# Athens Journal of Sports

**Front Pages**

# Athens Journal of Sports

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The **Athens Journal of Sports (AJSPO)** is an Open Access quarterly double-blind peer reviewed journal and considers papers from all areas of sports and related sciences. Many of the papers published in this journal have been presented at the various conferences sponsored by the Sport, Exercise, & Kinesiology Unit of the **Athens Institute for Education and Research (ATINER)** & the Panhellenic Association of Sports Economists and Managers (PASEM). All papers are subject to ATINER's Publication Ethical Policy and Statement.

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The current issue is the first of the eleventh volume of the *Athens Journal of Sports,* published by the [Sport, Exercise, & Kinesiology Unit]() of the ATINER under the aegis of the Panhellenic Association of Sports Economists and Managers (PASEM).


Gregory T. Papanikos, President, ATINER.

# Athens Institute for Education and Research

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### Important Dates
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# Gadamer's Hermeneutic Universality of Play: The Greatest Form of Human Play is Art and its Signification to Movement Education

## By Maria Kosma[*]

*Given that playful movement can be long-lasting and lead to health and well-being, the purpose of this concept-based paper was to showcase Gadamer's hermeneutic universality of play, including the reasons the highest form of human play is art. Specifically, Gadamer's universal elements of play are discussed, including its seriousness, non-purposeful nature, unique spirit, self-representation, and ideality via arts. The highest form of human play takes precedence in the arts because it represents the true before a participating audience. Subsequently, artistic play is timeless like the celebration of the festival whereby its playful nature sustains over time regardless of the way it is represented and experienced. In this paper, we also showcase how performing arts like dancing, aerial dancing, and physical theater encompass the universal qualities of play which assist with understanding the links among performing arts, the love of movement, health, and well-being. Therefore, key implications in movement education are proposed, including the need to incorporate corporeally expressed artistic, creative pieces (highest form of human play) within different settings like schools, sports clubs, recreational venues, and rehabilitation centers.*

**Keywords**: *Universality of play; art as the ideality of play; Gadamer; performing arts; movement education*

## Introduction

In his attempt to challenge the notion that universality in knowledge can be achieved only via the scientific method used in natural sciences (see also Wilson, 2022), Gadamer in his magnum opus *Truth and Method* showcased that there is universality in social sciences like in understanding human play (Gadamer, 1975/2012). Play constitutes movement and playful movement is part of culture and society; it is part of human nature (Gadamer, 1975/2012; Huizinga, 1950; Kosma, 2021; Sartre, 2003). Based on Gadamer (1975/2012), the highest form of human play is art, like the played festival, which is timeless and enduring. Therefore, the purpose of this paper was to showcase Gadamer's universal elements of play, including the reasons the highest form of human play is art. Given that performing arts incorporate all elements of human play like its seriousness, non-purposeful nature, fluid structure, timeless self-representation, and artistic expression of the true before a participating audience, implications for movement education are proposed. It is key to re-imagine movement programming by incorporating artistic, expressive, bodily elements across a variety of settings

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(e.g., schools, retirement and rehabilitation centers, recreational venues, and health and sports clubs). In this way, movement programs can be exciting for people to participate. Understanding the playful nature of physical culture via artistic play within movement programs can lead to meaningful, long-lasting physical activity participation linked to the love of movement, health, and well-being (Kosma & Erickson, 2020a, 2020b; Kosma et al., 2023a, 2023b; Kosma et al., 2021a, 2021b).

This concept-based paper is divided into five sections that showcase Gadamer's universality of play and its strong links to arts and performing arts. In this way, effective exercise programs can be developed and implemented for the love of movement, health, and well-being. In the first section, Gadamer's hermeneutic universality of play is explained by showcasing that the nature of play has key characteristics for *all* cultures (e.g., play is serious; it has no purpose; it has its own spirit/world; it is self-represented with its higher form being art). In the second section of the paper, I discuss in detail why art is the highest form of human play. Artistic work represents the true nature of play like in drama and festivals with strong links to real life as recognized by both the performers and spectators. In the third section, I showcase that artistic events like the festival are timeless; thus, their play is also timeless/contemporaneous. In the last two sections, I examine how performing arts encompass the universal qualities of play which assist with understanding the links among performing arts, the love of movement, and health. Subsequently, key implications in movement education are shared, including the importance to incorporate artistic, creative, and corporeally expressive activities within different settings that involve skill development and learning, fitness, games, recreation, and rehabilitation. Creative and arty movement programs can encompass the highest form of human play; thus, leading to the love of movement, health, and well-being.

**The Universality of Play**

Contrary to the emphasis on the subjective experiences of play in Kantian thought and modern research inquiries, Gadamer (1975/2012) showcased that hermeneutically play has universal elements and a holistic structure that reaches ideality in the arts. Based on Gadamer's magnum opus, *Truth and Method*, play has universal elements that attract the players to its magic. Although the subjective experiences of the players may vary, it is the universality of play that results in such a variety of practices and understandings. Therefore, Gadamer's key universal elements of play will be described below that explain the love of playful movement (Kosma, 2021). Inspired by the work of Huizinga, *Homo Ludens* (1950), Gadamer's key elements of play are as follows:

1. Play is serious.
2. Play has no purpose; its to-and-fro movement is endless/infinite.
3. Play's outcome is unknown, so there is risk.
4. Play has its own spirit (e.g., rules, regulations, and a playing field).
5. Play is self-represented.

6. Play represents the true and involves participating spectators, thus its highest form is art.

Based on Gadamer (1975/2012), an important element of play that justifies its hermeneutic universality – vs. the players' subjective views as studied mainly in modern scientific inquiries – is that **play is *serious***. Although the player may think that play is not serious (Kosma et al., 2023a), play is very serious, and this is why it "gives play its 'purpose'", which is nothing else than for its own sake, for "recreation" (Aristotle, 350 BCE/1962; Gadamer, 1975/2012. p. 102; Huizinga, 1950; Kosma, 2021; Kosma et al., 2023a).

> "Seriousness is not merely something that calls us away from play; rather, seriousness in play is necessary to make the play wholly play. Someone who does not take the game seriously is a spoilsport. The mode of being of play does not allow the player to behave toward play as if toward an object. The player knows very well what play is… but he does not know what exactly he 'knows' in knowing that" (Gadamer, 1975/2012, p. 103).

One cannot rely on the subjective reflections of the player to understand the nature of play. Rather, "play has its own essence, independent of the consciousness of those who play" (Gadamer, 1975/2012, p. 103). The players simply represent play, but they are "not the subjects of play" (Gadamer, 1975/2012, p. 103). "The actual subject of play is not the subjectivity of an individual who, among other activities, also plays, but is instead the play itself" (Gadamer, 1975/2012, p. 104).

Gadamer's second universal element of play is its purposelessness. The essence of play is its "***to-and-fro movement*** that is not tied to any goal that would bring it to an end..; rather it renews itself in constant repetition" (Gadamer, 1975/2012, p. 104). Ball games are an excellent example of the infinite to-and-fro movement because "the ball is freely mobile in every direction, appearing to do surprising things of its own accord" (Gadamer, 1975/2012, p. 106). This *endless* to-and-fro movement is proof of play's ***absence of purpose*** (Gadamer, 1975/2012; Huizinga, 1950; Kosma, 2021; Rodriguez, 2006). People do not play to increase skill, fitness levels, and improve mental health. Although all that may be positive side effects of play, the players enjoy the game because of its very nature (e.g., the to-and-fro movement in soccer, basketball, volleyball, etc.) (Kosma, 2021). Not only is play's movement without purpose but also it is without "strain." "The ease of play is… experienced subjectively as relaxation. The structure of play absorbs the player into itself, and thus frees him from the burden of taking the initiative, which constitutes the actual strain of existence" (Gadamer, 1975/2012, p. 105; Kosma, 2021).

Gadamer's third universal element of play is that ***when at play there is always something at risk***. Players may have different playing strategies and possibilities, but the ***outcome is unknown***; it may not be successful or continue to being successful (Huizinga, 1950; Kosma, 2021). Yet, this is "the attraction of the game. Whoever 'tries' is in fact the one who is tried… What holds the player in its spell, draws him into play, and keeps him there is the game itself" (Gadamer, 1975/2012, p. 106).

Another universal element of play is that ***it has its own spirit***, thus it is attractive to the player. "The variety of mental attitudes exhibited in playing various games, and in the desire to play them, is the result and not the cause of the differences among the games themselves" (Gadamer, 1975/2012, p. 107). The nature or spirit of a game and "the way the field of the game is filled" is based on its "**rules and regulations**" (Gadamer, 1975/2012, p. 107). "This is true universally, whenever there is a game" (Gadamer, 1975/2012, p. 107; Huizinga, 1950; Kosma, 2021). In other words, the game has a "certain structure which determines its movement from within" (Gadamer, 1975/2012, p. 107; Kosma, 2021; Mitchell, 2018; Rodriguez, 2006). There are universal rules and regulations for different games like soccer, basketball, baseball, which determine their structure and variety in experience.

The ***unique spirit of human play*** that encompasses its structure is that "it plays *something*" (Gadamer, 1975/2012, p. 107). Different games have a certain quality that attracts the player; the player chooses game A vs. game B because of the different structures of the games. Playing with waves while swimming or surfing has a different quality from playing tennis. "**Human play requires a playing field**", which is also part of the play's structure (Gadamer, 1975/2012, p. 107; Huizinga, 1950; Kosma, 2021). The playing field is a "closed world", which is very different from real life whereby there is purpose and goals to be achieved (Gadamer, 1975/2012; Huizinga, 1950; Kosma, 2021; Mitchell, 2018; Rodriguez, 2006). The rules of the game and playing field give the player a task (i.e., "playing of something"). However, the purpose of the game is not "to resolve any task" but "order and shape the movement of the game itself" (Gadamer, 1975/2012, p. 107).

Certainly, when a task in a game is solved, there is a sense of "lightness and relief" (Gadamer, 1975/2012, p. 108; Huizinga, 1950; Kosma, 2021); however, never is the goal to solve the task; rather this is a way to "present" the game or play (Gadamer, 1975/2012, p. 108). This "***self-representation***" of play is "a universal ontological characteristic of nature." The games always represent something (e.g., "Tinker, Tailor, soldier, Sailor… children playing cars") (Gadamer, 1975/2012, p. 108). Understanding the "form of living things" in nature has nothing to do with a "biological purpose" (Gadamer, 1975/2012, p. 108, Huizinga, 1950). Therefore, "human play is self-represented via the players' conduct, which is tied to the make-believe goals of the game. The meaning of the game though is not to achieve those goals; "rather, in spending oneself on the task of the game, one is in fact playing oneself out" (Gadamer, 1975/2012, p. 108).

The ***highest order of play is seen in art,*** which is Gadamer's last universal characteristic of play. Play finds its ideality and full structure in art because it involves the existence of an audience – it is presented to someone – and, at times, it represents the true (i.e., real life like in comedy and tragedy). We will elaborate below on these points as we examine in more detail the artistic element of human play.

**Art is the highest form of Human Play**

Human play is transformed into structure via art (its greatest form). Transformation is not alteration because in alteration "what is altered also remains the same and is maintained" (Gadamer, 1975/2012, p. 110); however, in transformation "something is suddenly and as a whole something else, that this other transformed thing that it has become is its true being, in comparison with which its earlier being is nil…Thus transformation into structure means that what existed previously exists no longer. But also, what now exists, what represents itself in the play of art, is the lasting and true" (Gadamer, 1975/2012, p. 111). In other words, artistic play has "absolute autonomy", "it is repeatable and thus permanent (Bellah, 2011; Gadamer, 1975/2012, p. 110; Huizinga, 1950; Kosma, 2021).

Play's transformation is represented by the players not through their subjective experiences but through the art they represent. Play's significance is not the personal perspectives of the players, including actors, playwriters, composers, because they only represent play's nature. They are disguised, not transformed; their main goal is not to change their being but to pretend that they are somebody else, so the audience think that the actors are indeed a play's character (which is the true in play). The nature of play is universal regardless of who is representing its "work or ergon." The audience is not concerned with the player's true identity, but with the meaning of their representation – the meaning of play, which has its own world (Gadamer, 1975/2012).

It is the play of art that transforms reality "into its truth" via imitation (Gadamer, 1975/2012, p. 112; Tate, 2009). The artists imitate reality, true existence that everybody recognizes. It is what they represent that counts via their disguise. "When the children dress up… they do not want to be discovered behind their disguise. The child intends that what he represents should exist, and if something is to be guessed, then this is it" (Gadamer, 1975/2012, p.113). When the actor is representing a play their "private, particular being of the actor" disappears; the actor's identity is not important. The spectator as well as the actor are interested in what is represented in the play, which is true and valid. When the actor imitates and represents the story of a play, they have essential knowledge of what they represent; it is knowledge of the true.

Although artistic play has its unique, universal world, like in sports, one of the reasons play finds its complete structure in arts is because it is a reminder of reality (Gadamer, 1975/2012; Rasmussen & Gürgens, 2006; Tate, 2009). The difference between reality and a dramatic play is "superseded" because "the pleasure of drama is the same in both cases (play or real life): it is the joy of knowledge" (Gadamer, 1975/2012, p. 112, parenthesis added). What is played is familiar to real life; it represents "the comedy and tragedy of life"; aspects we "desire", "fear", or are undecided about in the future (Gadamer, 1975/2012, p. 112). The play of art reaches its full "transformation into structure" or "into the true" by representing reality. As Aristotle exemplified, the tragedy in play is also the tragedy in real life evoking such overwhelming emotions to the spectator as "eleos" (pity) and "phobos" (fear).

"Phobos is a cold shudder that makes one's blood run cold, that make one shiver… the shivers of apprehension that come over us for someone who we see rushing to his destruction and for whom we fear" (Gadamer, 1975/2012, p. 126).

Similarly, "eleos" or sensations of misery is not just "an inner state of mind", but rather the unity between the spectator and the tragic like the life of Oedipus (Gadamer, 1975/2012, p. 126). These sensations of "eleos" and "phobos" "are modes of ekstasis, being outside oneself, which testifies to the power of what is being played out before us" (Gadamer, 1975/2012, p. 126).

This "tragic pensiveness" is therapeutic and cathartic in nature; it has a metaphysical meaning that overtakes the spectator (Emunah, 2020; Gadamer, 1975/2012; Pendzik, 2006; Shapiro & Hunt, 2003; Solbakk, 2006). The spectator is not just an observer at a distance enjoying an artistic work (aesthetic consciousness). but they actually participate by recognizing the tragic events within their own stories and lives (Gadamer, 1975/2012; Stanford Encyclopedia of Philosophy, 2023). These tragic events have taken place in the spectator's history, tradition, religion, language, or culture. This recognition is true also for the creator of art and the performer. They want to have an effect on people (the spectators) by showing how the work of art links to the existing world, culture, and society (Gadamer, 1975/2012). Play brings a state of "self-realization, sheer fulfillment, energeia which has its telos within itself" (Gadamer, 1975/2012, p. 112; Huizinga, 1950; Kosma, 2021).

Therefore, the second reason play finds its complete structure within art is because it involves spectators. In fact, "play is experienced properly by, and presents itself (as it is 'meant') to, one who is not acting in the play but watching it. In him the game is raised, as it were, to its ideality" (Gadamer, 1975/2012, p. 109). In other words, in artistic play not only are the players playing their roles and are absorbed in the play as an end in itself, but mainly this type of play "puts the spectator in the place of the player. He – and not the player – is the person for and in whom the play is played" (Gadamer, 1975/2012, p. 109). Both the player and the spectator experience the whole nature of play, which has "meaning to be understood" (Gadamer, 1975/2012, p. 110) – it is meaningful for both of them and any differences between the two are "superseded" (Gadamer, 1975/2012, p. 110).

To summarize, play finds its ideality and full structure within art because it represents reality via its players who present it to a participating audience. The work of art is presented to the spectator, who also "belongs to play", only "in being played" (Gadamer, 1975/2012, p. 115). The performance of a play is part of the play's true essence and being – they are inseparable. The aesthetic consciousness (subjective experiences) of the play is not the true being of the artistic work. "The work of art is encountered only through its performance… a drama really exists only when it is played" (Gadamer, 1975/2012, p. 115). The being of play takes place during its presentation and the aesthetic consciousness is simply "part of the *event of being that occurs in presentation*, and belongs essentially to the play as play" (Gadamer, 1975/2012, p. 115, emphasis on the original). In other words, an artistic work (e.g., drama) comes into existence only via its play. Ontologically, this means that

"play is structure… it is a meaningful whole which can be repeatedly presented… and the significance of which can be understood. But structure is also play… it achieves its full being only each time it is played" (Gadamer, 1975/2012, p. 116).

It does not matter how a poet forms a poem or how the actor represents it or how the audience recognizes it; the end result is the "same thing (the artistic work) that comes to existence" regardless of the subjective conceptions of the creator of art, the actor, and the spectator, which are secondary in essence (Gadamer, 1975/2012, p. 116). The true being of artistic work has a structure that comes to life only when it is played.

Certainly, performances and interpretations of a play can vary. This only shows "the work's own possibilities" (Gadamer, 1975/2012, p. 117). The different variations of an artistic work are not "free and arbitrary. In fact, they are all subject to the supreme criterion of "right" representation" (Gadamer, 1975/2012, p. 117). This does not mean that there is a fixed criterion to represent an artistic work. Although there is a traditional model of the work as represented by its creator, there is "free creation" and "re-creation" or "interpretation" of the work in a way that the work's "identity and continuity" over time holds strong (Gadamer, 1975/2012, pp. 117-118; Stanford Encyclopedia of Philosophy, 2023). The artistic representation (performance or total mediation) of the work of art occurs when it becomes one with the work without losing its identity: "… the performance is not thematic, but the work presents itself through it and in it" (Gadamer, 1975/2012, p. 118; Stanford Encyclopedia of Philosophy, 2023). A work of art is "*contemporaneous with every age*"; its identity is maintained throughout time – it is timeless and unique ("part of itself") even if it is next to other works of art in a gallery (Gadamer, 1975/2012, p. 119).

## The Timelessness of Play as seen in Art

To understand the timelessness of artistic play it is important to answer the following question: "what kind of temporality belongs to a work of art?" (Gadamer, 1975/2012, p. 120). As discussed, the presentation of an artistic work is part of the work itself (the work "cannot be detached from its presentation"); thus, when the artistic work is presented "the unity and identity of a structure emerge… This means that however much it is transformed and distorted in being presented, it still remains itself" (Gadamer, 1975/2012, p. 120). Although the representation (via play) of an artistic work has to hold up to its standard (structure), this repetition of the work is never the same. In fact, "each repetition is as original as the work itself" because it is part of the structure of that work (Gadamer, 1975/2012, p. 120). If we use the repetition of festivals as an example, the uniqueness of a festival is not its "historical temporality" – its experience each time of succession – but the fact that its unique structure/nature does not change ("it still remains one and the same festival") regardless of how it is celebrated – "in such and such a way, then differently, and then differently again" (Gadamer, 1975/2012, p. 121).

The historical experiences of a festival are secondary. The identity of and originality of the festival is that it is to be celebrated on a regular basis, even if it is not celebrated exactly the same way as before and/or since its inception. In fact, the "original essence of a festival is always to be something different" (Gadamer, 1975/2012, p. 121). Its representation is expected to vary, but it is the same festival ("sui generis"). The being of a festival does not relate to the subjective experiences of those celebrating it; rather "the festival is celebrated because it is there" (Gadamer, 1975/2012, p. 121).

In other words, the contemporaneity of the work of art (like the festival) is not its aesthetic consciousness (e.g., how different objects of art are aesthetically experienced at the same time) but its full presence via its presentation that links the past to the present. Contemporaneity in theology does not mean to "exist at the same time" but to merge "one's own present and the redeeming act of Christ" in such a way that the latter is seriously experienced "at present" and not "in a distant past" (Gadamer, 1975/2012, p. 124).

The festival is celebrated via the presence of spectators with their whole being (Gadamer, 1975/2012, p. 121). When a spectator is present, they are actually participating in the artistic work by being completely devoted to the task at hand like the Theoros in Greek metaphysics (Gadamer, 1975/2012). So, when the spectator attends a ceremony, they forget everything else, including their very "own purposes"; they "give oneself in self-forgetfulness"; they are "outside oneself" because their "whole being is with something else" (the festival) (Gadamer, 1975/2012, p. 122; Prendergast, 2004).

