“Human capital: assessing the financial value of football players on the basis of real options theory”

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Human capital: assessing the financial value of football players on the basis of real options theory

Abstract

This paper assesses the value of footballers' performance on the basis of new methods implemented in market finance by Black & Scholes (1973) and Merton (1973) and adapted to company finance by Myers (1977). This method, referred to as real options, complements other existing player price valuation methods and takes into account the uncertainty entailed in pricing football players.

Keywords: human resource valuation, real options, football player pricing.
JEL Classification: G13, O15, L83.

Introduction

At a time when transfer fees are reaching record levels and many clubs are in a critical financial situation, the value of their human assets can be crucial, especially for shareholders and creditors. In these conditions, what is the true value of a football player? By combining methods developed in human resources and real options, this article proposes a model for evaluating the transfer price of a football player that takes into account his varying performance levels. Two cases are considered: a "standard" player and an "atypical" player.

1. Which method of human resource valuation should be applied to football players?

1.1. Methods valuing human capital on the basis of monetary value. Human resource accounting models take three main approaches: cost, income and market. These approaches are currently used in the football world (Brummans & Langendijk, 1995; Morrow, 1996, for example).

1.1.1. The employee cost approach. Applying differential valuation, researchers in the 1960s compared the employee's cost with the products and flows associated with his use. Hekinian & Jones (1967) refer to the opportunity cost of an employee, which is "the cost that would be borne by a company in its operations should it deprive itself of his services", whereas Hermanson (1964) recommends calculating the net present value of human resource investment or of the goodwill associated with their possession.

In the seventies, there was a break away from this approach in particular with Sangeladjik (1977), who valued cost as the summation of expenses or income losses associated with the employee (Flamholtz, 1985; Reilly and Schweihs, 1998). Table 1 shows, however, that this approach is very open if one refers to in the case of replacement, opportunity or forecast costs.

Among these different costs, the historical cost of acquisition method is the most used by football clubs. Morrow (1996) proposes the following method applied to Scottish football clubs: "starting from an initial acquisition cost", the author proposes "to recoup it over the duration of the contract so as to obtain a net value at the end of each accounting period. This net value is then subjected or not to depreciation estimated by the manager with regard to recovering the purchase value of the player. This net value, which takes into account the implicit risk associated with the player, is normally inferior to the value of the player calculated on the basis of the income multiplier used by UEFA".

1.1.2. The income approach. The income multiplier was largely used by UEFA in the 1990s to determine the transfer prices of players between European football clubs. This price had to be at least equal to the gross salary of the player multiplied by a coefficient depending on the age of the player (UEFA, art. 3, 1992). In addition to the bias observed by Morrow (1996) which consisted in overpaying players to maximize their transfer price and the difficulty of applying the method owing to the often confidential nature of the players' real salaries, the main weakness of this method according to Scarpello & Theeke (1989) lies in the fact that it does not take account of the intemporal value of money. In the absence of updating, neither the minimum profitability expected by the investor nor the remuneration of the risk incurred are taken into account.

In order to value the risk borne by the club welcoming a transfer, Brummans & Langendijk (1995) report the following: the salary multiplier includes the player's level of salary at the time of his transfer, in addition to his age; a 0.25 prudence factor is included in this multiplier. Though this factor may be seen as a drastic way to update the value of the player, it is not justified by anything other than a randomly chosen number and, according to Morrow (1996), only weakens the credibility of the calculated values.

These values almost never stand in comparison with the prices observed during transfers. Quirk & Fort (1997) suggest an explanation related to the mechanism for fixing a player's salary. The salary reached is thought to result from the bids launched by multiple competing buyers. As in prestigious auction sales, overbidding is frequent and leads certain clubs to pay more, or even "considerably over the odds" for the item put up for sale. Though this hypothesis is plausible when a player's rating is increasing, it is not true when his value is falling even though his salary has remained constant for the duration of his contract. The market then reflects the rationality of the agents who take into account the player's varying performance level over time.

1.1.3. The market approach. The market approach is no doubt the most relevant method from an empirical point of view: the value of the player is formed by the market at the moment of his transfer. The "Human Capital Pricing Model" of Bender and Röhling (2001) is not applicable. The difficulty is due to the fact that the value of a player is noted at the time of his transfer and cannot be evaluated on the basis of comparisons. This occurs for at least two reasons. First, each player is unique and his performance as well as his record cannot be replicated. Second, his value is intimately linked to the content of the – often opaque – negotiations between the club which buys and the club which sells the player.

A review of traditional quantitative methods shows that the value of a player should include other dimensions that take qualitative data into account.

1.1.4. The option pricing approach. Welpe et al. (2007) justified and modelled real options for the evaluation of "human capital's inherent opportunities and risks". Tunaru et al. (2005) focus on the valuation of professional football players. Using the Carla Opta Index (a performance index) and considering the case of an injury, they develop an option pricing framework to assess the financial value of the players "at a given time". Tunaru et al. apply their pricing formula to the footballer Thierry Henry.

