

Welpel, Isabell; Lutz, Stephan; Barthel, Erich

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Isabell Welpé, Stephan Lutz, Erich Barthel*

The Theory of Real Options as Theoretical Foundation for the Assessment of Human Capital in Organizations**

The human capital represented by corporate employees involved in the information and knowledge economy is becoming an increasingly central value-creating factor in global competition. However, in contrast to other value-creating factors, human capital is more difficult to measure, evaluate and manage. Due to human capital's great importance for economic value creation, a series of studies on human capital evaluation have been published during the last few years. This paper discusses why so many traditional evaluation methods are only partly appropriate for categorizing, analyzing and evaluating human capital's special characteristics. In particular, it is difficult for many traditional approaches to integrate notions of flexibility and options with regard to the human capital of companies. Our result shows that the real options theory provides a theoretical framework for the evaluation of human capital and allows a differentiated analysis that, on a qualitative basis, enables investments in uncertainties that are associated with human capital. This theory thus forms the foundation for the quantification of human capital's inherent opportunities and risks. Consequently, this paper provides approaches for the future evaluation of human capital and a conceptual context for empirical studies.

Key words: **Human Capital, Real Options, Company Evaluation, Immaterial Assets, Company Value, Investment**

* Dr. Isabell Welpé, Institut für Information, Organisation und Management; Ludwig-Maximilians-Universität München, Ludwigstraße 28, D – 80539 München, Tel. +49 89 2023 8774. E-mail: welpé@lmu.de.

Stephan Lutz, Lutz & Kollegen GmbH, Euckenstraße 40, D – 28215 Bremen, Tel. +49 421 2476743. E-mail: stephan.lutz@lutz-kollegen.de.

Prof. Dr. Erich Barthel, Frankfurt School of Finance and Management, Sonnemannstraße 9-11, D – 60314 Frankfurt am Main, Tel. +49 69 154008207. E-mail: e.barthel@frankfurt-school.de.

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1. Introduction and problem formulation

In global competition, the information and knowledge economy's prerequisites increasingly focus employees' performance on economic efficiency considerations (see Lengnick-Hall/Lengnick 2002). The realization that people with their knowledge, experience, education, personality and behavior constitute the only resource that generates and retains organizational value led to the human capital concept (see Arthur 1994; Barney/Wright 1998; Becker/Gerhart 1996; Dyer/Reeves 1995; Ichniowski/Shaw/Prennushi 1997; Lepak/Snell 1999). In an economic sense, human capital is "the propensity of a person or group to perform behaviors that are valued by an organization" (Smart 1998, 158).

Human Resource Management has to make sure that investments in people improve the competitiveness of organizations. Therefore, the tools and practices have to prove their contribution to a successful transformation of strategic goals into organizational success (Welpe/Rachbauer 2006). Based on research of Human Resource Accounting (Flamholtz/Lacey 1981) indicators have been developed to demonstrate the economic value added by human resources (Friedman/Hatch/Walker 1998). Combined with the idea of Humanistic Psychology employees are now seen as the source of innovation (Pfeffer 1998; Davenport 1999; Fitz-enz 2000; Sveiby 1998; Edvinsson/Brüning 2000). Research has attempted to develop possibilities for the evaluation of human capital from a qualitative (e.g., Fitz-enz 2000; Sveiby 1998; Edvinsson/Brüning 2000) as well as from a quantitative perspective (Scholz/Stein/Bechtel 2006). Despite the progress that has been made (for a review see Scholz/Stein/Bechtel 2006, 54-210; Barthel/Gierig/Kuhn 2004) there is still not only a lack in theoretical and empirical knowledge about the way human capital does contribute to organizational success (Persch 2003; Becker/Huselid/Ulrich 2001), but also a common agreement is missing on how to translate human capital into economically relevant terms. The available qualitative approaches provide indications for the evaluation, assessment and control of various corporate human capital aspects. They are, however, unsuitable with regard to the representation of human capital as a value-creating factor like other production factors such as, for example, money capital, as they do not permit quantification (Persch 2003; Rachbauer 2003). Scholz/Stein/Bechtel (2006, 221 et seq; also see Scholz 2007a, 30 et seq; Scholz 2007b) developed the "Saarbrücker-Formel" which uses monetary terms to describe human capital. The Saarbrücker-Formel considers competent and highly motivated personnel as a value driver as long as the employees dispose of current value-creating knowledge. In order to prevent an erosion of that knowledge, human resource development is inevitable. Therefore, the Saarbrücker-Formel does not only take into account the existing human capital value but also possible losses in value, value changes that are due to motivation (or the lack of motivation, respectively), and value compensations that can be achieved by personnel measures. As a consequence, the Saarbrücker-Formel systematically combines the advantages of traditional evaluation approaches thereby positively influencing the discussion on human capital. Despite critics on the contents of the approach (Becker/Labucay/Rieger 2007), it promises to influence future studies and conceptualizations on human capital.

Besides, personnel economic concepts, the incremental value concept and capital asset pricing models (CAPM) are specifically regarded as very promising approaches in terms of quantitative interpretation. In spite of their rigid economical and quantitative basis, these approaches have a number of restrictions with regard to the evaluation of human capital as they are based on the discounted cash flow method (DCF): They assume that future profits through human capital are predictable and that the business environment will not change in future. Furthermore, they assume that the discounting interest movements are unambiguously determinable (either their own estimation or based on the market) and constant over the measurement period (see e.g., Amram/Kulatilaka 1999, 100 f.; Dixit/Pindyck 1995). The existing quantitative methods for evaluating human capital underestimate human capital's true value (see Kensinger 1987). The reason for this is that these methods assume that a future negative cash flow is inevitable so that such cash flows are discounted and considered with the entire expected amount. Consequently, the value of the investment is decreased by the present value of the entire expected amount, although there is often a possibility to reduce or avoid negative cash flows by reacting flexibly in reality (e.g., by dismissing someone instead of continuing to pay the salary thereby minimizing losses of the company). The existing quantitative methods therefore negate management's skills to avoid or at least reduce losses. Furthermore, traditional methods regard an investment as only feasible at present so that investments are evaluated as now-or-never decisions (see Dixit/Pindyck 1994). An analysis, of how the value of a measure changes if management decides to wait, is not carried out.