In other words, the mode of being of the work of art is its full presence before the spectator in such a way that results in the "spectator's ecstatic self-forgetfulness" (Gadamer, 1975/2012, p. 124; Prendergast, 2004), whereby they are completely absorbed in the artistic work – even though its presentation may vary – and find meaning within their own being. The presence of the artistic work before a spectator reflects "its very essence" – "the spectator is an essential element in the kind of play we call aesthetic" (Gadamer, 1975/2012, p. 125; Prendergast, 2004).


**Performing Arts is Play**

Given that the highest form of play is artistic work, in this section we will showcase how certain movement-central performing arts activities are captivating to both the performer and audience because of their universally playful nature. This is key because in the next section implications for movement education programs will be proposed considering the importance of performing arts to the love of movement, health, and well-being (e.g., Kosma, 2023; Kosma et al., 2023a; Kosma et al., 2021a, 2021b).

In several empirical studies, it is shown that dancing like aerial dancing and/or physical theater (artistic expression via mainly bodily movement) improve mental and physical health; lead to the love of movement and healthy lifestyles like increased physical activity and healthy diet; and they are viewed as playful and enjoyable by both the performers and spectators (Kosma & Erickson, 2020a,

2020b; Kosma et al., 2023a, 2023b; Kosma et al., 2021a, 2021b). During these activities, performers find meaning and joy not only in the creation of the expressive artistic pieces but also in their sharing with an audience; a process that keeps them excited and captivated to the art of movement (Kosma & Erickson, 2020a, 2020b; Kosma et al., 2023a, 2023b; Kosma et al., 2021a, 2021b). Such artistic endeavors evoke sensations of flow, ecstasy, and deep connection with others (Kosma & Erickson, 2020a, 2020b; Kosma et al., 2023a, 2023b; Kosma et al., 2021a, 2021b). Certain arty creations in performing arts also reflect reality that captivate both the performers and spectators; they evoke tragic emotions and instead of escaping reality – a Kantian approach in art – these artistic pieces come close to real life experiences like sensations of suffocation, drowning, struggling, surviving, and thriving (Kosma et al., 2023a; Stanford Encyclopedia of Philosophy, 2023). This is evidence of how human play comes to its full structure via artistic representations – in this case performing arts - that capture the true.

It is the universally playful nature of performing arts that attracts the performer. Beyond its self-representation and presentation of the true before an audience, performing arts captures all elements of play as exemplified by Gadamer, including its seriousness, to-and-fro movement, unknown outcome, and its unique spirt and world. Although in performing arts the individual performances and aesthetic consciousness may vary, the artistic expressions – full mediation of play – capture the universal nature of dancing, aerial dancing, and physical theater. There is a "model" of excellence, which is not thematic, and each performance is timeless, portraying the true nature of dance, aerial dance, and/or physical theater. The reliance on physical expression via the use of two pieces of fabric (aerial silks) and other equipment (e.g., stools, swords, and tables); the similar but also unique interactions with the silks and others; and the creative pieces are all based on the universal nature of physical theater, which is represented in acting, dancing, and/or aerial dancing (Kosma & Erickson, 2020a, 2020b; Kosma et al., 2023a, 2023b, 2023c; Kosma et al., 2021a, 2021b). The playful structure of physical theater is recognized by the performers. It gives them a sense of freedom, respite, childhood, close community, risk, and a venue to express before an audience (Kosma et al., 2023a, 2023b, 2023c; Kosma et al., 2021a). When creating a performance every performer tries to follow the "model" structure in performing arts' play even though each performance is unique as expected within the universality of artistic play.

Examples of such playful and universal structures in performing arts include the ways one climbs, inverts, and ties knots in aerial skills; the need for the floating aerialists to freely move from one position to another; the existence and nature of poses; the bodily and facial expressions; the interaction with the audience; the playing field (e.g., studio and theater stage); the seriousness of each performance (even though subjectively certain performers may think that physical theater is not serious); and the risk of the unknown in performance (the quality of each performance and its accurate interpretation are not known in advance) (Kosma & Erickson, 2020a, 2020b; Kosma et al., 2023a, 2023b; Kosma et al., 2021a, 2021b). This artistic, ultimate form of human play captivates the performers and the audience. The presentation and self-representation of performing arts is

magical and charming because of its very universal, playful nature (Kosma, 2021; Kosma et al., 2023a; Kosma et al., 2021a, 2021b).

## Implications for Movement Education and Conclusion

Given that the ideality of play is in art like performing arts, movement educators are in a pivotal position when it comes to programing. Although most Kinesiology experts in North America are vastly detached from performing arts, it is crucial to return to our roots and re-examine movement education. Kinesiologists need to collaborate with experts in performing arts and identify movement programs that can have artistic elements in them, fulfilling the outmost nature of play and making movement education a meaningful, engaging, enjoyable, and long-lasting experience for all age groups.

Playful artistic elements in movement education include opportunities to create physically demanding creative pieces to share a story within different settings like schools, sports clubs, recreational venues, and rehabilitation centers. Encompassing seasonal skits and plays at schools (e.g., during religious holidays) via bodily movement can be a way to reach the highest form of human play. This can be facilitated by physical educators. Older adults can engage in dancing and bodily theatrical movement by emphasizing freedom and creativity in expression vs. only technical aspects. Children can imitate superheroes during school recess. In rehabilitation settings, clinical populations can improve their body schema (e.g., body posture, awareness, confidence, and physicality) via playful, artistic expressions (Kosma et al., 2023c). Such artistic expressions can be individualized and group-based before a real or even an imaginary audience. Incorporating spectators when learning, creating, and performing a variety of sport skills can be another way to link the beautiful and artistic play of sports to their highest form.

In conclusion, the purpose of this paper was to showcase Gadamer's universal elements of play, including the reasons the highest form of human play is art. Given that performing arts incorporate all elements of human play like its seriousness, non-purposeful nature, fluid structure, timeless self-representation, and artistic expression of the true before an audience, implications for movement education were proposed above. Based on this philosophical framework, it is critical to re-imagine movement programming by incorporating bodily, creative, playful, artistic expression in a variety of settings like schools, retirement and rehabilitation centers, health and sports clubs, and recreational endeavors. If movement becomes creative and artistic, it reaches the highest form of human play, leading to the love of movement, health, and well-being.

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# Why No Swimming in the Ancient Olympics?

## By Edward Clayton[*]

*Numerous authors have raised, but not answered, the question of why there were no swimming events in ancient Greek athletic competitions. There are many reasons why it seems inevitable that such competitions would have taken place: the Greeks were intensely competitive, the knowledge of how to swim was seen as distinguishing the Greeks from the barbarians, and the proximity of the ocean. This paper argues that swimming events did not take place because of the danger that such events could have been won by fisherman, oyster divers, or other men who earned their livelihood from swimming. Such men, despite their physical abilities, could not have displayed the arete that was the true focus of Greek athletic competition.*

**Keywords:** *Ancient Greece, Olympics, swimming*

## Introduction

Why weren't there any swimming events in ancient Greek athletic competitions? More than one author has found their absence surprising. Tony Perrottet says "It is strange that, among a people who even held eating races at dinner, swimming was one of the only pursuits that was *not* elevated to a competition, except in one small, provincial city of Hermione." (Perrottet 2012, p. 137)[1]. Stephen Miller writes "We might assume that aquatic sports would have played a prominent role in a country tied so closely to the sea, but there are only passing references to swimming, always as a way of training for other sports, and depictions of swimming are rare and clearly show it as a recreation, not a competition." (Miller 2004, pp. 166–167)[2]. And in The Encyclopedia of Ancient History's entry on Swimming, Michael B. Poliakoff tells us that "Swimming was technically advanced in Antiquity….Remarkably, there is only minimal evidence of competition."[3] All of these authors are implicitly raising the question that inspired this paper, but none of them tries to answer it. This paper will do so, and in doing so I intend to show that their absence is quite consistent with ancient Greek attitudes about athletic competition and indeed it would have been surprising if swimming contests had taken place[4]. Their exclusion was intentional, and not the result of

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[1]The reference to Hermione is from Pausanias 2.35.1 and is therefore late; this contest may not have taken place during classical times. Larmour (1990) suggests that the contest at Hermione may have been a diving contest rather than a swimming contest.

[2]See also Golden (1998, p. 8), which will be discussed later in this paper.

[3]Poliakoff (n.d.) also cites the reference in Pausanias noted above.

[4]Because the amount of information available about the Olympics is much greater than that for other competitions, and the amount of information about Athens is much greater than that for other cities, my focus will be on the Olympics and on Athens. However, I believe my conclusions will hold true for other competitions and other cities.

being overlooked. I will argue that swimming competitions were excluded from athletic competition because if they had taken place the successful competitors would likely have come from a class that could not be allowed to compete: the *banausoi*, or laboring class. Men from this class were held to be inherently unable to achieve the excellence of body and soul that athletic competitors strove for, could not participate in the city's athletic culture, and would not have been able to properly represent their city in panhellenic competition. Therefore, any competition which such a man might win was by definition not an *athletic* competition and could not be treated as such.

## Methodology

The genesis of this paper was a study abroad trip led by the author several years ago. My students and I were returning to Athens with several employees of the Athens Centre from a field trip to Olympia, where archaeologist Michael Wedde and I had talked with the students about the role of the Olympics in particular and athletics in general in the ancient Greek world as we toured the site. We stopped at a café on the shore on the way back to take a break, and the students went off for a swim. As they swam, I asked Michael whether there were ever swimming events in the ancient Greek athletic competitions. I had developed a broad, but not exceptionally deep, understanding of ancient Greek culture and I thought that there must have been swimming competitions at some athletic competitions, even if there hadn't been in the Olympics. After all, how could there not have been? But Michael thought that there were not, a belief that I was able to confirm fairly quickly. As it had for the authors cited above, and doubtless others, this raised the question "Why not?" It seemed impossible to me that the Greeks, whose lives were tied so intimately to the sea and who were so invested in competition, had simply overlooked the possibility of competitive swimming, and so I set out to answer this question.

My approach was to focus on two questions which, when answered, would shed light on my main question. First, how did the ancient Greeks understand athletes, athletics, and athletic competition? Second, how did the ancient Greeks think about swimming? I thought that, after answering these questions, I could figure out why swimming did not fit into the understanding of athletics and why swimmers were not thought of as athletes.

## Discussion

It is certainly always risky to try to explain the reasons why something did not happen. After all, it may simply be that it never occurred to any of the Greeks that swimming contests might be a worthwhile addition to formal athletic competition. But this seems unlikely, given the intensely competitive spirit of the ancient Greeks already noted above. If we consider the Olympics alone, it is hard to imagine that at no point from the beginning of the Olympics in ca. 700 BCE to the

time of their closure by the Roman emperor Theodosius in 393 CE did it cross anyone's mind that swimming competitions might be possible. We know that the schedule of competitions at the Olympic Games changed over time, so innovation was certainly possible. We also know that there were hundreds of athletic festivals throughout Greece, from the smallest towns to the largest cities, yet aside from the ambiguous (and late) reference to competition at Hermione referenced above there is no mention of swimming competitions at any other location. Surely some of these smaller towns would have been able to innovate even if the Olympic organizers had chosen not to – unless, of course, there were very good reasons not to innovate in this way.

The absence of swimming contests also cannot be an issue of practicality. Several of the major Greek athletic festivals were held in close proximity to the ocean, along with many or even most of the minor ones, and even for those Greek cities that did not find the ocean readily accessible, it would not take a lot of imagination to modify the concept of public baths to create swimming pools and the possibility of competitive swimming[5]. It is also not the case that few Greeks swam, or that Greeks did not think swimming was important, or that they did not take pride in the ability to swim. Knowledge of how to swim was widespread among the Greeks[6], and in fact it was a proverbial way of calling someone ignorant to say of them that "they know neither how to read nor how to swim." (Plato, Laws 689d). We also know that the Greeks took pride in their ability to swim; they believed it to be an important distinction between themselves and the barbarians, who could not swim (Herodotus, Histories 8:89). So swimming events must have been imagined, would have been practically possible, could have been introduced, and would have involved a significant and (to the Greeks) uniquely Greek attribute. Nevertheless, there were no such events. Why not?[7]

Much scholarly analysis of Greek athletics argues that the particular athletic contests which took place at the Olympics and elsewhere were included because of their connection to military prowess. If this explanation is correct, swimming competitions would be left out of the Olympics because of their non-military nature. A number of scholars explicitly connect athletic and military competition in ancient Greece. Spivey, for example, says that the Greeks had "…an understanding, essentially, that all games were war games." (Spivey 2012, pp. 3, 18, 20). This also is the argument of Edith Hall, who says that "[Swimming] was

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[5]There is some disagreement in the literature about Greek "swimming pools". Swaddling says there was a swimming pool at Olympia, "unique in classical Greece." (Swaddling 1984, p. 30). "Swimming pools were used in antiquity…The most representative example is the swimming pool in the gymnasium at Delphi which was round, with a diameter of 10 m. and a depth of about 1.90 m. It is thought that the Lyceum at Athens had a swimming pool, and other gymnasia will have had them for the athletes." (Tzachou-Alexandri 1989, p. 37). Whatever their uses were, these pools were not suitable for competitive swimming. A modern Olympic swimming pool is 50 meters long and the "short course" pool is 25 meters long, so a round pool with a diameter of 10 meters will be much too small

[6]Harris (1972) 112 ff. He says that despite this "there is hardly anything in Greek literature to suggest that the Greeks looked on swimming as something to be done for pleasure or as a sport." (Harris 1972, p. 115). See also Gardiner (1930, pp. 93, 95) and Plato Republic 453d.

[7]One practical obstacle, which is that the punishment for fouls in athletic contests was flogging, and flogging someone underwater is not likely to be effective, will be set aside.

not treated as a formal competitive sport such as those performed at public games. This may have been because, unlike combat sports, equestrian sports, and running on land, swimming does not seem to have been a standard part of public military training." (Hall 2006, p. 266)[8]. There was also what Pritchard calls a cultural overlap between sport and war: "Classical Athenians described and thought of athletics and war with a common set of words and concepts." (Pritchard 2009, pp. 223–224). For example, both war and competition were *agon* – contests decided by mutually agreed rules (Pritchard 2009, pp. 223–224). This theory has some obvious merit, since as Hall correctly points out many athletic competitions certainly did have connections to military action.  Races with shield and armor took place at the Olympics and elsewhere, such as the Panathenaic Games (which had additional events with a clear military component not found at the Olympics). In addition to the improvement in the physique that would come from exercise, the courage to confront and the ability to endure the pain and injury that were almost inevitably part of the so-called "heavy events" – boxing, wrestling, and the pankraton – and continue to fight would have value for athletes who would almost certainly face them again on the battlefield as soldiers.

But there are two significant objections that can be raised to this explanation. First, swimming clearly did have military value, and the Greeks viewed it as an important asset in naval combat, as Herodotus tells us in reporting on a key battle during the Persian Wars: "There fell in this combat Ariabignes, one of the chief commanders of the [Persian] fleet, who was son of Darius and brother of Xerxes; and with him perished a vast number of men of high repute, Persians, Medes, and allies. Of the Greeks there died only a few; for, as they were able to swim, all those that were not slain outright by the enemy escaped from the sinking vessels and swam across to Salamis. But on the side of the barbarians more perished by drowning than in any other way, since they did not know how to swim." (Herodotus Histories 8.89)[9]. In addition to its usefulness during and after naval battles, swimming also had value as part of other kinds of military operations. There are recorded incidents of talented swimmers bringing supplies to the besieged Spartans during the Peloponnesian War, and of talented divers cutting the moorings and anchor-lines of Persian vessels during the Persian Wars, and of Athenians engaging in underwater swimming operations during the battle with Syracuse[10]. Since these incidents illustrate that the Greeks understood swimming to have military value, and historians found them important enough to record,

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[8]See also Gardiner (1930, pp. 93, 95) where he suggests that it is because the Greeks would have taught one another informally how to swim and thus this knowledge was ubiquitous across all social classes that there is no known training regimen for swimming and that the fact that everyone learned how to swim informally explains why the only known competition was the one at Hermione. This seems unlikely to me. All Greeks would also have learned informally how to run, yet running was developed into a training regimen and a competitive sport but swimming was not. Why the difference?

[9]See Hall (2006, pp. 269–270 ff.), who lists sources that describe the military value of being able to swim and argue that the inability to swim is one of the defining traits of the barbarians – swimming is therefore an element of Greek identity, as has been said.

[10]A list of swimming achievements noted by ancient authors can be found in Harris (1972), chapter 4.

swimming competitions could certainly have been included as athletic contests if military value was the sole standard that determined which events were allowed.

A second objection is that even if many events did have a clear military element, many others did not. This position was taken even by some of the ancient scholars, who made the argument that training for and competing in athletic competitions was of dubious military value[11]. For example, chariots were not used in Greek warfare, but chariot races were prestigious events in the Olympic games. Indeed, in all of the equestrian events the riders were slaves or hired drivers rather than their owners or trainers, because of the high likelihood of crashes and injury or death, so they would not prepare anyone for any kind of military action[12]. Many of the non-equestrian events are also of uncertain military value: the high jump was part of the pentathlon, but would not have been part of a hoplite's military training; the discus was not used in combat. Even if we were to accept that each of the individual activities might contribute to or demonstrate military ability in some way, it is still the case that all of the events were individual events. Individuals competing in the Olympic Games were not acting with the kind of regimented coordination that was the hallmark of phalanx combat[13]. Phalanx warfare required regimented coordination and when fighting in a phalanx the ability to e.g. run faster than one's companions would have been more of a liability than an asset since it would have broken the ranks. As Golden says, "the usual sports of the gymnasium and the competitive festivals were just not very well designed as preparation for hoplite warfare." (Golden 1998, p. 27)[14]. So even if swimming events were not related to military prowess, this in and of itself cannot be the reason for their exclusion.

But although the explanation for the exclusion of swimming events from athletic competition does not depend directly on their military character or lack thereof, it is nevertheless vitally important to recognize that only those who could be soldiers – in Athens, those who were from the aristocratic or hoplite classes – could engage in athletic competition. This is so because, despite the fact that the Olympics were theoretically open to all Greek men, there was an unwritten, but nevertheless essential, exclusion of men below a certain socioeconomic level from participation in the Games. For something to be an athletic competition, it needed to meet certain requirements. Crucially, the participants in an athletic competition needed to display *arete*, or excellence, not only in their physical performance but also in their physical appearance. Both of these served as proxies for the excellence of the soul, and it was the demonstration of the excellence of one's soul and the desire for the honor that was due as a result that was the basis of the real competition. This meant that they needed to come from families which were

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[11]As Christesen notes: "[T]he practical value of athletics as a form of military training was a subject of vigorous debate in ancient Greece." (Christesen 2012, p. 237). See Kyle (1993), chapter 5, and Christesen and Kyle (2014) Chapter 21 for critics and criticisms of athletics. See also Miller (2004, p. 198).

[12]The fact that it is nevertheless the owner of the horses rather than the rider who is declared the winner is very significant, and we will return to this point later.

[13]Though there were some such events in the games at Athens.

[14]He also notes that "If the games ever reflected the military metier of the mass of the citizenry, rowing would presumably be more prominent." (Golden 1998, p. 26).

capable of having such *arete*, and in Athens, this meant the aristocratic (and, later, the hoplite) class. The men in these upper classes were free from having to engage in the banausic labor that (as Aristotle and others argued) damaged both the body and the soul rather than perfecting them. Swimming was not associated with *arete*, and was instead associated with men who did not have any, such as divers for sponges or oysters, fishermen, and so on. It was associated not with the hoplites who bravely faced the spears of the enemy but with the rowers of triremes. Thus swimming is dismissed by Plato: in the Gorgias, Socrates responds to Callicles' assertion that he should cultivate rhetoric by comparing it to swimming. Callicles suggests that learning rhetoric is a good strategy for avoiding death in the law courts. Socrates responds by asking "But now, my excellent friend, do you think there is anything grand in the accomplishment of swimming?" Callicles replies "No, in truth, not I." And Socrates says "Yet, you know, that too saves men from death, when they have got into a plight of the kind in which that accomplishment is needed." (Gorgias 511b). So, however useful swimming might be, in military situations or otherwise, it was not esteemed as an activity connected to excellence. Men who were good swimmers as a result of their employment, like others who had to work for a living, could not achieve athletic excellence in any activity; therefore, anything they could excel in (such as swimming) was, by definition, not an athletic activity.

