Aggregate Wages Of Players and Performance in Italian Serie A

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AGGREGATE WAGES OF PLAYERS AND PERFORMANCE IN ITALIAN *SERIE A*

by

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Abstract

This paper investigated the relationship between players' wages and sport performance in the Italian top professional football league - Serie A. The analysis focused on 14 seasons from 2001/2002 to 2014/2015. Findings show that aggregate wage expenditure is a robust predictor of success for Italian professional football teams. We first exploited a fixed-effects panel data and eventually we have addressed the problem of endogeneity by providing a dynamic IV specification of the model. Based on the System-GMM framework, we employed a model including lagged terms of dependent variables and covariates as instruments to control for endogeneity as well as alternative exogenous instruments to control for geographical/environmental factors and for socio-economic factors that could be the actual predictors of performance through an indirect effect on payroll.

Keywords: Italian serie A, football, talent, wages, sport performance

Jel codes: Z21, L83, J49.

1. INTRODUCTION

Sport performance depends on a wide range of determinants, but the most important factor is undoubtedly the availability and access to talent. Conventionally, a reasonable way to approximate talent is given by monetary value. The paper explores the relationship between success in Italian professional football top league, *Serie A*, and the aggregate payroll of players. In order to do that, in what follows we apply three alternative measures for success and controlling for a wide set of covariates that are supposed to be related to sport performance.

To perform the analysis we collected data for 39 Italian professional football teams of *Serie A* tournaments (from season 2001/02 to 2014/15). The analysis is made of two steps. First, we test whether aggregate wage is a robust determinant of sport performance by means of a static panel estimation. Secondly, since the current level of aggregate wage is likely to be endogenous in the past realizations of the dependent variable (through increased revenues due to successful performances), in the second step we apply an IV dynamic panel model. The exogenous instruments chosen are supposed to influence socio-economic unobserved factors which eventually turn to have an impact on teams' likelihood of sport success. In sum, our approach combines alternative estimation techniques (Fixed-Effects and System-GMM) in order to assess the robustness of the results, and in particular to directly tackle endogeneity.

The paper is organised as follows: section 2 surveys the relevant literature. Section 3 describes data, and section 4 outlines the estimation strategy and results of our two-steps analysis, including both fixed-effects and dynamic panel data instrumental variable specifications. Finally, in the last section we present some concluding remarks.

2. PERFORMANCE AND SUCCESS IN FOOTBALL

This paper contributes to a large literature on team sport success. In a considerable set of studies it turns out that the probability of sport success is positively associated with teams' talent availability. In particular, since the seminal contributions of El Hodiri and Quirk (1971) and Scully (1974) the winning ratio between two teams has always been associated with the relative available talent, whose better proxy is considered, with few exemptions [Franck and Nüesch (2010, 2011)], the payroll. Along these lines, Fort and Quirk (1995), Vrooman (1995), Késenne (2000), Szymanski and Késenne (2004), Szymanski and Smith (1997), Hall et al. (2002), Burger and Walters (2003), Frick (2007), Berri and Schmidt (2010), Rodríguez et al. (2013), Frick (2013) and Szymanski (2013), among the others, have employed the talent ratio to compare the competitive balance equilibria inside professional team sports leagues.

Needless to say, in such a view, uncertainty of sport contest appears to be small. In fact, the outcome of tournaments can be easily predicted *ex-ante* at the beginning of each season. Albeit such a mechanism appears to be clear-cut and unchallenged, it might be also noted that a more complex complementarity mechanism is in place (Hall et al., 2002). In fact, a winning team increases its revenues through a variety of channels (monetary prizes, participation in continental competitions, match attendance, TV rights): since new revenues are generally spent in extra talent, this mechanism could be a source of further sport success and therefore it could lead to the creation and preservation of teams 'dynasties'.