Nevertheless, employees' human capital provides the company with a number of possible options that can be realized flexibly in future. This type of flexibility is in itself a value, as it enables the company to react flexibly to uncertain future expectations (Bhattacharya/Wright 2005). In contrast to established valid evaluation methods, the real options theory enables an analysis and evaluation of the inherent options in human capital.

From the real option viewpoint, human capital can as such have economic value for the organization in question, even if it does not contribute concretely to the operating income at a given point in time. Hence, the purpose of this article is to present the real options approach's reference framework as heuristic for the analysis of changes in human capital. In the light of this objective the current situation regarding human capital evaluation research is outlined, before the quantitative approaches of personnel economics, the incremental value concept and CAPM are introduced and their advantages and disadvantages discussed with regard to human capital evaluation. Thereafter, the real options theory is introduced, followed by an analysis of how existing methods could be expanded and enhanced by this approach with regard to the evaluation of human capital. Real options theory provides a reference framework for the observation of human capital's development dynamics and additionally allows economically sensible decisions to be made, even under uncertainty. The consequences that the use of the real options approach can have for business practices are discussed in the conclusion. As the created conceptual reference framework can furthermore serve as a basis for the empirical analyses of the employment of human capital evaluation in business practice, our conclusions are not only relevant to understand

the possibilities of human capital evaluation in practice but also to broaden the current theoretical concepts.

2. Approaches to the evaluation of human capital: The research situation

The concept of human capital was initially coined by Nobel prizewinner and economist Theodore Schultz who defined human capital as “skill, knowledge, and similar attributes that affect particular human capabilities to do productive work” (Schultz 1961, 8). During the last 40 years, other economists have taken up Schultz's definition of human capital many times and extended it in various ways, including measuring criteria, which led to the concept's greater heterogeneity. Currently, there are a variety of definitions and ideas associated with the human capital concept. It is therefore often unclear what human capital means in contemporary discussions (see Rachbauer/Welpe 2004, 145). Whereas traditional human capital theories and definitions that have been formed by economics assume that human capital can best be operationalized by intellectual cognitive factors, more recently personality and behavior dimensions are again included as part of human capital in theoretical models and empirical studies. In this study, human capital is understood as “the sum of all value creating behavior and qualities of the employees” (Smart 1998, 157). Besides knowledge and experience, this definition also includes motivational and socio-interactive dimensions (Hasebrook/Zawacki-Richter/Erpenbeck 2004).

The measurement and evaluation of human capital in companies are part of the most difficult but nevertheless vital problems of human capital research: Valid measuring methods assist in developing and exploiting human capital in accordance to the strategy of the firm (Huselid/Barnes 2002; Huselid/Becker 2000, 836). Human capital can be seen as one of the hidden factors that could help to explain the drifting apart of market and book values of a firm at an unprecedented rate (see Edvinsson/Brünig 2000, 11-13) and the stock markets' increasing volatility that can be interpreted as uncertainty with regard to “real“ company value and applied evaluation methods (Becker et al. 1997). In this regard, the actual company value is not the only important aspect, but the factors that determine this value are of equal importance. The uncertainty indicates that traditional value-determining factors are apparently no longer adequate to explain an organization's value (see Lev 2001, 2003).

The existing concepts for the quantitative evaluation of human capital are based on the application of established national economic and business management value-determining methods. They should therefore lead to a link between the general economy and the personnel work. The following exemplarily presents the personnel economy, incremental value concept, and CAPM as traditional evaluation approaches which are transferred to human capital with their pros and cons (for a review of further evaluation approaches to human capital see Scholz/Stein/Bechtel 2006, 54-210; Barthel/Gierig/Kuhn 2004). Subsequently, we demonstrate how the real options theory complements these approaches.

2.1 Personnel economics

Application-oriented personnel economics can be considered the basis of quantitatively oriented human capital. This ties in with the human capital theory's economic principles and thus with microeconomics, which examines the influence of education and continued education on individuals and their life earnings' measurable performance (see Backes-Gellner/Lazear/Wolff 2001). Human capital theory and, thus, personnel economics' fundamental assertion is that education efforts (i.e. investments) of the micro-economic equilibrium follow the compensating marginal utility. Investments are made in human capital until the expected marginal returns from the investment equal the cost limit (see Becker 1964; see also economical business theory). The simplified formula is

Formula 1: Determination of the optimal investment level from a personnel economics perspective

$$\sum_{i=0}^n \frac{C_i}{(1+r)^i} = \sum_{i=0}^n \frac{MP_i}{(1+r)^i}$$

C_i : Costs of the human capital investment during period i

MP_i : (Acquired) surplus from the human capital investment during period i

r : Discount rate

n : Number of periods (e.g., job tenure)

From the general formula that calculates the optimal investment level, a methodology can be derived to determine the human capital's absolute value. One can debate the interest rate r . If the present value C of an investment (relatively easy to determine for single period investments) and the future profit from this is known, then the resultant interest rate equals the internal rate of return. This is the interest rate that equalizes the two sides and/or makes the net present value zero (see Brealey/Myers/Marcus 2007, 190; Brealey/Myers/Allen 2006, 91).

