DECOMPOSING VALUE CREATION WHEN ASSESSING INVESTMENTS: A MULTICRITERIA APPROACH BASED ON THE ANALYTIC HIERARCHY PROCESS

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ABSTRACT

This paper aims to develop a novel capital budgeting method to improve the quality of the appraisal process for productive investments. This will be done by decomposing the total value that is created by the new assets into two components: financial value and nonfinancial capital value, the latter stemming from the intellectual capital of the firm. We propose a methodology based on the *Analytic Hierarchy Process* (AHP). Within the model, four main criteria (financial capital, human capital, structural capital, and relational capital), several subcriteria and the investment alternatives are defined. In order to determine the total value of each alternative, chief executive officer (CEO) preferences are required. A case study on the agrifood sector illustrates the model empirically. This illustrative application evidences the need to consider the impact of productive investments on firms' intangible assets, as this impact actually affects the choice of optimal investment alternative in the real world.

Keywords: Capital Budgeting, Multicriteria Decision Making, Nonfinancial Capital Value, Intellectual Capital, AHP.

1. Introduction

The corporate capital budgeting process is one of the most challenging tasks facing firms' management (Baker & English, 2011), as it concerns investment decisions which involve allocating scarce funds over time to achieve a firm's objectives. In order to support decision-making in investment appraisal processes, traditional financial techniques based on net present value (NPV) and the internal rate of return (IRR) have been widely employed by corporate decision-makers (Brounen, de Jong, & Koedijk, 2004). However, many authors have identified various problems and shortcomings derived from their application. Some of these criticisms question the realism of the firm's value maximization assumption when analyzing investment alternatives. In this sense, Steuer and Na (2003) affirm that modern corporations do not pursue the single objective of shareholder wealth maximization assumed by traditional techniques, instead taking into account a full array of objectives concerning the different stakeholders of the firm (shareholders, managers, employees, and customers). More recently, Koontz and Weihrich (2007) and Götze, Northcott, and Schuster (2008), following the seminal work by Freeman (1984), maintain that

decision-makers in organizations wish to pursue several competing goals rather than a single one as traditional methods assume[1]. Another source of criticism is related to the inability of traditional appraisal techniques to recognize the real value generated by an investment, simply because they ignore important qualitative variables, hardly measurable in monetary terms, that also add value to the firm (Firouzabadi, Henson, & Barnes, 2008; Kreng, Wu, & Wang, 2011). This paper focuses on the latter source of criticism of traditional corporate finance theory. Thus, assuming that the main objective when appraising investments in for-profit firms is market value creation (Dayananda, Irons, Harrison, Herbohn, & Rowland, 2002; Ross, Westerfield, & Jordan, 2007), we aim to (partially) solve the inability of conventional appraisal methods to recognize the real value of new productive assets by developing a novel approach to assessing investments.

Capital budgeting decisions have a major effect on the total or market value of the firm (Dayananda et al., 2002), affecting its two components, *financial value* and *nonfinancial capital value*. The latter is created by the *intellectual capital* of the firm, a concept that can be defined as all nonmonetary and nonphysical resources controlled by the firm that contribute to the organization's value creation (Roos, Pike, & Fernström, 2006). However, the effects of investments on the second component of the firm's value have, largely, not been considered by traditional financial appraisal techniques for two main reasons. First, because of the difficulty of monetarily quantifying the increase in cash flows from investing in intellectual capital (how much), and second, because of the uncertainty about the point in time where these cash flows will take place (when). Therefore, new capital budgeting methodologies capable of decomposing the total value generated by investments into these two components of a firm's value, financial and nonfinancial capital value, are welcome.

This paper intends to develop a novel approach to improve the quality of the investment appraisal process in for-profit firms by decomposing the overall value that is created by new assets into its two components, financial and intellectual value. In order to do so, this paper proposes a methodology based on the Analytic Hierarchy Process (AHP), which permits a more accurate assessment of the value creation of the different project investment alternatives, determining for this purpose the relative importance of each criterion (financial and intellectual value) and subcriterion involved in these decision-making processes. The method proposed is empirically illustrated by a case study of the agrifood sector.

The remainder of the paper is structured as follows. Section 2 briefly discusses a firm's total value and its two main components, financial and intellectual value, and describes the AHP technique. Furthermore, this section provides an analytical framework to quantify and decompose the real value of an investment project. In Section 3, the methodological approach proposed is implemented in a real case study, focusing on investment decisions in the meat industry regarding the food quality control system to be implemented. Finally, Section 4 presents the conclusions and suggests lines for further research.

[1] This circumstance is particularly relevant in nonprofit organizations (i.e., public administrations, NGOs, etc.), where other criteria such as employment generation or equity and gender issues can be taken into account. However, for most for-profit firms, the assumption of a firm's value maximization can be still considered as the most important criterion when making decisions regarding investments (Brigham & Ehrhardt, 2008).

