, temperature, men's soccer legacy, political and cultural factors are included. The author shows that dedicated governance staff and training are key correlates of successful football nations.

This literature review shows that there is robust evidence of several determinants of football performance, including, economics, demographics, weather and institutions. However, there are several gaps in the literature.

First, these studies fail to give sufficient consideration to a theoretical framework that would ensure theoretical consistency in their empirical estimations. Next section is devoted to adopt the theoretical developed by Bernard and Busse (2004), which is originally designed to study the determinants of success in the Olympics Games. Given that field of study is very similar to ours (sport success), in next section we adapt their theoretical model to analyse the determinants of success of national football teams.

Second, most of the analyses use cross-sections of countries. One of the main reasons for this is the methodological changes made to the computation of the FIFA classification in 1999 and 2006. Third, concerns regarding the FIFA classification, with the sole exception of Macmillan and Smith (2007), it is the only alternative employed.

To resolve this limitations, we considered an alternative indicator to the FIFA ranking: the Elo rating. With this indicator, we can run a panel analysis, because we have a longer time horizon (Elo rating don't have methodological changes over time). Besides, Elo rating has a several advantages, that we analyse later, compared to FIFA ranking.

III Theoretical framework

Bernard and Busse (2004) model the determinants of success at the Olympic Games. Their model assumes that the talent of athletes is randomly distributed around the world. Thus, assuming that countries are arbitrary divisions of the world population, adapting this model to football, we would expect success to be proportional to the population of each country.

$$E\left(football\ succes\ share_{i,t}\right) = \frac{football\ success_{i,t}}{\sum_j football\ success_{j,t}} = \frac{population_{i,t}}{\sum_j population_{j,t}} = pop\ share_{i,t} \quad (1)$$

However, there are several reasons why this equation might not hold. First, there are technical reasons that apply specifically to the game of football. For instance, the national football team of each country comprises the same number of players (the eleven sent out on to the pitch) irrespective of the size of the country's population. In addition, there are specific criteria as to how football performance is measured. For instance, playing the final stages of the major football tournaments, such as the FIFA World Cup (for which not all countries can qualify), gives a team more points and so a better FIFA ranking.

Yet, clearly, as football includes a range of technical features other than natural talent, it is sensible to consider that aside from population, there must be other factors that account for the success of national football teams. Indeed, boosting good players would appear to require a

considerable outlay in terms of commodities and personnel. In this regard, wealthy countries are more likely to have public and/or private organizations willing to make this investment. Further, there is a stronger likelihood that more developed countries offer sport as part of the school curriculum, and dispose of more free time to dedicate to sport. This means that socioeconomic factors related to development need to be included in the model.

Additionally, regardless of the size of the population of a country and its resources, the literature shows that mean temperature is a key variable for the practice of football and, at a subsequent stage, for success in the sport. Hoffman et al. (2002) claim that the optimal mean annual temperature for sporting performance is 14 ºC and that deviations from this temperature can hamper success.

Furthermore, institutions would seem to play a significant role. The previous literature (for example, Leeds and Leeds, 2009) points to a non-significant influence of political institutions. On the contrary, football institutions (including the national football association and private or public football clubs and their resources) may be connected with football performance. Consequently we only consider the inclusion of the latter in our model.

Thus, the production function of talent ($T_{i,t}$) of the football teams in country i in year t requires a population ($N_{i,t}$), economic resources ($Y_{i,t}$), a warm temperature ($W_{i,t}$), a number of football-related institutions ($I_{i,t}$) and some organizational skills ($A_{i,t}$):

$$T_{i,t} = f(N_{i,t}, Y_{i,t}, W_{i,t}, I_{i,t}, A_{i,t}) \tag{2}$$

The relative football success, $S_{i,t}^{*}$, obtained by the country is a function of the talent in that particular country:

$$E\left(\frac{football\ success_{i,t}}{\sum_j football\ success_{j,t}}\right) = S_{i,t}^{*} = g(T_{i,t}) \tag{3}$$

A Cobb-Douglas talent production function is assumed:

$$T_{i,t} = A_{i,t} N_{i,t}^{\gamma} Y_{i,t}^{\theta} W_{i,t}^{\varphi} I_{i,t}^{\xi} \tag{4}$$

This characterization leads to the following specification for a country's relative success at football:

$$S_{i,t}^{*} = \ln \frac{T_{i,t}}{\sum_j T_{j,t}}$$

$$S_{i,t} = ln\, A_{i,t} + \gamma\, ln\, N_{i,t} + \theta\, ln\, Y_{i,t} + \varphi\, ln\, W_{i,t} + \xi\, ln\, I_{i,t} - ln \sum_j T_{j,t} \tag{5}$$

As the socioeconomic variable can be expressed as the product of population and per capita income, the specification to be estimated is:

$$S_{i,t} = \beta_0 + \beta_1 \ln N_{i,t} + \beta_2 \ln \left(\frac{Y}{N}\right)_{i,t} + \beta_3 \ln W_{i,t} + \beta_4 \ln I_{i,t} + d_t + v_i + \epsilon_{i,t} \qquad (6)$$

where d_t is a time *dummy* included to capture the changes in the talent panel, v_i is a country effect, and $\epsilon_{i,t}$ the error term that is distributed normally.