Let me develop this argument more fully. First, it is well known that the Greeks were very careful to protect the ideal that the athlete was not a professional, by which they meant that the athlete was not competing in order to receive money. In most cases the athlete received money or saleable goods such as the famous Athenian amphorae of olive oil if he was successful, and the amount received could certainly be very substantial, especially for those men who participated in dozens of competitions every year[15]. Most games were so-called "prize games," in which successful competitors received money or other prizes, but the victors in the Olympics and other contests which did not offer such prizes would receive remuneration from their home cities upon their return because of the honor and status they brought to their cities, about which I will say more shortly. But the compensation for athletic successes was always considered a prize or an award, as befits an aristocrat who does not need to earn money to live, and never a form of pay, which would go to someone who did have to work. Certainly the athlete exerted himself and strove, both physically and mentally, and received money as a result, but from the Greek point of view it was important to maintain the belief that they were not engaged in using their bodies to earn a living. This would have been beneath anyone who was truly an athlete (Pleket, in König 2010, pp. 167–168). They were engaged in the pursuit of *arete*, and the recognition of that *arete* in the form of glory, to the point that some competitors chose death rather than defeat. They were also demonstrating a "strong and continuous emphasis on the manly and military virtues of sport." (Pleket, in König 2010, pp. 165–166). Because of this ideal, it would be unthinkable to associate an athletic contest with an activity

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[15]As many modern scholars point out, the attempt to project an ideal of amateurism back onto the original Olympics does not work if one considers the historical evidence.

that was undertaken for money, or one that was undertaken by someone who needed to work for a living.

Second, while the Olympic Games were famously open to all Greeks, the events were such that only someone who had at least a moderate amount of wealth (much greater wealth would be required for the equestrian events) would be able to participate; as a result, there was a de facto (and I am arguing intentional) exclusion of the poor, including anyone who had to work for a living. If swimming competitions had been included, they would undoubtedly have attracted those whose jobs meant that they spent their lives in the water (and remember that the Olympics were open to all free male Greeks, with no explicit exclusions). Such men would be able to compete against, would even be likely to win against, those who did not have to rely on swimming and diving in order to eat. But lower-class men lacked the wealth to be part of the hoplite class or the aristocratic class, and lacked the leisure to be part of the culture of the gymnasia, seeing and being seen while exercising[16]. Many authors have commented on the relationship between Olympic competition and aristocratic funeral games modeled after the funeral games for Patroclus, arguing that in both cases the participants would have come from the aristocratic class and the games would reflect aristocratic activities and values[17]. The aristocratic origins of the games would militate against the inclusion of anything that would be related to the kind of banausic labor that aristocrats believed to be destructive to the body and degrading to the soul. Golden draws a parallel between aristocratic games in Greece and those in Hawaii: "The elite [in Hawaii did not engage in surfing competitions], however, [and] preferred to race in sleds over ground they owned themselves, a cumbersome and costly form of competition which advertised their special status….We may be reminded that there is very little evidence for swimming races among the Greeks (and this only in connection with the cult and myth of Dionysius) and that even boat races are rarer than one would expect among a maritime people." (Golden 1998, p. 8)[18].

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[16]Spivey (2012, p. 56): those who did banausic labor did not attend the gymnasium. Reid's claim that virtue through sport becomes during the classical era "something available through cultivation to individuals regardless of social status" (2) is therefore overstated (Reid 2011). See also Reid (2011, p. 37).

[17]Funeral games continued to be held in the archaic and classical eras, in addition to the regularly scheduled civic and religious games. It should be noted that another theory about Greek athletics connects these competitions back to the funeral games of Patroclus: the events that were centrally important to the Greeks were those events that were recorded as having taken place in the Iliad. If this is the case, then swimming events would have been excluded from competitions because there were no such events in Homeric epic. I think that this is unconvincing. There were many events included in athletic competitions that were not part of Patroclus' funeral games. In addition, as Golden (1998) points out, the equestrian events that were central to those funeral games were introduced to the Olympics late, which is not what we would expect if derivation from the Iliad is central to determining which competitions would and would not be included in the Games. However, the aristocratic values that are so central to the Iliad were also central to the ancient Olympics. As Reid (2011) notes, at the funeral games Achilles "is recognizing virtue and distributing honour rather than merely recognizing results and distributing goods" (17). See also Cartledge in Easterling and Muir (1985, p. 106).

[18]In Chapter 5 of his book Golden writes that "Athletic activities were carried out under an ethos significantly different from that of the democratic polis." (Golden 1998, p. 161). However, as Hubbard notes, extending athletics downward in the social hierarchy actually reinforced the

The competitions celebrated aristocratic values and therefore required a level of wealth associated with aristocratic, or at least hoplite, status. It is true that, at least at Athens, access to participation in athletic competitions spread down the economic spectrum over time, but it never spread down further than the hoplite class. Fisher argues that participation in the gymnasium became more and more widespread over time at Athens: "participation in such things became part of democratic expectations, at least for those roughly of hoplite status." (See Fisher, in König 2010, pp. 66–86). He goes on to analyze the question of whether the games were, practically speaking, likely to have participants from the lower economic classes. The spread of participation is linked to the need for democratic political cohesion and military discipline and thus is particularly fostered by military drill. His conclusion is that "poor but able young athletes could well have found support and forms of patronage to develop their careers" but "poor" in this context means "poor but not too poor to be an *ephebe*" (p. 75) – which is to say that those of the working class were excluded. Pleket, in the same volume, says that "It is improbable that immediately after the rise of the gymnasion non-nobles penetrated into the Olympic realm…It is probably in the local contests, which increased rapidly from the sixth century onwards, that the hoplite middle class got its first chance to participate but we cannot substantiate this probability because of the usual lack of evidence." (Pleket in König 2010, p. 162)[19]. Even if participation did spread downward from the very top of the social order, "inclusion expanded only by steps and was more about preserving privilege by limited sharing than due to any genuine democratising idealism." (Hubbard 2008, p. 385). Spivey insists that anyone who did banausic labor did not attend the gymnasium and therefore would not have participated in the training that would have been necessary for aspiring athletes (Spivey 2012, p. 56)[20]. Pritchard concludes at the end of a detailed discussion of the various arguments about what classes of Athenians would have been able to participate in athletic competitions in the classical era that only the sons of upper class citizens received training in athletics[21]. Kyle says that "At Athens athletics were demonstrably related to wealth and social prominence." (Kyle 1993, p. 123). Their work all leads to the conclusion that the inclusion of events which did not fit into the aristocratic culture would have been disruptive to the social order and thus would be avoided. Discussions of Greek athletics often focus on the idea that there were two tiers of competition, with the equestrian events being the domain of the wealthy while the poorer citizens competed in the

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hegemonic power of the elite (Hubbard 2008, p. 379). For the alternative view that the values of sport reinforced democratization, see Christesen and Kyle (2014), chapter 13.

[19]He investigates in some detail the ideology of athletics and the status of those who earned money by participating in athletic competitions. Golden agrees that we cannot say that poorer athletes taking part "in any significant numbers was probable." (Golden 1998, p. 144).

[20]Is it possible that the belief in the connection between athletics and military virtue was in part maintained in order to justify the exclusion from athletics of those who did not have sufficient wealth to be part of the hoplite class?

[21]There is a long discussion of the likelihood that poor Greeks would be able to participate in athletic contests: Pritchard, "Athletics, Education and Participation in Classical Athens," in Phillips and Pritchard (2003). Pritchard notes his "profound disagreement" with Fisher (note 27 above) on page 332. See also Pleket in König (2010).

other events.  But this division overlooks the third tier of citizens: those who were not wealthy enough to participate in athletic training and also would not participate in hoplite military service (Crowley 2012, pp. 83, 91, 93). These two identities are linked: Fisher writes that he hopes his arguments "strengthen the case that the focus of the public gaze towards the ideal boy, youth, or adult male as equally athlete and warrior steadily extended downwards from the aristocratic or elite members at least as far as those in the hoplite class." (Fisher in König 2010, p. 81). Allowing swimming competitions would have meant allowing this class of citizen to participate, which would have been seen as intolerable. As Cohen says, "The ideology of egalitarianism embraces all those who are seen as entitled to compete for honor…To deny to a person as a matter of principle the right to compete means denying them a full social identity as an Athenian citizen…" (Cohen 1995, p. 64)[22]. This was intentionally done – restricting athletic competition to certain kinds of events denied those of the lower classes a full social identity while uniting the aristocrats and hoplites in a shared activity that would create a shared social identity which would carry over to the battlefield even if the events themselves were not especially helpful to military service.

Another set of reasons for the exclusion of swimming involves the idea of beauty, both of body and soul, that Olympic athletes were expected to demonstrate. As Simonides notes, expressing a widely shared Greek view, being handsome is the second best thing in life, after good health (Perrottet 2012, pp. 18, 27). Theognis connects physical activity with physical desire: "Happy is the lover who works out naked / And then goes home to sleep all day with a beautiful boy." (Theognis 2.1335–36). Aristotle, in the Rhetoric, praises the panathlete as the acme of human beauty: "Beauty varies with each age. In a young man, it consists in possessing a body capable of enduring all efforts, either of the racecourse or of bodily strength, while he himself is pleasant to look upon and a sheer delight. This is why the athletes in the pentathlon are most beautiful, because they are naturally adapted for bodily exertion and for swiftness of foot"[23]. Gaining victory in an athletic competition was, for the Greeks, a moral and intellectual achievement at least as much as it was a physical one, and one in which the beauty of the body displayed the inner beauty of the soul[24].  One of the characteristics that was expected of Greek aristocrats, and which they believed differentiated them from the lower classes and barbarians, was self-control. As James Arieti says, "Since the athletes were entirely stripped, stripped even of the loincloth the barbarians continued to wear, if they yielded to whatever sexual arousal they may have felt, it would have been blushingly apparent to all the spectators." (Arieti 1975, p. 435)[25]. Public nudity in athletic competition meant that the athlete's "intellectual

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[22]Cohen is speaking not about athletic competition in particular but the ethos of competition at Athens in general.

[23]http://www.perseus.tufts.edu/hopper/text?doc=Perseus%253Atext%253A1999.01.0060%253Abekker+page%253D1361b. See also Reid (2011) Chapter 6 "Aristotle's Pentathlete."

[24]See Plato, Symposium, for a famous account of how Alcibiades was vexed by Socrates' physical ugliness but inner beauty.

[25]Note that Socrates is prepared to allow the men and women of the ideal city of the Republic to exercise naked together because, due to the excellence of their souls, they can be trusted to not display or succumb to erotic desire.

sophrosyne would be as much subject to public scrutiny as his athletic *arete*." (Arieti 1975, p. 436). Heather Reid makes a similar point: "the beautiful athletic body is framed in ancient Greek thought, not just as an aesthetically pleasing image, but as an ideal expression of a certain kind of soul." (Reid 2012, p. 281). Scanlon also talks about the conjunction of physical beauty and moral excellence (Scanlon 2002, p. 205, see also Reid 2011). But this excellence could only appear among the elites, and not among the poor. For example, Kyle writes that "By the sixth century gymnastic nudity, with its attendant homoeroticism, was a costume and a social marker of free, male citizen status and Greek ethnicity." (Kyle, in Papakonstantinou 2010, p. 40). But, as has been noted, the poor could not participate in the culture of the gymnasium, and so their bodies would not have the same beauty, and neither would their souls (Christesen and Kyle 2014, p. 228).

So there are important reasons for athletic nudity and its role as a marker of social status and individual *arete*. But the homoeroticism noted by Kyle was also important. That athletic competitions had a strong erotic component for the ancient Greeks is beyond dispute[26]. Swimming events would not have allowed for this element of competition, since such competitions would have obviously taken place in the water, which would have substantially obscured the view of the competitors by the audience. Their bodies would not have been seen glistening with oil and dust as were those of the other competitors; indeed, it would have been hard for them to be seen at all. In addition, it is also likely that the motions of swimming were seen as less than beautiful by the ancient Greeks, given how ridiculous these motions would look if performed on land. Recall Patroclus' mockery of Cebriones, who he has just slain by hitting him with a rock: "And both [Cebriones'] brows did the stone dash together, and the bone held not, but the eyes fell to the ground in the dust even there, before his feet. And like a diver he fell from the well-wrought car, and his spirit left his bones. Then with mocking words didst thou speak to him, knight Patroclus: "Hah, look you, verily nimble is the man; how lightly he diveth! In sooth if he were on the teeming deep, this man would satisfy many by seeking for oysters, leaping from his ship were the sea never so stormy, seeing that now on the plain he diveth lightly from his car. Verily among the Trojans too there be men that dive."" (Iliad 16:740). Notice the mocking dismissal of his fallen foe's ridiculous appearance as he performs the "dive," as well as the insulting association of the Trojan warrior with the work of diving for oysters which Cebriones an aristocratic son of Priam would of course not do. Further evidence that swimming was not considered beautiful can be found by comparing the multitude of images of athletes in Greek art with the almost complete absence of images of swimmers[27]. If swimming was considered beautiful, or associated with excellence, there surely would be more representations of it in painting or sculpture than the handful that have survived. So, the difficulty of seeing the bodies (and by extension the souls) of competitors in swimming races, and the lack of beauty to be found in the motions of swimmers, would be reasons

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[26]See Fisher in König (2010, pp. 75–83) for a discussion of eroticism in the Athenian gymnasia and palaistrai. Golden (1998, p. 67) discusses athletic nudity. See also Christesen and Kyle (2014) Chapter 15.

[27]See fn. 2.

why such races would not have taken place as athletic competitions. But even when the swimmer was out of the water, they would not have been viewed as beautiful.

As has been said, the Greeks believed that not every human body, no matter how strong or well-trained for particular physical activities it might be, can be considered beautiful, because only some men can have beautiful souls. By definition, men who have to work for a living cannot have beautiful bodies or beautiful souls (Aristotle and others). As the Old Oligarch says: "[A]mong the best people there is minimal wantonness and injustice but a maximum of scrupulous care for what is good, whereas among the people there is a maximum of ignorance, disorder, and wickedness; for poverty draws them rather to disgraceful actions, and because of a lack of money some men are uneducated and ignorant." (Pseudo-Xenophon Constitution of the Athenians 1:5). Therefore, any physical competition at which such men might excel is, by definition, not a proper athletic competition; and swimming is an example of this kind of physical competition. If this theory is correct, it would also help explain why the Greeks did not have marathon races as part of their athletic competitions, because the winners would likely have been men that were couriers and heralds and therefore were among the banaousoi (Spivey 2012, p. 114)[28]. It would also contribute to an explanation of why there were (with the exception of Sparta) no athletic contests for women, because women could not have the beautiful bodies and souls that were necessary to succeed in athletic contests[29]. And it would also explain why the winners of the equestrian contests were the owners and not the riders. It was the riders and not the owners who demonstrated skill; the riders and not the owners who used physical strength to master their horses, and the riders, not the owners, who used their courage to master their fear of injury and death in what were incredibly dangerous competitions. But despite all this, slaves could not demonstrate *arete*, and so they could not be declared the winners of an athletic competition.

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[28]We can see an image of the different body types which are necessary to excel at different sports here: http://www.howardschatz.com/newsite/books/images/athlete/070.jpg. - notice that the photographer has chosen to have the athletes' bodies oiled, much as the Greek athletes would have been oiled in the past. However, the modern athletes are not covered with dust as the Greeks would have been. Neverthless, these photos show that the body type of the successful swimmers is distinctive when compared to wrestlers or boxers.

[29]Kratzmueller (2012) points to the depiction of women as engaged in swimming as an activity; since women by definition do not participate in sport, the depiction of women engaging in swimming may be another piece of evidence which can reinforce the fact that swimming was not regarded as a competitive sport. If I am right about this it would lead to the conclusion that the women running at Brauron were not in fact engaged in racing, but were simply running together. Lämmer, in Borms et al. (1981), says of the women running at Olympia that "[The Heraea] were not genuine contests with foreign or even Panhellenic participation, they were merely a traditional cultic ceremony for local girls" (19). This would also be evidence that the victory of Kyniska as an absentee horse owner was intended as a statement not about the ability of women but the absence of true *arete* from the equestrian events because even women could "win" at them – as Xenophon and Plutarch said (Reid 2011, p. 39). Note that Socrates allows identical and shared athletic exercise to the women and men in the ideal city of the Republic because the souls of the guardian men and women are the same with regard to excellence, but he does not allow the class that contains those who work for a living to exercise with the elite classes because their souls are different.

A final observation: The participants in the Olympic Games needed to be good citizens, good soldiers and good men because they were not only representing themselves. They represented their city as a whole, which is why the winners received lavish gifts and celebrations in their home cities. The cities were sending men who embodied the city, and so they had to be handsome, muscular in the appropriate ways, and demonstrate aristocratic qualities even if they were technically of the hoplite class. Think about Alcibiades' argument about his Olympic victory causing other Greeks to see Athens as more powerful than it was: "For the Grecians have thought our city a mighty one, even above the truth, by reason of my brave appearance at the Olympic games, whereas before they thought easily to have warred it down. For I brought thither seven chariots and not only won the first, second, and fourth prize, but carried also in all other things a magnificence worthy the honour of the victory. And in such things as these, as there is honour to be supposed according to the law, so is there also a power conceived upon sight of the thing done." (Thucydides 6.16). Papakonstantinou argues that "This representation of Olympic victory echoes a cliché argument found in late archaic and early classical (sixth to mid-fifth centuries) epinician (i.e., victory) poetry that depicts victories won by individuals of aristocratic origin as honorable and beneficial to both the victor and his home city." (Papakonstantinou 2003, p. 174)[30]. Howe agrees: "By outstripping the competitors from other Greek cities, Alkibiades brought honor both to himself and to his community, since victory at such an important pan-Hellenic religious festival was seen as a manifestation of heroic ability as well as divine support." (Howe 2008, p. 100)[31]. In return the Athenians gave him free meals for life, and this victory undoubtedly influenced their support for his command in the Sicilian Expedition. No city would want to send as its representative to any Panhellenic athletic competition an ugly, unsophisticated rustic who had to earn their living as something like a fisherman or sponge diver (or a messenger, or a courier). In order to avoid this, it was necessary to be sure that there were no events, such as swimming, that would allow such men to win.

## Conclusion

Although at first it might seem surprising that there were no swimming contests at ancient Greek athletic competitions, given the Greek devotion to competition and their connection to the sea, upon a closer examination we can see that there were very good reasons for this, given what they understood athletes and athletic competition to be. As I hope I have shown, to be an athlete was not merely

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[30]He goes on to say that this attitude was not universally shared: "[T]his survey demonstrates that both positive and negative evaluations of horseracing and sport in general were current throughout the classical period." Papakonstantinou (2003, p. 176).

[31]See also Gribble (2012): Alcibiades "staged a display of personal and civic wealth and power surpassing both previous competitors and those who would come after" (45). A book-length discussion of the Olympic Games of 416, focusing on Alcibiades' activities, can be found in Stuttard (2012).

about developing a physical ability and demonstrating this ability for the entertainment of an audience. To be an athlete was to dedicate one's life (and in some cases be willing to sacrifice it) to the idea of *arete*, or excellence, not only of the body but also of the soul. This effectively limited the kind of people who could be athletes, as well as the kinds of activities in which they could participate. They had to be excellent, not only physically, but also morally, which required training and which could only be achieved by certain types of people. Originally this meant only aristocrats, and although effective eligibility was eventually expanded to other elite citizens in at least some cities, there were clear limits as to who was understood to have the potential for athletic excellence. In addition, the bodily excellence of the athletes needed to be visible and beautiful; swimming would have fallen short with regard to both of these qualifications.

In addition, swimming was stereotypically something that all Greeks could do. Unlike the participants in athletic events that required athletes to train and display their excellence, and who at the highest levels did so for only a wreath, the best swimmers would have been judged incapable of virtue and would have developed their bodies in the cause of earning a living, which no athletic competitors would do (or, at least, no athlete would ever admit to doing). Swimming was in the province of the commoners who had to work for a living, and therefore was not and could not be connected to the displays of aristocratic values, beautiful bodies, and excellent souls that were crucial to any competition being seen as rising to the level of the athletic. Any competition that was likely to be won by men who did not have the prerequisites for a beautiful body and a beautiful soul could not be an athletic competition, and swimming competitions would inevitably have been competitions of this sort.