2. Investment decision-making and value creation

2.1 Firm total value: financial and nonfinancial capital value

The *total economic value* of a firm, or simply the *market value*, is the result of adding up its *financial capital* (*book value*) and *nonfinancial capital*, also called *intellectual capital* (Roos, Roos, Dragonetti, & Edvinsson, 1998; Johnson, 1999). Hence, a company's economic value is not merely the sum of the value of its tangible assets, but also the value of its intangible assets (Curado, Henriques, & Bontis, 2011), most of the latter being hidden or invisible for accounting and not reported in any financial statement. The knowledge of high-quality production processes or employees' talent and knowhow are good examples of intangible assets. In fact, intangible resources controlled by the firm have been identified as major contributors to the generation of persistent profits (Villalonga, 2004) and, thus, to increasing market value (Cañibano, Garcia-Ayuso, & Sánchez, 2000; Sullivan, 2000; Edvinsson, 2013). The management of these invisible assets is a key element of business strategy. Both financial and nonfinancial indicators should be jointly used to provide a complete measurement of company success and shareholder value (Sveiby, 1997).

The first component of a firm's total value (*financial capital*) has been extensively studied by classical finance theory. Both business valuation methods (balance sheet-based methods or income statement-based techniques) and capital budgeting methods such as the discounted cash flow techniques (net present value, internal rate of return, or the discounted payback period) have been proposed for this purpose. The latter of these techniques represents indicators of financial value creation by new investment projects.

The net present value (NPV) is one of the most frequently used capital budgeting techniques (Graham & Harvey, 2001). This method evaluates an investment project by discounting its future cash flows to their present values and subtracting the amount of the initial outlay from their sum. If the NPV is greater than 0, the project will create value for the firm. Two elements must be known to apply this technique: the *net cash flow* that the investment will generate over its life, that is, cash inflows minus cash outflows, and the discount rate that should reflect the degree of risk inherent in the project under consideration.

In contrast, nonfinancial or *intellectual capital* (IC) is a more recent concept grounded on the resource-based view (RBV) of firm theory (Kristandl & Bontis, 2007) which has been discussed in the literature over the last two decades. In fact, researchers have yet to fully agree on a definition of this term. Some of the most widely accepted definitions focus on the intangible aspect of the assets composing this kind of capital: "the sum of the hidden assets of the company not fully captured on the balance sheet" (Roos & Roos, 1997) or "the total stocks of all intangible assets and capabilities" (Edvinsson & Malone, 1997). Stewart (1997) provides a complementary view when stating that IC is "the sum of everything everybody in a company knows that gives it a competitive edge", that is, the full array of knowledge, information, intellectual property and experience useful in generating profits (wealth creation). Other definitions of intellectual capital also focus on its ability to provide value and utility for the company (Bontis, 1999; Sullivan, 2000; Roos et al., 2006).

There is no doubt that IC is an important source of sustainable competitive advantage for a firm (Itami, 1987; Roos & Roos, 1997) because invisible assets are difficult for competitors to imitate. Intangibles are important in the management process, as they have become a crucial resource for the firm, mainly due to their impact on innovation processes (Sánchez, Chaminade, & Olea, 2000). Villalonga (2004) found that

intangibles play an effective role in sustaining a firm's competitive advantage, measured through the persistence of firm-specific profits. Finally, it is worth mentioning that a strong relationship between intellectual capital and business performance has already been found in several empirical papers (Chen, Zhu, & Xie, 2004; Phusavat, Comepa, Sitko-Lutek, & Ooi, 2011), confirming the hypothesis that intellectual capital is a key element for value creation within the firm.

Although there is no unique classification of the components of IC, a considerable number of papers in the literature (Stewart, 1997; Bontis, 1998; Roos et al., 1998; Youndt, Subramaniam, & Snell, 2004) have divided it into the following three categories: *human capital*, *structural capital* and *relational capital* (see Figure 1).

Human capital may be defined as the collective capabilities of employees such as (Edvinsson & Sullivan, 1996): expertise, skills, intelligence and general knowhow of all of the firm´s employees. In the late sixties, Likert (1967) postulated that human resources contribute to value creation in the company and, following this theory, Edvinsson and Sullivan (1996) argued that *human capital* is a resource because it generates value for the company. This value stems from competence, attitude and the intellectual agility of employees (Roos et al., 1998). A firm with more capable employees is likely to earn higher profits than its competitors (Cañibano et al., 2000), thus positively affecting the firm's outcomes (Huselid, 1995; Hitt, Biermant, Shimizu, & Kochhar, 2001) and also having an impact on its competitive advantages (Johnson, 1999; Grigoroudis, Tsitsiridi, & Zopounidis, 2013). The scientific literature provides different attributes that can be measured relative to *human capital*: knowhow, capability, satisfaction, entrepreneurial spirit, leadership, attitude, creativity, etc. Employees' knowhow, entrepreneurial spirit and employees' satisfaction are the most highlighted components of *human capital* (Becker, Huselid, & Ulrich, 2001).