IV Data

As seen in section 2 above, the previous literature has primarily drawn on FIFA data, either using the Association's classification points or rankings. One of the main contributions of the study reported here, therefore, is its alternative use of the Elo rating (www.eloratings.net), a rating system that has been rarely exploited in the academic literature[13] and, to our knowledge, only once in the football literature, although in a small sample of European countries (Binder and Findlay, 2012). A detailed analysis of the methodology for calculating both the Elo and the FIFA ratings is shown in Appendix 2. Stefani and Pollard (2007) show that the Elo system has a series of advantages over the FIFA system. Since being introduced in 1993, the FIFA World Ranking has been the subject of much debate, especially with regard to its calculation and the resulting disparity between the perceived quality and the world ranking of certain teams. Thus, for example, Norway was surprisingly ranked second in October 1993 and again between July and August 1995, while the United States climbed to fourth in 2006, much to the surprise even of their own players. This criticism of the ranking has continued even after the implementation of a new formula in 2006. Leeds and Leeds (2009) identify major methodological problems with the FIFA. The methodical problems are:

a. The authors claim that national teams can obtain better rankings by switching to a different confederation.

b. They highlight the volatility among the rank position of the top ten teams.

c. Additionally, the FIFA ranking only takes into consideration if the team wins, loses or draws the match.

These methodological problems are solved when using the Elo rating, since it uses a low volatility index (is an index that has more memory present) and problems attributable to geography are avoided, as the rating does not depend on the confederation to which a national

team belongs. Regarding to the result of the match, the Elo rating incorporates more information because it consider expected and goal difference in the game, and not only if the team wins, loses or draws the match. Even though the more recent FIFA ranking has improved the previous rating systems (methodological change in 2006) by taking into account strength of opponents and game importance, all losses are treated as equal, regardless of the opponents, and home advantage is ignored.

In addition, FIFA ranking is not an internal ratings-based system source (IRB system). The IRB system employs a predictor/corrector adjustment in which defeating a weak team provides less gain than defeating a strong team, while losing to a weak team elicits a much larger negative adjustment than losing to a strong team, arguably a fair and efficient methods for rating competitors. As can be seen in Appendix 2, Elo based system, employing many of features of the IRB system, and so appears to have advantages over the FIFA system.

A further advantage of using the Elo rating is the wider horizon can be analysed: while FIFA ranking suffers methodological changes in 1999 and 2006, the Elo rating allows for comparative analysis in longer periods. Although the Elo rating can in fact be computed since 1872, we opt here to consider the period from 1980 to 2012, as the panel can be largely balanced with information for the explanatory variables[14].

In another vein, as usual, the UK is not included as a single country, since FIFA recognizes England, Scotland, Northern Ireland and Wales individually as independent teams with the right to play in international competitions. Following Hoffman et al. (2002), we therefore opt to include England, as the largest of the home countries, to represent the UK.

Regarding to the socioeconomic factors, it would be appropriate to use facilities such as the number of youth training camps, sport education, etc. However, the difficulty of obtaining data on these variables at the country level requires us to use GDP per capita as a proxy for such socioeconomic explanatory variables[15]. An alternative to GDP per capita could be the use of the Human Development Index, developed by the Human Development Report. We make correlations between Elo rating and GDP per capita and HDI[16].

Contrary to what one might think a priori, GDP per capita is a better explanatory variable to explain football performance (the overall correlation between ELO rating is higher for logarithm of GDP per capita: 0.4217, compared to HDI: 0.3994.) Thus, we use GDP per capita as a socioeconomic indicator.

Population data come from the World Development Indicators. Although we wanted to include the number of people playing football regularly, in line with Gelade and Dobson's (2007) recommendation, this variable is only available for 2006 and, so, we had to rule out its use in our panel specification. The weather variable is computed as $(TEMP-14)_i^2$,[17] where *TEMP* refers to the average annual temperature between 1961 and 1999 (in degrees Celsius). As this variable is very stable, we take this valour as a representative of the whole period.

In the case of the football institutions variable, as we do not have access to the budgets of all the associations and clubs, and as we do not dispose of a variable that measures the quality of these institutions, a proxy is required. In line with Leeds and Leeds (2009), we consider the best proxy of football institutions to be the number of years a country's football association has belonged to FIFA in 2012. This is the most convenient variable for capturing the maturity of football institutions[18]. Additional proxies of football institutions include the *Host* variable (a dummy for those countries that have hosted a World Cup finals tournament[19]) and a list of dummies of the regional football confederations[20]. The description of all variables are in Appendix number 4.

V Results

A. - Basic model

We follow the empirical strategy of Bernard and Busse (2004) who use a parsimonious model specification, starting from the estimation of equation 1 by means of a panel OLS (column I of Table 1). Column II reports the estimation using the log of population rather than the share, reporting a much larger R^2. At this stage, the preferred model (the highest R^2 value) is the one that considers the log of population, what supports the basic framework of the Bernard and Busse's (2002) model. Column III shows the estimates using both the log of population and the log of GDP per capita.

Column IV considers equation 6, which includes population, GDP per capita, weather and institutions, expressed as log values. When jointly included, all the variables remain significant and present the expected sign in accordance with the literature. This points to the importance of a moderate temperature and the number of years a country's football association has been affiliated to FIFA for success in international football.

Next we estimate the panel specification of equation 6, following Baltagi and Griffin (1984) and Pirotte (1999). The panel between estimates would capture the long run effect of a model where the explanatory variables would impact the endogenous variable by means of a distributed lag structure. On the contrary, the fixed effects specification would report the short run effects. Finally, the OLS and random effects models would report estimates averaging the long and short run specifications.