In addition, in the existing literature, few studies investigate the determinants of sport performance in the Italian *Serie A*. The first attempt is that of Di Betta and Amenta (2010); it focuses on the 'tradition' as the main factor in determining football success in *Serie A*; the authors consider two measures of success/performance: (*i*) a team's historical ranking; (*ii*) the number of points achieved in each season in the Italian first division. The empirical analysis, that covers the period 1929-2009, shows that *Serie A* is characterized by a "self-reinforcing mechanism" of supremacy. This implies that only ten teams do represent the 'aristocracy' of Italian football. Moreover, Szymanski (2004) considers payrolls and final standings of 27 Italian teams playing in *Serie A* and *B* from 1987 and 2001. He finds that in *Serie A* and *B* in 62% of cases an increase (decrease) in the payroll translated into a better (worse) position in the final standing. In addition, the author compares data on final standing and payroll of Italian professional teams competing in *Serie A* and *B* with those of 29 English teams playing in *Premier League* and in *First Division* from 1991 to 2001. It emerges a strong association between the two variables, without relevant cross-country differences. The only remarkable difference is that the payroll distribution among teams is able to explain the variability of seasonal performances of Italian teams more than the English teams do. In fact, the R-squared associated to the relationships payroll-final position in standing in Italy is .93, while it is .82 for the English context. Szymanski (2004, 161) supports the idea that, in the period under investigation, Italian teams competing in the first two divisions, obtained "more or less" what they have paid for.

The analysis on the payroll-performance relationship for the Italian context was also in Simmons and Forrest (2004) and Forrest and Simmons (2002). In the first, the authors investigate the relationship for English, German and Italian championships, for different time spans, testing for the hypothesis if the increase in the wages spending enhances sport performance.

In particular, findings show that Italian teams – from 1987 to 1999 – have enhanced on-field performances by increasing relative payroll, but at decreasing rate, such as in the English context. Forrest and Simmons (2002) compare the points ratio elasticity to wages in the season 1995/96 with that of the season 2001/02. Interestingly, the elasticities of points ratio and payroll, at the sample mean, were .4 and .2 in the seasons 1995/96 and 2001/02, respectively. The decline of the elasticity is explained by the free agency of players after the Bosman ruling.

Moreover, the Italian context appears to be atypical in the analysis of Frick (2013). The author collected a data set from 13 European leagues for three seasons (2006/07, 2008/09, and 2010/11), in order to make an econometric comparative analysis of the impact of team aggregate wage on position gained in the final standing. The dependent variable is the position in the final standing of team i in season j – weighted by the strength of team's national league.The main explanatory variable is the log of wage bill of team i in season j relative to European average. Results show that the impact of relative payroll on weighted league position is negative and statistically significant for all countries with the exception of Italy.

Our paper provides a novel contribution in two ways: *i*) it combines different streams of the literature on sport success, analysing a variety of factors searching for the best predictor of teams' performances; *ii*) it adopts a variety of estimation techniques (Fixed-Effect and System-GMM). The latter contribution is particularly important as it provides a novel attempt to tackle endogeneity and to assess the direction of the causal nexus in the wage/performance relationship.

3. THE DATA SET

The dataset includes information about Italian football top league championships (*Serie A*) from season 2001/02 to 2014/15. The Italian *Serie A* is an open league composed by 20 teams.[1] At the end of each season the three bottom teams relegate in the lower division (*Serie B*), being replaced by the best three teams of *Serie B*. In sum, the dataset consists of an unbalanced panel of 39 teams.
The dependent variable does proxy performance and success of teams. It is analysed at seasonal level, by means of a measure based on teams' ranking positions at the end of each season, which is calculated as follows:

$$rank_{i,t} = -log\left[\frac{P_{i,t}}{N_t+1-P_{i,t}}\right],$$

where $P_{i,t}$ is the position of team i at the end of season t and N_t is the number of teams competing in season t.[2] This formulation was suggested by Szymanski and Smith (1997) for the English context, and successively applied by Szymanski (2004) to Italian championships; it emphasizes the gap between teams positioned in the top or in the bottom of the final standing with respect to the same gap between team positioned in the middle. Higher values of $rank$ implies better performance.

Following Franck and Nüesch (2011) we also employ an alternative measure of success built on the percentage of points achieved by each team (i) in each tournament (t):

$$points\_pct_{i,t} = \frac{points_{i,t}}{points_t},$$

[1] For details about the organization of Italian *Serie A* see Baroncelli and Caruso (2011).
[2] Note that *Serie A* seasons 2001/02, 2002/03, and 2003/04, enrolled 18 teams; since 2004/05 *Serie A* has enrolled 20 teams.

where $points_t$ is the maximum points achievable in season t. The two alternative variables adopted to capture sport success are strongly correlated (0.964).

As noted above the payroll can be assumed to proxy the available talent of each team. Data on wages are collected from the annual report of *La Gazzetta dello Sport* which provides total wage expenditure of each *Serie A* team.[3] In our estimations, we converted current aggregate wages in *real_wages* (constant €/2014) by using the consumer price index (CPI) provided by the Italian Institute of Statistics (ISTAT).