## Acknowledgments

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# Analyzing the Efficiency of Passing Networks in Soccer

*By Jeffrey Leela[\*], Karim Rahaman[±] & Donna M. G. Comissiong[°]*

*This article explores the passing networks for the most used team formations of Manchester United and Chelsea during the 2016/2017 Premier League Season. A passing matrix is created for each team which distributes the average passes between players in a game. This facilitates the calculation of three centrality measures complementary to those previously explored by (López-Peña and Touchette 2012). These measures unlock hidden details about the strengths and weaknesses within the networks. Such include the extent to which a player stays or leaves his position, the ability of a player to affect the game through penetration, and a player's pass distribution evenness within the team. The optimal assignment for each network is also determined by applying the Travelling Salesman Problem, thereby establishing the least number of passes that keeps all players within each team connected. Useful knowledge can be obtained from this analysis - to inform coaching staff and enhance the overall level of play.*

**Keywords**: *territorial, penetration, balance, optimal-assignment, team-connectivity*

## Introduction

Network Science is one of the most dynamic fields in applied science and mathematics (Newman 2010). We are primarily concerned about the investigation of one of the most popular team sports – soccer (Sumpter 2016). This is a tactically sophisticated sport played by an intrinsically networked team of players, and it presents us with an ideal opportunity to investigate various areas of team organization. It is a well-known fact among coaching staff that success is achieved by creating the ideal team balance, rather than focusing only on the skills possessed by individual players. Indeed, achieving the correct combination of player abilities is key to proper team function - as a coordinated unit.

The ready availability of data (housed in online repositories) for all activities during a game of soccer in the major European leagues facilitates a more detailed analysis of team play. This in turn provides considerable insight into the overall behaviour of a team as a unit, based on the roles of individual players (Gudmundsson and Horton 2017). Beneath this structure, the arrangement of a team can be viewed with respect to the connection between its players, leading to a network analysis of passes presented as directed graphs, with the weights as the

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numbers of passes between spatially embedded links. The system is dynamic, as the network continuously changes its structure with the movement of the players as the game progresses.

Key 'topological scales' may be pinpointed within the passing network of a soccer team: (i) the micro scale, which examines the players and their jobs within the system, (ii) the meso scale, that starts from little inner cliques showing the connection between three or four players to the structure of bigger cliques of players that operate as sub-networks within the framework (iii) the macro scale, which takes a look at the system in general.

At the topological micro scale, the significance of each player's role has been identified by; its degree, which is the quantity of passes made by a player (Cotta et al. 2013); eigenvector centrality, a degree of significance deduced from the eigenvectors of the adjacency matrix (Cotta et al. 2013); closeness, estimating the smallest number of stages that the ball needs to experience from one player to arrive at another in the team (López-Peña and Touchette 2012); or betweenness centrality, which presents evidence for the degree to which a given player is needed for connecting the routes between any other combination of players of the team (Duch et al. 2010, López-Peña and Touchette 2012). Other measures are possible, for instance, the clustering coefficient, which calculates the resulting triangles around a player (i.e., a clique of three (3) players in a sub-network) identifying the areas of high passing intensity on the spatial map. This has likewise been utilized to assess the commitment of any given player to the enthusiasm of the passing system (López-Peña and Touchette 2012).

At the meso scale level, the investigation of system patterns has demonstrated how the excessive passes of a particular kind between gatherings of three or four players can be identified with both the achievement of a team (Gyarmati et al. 2014) and the identification of pioneers in the passing system (López-Peña and Sánchez Navarro 2015). Clemente et al. (2015) related the high assorted variety of passes between team players to the presence of sub-networks, which would influence the activities of the overall group. In a similar sense, Gyarmati and Anguera (2015) considered repetitive pass arrangements, thereby showing the grouping arrangement patterns central to a teams' playing design.

At the topological macro scale, system measurements are key to uncovering the exhibition and playing style of soccer teams. For instance, the system centroid appears to move in reverse when teams play as the visiting team (Bialkowski et al. 2014). Positional factors such as the 'stretch index' have been used to gauge the mean spread of the players around the centroid, while the team length and width have been utilized to estimate the effectiveness of overall team execution (Duarte et al. 2012). Duch et al. (2010) introduced a presentation metric dependent on the 'betweenness' of the players, which can be used to estimate the likelihood of winning a match. Other large-scale estimates, such as the 'team average degree' - the mean number of passes or the changeability of the players' degrees - have been proposed for measuring team execution (Cintia et al. 2015). The average team cluster coefficient has been demonstrated to be a lot higher during a match than in comparable irregular systems, uncovering the formation of 'player triplets' (Cotta et al. 2013). With respect to overall player position, for maximum efficiency, it is

also highly recommended to maintain 'fair betweenness' and 'high closeness' among the nodes of the passing system (Gonçalves et al. 2017).

A network is essentially a system consisting of branches and nodes. The flow through a network enters and exits each node via the connecting branches, and the resulting flow pattern can provide useful insight about the specific components of the network. In network analysis, the nodes are the junctions of the flow, and it is crucial to gauge the individual value of each node relative to the overall network (Lopez-Peña and Touchette 2012).

Players in a soccer team arranged in a specific formation can be studied using network analysis. Each player is represented by a node. The flow into each node equates to the passes each player receives with the flow out represented by the passes made by each player. These passes to and from each player can be analyzed using established measures - to judge the value of the contribution to the network by each player (López-Peña and Touchette 2012). This can inform the coaching staff as to what is working and what needs to be changed or improved. It is also important to measure the extent of the involvement of each player within the team. More involvement would be indicative of the team operating as a unit, with less reliance on individual players. The minimum number of passes used by a team to ensure that each player gets a touch could measure this (Anderson 1989, pp. 33–41). This is an application of the travelling salesman problem. Greater involvement would essentially heighten the awareness of players and keep them alert – thus providing the team with more opportunities to pounce on opponents during attacking plays, and with the heightened level of preparedness that is crucial for the effective maintenance of defensive team positions.

## Literature Review

*The Assignment Problem – Key References*

The 'assignment problem' was first addressed by (Kuhn 1955), who suggested that numerical scores were accessible for the exhibition of every one of (n) people on every one of (n) employments. This quest for an assignment of persons to jobs was performed in such a manner that the (n) scores were as large as possible. The assignment of heterogeneous workers to heterogeneous jobs where workers may adopt varying strategies for seeking employment was later studied by Shimer (2005). Complex constraint programming to achieve near-optimal assignments while taking into account all available resources and positions was considered by Naveh et al. (2007). A linear assignment problem in the context of network systems to address this challenge by means of an auction algorithm was later postulated by Zavlanos et al. (2008). Two traditional issues from location theory which may fill in as hypothetical models for key strategic issues, where one allocates components in such a way that an appropriate linear or quadratic function accomplishes its minimum was implemented by Povh (2008). With respect to an important application to sport science, a framework to evaluate the capacities of baseball players in each pragmatic aspect of the game, and to create a group wherein every

one of the players is allotted to positions to such an extent that the aggregate group ability is augmented was built by Britz and Maltitz (2010). A thesis written by Mansi (2011) dealt with approaches for solving the related transportation, transhipment and assignment problems as well as supply chain management.

*Metrics for Network Analysis*

An outline of the salient concepts of a dynamical framework hypothesis - of primordial importance in the investigation of coordination processes within and between soccer players - was presented by Davids et al. (2005). Of noteworthy mention is the situational investigation of the AC Milan Football club carried out by Papahristodoulou (2010), who formulated a quadratic assignment problem for the determination of the ideal field placement of three midfielders and three forward players. The overall significance of every player in a game of soccer was later analysed by López-Peña and Touchette (2012), utilizing player pass data collected from the 2010 FIFA World Cup.

For each team, a coordinated system can be devised, with nodes representing the players and arrows signifying passes between players. It is then possible to use a weighted graph clustering approach to study network location within a large-scale system. This approach was successfully employed to analyse client relationships within Internet communities (Liu et al. 2014). For a well-documented illustration of the efficient use of network metrics to extrapolate team characteristics to provide coaching support, see Clemente et al. (2015).

**Methodology**

It is crucial to this study that certain assumptions be made. This is primarily due to the lack of video data of match coverage, which limits our ability to capture the movement of players and the exact numbers of passes made and received by each player. It is however possible to source post-match data from freely available internet sources to document the pass distribution amongst players. For our purposes, the number of passes to and from each player was collected from internet sources – leading to the calculation of an average number of passes per player for a given season. Passes can be classified as forward, sideways and backwards. It is important to note that precise data on the direction of each pass was not available. Therefore, we used our intuition to distribute these passes based on reported averages, while taking into account each player's position within the network. Of course, players in general would naturally make most passes to teammates closer to them. Our analysis only considers players in the static positions that they occupy according to the team's formation, as done previously by López-Peña and Touchette (2012). Any movement must therefore be viewed as a collective shift of the entire network.

The first measure that we introduce is called 'territorial'. It measures the extent to which a player leaves or stays within his territory. The passes a particular player receives and makes can give us some understanding of the player's

territorial rating. Receiving passes would coincide with a player remaining in his territory and making passes leaving his territory. The construction involves the summation of the difference between the number of passes received and made by each player $\sum_{i \neq j}(A_{ji} - A_{ij})$. A positive value indicates that the player receives more passes than the player makes, and vice versa for a negative value. We now divide the above summation by the total number of passes the player receives and makes given by $\sum_{i \neq j}(A_{ij} + A_{ji})$. We neutralize the result by adding one.

Territorial values under one will indicate that players tend to leave their position more often during play. By comparison, the smaller the territorial value under one, the more the player ventures out from his assigned team position. The result is analogous to values over one indicating that the players stay more in their position. Holding players tend to stay to a high extent within their territories. We can compare the scores for each player within a team to understand the extent to which players perform their functions within the formation in general.

$$T_i = \frac{\sum\limits_{i \neq j} A_{ji} - A_{ij}}{\sum\limits_{i \neq j} A_{ij} + A_{ji}} + 1 \tag{1}$$

where $A_{ij}$ – the number of passes from player $i$ to player $j$, $i \neq j$

$A_{ji}$ – the number of passes from player $j$ to player $i$, $i \neq j$

$T_i = 1$ means the player is neutral and the result is inconclusive

Another measure we have established combines the ratios of the various categories of passes. As mentioned earlier, passes are categorized as forward, sideways and backwards. Each ratio has the higher rated pass over the lower rated one. This defines the penetration of a player in terms of passes. The formulation is given by the following equation.

$$P_i = \frac{\sum\limits_{i \neq j} A_{ij} \text{ forward}}{\sum\limits_{i \neq j} A_{ij} \text{ backward}} + \frac{\sum\limits_{i \neq j} A_{ij} \text{ forward}}{\sum\limits_{i \neq j} A_{ij} \text{ sideways}} + \frac{\sum\limits_{i \neq j} A_{ij} \text{ sideways}}{\sum\limits_{i \neq j} A_{ij} \text{ backwards}} \tag{2}$$

Higher penetration scores can be interpreted as players being more inclined to move the ball towards their opponent's goal. Of course, for some players at least one of the ratios may be undefined. Players who retreat with passes a lot in comparison to going forward will have low penetration scores.

The length of a pass between two players may be classified as short, medium or long. The distance measured in metres would determine the length of a pass. A short pass can be defined as having a range less than or equal to ten metres ($\leq 10\,\text{m}$). A medium range pass would be in the range between ten and twenty-five metres ($10\,\text{m} < x < 25\,\text{m}$) where x represents the pass length. A long pass

would be greater than or equal to twenty-five metres ($\geq 25\,\mathrm{m}$). To measure the balance of a player, take the ratio of short to medium to long range passes made and received by the player. This is illustrated in the following equation.

$$B_i = \frac{\sum\limits_{i \neq j} A_{ij}}{\sum\limits_{i \neq j} A_{ji}} \text{short} : \frac{\sum\limits_{i \neq j} A_{ij}}{\sum\limits_{i \neq j} A_{ji}} \text{medium} : \frac{\sum\limits_{i \neq j} A_{ij}}{\sum\limits_{i \neq j} A_{ji}} \text{long}$$

(3)

A well-balanced player in the network is one who passes and receives almost the same number of short, medium and long passes. As with penetration, at least one ratio may be undefined in some instances. Perfect balance is defined as the ratio 1:1:1. However, results such as 1:1 and 1 will also be balanced scores for players involved in two categories and one category of passes respectively. It is important to mention that our methods did not include any error measures to check the accuracy of the computed data. This can be considered in future investigations on this subject.

To effectively illustrate our methods, we consider the average network of two teams in the Premier League over the 2016/2017 season, for which pass data is readily available. This was a very interesting season to consider the performance of Manchester United – so soon after the appointment of the well-respected manager José Mourinho, and the recruitment of highly rated players Paul Pogba and Zlatan Ibrahimovic. In that season, Chelsea won the title, while Manchester United placed sixth with twenty-four points less than Chelsea. The two teams that we select for our analysis are Chelsea and Manchester United. Our main goal is to determine what Chelsea did effectively, and to suggest reasons for the poor league performance of Manchester United.

For the ten outfield players in each team, the average passes made by each player are first categorized as forward, sideways and backward passes – in accordance with the static team formations. Given the pass completion percentage, we are then able to create a network of directed edges for each team.

We begin by considering the pass network for Manchester United. The players selected for our analysis were the ones who were most used in the (4-2-3-1) formation used by Manchester United in the 2016/2017 Premier League Season. We then proceed to construct the network with successful passes between nodes denoted by weights and the direction indicated by arrows, noting that this is a theoretical model based on the data available and the application of our intuition. By this we mean that we take the average number of passes players make and receive, we consider the static team formation, and we then proceed to categorize the passes based on each player's position. For example, a left sided full back is likely to make more forward and sideways passes whereas a defensive midfielder more sideways and backwards passes. An attacking midfielder would tend to make more forward passes than the latter.

The websites www.whoscored.com and www.squawka.com provide the collective pass data on each player, which we categorize, based on our intuitive

understanding of players, positions and team formations. Figure 1 presents the passing network for Manchester United.

**Figure 1.** *Manchester United's Passing Network*
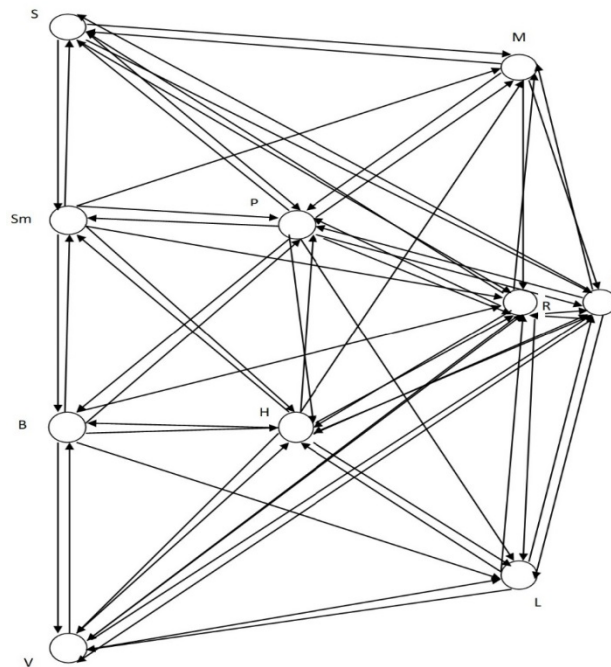


Manchester United's average passes per game is given as 514.21 (Squawka 2022). Table 1 presents the average successful passes per game for Manchester United for the ten most used outfield players in the 2016/2017 Premier League Season.

**Table 1.** *Average Passes Completion Percentage for Manchester United*

| Player | Total Passes | Pass Completion (%) |
|---|---|---|
| 1. Shaw (S) | 29.09 / 34.27 | 85% |
| 2. Smalling (Sm) | 22.28 / 25.28 | 88% |
| 3. Bailly (B) | 29.32 / 34.12 | 86% |
| 4. Valencia (V) | 41.29 / 48.21 | 86% |
| 5. Pogba (P) | 60.40 / 71.20 | 85% |
| 6. Herrera (H) | 57.77 / 65.97 | 88% |
| 7. Martial (M) | 19.68 / 24.12 | 82% |
| 8. Rooney (R) | 25.68 / 30.68 | 84% |
| 9. Lingard (L) | 25.44 / 28.92 | 88% |
| 10. Ibrahimovic (Ib) | 27.29 / 37.07 | 74% |

The players in the network are Shaw (S), Smalling (Sm), Bailly (B), Valencia (V), Pogba (P), Herrera (H), Martial (M), Rooney (R), Lingard (L), Ibrahimovic (Ib). The number of passes between players was distributed accordingly and is illustrated in the passing matrix shown in Table 2.

**Table 2.** *Passing Matrix for Manchester United*

*( $A_{ij}$ = passes from player "i" to player "j" )*

| Player | S | Sm | B | V | P | H | M | R | L | Ib |
|---|---|---|---|---|---|---|---|---|---|---|
| S | 0 | 11 | 0 | 0 | 8 | 0 | 6 | 2 | 0 | 2 |
| Sm | 3 | 0 | 3 | 0 | 6 | 6 | 2 | 2 | 0 | 0 |
| B | 0 | 3 | 0 | 4 | 9 | 9 | 0 | 2 | 3 | 0 |
| V | 0 | 0 | 20 | 0 | 0 | 8 | 0 | 2 | 8 | 3 |
| P | 7 | 7 | 7 | 0 | 0 | 8 | 9 | 9 | 7 | 6 |
| H | 0 | 7 | 8 | 7 | 7 | 0 | 6 | 8 | 8 | 6 |
| M | 5 | 0 | 0 | 0 | 5 | 0 | 0 | 5 | 0 | 5 |
| R | 2 | 0 | 0 | 2 | 5 | 4 | 5 | 0 | 5 | 3 |
| L | 0 | 0 | 0 | 6 | 0 | 7 | 0 | 6 | 0 | 6 |
| Ib | 3 | 0 | 0 | 3 | 4 | 3 | 4 | 6 | 4 | 0 |

The travelling salesman problem is essentially an optimization process with far-reaching applications in the field of software engineering and operations research. It normally poses the inquiry: "Given a rundown of urban areas and the separations between each pair of urban areas, what is the briefest conceivable course that visits every city and comes back to the first city?" This is most effectively communicated as a chart portraying the areas of a set of nodes.

Dorigo and Gambardella (1997) considered a fake subterranean insect state to define and solve a 'travelling salesman problem' (TSP). Ants of the fake province can create progressively shorter feasible visits by utilizing data amassed as a pheromone trail saved on the edges of the TSP chart. Four unrelated problems that arise in the context of computer wiring, vehicle routing, clustering a data array and job-shop scheduling with no intermediate storage were explored by (Lenstra and Rinnooy Kan 1975).

We now present another important application of the travelling salesman problem. The graph that we analyse is representative of the network of passes between soccer players, as previously described. The passes between each pair of players represent the distances between the nodes. Let us consider the minimum number of passes that connects each player in the network. This translates to the passage of the football through the entire team via an optimal sequence of passes. In other words, "What sequence of passes produces the minimum number when the ball leaves a player and returns to the same player having been played to every other player in the network?" We will illustrate the process in detail using the passing matrix for Manchester United (see Table 2).

We first subtract the smallest element in each row from every other element in the row. This is followed by subtracting the smallest element in each column from every other element in that column. Now, add the minimum element in its corresponding row and column to each zero, where this minimum element excludes the zero itself. The dashes in the matrix indicate no passes between the players in the corresponding rows and columns. This is illustrated in Tables 3, 4 and 5.

**Table 3.** *Pass Matrix with Minimum Element of Each Row in Rightmost Column*

| Player | S | Sm | B | V | P | H | M | R | L | Ib | Minimum |
|---|---|---|---|---|---|---|---|---|---|---|---|
| S | - | 11 | - | - | 8 | - | 6 | 2 | - | 2 | 2 |
| Sm | 3 | - | 3 | - | 6 | 6 | 2 | 2 | - | - | 2 |
| B | - | 3 | - | 4 | 9 | 9 | - | 2 | 3 | - | 2 |
| V | - | - | 20 | - | - | 8 | - | 2 | 8 | 3 | 2 |
| P | 7 | 7 | 7 | - | - | 8 | 9 | 9 | 7 | 6 | 6 |
| H | - | 7 | 8 | 7 | 7 | - | 6 | 8 | 8 | 6 | 6 |
| M | 5 | - | - | - | 5 | - | - | 5 | - | 5 | 5 |
| R | 2 | - | - | 2 | 5 | 4 | 5 | - | 5 | 3 | 2 |
| L | - | - | - | 6 | - | 7 | - | 6 | - | 6 | 6 |
| Ib | 3 | - | - | 3 | 4 | 3 | 4 | 6 | 4 | - | 3 |

After subtracting the smallest element in each row, the result is presented in Table 4, where the last row contains the smallest element from each column.

