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DETERMINANTS OF THE TENNIS PLAYERS' SUCCESS AND THEIR EFFECT ON THE SPORTS ORGANIZATIONS' SUSTAINABILITY*

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Abstract. The article aims to reveal whether the number of tournaments in different categories, GDP, and the average wage impact athletes' success. GDP and average wage are viewed as the factors influencing the financial support of athletes. It allows the players to participate in the tournaments in their home country, increasing the chances of achieving better results. On the other hand, a high average wage can change athletes' decisions to pursue university studies. The main research question is: Which of the selected factors affect the success of juniors, men, and women playing tennis professionally? This was studied on the sample starting with fifty European countries (geographically assigned in this international research perspective). The relationship was corroborated between the number of tournaments organized in the country and the number of athletes from the country in the TOP 100 rankings. The article builds on the previous research works conducted worldwide, focusing on other relevant factors and their effect on the success of professional tennis players. The empirical research focuses on economic factors playing a pivotal role in tennis associations' operation and economic sustainability and other entities involved. Econometric regression modeling was applied to the panel data as a quantitative method to justify the relationships among the variables studied.

Keywords: sport; tennis; tournaments; average wage; GDP

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1. Introduction

Earning a living via sport is a dream for many children. However, this way is long and affected by numerous factors. Looking at the sports system in the USA, less than five percent of high school athletes become collegiate athletes, and only less than three percent of those become professional athletes. A high school athlete's chance of becoming a professional is around 0.001% (Bryan, 2009). Within individual sports, the best-paid athletes are boxers, golfers, and tennis players. Swiss tennis player Roger Federer was the best-paid athlete of 2020 (Gough, 2020). Following the path of a professional athlete is accompanied by decisions from an early age. These are influenced by the environment, traditions, upbringing, and other factors. The impact of the environment on sport and vice versa creates a plethora of possible variations leading to the decision of a young athlete to pick up or give up the sport.

One of the critical factors affecting a young athlete's path toward a professional career is the chance of success (Schmidt et al., 2016). Bringing up successful athletes is an aim of national governing bodies. Associations need successful athletes to gain direct funds bound to their results, attract children, and extend their membership bases to succeed in the future. Even though there are many factors the associations cannot influence, there are others they can control. The article aims to identify the factors affecting tennis players' career trajectories, adding to the previous research, determining factors that can be affected by the national association to support the upbringing of athletes.

The authors are aware that various factors influence athletes' success. The article focuses mainly on those states or tennis associations can control. A question emerged: *Why are fewer TOP 100 athletes in historically successful tennis countries now than in the past?*

This question, revealed during the initial analysis, formed the motivation to address the issue. Therefore, examples of historically most prosperous countries in tennis were selected (Figure 1, Figure 2). In these countries, the number of athletes in the TOP 100 and the stagnation of new faces in the ranking was examined. Based on the graph, the attention was focused on the financial situation, too. The purpose was to create recommendations for associations leading to an effective strategy to improve the case in the short term.

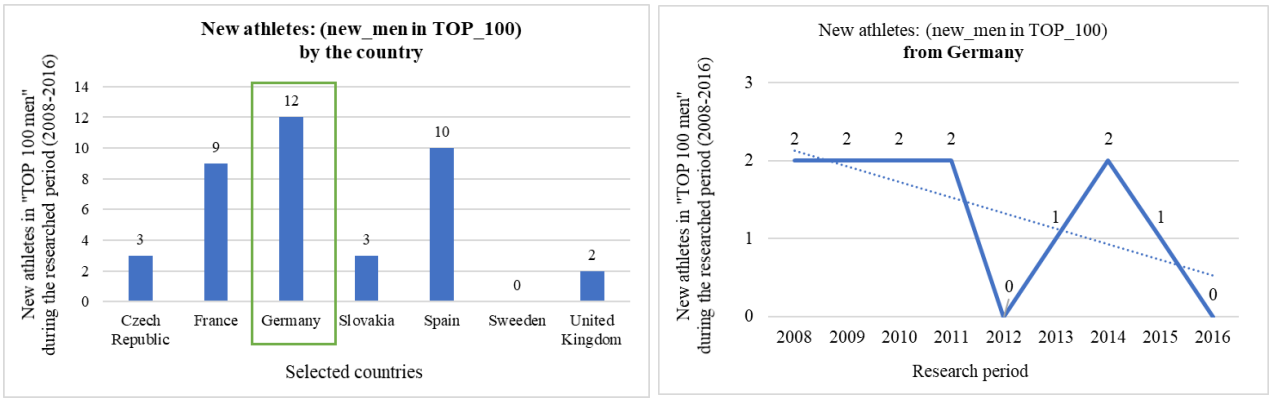

Figure 1. Number of athletes in the TOP 100 ranking (TOP 100 men) for the countries selected (left) and the number of new faces in the ranking for Germany (right) during the analyzed period

Source: own elaboration

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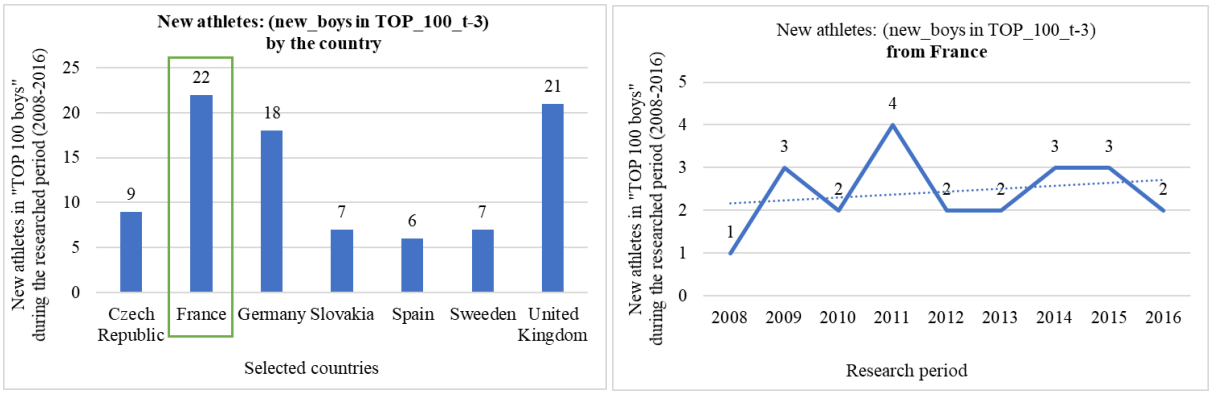

Figure 2. Number of athletes in the TOP 100 ranking (TOP 100 boys) for the countries selected (left) and the number of new faces in the ranking for France (right) during the analyzed period

Source: own elaboration

Specifically, the article focuses on examining the interconnection between the country's economic situation, its ability to organize tennis tournaments, and the final success of the country in this sport. The economic situation is represented by GDP, GDP per capita, and the average wage. The country's success in tennis was defined by the number of athletes placed in the junior and adult rankings and by the annual increase of these variables. This logic presented in the article is captured in Figure 3.

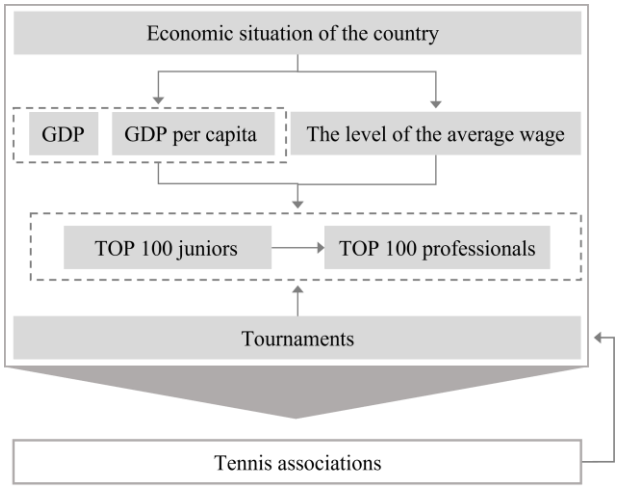

Figure 3. Logical structure underpinning the research

Source: own elaboration

2. Theoretical background

According to the previous research, the factors affecting a young tennis player's path towards being a professional athlete include two main categories. The first are socioeconomic factors, representing the impact of the environment, family, or school on individual athletes, and the state's attitude towards sport. The second group represents a chance for a successful career not only during the junior age.