Formula 2: Determination of the human capital value from a personnel economics perspective

$$C = \sum_{i=0}^n \frac{MP_i}{(1+r)^i}$$

C : Present value of human capital costs

MP_i : (Acquired) surplus from the human capital investment

n : Age

r : Discount rate / internal rate of return

From a personnel economic approach, the value of a human capital investment should match the investment costs because these would equal the future returns' present value. From an economic viewpoint, this matches a good's fair price and, consequently, its value (see Becker 1975). As it is often impossible to quantify opportunity costs, it is also difficult to quantify the overall costs of C . Even though the above formula suggests simplicity and calculability in the application to real live settings the following problems arrive: First, MP and thus also C can hardly be determined with sufficient precision, since the opportunity losses in the case of a non-investment

would have to be known. The value of the human capital investment can, however, be calculated because it is possible to determine the monetary surplus from a human capital investment. If an appropriate discount rate – reflecting uncertainty/ opportunity costs - can be found, the present value of the transacted human capital investment can be calculated. If all investments are dealt with in this way, the total value of an individual's human capital equals the sum of the present values of the human capital investments in this individual (see Becker 1964, 1975; Franck/Opitz 2000).

2.2 Incremental value concept

The incremental value concept is based on the assumption that the additional value that an employee yields for the company or that individual personnel measures can be recorded relatively exactly. It is a first approximation to obtain a sense of the recoverability from employees and is theoretically based on human capital theory and personnel economics' explanations. As already explained, human capital value matches the sum of the present values of personnel measures' accruing contributions in the respective periods. An isolated observation of personnel measures with regard to their respective contribution to human capital as a whole would be meaningful. The present value of a personnel measure is calculated as follows:

Formula 3: Determination of the present value of a personnel measure

$$PV_{\text{Personnel measure}} = \sum_{i=0}^n \frac{MP_{\text{Personnel measure}_i}}{(1+r)^i}$$

$PV_{\text{Personnel measure}}$: Present value of personnel measure in t_0
 n : Effective period from the time of the measure (e.g., staff membership from the beginning of the measure)
 $MP_{\text{Personnel measure}_i}$: Contribution to operating income from the measure in period i
 r : Discount rate

Where the contributions to the operating income MP_i equal the difference between the gross inflows and expenditure on the measures

Formula 4: Determination of a personnel measure's contribution to operating income

$$MP_i = MP_i^{\text{Gross}} - C_i$$

MP_i : Contribution to operating income from the measure at time i
 MP_i^{Gross} : Gross personnel measure inflow during period i
 C_i : Personnel measure expenses during period i

If to simplify the computation, one assumes that the MP_i has a constant value – for example, due to mostly unchanging job performance, wages etc. - the present value can be simply calculated by the annuity formula:

Formula 5: Determination of the present value of a personnel measure as an annuity

$$PV_{\text{Personnel measure}} = MP \cdot \left(\frac{1 - \frac{1}{(1+r)^n}}{r} \right)$$

$PV_{\text{personnel measure}}$: Present value of personnel measure in t_0
 MP : Assumed constant contribution to operating income of a personnel measure
 n : Staff membership from the time of the measure in years
 r : Discount rate

As already explained, the sum of the present values of all personnel measures comprises an organization's human capital:

Formula 6: Determination of the human capital value from an incremental value perspective

$$PV_{\text{Human capital}} = \sum_{i=1}^n PV_{\text{Personnel measure } i}$$

$PV_{\text{Human capital}}$: Human capital present value at time t_0
 $PV_{\text{Personnel measure } i}$: Present value of personnel measure i
 n : Number of personnel measures

2.3 Market oriented concept

One problem regarding static incremental value considerations is that the uncertainty concerning the results are not adequately incorporated even if risk adjusted discount rates are applied. That is because benchmarking against the market or capturing opportunity costs incorporating uncertainty is not captured by incremental value considerations. Additionally, example portfolio effects cannot be included (e.g., the employment of a larger number of employees). Financial economy can help in this regard. Due to future uncertainty, the expected rate of return on a human capital investment must be related to the inherent risk in human capital. Only if the rate of a human capital investment's return-risk relation matches that of the market as a whole, is the price fair.

Sharpe (1964) and Treynor (1961) primarily developed the CAPM as a decision-making model for capital market products in respect of investments in risk-carrying assets. The CAPM (see, for example, Heidorn 2006; Brealey/Myers/Allen 2006, 181 et seqq; Spremann/Pfeil/Weckbach 2001, 151 et seqq) is described by the security market line which relates expected return to systematic risk. One of the basic assumptions of the CAPM is that one can borrow and lend money at the same risk free rate. Therefore, the security market line is defined as the risk free rate plus the product of systematic risk and the risk premium. As investors are assumed to be risk-averse (i.e. investors require a higher return as a compensation for taking additional risk), the security market line is upward sloping. The CAPM "states that the expected risk premium from any investment should lie on the security market line" (Brealey/Myers/Allen 2006, 193). If the return of an investment lies above or below the ex-

pected return resulting from security market line calculations, the investment is undervalued or overvalued, respectively.

Bender/Röhling (2001, 27 et seqq) re-interpret CAPM as a Human Capital Pricing Model (HCPM). In particular, the CAPM variables are interpreted in relation to human capital. This results in a human capital market model and/or a support aid for deciding whether human capital should be acquired or reduced.