**Table 4.** *Minimum Element of Each Column Recorded in Bottommost Row after Subtracting Minimum Element in Each Row*

| Player | S | Sm | B | V | P | H | M | R | L | Ib |
|---|---|---|---|---|---|---|---|---|---|---|
| S | - | 9 | - | - | 6 | - | 4 | 0 | - | 0 |
| Sm | 1 | - | 1 | - | 4 | 4 | 0 | 0 | - | - |
| B | - | 1 | - | 2 | 7 | 7 | - | 0 | 1 | - |
| V | - | - | 18 | - | - | 6 | - | 0 | 6 | 1 |
| P | 1 | 1 | 1 | - | - | 2 | 3 | 3 | 1 | 0 |
| H | - | 1 | 2 | 1 | 1 | - | 0 | 2 | 2 | 0 |
| M | 0 | - | - | - | 0 | - | - | 0 | - | 0 |
| R | 0 | - | - | 0 | 3 | 2 | 3 | - | 3 | 1 |
| L | - | - | - | 0 | - | 1 | - | 0 | - | 0 |
| Ib | 0 | - | - | 0 | 1 | 0 | 1 | 3 | 1 | - |
| Minimum | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |

**Table 5.** *Minimum Element of Corresponding Row/Column in Brackets Next to Each Zero*

| Player | S | Sm | B | V | P | H | M | R | L | Ib |
|---|---|---|---|---|---|---|---|---|---|---|
| S | - | 8 | - | - | 6 | - | 4 | 0 (0) | - | 0 (0) |
| Sm | 1 | - | 0 (0) | - | 4 | 4 | 0 (0) | 0 (0) | - | - |
| B | - | 0 (0) | - | 2 | 7 | 7 | - | 0 (0) | 0 (0) | - |
| V | - | - | 17 | - | - | 6 | - | 0 (1) | 5 | 1 |
| P | 1 | 0 (0) | 0 (0) | - | - | 2 | 3 | 3 | 0 (0) | 0 (0) |
| H | - | 0 (0) | 1 | 1 | 1 | - | 0 (0) | 2 | 1 | 0 (0) |
| M | 0 (0) | - | - | - | 0 (1) | - | - | 0 (0) | - | 0 (0) |
| R | 0 (0) | - | - | 0 (0) | 3 | 2 | 3 | - | 2 | 1 |
| L | - | - | - | 0 (0) | - | 1 | - | 0 (0) | - | 0 (0) |
| Ib | 0 (0) | - | - | 0 (0) | 1 | 0 (1) | 1 | 3 | 0 (0) | - |

There are three zeros with the largest penalty (1) shown in Table 5 (highlighted in red); Valencia→Rooney, Martial→Pogba and

Ibrahimovic → Herrera. We select Valencia → Rooney, which indicates that we cannot look at the arc Rooney → Valencia. We rewrite the matrix after deleting all entries in the row and column corresponding to Valencia → Rooney, and we repeat all these steps summarising the results in Tables 6 and 7.

**Table 6.** *Modified Pass Matrix after Deletions*

| Player | S | Sm | B | V | P | H | M | R | L | Ib |
|---|---|---|---|---|---|---|---|---|---|---|
| S | - | 8 | - | - | 6 | - | 4 | - | - | 0 |
| Sm | 1 | - | 0 | - | 4 | 4 | 0 | - | - | - |
| B | - | 0 | - | 2 | 7 | 7 | - | - | 0 | - |
| V | - | - | - | - | - | - | - | - | - | - |
| P | 1 | 0 | 0 | - | - | 2 | 3 | - | 0 | 0 |
| H | - | 0 | 1 | 1 | 1 | - | 0 | - | 1 | 0 |
| M | 0 | - | - | - | 0 | - | - | - | - | 0 |
| R | 0 | - | - | - | 3 | 2 | 3 | - | 2 | 1 |
| L | - | - | - | 0 | - | 1 | - | - | - | 0 |
| Ib | 0 (0) | - | - | 0 | 1 | 0 | 1 | 3 | 0 (0) | - |

**Table 7.** *Minimum Element of Corresponding Row/Column in Brackets next to Each Zero*

| Player | S | Sm | B | V | P | H | M | R | L | Ib |
|---|---|---|---|---|---|---|---|---|---|---|
| S | - | 8 | - | - | 6 | - | 4 | - | - | 0 (4) |
| Sm | 1 | - | 0 (0) | - | 4 | 4 | 0 (0) | - | - | - |
| B | - | 0 (0) | - | 2 | 7 | 7 | - | - | 0 (0) | - |
| V | - | - | - | - | - | - | - | - | - | - |
| P | 1 | 0 (0) | 0 (0) | - | - | 2 | 3 | - | 0 (0) | 0 (0) |
| H | - | 0 (0) | 1 | 1 | 1 | - | 0 (0) | - | 1 | 0 (0) |
| M | 0 (0) | - | - | - | 0 (1) | - | - | - | - | 0 (0) |
| R | 0 (1) | - | - | - | 3 | 2 | 3 | - | 2 | 1 |
| L | - | - | - | 0 (0) | - | 1 | - | - | - | 0 (0) |
| Ib | 0 (0) | - | - | 0 (0) | 1 | 0 (1) | 1 | - | 0(0) | - |

In Table 7, the zero with the largest penalty (4) is highlighted in red: Shaw → Ibrahimovic. We must therefore choose Shaw → Ibrahimovic, which would eliminate Ibrahimovic → Shaw. We then rewrite the matrix after deleting the row and column containing Shaw → Ibrahimovic. The result is illustrated in Table 8.

**Table 8.** *Minimum Element of Corresponding Row/Column next to Each Zero*

| Player | S | Sm | B | V | P | H | M | R | L | Ib |
|---|---|---|---|---|---|---|---|---|---|---|
| S | - | - | - | - | - | - | - | - | - | - |
| Sm | 1 | - | 0 (0) | - | 4 | 4 | 0 (0) | - | - | - |
| B | - | 0 (0) | - | 2 | 7 | 7 | - | - | 0 (0) | - |
| V | - | - | - | - | - | - | - | - | - | - |
| P | 1 | 0 (0) | 0 (0) | - | - | 2 | 3 | - | 0 (0) | - |
| H | - | 0 (0) | 1 | 1 | 1 | - | 0 (0) | - | 1 | - |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| M | 0 (0) | - | - | - | 0 (1) | - | - | - | - | - |
| R | 0 (2) | - | - | - | 3 | 2 | 3 | - | 2 | - |
| L | - | - | - | 0 (0) | - | 1 | - | - | - | - |
| Ib | - | - | - | 0 (0) | 1 | 0 (1) | 1 | - | 0(0) | - |

The zero with the largest penalty (2) in Table 8 is Rooney$\rightarrow$Shaw, so we must also eliminate the entry Shaw $\rightarrow$ Rooney. Next, we rewrite the matrix deleting the entries from the row and column containing Rooney$\rightarrow$Shaw. For simplicity, we will reduce the size of the pass matrix by removing all the players connected exclusively by dashes (i.e., delete the appropriate row/column). This procedure is summarized in Tables 9 and 10.

**Table 9.** *Connections between Rooney and Shaw Removed (Indicated with Dashes)*

| Player | S | Sm | B | V | P | H | M | R | L | Ib |
|---|---|---|---|---|---|---|---|---|---|---|
| S | - | - | - | - | - | - | - | - | - | - |
| Sm | - | - | 0 | - | 4 | 4 | 0 | - | - | - |
| B | - | 0 | - | 2 | 7 | 7 | - | - | 0 | - |
| V | - | - | - | - | - | - | - | - | - | - |
| P | - | 0 | 0 | - | - | 2 | 3 | - | 0 | - |
| H | - | 0 | 1 | 1 | 1 | - | 0 | - | 1 | - |
| M | - | - | - | - | 0 | - | - | - | - | - |
| R | - | - | - | - | - | - | - | - | - | - |
| L | - | - | - | 0 | - | 1 | - | - | - | - |
| Ib | - | - | - | 0 | 1 | 0 | 1 | - | 0 | - |

**Table 10.** *Reduced Matrix with Minimum Element of Corresponding Row/Column next to Each Zero*

| Player | Sm | B | V | P | H | M | L |
|---|---|---|---|---|---|---|---|
| Sm | - | 0 (0) | - | 4 | 4 | 0 (0) | - |
| B | 0 (0) | - | 2 | 7 | 7 | - | 0 (0) |
| P | 0 (0) | 0 (0) | - | - | 2 | 3 | 0 (0) |
| H | 0 (0) | 1 | 1 | 1 | - | 0 (0) | 1 |
| M | - | - | - | 0 (1) | - | - | - |
| L | - | - | 0 (1) | - | 1 | - | - |
| Ib | - | - | 0 (0) | 1 | 0 (1) | 1 | 0(0) |

As shown in Table 10, there are three zeros with the largest penalty (1) indicated in red. These correspond to Ibrahimovic$\rightarrow$ Herrera, Lingard $\rightarrow$ Valencia and Martial$\rightarrow$Pogba. We can choose any of these, and we select Ibrahimovic$\rightarrow$Herrera. Repeating the process, we remove the interactions between Ibrahimovic and Herrera and reduce the matrix by deleting the corresponding empty row and column. The results are recorded in Tables 11 and 12.

**Table 11.** *Connection between Ibrahimovic and Herrera Removed (Indicated by a Dash)*

| Player | Sm | B | V | P | H | M | L |
|---|---|---|---|---|---|---|---|
| Sm | - | 0 | - | 4 | - | 0 | - |
| B | 0 | - | 2 | 7 | - | - | 0 |
| P | 0 | 0 | - | - | - | 3 | 0 |
| H | 0 | 1 | 1 | 1 | - | 0 | 1 |
| M | - | - | - | 0 | - | - | - |
| L | - | - | 0 | - | - | - | - |
| Ib | - | - | - | - | - | - | - |

**Table 12.** *Reduced Matrix with Minimum Element of Corresponding Row/ Column in Brackets next to Each Zero*

| Player | Sm | B | V | P | M | L |
|---|---|---|---|---|---|---|
| Sm | - | 0 (0) | - | 4 | 0 (0) | - |
| B | 0 (0) | - | 2 | 7 | - | 0 (0) |
| P | 0 (0) | 0 (0) | - | - | 3 | 0 (0) |
| H | 0 (0) | 1 | 1 | 1 | 0 (0) | 1 |
| M | - | - | - | 0 (1) | - | - |
| L | - | - | 0 (1) | - | - | - |

There are two zeros with the largest penalty (1); Martial$\rightarrow$Pogba and Lingard$\rightarrow$Valencia. We select Martial$\rightarrow$Pogba by removing the interaction Pogba$\rightarrow$Martial, deleting the row and column corresponding to Martial$\rightarrow$Pogba, and reducing the matrix appropriately. The resulting matrix is illustrated in Tables 13 and 14.

**Table 13.** *Connections between Martial and Pogba Removed (Indicated by a Dash)*

| Player | Sm | B | V | P | M | L |
|---|---|---|---|---|---|---|
| Sm | - | 0 | - | - | 0 | - |
| B | 0 | - | 2 | - | - | 0 |
| P | 0 | 0 | - | - | - | 0 |
| H | 0 | 1 | 1 | - | 0 | 1 |
| M | - | - | - | - | - | - |
| L | - | - | 0 | - | - | - |

**Table 14.** *Reduced Matrix with Minimum Element of Corresponding Row/ Column in Brackets next to Each Zero*

| Player | Sm | B | V | M | L |
|---|---|---|---|---|---|
| Sm | - | 0 (0) | - | 0 (0) | - |
| B | 0 (0) | - | 2 | - | 0 (0) |
| P | 0 (0) | 0 (0) | - | - | 0 (0) |
| H | 0 (0) | 1 | 1 | 0 (0) | 1 |
| L | - | - | 0 (1) | - | - |

The zero with the largest penalty from Table 14 is one (1), i.e., Lingard$\rightarrow$Valencia. We repeat the process, summarizing the results in tables 15 and 16.

**Table 15.** *Connections between Lingard and Valencia Removed (Indicated by a Dash)*

| Player | Sm | B | V | M | L |
|--------|----|----|----|----|----|
| Sm | - | 0 | - | 0 | - |
| B | 0 | - | - | - | 0 |
| P | 0 | 0 | - | - | 0 |
| H | 0 | 1 | - | 0 | 1 |
| L | - | - | - | - | - |

**Table 16.** *Reduced Matrix with Minimum Element of Corresponding Row/Column in Brackets next to Each Zero*

| Player | Sm | B | M | L |
|--------|----|----|----|----|
| Sm | - | 0 (0) | 0 (0) | - |
| B | 0 (0) | - | - | 0 (0) |
| P | 0 (0) | 0 (0) | - | 0 (0) |
| H | 0 (0) | 1 | 0 (0) | 1 |

We can now eliminate any row and column containing a zero since all remaining zeros have the same penalty. We select Smalling $\rightarrow$ Martial, leading to the reduced pass matrix shown in Table 17.

**Table 17.** *Reduced Matrix with Minimum Element of Corresponding Row/ Column in Brackets next to Each Zero*

| Player | Sm | B | L |
|--------|----|----|----|
| B | 0 (0) | - | 0 (0) |
| P | 0 (0) | 0 (1) | 0 (0) |
| H | 0 (1) | 1 | 1 |

There are two zeros with the largest penalty (1), i.e., Herrera $\rightarrow$ Smalling and Pogba $\rightarrow$ Bailly. We select Herrera $\rightarrow$ Smalling, eventually leading to the result shown in Table 18.

**Table 17.** *Reduced Matrix with Minimum Element of Corresponding Row/ Column next to Each Zero*

| Player | B | L |
|--------|----|----|
| B | - | 0 (0) |
| P | 0 (0) | 0 (0) |

Once again, all remaining zeros have the same penalty (0). We select Pogba $\rightarrow$ Bailly, and finally we are left with Bailly $\rightarrow$ Lingard.

Recapping the pass sequences that we obtained, we have: Valencia $\rightarrow$ Rooney; Shaw $\rightarrow$ Ibrahimovic; Rooney $\rightarrow$ Shaw; Ibrahimovic $\rightarrow$ Herrera; Martial $\rightarrow$ Pogba; Lingard $\rightarrow$ Valencia; Smalling $\rightarrow$ Martial; Herrera $\rightarrow$ Smalling; Pogba $\rightarrow$ Bailly; Bailly $\rightarrow$ Lingard.

The minimum path of passes to keep the team connected is therefore:

Lingard → Valencia → Rooney → Shaw → Ibrahimovic → Herrera → Smalling → Martial → Pogba → Bailly → Lingard.

We now perform the same analysis to determine the minimum number of passes that keeps each player in the Chelsea Network connected. Figure 2 illustrates Chelsea's passing network. The players in the network are Cahill (Ca), Luiz (L), Azpilicueta (Az), Alonso (Al), Matic (Ma), Kanté (K), Moses (Mo), Hazard (H), Costa (Co) and Pedro (P).

**Figure 2.** *Chelsea's Passing Network*
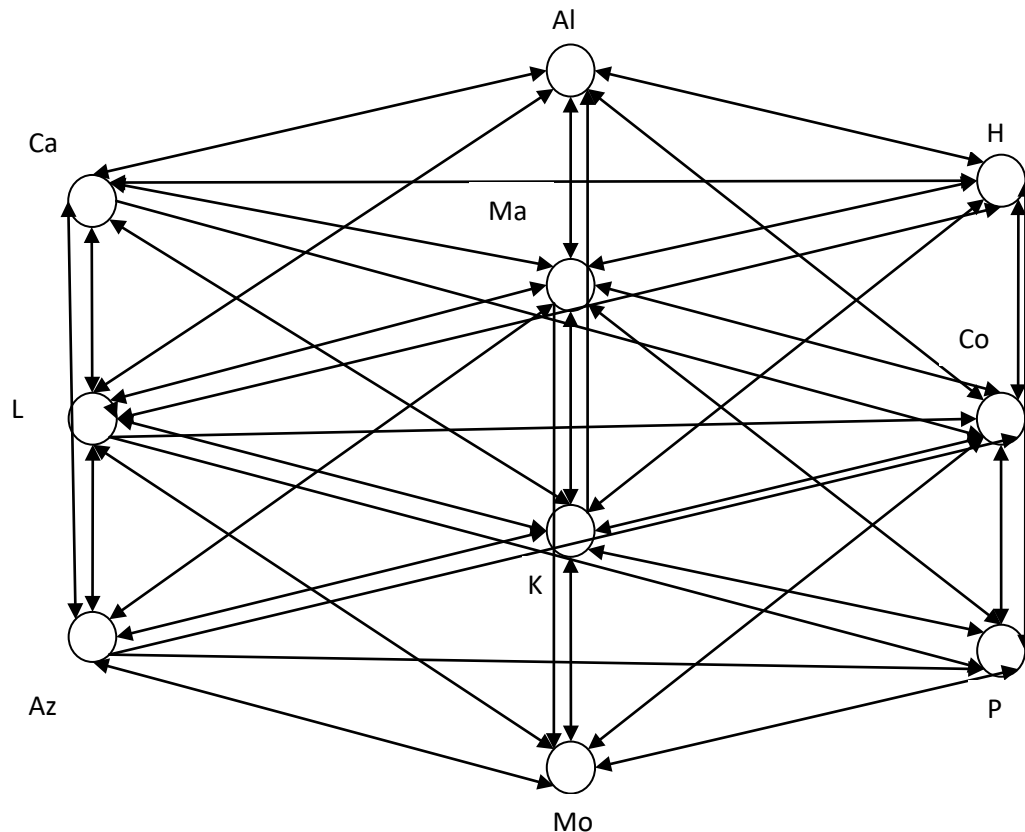


Chelsea's average Passes per Game – 429.97 (Squawka 2022). As done previously for Manchester United, we begin by presenting the data for average successful passes with percentage completion and the associated pass matrix with the summarized pass distribution. This is illustrated in Tables 18 and 19 respectfully.

**Table 18.** *Average Passes Completion Percentage for Chelsea*

| Player | Total Passes | Pass Completion (%) |
|---|---|---|
| 1. Cahill (Ca) | 45.05 / 48.89 | 92% |
| 2. Luiz (L) | 37.70 / 44.91 | 84% |
| 3. Azpilicueta (Az) | 55.18 / 63.50 | 87% |
| 4. Alonso (Al) | 30.90 / 39.87 | 78% |
| 5. Matic (Ma) | 45.77 / 52.17 | 88% |
| 6. Kanté (K) | 53.29 / 60.11 | 89% |
| 7. Moses (Mo) | 23.26 / 29.50 | 79% |

| 8. Hazard (H) | 40.42 / 47.97 | 84% |
|---|---|---|
| 9. Costa (Co) | 22.09 / 29.43 | 75% |
| 10. Pedro (P) | 22.17 / 26.86 | 83% |

**Table 19.** *Passing Matrix for Chelsea*
( $A_{ij}$ = *passes from player "i" to player "j"*)

| Player | Ca | L | Az | Al | Ma | K | Mo | H | Co | P |
|---|---|---|---|---|---|---|---|---|---|---|
| Ca | 0 | 9 | 3 | 8 | 8 | 8 | 0 | 4 | 3 | 0 |
| L | 4 | 0 | 4 | 6 | 6 | 6 | 6 | 2 | 2 | 1 |
| Az | 7 | 10 | 0 | 0 | 9 | 9 | 9 | 0 | 3 | 7 |
| Al | 10 | 4 | 0 | 0 | 7 | 0 | 0 | 7 | 3 | 0 |
| Ma | 7 | 7 | 3 | 6 | 0 | 6 | 2 | 7 | 5 | 3 |
| K | 6 | 6 | 7 | 2 | 7 | 0 | 7 | 4 | 7 | 7 |
| Mo | 0 | 5 | 6 | 0 | 0 | 5 | 0 | 0 | 2 | 5 |
| H | 3 | 3 | 0 | 4 | 4 | 3 | 0 | 0 | 13 | 10 |
| Co | 0 | 0 | 0 | 2 | 4 | 4 | 2 | 5 | 0 | 4 |
| P | 0 | 0 | 0 | 0 | 4 | 4 | 4 | 4 | 6 | 0 |

Again, this reduces to the rotation of the football throughout the entire team through a sequence of passes that is optimal. The exact calculations as before will now be performed. Subtract the smallest element from each element of its corresponding row then do likewise for each column. After subtracting the smallest element in each row, the smallest element to subtract from each column is zero. Table 20 shows the results.