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2.1 The impact of socioeconomic environment on sport

Several authors focused on the relationship between sport and macroeconomic behavior in developed countries (Erben, 2003) or the economic impact of collegiate (Baade et al., 2011) and professional sport (Storm et al., 2017) on local economies. Leeds & Leeds (2009) studied the impact of the external environment on success in sport. They focused on the impact of a nation's political regime, institutions, and colonial heritage on soccer performance. The effect of a nation's standard of living and culture on success in soccer was examined in other studies. The impact of these factors on a national soccer team's success in international competitions was confirmed by Hoffman et al. (2002) and Foer (2006).

The athletes' motivation to decide on a professional career is also important, as it was concluded in several studies. According to Frey (1988), individuals perceive their chances of becoming top-level athletes as higher than they are. Their surroundings influence young athletes' decision-making. The link between the events of becoming top-level athletes, birthplace, and the size of the community was confirmed by other studies (Bruner et al., 2011; Turnnidge et al., 2014; Imtiaz et al., 2014; Rossing et al., 2016; Hancock et al., 2017; Rossing et al., 2018). Authors observed a trend when young athletes are supported to become elite via selective sports clubs beyond the standard interscholastic sports systems. This approach aims to enhance their skills and showcase their skills in front of scouts (Brenner and Council on Sports Medicine and Fitness, 2007, 2016; LaPrade et al., 2016).

The state's policy can also be aligned with the preparation of elite athletes. It usually sets the rules for allocating funds towards the best athletes, not spending a lot of money on athletes with weaker performance. This contrasts with national federations' approach to building large memberships (De Bosscher et al., 2003).

Schmidt et al. (2016) studied the selection between education and a professional soccer career. They dealt with the impact of socioeconomic factors from a macroeconomic perspective, observing that athletes from countries with lower economic status have a higher tendency to give up their studies in favor of professional sport. They assume that athletes from poorer countries perceive a sports career as significant progress in social status. This means that via playing soccer, they are striving for recognition. On the other hand, in a country with a high living standard, such as Hongkong, the youths are more focused on the academic environment (Shuttleworth & Wan-Ka, 1998; Bridges, 2012; Zheng, 2015). An even more significant effect than the one described above can be observed concerning the socioeconomic status and the impact on the athletes' families.

Families' social status in relation to the child's hockey career was studied by Moret & Ohl (2018). They did not compare sports on an international level but only in Switzerland. According to their findings, for athletes from the upper-middle class, the faith in becoming successful in sport is combined with the family's strategy, assessing the risks in a sports career as a type of entrepreneurship. These athletes have strong support from their families. The family perceives hockey as a good source of social status. Athletes from the lower-middle class aspire to improve their social position via hockey. However, their families are more supportive of education. These athletes have a backup plan applicable after the end of a sports career.

Sletten (2010) studied the athletes from the lower-middle class, stating that the ideology of sport without social barriers is not aligned with reality and Post et al. (2018) agreed. Studying the sports system in the USA, they concluded that year-round participation in the sports process could limit the engagement of children from families without sufficient resources. Regardless of social class, a young athlete is influenced by the family's sports tradition. According to Park et al. (2013), such an intense sports identity can negatively affect study results. This leads to perceiving a young person as an athlete, not a student. The family background also influences the sports children to want to do or the club they wish to join. Especially the USA has unique conditions with an elaborate collegiate system. Selecting a particular university is often the most critical decision in an athlete's life. This

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inspired the authors to study the reasons for choosing a specific university (Goss et al., 2006; Feldman, 2007; Croft, 2008; Puline et al., 2008; Magnusen et al., 2014).

Concerning the past research focused on the athletes' background, family support, their motivation to play tennis professionally, and the wage young people can expect in a specific country, the first preconditions for the research presented emerged. The authors focused on the following perspectives:

(1) With a high wage, parents have money to fund athletes during their career advancement.
(2) With a lower wage, parents want their children to have better conditions and secure themselves via tennis.

This determined the first partial research question: **V_1 – Does the average wage affect the success of junior athletes in tournaments?** The following research question was based on the consideration that the higher the average salary in the country, the more athletes lose their motivation to make a living from sports. The paradox of prosperity applies when athletes from countries with good conditions for performance growth lose their interest in professional sports: **V_2 – Does the average wage in the country affect the motivation of professional athletes to get into the TOP 100?**

2.2 Factors affecting success in tennis

An athlete's career cycle, including transitioning to adult categories, is intertwined with success. This is most frequently deciding whether an athlete will continue competing or switch to another profession. Regarding individual sports such as tennis, one's deficiencies cannot be hidden behind the team's success. Everything depends on the individuals, even if they are surrounded by professional staff. De Bosscher et al. (2003) classify three levels of impact on the tennis player's success. These include *micro-level encompassing genetic predispositions and environment; macro level related to the social background; and meso level including the structure of tournaments, system, and rules.* Crespo et al. (2001) identify competitors as an important factor in athletes' development. According to the authors, all athletes need sufficient opportunities to compete. In tennis, the key position is held by the tournaments. The research on the tournaments' impact on the position of athletes from the countries organizing them was conducted by several authors.

According to Galenson (1993), the total number of tournaments in the countries correlates with the number of male tennis players in the international ranking. Filipcic et al. (2013), focusing on the TOP 300 ranking, found a steadily decreasing correlation over time between the number of tournaments and the position of male athletes in the ATP ranking. They assumed that the athletes from these countries use the tournaments in the neighboring countries. Reid et al. (2007) studied a similar topic in women's tennis. Their study examines the relationship between the number of professional tournaments and the results of professional female athletes from these countries. The authors divided the countries into five subgroups based on the type of tournaments. A positive correlation was detected between the subgroup and the number of female athletes in the ranking. The subgroups correlate with the best five female athletes in the ranking. This means that extensive tournament structures help the nations produce elite female athletes. However, the success of players from the countries such as Russia, the Slovak Republic, and Belgium serves as a reminder that competition opportunities are only one of the components of success.

Other research questions were built on the premise: that the more tournaments the country organizes, the more opportunities home players have for getting the necessary points and advancing in the rankings. In addition, organized tournaments allow athletes to get wild cards. This increases the athletes' confidence that they will participate in the main competition (without taking part in the qualification) or in the qualification (regardless of the points earned). Another advantage of home tournaments is the saving on travel costs. These assumptions led to the following research questions: **V_3 – Does the number of tournaments in the country affect the athletes' success in the TOP 100 ranking?** and **V_4 – If so, which tournaments have the most significant impact?**

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Kovalchik et al. (2017) studied the career trajectory of female players in relation to their age and experience on the professional circuit. The authors detected a strong correlation between the shape of the trajectory and the best placement in the ranking. The athletes who achieved the highest placements during their careers got into the ranking while being juniors. This corroborated the research of Reid & Morris (2011), focusing on the benchmarks between the 16th and 17th years of age of professional players in the TOP 100 ranking. Comparing the interannual placement, the authors assessed the athletes' average progress. They concluded that the athletes aspiring towards the TOP 100 should get their first points in the ATP ranking at the age of 16 or 17, and they should be around 250th place at the age of 19. A more recent work by Reid et al. (2014) broadened this by assessing indicators based on the athletes' highest placement in their careers. The aim was to compare the career trajectories of male athletes who reached the highest professional placement in the ranking between TOP 250 and TOP 10. The study confirms that the placement of athletes who reached different peaks started to differ as early as in the first year on the professional circuit. Therefore, it is possible to predict athletes' placement between TOP 10 and TOP 100 to a certain extent based on their placement in the ranking during the initial phases of their career. Therefore, this article also focuses on examining the relationship between success in junior tennis and success in adult professional tennis. Specifically, the fifth research question was: **V_5 – Does the success of junior athletes affect the success of professional tennis players?**

This is connected to the research by Bane et al. (2014), who compared the career trajectories of athletes between 1985 and 2010. They detected differences between the points when the athletes achieved their first points on the circuit to the moment of getting into TOP 100. This period extended the time athletes spent at the peak of their careers. The athletes stay in the TOP 100 longer. Thus it takes longer for new players to get there. This connection stems from the development in the sports sciences, medicine, training process, and the increase in financial rewards for professional athletes.