Our panel specifications use GDP per capita as a proxy of socioeconomic factors related to development which in turn impact the available resources (facilities such as the number of youth training camps, sport education, etc.) to train and *produce* football players. We interpret then our model as a sort of reduced form specification where the variables will capture all other omitted variables directly related with football performance. This effect will be particularly strong in the between specification, as the fixed effects structure will capture the permanent differences between countries in such socioeconomic and related factors other than just GDP per capita.

Table 1.

VARIABLES	(I) ELO points OLS	(II) ELO points OLS	(III) ELO points OLS	(IV) ELO points OLS	(V) ELO points Between	(VI) ELO points Fixed	(VII) ELO points Random
Popshare	1,037***						
	(164.8)						
LPOP		67.49***	81.77***	56.80***	50.35***	18.31**	34.46***
		(1.766)	(1.641)	(2.001)	(10.64)	(8.696)	(6.263)
LGDP			76.06***	51.37***	42.02***	12.07**	21.11***
			(1.836)	(2.235)	(12.66)	(5.175)	(4.699)
LWeather				-28.12***	-32.87***		-31.67***
				(2.324)	(12.11)		(10.90)
LYearsFIFA				125.0***	173.3***		165.5***
				(7.246)	(42.75)		(28.03)
Constant	1,393***	370.8***	-443.9***	-254.4***	-2,383***	1,020***	187.6
	(22.18)	(32.18)	(33.94)	(38.73)	(848.9)	(146.4)	(133.6)
Observations	5,667	5,667	5,344	5,344	5,344	5,344	5,344
Countries					180	180	180
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R2 or Pseudo R2	0.006	0.227	0.404	0.453	0.563	0.376	0.435

Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Columns V to VII present the between, fixed and random effects estimations. All models report significant parameters for all variables, although the fixed effects results display lower values for population and GDP per capita. The interpretation is in line of the above comments: the between estimates captures long run effects of a reduced form model where GDP per capita proxies socioeconomic factors. Thus, a *level* of GDP per capita 1% higher implies 42 Elo points higher. The fixed effects model, on the contrary, presents a parameter value much lower. On

the other hand, the Hausman test between the Random and Fixed effects specifications reject the null hypothesis of equal vectors of parameters, which implies endogeneity in the random effects estimation. Consequently, the fixed effects estimation is preferable to the random effects estimation, although in both cases football is significant. Population, weather and years in FIFA maintain the same behaviour all over specifications.

B.- Additions to the model

The empirical specification of equation (6) leaves some specific information relating to each country in the error term. This section incorporates various factors (derived from our study of the literature) that we consider important for improving the analysis of the determinants of the sporting success of national football teams[21]. Specifically, we include the square of the socioeconomic variable (to confirm whether there is an inverted U-shape relationship in the impact), the *Host* dummy[22] and the dummy of the regional football confederations[23] (so we can control the potential effects of belonging to a particular geographical region).

$$S_{i,t} = \beta_0 + \beta_1 \ln N_{i,t} + \beta_2 \ln\left(\frac{Y}{N}\right)_{i,t} + \beta_3 \ln\left(\frac{Y}{N}\right)^2_{i,t} + \beta_4 \ln W_{i,t} + \beta_5 \ln I_{i,t} + \beta_6 Hos + \sum_{j=1}^{5} \theta_j Conf_j + d_t + v_i + \epsilon_{i,t} \quad (7)$$

The results are presented in column I to IV of Table 2. All variables are significant and present the expected sign in accordance with the literature.

In line with Hoffman et al. (2002) and Houston and Wilson (2002) we observe decreasing returns in the effect of per capita wealth on football success. Specifically, when developing countries increase their per capita wealth they have, on average, more success in sport because they can allocate more resources to achieving this goal. However, once a certain wealth threshold is reached, any subsequent increase in per capita wealth does not lead to greater sporting success. Consequently, we might expect to find that the relationship between sporting success and GDP per capita is more relevant in developing countries. The results point to a decreasing relationship in these first two estimations. The fixed and random effects results point to a linear relationship at sample values[24]. Countries with strong football institutions (proxied by having hosted a World Cup and the number of years affiliated to FIFA) display better outcomes in the Elo rating. We also find geographical differences, so that while CONMEBOL (South America) countries display better results than UEFA (Europe) countries, the other confederations present significantly negative values for this parameter.