**Table 20.** *Pass Matrix with Minimum Element of Each Row in Rightmost Column*

| Player | Ca | L | Az | Al | Ma | K | Mo | H | Co | P | Minimum |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Ca | - | 9 | 3 | 8 | 8 | 8 | - | 4 | 3 | - | 3 |
| L | 4 | - | 4 | 6 | 6 | 6 | 6 | 2 | 2 | 1 | 1 |
| Az | 7 | 10 | - | - | 9 | 9 | 9 | - | 3 | 7 | 3 |
| Al | 10 | 4 | - | - | 7 | - | - | 7 | 3 | - | 3 |
| Ma | 7 | 7 | 3 | 6 | - | 6 | 2 | 7 | 5 | 3 | 2 |
| K | 6 | 6 | 7 | 2 | 7 | - | 7 | 4 | 7 | 7 | 2 |
| Mo | - | 5 | 6 | - | - | 5 | - | - | 2 | 5 | 2 |
| H | 3 | 3 | - | 4 | 4 | 3 | - | - | 13 | 10 | 3 |
| Co | - | - | - | 2 | 4 | 4 | 2 | 5 | - | 4 | 2 |
| P | - | - | - | - | 4 | 4 | 4 | 4 | 6 | - | 4 |

**Table 21.** *Minimum Element of Corresponding Row/Column next to Each Zero*

| Player | Ca | L | Az | Al | Ma | K | Mo | H | Co | P |
|---|---|---|---|---|---|---|---|---|---|---|
| Ca | - | 6 | 0 (1) | 5 | 5 | 5 | - | 1 | 0 (0) | - |
| L | 3 | - | 3 | 5 | 5 | 5 | 5 | 1 | 1 | 0(2) |
| Az | 4 | 7 | - | - | 6 | 6 | 6 | - | 0 (4) | 4 |
| Al | 7 | 1 | - | - | 4 | - | - | 4 | 0 (1) | - |
| Ma | 5 | 5 | 1 | 4 | - | 4 | 0 (1) | 5 | 3 | 1 |
| K | 4 | 4 | 5 | 0(2) | 5 | - | 5 | 2 | 5 | 5 |
| Mo | - | 3 | 4 | - | - | 3 | - | - | 0(3) | 3 |
| H | 0(3) | 0(1) | - | 1 | 1 | 0(0) | - | - | 10 | 7 |
| Co | - | - | - | 0(0) | 2 | 2 | 0(0) | 3 | - | 2 |
| P | - | - | - | - | 0(1) | 0(0) | 0(0) | 0(1) | 2 | - |

The penalty associated with each zero is shown above in Table 21, i.e., the sum of the minimum element in that row and column containing the zero and excluding the zero itself. The zero with the largest penalty (4) exists at Azpilicueta→Costa, which is highlighted in red in Table 21. We cannot look at Costa→ Azpilicueta. We rewrite the matrix deleting the row and column containing Azpilicueta →Costa and repeat the steps. For brevity, we will summarize our eventual findings. After a sequence of eliminations as with the application of the algorithm on Manchester United's passing matrix, the following links are produced.

| | | |
|---|---|---|
| Azpilicueta | → | Costa |
| Hazard | → | Cahill |
| Cahill | → | Azpilicueta |
| Alonso | → | Luiz |
| Pedro | → | Matic |
| Matic | → | Moses |
| Moses | → | Kante′ |
| Luiz | → | Pedro |
| Kante′ | → | Hazard |
| Costa | → | Alonso |

For Chelsea, the minimum path of passes to keep the team connected is therefore:

Costa → Alonso → Luiz → Pedro → Matic → Moses →  Kante′  → Hazard → Cahill → Azpilicueta → Costa

**Results**

Territorial scores $T_i$ for the ten outfield Manchester United players are as follows:

(*where $T_1$= Shaw, $T_2$= Smalling, $T_3$= Bailly, $T_4$= Valencia, $T_5$= Pogba, $T_6$= Herrera, $T_7$= Martial, $T_8$= Rooney, $T_9$= Lingard, $T_{10}$= Ibrahimovic).

$$T_1 = \frac{\sum_{i \neq j} A_{j1} - A_{1j}}{\sum_{i \neq j} A_{1j} + A_{j1}} + 1 = \frac{(5-6) + (3-2) + (2-2) + (7-3) + (3-11)}{44} + 1$$

$$= \frac{-4}{44} + 1 = 0.909$$

In a similar way, we get: $T_2 = 1.120$, $T_3 = 1.118$, $T_4 = 0.733$, $T_5 = 0.788$, $T_6 = 0.882$, $T_7 = 1.231$, $T_8 = 1.235$, $T_9 = 1.167$, $T_{10} = 1.069$.

Valencia's territorial score ($T_4 = 0.733$) is the lowest by comparison, which shows that he left his position more than any other outfield player under consideration. Rooney in contrast had the highest score ($T_8 = 1.235$), indicating that he remained within his territory the most.

Penetrative scores $P_i$ for the ten outfield Manchester United players (*where $P_1$= Shaw, $P_2$= Smalling, $P_3$= Bailly, $P_4$= Valencia, $P_5$= Pogba, $P_6$= Herrera, $P_7$= Martial, $P_8$= Rooney, $P_9$= Lingard, $P_{10}$= Ibrahimovic) are as follows:

$$P_1 = \frac{\sum_{i \neq j} A_{1j} \text{ forward}}{\sum_{i \neq j} A_{1j} \text{ backward}} + \frac{\sum_{i \neq j} A_{1j} \text{ forward}}{\sum_{i \neq j} A_{1j} \text{ sideways}} + \frac{\sum_{i \neq j} A_{1j} \text{ sideways}}{\sum_{i \neq j} A_{1j} \text{ backwards}}$$

$$= \frac{6 + 2 + 2 + 3 \text{ forward}}{11 \text{ sideways}} = \frac{13}{11} = 1.182$$

Similarly, we can show that $P_2 = 2.667$, $P_3 = 3.286$, $P_4 = 1.050$, $P_5 = 5.732$, $P_6 = 5.591$, $P_7 = 1.861$, $P_8 = 1.300$, $P_9 = 1.923$, $P_{10} = 0$.

The most penetrative player was Pogba (5.732) with Herrera second (5.591). Ibrahimovic was last, scoring zero on penetration.

Finally, we calculate the balance score $B_i$ for each of the 10 outfield Manchester United players under consideration, where $B_1$= Shaw, $B_2$= Smalling, $B_3$= Bailly, $B_4$= Valencia, $B_5$= Pogba, $B_6$= Herrera, $B_7$= Martial, $B_8$= Rooney, $B_9$= Lingard, $B_{10}$= Ibrahimovic.

$$B_1 = \frac{\sum\limits_{i \neq j} A_{1j}}{\sum\limits_{i \neq j} A_{j1}} \, short : \frac{\sum\limits_{i \neq j} A_{1j}}{\sum\limits_{i \neq j} A_{j1}} \, medium : \frac{\sum\limits_{i \neq j} A_{1j}}{\sum\limits_{i \neq j} A_{j1}} \, long$$

$$= \frac{11+3}{3+7} \, short : \frac{6}{5} \, medium : \frac{2+2}{2+3} \, long = 1.400 : 1.200 : 0.800$$

Similarly, we can show that: $B_2 = 0.643$ short, $B_3 = 0.658$ short,

$B_4 = 2.545$ short: $1.250$ medium: $1.000$ long; $B_5 = 1.343$ short : $1.500$ long,

$B_6 = 1.071$ short: $2.000$ long, $B_7 = 0.714$ short : $0.476$ medium,

$B_8 = 0.647$ short : $0.500$ long,

$B_9 = 1.118$ short : $0.333$ medium, $B_{10} = 1$ short : $0.765$ long

The most balanced player was Shaw with almost equal numbers of passes made and received of the three types. Ibrahimovic was second with even distribution of short passes and somewhat even long passes made and received. Unbalanced players include Smalling, Bailly, Martial and Rooney all of which had each part of their defined ratios far from one. Valencia's short and medium passing made and received were the most unbalanced in the network. However, his long-range pass distribution was balanced. Due to the fact his other types of passes were more unbalanced than any other player; he would be the most unbalanced player in the team.

The title winning team Chelsea also provides insightfulness on what they did better that Manchester United. We now provide the same analysis to possibly uncover their strengths. Recall Chelsea's passing data from Table 19.

Based on the above ten (10) outfield players the average passes made by each player are divided into forward, sideways and backward passes with pass completion percentage. We are then able to create a network of directed edges. We chose these players since they were the individuals most used in the (3-4-3) formation of the 2016/2017 Premier League season (Whoscored 2022).

We construct the network with successful passes between nodes denoted by weights and the direction indicated by arrows. Recall that this is a theoretical model based on the static data available, and that Chelsea's passing network was presented in figure 2.

The territorial scores for Chelsea (where $T_1$= Cahill, $T_2$= Luiz, $T_3$= Azpilicueta, $T_4$= Alonso, $T_5$= Matic, $T_6$= Kanté, $T_7$= Moses, $T_8$= Hazard, $T_9$= Costa, $T_{10}$= Pedro) are given by:

$T_1 = 0.925$, $T_2 = 1.086$, $T_3 = 0.597$, $T_4 = 0.949$, $T_5 = 1.032$, $T_6 = 0.883$, $T_7 = 1.132$, $T_8 = 0.904$, $T_9 = 1.354$, $T_{10} = 1.254$.

The penetration scores for Chelsea (where $P_1$= Cahill, $P_2$= Luiz, $P_3$= Azpilicueta, $P_4$= Alonso, $P_5$= Matic, $P_6$= Kanté, $P_7$= Moses, $P_8$= Hazard, $P_9$= Costa, $P_{10}$= Pedro) are:

$P_1$ = 2.583, $P_2$ = 3.625, $P_3$ = 2.176, $P_4$ = 2.643, $P_5$ = 2.777, $P_6$ = 2.914, $P_7$ = 2.491, $P_8$ = 1.353, $P_9$ = 0.750, $P_{10}$ = 0.833.

Chelsea's balance scores for each player, where $B_1$= Cahill, $B_2$= Luiz, $B_3$= Azpilicueta, $B_4$= Alonso, $B_5$= Matic, $B_6$= Kanté, $B_7$= Moses, $B_8$= Hazard, $B_9$= Costa, $B_{10}$= Pedro, are as follows:

$B_1$ = 1.190: 0.846: 2.333, $B_2$ = 0.625: 1.333: 1.667, $B_3$ = 1.647 short: 2.667 medium,

$B_4$ = 1.333 short: 0.875 medium, $B_5$ = 1.056 short: 0.462 medium,

$B_6$ = 1.206 short: 1.091 medium, $B_7$ = 0.800 short: 0.875 medium, $B_8$ = 1.105: 1.625: 1.000,

$B_9$ = 0.548 short: 0.800 medium, $B_{10}$ = 0.875 short: 1.333 medium.

The player with the smallest territorial score was Azpilicueta and the largest was Costa. Luiz was the most penetrative with his passes while Costa was the least penetrative. Kanté was balanced with Cahill, Azpilicueta, Matic, Moses and Costa unbalanced. The most balanced player in Chelsea's network was Hazard, while the least balanced player was Azpilicueta.

Revisiting our pass matrix data, the sequence = 6 + 2 + 2 + 2 + 3 + 7 + 2 + 5 + 7 + 3 = 39. Based on the average passing data matrix, 39 is the optional number of passes needed to keep all players in the Manchester United network connected. Consequently, for Chelsea this sequence = 2 + 4 + 1 + 4 + 2 + 5 + 4 + 3 + 3 + 3 = 31.

## Discussion

The territorial scores by comparison reveal that Chelsea's scores had a significantly higher range than Manchester United's. This suggests that Chelsea utilizes the playing space better than Manchester United. Chelsea also had four players as opposed to Manchester's three leaving their territories. However, only one of the four did this to a greater extent than the three Manchester United players. When too many players venture out of position, this could cause opposing teams to counterattack successfully. Chelsea had only one player doing this excessively, making them less susceptible to counter attacks than Manchester United.

Penetration is a very important aspect of soccer. It measures a player's ability to pierce an opponent's defence creating a goal scoring opportunity. Although Manchester United had a couple of players with higher individual penetration scores, Chelsea's all-round scores were better indicating that most of the Chelsea players contributed to penetration. Manchester relied heavily on Pogba and Herrera to provide the cutting passes. This is dangerous for a team, since the absence of such players (as a result of injury) will have a significant impact on overall team performance. Consequently, Chelsea operated more as a unit.

The ratios of short, medium and long passes to and from each player reveal better balance ratios for Chelsea than Manchester United. Although Manchester United had the overall best-balanced player in Shaw, Chelsea collectively had better scores. For instance, every player for Chelsea had at least two types of passes in their ratios which were not the case for Manchester United. In fact, two players for Manchester had only one type of passes in their distribution. This suggests that Chelsea's play had more variety. Subsequently, Chelsea's better balance resulted in a more even pass distribution. By comparison Chelsea's players' scores are generally closer in proximity to each other than Manchester United's demonstrating less disparity amongst players. Therefore, the Chelsea team was more connected than Manchester United, which justifies their respective League positions at the end of the season. It is clear from our analysis that Chelsea's all-round team performance was better than Manchester United's.

Based on the average passing data matrix, thirty-one is the optimal number of passes needed to keep all Chelsea players in the network connected. This is eight passes less than Manchester United. Chelsea's players by comparison are about twenty percent more efficiently involved in their team's play than Manchester United's players are. This heightens the alertness and sharpness of the Chelsea players, which improves all round team play. No wonder they finished significantly higher than Manchester United in the 2016/2017 Premier League Season.


**Conclusion**


Network analysis is an area in optimization that studies the efficiency of routes. This is done through the construction of graphs. Our passing networks are created by the formations of the teams. The outfield players constitute the nodes and the edges are the passes between them. The graphs are directed as indicated by the arrows on the passes. We are able to use the passes between players to solve the 'Travelling Salesman' problem, thereby determining the minimum number of passes required to keep the entire team involved. This is critical to the team's function as a unit. Players as a result will be more alert, knowing that they must be prepared at all times to receive passes. It enables each player to contribute to the team's all-round play and discourages the establishment of cliques. The whole is better than the sum of its parts. From the two networks studied, we saw that Chelsea had eight passes fewer than Manchester United to involve all the players. This is one of the reasons why Chelsea performed much better and finished much higher in the league table than Manchester United.

We successfully developed metrics - territorial, penetration and balance - to measure the impact of each player in the team network. These measures involved the construction of formulas using the pass data for each player. The territorial score measures the extent to which a player stays or leaves his/her position. Now, if a player's territorial score suggests the player is always out of position, this may be viewed in two ways depending on the player's position. The coach may be inclined to make an adjustment if the player is a defensive player – to prevent the team from being susceptible defensively. On the other hand, if the player has a free

role to roam and create opportunities, this may be exactly what the coach wants. Similar arguments can be made for a player whose territorial score suggests the player stays in position when the coaching staff would have preferred more fluidity in team formation.

Penetration is the ratio of forward to backwards and sideways passes. This measures the extent to which a player is able to push the play forward in the opponent's defensive area. This is a crucial aspect of attacking. Players who are less penetrative tend to pass backward and sideways a lot. This decreases the time the ball spends in the opponent's defensive third of the field thus, reducing the probability of scoring a goal. Penetrative players are very creative and are considered critical in piercing defences. In the selection of a team, a coach must be very careful in maintaining the proper balance of players. A well-balanced player in the network is one who passes and receives almost the same number of short, medium and long passes. The pass classification is based on the length of the pass. A player passing and receiving the same number of short, medium and long passes is said to be in equilibrium. However, this will in most instances be impossible. Therefore, the balance score sheds some light on a player on how effective he/she performs his/her role. The position a player occupies on the field will be an indicator of the type of passes required to make. Since some players are very efficient at making passes of all lengths they can be better utilized in a variety of roles. This adds to the strength of the team. Knowing these attributes places a coach in an advantageous position in solving selection dilemmas.

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# Foreign Players in the Greek Football League: Evidence from the 2023-24 Regular Season

### By Gregory T. Papanikos[*]

*After the Bosman ruling of the European Court of Justice in 1995 and the freedom of movement of football players that followed, professional football clubs have become a modern Tower of Babel. The Greek Football League is not only not an exception but leads the relevant list of the highest percentage of expatriates in its first division. This paper uses descriptive statistics to showcase the extent of the use of foreign players in the world of football, with an emphasis on the Greek professional football league. Descriptive evidence from professional football clubs in 31 European countries shows that there is a non-linear association between the percentage of foreign players and the average age of players. There also exists a negative non-linear association between the percentage of foreign players and club-trained players. In the Greek football league, the use of foreign players improves the results as measured by the points gained during the 2023-24 season. It is found that a 10% increase in the number of foreign players results in a 14% increase in the number of points gained.*

**Keywords:** *sports, football, players, expatriates, migration, Greek League, Olympic Games, sports performance*

## Introduction

Football is the most popular game in Greece. In several previous studies, I have examined various facets of Greek and international football, including the utilization of foreign players by Olympiakos Piraeus, the most popular Greek football team[1]. In the last football season of 2023-24, foreign players not only dominated the roster of the team but also the number of players in the lineup. This phenomenon is not unique to Greek football but is observed in many leagues around the globe, particularly in European leagues. In any case, Greece ranks third in the utilization of foreign players, with a rate of 71.2% in the beginning of the 2023-204 season, following Cyprus (80%) and Turkiye (71.5%).

The use of foreign players in Greek professional sports has been debated at political and social levels. Apart from the nationalistic and racist sentiments that exist in any society, there are serious arguments against the use of foreign players because it violates the true spirit of sports. This is particularly significant in a

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[1]Refer to Papanikos (2015) for the Olympiakos case study. Teams like Olympiakos lack a European distinction. Typically, the use of foreign players is justified as a means to achieve this distinction. However, in the study, I showed that foreign players actually had a negative effect on Olympiakos's performance in European team competitions. In several studies, I have examined various issues in Greek and world football, including the effects of the 2004 Olympic Games. See Papanikos (1999, 2014, 2017, 2020, 2021, 2022, and 2023) for more details.

country like Greece, which is the birthplace of the Olympic Games, one of many contests organized in ancient times, alongside other cultural events such as drama and comedy competitions.

Bringing foreign players to compete in a national league does not serve the ideal of fostering national youth competition, which is essential for building a better society. Isn't this the true purpose of sports? Many argue that by introducing foreign players, Greek youth are not encouraged to be more active in sports; rather, their role is confined to that of consumers and fans. Instead of being active participants, the youth become passive consumers of sports activities. Consequently, the essence of sports is lost. As a result, the argument goes, the national football team has limited choices of players.

However, there are many more compelling arguments against the use of foreign players. One argument that has not been emphasized in sports literature is that football players serve as role models. Typically, foreign players play for a few seasons and then depart for other clubs outside Greece. This turnover is significant, with many foreign players not even completing a full season. After retirement, they most probably return to their homeland. Very few foreign players who have played in Greece choose to stay in the country after retirement. However, the former stars of Greek football become ambassadors for the game. Before the employment of foreign players, many Greek football stars served not only the game but also society at large as coaches, consultants, politicians, and volunteers in various philanthropic activities. Given the dominance of foreign players in the Greek league today, there will be no Greek retired players who can serve this role in the near future. I believe this is the most serious argument against the use of foreign players.

Of course, there are arguments in favor of using foreign players, especially if, on average, they are better players than the local players. They can serve as mentors by training and playing alongside others. Additionally, there are economic benefits; foreign players typically offer their services at a lower cost compared to Greek football players. Furthermore, foreign players often demonstrate greater commitment to the game, as they may have fewer social distractions than domestic players. The question raised in this paper is whether the use of foreign players by Greek teams raises their performance as measured by the number of points gained.