Athletes' careers were also studied by Guillaume et al. (2011), focusing on athletes in the TOP 10 and the differences in the number of matches played and won depending on gender during their careers. The relationship between the age at which junior players shall start playing on the international scene and their later success in the adult ranking was studied by Brouwers et al. (2012). However, the age at which the athletes shall start playing to become successful on the professional level was not identified. It is also challenging to determine the age at which the performance could be used as a reliable indicator for the selection of talents. The transition from junior to adult competitions was studied by Reid et al. (2009). These authors studied the possibility of predicting the placement of the players from the TOP 20 of the International Tennis Federation's Junior Circuit in the adult ranking. 99% of female athletes from the junior TOP 20 got in the adult ranking. A high percentage of the junior female athletes from the TOP 20 got into the adult TOP 100 (61.4%). Reid et al. (2007) studied the same focus on boys. In this case, 91% of male athletes from the junior ITF TOP 20 ranking got to the adult professional ranking.

The current research is focused on the influence of the family, state, or environment on young athletes' decision to continue their careers. In tennis, emphasis was also put on the level athletes in junior age must achieve to become adult professionals. This article examines the factors that affect young tennis players, defining those that the national association can influence. *What can an association do? Can it manage the number of tournaments or financially support athletes?*

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3. Research objective and methodology

Based on the research questions, the necessary data were collected. Details are provided in section 3.1. Since the created data set was complex and allowed to examine multiple connections, the authors decided to narrow it down. This was done by correlation analysis of all variables (Figure 4).

This was performed via a correlation matrix. It represented the initial assessment of the logic behind selecting variables needed to test the research hypotheses. Figure 4 illustrates the distinction between negative (blue) and positive relationships (red); saturation represents the relationships' strength. The analysis of the correlation matrix consisted not only of studying it visually but also of evaluating the values.

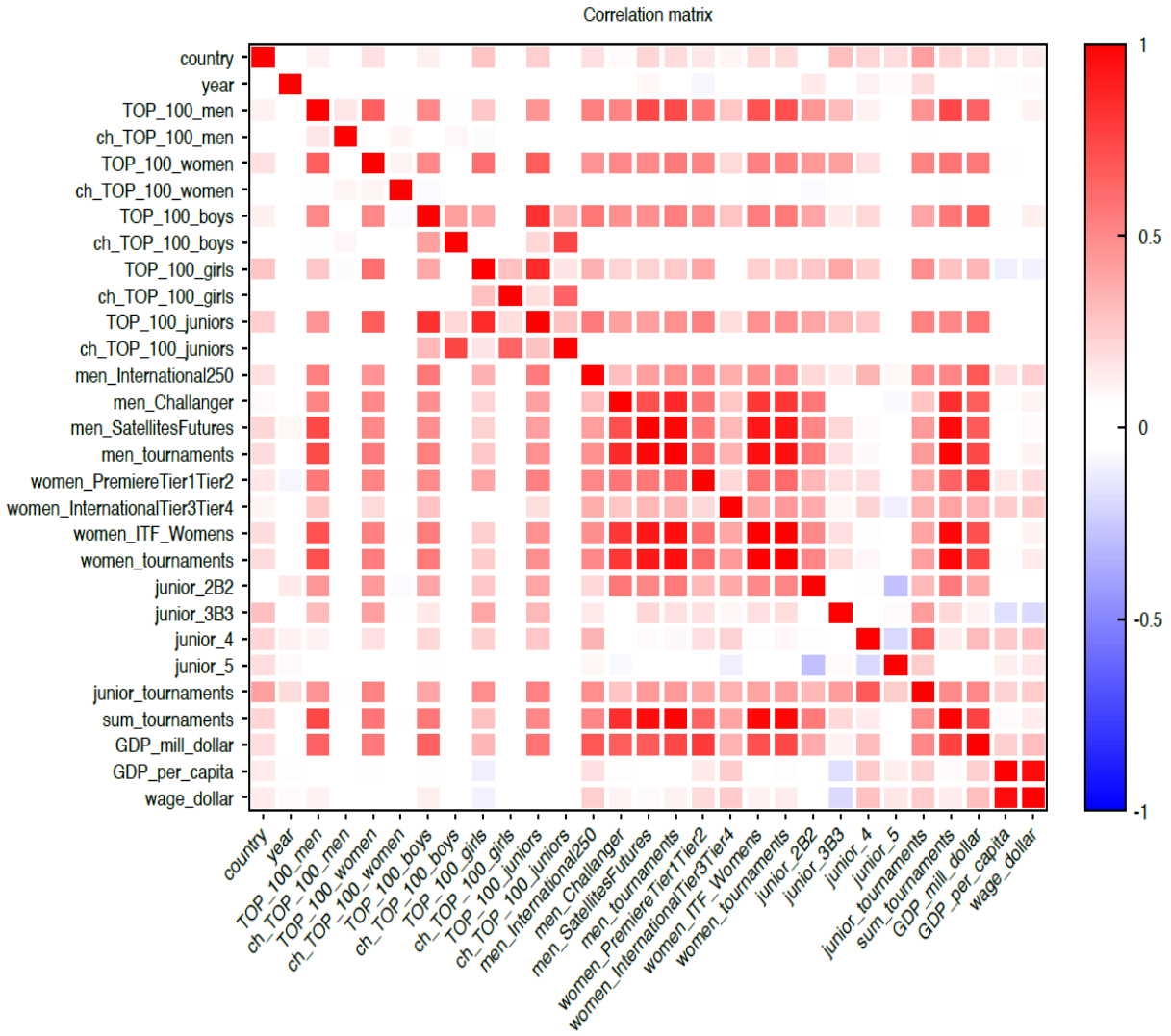

Figure 4. Correlation matrix of all variables obtained
**The variables of the correlation matrix are explained in Appendix A*

Source: own elaboration in Gretl

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The main research area consists of the factors affecting the country's success in tennis which led to the hypotheses defined:

H_1: If a country organizes more tournaments, the number of athletes in the TOP 100 ranking is higher.

H_2: The better the economic situation (represented by GDP and average wage), the more athletes the country has in the TOP 100 ranking.

H_3: If a country has more successful junior athletes, it becomes more successful in adult professional tennis.

3.1 Data description

The research is based on the data collected for 13 years, between 2004 and 2016, including 50 European countries. Data was collected from a historical database of the ITF. The data entries represent the achievements of junior and adult tennis players. They also include the number of tennis tournaments organized by the studied countries. In addition, economic data on GDP, GDP per capita, and average wage per country were collected.
For Serbia and Montenegro, the tournaments before 2006 were added to the countries according to their current geographic division.

The groups of tournaments used in the analysis were created to deal with the changes in the names and classification of the tournaments over time. For example, a group of comparable male tennis tournaments was created by putting together Satellite and Future tournaments. A similar approach was applied to all other types. Certain types were deliberately excluded from the analysis (the Olympics, World Cup team). The canceled tournaments were also excluded. Within junior tournaments, type C and team tournaments were excluded. The numbers of athletes placed in the TOP 100 to 31 December of each year were extracted from the ITF website (2021) and Rank tennis (2021).

The data on the average wage was collected from the UNECE website (2021) in US dollars and calculated using current exchange rates. The GDP and GDP per capita data were also collected in current US dollars. This was retrieved for the selected countries from the World Bank open database (2021).