Although human capital does not deal with fungible convertible values and one cannot sell human capital because it is linked to people (see Copeland/Weston 1992; Davenport 1999), at least temporally limited licensed rights can be sold and even be partially traded (see Lepak/Snell 1999). Temporary employment agencies, freelancers, headhunting for highly trained human capital and similar phenomena are indications that there is a moderate trade in human capital, at least on a limited scale, and this is still in a development stage (see Bender/Röhling 2001).

Copeland and Weston (1992) also demonstrate that the CAPM's explanation content is also maintained in respect of non-marketable assets. According to Bender/Röhling (2001, 33), the market portfolio for an HCPM includes "all human capital bearers (company employees), i.e. all potential company-internal human capital investment possibilities." From an opportunity viewpoint, this is logical because a company can only superficially invest in its own human capital bearers and not in others.

Since the market for human capital nevertheless tendentiously comprises all accessible human capital bearers and their skills, the definition of market portfolio as portfolio of all available human capital bearers (e.g., a national economy's manpower potential) and/or the designation of market portfolios as a total of all of a particular qualification group's human capital bearers are sensible. Consequently, it is, for example, possible to compare an investment in a mechanical engineer's human capital with the market for mechanical engineers and thus with relevant alternative investments. A mechanical engineer position will therefore not be filled by a business economist or an office clerk.

Risk-free interest can be re-interpreted as mechanical productivity since an investment in human capital has the opportunity to invest in assets which do not feature human-capital-specific risk. Fluctuation risk can be disregarded in this instance because the following considerations are based on single period valuation. Additionally fluctuation risk of unqualified human capital may be approximated by mechanical productivity's risk of technical breakdowns.

The extended line resulting from the market portfolio connection with risk-free interest can therefore be described as the human capital market line. The human capital rate of return is regarded as value creation, allocated to the individual human capital bearer and consequently defined as value creation per employee (see Bender/Röhling 2001). This can also be regarded as value creation per personnel measure, as there can be various measures for human capital creation (see above). The single human capital assets' rate of return can be iterated backwards from the present values.

From a comparison of the personnel measure costs' present value

Formula 7: Determination of the present value of personnel measure costs

$$PV_{Personnel\ measure} = \sum_{i=0}^n \frac{C_i}{(1+r)^i}$$

$PV_{Personnel\ measure}$: Present value of personnel measure in t_0 / Price of the human capital asset

C_i : Cost of personnel measure during the period i

r : Discount rate

n : Effective period of the personnel measure

with r equaling the risk-free interest (as this is the alternative investment possibility for the financial means) and the expected future gross inflows

Formula 8: Determination of the present value of the gross inflow from the personnel measure

$$PV_{Personnel\ measure} = \sum_{i=0}^n \frac{MP_i^{Gross}}{(1+r_{HC})^i}$$

$PV_{Personnel\ measure}$: Personnel measure present value on cost base during t_0 / Price

MP_i^{Gross} : Gross inflow from the personnel measure during the period i

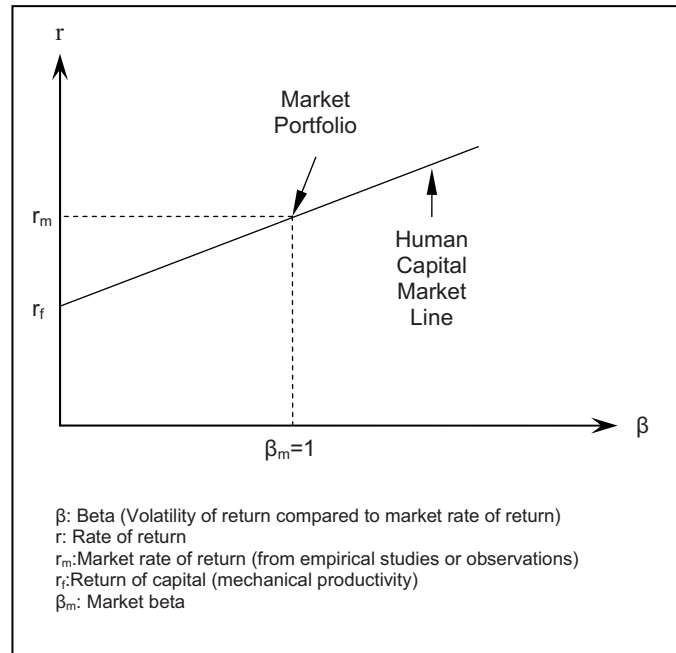
r_{HC} : Human capital rate of return

n : Effective period of the personnel measure

yields the human capital rate of return and/or the personnel measure. In the above equation, the only unknown variable is r_{HC} . $PV_{Personnel\ measure}$ are the costs and MP_i^{Gross} are the expected benefits (e.g., increase in EBIT of X) of the measure evaluated. r_{HC} can be computed then and a company's human capital investments can be compared to the human capital market rate of return, i.e. the market portfolio rate of return, as presented in figure 1, by using r_{HC} .

The definition of risk in terms of human capital is difficult. In this context, Bender and Röhling propose to define human capital risk as non-performance and/or poor performance risks within the context of HCPM. They base this definition on CAPM's single period characteristic on which it is based. In a single period consideration, withdrawal and adjustment risks from human capital are irrelevant (see Bender/Röhling 2001). The non-performance or poor performance risk encompasses motivation risk and therefore represents the original human capital risk within a specific period (see classification by Kobi 1999). This risk becomes measurable in monetary units through the performance's standard deviation, or, in a financial product, through the variance around the expected rate of return. The expected variance can be relatively exactly determined through diagnostic methods (see Kanning 2002, 55-60).