A second independent variable (*aristocracy*) counts the number of participations of each team in *Serie A* since 1929, including the season under investigation. The introduction of *aristocracy* acknowledges the role of tradition and experience in explaining long run performances of Italian teams, as emerged in previous empirical works. We include five other covariates; as in Bucciol et al. (2014) and Yamamura (2015) we introduce the average age of team players, and in order to consider potential not linear relationship, we also use it squared (*age* and *age_squared*). Moreover, as suggested by Bryson et al. (2014) we also include the share of foreigners players (*foreigners*), searching for potential superstar effect. Again, as in Franck and Nüesch (2011) we consider the total number of players in the roster, including both the linear and squared term (*roster* and *roster_squared*), to account for a possible non-linear relationship: in fact, the size of roster can be positively associated to sport success, by approximating the total team's availability of talent, up to a threshold, since then the effect reverses, due to the concurring detrimental effect on coach's decisions and to the difficult management of locker room's dynamics. Data are drawn from the *Almanacco Illustrato del Calcio* – Panini that provides information about rosters, fixtures and results of all Italian professional championships. The *Almanacco* includes details about players, such as age, nationality, and career. Finally, since the 2004/2005 season the total number of teams taking part to the *Serie A* has been increased to 20, rather than 18, we also include a dummy variable, labelled *18_teams*, that takes the value of unity in seasons characterized by 18 teams. Descriptive statistics are in Table 1.

[3] Missing data have been provided by Giambattista Rossi .

Table 1- Descriptive statistics of main variable						
	Obs.	**Mean**	**Median**	**Std. Dev.**	**Min**	**Max**
rank	274	≈ 0	≈ 0	1.493	-2.996	2.996
log_points_pct	274	0.453	0.421	0.141	0.127	0.895
real wages	274	44.638	24.189	43.610	8.477	190.400
aristocracy	274	41.441	41.500	27.274	1	83
age	274	26.526	26.52	1.378	22.85	30.56
foreigners	274	0.409	0.415	0.187	0.04	0.893
roster	274	27.328	27	2.484	21	37

4. MODEL IDENTIFICATION AND ESTIMATION

A core issues in estimating the effect of payroll on sport performance is given by endogeneity and potential simultaneous causality. As mentioned above, Hall, Szymanski and Zimbalist (2002) highlight this issue in an effort to determine a causal relationship between payroll and sport performance; they find that payroll actually Granger-causes sport performance in English soccer in the period 1974-1999. However, this result does not fully tackle the endogeneity issues implied in the relationship between wage and sport performance. In particular, one team's successful performance in the current season is likely to affect its overall wage bill in the following season: therefore, current level of payroll has to be considered endogenous with respect to past realizations of sport success. A further problem is given by the relative *inertia* of sport performance, i.e. the fact that, *ceteris paribus*, current year performance is likely to be affected by last season's results. Therefore, the identification strategy for estimating the effect of wage on success needs to be included in a dynamic setting. For this reason, in this paper we adopt a set of alternative estimation techniques in order to account for the dynamic setting of the model. The baseline model is constructed starting from the following specification:

$$y_{i,t} = \alpha + \beta_1 \log(real\_wages_{i,t}) + \beta_2 \log(aristocracy_{i,t}) + \beta_3 \log(age_{i,t}) + \beta_4 [\log(age_{i,t})]^2 + \beta_5 \log(foreigners_{i,t}) + \beta_6 \log(roster_{i,t}) + \beta_7 [\log(roster_{i,t})]^2 + \beta_8 18\_teams_t + \mu_i + \varepsilon_{i,t}, \quad (1)$$

where, μ_i is a team-specific time-invariant term, and $\varepsilon_{i,t}$ is the usual stochastic error term. All covariates are logged, so the coefficients can be interpreted in terms of elasticity. The results of the the Hausman test allows to conclude that the inclusion of fixed-effect is preferable, therefore they are included in the model.[4] On the opposite, the appropriate Wald test does not allow to reject the null hypothesis of joint nullity of time-fixed effects (seasonal-dummies),[5] that therefore are not included in the model. As a starting point for our analysis we exploit the within-transformation to implement Fixed-Effect OLS (FE), in order to control for unobserved time-invariant factors: thus, the table presenting estimation results always provides FE estimations in the first column. However, in our dynamic setting, since past realizations of y_i can influence present realizations of $real\_wages_i$, the time-invariant factor (μ_i) is correlated with $y_{i,t}$, thus introducing a dynamic bias in the model that cannot be solved through the demeaning process of within-transformation in FE estimation (Nickell, 1981). This feature of the relationship can be explicitly modelled by including the lagged value of the dependent variable. In this way, we are acknowledging that some *inertia* occurs in the sport success dynamics:

$$y_{i,t} = \alpha + \pi y_{i,t-1} + \beta_1 \log(real\_wages_{i,t}) + \beta_2 \log(aristocracy_{i,t}) + \beta_3 \log(age_{i,t}) + \beta_4 [\log(age_{i,t})]^2 + \beta_5 \log(foreigners_{i,t}) + \beta_6 \log(roster_{i,t}) + \beta_7 [\log(roster_{i,t})]^2 + \beta_8 18\_teams_t + \mu_i + \varepsilon_{i,t}. \qquad (2)$$

Here, the inclusion of $\pi y_{i,t-1}$ makes the dynamic bias more evident. The within-transformation usually applied in the fixed-effect framework, introduces a bias in the estimates, since the lagged dependent variable is correlated with the error term. In order to provide a first solution to this problem, we implement a Fixed-Effect model with Panel-Corrected Standard Errors (PCSE), including an AR1 autocorrelation structure (PSAR1). This technique allows for standard errors to be heteroskedastic and correlated across panels, while at the same time accounting for first order autocorrelation within panels.

[4] The chi-square statistics for the full model specification is 44.99, that allows for rejection of the null hypothesis with $p<0.01$.
[5] The F statistic is .46, hence the null hypothesis of joint nullity of all the season-specific dummies cannot be rejected at conventional levels of statistical significance.

Finally, a System-GMM model is implemented in order to tackle autocorrelation and endogeneity at the same time. System-GMM includes a first-difference transformation that sorts out the constant term and the time-invariant team-specific term:

$$\Delta y_{i,t} = \Delta \pi y_{i,t-1} + \beta_1 \Delta \log(real\_wages_{i,t}) + \beta_2 \Delta \log(aristocracy_{i,t}) + \beta_3 \Delta \log(age_{i,t}) + \beta_4 \Delta[\log(age_{i,t})]^2 + \beta_5 \Delta \log(foreigners_{i,t}) + \beta_6 \Delta \log(roster_{i,t}) + \beta_7 \Delta[\log(roster_{i,t})]^2 + \beta_8 \Delta 18\_teams_t + \Delta \varepsilon_{i,t}. \quad (3)$$

First-differencing removes all constant terms, in particular the team-specific unobserved term.[6] Therefore, an instrumental variable technique is now feasible. Following Arellano and Bond (1991), all the independent variables (taken as endogenous) are instrumented by their own available lags in level (up to 2). In the System-GMM framework, both the level and the differenced equation are instrumented using lags.

The instrumentation illustrated so far exploits all the information available within the dataset in order to sort out potential endogeneity. Finally, clustered robust standard errors are always included in the estimation, in order to allow for within-team correlation of residuals. Furthermore, in order to strengthen our analysis, we have developed an identification strategy to include "standard" exogenous instruments in both equations, as well as the lags of independent variables. Clearly, in this case, the standard IV exclusion restrictions must hold: i.e., the instrumental variables that are excluded from the second stage estimation must be exogenous and correlated with our measure for payroll.

We identified two exogenous instruments (following common IV-technique's notation hereafter we referred to these instruments as "*excluded instruments*", since they are excluded from the main equation) in order to account for potential deep determinants of wages that are not related to sport performance. In particular, payroll can be determined by either environmental conditions, socio-economic factors or both. These indirect effects are channelled through the economic potential of the area in which the hometown is set since more developed/rich areas are more

[6] As a further robustness check, first-differencing is also applied to PCSE estimator (PSAR1-FD) when presenting the main results.

likely to sustain successful sport teams in the long-run. Therefore, we used the following exogenous instruments (both logged) to proxy for geographical and socio-economic conditions:

a) the average altitude of the hometown (*log_alt*). This instrument is used to proxy the weather and more general environmental conditions of the hometown, as potential determinants for economic and social activity, that in turn is likely to affect the chances that the local football team enjoys strong economic support. Higher altitudes are usually associated to more extreme weather conditions as well as to geographical settings that can hinder the development of economic activities. Furthermore, large-sized enterprises are more prone to settle in lowlands rather than in highlands. This is especially true in Italy where the largest part of the terrain is mountainous and industrial clusters are by far located in flatlands. Therefore, it is more likely that a favourable environment for economic activity occurs in lowlands, where, in turn, it is likely to affect local football teams' financial strength: directly, through local entrepreneurs willing to invest in the team; indirectly, through merchandise and match attendance. This in turn will affect teams' payroll. For these reasons, we believe that altitude is a valid exogenous proxy to capture geographical burdens for economic activity that indirectly influence teams' payroll.