Table 2.-

	(I) ELO points OLS	(II) ELO points Between	(III) ELO points Fixed	(IV) ELO points Random	(V) ELO points Sys GMM	(VI) ELO ranking Neg Binomial	(VII) ELO ranking Neg Bin Fixed	(VIII) ELO ranking Neg Bin Random
$ELOpoints_{t-1}$					0.775***			
					(0.033)			
LPOP	71.42***	70.23***	29.77***	51.01***	16.47***	-0.164***	-0.231***	-0.168***
	(1.908)	(10.54)	(9.195)	(6.176)	(3.092)	(0.00579)	(0.00964)	(0.0108)
LGDP	184.8***	190.5*	-45.91**	-49.28**	46.74**	-0.522***	0.132**	0.0788
	(17.10)	(100.5)	(22.13)	(21.23)	(18.20)	(0.0431)	(0.0540)	(0.0496)
$LGDP^2$	-7.698***	-8.184	3.886***	4.707***	-2.001*	0.0236***	-0.0189***	-0.0114***
	(1.074)	(6.177)	(1.463)	(1.383)	(1.117)	(0.00278)	(0.00357)	(0.00328)
LWeather	-13.18***	-20.69*		-12.88	-2.631	0.0506***		0.0661***
	(1.881)	(10.89)		(9.934)	(1.936)	(0.00562)		(0.0200)
LYearsFIFA	56.69***	80.69**		84.66***	13.81*	-0.120***		-0.608***
	(6.721)	(39.43)		(25.76)	(7.785)	(0.0173)		(0.0648)
Host	80.60***	84.09	89.64***	94.39***	17.06*	-0.894***	-0.725***	-0.480***
	(8.470)	(60.70)	(17.28)	(16.56)	(8.899)	(0.0438)	(0.0778)	(0.0603)
CONCACAF	-123.2***	-115.5**		-144.0***	-27.06**	0.450***		0.610***
	(10.26)	(52.57)		(42.20)	(12.77)	(0.0301)		(0.0859)
CONMEBOL	52.81***	62.03		53.34	13.84	-0.0995**		-0.365***
	(10.59)	(68.07)		(58.93)	(11.07)	(0.0439)		(0.107)
AFC	-298.1***	-297.7***		-305.0***	-69.08***	0.742***		0.854***
	(8.752)	(49.99)		(37.28)	(13.64)	(0.0219)		(0.0789)
CAF	-14.30*	13.33		-98.71**	-2.566	0.163***		0.443***
	(8.111)	(54.97)		(38.64)	(8.697)	(0.0234)		(0.0794)
OFC	-79.91***	-78.03		-91.92	-17.96	0.231***		0.779***
	(12.98)	(78.11)		(64.69)	(14.93)	(0.0280)		(0.149)
Constant	-744.2***	-2,895***	1,045***	534.5***	-209.7**	9.556***	7.179***	7.917***
	(78.86)	(765.9)	(149.3)	(138.7)	(83.24)	(0.188)	(0.253)	(0.333)
Observations	5,344	5,344	5,344	5,344	5,187	5,344	5,343	5,344
		180	180	180	180		180	180
R2 or Pseudo R2	0.625	0.712	0.400	0.596	0.966	0.559	0.416	0.541

Note: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

C.- Time to build

Up to this juncture, we have assumed that the achievement of sporting success is a process in which the capabilities of each country are potentially persistent. However, it seems logical that investment in the achievement of sporting success at the national level should increase the chances of success in subsequent years. To test this, we firstly lag the socioeconomic variable for a time period of up to ten years. Appendix 5 reports the fixed effects estimations[25]. The better model adjustment is found when GDP per capita is lagged nine years; that is, on average, economic improvements record their maximum outcome in terms of football performance after nine years. A second option for accounting persistence is the addition of a one-year lag of the endogenous variable to the model:

$$S_{i,t} = \beta_0 + (1-\delta)S_{i,t-1} + \beta_1 \ln N_{i,t} + \beta_2 \ln\left(\frac{Y}{N}\right)_{i,t} + \beta_3 ln\left(\frac{Y}{N}\right)^2_{i,t} + \beta_4 \ln W_{i,t} + \beta_5 \ln I_{i,t} + +\beta_6 Host_{i,t} + + \sum_{j=1}^{5} \theta_j Conf_j + d_t + v_i + \epsilon_{i,t} \quad (8)$$

This dynamic panel model is estimated using Blundell and Bond's (1998) System-generalised method of moments (GMM) estimator. The results are presented in column V of Table 2, where the inclusion of the lagged endogenous variable is shown to improve the model fit markedly. Clearly, the best determinant of a team's football success is to consider its football success in the recent past. In this case, if we include the lagged dependent variable, our model fit increases to 96.6% of the determinants of success in international football. The estimates pass the Arellano andBond´s (1991) tests and, therefore, the instruments are valid.

As expected, the introduction of the lagged endogenous variable in the dynamic model captures most of the fixed information that was controlled by variables such as the weather or the regional dummies. Nevertheless, several other variables, including population and GDP per capita, remain significant. Interestingly, two confederations, CONCACAF and AFC, are still significant.

D. – Sensitivity analysis and robustness checks

To check the robustness of our results, we estimate equation (7) by replacing the dependent variable with the Elo ranking (as opposed to Elo points). Following Leeds and Leeds (2009) and Berlinschi et al. (2013), we use a negative binomial regression, as the data display excess dispersion in the rank variable, with the conditional variance exceeding the conditional mean[26]. The results (column VI to VIII of Table 2) are similar to previous estimates (the parameters present the reverse sign, as the lower the position occupied in the ranking, the better the performance). The difference in sign recorded for GDP and GDP squared is, in fact, not relevant, as the relationship is almost linear (if we do not include GDP squared, the relationship between GDP per capita and football success becomes positive).

A second robustness check is to use the FIFA ranking[27] for the period 1993-2012[28] and to compare the results with the Elo ranking for the same period. The results of the negative binomial panel specifications (Table 3) are similar for both indicators of football performance. Here again the difference in sign of GDP and GDP squared is due to the fact that the relationship is practically linear in the two estimations.