Based on the data accessibility, the main data set included the data representing 39 countries. After filtering the data using deliberate criteria, there were 21 countries left to be used for other operations. The complementary data set 1 described data points from 28 countries for nine years. The complementary data set the data from 27 countries created 2 during the same time. Details on the filtration and variables included in complementary data sets are listed below.

3.2 Description of the procedure

The methodological approach consisted of three phases – data pre-processing, data analysis, and econometric modeling. Each stage was divided into parts comprising several activities (Figure 5).

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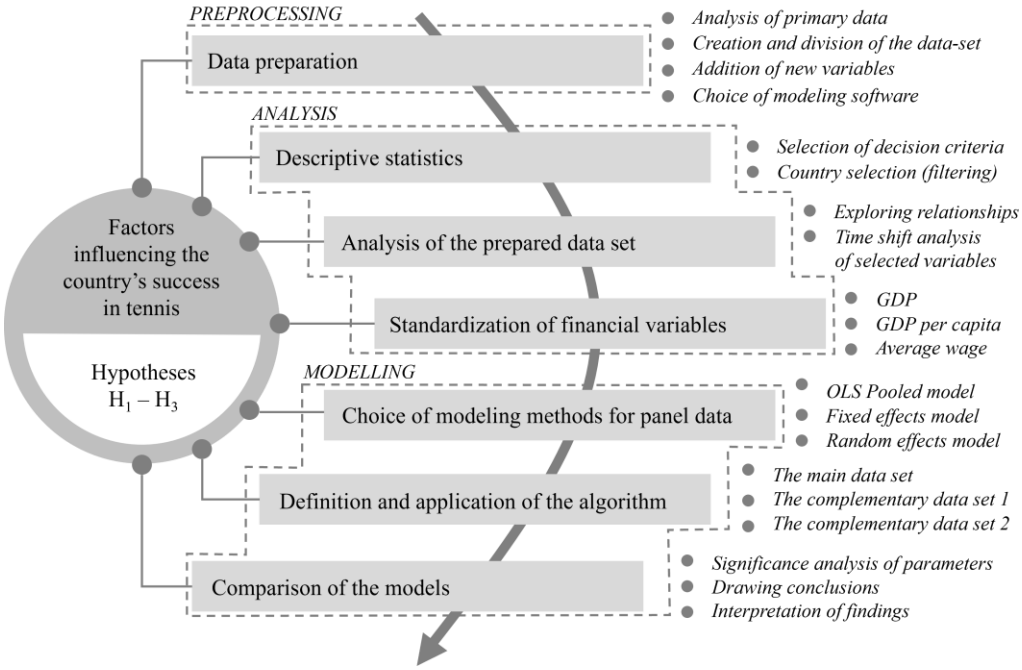

Figure 5. Modeling procedure

Source: own elaboration

The data were divided into three data sets before performing other operations on them: *the main data set, complementary data set 1, and complementary data set 2.* The main data set included all the essential variables to be applied in the modeling. However, other variables were added, created as a sum of the selected variables (e.g., all the men's tournaments), the annual change of the studied variables (e.g., change in TOP 100 men), or the time lag of variables (the lag up to three years: t-1 to t-3). The last activity performed on the main data set was filtering the countries according to the set criteria. These included the average value and the sum of variables entering the models as dependent variables (TOP 100 men, TOP women). The countries with the average value of 0 for at least one of the selected variables and those with the sum of <0;3> for the whole studied period were filtered out for at least one of the selected variables.

The complementary data set 1 included the annual increase in men in the TOP 100 ranking, and the yearly growth in the boys in the TOP 100 ranking lagged by three years (t-3). This shift was deliberately selected in relation to the data collection to capture a period needed for effect to manifest itself (transition from the juniors into the adult category). The same logic was applied to create the complementary data set 2, which covered the situation of female athletes.

Gretl statistical software was selected for working with the panel data structures. One of such operations was data standardization. This was applied to the macroeconomic variables since they differed by magnitude. Standardization allowed to eliminate distortion of the modeling results. The relevant variables were standardized using a standard procedure: (original value – average value)/standard deviation.

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The main part of modeling was the creation and application of the following algorithm:

- selection of the dependent variable and independent variables (conditioned by the logic and the results of correlation analysis),
- application of OLS (ordinary least squares) Pooled model,
- analysis of the parameters' significance and the model's significance accompanied by the study of relevant statistical tests,
- adjustment of the model/elimination of the variables with insignificant,
- selection of the most appropriate model,
- application of panel diagnostics tests,
- analysis of the tests' results,
- assessment of the appropriateness of individual models: OLS model/Fixed effects model/Random effects model,
- creation of the appropriate model using the selected variables,
- verification of the model focusing on three perspectives: *(1) logical, (2) statistical, and (3) econometric:*
  - if the parameters are insignificant, the modeling algorithm is rerun with different variables (statistical verification),
  - if the parameters are significant, the presence of other phenomena is tested (autocorrelation, heteroskedasticity, normality of residues – econometric verification),
    - if the phenomena are present, the model is modified based on the test's results (Between model was applied),
- the selected models with significant parameters were noted as the final models.

The application of the algorithm described led to **88 modeling experiments.** The selected results from the modeling are described below.

4. Results and discussion

The results section is divided according to the data sets used. The initial tool of the analysis was the correlation matrix. This was followed by experimenting with econometric models.

4.1 The results of the main data set analysis

The variables included in the main data set were analyzed to obtain the results presented. Other added variables supplemented the basic variables. The technique of filtering the data based on deliberate criteria was also applied in the modeling.

4.1.1 Results of the selected experiments of the econometric modeling

The application of the procedure described in the methodology led to numerous branches of modeling experiments. A considerable portion of them was not considered successful since they did not bring statistically, econometrically, or logically significant models. This section presents examples of how individual modeling branches ended.

Modeling with the basic data

Among the basic data, relevant variables were selected (number of TOP 100 men, men International 250 tournaments, men Challenger tournaments, men Satellites + Futures, standardized GDP, standardized GDP per capita, and standardized average wage). TOP 100 men represented the dependent variable in the model**ing.** Firstly, the Pooled OLS model was created, in which the variables with insignificant variables were gradually

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eliminated. The panel diagnostics tests were run on this model. The results (joint significance of differing group means: F (38,465) = 46.5891, p-value <0.001; Hausman test statistic: H = 81.2744, p-value <0,001) indicated suitability of a Fixed effects model. After eliminating all the variables with insignificant parameters in this model, the resulting model included only one independent variable – standardized GDP (coefficient = -0.5931; t = -2.284; p-value = 0.0228 **). However, this model was not considered appropriate econometric-wise. Therefore, no further procedure was applied.

Subsequently, the following variables entered the modeling process: the number of TOP 100 women, women Premiere + Tier 1 + Tier 2 tournaments, women International + Tier 3 + Tier 4 tournaments, women ITF Women's tournaments, standardized GDP, standardized GDP per capita, the standardized average wage in the country. **TOP 100 women** were the dependent variable. The modeling procedure started with the Pooled OLS model. After achieving a model with only significant parameters, the panel diagnostics followed. The results (joint significance of differing group means: F (38,464) = 37.9772, p-value <0.001; Hausman test statistic: H = 61.2969, p-value <0.001) indicated the suitability of a Fixed effects model. After eliminating variables with insignificant parameters, two independent variables remained (women Premiere + Tier 1 + Tier 2 tournaments, standardized GDP). The tests for detecting autocorrelation (Wooldridge test: F (1,38) = 27.8375, p-value <0.001), heteroskedasticity (Wald test: Chi-square (39) = 5.63529e+11, p-value = 0), and the normality of residuals (Chi-square (2) = 230.905, p-value = 0) were performed. Autocorrelation and heteroskedasticity were detected, and the residuals were not normally distributed. Therefore, a modification using the Between model followed. The best-resulting model contained one independent variable (women Premiere +Tier 1 + Tier 2 tournaments). The values for this variable were as follows: coefficient = 4.22485; t = 5.544; p-value <0.001 ***. The significance of the whole model was described by the adjusted R2 = 0.439. These results support the premise of a positive impact of the tournaments within the studied categories organized in the country on the number of professional women athletes in the TOP 100 ranking.