1.2. Human capital valuation methods on a mixed basis. Taking into account the Stockholm School, Roslender & Dyson (1992) called for a paradigm shift at the beginning of the 1980s. Human resource valuation should move from an economic and accounting perspective to a "socio-scientific" approach. Estimating the value of an employee must also be based on "qualitative accounting data". This data which is crucial to the valuing of a football player goes far beyond a simple monetary estimation.

1.2.1. Taking qualitative data into account. The first human capital evaluations based on data other than accounting data came from Likert (1967) and then Likert & Bowers (1973) and proposed several measurements that were mainly behavioral. Flamholtz (1971, 1972), Myers & Flowers (1974) and then Macy & Mirvis (1976) advocated a mixed approach including economic and behavioral variables. In Flamholtz's model (Flamholtz et al., 2002), the value of an individual for an organization is assessed on the basis of the services he is likely to render it in his future roles or functions. These services rendered were thought to follow a probabilistic process over time.

The literature review carried out by Grove el al. (1977) shows the great variety and wealth of mixed valuation methods some of which go as far as to associate several models as in Morse (1975) or in Sadan & Auerbach (1974) which propose to aggregate the models of Flamholtz (1972) and Lev & Schwartz (1971).

1.2.2. The determinants of the value of a football player. The amount of the transfer, the salary and the duration of the contract contribute significantly to the valuation of a football player. The transfer amount is an investment for the club to the same extent as the cost of an investment in fixed assets. For this reason, new accounting norms require that the price of players should be recorded as intangible assets on the balance sheet. The value of the player at the signature of the contract is thus quantified by the amount of his transfer. This amount must be expensed (amortized) and its carrying value in the balance sheet becomes zero at the end of the contract.

This relieves the player from any obligation towards the club. Before the end of the contract, the club reserves the possibility to open negotiations with the player for a possible renewal of the contract or a transfer to another club.

When the player is purchased, the club implicitly has three mutually exclusive options on its player: the option to lend him to another club with or without an option to buy, the option to extend the contract, or the option to "sell" him. The underlying asset of these different options is the value of the player.

The transfer amount quantifies the monetary value of the player's performance at the signature of the contract. The value of the player evolves unpredictably (upward or downward) throughout their careers. Thus when the carrying value of the transfer amount is zero in the balance sheet, it does not mean that the value of the player is zero. His talent capital, his experience and ability to get media exposure remain intact. On the other hand he is free from any commitment to the club. He is free to enter into negotiations with other clubs and the new amount of the transfer fee and salary will be established on the basis of his performance at that time.

The amount of the transfer fee, the salary and duration of the contract are contractual factors which are influenced by factors such as age, margin for improvement, experience, talent and the player's level of media exposure etc. Age is a major factor in the valuation of the player. To play its role adequately, age must be linked with other factors such as, for example, the player's talent and his margin for improvement. Football clubs are often prepared to invest and pay more for a young talented player than for an experienced player at the end of his career. The margin for improvement thus influences the value of the player but remains a somewhat uncertain concept since this there is only a degree of probability that these expectations will be fulfilled.

An eighteen year old with limited talent and a low margin for improvement will fetch a lower purchase price and salary than a player of the same age but known to be talented and having much greater potential. On the other hand, experience may progressively improve the value of a player whose talent is limited. In this case, his salary and purchase price can both increase rapidly. Experience is acquired progressively according to the league in which the footballer plays, the number of matches played in the league, in European competitions, the number of caps for the national team (senior or youth team…), the number of titles won etc. It is rather difficult to quantify this experience but it can be assessed by the player's technical skills, and the confidence displayed in certain situations.

At the end of his career, a very experienced player can use his experience to offset the loss in his former potential and maintain a reasonable level of performance.

The talent of a player can also be measured according to the position in which he plays. The talent of a midfielder is measured in terms of his technical qualities, his dribbling, crossing passing and tackling ability, his stamina, goal assists, the number of goals scored per match and his ability to read the game. A defender will be judged on his ability to defend, distribute the ball and the quality of his tackles. Finally, a goalkeeper will be judged on his technical skills, his ability to react, his agility, goal coverage etc. There are sport newspapers and specialized websites which quantify these different characteristics and rank players.