Structural capital is defined as the organizational ability of the firm to utilize human intellect and innovation to create wealth (Johnson, 1999), representing institutionalized knowledge and codified experience stored in databases, routines, manuals, structures and the like (Hall, 1992). This type of knowledge "doesn't go home at night" (Stewart, 1997), unlike *human capital*, and provides coherence and guidance for the whole organization (Edvinsson & Malone, 1997). The essence of *structural capital* is the knowledge embedded within the routines of an organization, containing the key elements for productive efficiency, optimization of transaction times, procedural innovativeness and adequate access to information (Bontis, 1998). There is also a positive relationship between *structural capital* and value creation (Marr, Schiuma, & Neely, 2004; Díez, Ochoa, Prieto, & Santidrián,2010). Chen et al. (2004) break this category of IC down into company culture, organizational structure, organizational learning, operational processes and information systems. The same authors also find that the *product quality* level is an important *structural capital* indicator, because it has a direct effect on customer satisfaction and therefore upon customer loyalty. Also, numerous authors (Chang, Chen, & Lai, 2008; Wu, Chang, & Chen, 2008) have pointed to *organizational routine knowledge* as another important indicator of *structural capital*.

Lastly, *relational capital* refers to all resources that are linked to the external relationships of the firm, those connecting it to both other economic agents related to the business (shareholders, customers, suppliers, allies, unions, etc.), and also social or civil agents, such as non-governmental organizations (NGO) or public institutions (Martín-de-Castro, Delgado-Verde, López-Sáez, & Navas-López, 2011). Johnson

(1999) and Bontis (1999) point out that companies' *relational capital* has a positive effect on their competitive advantage. *Customer relations, supplier relations* and *environmental consciousness* are considered the most important components of *relational capital* (Lev, 2004). Regarding the first element, a positive association exists between customer satisfaction and market value (Anderson, Fornell, & Mazvancheryl, 2004), because higher customer satisfaction increases the loyalty of existing customers, reduces price elasticity and enhances the firm´s reputation. Better supplier-firm interaction may also enhance the reputation of the firm (Johnson, 1999). Many authors (Claver, López, Molina, & Tarí, 2007; López-Gamero, Zaragoza-Sáez, Claver-Cortés, & Molina-Azorín, 2011) have considered e*nvironmental consciousness* as an important component of *relational capital*. Furthermore, numerous references in the literature identify a positive relationship between environmental management and firm performance (Naffziger, Ahmed, & Montagno, 2003; Montabon, Sroufe, & Narasimhan, 2007). Porter and van der Linde (1995) argued that companies which engage in corporate environmental management and green innovation can actively improve their corporate image, charge relatively high prices for green products, sell the knowhow and services of environmental protection, develop new markets and eventually obtain competitive advantages.

2.2 The Analytic Hierarchy Process

The AHP method (Saaty, 1980) is a structured but flexible technique to support multicriteria decision making, suitable when both qualitative and quantitative aspects need to be considered in the problem. This section provides a brief overview of the AHP technique. For a more detailed explanation of the method, both from a theoretical and a practical point of view, readers can consult Saaty (1980) and Saaty and Vargas (2000).

The implementation of AHP involves four phases. In the first step, *a complex decision problem is structured as a tree-based hierarchy*, with at least three levels: the final 'target' at the highest level of the structure, decision 'criteria' at an intermediate level and 'alternatives' forming the base of the structure. When criteria are abstract or complex, the intermediate level can be split into a series of sequentially organized 'subcriteria' levels.

The second step is the *measurement and data collection*, which involves assigning pairwise comparisons (judgments) by the decision maker to all elements (criteria/subcriteria/alternatives) hanging from every node in the hierarchy following Saaty's fundamental scale (see Table 1). The comparative judgments start from the target node, comparing all criteria included in the second level of the hierarchy and finish with the (sub)criteria nodes, comparing the alternatives considered in the lowest level. For each node, the hanging elements are pairwise compared according to the decision maker's opinions on their importance regarding the (sub)criteria considered in the higher level. A questionnaire is designed and used to collect these comparison judgments.

Table 1
The nine-point scale for pairwise comparison in the AHP

Importance intensity	Definition
1	Equal importance
3	Moderate importance of one over another
5	Strong importance of one over another
7	Very strong importance of one over another
9	Extreme importance of one over another
2, 4, 6, 8	Intermediate values

The judgments provided allow positive matrices to be built for each node with the following structure (Saaty's matrices):

$$A = (a_{ij})_{n\times n} = \begin{bmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ \dots & \dots & a_{ij} & \dots \\ a_{n1} & a_{n2} & \dots & a_{nn} \end{bmatrix} \quad (1)$$

where a_{ij} represents the relative importance of the element i with respect to the element j (both at the same level of the hierarchy). This matrix has two fundamental properties: (i) all the elements in its main diagonal area take a value of one; and (ii) all other elements maintain that pairwise comparisons are reciprocal (if $a_{ij} = x$, then $a_{ji} = 1/x$). Given that the second property, one needs to make only $n(n-1)/2$ of the comparisons to fill in the matrix of judgments. Furthermore, if the pairwise comparison matrix A satisfies that $a_{ih} \times a_{hj} = a_{ij}$ for all $i, j,$ and $h,$ then A is said to be perfectly consistent, meaning that the numerical ratings a_{ij} satisfy $a_{ij} = w_i/w_j$, with w_i and w_j being the weights of the elements i and j, respectively. In this case, weights for every element can be obtained by normalizing any of the rows or columns of A.