The fact is that foreign players are here to stay. Their role has become increasingly significant, especially in the Greek Football League, which boasts the third-largest percentage of foreign players in Europe. This paper utilizes descriptive statistics to examine the number of foreign players participating in the Greek Football League during the regular season of 2023-24 as well as their productivity.

Including this introduction, the paper is organized into five sections. Section II provides a short, selective literature review of the sports industry, primarily based on papers published in this journal. Section III compares the use of foreign players by football confederations, with an emphasis on European Football. This section also provides evidence-based answers to two issues: First, whether there exists an association between the percentage of foreign players at the country level and the average age of a team. Second, how the extent of foreign player use is associated with the percentage of club-trained players. In other words, does the use of foreign

players help a team develop its own football talents? Section IV focuses on the use of foreign players by the 14 teams of the Greek first division during the regular football season of 2023-24. This section also statistically tests the productivity of foreign players in the Greek Football League. Finally, section V concludes.

**A Brief Review of Selected Football Studies**

Football is the most recognizable sport around the world. This journal has published many papers dealing with various aspects of sports, including economic, political, social, and cultural dimensions. The economics of football analyze the behavior of consumers (fans) and producers (clubs). Examples of studies focusing on fans/spectators include Abdel-Naby Ibrahim (2014), Binjwaied et al. (2015), Borges (2018), Glebova and Desbordes (2020, 2021), Harasta (2021), Özgen and Argan (2017), and Pfeffel et al. (2017).

On the other hand, studies by Bachan and Reilly (2016), Bouvet (2020), Cincimino (2014), Dilger and Vischer (2022), Espitia-Escuer and Garcia-Cebrian (2016), Farmer (2019), Gebler-Branch (2018), Hebbel-Seeger (2017), Hebbel-Seeger et al. (2017), Hebbel-Seeger & Horky (2018), Hebbel-Seeger & Diesch (2019), Huth & Kurscheidt (2022), Leela et al. (2023, 2024), Leite (2017), Magueta et al. (2015), Ogunsanya & Rasheed (2019), Papanikos (2014, 2015, 2021), Robeers and van den Bulck (2018), Suominen (2017, 2018), Wewer (2018), Zambom-Ferraresi et al. (2017), and Zawadzki (2015) deal with the producers and organizers of football or sports production processes in general.

Of course, football as a sports activity has been analyzed within social and community contexts, including its effects on youth. Examples of such studies are by Balatoni et al. (2020), Burke et al. (2014), Djafarova and Thompson (2020), Ellapen et al. (2014), Harman (2022), Hyre et al. (2017), Lemcke and Weh (2018), and Maugendre (2018).

Finally, the media play an important role in bringing football and sports to viewers across the globe, as well as in a soft diplomacy role. The role of media has been analyzed by Kang (2022), Papanikos (2023), Katyal (2021), King and King (2018), Kristiyanto and Suparman (2019), Majaro-Majesty (2015), Newman (2014), Nicoliello (2021), Nunes and Valério (2020), Papanikos (1999, 2017, 2020, 2021, 2022), Pitluk et al. (2023), and Zare and Géczi (2022).

The main conclusions emerging from the literature above can be summarized as follows. First, the professional football industry can be analyzed using the standard tools of microeconomic and macroeconomic analysis, including the theory of industrial organization and regulation. Economics provides a framework to analyze the behavior of the various segments of football consumers, commonly referred to as fans in sports. However, as mentioned by many papers in the cited literature, the behavior of sports fans constitutes a unique category of consumers, with some exhibiting a highly inelastic demand for their favored professional sports club, which has significant repercussions for society and the economy at large. Violence, for example, represents just one aspect of the social repercussions of football organization.

On the other hand, the producers of the sports industry are also unique in the sense that the profit motive is more complex than in a typical industry. The literature mentioned above examines aspects of the uniqueness of this industry from the producers' point of view. Sponsorship is one such unique characteristic of the sports industry. Many companies utilize football and other sports activities, including, of course, the Olympic Games, as a means to advertise their products and services. Sponsoring a sports event and/or a sports club is an effective way of reaching out to consumers of their own products and services. A professional football club today has many opportunities to increase its revenue beyond what can be achieved by selling attendance tickets to its fans and other sports consumers.

Of course, media attention is another way that a sports activity can increase its revenue, especially when broadcasting rights are negotiated either at the club and/or at the industry (league) level. The new ways of communication through social media and, of course, new technology have changed the production process of a football game. The role of the referee, for example, is now influenced by smart technology, which can determine through the use of Video Assistant Referee (VAR) whether a goal, a penalty, or a red card was valid. Studies referred to above have examined how the use of newly developed technology has affected football. The game has become more objective, and decisions are no longer solely reliant on the judgment of one or two individuals made in a split second. If this trend of using technology continues, referees may become redundant.

The final aspect of the football industry that I want to address here relates to the labor market of football players. The literature on this topic is vast and encompasses various disciplines such as economics, law, sociology, psychology, as well as the role of government and other institutions such as the European Union and FIFA (UEFA). One crucial aspect of the labor market is migration, especially of players. The market for foreign football players has opened up with very few restrictions imposed by national governments, the European Union, and UEFA. This paper focuses on this aspect of football, and the next section provides descriptive statistics on the importance of foreign players at the club, confederation, and national levels.

**Expatriate Football Players**

Figure 1 and Tables 1, 2 & 3 display selected demographic statistics of foreign players, with an emphasis on the European Confederation of Football (UEFA). Table 1 reports data obtained from a recent study by the CIES Football Observatory (2023), which used a sample of six football confederations and, in total, covered 135 leagues, 2200 clubs, 62,610 players, and 1445 foreign players. According to the official report by FIFA[2], "nearly 130,000 professional players and more than 4,400 professional clubs have been identified around the world". Thus, Table 1 reports only a share of players and clubs.
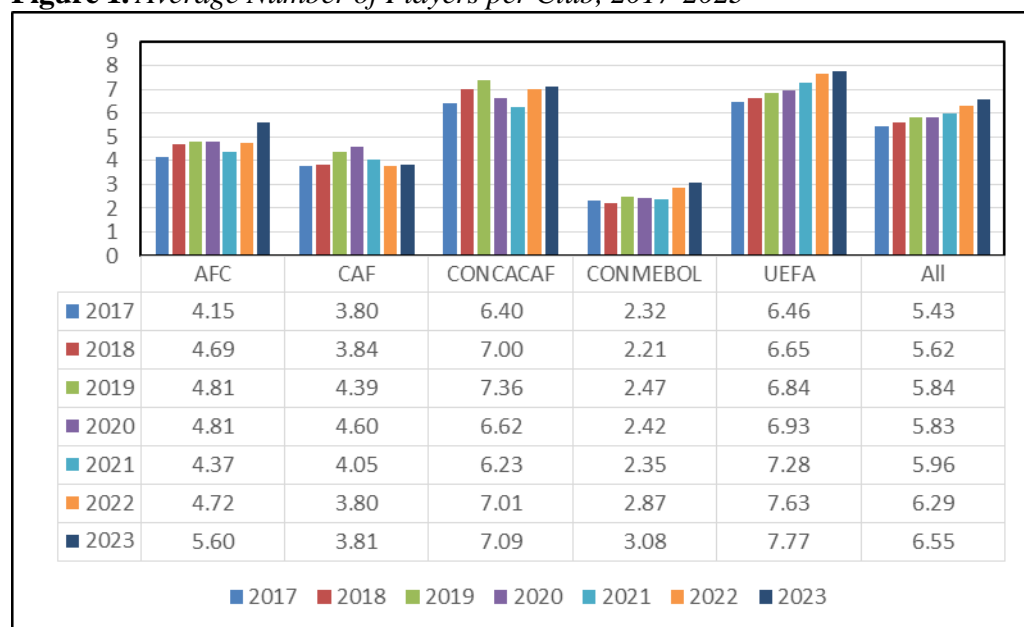
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[2]https://publications.fifa.com/en/annual-report-2021/around-fifa/professional-football-2021/.

According to Table 1, 23% of all players in 2023 were expatriates, defined as players who play in a different association from the one they grew up in. It is also noteworthy that expatriates are defined within countries and not across continents. Thus, in Africa, 12.1% of players were expatriates, but these players include individuals from other African countries. A similar argument applies to other confederations. Europe (UEFA) boasts the largest number of foreign players at 27.7%, followed by North and Central America and the Caribbean with 25%. In South America, only 10.7% of football players are expatriates. Finally, in the Asian Football Confederation, 12.1% of players were foreign players.

On average, each club uses 6.55 expatriate players. UEFA's clubs use, on average, 7.77 players, followed by CONCACAF with 7.09 players. African football federations' clubs use 3.81 players per club, while the lowest figure is reported by South American clubs at 3.08 players per team. Asian football clubs employ, on average, 5.6 players.

**Figure 1.** *Average Number of Players per Club, 2017-2023*



| | AFC | CAF | CONCACAF | CONMEBOL | UEFA | All |
|---|---|---|---|---|---|---|
| 2017 | 4.15 | 3.80 | 6.40 | 2.32 | 6.46 | 5.43 |
| 2018 | 4.69 | 3.84 | 7.00 | 2.21 | 6.65 | 5.62 |
| 2019 | 4.81 | 4.39 | 7.36 | 2.47 | 6.84 | 5.84 |
| 2020 | 4.81 | 4.60 | 6.62 | 2.42 | 6.93 | 5.83 |
| 2021 | 4.37 | 4.05 | 6.23 | 2.35 | 7.28 | 5.96 |
| 2022 | 4.72 | 3.80 | 7.01 | 2.87 | 7.63 | 6.29 |
| 2023 | 5.60 | 3.81 | 7.09 | 3.08 | 7.77 | 6.55 |

**Table 1.** *Foreign Players per Football Confederation (2023)*

| Confederation | Abbreviation | Leagues | Clubs | Players | Expats | Per club | % expats |
|---|---|---|---|---|---|---|---|
| Asian Football Confederation | AFC | 20 | 281 | 8223 | 1573 | 5.60 | 19.1 |
| Confederation of African Football | CAF | 4 | 64 | 2019 | 244 | 3.81 | 12.1 |
| Confederation of North, Central American and Caribbean Association Football | CONCACAF | 10 | 157 | 4444 | 1113 | 7.09 | 25.0 |
| Confederación Sudamericana de Fútbol | CONMEBOL | 18 | 368 | 10562 | 1135 | 3.08 | 10.7 |
| Union of European Football Associations | UEFA | 83 | 1330 | 37362 | 10340 | 7.77 | 27.7 |
| Oceania Football Confederation | OFC | NA | NA | NA | NA | NA | NA |
| **Total** | | 135 | 2200 | 62610 | 14405 | 6.55 | 23.0 |

*Source:* CIES Football Observatory Monthly Report n° 85 - May 2023 (https://football-observatory.com/MonthlyReport85).

Figure 1 displays the evolution of football players per club from 2017 to 2023. Overall, the sample data show that the number of foreign football players per club has been increasing during this seven-year period. It rose from 5.43 players per team in 2017 to 6.55 players in 2023, marking a 21% increase. The largest increase, 33% over the seven-year period, was observed in the South American confederation, where the number of players per team rose from 2.32 to 3.08. However, this number was the lowest among all five confederations; it was only 40% of the UEFA average of foreign players, which stood at 7.77, the highest among all confederations in 2023.

Where do these players come from? Table 2 reports data on the primary home countries of foreign players. The first column presents the number of foreign players by their home countries; the second column displays the change over the 2023-2022 period; the third column shows the total male population of each country, and the last column presents the number of foreign players per 100 thousand male population.

If we consider total numbers, then Brazil leads the list with 1289 players, followed by France with 1033 players. France, England, and Germany are of particular interest because they reveal the existence of intra-industry trade within the football market. Intra-industry trade occurs when a country both imports and exports the same product or service within a given period of time, meaning imports and exports of the same commodity happen simultaneously. These three European countries not only export football players but also import them, as a significant portion of players in their national leagues are foreign, as shown in Table 3.

**Table 2.** *Main Country of Origins of Foreign Players*

| Country | Expatriates (2023) | Change 2023/2022 | Male Population | Number of Expatriates per 100,000 Male Population |
|---------|--------------------|------------------|-----------------|---------------------------------------------------|
| Brazil | 1289 | 5.6% | 105733027 | 1.22 |
| France | 1033 | 5.6% | 32847321 | 3.14 |
| Argentina | 905 | 10.8% | 22889298 | 3.95 |
| England | 535 | 1.7% | 33094839 | 1.62 |
| Spain | 458 | 13.1% | 23416745 | 1.96 |
| Colombia | 448 | 5.2% | 25575607 | 1.75 |
| Germany | 446 | 1.4% | 41347556 | 1.08 |
| Croatia | 407 | 1.5% | 1877922 | 21.67 |
| Nigeria | 385 | 13.6% | 110448136 | 0.35 |
| Serbia | 380 | 0.0% | 3194331 | 11.90 |
| Netherlands | 346 | -5.5% | 8797815 | 3.93 |
| Portugal | 339 | 12.6% | 4911677 | 6.90 |
| Uruguay | 338 | 0.0% | 1658372 | 20.38 |
| Ghana | 318 | 8.2% | 16695114 | 1.90 |
| Belgium | 277 | 3.0% | 5774066 | 4.80 |
| Sweden | 239 | 16.6% | 5285164 | 4.52 |
| Ivory Coast | 227 | 6.6% | 14215570 | 1.60 |
| Denmark | 225 | 4.7% | 2936844 | 7.66 |
| Senegal | 211 | 9.9% | 8516043 | 2.48 |
| Ukraine | 206 | 11.4% | 17449249 | 1.18 |

*Source:* World Bank (Population data) and CIES Football Observatory Monthly Report n°85 - May 2023.

The last column of the table also presents the significance of home countries from a different perspective. It is expected that countries with higher male populations will have more male football players and, therefore, potentially more players to export. When the number of expatriate players is weighted by population, the significance of home countries changes. Now, it is Croatia that leads the list of foreign player migration, with 21.67 players per 100 thousand male population; whereas Brazil has only 1.22 players. Top scores in this index relevant to population are Uruguay (20.38) and Serbia (11.9).

Table 3 displays football players' data from 31 UEFA countries, including the average age of football players, the percentage of club-trained players, and the percentage of foreign players. The average age, estimated on the 1st of October 2023, was 26.6 years. The maximum value was 28.6 years (Greece), and the minimum was 24.7 years (Slovenia). The variation, measured by the standard deviation, was close to one year. On average, UEFA teams had 13.8% of their players club-trained, with a standard deviation of 5.6%. The maximum value was 23% (Belarus), and the lowest was 4.2% (Turkiye). On average, almost half of the football clubs in Europe employed foreign players (45.8%), with a standard deviation of 15.5%. The variations are significant, ranging from a maximum of 80% (Cyprus) to a minimum of 11.2% (Ukraine). In 2023, Greece's football clubs employed an average of 71.2% foreign players.

The data from Table 3 can be used to answer two questions. First, do teams that use proportionally more foreign players tend to have, on average, an older squad? Second, does the use of foreign players become a disincentive for a football team to develop its own players? To address these questions, I use two scatter diagrams (see Figures 2 & 3) that show the correlation between the percentage of expatriate football players and the average age, as well as the association of foreign players with the club-trained players.

Figure 2 plots the average age of players per country against the percentage of foreign players. The best fit is given by a third-degree polynomial, which in economics is used to approximate production functions. However, there is a large dispersion of the data, primarily because of Ukraine and Belarus. If the extreme values of these two countries are omitted, the correlation improves (the coefficient of determination $R^2$ increases by 5 percentage points), but the shape of the fitted line does not change.

Some important conclusions of interest emerge from looking at the scatter diagram. First, when teams use less than 50% foreign players, the average age of their squad is not affected. As the percentage of foreign players increases above 50%, the average age of the team's players sharply increases. Thus, this association implies that teams, on average, hire foreign players who are older than domestic players. This may be interpreted as teams capitalizing on experience and usually bringing in players who are at the decline stage of their career. This type of employment of foreign players is conducive to a strategy that aims at maximizing short-run benefits. The alternative that many teams follow is to hire players at a much younger age with good talent, which becomes an asset for the club that can be transferred in the future to a richer club, thus increasing its profits. Of course, football clubs may follow both these strategies and have a mix of young and old

foreign players. What counts, though, is which strategy dominates. In the Greek football league, the strategy of hiring experienced foreign players dominates. Greece ranks top in the average age of its foreign players, at 28.6 years.

**Table 3.** *UEFA Members* (2023)

| Country | Average Age (years) | Club-Trained (%) | Expatriates (%) |
|---|---|---|---|
| Austria | 25.3 | 15.0 | 41.8 |
| Belarus | 25.4 | 23.0 | 21.0 |
| Belgium | 25.4 | 15.1 | 59.5 |
| Bulgaria | 26.4 | 12.6 | 50.9 |
| Croatia | 25.8 | 14.1 | 37.7 |
| Cyprus | 28.4 | 5.5 | 80.0 |
| Czech Republic | 27.0 | 18.0 | 29.9 |
| Denmark | 26.1 | 22.8 | 43.6 |
| England | 26.8 | 7.5 | 63.3 |
| Finland | 25.6 | 16.2 | 42.2 |
| France | 26.3 | 14.1 | 45.1 |
| Germany | 27.0 | 7.4 | 48.5 |
| Greece | 28.6 | 4.7 | 71.2 |
| Hungary | 27.2 | 12.4 | 46.5 |
| Israel | 26.8 | 18.9 | 33.3 |
| Italy | 26.9 | 5.8 | 62.2 |
| Netherlands | 25.3 | 16.1 | 43.8 |
| Norway | 26.2 | 20.8 | 30.7 |
| Poland | 27.2 | 11.0 | 47.6 |
| Portugal | 26.5 | 7.6 | 58.3 |
| Romania | 27.7 | 10.3 | 46.0 |
| Russia | 27.0 | 13.2 | 41.2 |
| Scotland | 27.0 | 7.1 | 65.6 |
| Serbia | 26.3 | 11.5 | 24.7 |
| Slovakia | 26.4 | 21.3 | 36.3 |
| Slovenia | 24.7 | 16.4 | 43.4 |
| Spain | 27.5 | 19.1 | 39.4 |
| Sweden | 26.6 | 20.1 | 33.1 |
| Switzerland | 25.9 | 17.8 | 50.9 |
| Turkiye | 28.4 | 4.2 | 71.5 |
| Ukraine | 26.4 | 18.9 | 11.2 |
| **Average** | **26.6** | **13.8** | **45.8** |
| **Standard Deviation** | **0.94** | **5.6** | **15.5** |
| **Maximum** | **28.6** | **23.0** | **80.0** |
| **Minimum** | **24.7** | **4.2** | **11.2** |