Modeling with added variables

The men's tournaments variable was added, representing the sum of all men's tennis tournaments. This entered the modeling with the standardized macroeconomic variables as independent variables. The dependent variable **TOP 100 men.** The algorithm was applied, leading to the best result of this experiment, a Fixed effects model with one independent variable (standardized GDP; coefficient = -0.593147; t = -2.284; p-value = 0.0228**).

For women, the added variable was represented by all women's tournaments. This independent variable entered the modeling process with the standardized macroeconomic variables. The dependent variable was the **TOP 100 women.** The algorithm led to a Fixed effects model, but after the adjustments, only one independent variable remained (standardized GDP; coefficient = -1.06279; t = -3.288; p-value = 0.0011***). This was where the procedure ended for this experiment.

Similarly, a model with the dependent variable **TOP 100 juniors** was created, using the added variable representing all junior tennis tournaments studied. The algorithm led to a Fixed effects model as the best result achieved. Again, this model contained only one independent variable – standardized GDP (coefficient = -0.625486; t = -1.690; p-value = 0.0917*).

Modeling with filtered data

One of the branches of experimenting with the filtered data was working with the sum variable for all men's tournaments. Since this branch was unsuccessful, the research followed the other direction, using variables for individual categories of tournaments separately.

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The algorithm worked with the dependent variable **TOP 100 men** and independent variables (types of men tournaments and standardized GDP). The best result was a Pooled OLS model. It contained two independent variables with significant parameters (at the significance $\alpha = 0.01$). The panel diagnostics tests followed and indicated the suitability of a Fixed effects model. However, the parameters were insignificant. Thus, this experiment ended.

The dependent variable of another experiment using the filtered data was **TOP 100 women.** The independent variables included all studied categories of women's tournaments and standardized macroeconomic indicators. The best result was a Fixed effects model with one independent variable – standardized GDP (coefficient = -1.31483; t = -2.472; p-value = 0.0141**).

Subsequently, a model with the dependent variable **TOP 100 juniors** was created. The independent variables included all studied types of junior tennis tournaments and standardized macroeconomic variables. The best result was a Between model. However, this model did not belong among the final models since it contained only one independent variable – standardized GDP (coefficient = 1.27540; t = 3.200; p-value = 0.0047***). This model had the adjusted R2 = 0.316, representing the extent to which it explained the variability of the data.

4.1.2 Selected final models

The first final model (Table 1) resulted from a successful run of the selected algorithm. The dependent variable in this model was **TOP 100 juniors**, and the independent variables included individual categories of junior tennis tournaments and standardized macroeconomic variables. The Between model was successful in eliminating the previously present autocorrelation Wooldridge: F (1,38) = 20.4815; p-value <0.001) and heteroskedasticity (Chi-square (39) = 6.04376e+11; p-value = 0).

Table 1. Between model with dependent variable Top_100_juniors

Between model, using observations 1-39					
Dependent variable: Top 100 juniors					
Adjusted R^2 = 0.622					
	coefficient	std. error	t-ratio	p-value	sign.
const.	0.945501	0.283796	3.332	0.0020	***
junior G2 + B2 tournaments	0.564562	0.285718	1.976	0.0561	*
junior G3 + B3 tournaments	1.57488	0.427353	3.685	0.0008	***
standardized GDP	1.12597	0.225567	4.992	1.64e-05	***

Source: own elaboration

However, the modification did not achieve residue normality, as evidenced by the test results shown in the graph (Figure 6). Failure to achieve normality limits the possibility of generalizing model results beyond the sample used.

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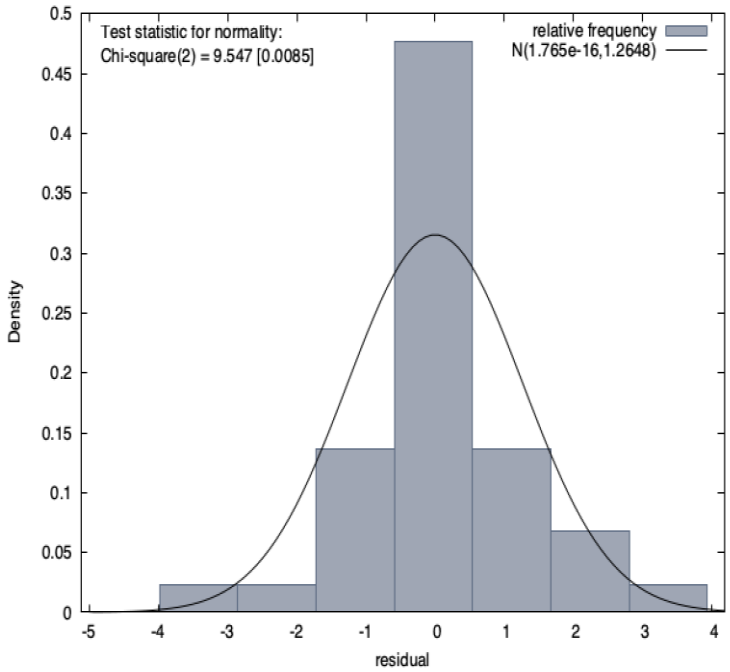

Figure 6. Test for normality of residuals (Between model with dependent variable Top_100_juniors)

Source: own elaboration in Gretl

The model achieved a degree of data variability explanation of more than 60%. The variables with significant parameters at the significance level of 0.01 in the model were: juniors G3 + B3 tournaments and standardized GDP. The results show that their effect on the investigated dependent variable is positive.

The second final model (Table 2.) also included the dependent variable **TOP 100 juniors.** This model was based on analyzing the variables' time shift effect. The previously present autocorrelation (Wooldridge: F (1.38) = 25.0041; p-value <0.001) and heteroskedasticity (Chi-square (39) = 5.24526e+11; p-value = 0) were removed using the Between model.

Table 2. Between model with dependent variable Top_100_juniors, examining a lagged effect of GDP

Between model, using observations 1-39					
Dependent variable: Top 100 juniors					
Adjusted R^2 = 0.608					
	coefficient	std. error	t-ratio	p-value	sign.
const.	1.11253	0.287005	3.876	0.0004	***
standardized GDP (t-3)	1.28337	0.238635	5.378	5.11e-06	***
junior G2 + B2 tournaments	0.478034	0.282850	1.690	0.0999	*
junior G3 + B3 tournaments	1.21708	0.429124	2.836	0.0075	***

Source: own elaboration

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The modification did not achieve the normality of the residues, as evidenced by the test results in Figure 7. Failure to achieve normality limits the generalization of the model's results.

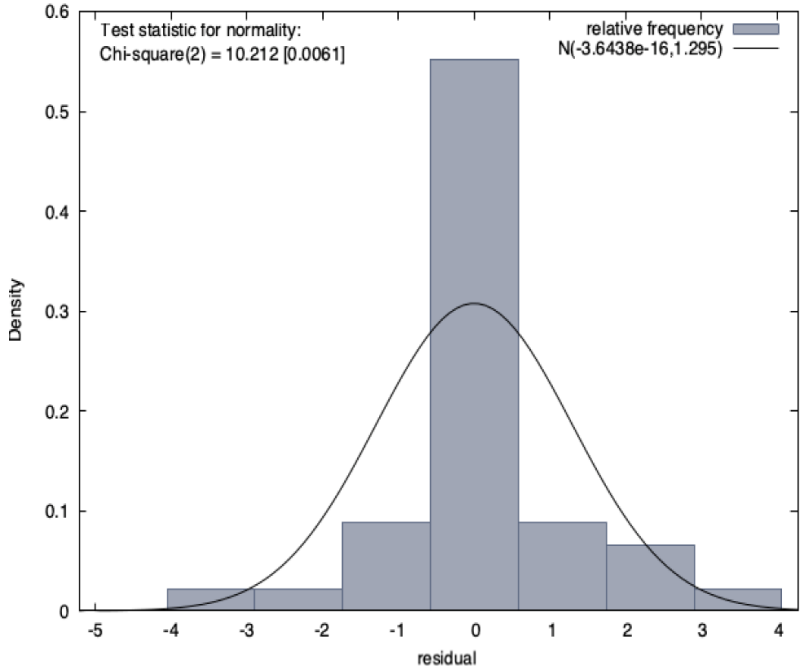

Figure 7. Test for normality of residuals (Between model with dependent variable Top_100_juniors, examining a lagged effect of GDP)

Source: own elaboration in Gretl

The model's explanation rate of data variability is very similar to the previous case (about 60%). The model also describes a similar effect of the explanatory variables on the dependent variable **TOP 100 juniors.** Based on the results, the conclusion is that the country's GDP for the examined variable is consistent over time.