However, decision makers rarely provide perfect consistent judgments in reality (especially for high-order matrices) for a number of reasons (lack of information or an unclear opinion, lack of concentration, etc.). In these cases, the literature proposes different approaches to estimate the weight vector $(W = (w_1, \dots, w_i, \dots w_n))$ for each matrix, that is, the vector of the relative priorities of the elements that hang from a common node (local priorities). Saaty (1980) proposed two alternatives: the row geometric mean and the main eigenvector. Other alternatives also suggested include models based on regression analysis or goal programming (Srdjevic, 2005). Although there is no agreement in the literature regarding any alternative outperforming another (Fichtner, 1986), we have chosen the main eigenvector method as suggested by Saaty (2003). Following this method the vector of priority weights is obtained by solving the following characteristic equation:

$$AW = \lambda_{max} W \quad (2)$$

where λ_{max} is the maximum eigenvalue of A.

AHP allows some small inconsistency in decision maker's judgments, but obtaining reliable weights requires that this inconsistency remains below certain limits; otherwise, the weight vector W derived from the eigenvector (or any other) method

could not be considered trustworthy. In order to check this requirement, a specific measure of inconsistency for each Saaty's matrix A needs to be calculated. If the pairwise comparisons provided by the decision maker are completely consistent, the maximum eigenvalue (λ_{max}) of matrix A is equal to the number of elements considered (n). Then, the amount resulting from the difference $\lambda_{max} - n$ is a measure of the degree of inconsistency within the matrix A. This is why Saaty (1980) defined the consistency index (CI) as:

$$CI = (\lambda_{max} - n)/(n-1) \tag{3}$$

Denote the consistency index for a randomly generated $n \times n$ matrix as RI. From CI and RI indexes, Saaty (1980) defined the consistency ratio (CR) as:

$$CR = CI/RI \tag{4}$$

If the CR is smaller than 0.1, then the matrix A can be considered as having an acceptable consistency, and the resulting weights being deemed as reliable. If the CR is greater than 0.1, the subjective judgments need to be revised.

If we wish to compare the relative importance assigned to the different (sub)criteria proposed in the hierarchy, it is necessary to obtain the corresponding global priorities (w_i^*) for all the (sub)criteria on the same level of the hierarchy, that add up to one. Thus, w_i^* is an indicator of the importance of (sub)criterion i across the whole set of (sub)criteria considered on this level with respect to the global goal. These global priorities are obtained from the second level down by the *hierarchical composition principle*, multiplying each local priority by the priority of the parent node in the level immediately above (the second level elements are each multiplied by unity, the weight of the single top level goal).

The quantification of local and global priorities and the measurement of the consistency constitute the third stage of the AHP, *prioritization*.

And finally, in the fourth stage, *synthesis*, the composite priority of each alternative with respect to the decision goal on the top of the hierarchy is generated by the adding of weights to the common nodes at the bottom level[2]. This is why the AHP has been traditionally associated with an additive value function (Kamenetzky, 1982) as follows:

$$V_i = \sum_{j=1}^{m} v_{ij} w_j \tag{5}$$

where V_i $(i = 1, \dots, n)$ are the overall values of decision alternatives; v_{ij} $(j = 1, \dots, n)$ are the values of decision alternatives with respect to (sub)criteria j, and w_j $(j = 1, \dots, m)$ are the weights of decision (sub)criteria.

[2] Other aggregation procedures to obtain composite priorities of alternatives have been proposed, including both additive and multiplicative shaped formulations (Stam & Duarte Silva, 2003).

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2.3 Proposal for quantifying total value generated by productive investments

Since AHP is perfectly suited to capital budgeting decision-making, this technique has been widely used in the literature to support investment selection in multicriteria frameworks (Vaidya & Kumar, 2006), as well as in asset valuation processes (Aznar, Cervelló, & Romero, 2011). However, no research has addressed investment appraisal considering both the financial and intellectual value derived from the capital budgeting decision. Furthermore, researchers have paid little attention to the management of intellectual capital with multicriteria techniques. The only exceptions are a few papers focusing on the selection of indicators to measure intellectual capital (Han & Han, 2004; Bozbura, Beskese, & Kahraman, 2007) and on the relationships linking knowledge assets with company's performance in a new product development problem (Carlucci & Schiuma, 2007).

Being aware that value creation in the firm does not only stem from financial capital, as traditional valuation methods assume, but also from nonfinancial capital, it is necessary to incorporate the latter into capital budgeting appraisal processes. We therefore propose an analytical approach based on the AHP technique that quantifies the total market value created by productive asset investments.

The hierarchical structure of the proposed approach has four levels (see Figure 1): the final target of the decision problem (market value creation by investments), criteria (the components of financial capital and intellectual capital), subcriteria (indicators of the different components of a firm's capital) and alternatives (investment alternatives).

This hierarchy was developed based on the literature review carried out regarding this field of knowledge. Moreover, this structure was found suitable for investment appraisal in for-profit firms in a real setting by a group of academic experts in the fields of Corporate Finance and Management Science and by several widely experienced managers. In any case it is worth mentioning that the experts who were consulted agreed that the structure shown in Figure 1 must be considered only as a general yet flexible hierarchy, which would need specific fine-tuning before its implementation in case studies. Thus, this model needs to be adaptively modified in accordance with each investment appraisal process in order to consider the specific features of the assets to be incorporated and the influence of the investment options on the different components of a firm's value. This is particularly relevant when defining the concrete set of indicators of the intellectual capital subcriteria, an issue that is directly influenced by the nature of the investment and the features (size, structure, market orientation, etc.) of the firm.