Figure 1: Human Capital Pricing Model (based on Bender/Röhling 2001)



3 Enhancement of established methods through real options theory

3.1 Boundaries of established human capital evaluation methods

Personnel economics can be regarded as the human resources management trend that supplies economic and quantitatively applicable decision support for personnel-oriented business problems. In personnel economics, it is more important to create a decision framework for personnel decisions than to explain the why and the how (see Backes-Gellner/Lazear/Wolff 2001). From this perspective, it strongly resembles investment and financial studies in business studies (see Perridon/Steiner 1997).

Personnel economics have not, however, explicitly produced methods with which to determine the amount of a company's or organization's human capital. There is nevertheless a possibility to operationalize human resource problems further and to review whether approaches achieve their objectives. By referring to the investment and financial studies analogy, personnel economics seems like making investment decisions without having viewed the existing or necessary capital stock. Personnel economics instruments can, however, be adapted and extended to develop initial approaches to quantify the human capital that is available to an organization.

The incremental value concept also presents a series of restrictions. Human capital value is calculated from discounted contributions to the operating income, which can be generated by implementing a personnel measure. Problems encountered in the process are determining an appropriate discount rate as well as uncertainty about future environmental conditions that will affect (personnel) measures' future contribu-

tions to the operating income. Consequently, the incremental value concept is especially suitable for organizations whose environment is relatively stable. Specific decision rules arise from the calculation of the value of human capital: Personnel measures are only implemented if the resulting net present value is greater than zero. In other words, a measure's direct costs may not exceed the value of discounted contributions to the operating income. A measure that is nevertheless implemented will cause losses. In addition, based on the incremental value concept the value of an organization's human capital can be approximated and considered when assessing the company value.

Since most organizations are confronted with relatively uncertain environmental conditions, the market-oriented concept was developed. In the HCPM (Röhling/Bender 2001), the evaluation of personnel measures is based on the market price, thus on the present value of the respective personnel measure's implementation costs. This is analogous to the financial accounting of a company's other assets. If future contributions to the operating income are also available, the measure's internal rate of return can be calculated. This internal rate of return is then compared to the accepted risk and the human capital's market rate of return. If the risk-return relation is better or at least equal to that of the market, it is wise to implement a personnel measure. If the risk-return relation is worse, the personnel measure should not be implemented, because the expected return is not appropriate with regard to the risk inherent; i.e. such a personnel measure would be uneconomic, as the return earned on a theoretical investment in the market portfolio would be higher without the need for taking additional risk.

In summary, the established human capital evaluation methods point to a weakness in the range of active human resource management considerations: The flexibility associated with human capital deployment is not included in the evaluation. If, for example, a personnel measure that is initially regarded as profitable becomes unprofitable later, there are opportunities to improve the situation. As a result, future negative contributions to the operating income can be decreased or avoided. Hence, a personnel measure's value as well as that of the human capital increases automatically. However, the above-mentioned concepts assume that future profits are predictable and that future circumstances are static, i.e. the negative contributions to the operating income are accepted and flow completely into the evaluation. Consequently, the human resource management value and, thus, human capital are systematically undervalued in this case. Contrary to this situation, the flexibility value must be subtracted from the human capital, for example, during a personnel layoff so that a personnel layoff is possibly not sensible from an economic perspective, in spite of short-term savings.

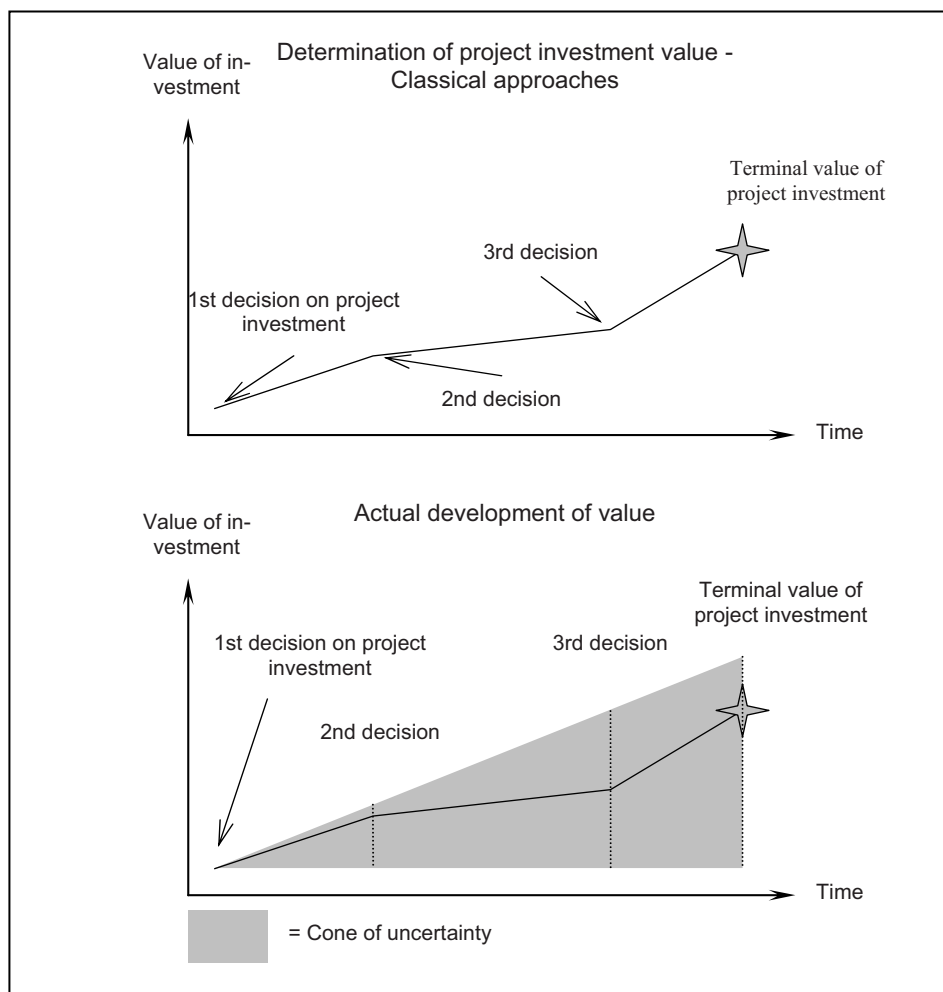
In the following, the flexible deployment of human capital is considered by applying the real options' theory framework to human capital. This approach allows evaluating potential value originating from the flexibility so that personnel measures are not only evaluated according to the direct value of the expected contributions to the operating income.