*Source:* CIES-Football Observatory (https://football-observatory.com/Tool-Demography).
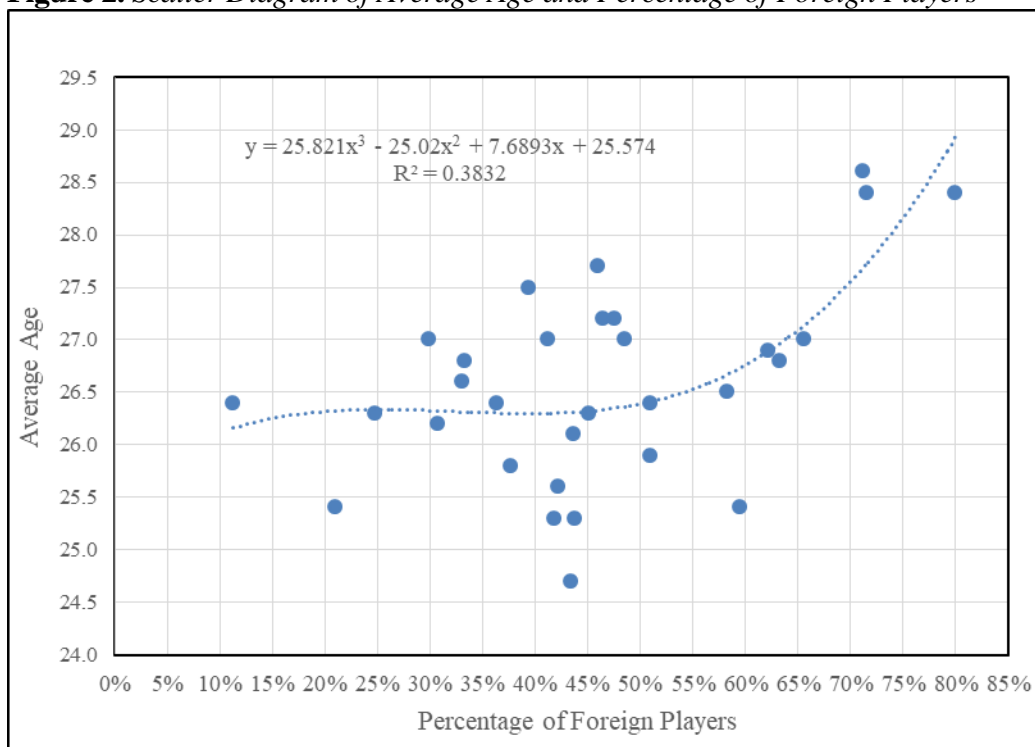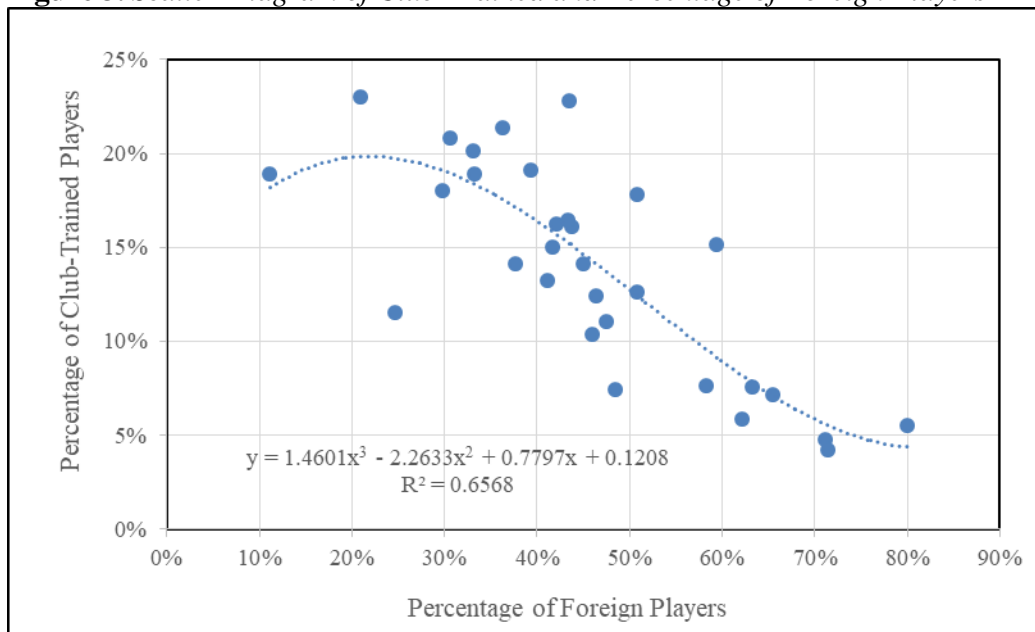
**Figure 2.** *Scatter Diagram of Average Age and Percentage of Foreign Players*



**Figure 3.** *Scatter Diagram of Club-Trained and Percentage of Foreign Players*



Figure 3 shows the association between the percentage of foreign players and the number of club-trained players. The argument is that foreign players may crowd out those developed by the team, who then have no opportunity to play for the team at the highest possible level. However, there is a counterargument: good foreign players can help the team grow its own talent and therefore increase the

number of club-trained players. It seems that both arguments may be valid, depending on the percentage of foreign players used. Figure 3 shows that the shape of the best approximation of the data is a third-degree polynomial, which is non-linear with a saddle point occurring when the team uses 20% foreign players, associated with 20% club-trained players. At less than 20%, which can be considered an optimal strategy of hiring foreign players if the objective is to maximize the percentage of developing club talent, an increase in the share of foreign players increases the share of club-trained talent. However, at shares higher than 20%, the percentage of club-trained players falls sharply. At rates higher than 70% share of foreign players, as is the case for Greece, Cyprus, and Turkiye, the percentage of club-trained players is less than 5%. Even in Italy, with such a long tradition in developing football talents, they use 62.2% foreign players, and only 5.8% are club-trained players.

The conclusion that emerges from the above discussion is that if a team aims to maximize the development of club-trained players, then it should use a small percentage of foreign players. Maximizing club-trained players is consistent with profit maximization if the team gains by selling the players to the international market. However, some teams prioritize performance, either in the national league or in international competitions. The next section examines the association between the percentage use of foreign players and the team's performance on the pitch using data from the regular 2023-24 season of the Greek first division football league.

## Foreign Players in the Greek Professional Football League

This section examines the most recent regular Greek first division football season of 2023-2024, which started on Friday, August 18, 2023, and ended on Sunday, March 3, 2024. There were 14 teams that played 26 games during the regular season. Following the regular season, teams participate in play-offs and playouts. The playoffs determine which team wins the championship and which teams earn their ticket to compete in the three European competitions. The playouts determine which teams are relegated to the second division.

Greek football became professional in 1979, but for all practical purposes, the previous seasons cannot be called amateur. The first football games took place before World War II. During this long period of more than 100 years, two achievements have marked Greek football. In 1971, Panathinaikos reached the finals of the European Champions League, which was played against Ajax at Wembley Stadium in London. This unprecedented achievement at a team level was made possible with a team that had no foreign players; all players were Greek. Even today, if a team were to repeat what is considered by many as a triumph, it would not be comparable because all teams now use foreign players, as shown in Table 4. The second great achievement was winning the European Championship for national teams in 2004. All players were home-grown talents, and most of them played for a Greek team at the time. Only eight out of twenty-three were playing abroad.

The last column of Table 4 gives the percentage of foreign players for each team. There is a wide range. The average was 59.6%, but the maximum was 80%, and the minimum was 44.4%. In total, there were 516 players, and 308 of them were expatriates. Fourteen teams were competing, and Table 4 provides the rank and the points obtained by each team. I measure the performance of a team by the number of points gained during the regular season. It is akin to a production function. In a very simple model, I assume that points obtained depend on the number of foreign players used. I will test this statistical association below after discussing some other characteristics of the foreign players in Greece.

**Table 4.** *Number of Foreign Players (2023-24 Regular Season)*

| Team | Rank | Points | Number of Players | Number of Foreign Players | % of Foreign Players |
|---|---|---|---|---|---|
| P.A.O.K. | 1 | 60 | 38 | 24 | 63.2% |
| A.E.K. | 2 | 59 | 34 | 25 | 73.5% |
| OLYMPIACOS | 3 | 57 | 46 | 29 | 63.0% |
| PANATHINAIKOS | 4 | 56 | 42 | 28 | 66.7% |
| ARIS | 5 | 42 | 35 | 28 | 80.0% |
| PAS LAMIA | 6 | 34 | 37 | 21 | 56.8% |
| ASTERAS TRIP. | 7 | 31 | 42 | 20 | 47.6% |
| ATROMITOS ATH. | 8 | 28 | 31 | 16 | 51.6% |
| PANSERRAIKOS | 9 | 27 | 36 | 16 | 44.4% |
| O.F.I. | 10 | 25 | 34 | 20 | 58.8% |
| PANETOLIKOS | 11 | 20 | 33 | 16 | 48.5% |
| VOLOS NFC | 12 | 20 | 35 | 22 | 62.9% |
| KIFISIA | 13 | 19 | 37 | 24 | 64.9% |
| PAS GIANNINA | 14 | 18 | 36 | 19 | 52.8% |
| | Total | | 516 | 308 | 59.7% |
| | Average | | 36.9 | 22 | 59.6% |
| | Maximum | | 46 | 29 | 80.0% |
| | Minimum | | 31 | 16 | 44.4% |
| | Standard Deviation | | 4.04 | 4.51 | 10.1% |

*Source:* Super League Greece https://www.slgr.gr/el/ and author's calculations. I did subtract 3 points from Volos that was penalized for violating the antiracist regulation.

Table 5 provides the number of foreign players per country of origin. The Greek first division is a modern Babel, with players from 70 different countries and all continents represented among the 14 teams. Interestingly, many players come from countries with highly ranked football competitions. For instance, there are 41 players from Spain, 32 from Argentina, 15 from Brazil, 15 from Portugal, 14 from France, 14 from Serbia, 9 from Croatia, and 8 from Uruguay. Additionally, half of the teams use foreign trainers, which is another issue altogether but may explain why some countries have so many players competing in the Greek first division. This is illustrated in Table 7 below.

**Table 5.** *Number of Foreign Players per Country of Origin (2023-24 Regular Season)*

|   | Country | Number |   | Country | Number |
|---|---|---|---|---|---|
| 1 | Albania | 4 | 36 | Italy | 4 |
| 2 | Angola | 1 | 37 | Lithuania | 1 |
| 3 | Argentina | 32 | 38 | Mali | 2 |
| 4 | Austria | 6 | 39 | Mexico | 2 |
| 5 | Belarus | 2 | 40 | Moldova | 2 |
| 6 | Belgium | 6 | 41 | Montenegro | 2 |
| 7 | Bosnia and Herzegovina | 3 | 42 | Morocco | 2 |
| 8 | Brazil | 15 | 43 | Netherlands | 7 |
| 9 | Bulgaria | 2 | 44 | Nigeria | 3 |
| 10 | Burkina Faso | 1 | 45 | North Macedonia | 1 |
| 11 | Cameroon | 3 | 46 | Northern Ireland | 1 |
| 12 | Cape Verde | 1 | 47 | Norway | 2 |
| 13 | Chile | 2 | 48 | Paraguay | 1 |
| 14 | Colombia | 2 | 49 | Peru | 1 |
| 15 | Costa Rica | 4 | 50 | Poland | 5 |
| 16 | Cote d'Ivoire | 1 | 51 | Portugal | 15 |
| 17 | Croatia | 9 | 52 | Romania | 3 |
| 18 | Cyprus | 4 | 53 | Russia | 3 |
| 19 | Czech Republic | 3 | 54 | Serbia | 14 |
| 20 | Denmark | 2 | 55 | Slovakia | 4 |
| 21 | DR Congo | 1 | 56 | Slovenia | 3 |
| 22 | Ecuador | 2 | 57 | Spain | 41 |
| 23 | Egypt | 2 | 58 | Suriname | 1 |
| 24 | Finland | 2 | 59 | Sweden | 7 |
| 25 | France | 14 | 60 | Switzerland | 3 |
| 26 | Gambia | 1 | 61 | Tanzania | 1 |
| 27 | Georgia | 3 | 62 | Trinidad & Tobago | 1 |
| 28 | Germany | 3 | 63 | Tunisia | 1 |
| 29 | Ghana | 4 | 64 | Turkey | 3 |
| 30 | Guinea | 3 | 65 | Ukraine | 1 |
| 31 | Honduras | 1 | 66 | United Kingdom | 5 |
| 32 | Hungary | 4 | 67 | Uruguay | 8 |
| 33 | Iceland | 4 | 68 | USA | 3 |
| 34 | Iran | 3 | 69 | Uzbekistan | 1 |
| 35 | Israel | 2 | 70 | Venezuela | 2 |

*Source*: Super League Greece https://www.slgr.gr/el/.

How good are the foreign players? One notable index is the top scorers. Table 6 reports data on the 10 top scorers of the Greek first division during the 2023-24 regular season. Only one Greek player makes it to this list. All other players are expatriates. The issue of how foreign players affect the performance of a team is discussed next.

**Table 6.** *Top 10 Scorers (2023-24 Regular Season)*

|  | Player | Club | Games Played | Goals | Country | Goals per Game Played |
|---|---|---|---|---|---|---|
| 1 | EL KAABI AYOUB | OLYMPIACOS | 21 | 15 | Morocco | 0.71 |
| 2 | MORON LOREN | ARIS | 24 | 13 | Spain | 0.54 |
| 3 | MIRITELLO JUAN | ASTERAS TRIP. | 23 | 12 | Argentina | 0.52 |
| 4 | GARCIA LEVI | A.E.K. | 12 | 11 | Trinidad & Tobago | 0.92 |
| 5 | DESPODOV KIRIL | P.A.O.K. | 22 | 10 | Bulgaria | 0.45 |
| 6 | CARLITOS | PAS LAMIA | 22 | 10 | Spain | 0.45 |
| 7 | PONCE EZEQUIEL | A.E.K. | 18 | 10 | Argentina | 0.56 |
| 8 | OZEGOVIC OGNJEN | KIFISIA | 22 | 10 | Serbia | 0.45 |
| 9 | IOANNIDIS FOTIS | PANATHINAIKOS | 19 | 9 | Greece | 0.47 |
| 10 | MURG THOMAS | P.A.O.K. | 22 | 8 | Austria | 0.36 |

*Source:* Super League Greece https://www.slgr.gr/el.

Figures 4a & 4b plot the scatter diagram between the number of foreign players and the total points gained and the same variables in logs, respectively. I have also included the best-fitted lines using the coefficient of determination as a criterion. Figure 4a resembles a production function, as it should. The best approximation is a third-degree polynomial function. At a relatively low number of foreign players, an increase in their number decreases the points gained. However, as the number of players increases, the number of points increases, reaching a maximum at 28 players per team. After that, further increases lower the number of points obtained. Overall, this "production function" of points is well determined by this third-degree polynomial. The variations in the number of foreign players can explain 57.11% of the variations in points obtained.

Figure 4b provides the same scatter diagram, but now the variables are in logarithms. I also plot two fitted lines: one linear and the other quadratic. The latter provides a better fit, explaining 50% of the variations in points gained. The linear model is useful as a first good approximation within the range of values of the sample data. The interesting question is how the number of foreign players affects the points gained. In the linear model, this can be easily seen as the coefficient of the logarithm of the foreign players, 1.4235. This implies that if the number of foreign players increases by 10%, the points gained will increase by 14.2%. This suggests that foreign players help the team to gain more points. This might explain why foreign players are used so extensively in the Greek football league. As shown in the previous section, the Greek league ranks third among 31 European countries in the use of foreign players.

**Figure 4a.** *Scatter Diagram of Foreign Players and Points Gained during the Regular Season of 2023-24 (total non-linear)*
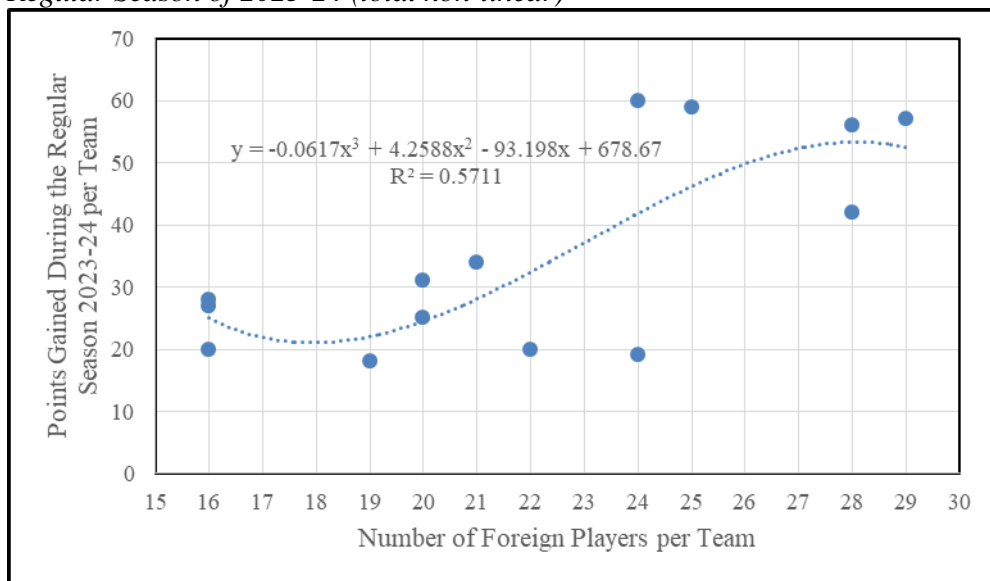


**Figure 4b.** *Scatter Diagram of Foreign Players and Points Gained during the Regular Season of 2023-24 (logarithmic specification; linear and non-linear)*
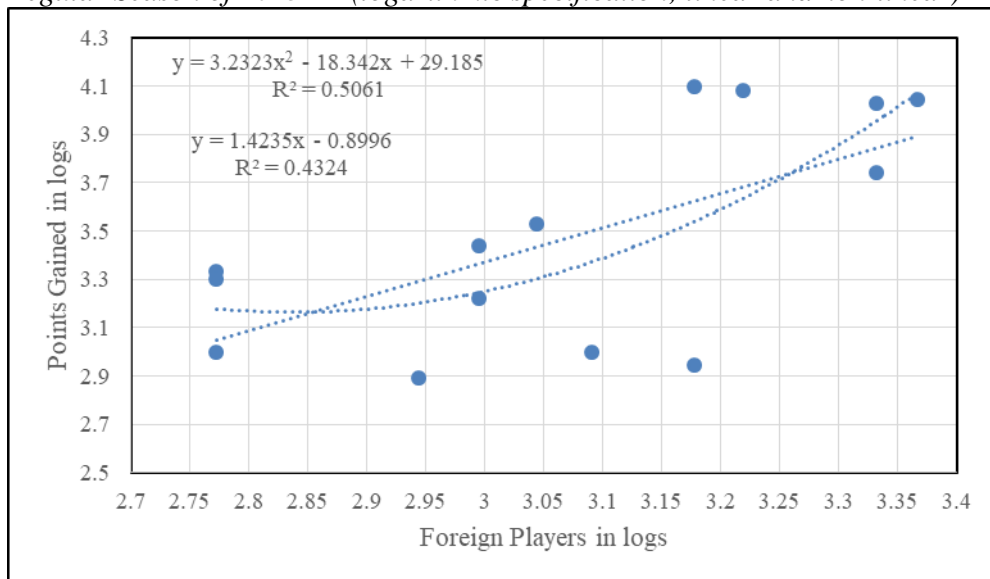


Table 7 shows the 14 coaches of the Greek teams. The table reports the coaches who sat on the bench for the last game of the season. Half of the coaches were from Greece. The others were from Argentina, Serbia, Spain, Turkey, Uruguay, and Romania.

**Table 7.** *Coaches by Country of Origin (2023-24 Regular Season)*

| Coach | Home Country | Football Club |
|---|---|---|
| Konstantinos Bratsos | Greece | AE Kifisias |
| Matías Almeyda | Argentina | AEK Athens |
| Apostolos Mantzios | Greece | Aris Thessaloniki |
| Milan Rastavac | Serbia | Asteras Tripolis |
| Sasa Ilic | Serbia | Atromitos Athens |
| Traianos Dellas | Greece | OFI Crete FC |
| José Luis Mendilibar | Spain | Olympiacos Piraeus |
| Fatih Terim | Türkiye | Panathinaikos FC |
| Giannis Petrakis | Greece | Panetolikos GFS |
| Pablo García | Uruguay | Panserraikos |
| Răzvan Lucescu | Romania | PAOK Thessaloniki |
| Michalis Grigoriou | Greece | PAS Giannina |
| Leonidas Vokolos | Greece | PAS Lamia 1964 |
| Christos Kontis | Greece | Volos NPS |

*Source:* Super League Greece https://www.slgr.gr/el/.

Summarizing the discussion in this section, we conclude that foreign players play an important role in the Greek football league, which explains why Greek football teams use them so extensively.


**Conclusions**

Foreign players dominate the Greek professional first division football league. The percentage of foreign players playing for Greek teams is the third-highest in Europe, after Cyprus and Turkiye, with more than 70% of the players being foreigners. As mentioned in this paper, football players play an important role when they retire by serving the community and the country at large. However, foreign players do not typically stay in Greece after retirement, and even if they do, they cannot become ideal examples to be followed by Greek youth. As the old generation of Greek football players deceases, there will be no substitutes by new retired Greek players. I consider this the most important negative impact of using foreign players. This problem can only be solved if there is a tacit agreement that teams will use a certain percentage of Greek players, perhaps aiming for the average European rate of 45.8%.

The evidence in this paper shows that a higher-than-average number of foreign players, compared to the European average, is negatively associated with the development of club-trained players. It is found that the optimal percentage is about 20%, at which rate the percentage of club-trained players is maximized.

The final conclusion relates to performance and the use of foreign players in the Greek football league. Using data from the 2023-24 regular football season of the Greek first division, it was found that the performance of a team is positively associated with the use of foreign players. A 10% increase in the number of foreign players results in a 14% increase in points gained in the competition.

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