4.2 Results of analyzing the complementary data set 1

A similar approach was applied to the complementary data set 1. The results are presented in a structured manner.

4.2.1 Correlation matrix for the complementary data set 1

The analysis of the correlation matrix represented the first layer of analysis. The logic captured in Figure 8. is identical to the case from the main data set.

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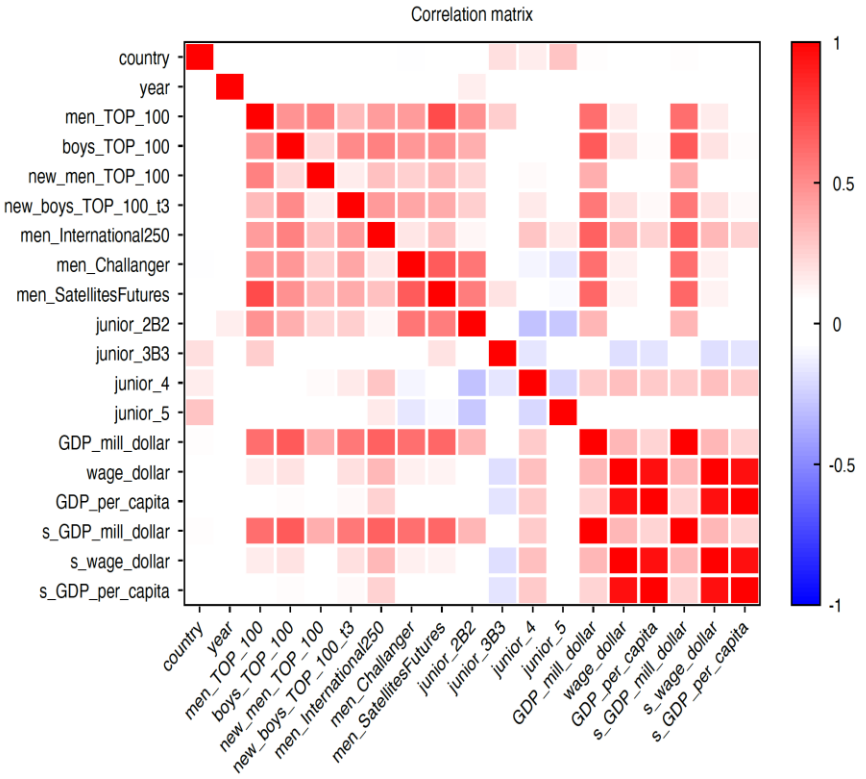

Figure 8. Correlation matrix of variables included in complementary data set 1

Source: own elaboration in Gretl

4.2.2 Results of selected econometric modeling experiments for the complementary data set 1

As described in the methodology, complementary data set 1 provided further insight into the analyzed relationships by examining new faces in the TOP 100 rankings. A Between model was the best result of several modeling experiments using this data set. The first assumption of this model was the Pooled OLS model, where the **new TOP 100 men** entered as the dependent variable. Based on previous experiments, the independent variables included: new boys TOP 100 t-3, men International 250 tournament, men Satellites + Futures tournament, standardized GDP t-3, and the standardized average wage t-3. Finally, in the Between model, the standardized GDP t-3 (coefficient = 0.236219; t = 5.127; p-value <0.001 ***) remained the only variable with a significant parameter. The explanation rate of data variability by the model is represented by adjusted R2 = 0.484. The model was not chosen as final.

4.2.3 Selected final models for the complementary data set 1

The third final model was obtained by modification using the Between model estimator. It was based on the OLS Pooled model, where the dependent variable was **new TOP 100 men** (new faces in the ranking). Independent variables included: macroeconomic indicators, men's tennis tournaments and new faces among boys in the TOP 100 t-3.

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In the final Between model (Table 3.), there were two explanatory variables: men Satellites + Futures tournaments and standardized GDP. The parameter for the variable standardized GDP had a higher degree of significance. The adjusted R2 of the model was above the 50% level.

Table 3. Between model with dependent variable new Top_100_men

Between model, using observations 1-28					
Dependent variable: new Top 100 men					
Adjusted R^2 = 0.545					
	coefficient	std. error	t-ratio	p-value	sign.
const.	0.213793	0.0714761	2.991	0.0062	***
men Satellites + Futures tournaments	0.0121539	0.00624031	1.948	0.0628	*
standardized GDP	0.164344	0.0575864	2.854	0.0086	***

Source: own elaboration

This modification removed previously present heteroskedasticity (Wald test: Chi-square (28) = 6.63373e + 07; p-value = 0) and achieved normality of residues (test results shown in the Figure 9.). Autocorrelation was not present before the modification (Wooldridge test: t (27) = -0.533269; p-value = 0.59821). The model indicates a positive, albeit very weak, impact of the given categories of tournaments on the examined dependent variable.

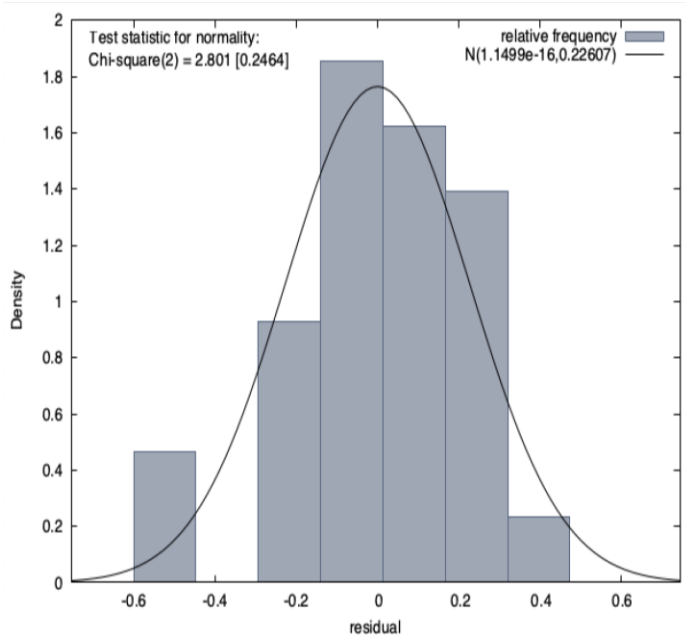

Figure 9. Test for normality of residuals (Between model with dependent variable Top_100_men)

Source: own elaboration in Gretl

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4.3 Results of analysing the complementary data set 2

Finally, the last section of results shows the analysis of the second complementary data set, including new variables described in the methodology.

4.3.1 Correlation matrix for the complementary data set 2

Based on the correlation analysis, relationships were selected for closer examination via modelling (Figure 10.).