3.2 The real options theory

Traditional methods for the evaluation of investment possibilities calculate future cash flows, discount these to the moment of the decision and compare this value with the

financial means to be deployed, thus arriving at a decision whether an investment should be made or not. The above-mentioned problems already emerge within these forecasts. Traditional methods assume certainty where there is none. Specifically in multi-stage decision-making processes, during which a project's continuation and design can be determined at any of the stages, valuation cannot be adequately done. No single outcome is probable, instead an investment project moves inside a "cone of uncertainty" (Amram/Kulatilaka 1999, 101) in which each final outcome can be achieved in various ways.

Figure 2: Uncertainty Cone (based on Amram/Kulatilaka 1999, 101)



Due to the characteristics and the flexibility that are embedded in investments in human capital, the pattern of a human capital investment's value development is similar to a financial option's value pattern: A financial option is a contract that gives the buyer the right to buy (call) or sell (put) an underlying asset for a predetermined price

(also called exercise price or strike) at maturity (European style) or during a time period (American style). As the holder of the option only has the right, but not the obligation, to exercise the option, he has to pay a premium to the seller who is obligated to deliver the underlying asset for the predetermined price in case of exercise. A call is exercised if the price of the underlying asset in the market is higher than the strike, whereas a put is exercised if the market price is lower than the exercise price. Consequently, the value of the option is the maximum of zero (if the market price develops in an unfavorable direction so that the option is not exercised) or the difference between the market price and the strike (or the difference between the strike and the market price, respectively) (see e.g., Brealey/Myers/Allen 2006, 542; Heidorn 2006, 157 et seqq; Rudolph/Schäfer 2005, 19; Black/Scholes 2004, 243).

Since 1984 financial options' evaluation methods have been transferred to real investment decisions. The initiator was Stewart Myers who published an article introducing the real options concept (see Myers/Majd 1984). The theory of real options applies financial options to investments in various real assets (Bhattacharya/Wright 2005, 931). With reference to human capital, investments in human assets can be compared to the premium that is paid in order to receive the option to respond flexibly to future contingent events (Bhattacharya/Wright 2005, 938; Kogut/Kulatilaka 2001, 745). For example, a firm can invest in language courses in order to be prepared for a global expansion strategy: The costs for the language course are equivalent to the option premium which is paid with a view to the language abilities of the employees in case of a global expansion. If the firm indeed expands so that the language skills are needed, the call option carries value. Otherwise, the employees will not use the capabilities achieved in the language courses, thereby contributing to a potential loss of these skills over time which results in the expiration of the real option. As such events are more likely to occur over a period of time than at a certain point in time, human capital investments can rather be compared to American-style options than to European-style options. So, the possibility of carrying out an investment is similar to an American-style call (see Grenadier 2000).

The most important characteristic of this approach is the flexibility that the option perspective shows in contrast to the traditional view. An option holder will, for example, avoid future losses by not exercising the option or by postponing it. With regard to evaluation methods for financial options, this behavior is included in the price, whereas in the traditional view of investments, future negative cash flows are offset against positive ones, thus decreasing the investment possibility's value (see Kensinger 1987).

Due to investment decisions' multi-stage character, which can usually be observed, the real options approach entails various options (see e.g., Amram/Kulatilaka 1999, 96-98). Further options and, thus, value are added to the actual investment possibility's value. Once an investment has occurred, new values arise because by exercising an option - i.e. by realizing an investment - new options develop. These are called operating options (see e.g., Trigeorgis/Mason 1987). According to Trigeorgis (1996) these operating options, which describe an active management's flexibility, include the following options:

- Option to defer the investment: This option allows the option holder not to undertake the investment immediately, but to do so at a later stage. This option is particularly valuable if the strike (i.e. the investment costs) and/or the underlying asset's value are very volatile. A waiting option is denoted as timing or learning option, as new knowledge is collected about the investment during the deferment (see Hommel/Pritsch 1999).
- Option to expand: This option describes the possibility of expanding an investment's capacities if it is successful. The option to extend an investment project is also part of the options to expand (e.g., an option to extend a license.) (see Copeland/Antikarov 2001).
- Option to contract: This option is the opposite of the option to expand and primarily describes the possibility to reduce capacities during the investment project's duration to prevent negative results or at least reduce them.
- Option to shut down temporarily: This option describes the possibility to temporarily close the investment project until conditions improve. This possibility prevents or reduces negative contributions to operating income.
- Option to switch: This evaluates the possibility to replace the input parameters and change the output under the given conditions. Similar to deferment and waiting options, this option is especially valuable if the input or output prices are very volatile.
- Option to abandon: The option to abandon evaluates the advantage from the possibility to break off the investment project during the duration, thereby decreasing or avoiding losses.