Table 3.- Elo ranking versus FIFA ranking (1993-2012)

	(I) ELO ranking Neg Bin	(II) FIFA ranking Neg Bin	(III) ELO ranking NB Fixed Eff	(IV) FIFA ranking NB Fixed Eff	(V) ELO ranking NB Rand Eff	(VI) FIFA ranking NB Rand Eff
LPOP	-0.181***	-0.169***	-0.340***	-0.310***	-0.225***	-0.237***
	(0.00650)	(0.00638)	(0.0198)	(0.0181)	(0.0180)	(0.0171)
LGDP	-0.470***	-0.534***	0.154**	-0.136	0.0980	-0.188**
	(0.0536)	(0.0512)	(0.0738)	(0.0919)	(0.0690)	(0.0859)
LGDP2	0.0194***	0.0235***	-0.0203***	-0.00525	-0.0143***	-0.000787
	(0.00342)	(0.00318)			(0.00448)	(0.00549)
LWeather	0.0549***	0.0526***			0.0662***	0.0285
	(0.00708)	(0.00758)			(0.0240)	(0.0196)
LYearsFIFA	-0.103***	-0.133***			-0.335***	-0.155***
	(0.0201)	(0.0218)	(0.00481)	(0.00592)	(0.0702)	(0.0581)
Host	-0.915***	-0.860***	-0.327***	-0.407***	-0.267***	-0.273***
	(0.0521)	(0.0564)	(0.0899)	(0.101)	(0.0658)	(0.0776)
CONCACAF	0.393***	0.388***			0.603***	0.483***
	(0.0325)	(0.0316)			(0.111)	(0.0910)
CONMEBOL	-0.151**	0.0341			-0.676***	-0.456***
	(0.0588)	(0.0575)			(0.131)	(0.117)
AFC	0.757***	0.700***			1.049***	1.050***
	(0.0262)	(0.0265)			(0.0996)	(0.0797)
CAF	0.188***	0.145***			0.350***	0.166**
	(0.0265)	(0.0288)			(0.0960)	(0.0825)
OFC	0.232***	0.393***			0.730***	0.947***
	(0.0327)	(0.0346)			(0.175)	(0.147)
Constant	9.638***	9.747***	9.185***	8.968***	8.161***	8.158***
	(0.232)	(0.229)	(0.405)	(0.439)	(0.406)	(0.427)
Observations	3,473	3,348	3,472	3,347	3,473	3,348
Countries individual effects			179	178	180	179
R2 or Pseudo R2	0.559	0.554	0.397	0.4286	0.571	0.582

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 3 shows that the results based on the Elo ranking and FIFA ranking are extremely similar. Thus one of the main contributions of our work is to provide empirical evidence that the Elo ranking (and therefore, surely, the Elo rating) is a good alternative indicator to the FIFA ranking/rating. Thus, in subsequent academic works on this field, the Elo rating may be used as an alternative to the FIFA rating for these works that wish to analyse a long period of time.

All in all, the results obtained are highly robust to the football performance indicator, the period of analysis and the model specification.

VI Conclusions

In this paper we have analysed the determinants of success in international football. Thanks to the demonstrated adequacy of Bernard and Busse's (2002) theoretical framework, our empirical estimation is guaranteed theoretical consistency. This means the choice of variables is clear, as is the way in which they should be considered.

The GDP per capita is a better socioeconomic variable to explain football performance, regarding the HDI.

The use of the Elo rating as our football performance indicator has a series of advantages over the use of the FIFA classification. In particular it has enabled us to conduct a list of panel regression estimates over a 33-year period and so to provide stronger empirical evidence of the determinants of success in international football. In this way, Elo ranking is a better alternative indicator to the FIFA ranking. Thus, in subsequent academic works on this field, the Elo rating may be used as an alternative to FIFA rating for these works that wish to analyse a long period of time, as in Binder and Findlay (2012).

The results show that the economics, demographics, weather, football institutions and geography are all determinants of performance at the international level. We make different specifications and the explicative variables the same behaviour remain.

The economic performance of a country influences positively its performance in international football, this influence reaching a maximum point after a ten-year lag. In addition, the model's persistence can be taken into account by including the lagged dependent variable, making it a dynamic panel model. In this way, the model fit increases to 96.6%.

Future research needs to take into consideration additional factors, including the influence of migrating football players on a nation's football performance (like Gelade et al., 2007, and Berlinschi et al., 2013). However, these studies cited are cross-section due to the enormous work involved in building a proper indicator of migration for various years. The work that would build a migration index for over 30 and the exhaustive analysis of this variable exceeds the work of this paper. This work, by itself, would be worthy of a single academic work. Nevertheless, it is our firm belief that constructing a measurement of migration (e.g., the percentage of players in the national team playing for clubs in foreign leagues) for a wide panel of countries over a long period of time would greatly enrich the analysis.

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Appendices to "**The determinants of international football success: A panel data analysis of the Elo rating**", by R. Gásquez and V. Royuela