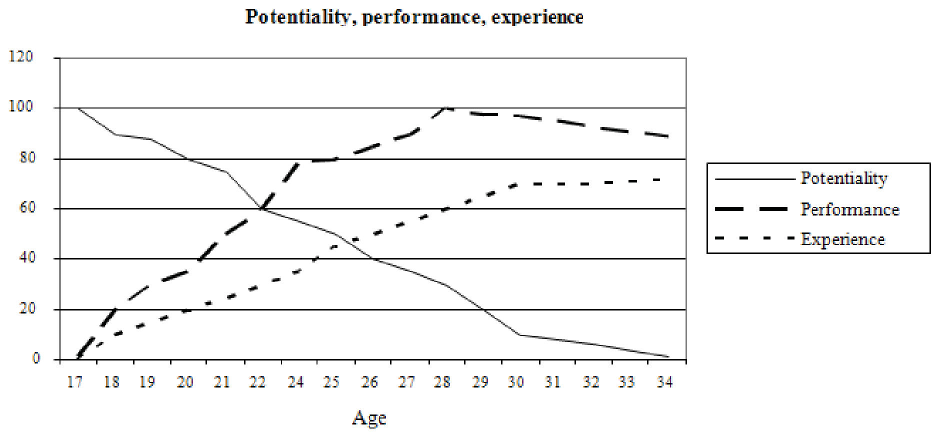

Fig. 1. Connections between age, potentiality, performance and experience

When observing Figure 1, one notices the obvious correlation between age, performance, potential and experience. The younger the player, the higher his margin of improvement and the higher his value is likely to be in comparison with that of a player at the end of his career. As a player grows older, his potential decreases, but he gains in terms of experience and performance up to a certain maximum point, which is on average around 32 years old. After this age, the player's performance declines. To sum up, the age, the talent, qualities and margin of improvement (potentiality) clearly contribute to the variations in value of a football player.

For some players other criteria for valuation parameters may be important. Indeed some players have specific qualities which could be termed as "extra-football" qualities that have a major impact on their valuation. Their image, their ability to attract crowds, because of their personality, the original and even exotic way in which they dress or sport more or less fashionable hair styles. In this respect, David Beckham is an iconic example: 2/3 of the €18m income he declared in 2005 came from advertising contracts and miscellaneous operations. This sort of popularity is an additional asset for clubs which can thus rely on additional income generated by merchandising.

Football and extra-football parameters affect the evolution of football players' value and make it unpredictable. This evolution justifies our choice to model the value of football players using modern financial valuation methods which distinguishing feature is that they take time and uncertainty into account.

2. Modeling an option to purchase or sell which underlying asset is the value of a football player

The normality of return on a financial asset has played a major role in financial theory since the work of Markowitz. This concept of normality has been reinforced and is the basis of financial models since Samuelson (1965) introduced the hypothesis of trajectory continuity, characterized by Brownian geometric motion and later used by Black & Scholes (1973) and Merton (1973).

In reality, financial asset return trajectories do not follow a normal distribution but rather a leptokurtic distribution as noted by Fama (1963). When observing the behavior of some assets, for example, electricity negotiated on financial markets, we may notice that their trajectories are sometimes characterized by jumps linked to seasonal phenomena. In this case, the evolution of the price of electricity is modeled using a geometric Brownian motion with a jump characterized by Poisson's law.

The interest of adapting and modeling the value of a football player using Brownian motion and possibly including the jump is twofold. We show that modeling the value of the player can in certain conditions be compared to the theoretical models of modern finance and can in other conditions present the same contradictions that are to be found in traditional models.

The football world fundamentally operates in an uncertain environment characterized by competitive interactions, uncertain future results and flows and specific risks. The problem of uncertainty and uncertain future flows was met and dealt with in market finance using the models developed by Black & Scholes and Merton (1973) and were then transposed to real assets by Myers (1977). In these conditions, valuation methods taking into account the operational flexibility represented by a portfolio of options on the player on one hand and on the other hand, the strategic value resulting from its interdependency with the future environment are seen as liable to improve the methods of valuing a player on the basis of options on real assets.

Giving the football player a value V and assuming that the underlying asset is the value of the player which supposedly follows a stochastic process, and that the value of the player can admit a jump (due to injury or exceptional performance) and that this jump is represented by a Poisson's law, we propose to model here, firstly the value associated with the performance of a standard player and secondly that of an atypical player.

2.1. Real options and non-arbitrage opportunities (NAO). We are assuming no arbitrage opportunities and relying on real options.

The valuation of an option via arbitrage models is particularly based on non-arbitrage opportunities and market completeness. An arbitrage opportunity involves carrying out profitable operations in some states of nature, with an initial investment of zero and without incurring losses in another state. If there are no limits on the quantities exchanged by investors in an arbitrage situation, the operators would do well to exploit it infinitely, for an arbitrage opportunity cannot last. But since the quantities of securities are limited, and competition and the number of stakeholders on the market quite high, the situations of arbitrage opportunity are swiftly exploited. As a result, we postulate non-arbitrage opportunities here.

Nevertheless the NPV (see note 1 in the Appendix) model uses a single rate to discount the player's future values, and the risk is considered both static and non-dynamic. It is optimal to consider the rates prevailing at each period, since the risk and risk premium varies over time depending on the strategic development of the club, performance and even the relationship between the age, performances and potential of the player. It may also vary in relation to a player's level of confidence, or to the confidence relationship between the player, coach and team mates.