In contrast to, for example, the option to expand, the option to abandon and, partly, the shrink option can be interpreted as American-style put options. Here, the holder has the right, but not the obligation, to sell the complete or part of the underlying asset. He will always do so if the strike is higher than the value that can be generated from the underlying asset.

3.3 Application of the real options theory on human capital evaluation

The transfer of the real options approach to the evaluation of human capital inevitably involves the emergence of an option because organizations are able to gain certain human capital bearers. Only this possibility has a value that can increase the original company value. A start-up company, for example, cannot always recruit appropriately qualified and experienced human capital and, on its own, therefore has at least a temporary disadvantage compared to established competitors (Stinchcombe 1965). The options that arise from concrete personnel measures should be presented in such a way that, for example, human capital as such (i.e. the employee) can have an economic value for the company in question, even if it does not contribute to the operating income. In a transcending, demand-driven personnel policy view, it would, for example, be conceivable to acquire human capital without having an actual need for this, because one believes in increasing value. This is what is currently happening in sports (e.g., in football).

The possible application of the real options concept to personnel measures was already identified by Dixit/Pindyck (1994) in a brief examination that contrasted decisions regarding permanent workers' employment and that of temporary workers, but was not investigated any further (see Dixit/Pindyck 1994).

From the option view, not only human capital is acquired during personnel employment, but also all the above-mentioned operating options, with the exception of the deferment and the waiting option, as these expire at the time of the human capital acquisition (e.g., the employment of a worker). The value of the deferment or waiting option cannot be underestimated during an acquisition decision. If, specifically, an ambiguous qualification or ambiguous requirement situation is apparent, a waiting period can be valuable until a conclusive decision can be made (although there is a risk of losing the human capital to the competitors). It is therefore probable that during times of economic uncertainty, employment contracts will require more time from the first contact to the actual closing of the contract than in boom periods.

With a human capital acquisition, the contracting parties are free to expand the employment contract (option to expand - in this case an option for more human capital), i.e. to assign the human capital bearer further tasks in his/her current area of activity or to suggest a management position for him. This would generate increased contributions to the operating income, which would correspond to the option's underlying asset. The strike would be the granting of a salary adjustment or the increased work-related costs (additional equipment, travel costs, etc.). The option duration is equal to the length of the human capital bearer's employment in the company.

Just as with the option to increase the human capital, there is the possibility to "decrease" human capital in a limited way (option to shrink). At first, this hardly seems possible due to (especially European Union) labor protection laws. The shrink option can nevertheless be easily executed. Examples of the exercising of such options are reduced hours, reduction of overtime, conversion to part-time work, sabbaticals, reduction of freelancers' hours, and similar measures. This option is particularly valuable for companies that are subject to strong seasonal or cyclical workload fluctuations because through it, human capital bearers could be bound to the organization; conversely, they could be decreased or avoided during times of negative performance. The underlying asset here is the increased contribution to the operating income through reduced human capital employment and the strike is the compensations that has to be made to execute the option. The duration is again the human capital bearer's length of employment in the company.

In respect of human capital, the intermittent abandonment option is not unambiguous. If the above-mentioned measures have a large temporal dimension, this can be interpreted as an intermittent abandonment of human capital. In respect of a long time horizon, it is probable that the human capital will be completely drained by the human capital bearers and will therefore be unavailable. The earliest that such options could be exercised is in collaboration with, for example, agencies or freelance "employees", who will temporarily receive no tasks until the situation changes. Underlying asset, strike and duration can be defined in the same way as shrink options. On account of the difficult evaluation and the reduced execution possibility (because of the

risk of human capital withdrawal), an intermittent abandonment option's value should be very low.

In the context of human resource management, the option to switch should have the greatest intrinsic value. This means the possibility of a change of job provided that there is no associated task extension. It is in fact relatively easy for qualified human capital to "hop" between various jobs. Within certain boundaries, it is possible to allocate various tasks to a human capital bearer and, consequently, to increase the company flexibility. Human capital is clearly more flexible and thus more sustainable than capital equipment, particularly with regard to changing environmental conditions. In fact, when environmental conditions change, it is scarcely possible to convert capital equipment to new production methods or completely new products, and it often has to be replaced. The underlying asset here is once again the greater contribution to the operating income that is generated by the conversion. The strike includes all compensation payments and the opportunity costs related to the part of the operating income that was contributed by the previous deployment. The duration is again determined by the human capital bearer's continued employment in the company.

The option to abandon is comparable to the possibility of the human capital bearer's retirement from the company at the company's initiative. This option is very valuable during the trial period, because (in most European countries) regulations regarding protection against unlawful dismissal do not as yet apply. After the trial period, this option quickly loses its value, because an employment contract's termination can be made more difficult by the legal situation and severance payments can burden company results significantly. With regard to freelancers and cooperation, this option is easy to include, and therefore intrinsically valuable, due to its free contract form. The underlying asset is the increased contributions to the operating income (similar to the reduced negative results) with the compensations as strike. The duration of the option is as long as the human capital bearer's association with the company.

Training measures generate the same options, albeit to a lesser extent, because training measures, like personnel employment, are about human capital acquisitions.

Based on this reasoning, it can be concluded that, besides the actually planned application, establishing employment relationship and, to a lesser extent, training measures creates a distinct value for the company. It remains to be resolved To what extent the human capital bearer should be remunerated for his/her willingness to grant options. It is, after all, his/her flexibility that creates company value. The human capital bearer should be specifically remunerated for granting options in respect of efforts to increase employee competence and responsibility.

In this concept (similar to the above), the personnel measure costs should be added to the present values to understand the human capital value in order to ascertain the human capital market price. In addition, the present values of the options resulting from a human capital acquisition should be added to this market price to correctly reflect the total human capital value. A company's total human capital value is obtained by the sum of the individual present values.