Appendix number 1.-

1. Afghanistan
2. Albania
3. Algeria
4. Andorra
5. Angola
6. Antigua and Barbuda
7. Argentina
8. Armenia
9. Australia
10. Austria
11. Azerbaijan
12. Bahamas
13. Bahrain
14. Bangladesh
15. Barbados
16. Belarus
17. Belgium
18. Belize
19. Benin
20. Bermuda
21. Bhutan
22. Bolivia
23. Botswana
24. Brazil
25. Brunei
26. Bulgaria
27. Burkina Faso
28. Burundi
29. Cambodia
30. Cameroon
31. Canada
32. Cape Verde
33. Central African Republic
34. Chad
35. Chile
36. China
37. Colombia
38. Comoros
39. Congo Dem Rep
40. Congo Rep
41. Costa Rica
42. Cote d'Ivori
43. Croatia
44. Cuba
45. Cyprus
46. Czech Rep
47. Denmark
48. Djibouti
49. Dominica
50. Dominican Republic
51. Ecuador
52. Egypt
53. El Salvador
54. Ecuatorial Guinea
55. Estonia
56. Ethiopia
57. Fiji
58. Finland
59. France
60. French Polynesia
61. Gabon
62. Gambia
63. Georgia
64. Germany
65. Ghana
66. Greece
67. Grenada
68. Guatemala
69. Guinea
70. Guinea-Bissau
71. Guayana
72. Honduras
73. Hong Kong
74. Hungary
75. Iceland
76. India
77. Indonesia
78. Iran
79. Ireland
80. Israel
81. Italy
82. Jamaica
83. Japan
84. Jordan
85. Kazakhstan
86. Kenya
87. Korea Rep
88. Kuwait
89. Kyrgyzstan
90. Laos
91. Latvia
92. Lebanon
93. Lesotho
94. Liberia
95. Libya
96. Liechtenstein
97. Lithuania
98. Luxembourg
99. Macao
100. Macedonia
101. Madagascar
102. Malawi
103. Malaysia
104. Mali
105. Malta
106. Mauritania
107. Mauritius
108. Mexico
109. Moldova
110. Mongolia
111. Morocco
112. Mozambique
113. Namibia
114. Nepal
115. Netherlands
116. New Caledonia
117. New Zealand
118. Nicaragua
119. Niger
120. Nigeria
121. Norway
122. Oman
123. Pakistan
124. Panama
125. Papua New Guinea
126. Paraguay
127. Peru
128. Philippines
129. Poland
130. Portugal
131. Puerto Rico
132. Qatar
133. Romania
134. Russia
135. Rwanda
136. Samoa
137. San Marino
138. Saudi Arabia
139. Senegal
140. Serbia
141. Seychelles
142. Sierra Leone
143. Singapore
144. Slovakia
145. Slovenia
146. Solomon Islands
147. South Africa
148. Spain
149. Sri Lanka
150. St. Kitts and Nevis
151. St. Lucia
152. St. Vincent & Grenadines
153. Sudan
154. Surinam
155. Swaziland
156. Sweden
157. Switzerland
158. Syria
159. Tajikistan
160. Tanzania
161. Thailand
162. Togo
163. Tonga
164. Trinidad and Tobago
165. Tunisia
166. Turkey
167. Turkmenistan
168. Uganda
169. Ukraine
170. United Arab Emirates
171. UK
172. United States
173. Uruguay
174. Uzbekistan
175. Vanuatu
176. Venezuela
177. Vietnam
178. Yemen
179. Zambia
180. Zimbabwe

Appendix number 2.-

A. The World Football Elo Rating System

The World Football Elo Ratings are based on the Elo rating system, developed by Dr. Arpad Elo. This system is used by FIDE, the international chess federation, to rate chess players. In 1997 Bob Runyan adapted the Elo rating system to international football and posted the results on the Internet. He was also the first maintainer of the World Football Elo Ratings web site. The system was adapted to football by adding a weighting for the kind of match, an adjustment for the home team advantage, and an adjustment for goal difference in the match result.

These ratings take into account all international matches for which results could be found. Ratings tend to converge on a team's true strength relative to its competitors after about 30 matches. Ratings for teams with fewer than 30 matches should be considered provisional. Match data are primarily from International Football 1872 - Present.

The ratings are based on the following formulas:

$$R_n = R_o + K \times (W - W_e)$$

R_n is the new rating; R_o is the old (pre-match) rating.

K is the weight constant for the tournament played:

- **60** for World Cup finals;
- **50** for continental championship finals and major intercontinental tournaments;
- **40** for World Cup and continental qualifiers and major tournaments;
- **30** for all other tournaments;
- **20** for friendly matches.

K is then adjusted for the goal difference in the game. It is increased by **half** if a game is won by two goals, by **3/4** if a game is won by three goals, and by **3/4 + (N-3)/8** if the game is won by four or more goals, where **N** is the goal difference.

W is the result of the game (**1** for a win, **0.5** for a draw, and **0** for a loss).

W_e is the expected result (win expectancy), either from the chart or the following formula:

$$W_e = 1 / (10^{(-dr/400)} + 1)$$

dr equals the difference in ratings plus **100** points for a team playing at home.

Sample Winning Expectancies

Difference in	Higher	Lower related
0	0.500	0.500000
10	0.514	0.486
20	0.529	0.471
30	0.543	0.457
40	0.557	0.443
50	0.571	0.429
60	0.585	0.415
70	0.599	0.401
80	0.613	0.387
90	0.627	0.373
100	0.640	0.360
110	0.653	0.347
120	0.666	0.334
130	0.679	0.321
140	0.691	0.309
150	0.703	0.297
160	0.715	0.285
170	0.727	0.273
180	0.738	0.262
190	0.749	0.251
200	0.760	0.240
210	0.770	0.230
220	0.780	0.220
230	0.790	0.210
240	0.799	0.201
250	0.808	0.192
260	0.817	0.183
270	0.826	0.174
280	0.834	0.166
290	0.841	0.159
300	0.849	0.151
325	0.867	0.133
350	0.882	0.118
375	0.896	0.104
400	0.909	0.091
425	0.920	0.080
450	0.930	0.070
475	0.939	0.061
500	0.947	0.053
525	0.954	0.046
550	0.960	0.040
575	0.965	0.035
600	0.969	0.031
625	0.973	0.027
650	0.977	0.023
675	0.980	0.020
700	0.983	0.017
725	0.985	0.015
750	0.987	0.013
775	0.989	0.011
800	0.990	0.010

B. Ranking FIFA (methodology since 2006)

How are points calculated in the FIFA/Coca-Cola World Ranking?