Under certain conditions, the value of player may therefore be based on the Net Present Value (NPV). But this method lacks flexibility and there is a systematic and implicit refusal to postpone the plan to buy a player to a later date. In addition, the value of the player contains certain variables that the NPV is unable to reflect.

This limit justifies our choice for the real options model in valuing a player. Indeed, a real option is a right to buy or sell a real asset [a player for example] under conditions set beforehand – price and due date or time interval (Trigeorgis, 1995). The interest of this product lies above all in the flexibility[1] of an organization [a sport's club] to make a decision about real assets (Sick 1995), and in a search for future opportunities on these assets (Bowman and

[1] The notion of flexibility is particularly important in the theory of real options, but the measures taken to benefit from the value of real options can generate perverse effects: the dynamics linked to human capital and to collaboration strategies can – in the long term – limit exploitation of real options; and the mechanisms seeking to reduce the negative effects can inhibit the benefits generated by the positive risks (Pérez and Bérard, 2009). In the authors' opinion, a balance must therefore be found between the risks and benefits to value uncertainty.

Hurry, 1993). The traditional financial tools are unsuitable: the entry parameters used are deterministic while based on marred expectations of uncertainty and risk, and they do not take into account the inherent flexibility of investment projects (Bellamy and Sahut, 2007). Applying the theory of real options to the world of football is entirely appropriate as the real options allow for a revision of the strategy based on the environment. Since the purchase of a player is a strategic decision to be made exclusively by club managers, the interest of valuing a player by real options is to provide a new quantitative and theoretical basis so as to gauge the intuitions of managers.

2.2. Modeling the performance of a typical player. We consider that part of the value of a footballer can be quantified by using traditional methods of valuation in the same way as quantifying the value of a share on the basis of economic fundamentals. A second part of his value is uncertain; it depends on various aspects linked to uncertainty (his fame, his ability to attract the public, his ability to make fans buy football merchandise, the psychological impact of his private life on his work…).

Most players belong to an average category[1]. The value of the category of players termed as "standard" adapts to a Brownian motion in the form[2]:

$$\frac{dV}{V} = \mu dt + \sigma dz. \tag{1}$$

The interest of this form of valuation is that it takes into account the share of additional and uncertain value of the player in the form of a real option that traditional methods are unable to capture. This additional value, added to NPV, constitutes net adjusted present value. If a player transfers to another club, the additional value will be the difference between the player's transfer fee and his initial purchase price.

We recognize only real options. There is, however, a difficulty in putting together a cover portfolio and in particular in achieving a dynamic replication of the assets which make up this portfolio so as to keep it risk free. In order to get around this difficulty when valuing a football player, we make the basic assumption that the player (in particular thanks to training and the appropriate means provided by his club) will maintain himself, for the duration of the contract, at a standard level of performance that is at least equivalent to his initial output. In this case we calculate $C(t)$ value of the option at a given moment t applying Ito's lemma.

$$dC(t) = \left[\frac{\partial C_t}{\partial t} + \mu V_t \frac{\partial C_t}{\partial V_t} + \frac{1}{2}\sigma^2 V_t^2 \frac{\partial^2 C_t}{\partial V_t^2}\right] dt + \tag{2}$$
$$+ \sigma V_t dz_t.$$

Comparing the risk free portfolio (see note 2 in the Appendix) with Ito's lemma expression leads to the partial differential equation in the form:

$$\frac{\partial C_t}{\partial t} + rV_t \frac{\partial C_t}{\partial V_t} + \frac{1}{2}\sigma^2 V^2 \frac{\partial^2 C_t}{\partial V_t^2} - rC_t = 0. \tag{3}$$

By associating a condition to the bounded form: $C(T) = \max(V(T) - I, 0)$ we obtain the following final and unique solution

$$C_t = V_t N(d_1) - I\, e^{-r(T-t)} N(d_2) \tag{4}$$

with N: Gaussian distribution function,

$$d_1 = \frac{\ln\left(\frac{V_t}{I\, e^{-r(T-t)}}\right) + \frac{1}{2}\sigma^2 (T-t)}{\sigma\sqrt{T-t}} \text{ and}$$

$$d_2 = d_1 - \sigma\sqrt{T-t}$$

Once the value of the option is determined, the value of the player[3] can be broken down as follows:

$$V(T) = NPV + \max\,(V(T) - I, 0).$$

This value constitutes the net increased value of the player.

2.3. Modeling the price of an atypical player. The exceptional performances of an atypical player can be expressed in the form of jumps. These jumps characterize the sudden improvement of the player's performances during a season or else a brutal, temporary or definitive interruption of his career, due to injury. The process combines a geometric Brownian motion with the return to average (Ornstein-Uhlenbeck) and Poisson's law:

$$dV(t) = k(b - V(t))dt + \sigma V(t)dz + \lambda V(t)dw, \tag{5}$$

where k is the recall force and λ is the parameter that expresses the intensity of the jump. The fact of introducing Poisson's law in the player's performance evaluation raises various problems. From a mathematical point of view, the solution of this equation is rather complicated (see note 3 in the Appendix), (see Geman, 1999).