Finally, it is also worth noting that the experts who were consulted commented that the measurement of the values of investment alternatives with respect to nonfinancial criteria (v_{ij} in expression (5)) would be the main difficulty for the implementation of this proposal in the real world, taking into account that most of these criteria have an intangible nature (i.e., there is no measurement scale for them). However, all experts agreed that using the AHP to quantify these intangible criteria as proposed by Saaty, Vargas, and Dellmann (2003) is an accurate enough solution in order to make this proposal operative. In our case, this measurement process involves calculating the weights derived from paired comparisons of the investment alternatives considered with respect to their efficiency in attaining each of the nonfinancial criteria. These weights are a measure of the value v_{ij} along a ratio scale within a range [0-1]. For homogeneity reasons, the same method of measurement has been used for financial criteria, valuing investment alternatives for these criteria also within a range [0-1].

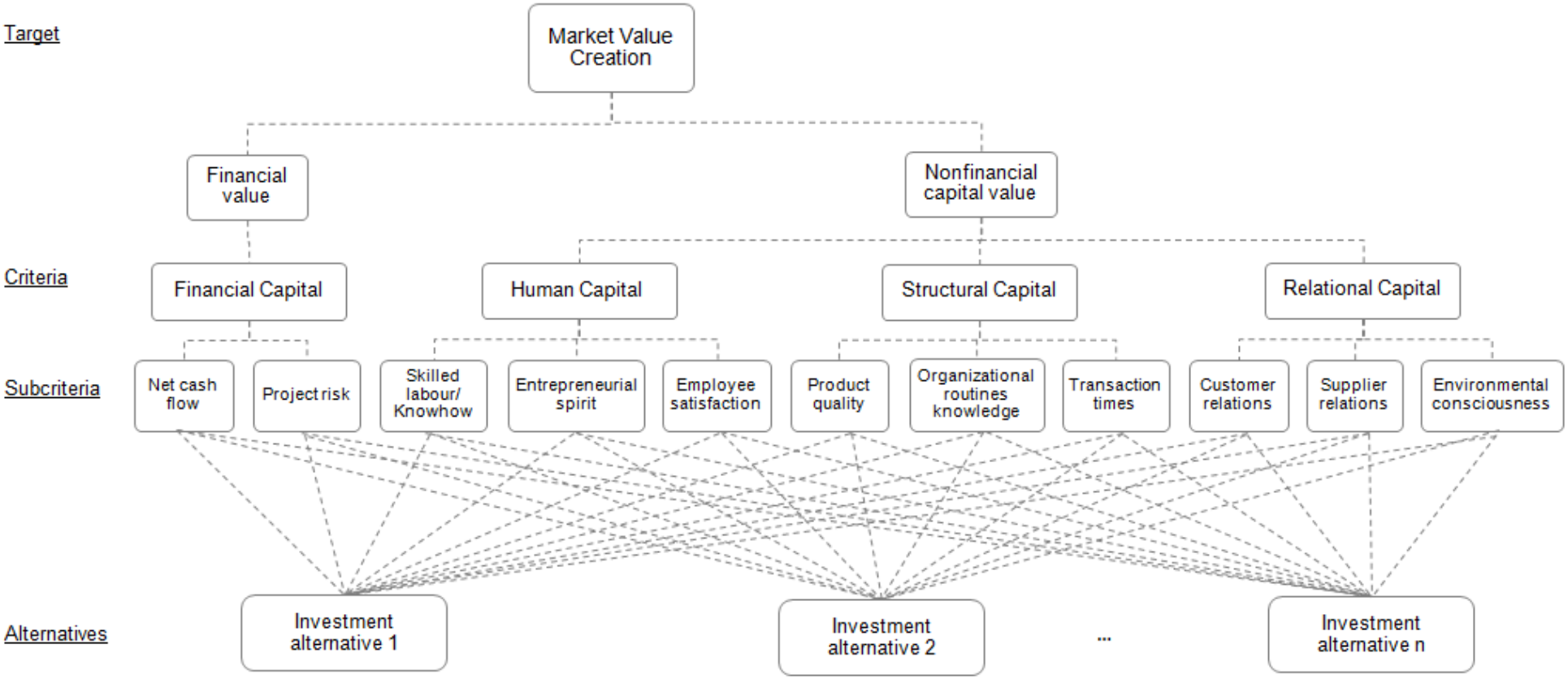

Figure 1. Decomposition of market value creation in assessing productive investments

3. An illustrative case study

3.1 Model tuning

In order to demonstrate the applicability of the proposed model, this section presents a real decision-making problem focused on the selection of an investment project in the food industry. The problem consists of assessing and prioritizing the following three alternative systems for meat-product quality control:

(1) Establishing a firm´s own traditional laboratory, where samples of products are analyzed to control their quality.