Formula 9: Determination of the human capital value from a real options perspective

$$PV_{HC} = \sum_{i=0}^n PV_{Personnel\ measure_i} + PV_{Option_i}$$





















PV_{HC} : A company's human capital present value


$PV_{Personnel\ measure_i}$: Personnel measure present value i on cost base / human capital price

PV_{Option_i} : Present value from the options that arise from personnel measure i

In conclusion, the main difference between traditional evaluation concepts and the real options approach is that uncertainty is completely taken into account with real options. As a result, this evaluation method is highly applicable to decisions so that it is likely to be accepted in the community. Just as the traditional approaches, the real option theory faces the problem of computability with regard to intangible assets. Nevertheless, it can be expected that the importance of the concept in the context of human resource management and human capital, in particular, will rise in future. The following figure summarizes the main differences between the evaluation concepts discussed in this paper.

Figure 3: Comparison of different approaches to the evaluation of human capital

Tool/ methodology	Acceptance in community	Consideration of uncertainty	Applicability on decisions	Computability	Empirical evidence
Personnel economics					
Incremental value concept					
Market oriented concept					
Real options theory					

 Fill of ball indicates fulfillment of requirement

4. Summary, critical appraisal and future prospects

Based on the opinion that as far as human capital evaluation is concerned, the above-mentioned approaches exhibit a range of weaknesses, this contribution has identified the real option approach's possibilities and boundaries in this regard. In addition, we have pointed out the consequences that arise from the real options approach's ideas for dealing with human capital in practice. On the one hand, the ideas ought to contribute to a link between investment and capital finance account and personnel work

and, on the other hand, enable an improved analysis and evaluation of human capital by taking realistic assumptions into account.

The implementation of real options approach in respect of human capital is helpful for the company because sensible financial decisions can then be made, also during uncertainty and without an appropriate opportunity interest rate having been determined. Although there are as yet no (publicly) available real options models within the field of human capital management, a consideration of this concept can lead to a more economic handling of human capital and therefore retain future growth opportunities.

The main advantage of the real options concept is exemplifying the value of uncertainty. Contrary to the former described models in this article, real options consider certain types of uncertainty as value increasing and not as a risk factor, reducing value. There are different uncertainties which involve various options (Battacharya/Wright 2005). For example, uncertainties of returns can result in growth and learning options. Therefore, a company should not only consider the current utility but also take into account the new options generated by a personnel measure. If a company, for example, offers a language course to its employees, this course may carry value, although the specific knowledge gained cannot be used immediately. This knowledge increases the option of taking over another company in a country where that language is spoken. Consequently, the real option approach will lead to different results compared to personnel economics, the incremental value concept and the CAPM in evaluating personnel measures as well as the overall value of human capital employed. Further research will have to determine relevant fields of options as well as the value of these options within the research area of human capital.

A Human Capital Management, which takes the real options approach into account could for example keep track of all qualifications, interests and skills of its employees, instead of focusing on their job related qualifications, interests and skills. In the future, skills and qualifications that were previously unrelated to successful job requirements might suddenly become necessary. In the same vein, companies that want to apply the real options reasoning, might want to put special emphasis on the learning capabilities of their employees, as learning capabilities can be considered as the personal equivalent of real options in employees.

The problem with the implementation of the real options approach with regard to human capital evaluation is the difficulty of sufficiently determining the parameters that are required for the option value calculation. A further limitation of the real options concept is that to date there are no publicly available pricing models. Future research will probably concentrate on the concept that is based on the Black/Scholes model (see Black/Scholes 1973). The ease with which the approach can be understood is, however, reversed during an actual implementation: The inevitable and complex evaluation algorithms become a black box for management. Due to the algorithms probably being inadequately understood, hardly any influence can be exerted on the decision-making principles, which consequently means that such a concept is not applied.

Further scientific study is required for human capital measurement methods to be applied in the operational area. Despite all the logic in favor of establishing an eco-

conomic monetary evaluation system, empirical research should be conducted in respect of result improvement if such a system were to be implemented. The first indications were already presented in Watson Wyatt's studies in his "Human Capital Index – European survey report 2002" (Watson Wyatt 2002). This study particularly covered human resources management's added value, which is orientated towards financial business objectives, rule driven, and performance related. A more direct empirical proof would, however, be required to establish clarity about the need for such instruments.

Beside this, possible human capital evaluation models should be better aimed at business interest to enable operational deployment. A human capital pricing model, specifically, needs to be refined further so that variables can be defined more accurately, in order to be applied.

The real option approach must also be extended further and be differentiated to a greater degree so that real decision-making models could be established for the human resources area. A mathematical development of the real options approach would be essential to assign a concrete value to individual personnel measures and to test the model in practice.

Such an operationally supported system for human capital evaluation and the decision-making model based on this can lead to personnel work's improved orientation in respect of business objectives. In addition, the implementation of such a system will lead to bridge building between the personnel work and other company sections and functions like control and marketing. Thereby, the language used by these sections and functions would become more similar and would it become more apparent that ultimately people have the same objectives – to boost the company value.

In the context of empirical research, it would be possible to analyze the extent to which the early implementation of the real options theory produces explanatory approaches with regard to company value and human resource decisions that have already been. Furthermore, studies could be developed to analyze whether human resource decisions that with hindsight turned out to be detrimental, could have been avoided by taking the real options theory into account.

Besides this, the real options approach's reference framework also offers heuristics for the analysis of human capital changes so that considerations regarding human capital's development dynamics can be examined.

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