[1] On average the fame and marketing value of these players is not exceptional. We have ranked them in the standard category. They are average players with an average non explosive career.

[2] Here μdt is the drift and completely observable. σ is volatility and dz is the increment of the Wiener process.

[3] The performance of players can also vary during the season or can weaken according to tiredness (end of season), age, or the number of matches (championship, Cup competitions, World Cup). In this case, it is possible to measure the player's average performance. From then on, the player's performance varies around this average. In this case the Brownian motion presented initially in the case of a standard player can be replaced by an Ornstein-Uhlenbeck type process (a Brownian motion with a return to average).

Considering the difficulty of recalculating the value of the option on the basis of this model, we propose to represent the value associated with the atypical player's variation in performance, by means of a graphical representation on the basis of a Matlab simulation, and then determine the payoff of the option by the difference between the value of the transfer and the initial value of the player. In this perspective, a sample of transfer price trajectories will be determined from a Monte Carlo simulation.

3. Cases of a standard player and an atypical player

3.1. The standard player: case of Habib Jean Balde. Trained at the Gueugnon youth academy, Baldé signed a contract with the Stade de Reims club in 2005 for a transfer fee of €15,000. This young player does not attract crowds, but has just renewed his contract for another two years. His level of performance puts him in the standard player category.

Globally, the elements that have a positive effect on the performance and the football value of this category of players are the number of training sessions and matches and the experience acquired.

The case of this player seems interesting to us for two reasons. He both typifies the situation of players who come from youth academies and the valuation of standard players. Indeed when a young player is trained in a club, he can either become a professional at that club or be transferred to another club with a new contract and a salary that reflects his new status as a professional. In this case his value corresponds to the present value of future salary payments. When he is transferred to another club, the transfer price of the young player coming from a youth academy does not completely reflect his performance since he does not have enough experience to prove his talent and attract attention. A negotiation between two clubs is then necessary to determine the transfer fee. The difficulty in this process is most likely to be found in the models, and especially the variables that need to be retained to reach a balanced price for both parties. Globally, since the negotiations take place within an opaque environment and by mutual agreement and since the different variables and determination modes are not standardized but specific to each case, the transfer amount for young players coming from youth academies is hypothetical and uncertain.

The difficulty of defining the true value of a player coming from a youth academy and thus his first transfer fee is confirmed in the case of the player Baldé. The present value of future salary payments in his first year of contract at Reims was around €40,000 in 2006 whereas his transfer fee was only €15,000. With the signature of a new two year contract and taking into account his performance in the club, he received a pay rise and is now paid around €50,000. The 25% increase in the present value of the monthly salary of this player reflects the normal progression in the salary of second division players at the same level of performance. This increase is much lower than that of atypical players.

The Stade de Reims has an option to sell Baldé. Barring an exceptional event, the value of this option is unlikely to be exceptionally high because the value of the player is not sufficiently volatile. In others terms, the amount of his transfer cannot increase exponentially between now and the end of his contract.

Knowing his transfer price in 2005, which in theory corresponds to his value at the time of the transfer, it is easy to define the payoff of this option to sell by simulating a sample of trajectories of the future values of the player. This payoff corresponds to the difference between the resale price (the price of exercising the option) and the purchase price of the player.

The value of the standard player is assumed to follow a random process materialized by a Brownian motion expressed graphically as follows[1]:

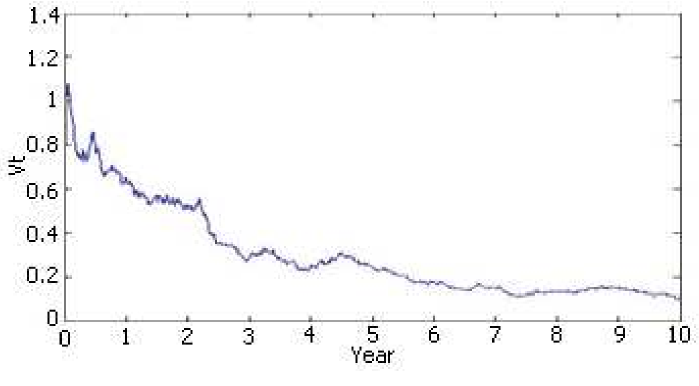

Fig. 2. Trajectory of standard player value

[1] Volatility is identical for all players. We put it at 20% on the basis of the high potential fluctuation in salaries, both upwards and downwards. The duration of a player's career is in the range of 8 to 15 years, and we postulate the career of a conventional player to be 8 years and that of an exceptional player to be 11.5 years.