(2) Acquiring a Near Infrared Spectroscopy (NIRS) system, a fast and non-destructive analytical technique based on the absorption of electromagnetic spectrum of the products suitable to control all quality parameters. These features are responsible for the application of the system becoming increasingly widespread in the food industry in general and meat manufacturing in particular (Pérez-Marín, De Pedro Sanz, Guerrero-Ginel, & Garrido-Varo, 2009).

(3) Outsourcing analysis and quality control services to an external laboratory.

Valuation of these three alternatives is a complex task, as food quality control systems have strategic implications for the firm as a whole, impacting both tangible and intangible capital (Irudayaraj & Reh, 2008). For this reason, it is appropriate to apply the model proposed in the previous section to this case study.

Based on the value creation model proposed (Figure 1), we fine-tuned the hierarchy to be used in this case study. In order to do so, the authors first performed an extensive review of the literature to catalogue indicators of value creation in the food industry regarding each of the subcriteria considered in the general model. Later, a group of academic experts (four with expertise in Finance and Management and two from the Food Technology field) discussed the catalogue developed, and chose the most relevant subcriteria to be taken into account in order to analyze value creation by the investments in quality control in the meat industry. In this way, eight subcriteria were finally chosen, as displayed in the adapted hierarchy shown in Figure 2. Lastly, it is worth mentioning that the five firms' managers (CEO) involved in the empirical application (see next section) also validated the subcriteria chosen and the whole hierarchy proposed, prior to completing the questionnaire developed for the implementation of the methodology.

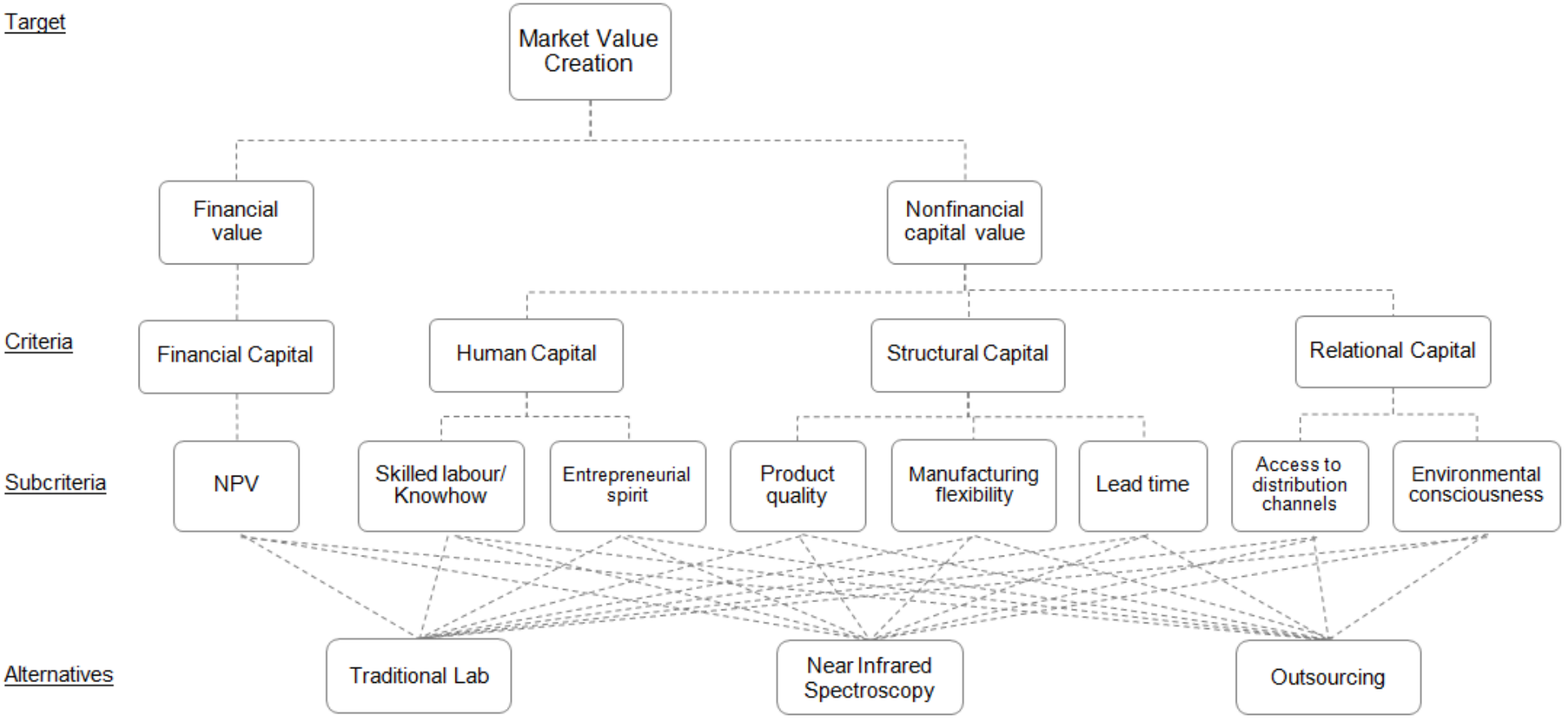

Figure 2. Hierarchical structure used to value an investment in food quality assessment

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3.2 Data collection

Five Spanish meat firms with a minimum annual turnover of 1.5 million Euros each were selected for the empirical application of the proposed methodology (referred to as A, B, C, D, and E to protect their identity). This size restriction is justified by the technical and financial impossibility of undertaking the investment projects required by alternatives 1 and 2.