A team's total number of points over a four-year period is determined by adding:

- the average number of points gained from matches during the past 12 months; and
- the average number of points gained from matches older than 12 months (depreciates yearly).

Calculation of points for a single match

The number of **p**oints that can be won in a match depends on the following factors:

• Was the **m**atch won or drawn? (**M**)

• How **i**mportant was the match (*ranging from a friendly match to a FIFA World Cup™ match*)? (**I**)

• How strong was the opposing **t**eam in terms of ranking position and the **c**onfederation to which they belong? (**T and C**)

These factors are brought together in the following formula to ascertain the total number of points (**P**).

P = M x I x T x C

The following criteria apply to the calculation of points:

M: Points for match result

Teams gain 3 points for a victory, 1 point for a draw and 0 points for a defeat. In a penalty shoot-out, the winning team gains 2 points and the losing team gains 1 point.

I: Importance of match

Friendly match (including small competitions): I = 1.0

FIFA World Cup™ qualifier or confederation-level qualifier: I = 2.5

Confederation-level final competition or FIFA Confederations Cup: I = 3.0

FIFA World Cup™ final competition: I = 4.0

T: Strength of opposing team

The strength of the opponents is based on the formula: 200 – the ranking position of the opponents. As an exception to this formula, the team at the top of the ranking is always assigned the value 200 and the teams ranked 150th and below are assigned a minimum value of 50. The ranking position is taken from the opponents' ranking in the most recently published FIFA/Coca-Cola World Ranking.

C: Strength of confederation

When calculating matches between teams from different confederations, the mean value of the confederations to which the two competing teams belong is used. The strength of a confederation is calculated on the basis of the number of victories by that confederation at the last three FIFA World Cup competitions. Their values are as follows:

UEFA/CONMEBOL 1.00 CONCACAF 0.88 CAF 0.86 AFC/OFC 0.85

Note: FS-590_10E_WR_Points.Doc 11/02 Content Management Services 2/3 on FIFA website

Appendix number 3.-

a. The Asian Football Confederation (AFC) is the governing body of association football in Asia. It has 47 member countries, located in the main on the Asian continent. All the transcontinental countries with territory straddling both Europe and Asia are members of UEFA (Azerbaijan, Armenia, Georgia, Kazakhstan, Russia and Turkey). Israel, although it lies entirely in Asia, is also a UEFA member. Australia, formerly in the OFC, has been in the AFC since 2006, and the Oceanian island of Guam, a territory of the United States, is also a member of the AFC.
b. The Confederation of African Football (CAF) represents the national football associations of Africa.
c. The Confederation of North, Central American and Caribbean Association Football (CONCACAF) is the continental governing body for association football in North America, Central America and the Caribbean.
d. The South American Football Confederation (CONMEBOL) is the continental governing body for association football in South America.
e. The Oceania Football Confederation (OFC) is one of the six continental confederations of international association football, consisting of New Zealand and island nations such as Tonga, Fiji and other Pacific Island countries. In 2006, the OFC's largest and most successful nation, Australia, left to join the Asian Football Confederation.
f. The Union of European Football Associations (UEFA) is the administrative body for association football in Europe and, partially, Asia. UEFA membership coincides with sovereign countries in Europe, although some UEFA members are transcontinental states (e.g. Turkey). Several Asian countries have also been admitted to the European football association: Azerbaijan, Armenia, Georgia, Kazakhstan, Israel, Russia and Turkey, which had previously been members of the Asian football association.

Appendix number 4.-

Variables used

Variable	Description	Source
ELO_points	World Football Elo Ratings	http://www.eloratings.net/
ELO_ranking	World Football Elo Ranking	http://www.eloratings.net/
FIFA_ranking	FIFA/Coca-Cola World Ranking	FIFA
Popshare	Share of Population (% of World)	World Development Indicators
LPOP	Population (in log).	World Development Indicators
LGDP	GDP per capita (in log). Constant 2005 international $	World Development Indicators
LGDP2	GDP per capita squared (in log). Constant 2005 international $	World Development Indicators
LWeather	(TEMP-14) squared, where TEMP refers to the average annual temperature between 1961 and 1999 (in degrees Celsius)	Climate Data API (World Bank website)
LYearsFIFA	Years affiliated to FIFA (in log)	FIFA
Host	A dummy for those countries that have hosted a World Cup finals tournament	FIFA
CONCAFAF	Confederation of North, Central American and Caribbean Association Football	CONCAFAF
CONMEBOL	South American Football Confederation	CONMEBOL
AFC	Asian Football Confederation	AFC
CAF	Confederation of African Football	CAF
OFC	Oceania Football Confederation	OFC
UEFA	European Union of Association Football	UEFA