By observing the evolution of the value curve of the standard player (Figure 2), barring exceptional events, there is nothing to herald a positive jump. In other terms, the probability of witnessing a sudden improvement in performance is quite weak. Conversely, a negative jump of variable intensity can arise due to injury.

Standard and atypical players face the risk of injury. This risk leads to a temporary or definitive interruption of the player's career. This risk is identified by two real options which are mutually exclusive, the temporary interruption option and the abandonment option.

In the presence of these options, the theory of real options makes sense insofar as the club managers and the players need to anticipate and foresee right from the beginning their response to such a situation if it ever occurred. The responses the club makes today to such a situation result in future flexibility and opportunity. They have a value which can be quantified from the theory of real options (Pindyck, 1991; Paddock et al., 1988; Broadie & Detemple, 1994; Berger et al., 1996).

Two cases appear in the situation of injured players and come and confirm the two options.

1. The player is injured, but will be able to play again.

This is the temporary interruption option. This interruption can have a temporary impact on the value of a club and can compromise the selling option. The magnitude of the deterioration in value of the option depends on the duration of the interruption. The risk of non execution of the option will only be likely if the end of the player's contract is close to the date of injury or if the interruption continues until the end of his contract.

2. The player is seriously injured and will not be able to play again

This is the abandonment option. The corollary of this type of injury is a net loss for the club since the value of the option to sell becomes null and non exercisable. The value of the player (Figure 3), which is the major determinant of the transfer fee is affected by any injury and becomes null when the injury is very serious and irreversible.

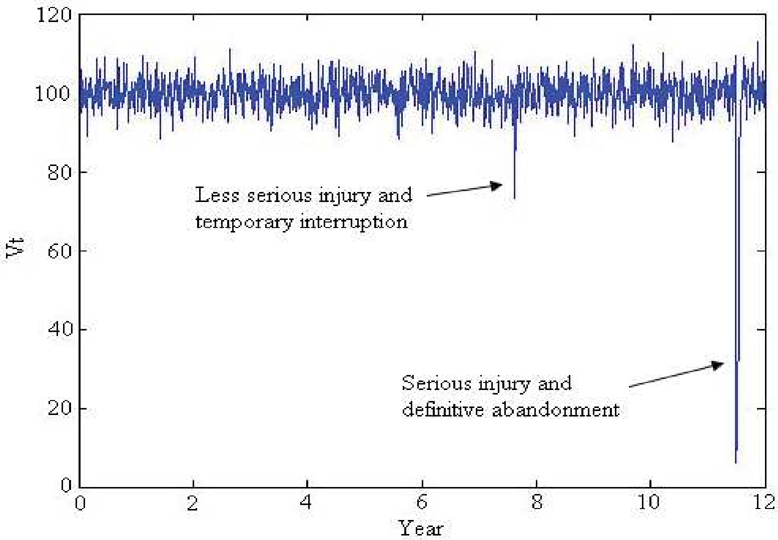

Fig. 3. A trajectory of value *V* as a function of time *t*

To save players from repeated injury, often linked to fatigue and overexploitation of the players (championship, continental cup etc…), clubs over-protect their players. This translates, for example, into clubs increasingly refusing to release their players to national teams.

3.2. Atypical players: the case of exceptional performance. We will analyze two examples. The first example presents the situation of a player bought at a low price by his club, who improves his performance during the single season he spends there and is then transferred at a substantially higher price.

The second case considers the reverse situation: that of a player bought at a very high price who suffers injury or fails to enhance his value and finds himself undervalued on the transfer market. Considering his situation, his club is obliged to loan him out with an option to purchase him at a derisory price or to sell him at a lower price than he was initially worth. These situations can be summed up in the following process:

$$dV(t) = k(b(t) - V(t))dt + \sigma V(t)dz + \lambda V(t)dw. \quad (6)$$

Indeed, the performance in this case is similar to an American type option in so far as the jump which characterizes this process corresponds to a probabilistic stopping time. The theoretical and empirical resolution of American options has been the subject of many studies.

It is the case, in particular in the work by Whaley (1981) which offers a closed form solution, or by

Merton (1976) who adapted Black & Scholes' model to the valuation of American options. The work by Roll (1977), Geske (1977, 1979) also contributed significantly to the valuation of American options. In the case of our problem, it is difficult to find a theoretical solution. For this reason, we will conduct a graphical analysis to explain different situations.