b) the number of total extortions (*log_ext*) reported to the public authority in the region where the team is hosted. It can be interpreted as a proxy of the social and institutional environment that team owners have to face when they decide to invest in the area. While *log_alt* relates to the physical geographical burdens on economic activity that indirectly affect payroll, *log_ext* is assumed to capture the burden to local economic development due to criminal activity. In fact, it can discourage entrepreneurs to invest in the area. Following the same rationale presented above, where the social cost of establishing economic activity (approximated by the number of reported extortions) is higher, the detrimental effect discouraging entrepreneurs to invest in the area will in turn depress the chances of higher payroll for local football teams[7].

[7] Caruso (2011) analyzes the relationship between crime and sport in Italy.

The validity of our excluded instruments requires exogeneity and relevance to hold. Both assumptions are tested adopting the appropriate tests after model estimations. However, we provide further evidence that our instruments are conceptually valid in two further ways: (1) by analysing the reduced forms and (2) by inspecting the correlation matrix of relevant variables.

Firstly, in order to test the absence of a direct effect of our chosen exogenous instruments on sport success we estimated the following reduced form of our models:

$$y_{i,t} = \alpha_i + \varphi y_{i,t-1} + \gamma_1(INST_{i,t}) + \gamma_2\log(aristocracy_{i,t}) + \gamma_3\log(age_{i,t}) + \gamma_4[\log(age_{i,t})]^2 + \gamma_5\log(foreigners_{i,t}) + \gamma_6\log(roster_{i,t}) + \gamma_7[\log(roster_{i,t})]^2 + \gamma_8(18_{teams_t}) + \eta_{i,t}. \quad (4)$$

where $INST_{i,t}$ represents the two instrumental variables, α_i is the team-specific constant term; $\gamma_1 \ldots \gamma_8$ are the parameters to be estimated; $\eta_{i,t}$ is the random error component. All the other variables are the same as in (1).

In order to test the strength of our instruments we analyse a reduced form equation in which *log_alt* and *log_ext* directly enter the estimated model of sport success in the first stage: in other words, we implement a fixed-effect model in which the dependent variable is sport performance and *log_alt* and *log_ext* are included among the covariates. The statistical significance of the coefficients associated to these variables would show the direct effect of geographical and socio-cultural proxies on sport success, providing evidence against the validity of our excluded instruments, and that should be indeed included in the main model.

The results of the reduced form estimations for the full sample are in Table 2, for both instrumental variables and proxies of sport success (*rank* and *log_points_pct*). The coefficients associated to the instrumental variables, when directly included in the regression, are never significant: therefore, we can exclude the existence of a statistically significant direct association between our chosen instruments and our dependent variable, and conclude that *log_alt* and *log_ext* can be reasonably used as exogenous instruments to sort out potential endogeneity in our main independent variable, namely payroll.

Table 2- Reduced forms				
Dep. var.	***rank***		***points_pct***	
Instrumental var.:	*log_alt*	*log_ext*	*log_alt*	*log_ext*
	(1)	(2)	(3)	(4)
instrumental var.	0.132	-0.118	0.029	-0.046
	(0.098)	(0.163)	(0.027)	(0.049)
lagged dep. var.	**0.379*** **	**0.368*** **	**0.278*** **	**0.275*** **
	(0.090)	(0.091)	(0.101)	(0.101)
aristocracy	**0.403** **	**0.412*** **	**0.070** **	**0.072** **
	(0.164)	(0.171)	(0.049)	(0.050)
age	-6.319	-16.03	-12.27	-12.18
	(68.91)	(71.56)	(17.77)	(17.83)
age squared	1.204	2.747	1.930	1.928
	(10.60)	(11.01)	(2.717)	(2.724)
foreigners	0.237	0.246	0.027	0.033
	(0.192)	(0.199)	(0.046)	(0.047)
roster	**-66.32*** **	**-65.05** **	**-12.20* **	**-11.90* **
	(24.33)	(24.35)	(4.758)	(4.803)
roster sq.	**9.585*** **	**9.417** **	**1.758* **	**1.714* **
	(3.646)	(3.651)	(0.712)	(0.719)
18_teams	YES	YES	YES	YES
Observations	212	212	212	212
Teams	33	33	33	33
Seasons	14	14	14	14
Team FE	YES	YES	YES	YES
Adj R-Sq. overall	0.512	0.505	0.477	0.458
All variables are logged. Clustered robust standard errors in parenthesis. Level of statistical significance: * 10%, ** 5%, *** 1%.				