Appendix number 5.-

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
LPOP	28.84***	27.55***	25.74***	23.84**	22.27**	20.41**	20.21**	19.81*	20.26*	32.35**
	(9.210)	(9.275)	(9.376)	(9.494)	(9.641)	(9.821)	(10.05)	(10.22)	(10.41)	(15.12)
Host	86.85***	84.97***	82.09***	77.70***	72.37***	70.09***	67.11***	63.81***	60.43***	58.99***
	(17.60)	(17.98)	(17.90)	(17.86)	(17.89)	(17.96)	(18.11)	(18.15)	(18.26)	(18.40)
$LGDP_{t-1}$	-25.25									
	(22.41)									
$LGDP2_{t-1}$	2.886*									
	(1.480)									
$LGDP_{t-2}$		-7.359								
		(22.70)								
$LGDP2_{t-2}$		2.081								
		(1.499)								
$LGDP_{t-3}$			8.102							
			(22.98)							
$LGDP2_{t-3}$			1.200							
			(1.517)							
$LGDP_{t-4}$				23.12						
				(23.30)						
$LGDP2_{t-4}$				0.319						
				(1.538)						
$LGDP_{t-5}$					39.18					
					(23.91)					
$LGDP2_{t-5}$					-0.749					
					(1.582)					
$LGDP_{t-6}$						53.49**				
						(24.68)				
$LGDP2_{t-6}$						-1.719				
						(1.637)				
$LGDP_{t-7}$							68.18***			
							(25.52)			
$LGDP2_{t-7}$							-2.732			
							(1.697)			
$LGDP_{t-8}$								81.59***		
								(26.19)		
$LGDP2_{t-8}$								-3.604**		
								(1.748)		
$LGDP_{t-9}$									103.2***	
									(26.96)	
$LGDP2_{t-9}$									-5.109***	
									(1.806)	
$LGDP_{t-10}$										121.7***
										(27.78)
$LGDP2_{t-10}$										-6.304***
										(1.873)
Observations	5,206	5,058	4,903	4,742	4,579	4,414	4,248	4,080	3,911	3,740
Pseudo R2	0.4185	0.4276	0.4305	0.4309	0.4348	0.4365	0.4448	0.4483	0.4571	0.4531

Note: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

[1] That is soccer in North America.
[2] Football is the sport with most participants worldwide. According to the FIFA, 265 million people regularly play football around the world (FIFA, 2006).
[3] Dimitrov et al. (2006), cited by the European Commission's White Paper on Sport, estimates that the sports industry in the European Union accounts for around 3.7% of total GDP and 5.4% of total employment.
[4] The full list of countries analysed can be consulted in Appendix 1.
[5] In addition, Mourão (2010) analyses the football performance at the European level through analyzing the performance of the professional clubs with an original ranking system for European soccer teams. These rankings measure the success of the professional clubs in the European Champions League.
[6] These 126 observations consider the performances of each team in the 63 games played in the 2002 World Cup, excluding the match for third place (63 games).
[7] The author claims that this is the only way to capture the temporal dimension, given that the FIFA ranking only began to be calculated in 1993 and, moreover, it underwent a change in methodology in 1999.
[8] The countries that participated in the World Cup final up to and including 2002, with the exception of Cuba, North Korea, Iraq and East Indies, for which the author does not find data for the explanatory variables.
[9] The proxies used are having hosted the competition and the number of years as a member of FIFA.
[10] Specifically, whether the country has ever operated a communist or socialist political system.
[11] Subsequently, football confederations will also be used in Leeds and Leeds (2009) and Berlinschi et al. (2013).
[12] Note that as this indicator was somewhat rudimentary, the website at which it could be consulted (www.elerankings.com) is no longer operational.
[13] Created by the physicist Arpad Elo to establish a system for rating chess players, the Elo rating has only been used in the academic literature on a few occasions to measure the degree of efficiency of predictions in sports betting markets (Hvattum and Arntzen, 2010; Leitner et al. 2010; Ryall and Bedford, 2010)
[14] We select the rating and the position of each country when playing their last match in the year.
[15] GDP per capita (constant 2005 international $) data come from World Development Indicators.
[16] To make a homogeneous comparison between the 2 variables, we use 135 countries. This is the number of countries available in the Hybrid HDI, accessible at http://hdr.undp.org/en/data/trends/hybrid/.
[17] This variable is available at http://data.worldbank.org/data-catalog/cckp_historical_data.
[18] Leeds and Leeds (2009) use other proxies: namely, the international success of the country's club teams. This variable considers how many teams from each country dispute the main competition organised in their region, such as the Euro Champions League or the Copa Libertadores. However, one caveat for working with this variable is the fact that the rules for playing in such competitions have strongly changed over time: the European Champions League now included several clubs from each country, while in the 80s only one club per country was included.
[19] Argentina, Brazil, Chile, England, France, Germany, Italy, Japan, Korea, Mexico, South Africa, Spain, Sweden, Switzerland, United States of America and Uruguay.
[20] UEFA, CONCACAF, CONMEBOL, AFC, CAF and OFC. Appendix 3 provides details of the countries in each confederation.
[21] Following Macmillan and Smith (2007), we do not incorporate the interaction between people and the *Latin* dummy variable, as they conclude that the size of the population is significant without the need to relate it directly to whether a country is of Latin origin or not.
[22] This dummy variable is not permanent. The variable takes the value 0 until the World Cup takes place in the country, and from that year is equal to 1.
[23] UEFA is the confederation omitted.
[24] The difference in sign recorded for GDP and GDP squared in fixed and random effects is, in fact, not relevant. For real GDP values the relationship is almost linear. If we do not include GDP squared, the relationship between GDP per capita and football success becomes positive.
[25] The Hausman test between the Random and Fixed effects specifications reject the null hypothesis of equal vectors of parameters, and so the fixed effects estimation is preferable to the random effects estimation.
[26] The excess dispersion means the negative binomial model is preferred, while the Poisson is inappropriate.
[27] We cannot use the points, because FIFA ranking suffers a methodological change in 1999 and 2006.
[28] The period for which the FIFA ranking exists.