3.2.1. An exceptionally high performance of atypical player, Didier Drogba. Didier Drogba's rating has been at its highest since he has left his first club to go to Olympique de Marseille. His rating grew rapidly to the point that he drew the attention of the major European clubs. The transfer fee Marseille paid for him (€5m) reflects his real value since it remains within the average transfer price range and is not exceptional. Drogba's exceptional status comes from his transfer to the UK. Indeed, Drogba's remarkable progress during the season he spent at Marseille in no way explains the very high amount paid for his transfer to the UK. Beyond his real value, this player catches the imagination and his image sells. It is thus his marketing value and then the potential improvement of his performance which partly explain his soaring sale price. All these elements which add to the value of a player and are not perceptible are quantifiable in our analysis made from real options. These can be, depending on the case, appreciated in the same way as share options or currency options, options on futures contracts, exchange options and many others (Black, 1976; Whaley, 1981; Garman & Kohlhagen, 1983). The difference between the initial purchase price Marseille paid for this player and his resale value (the transfer fee) constitute a large part the value of the real option.

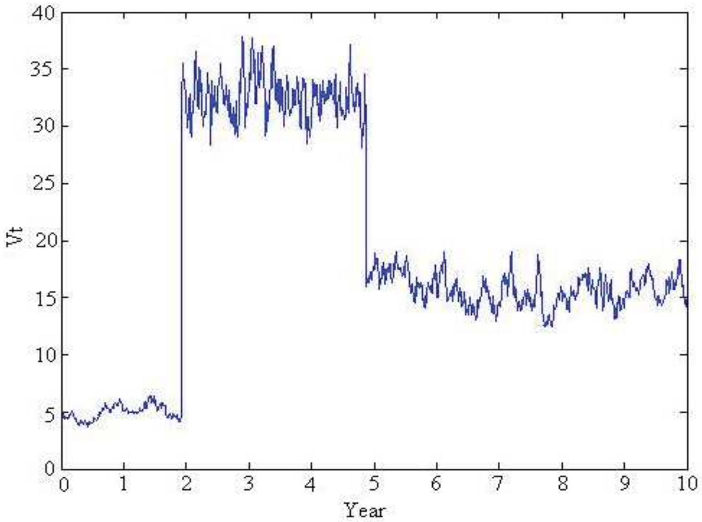

Fig. 4. A trajectory of value *V* as a function of time *t*

Figure 4 expresses the overall evolution of great players and more particularly that of Drogba. The first period represents the time when he starts to reveal his ability and implicit value. The overbidding starts, because each club anticipates the profit they are likely to make by securing the services of this player. At the end of the second period, his performance improves dramatically. He is transferred to the UK and this augurs a better future for him and his new club. His performance improves even more, to reach a new average performance level with regular peaks.

By investing such a huge amount, the club hopes to make a profit when it sells the player. There is however a risk of possible loss linked for example to injury or below average performances by the player. If the player improves his performance, his club may decide to extend his contract or to exercise its option to sell the player to another club. They can exercise this option at any time before the contract lapses. The use of this option depends on an uncertain transfer fee, which itself depends on the player's value. The club will exercise the option only if the fee exceeds the amount of the initial transfer price of €36m. The higher the fee offered by the other club, the more Chelsea will be motivated to exercise its option.

By keeping the player too long, the club takes the risk of seeing his value deteriorate, just as a speculator who anticipates a bullish market is likely to find himself facing a bear market. In order to hedge against this risk, the club will offer him the best training conditions, a work environment likely to stimulate him to redouble his efforts in a very competitive environment (win bonuses).

Indeed, Marseille bought Drogba for €5m (his real market value). By using their option, Marseille delivered the player at the exercise price negotiated at delivery. Marseille's profit which is also constitutes the intrinsic value of this option to sell was the difference between the exercise price and Drogba's initial purchase price.

Calculating the value of the option:

The value of the option to sell = $\max(I - V, 0)$

Table 1. Footballer financial data

Purchase value of the player Drogba (*V*)	Transfer value (*I*)
€5 000 000	€36 000 000

To determine the value of the option to sell, one needs to determine the current value since the two amounts do not intervene at the same moment of time. This rate is determined using the following formula[1]:

$$E(\tilde{r}) = r_f + \beta(E(R_M - r_f). \quad (7)$$

The determination of the discount rate requires using a club that is quoted on the stock exchange such as Glasgow Rangers, to determine the value of the beta of club in relation to an appropriate index, for example the DJ Stoxx Football Index.

Table 2. Club financial data

Risk free Euribor rate 1 year	Beta (1 year) of the club
3.52 %	0.029

This gives the following result:

$$E(\tilde{r}) = 3{,}52 + 0{,}029 \times 5{,}06,$$

$$E(\tilde{r}) = 3{,}66\,\%.$$

In concrete terms, the value of the option to sell exercised by OM at the moment when Drogba was transferred was:

$$C = \frac{36000000}{1 + 0{,}0366} - 5000000 = 34728921{,}5 - 5000000,$$

$$C = 29728921{,}5.$$

The sales price of the player (his transfer fee), partly corresponds to the improvement in Drogba's performance, but is also related to extra-football qualities such as his marketing value, and so on. This extra value is absolutely uncertain and difficult to dissociate from the value linked to the improvement in his performance. What is certain is that it is included in the value of the option to sell and can for example be quantified by the figure linked to merchandising and commercials.