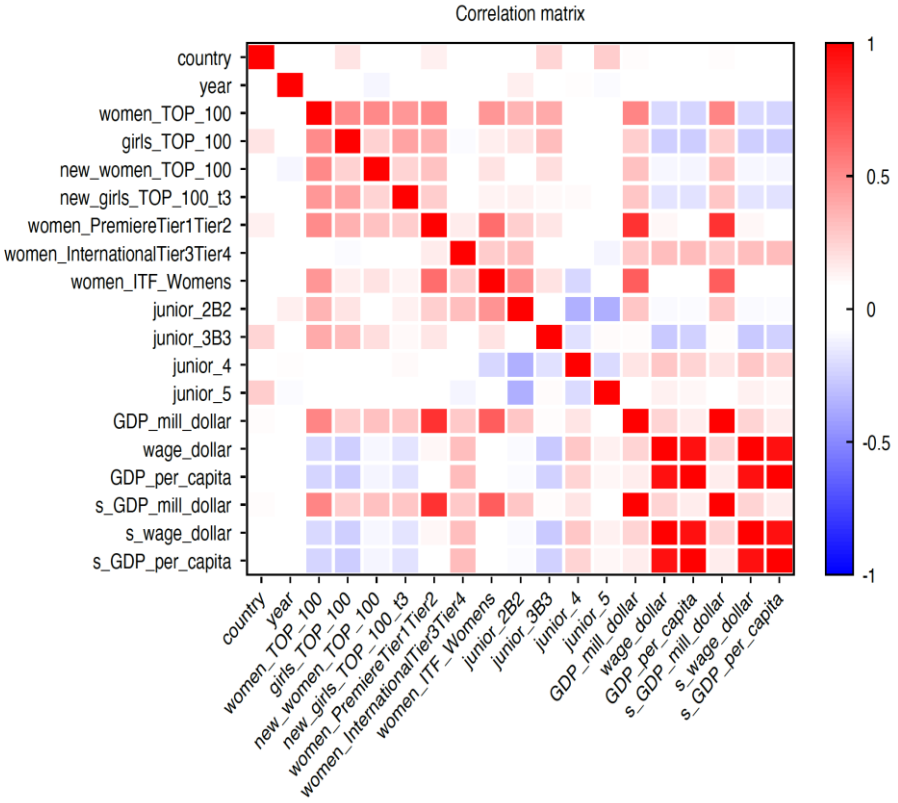

Figure 10. Correlation matrix of variables included in complementary data set 2

Source: own elaboration in Gretl

4.3.2 Results of selected econometric modelling experiments for the complementary data set 2

Within this branch of modelling experiments, the best result was the Fixed effects model, derived from the Pooled OLS model. The initial model contained the dependent variable **TOP 100 women** and the independent variables included: new girls TOP 100 t-3, standardized GDP, and all women's tournaments. However, the resulting Fixed effects model contained only one explanatory variable with a significant parameter – standardized GDP (coefficient = - 0.557090; t = -2.026; p-value = 0.044 **).

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4.3.3 Selected final models for the complementary data set 2

The starting point for the last final model (a Between model – Table 4.) was the Pooled OLS model with the dependent variable **new TOP 100 women.** In this case, the independent variables were women's tournaments, new girls TOP 100 t-3, and standardized macroeconomic indicators t-3.

Table 4. Between model with dependent variable new Top_100_women

Between model, using observations 1-27					
Dependent variable: new Top 100 women					
Adjusted R^2 = 0.489					
	coefficient	std. error	t-ratio	p-value	sign.
const.	0.328833	0.0412069	7.980	3.30e-08	***
standardized GDP (t-3)	0.214953	0.0443092	4.851	6.06e-05	***
standardized wage (t-3)	-0.122668	0.0425119	-2.886	0.0081	***

Source: own elaboration

Modification using the between model removed previously present heteroskedasticity (Wald test: Chi-square (27) = 978418; p value = 0) and led to achieving residue normality (Figure 11; Chi-square (2) = 1,426; p value = 0.49006). Autocorrelation was not present before the model modification (Wooldridge test: t (26) = 0.795036; p value = 0.433791).

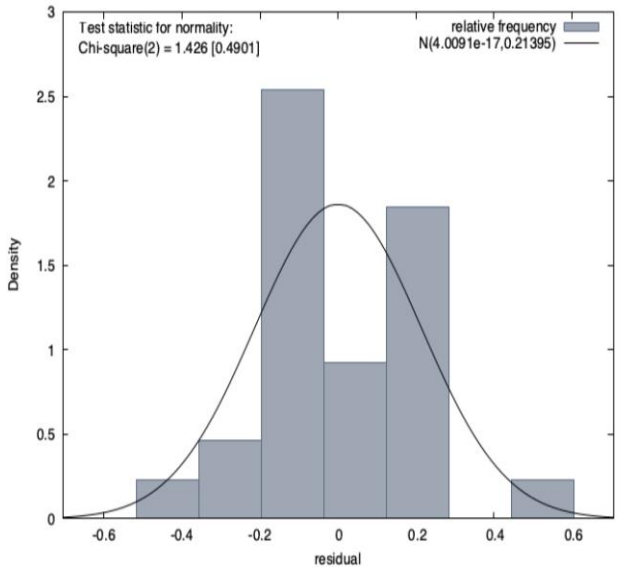

Figure 11. Test for normality of residuals (Between models with dependent variable Top_100_women)

Source: own elaboration in Gretl

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Both variables in the model affect the dependent variable. The lagged impact of standardized GDP is positive, as in the previous case. The lagged effect of the average wage in the country on the dependent variable is negative.

Results of the hypotheses' testing
Synthesizing all the results in the form of final models, the testing of the research hypotheses came to these conclusions:

- hypothesis H_1 was confirmed,
- hypothesis H_2 was explicitly confirmed for men and junior athletes,
- hypothesis H_3 could not be confirmed by the research.

Discussion

Becoming a professional athlete is a childhood dream. Tennis is the most popular individual sport (Gough, 2020). However, the fulfillment of this dream is affected by numerous factors. The previous research on this topic focused on several aspects. The first was the relationship between the standard of living, political situation, and the country's culture toward sport (Erben, 2003; Foer, 2006; Leeds & Leeds, 2009; Baade et al., 2011; Storm et al., 2017). Another aspect was represented by various impacts on the athlete's decision-making in a professional career. An important role is played by motivation and life values (Frey, 1988; Goss et al., 2006; Feldman, 2007; Croft, 2008; Puline et al., 2008; Magnusen et al., 2014), the impact on the environment (Bruner et al., 2011; Turnnidge et al., 2014; Imtiaz et al., 2014; Rossing et al., 2016; Hancock et al., 2017; Rossing et al., 2018), the upbringing of elite athletes (De Bosscher et al., 2003; Brenner and Council on Sports Medicine and Fitness, 2007; Brenner and Council on Sports Medicine and Fitness, 2016; LaPrade et al., 2016), the macroeconomic situation (Shuttleworth & Wan-Ka, 1998; Bridges, 2012; Zheng, 2015; Sascha et al., 2016; Moret & Ohl, 2018), and the family's socioeconomic position (Sletten, 2010; Park et al., 2013; Moret & Ohl, 2018; Post et al., 2018).

The previous research studying the factors affecting success in tennis (De Bosscher et al., 2003) also focused on the competitive environment based on the number of tournaments (Galenson, 1993; Crespo et al., 2001; Reid et al., 2007; Filipcic et al., 2013). The second factor was the level of quality the junior players must achieve to continue in their adult professional careers (Reid et al., 2006; Reid et al., 2009; Brouwers et al., 2012), followed by its trajectory (Guillaume et al., 2011; Reid & Morris, 2011; Reid et al., 2014; Bane et al., 2014; Kovalchik et al., 2017;). Other research works focused on social and economic factors affecting the athlete's career. These included the impact of the macroeconomic and political situation. The latest research projects from around the world within the sports management field also studied the topic of sports organizations' sustainability. They examined its various aspects such as social responsibility (Barbu et al., 2022), impact on the environment (Moon, et al., 2022), economic issues (Lesch et al., 2022), sustainable tourism (Tsekouropoulos et al., 2022), but also the sustainable psychological well-being of athletes (Jovanovic et al., 2022). The last aspect listed is connected to human potential management and its application within the broader sports management field, being closely linked to the research presented in this article.