Table 2 shows the main characteristics of the five firms. On the one hand, it is worth noting that A and D are family businesses with annual turnovers of less than €2 million, total assets of 5.3 and 1.9 million, respectively, and that neither has more than ten employees. On the other hand, the rest of the firms are larger corporations displaying higher annual turnovers, ranging from €6.4 million in the case of B to €15.8 million for E, as well as higher total asset figures, amounting to €31.2 million in the case of B. Furthermore, for the larger corporations the number of employees ranges from 31 in B to 53 in C.

Table 2
Financial-economic description of the firms

	FIRM				
	A	B	C	D	E
Net revenue (M€)	1.9	6.4	14.8	1.6	15.8
Total assets (M€)	5.3	31.2	16.6	1.9	14.1
Employees	8	31	53	10	46

After selecting the five firms, we contacted their CEOs for an interview at their workplaces during which they completed the questionnaire provided in order to obtain the evaluations. Thus, each CEO was asked to make pairwise comparisons to obtain the weights of the criteria and subcriteria considered in the analysis. Furthermore, these managers also provided the pairwise comparisons required to quantify the contribution of each investment alternative with respect to each subcriterion.

3.3 Results

First, to determine the consistency of CEO's in assessing pairwise comparisons, the CR was calculated for each judgment matrix. Since CR was smaller than the threshold value of 0.1 in all cases, judgments and the derived weights were considered consistent and valid for the empirical analysis.

Table 3 summarizes the relative importance derived for financial and non-financial capital in each firm. As can be observed, the family-run firms (A and D) assigned greater relevance to nonfinancial capital value, 75% in both cases; while for large industrial corporations (B, C, and E) financial value is substantially more important, at around 80%. This duality is justified, firstly because family firms prefer to improve their competitiveness and therefore their total value, through long term strategies (D´Allura & Minichilli, 2012) focused primarily on intangible issues (Habbershon, Williams, & MacMillan, 2003). Thus, their value creation strategies are mainly based on increasing their nonfinancial capital value. Secondly, the differing importance assigned to financial and nonfinancial capital values by firms can be explained by the *Agency Theory* (Jensen & Meckling, 1976) and, more specifically, by *"managerial myopia"*. This means that managers of large corporations may pursue their own interests by investing in projects with cash-flows closer in time, but less profitable in

the long term or by rejecting highly profitable projects because they have smaller cash flows in the short term (Byrd, Parrino, & Pritsch, 1998). However, in family businesses, where ownership and management are not separate, this problem has very little impact; hence, they prefer to sacrifice short-term profitability to generate long-term value, prioritizing attributes associated with nonfinancial capital. By contrast, in larger firms where there is total separation between shareholders and managers, this agency problem does occur, the short-term view taking priority and more relevance being assigned to the attributes associated with financial value (NPV).

Table 3
Weights derived for financial and non-financial capital in each firm

	FIRM				
	A	B	C	D	E
Financial value	**25.0**	**75.0**	**83.3**	**25.0**	**87.5**
Financial Capital	*25.0*	*75.0*	*83.3*	*25.0*	*87.5*
NPV	25.0	75.0	83.3	25.0	87.5
Nonfinancial capital value	**75.0**	**25.0**	**16.7**	**75.0**	**12.5**
Human Capital	*32.1*	*10.7*	*11.6*	*25.0*	*3.5*
Skilled labor/knowhow	24.1	1.8	1.5	3.1	0.9
Entrepreneurial spirit	8.0	8.9	10.1	21.9	2.6
Structural Capital	*10.7*	*10.7*	*2.2*	*25.0*	*7.3*
Product quality	6.8	6.3	1.7	19.2	1.6
Manufacturing flexibility	3.3	3.0	0.2	1.9	5.2
Lead time	0.7	1.5	0.2	4.0	0.5
Relational Capital	*32.2*	*3.6*	*2.9*	*25.0*	*1.7*
Access to distribution channels	28.1	3.0	2.5	21.9	1.5
Environmental consciousness	4.0	0.6	0.4	3.1	0.2

Table 3 also shows the weights of the criteria and subcriteria in each firm. In reference to nonfinancial capital value, there is no common pattern regarding the weights assigned to the different components. In regards to the two family firms, which assigned a preferential weight to this component of total value, it is worth noting that A gives a strong and similar weight to the criteria related to *human capital* and *relational capital* (32% each), while D gives equal importance (25%) to each of the three nonfinancial capital value criteria. In any case, it is worth pointing out that *human capital* is highly relevant in both firms because it is an essential element of the success of smaller companies (Coleman, 2007). Also, access to distribution channels, as a subcriterion of *relational capital*, was perceived as highly significant by the two family firms: 28.1% in A and 21.9% in D. This fact can be explained by the strategic importance of commercial relations in small firms positioned in market segments of high quality and high added value products, which require narrow and specific marketing channels.