Player value remains uncertain and the best way to observe it is to do so progressively, at fixed dates. In this way it is possible to observe the total value of player over different periods.

Conclusion

This article demonstrates two methods of evaluating a footballer and shows that his value (based on random parameters such as injury) and his marketing value (related to the sale of jerseys, etc.) can be modeled on the basis of options on real assets. This accounting value may be more or less than the initial value of the contract between the player and his club. This model, applied to the evaluation of certain players could contribute to the reliable valuation of human assets (close to a fair value) on the balance sheet of football clubs.

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[1] Here r_f is the rate without risk, β measures the variation in the profitability of the club in relation to the variation of the index, and $(E(R_M - r_f)$ is the risk premium.

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Appendix

Note 1. Note that, in a discrete environment for example, the NAO principle allows for the theoretical values *V* of financial assets to be defined by discounting the future flows at the rate tailored to the equivalent risk. This principle forges a relationship between the prices of financial securities of different periods.

Indeed, a relationship is naturally forged between value F_0 in t_0 the future flow F_1 in t_1, quantified by the equation $F_1/(1 + r)$. By reasoning by absurdity and supposing that $F_0 < F_1/(1 + r)$, it is possible to start with nothing, borrow flow F_0 at the risk-free rate r and make a risk-free profit by buying future flow F_1 at price F_0. In t_0, the net flow of the operation is nil. In t_1, the arbitrageur reimburses $F_0 \times (1 + r)$ and collects F_1. In theory, this operation releases a certain positive flow.

NAO conditions are essential in valuing assets as they ensure the uniqueness of the price associated with the hypothesis of market completeness, the NAO confirms that the option price is equal at all times to the value of the replicating portfolio.

In the case of random flows or at-risk flows, the Capital Asset Pricing Model should be used to deduce a discount rate which takes account of the risk:

$$E(R_i) = r_f + \frac{\left(r - E(R_m)\right)}{\sigma_m}\rho_{i,m} \times \sigma_i.$$

Although the risk has been taken on board, the comparison of the present value with reality raises the question of evaluating future flows, for future cash flows are a successive series of random variables which do not favor usability of the present value to justify the player's price.

By considering a random flow process, $\tilde{V}_i(t)$ corresponding to the future values of the player over a period of time t, the theoretical price is the present value. In t_0 and in a certain universe, this value is $V_0 = \sum_{t=1}^{n} \tilde{V}_i e^{-rt}$, and in continuous time: $V_0 = \int_0^T \tilde{V}_t e^{-rt} dt \cdot$

In reality, the practical use of the value present gets round this problem of random variables by replacing them with mathematical expectations and neutral risk probability, noted Q, giving: $V_0 = \sum_{t=1}^{n} E_Q(\tilde{V}_i)e^{-rt}$, and in continuous time:

$$PV_0 = \int_0^T E_Q(\tilde{V}_t)e^{-rt}dt \cdot$$

In this case, the price of a player's purchasing option will then be: $C = E_Q(S_T - K,0) \times e^{-r(T-t)}$.

Note 2. On the basis of a coverage portfolio including an option and a certain number of underlying assets, $P(t) = C_t + nV_t$, to eliminate randomness and reach risk-free output like Black & Scholes, we need to replicate our portfolio dynamically, which in other terms amounts to determining the amount of assets necessary to maintain our portfolio at a given level of output, that is $dP(t) = dC_t + ndV_t$.

The amount of: $n = -\frac{\partial C_t}{\partial V_t}$ enables us to eliminate randomness in the formula and reach risk-free output, and corresponds in our analysis to the effort made by the player and the level of training imposed by the club to maintain the player at a continuous given level of output throughout the duration of his contract. By referring to the hypothesis of a lack of arbitrage opportunity (NAO), we can compare the efforts made by the player with the output of a financial asset which remunerates shareholders at a risk free rate whatever its nature.

Note 3. For the following reasons: the risk of no return to average increases with the intensity of the jump, that is to say, with the seriousness of the injury. This intensity is not controlled by club managers, and it is thus an uncertain quantity. Moreover, there is also the problem of the duplication of the derivative whose underlying assets are largely currency linked and therefore of the completeness of the market:

- The dates of the injury as well as of the exceptional variation in the performance of the player are not known beforehand. As a result, the jump can occur and the value of the player can improve or deteriorate at any time. The real option becomes an American type option.
- In addition, the impact of the injury on the value of the player is linked to the seriousness of the injury and the time necessary for recovery. These elements are taken into account in the calibration of parameter λ.

λ defines the degree of seriousness of the injury and the intensity of the jump.

Injury has an immediate effect on the value of a player. It is comparable to the payment of a dividend for financial assets. We could envisage using Merton's model (1976) which foresees the payment of dividends. However, Merton's solution does not solve the problem of taking into account the jump which represents the exceptional variation in the performance of the atypical player.