Furthermore, we examined the matrix of covariance of our excluded and included variables. In particular, we focused on the correlation between our chosen instrumental variables and our main explanatory variable, i.e. wage, in order to exert the relevance of our instruments: in fact, the lack of correlation between the endogenous variable and its chosen instrument can severely bias the estimation of the structural model (Woolridge, 2010). As Table 3 shows, firstly, the correlation coefficients that describe the relationship between our excluded instruments and our measure of sport success are always statistically significant; secondly they are always larger than the pairwise correlation coefficients of the IV/Dep. Var.

correlation coefficients. Therefore, the relevance of our chosen instrumental variable is supported by data evidence.[8]

Table 3- Pairwise correlation of instrumental variables, dependent variables and main explanatory variable.

Excluded IV	***rank***	***log_points_pct***	***log_real_wages***
Extortion (log_ext)	0.174***	0.184***	0.352***
Altitude (Log_alt)	0.188***	0.209***	0.232***

Note: *** indicates 1% level of statistical significance

Then we implement a System-GMM model in which the dependent variable and the main explanatory variables (i.e. our endogenous variables) are instrumented with 2 period lags. In addition, a set of exogenous instruments are also included in the model. Table 4 shows the results.

Table 4-The effect of payroll on sport performance in the Italian *Serie A* league
Dep. Var: *rank* (2001/02 - 2014/15)

Model	**FE**	**PCSE**		**SYS-GMM**	
		PSAR1	*PSAR1- FD*	*exog.*	*endog.*
	(1)	(2)	(3)	(4)	(5)
real_wages	**0.589***	**0.565*****	**0.553****	**0.634***	**0.831*****
	(0.320)	(0.216)	(0.260)	(0.383)	(0.190)
lagged dep. var.	0.152	0.108	**-0.254****	**0.301***	**0.347*****
	(0.0916)	(0.124)	(0.111)	(0.170)	(0.077)
aristocracy	**-0.872****	**-0.794*****	**-1.672****	0.223	0.096
	(0.424)	(0.229)	(0.816)	(0.189)	(0.128)
age	78.53	129.4	35.06	**73.80****	**67.20****
	(128.3)	(103.7)	(128.5)	(29.26)	(27.49)
age squared	-11.95	-19.80	-5.166	**-11.12****	**-10.34****
	(19.64)	(15.88)	(19.66)	(4.587)	(4.236)
foreigners	0.261	0.370***	0.260	0.177	0.264
	(0.209)	(0.117)	(0.194)	(0.186)	(0.189)
roster	-49.85	-29.97	-53.08*	**-73.75*****	**-65.24****
	(39.30)	(26.68)	(30.08)	(28.23)	(27.12)
roster sq.	7.160	4.206	7.708*	**10.85****	**9.469****
	(5.915)	(4.022)	(4.575)	(4.250)	(4.089)
18_teams	-0.223	-0.175	0.184	-0.062	-0.182
	(0.259)	(0.239)	(0.271)	(0.244)	(0.212)

[8] The discussion about exogeneity of our instruments is postponed to the results' section.

constant	YES	YES	YES	YES	YES
Team FE	YES	YES	YES		
Observations	212	212	167	212	212
Teams	33	33	26	33	33
Seasons	14	14	14	14	14
R-Sq. Within	0.120	0.694	0.192		
Hansen Test df				46	182
Hansen Test (Chi-Sq.)				26.67	23.29
log_alt: Diff.-in-Hansen Test (Chi-Sq.)				1.33	1.26
log_ext: Diff.-in-Hansen Test (Chi-Sq.)				0.23	0.97
AR(1) test (p-value)				0.013	0.001
AR(2) test (p-value)				0.494	0.371

All variables are logged. Clustered robust standard errors in parentheses, unless otherwise specified in model specification column. Model (1) to (4) include a constant term. * p<.1 ** p<.05 *** p<.01.

The first column includes a standard Fixed-Effect estimation, including team-specific fixed-effect; columns (2) and (3) include PSAR1 specifications; columns (4) and (5) show results of the System-GMM models, modelling covariates respectively as exogenous and endogenous. As the table shows, the real wages are always positively and significantly associated to sport success, in all estimated models. More specifically, a one percent increase in *real_wages* is associated to an increase in seasonal performance ranging from 0.56% to 0.59% in the fixed-effect models. The increase is substantially higher in the System-GMM specifications, when endogeneity is fully accounted, ranging from 0.63% to 0.83%.