The problem is the high costs of a successful tennis player's development. It is justified to study the possibilities of the parents to financially support their children in this sport. The study of the impact of the average wage in the country on the success of junior tennis players was based on the presumption that its level positively affects athletes' success because of the funds the parents can use to pay for the training, tournaments, and traveling. The results showed that the success of junior athletes is not significantly affected by the average wage in the country. The research included the study of the number of male and female junior athletes in the TOP 100 ranking. This was followed by the study of the impact of the average wage in the country on the success of adult professional athletes on the men's and women's circuits. The presumption was that a higher average salary in the country lowers the motivation of tennis players to continue in their careers. This is aligned with the results achieved by Zheng (2015), Bridges (2012), and Shuttleworth & Wan-Ka (1998), who concluded that people living in countries

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with a higher living standard focus on sport less. Sascha et al. (2016) focused on a different perspective, revealing that athletes from poorer countries see sport as an opportunity to improve their social status.

Another critical factor is the competitive environment. Athletes test their skills in sports duels. In tennis, there is a system of tournaments where athletes can play several matches during a few consecutive days. A higher number of tournaments in a country means a better chance to compare the skills, leading to faster progress. This is also related to the socioeconomic background of players since a higher number of tournaments in the home country means lower costs of traveling and accommodation. From this perspective, the relationship between the number of tournaments and the number of players in the TOP 100 was studied for junior and adult athletes. It can be stated that there is a statistically significant relationship between the number of tournaments organized in the country and the success of its tennis players. This finding further confirms the conclusions reached by Gleeson (1993) & Filipcic et al. (2013). Since the research indicates that the number of tournaments influences the quality of the athletes' base, it is also relevant to study the ability of the countries to organize these tournaments. This represents a financially demanding activity.

The research results add new knowledge to the previous works dealing with socioeconomic factors affecting individuals' professional sports activity. Novel aspects are represented by the focus on both genders in junior and adult professional sports and the relationship between the success of the athletes and their competitive environment. The length of the period analyzed led to enough data points for relevant statistical results. Even though the article focuses specifically on tennis, conclusions can be applied to other individual sports based on similar principles.

Conclusions

The research focuses on the success of junior and adult tennis players. The factors influencing it can be divided into two groups, economic and competitive. The main findings include the corroboration of the relationship between the number of tournaments organized in the country and the number of athletes from the country in the TOP 100 rankings. These results, focusing on the macro-level perspective, bring a more comprehensive view of the issue and help tennis federations to develop a concept for preparing successful athletes. It should be focused on the creation of a competitive environment with a high number of tournaments.

Model 1 – The success of the junior athletes is influenced by GDP and tournaments organized by the country in the G2 and G3 categories

Athletes get more points in G2 and G3 tournaments than in G4 and G5 categories, so they need to win fewer matches. A G2 winner has 200 points, and a G5 winner only 30 points (ITF, 2021). If the country organizes these tournaments, home athletes have a higher chance to get wild cards, thus play better matches and get more points when they win in the first round (at a G2 tournament, it is 18 points, and at a G5 tournament, it is 0). Athletes who achieve points this way have a better starting position to get into the tournaments abroad, or they do not have to participate in qualifiers. This gives athletes greater comfort and confidence. In addition, these tournaments are easier to plan and require fewer funds since tournaments from G3 or higher must provide hospitality for the participants. The impact of GDP on the number of G2 and G3 tournaments is related to this, as they are more costly. The level of GDP in the country has an impact on the willingness of sponsors to support young athletes, too.

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Model 2 – The success of male adult athletes is influenced by GDP and tournaments in a country in the ITF M15 and M25 category

In these tournaments, athletes gain their first ATP points and move to professional tennis. Here, home players are more likely to get wild cards and become confident that they will participate in a tournament. This eliminates the frustration of not getting to tournaments and increases comfort by making it easier to plan a tournament calendar for individual athletes. GDP affects the willingness of sponsors to support athletes and the organization of tournaments. The costs of organizing a $15,000 tournament are around $25,000, so it is not easy to raise the money. The question is why the organization of higher-subsidized tournaments, such as the *ATP Challenger* or the *ATP Tour,* did not positively impact athlete success. The answer can be found in the quality of athletes on the ATP circuit, where it is much harder to prevail; therefore, athletes must come prepared from the circuit with a lower subsidy.

Model 3 – The success of female adult athletes is influenced by GDP and the average wage

This result can be considered intriguing but explainable. According to the ITF, WTA, and ATP calendars, there are fewer women's tournaments than men's tournaments. This played a role in the statistical evaluation – *low number of tournaments organized, incomparable samples.* On the other hand, the impact of GDP and average wage may signal the need to get sponsors, or the family members must support athletes to travel abroad to participate in the tournaments. Another question is whether lower wages in the country do not incentivize women athletes to make a living at tennis.

Focusing on a specific sport and the system of competitions is the main limitation of the research. It prevents further generalization of conclusions for the whole sport. Another limitation is the period studied. A longer period could provide a more complex picture. Future research can focus on verifying the findings achieved via the analysis of the impact of socioeconomic factors and the competitive environment on the athletes' success in other individual sports. Other opportunities include broadening the scope and studying other countries or going deeper and selecting fewer countries with similar attributes, adding other factors to be examined such as the size of the country of interest in tennis (size of the player base, number of registered tennis players in relation to the number of citizens). Subsequent model creation for these countries and selection of the best model will form the basis for deriving measures other countries could take based on the selected model.

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Appendix A – List and description of the variables used in the research (Figure 4)

Country	… country of athletes' origin (country they represent)
Year	… specific year within the studied period
TOP_100_men (men_TOP_100)	… number of male athletes from the country in the TOP 100 ranking
ch_TOP_100_men	… annual change in the TOP 100 ranking of male athletes
new_men_TOP_100	… new faces in the TOP 100 ranking of male athletes
TOP_100_women (women_TOP_100)	… number of female athletes from the country in the TOP 100 ranking
ch_TOP_100_women	… annual change in the TOP 100 ranking of female athletes
new_women_TOP_100	… new faces in the TOP 100 ranking of female athletes
TOP_100_boys (boys_TOP_100)	… number of junior male athletes from the country in the TOP 100 ranking
ch_TOP_100_boys	… annual change in the TOP 100 ranking of junior male athletes
new_boys_TOP_100	… new faces in the TOP 100 ranking of junior male athletes
TOP_100_girls (girls_TOP_100)	… number of junior female athletes from the country in the TOP 100 ranking
ch_TOP_100_girls	… annual change in the TOP 100 ranking of junior female athletes
new_girls_TOP_100	… new faces in the TOP 100 ranking of junior female athletes
TOP_100_juniors	… number of junior athletes from the country in the TOP 100 ranking
ch_TOP_100_juniors	… annual change in the TOP 100 ranking of junior athletes
men_International250	… number of International 250 tournaments organized in the country
men_Challenger	… number of Challenger tournaments organized in the country
men_SatellitesFutures	… number of Satellites and Futures tournaments organized in the country
men_tournaments	… number of tennis tournaments for men organized in the country (sum of all the categories analysed)

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women_PremiereTier1Tier2	… number of Premiere, Tier1, and Tier2 tournaments organized in the country
women_InternationalTier3Tier4	… number of International, Tier3, and Tier4 tournaments organized in the country
women_ITF_Womens	… number of ITF tournaments organized in the country
women_tournaments	… number of tennis tournaments for women organized in the country (sum of all the categories analysed)
junior_2B2	… number of G_2 and B_2 tournaments organized in the country
junior_3B3	… number of G_3 and B_3 tournaments organized in the country
junior_4	… number of G_4 tournaments organized in the country
junior_5	… number of G_5 tournaments organized in the country
junior_tournaments	… number of tennis tournaments for junior players organized in the country (sum of all the categories analysed)
sum_tournaments	… number of all tennis tournaments organized in the country (sum of all the categories analysed)
GDP_mill_dollar of US dollars	… financial value of GDP in millions
GDP_per_capita	… financial value of GDP per capita in US dollars
wage_dollar	… financial value of average wage in US dollars
s_GDP_mill_dollar	… standardized financial value of GDP in millions of US dollars
s_GDP_per_capita	… standardized financial value of GDP per capita in US dollars
s_wage_dollar	… standardized financial value of average wage in US dollars

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