This result confirms the existing literature on the relationship between payroll and seasonal performance, while providing a stronger contribution for it control for the dynamic features of the relationship as well as for endogeneity (in columns 4 and 5), through the inclusion of exogenous instrumental variables. This point is worth stressing by inspecting the diagnostic statistics for columns (4) and (5) provided at the bottom of Table 4. Firstly, the autocorrelation tests confirm that the dynamic pattern of the model is correctly specified: in fact, the null hypothesis of absence of autocorrelation is rejected, as expected for AR(1), while the p-values

associated to the AR(2) tests confirm that the null hypothesis of no second-order autocorrelation cannot be rejected, hence two-period lags are good instruments.[9]
As for thee excluded instruments (i.e. *log_alt* and *log_ext*), the chi-square statistics of the Hansen tests reported in the bottom of Table 4 consistently confirm the exogeneity of the instruments (none of these statistics is significant at conventional levels), both when considered along with the full set of covariates and endogenous instruments (in column 5) and when they are considered individually: the Diff-in-Hansen tests cannot reject the null hypothesis of exogeneity for both *log_alt* and *log_ext*.

Therefore, Table 4 provides a striking result: our main explanatory variable of interest, namely *real_wages*, is always positively and significantly associated to seasonal performance, and this result is robust to different model specifications and estimation techniques. Furthermore, the results are strengthened by the inclusion of the lagged dependent variable: even controlling for potential *inertia* of the outcome variable, wage remains a strongly significant predictor of sport success.
Regarding the covariates included in our models, some remarks are worth stressing. Firstly, the negative sign associated to *aristocracy*, (in the FE and PCSE model specifications, when the coefficient is statistically significant) suggests that being part of the Italian football's aristocracy has been detrimental in terms of seasonal performances. This contrasts with previous empirical research that considers the aristocracy a key factor to be a top team in *Serie A* in the long run.

Interestingly, when the dynamics of sport success are fully accounted and controlled for in the System-GMM models, the effect associated to *aristocracy* fades out becoming not statistically different from zero. On the contrary, our estimations outline a 'convergence process' among Italian teams with different traditions, opening to new opportunities for 'rising stars' teams. Secondly, in the System-GMM model specifications, *age* is found to be non-linearly associated to success, according to an inverted-U shaped relationship, implying that average age increases sport performance (for instance due to experience, training and learning) up to a maximum threshold, when the increase in age turns to be detrimental. This

[9] First-order autocorrelation cannot be excluded instead, consistently with the dynamic framework of the model: we actually expect that sport success is serially (first-order) correlated. See, among others, Roodman (2007).

threshold in our estimated models spans from 26 (column 5) to 27 (column 4).[10] This relationship is consistent with prevailing empirical results and reflects a potential non-linear association also between talent and age: when a team is relying on too young or too old players, on average, it is signalling, *ceteris paribus*, a smaller availability for talent's remuneration, which typically reaches its top with a player's maturity and then decreases in the final part of his professional career. Finally, *foreigners* is significant only in one model specification, although its coefficient always appears with the expected positive sign, while roster's size is found to be significantly and non-linearly associated to success only in columns 3 to 5.

To provide a robustness check of our results, we rerun all our models specifications adopting an alternative measure of seasonal performance, represented by *ln_points_pct*. Table 5 reports the results.

Table 5- Robustness check. An alternative measure of sport perfomance.
Dep. Var: *log_points_pct* (2001/02 - 2014/15)

Model	**FE**	**PCSE**		**SYS-GMM**	
Specification		*PSAR1*	*PSAR1- FD*	*exog.*	*endog.*
	(1)	(2)	(3)	(4)	(5)
real_wages	**0.141****	**0.130*****	**0.118****	0.101	**0.174*****
	(0.064)	(0.043)	(0.052)	(0.084)	(0.039)
lagged dep. var.	0.090	0.062	**-0.285*****	**0.258***	**0.336*****
	(0.092)	(0.119)	(0.100)	(0.151)	(0.088)
aristocracy	**-0.206****	**-0.206*****	**-0.390****	0.066	0.016
	(0.084)	(0.055)	(0.174)	(0.043)	(0.028)
age	5.415	15.02	-12.45	**11.67***	**11.47****
	(25.39)	(22.22)	(26.59)	(6.218)	(5.682)
age squared	-0.792	-2.274	1.983	**-1.708***	**-1.761****
	(3.887)	(3.395)	(4.060)	(0.969)	(0.865)
foreigners	0.0470	**0.0703*****	0.0325	0.0303	0.0491
	(0.041)	(0.022)	(0.032)	(0.044)	(0.040)
roster	-8.843	-5.621	**-10.37***	**-12.35****	**-11.48****
	(7.788)	(5.378)	(5.509)	(5.980)	(5.645)
roster sq.	1.268	0.793	**1.511***	**1.807****	**1.657***
	(1.172)	(0.812)	(0.837)	(0.898)	(0.847)
18_teams	-0.054	-0.038	0.059	-0.009	-0.043

[10] The threshold, age^*, is simply the maximum of the non-linear function, which is calculated as follows: $age^* = e^{\left(-\frac{\hat{\beta}_3}{2\hat{\beta}_4}\right)}$ where $\hat{\beta}_3$ and $\hat{\beta}_4$ are the estimated coefficients respectively associated to the linear and non-linear terms of age.

	(0.051)	(0.046)	(0.063)	(0.052)	(0.047)
constant	YES	YES	YES		
Team FE	YES	YES	YES	YES	YES
Observations	212	212	167	212	212
Teams	33	33	26	33	33
Seasons	14	14	14	14	14
R-Sq. Within	0.130	0.911	0.211		
Total number of instruments				46	183
Hansen Test (Chi-Sq.)				27.11	21.79
log_alt: Diff.-in-Hansen Test (Chi-Sq.)				3.60	0.14
log_ext: Diff.-in-Hansen Test (Chi-Sq.)				2.92	0.05
AR(1) test (p-value)				0.014	0.001
AR(2) test (p-value)				0.268	0.123

All variables are logged. Clustered robust standard errors in parentheses, unless otherwise specified in model specification column. Model (1) to (4) include a constant term. * p<.1 ** p<.05 *** p<.01.

The use of an alternative dependent variable confirms the robustness of the estimated relationship between aggregate wage and sport success, since all but one coefficients are statistically significant. In particular, the coefficients of *real_wages* are smaller, due to the different dependent variable, implying an increase in seasonal performance ranging from 0.12% to 0.17% when *real_wages* increase by 1%. Again, the diagnostic statistics for the System-GMM specifications confirm the validity of our excluded instrumental variables, supporting our identification strategy. A further evidence about the strength of our results is given by the magnitude and direction of the covariates' coefficients.

The results of the System-GMM specifications highlight two major differences with the FE estimations. Firstly, the magnitude of the coefficients of wage is sensibly larger when performance is measured by *rank*. Similarly, the coefficients of *log_points_pct* are larger as well, although within a more similar range than FE estimates (around .2%). Secondly, *aristocracy* is not significant in the System-GMM specifications, while it is in the FE models, implying that tradition is no more relevant as a determinant of sport performance, in contrast with existing literature, when the dynamic of seasonal performance are fully modelled and accounted for. The interpretation of this results is actually consistent with the fact that in FE estimations a negative coefficient of *aristocracy* implied that the role of tradition fades along time. Yet in the GMM specification the lagged value of success captures a ‘smoothed’ version of tradition. In sum, even after proper instrumentation, payroll is the best predictor of success in Italian *Serie A* and the result is robust to alternative model estimation techniques, alternative measures of success, and to the inclusion of two exogenous instrumental variables.

5. CONCLUSION

This paper investigated the relationship between aggregate wage of players and sport performance in the Italian top professional football league - *Serie A*. The analysis focused on 14 seasons from 2001/2002 to 2014/2015. We combined alternative estimation techniques, in order to test the hypothesis that teams that can afford to pay for it succeed in obtaining better performances.

We first exploited a fixed-effects panel data. We found that payroll is strongly and significantly associated to sport success. This result is robust to alternative measures of success (rank, wins or points associated), to alternative measures of wages and to the inclusion of a set of covariates potentially related to sport performance.

In addition we have addressed the problem of endogeneity. Since current payroll can be endogenous in past success, the paper provided a dynamic specification of the model. Based on the System-GMM framework, this model includes lagged terms of dependent variables and covariates as instruments to control for endogeneity. To further strengthen the analysis, we also included alternative exogenous instruments to control for geographical/environmental factors and for socio-economic factors that could be the actual predictors of success through an indirect effect on payroll. The results from the second step’s analysis confirmed and strengthened the findings: aggregate wage expenditure is a robust predictor of performance and success for Italian professional football teams.

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