With reference to larger industrial firms, it should be emphasized that B assigns the most importance (25%) to nonfinancial capital value, primarily to *human capital* and *structural capital*, with 10.7% each. In C, much of its nonfinancial capital value is generated by *human capital* and, in particular, through the entrepreneurial spirit of employees (10.1% out of a total of 16.7% of the nonfinancial capital value). In contrast, in the case of the firm that gives the least weight to this second component

of value (E), *structural capital* is the most important criterion, *manufacturing flexibility* figuring prominently with 5.2%. This reflects the need of this firm to adjust their production portfolio quickly to meet variable customer demands.

One common feature of four out of the five firms (all except E) is that *product quality* is the key subcriterion within *structural capital* (reaching up to 19.2% in D). This reflects that the focus on quality is the main differentiation and value generation strategy of most of the firms in this food sector.

These results corroborate the evidence obtained in Youndt et al. (2004), which confirmed the existence of multiple intellectual capital profiles in a wide group of firms. According to these authors, business strategy determines orientation towards different types of intellectual capital.

After obtaining the weights of the criteria and subcriteria from the CEOs, Equation 5 was used to compare the total value generated by each investment alternative in every firm, providing the results shown in Table 4. Furthermore, in order to validate the proposed model, these results were compared to the alternatives to meat quality control actually chosen by the five firms analyzed.

As can be seen, NIRS is the alternative that, to a greater extent, creates the most value in four of the five firms (A, B, C, and E). This is considerably ahead of the other two alternatives in larger firms. For example in E, the NIRS system records a value of 0.75, compared to 0.17 in the case of traditional lab and 0.08 for outsourcing. However, only two (B and E) of the four firms have already implemented this technology. The CEOs at A and C indicated in their interviews that the decision to invest in NIRS had actually been taken, but effective implementation of the system would ultimately depend on the restrictions on access to credit arising from the current financial crisis. In fact, these two firms are involved in two research projects for the development and future implementation of NIRS in their production processes.

Regarding firm D, the smallest of the five, outsourcing is the alternative that generates the most value and this is the option the firm actually chose for meat quality control.

Table 4
Market value creation of each alternative

Firm	Traditional Lab	Near Infrared Spectroscopy (NIRS)	Outsourcing	Quality control system currently implemented
A	0.27	**0.50**	0.23	Outsourcing*
B	0.26	**0.51**	0.23	NIRS
C	0.09	**0.73**	0.18	Outsourcing*
D	0.32	0.28	**0.40**	Outsourcing
E	0.17	**0.75**	0.08	NIRS

* The decision to invest in NIRS system has already been taken but it still has not been effective.

The practical interest of the theoretical model this paper proposes was thus confirmed when comparing the results obtained by our model and the actual investment decisions taken in each firm. This fact leads to the conclusion that the proposed model is a formalization of the process actually followed by financial decision

makers to capital budgeting. In this formalized process, all value creation criteria, both financial and nonfinancial, are integrated in a transparent and instrumental way. However, further empirical evidence is required to definitively confirm this proposition. Nevertheless, these results clearly evidence that the CEOs of the firms surveyed certainly consider nonfinancial capital value creation components in their analysis for capital budgeting decision-making, in addition to traditional financial criteria (financial value measured by NPV or IRR).

4. Conclusions and future research

This paper has developed a novel methodology for capital budgeting in for-profit firms, bearing in mind that this is a complex task due to the non-monetary and intangible impacts involved in productive assets investment, which have traditionally been ignored by classical financial techniques. Thus, it has been assumed that investment appraisal in for-profit firms should take into account not only financial value creation, that is, the contribution of new assets to the cash-flows of the firm (as NPV and IRR do), but also the creation of nonfinancial capital value derived from the increase in corporate intellectual capital.

Given the intangible nature of nonfinancial capital value, as well as its three components (*human capital*, *structural capital* and *relational capital*), an AHP-based model was formulated to quantify and assess both the criteria and subcriteria related to financial value creation and the intangibles related to nonfinancial capital value. In this way, we tried to (partially) avoid the problem of estimating how much cash flows will increase associated with the intellectual capital generation due to productive investments, and the problem of fixing this when it does occur.

The proposed investment appraisal model has been applied to a real case study in order to assess several quality control investment alternatives in the meat industry. The empirical application of our model to this case study has demonstrated its feasibility and effectiveness in a real setting and also evidenced the need to consider the impacts of productive investments on a firm's intangible assets, as these impacts actually affect the selection of optimal investment alternatives in the food industry.

Furthermore, it is also worth indicating that the model proposed could be applied to any investment decision, albeit following adaptation to each particular case study in order to initially establish the specific intangibles (components or subcriteria related to *human capital*, *structural capital* and *relational capital*) that the investment alternatives under consideration may have an impact on.

The results achieved in the empirical application suggest that there is no common pattern explaining the distribution of intellectual capital components. Indeed, why firms focus on one type of intellectual capital or another is determined by an organization's own strategies. Therefore, it is necessary for financial decision-makers to link the investment project valuation process to the business strategy followed in order to give more weight to attributes related to it. This diversity of business strategies (disparity in the contribution of financial capital and intangible capital to firms' total value) can be seen in an integrative way through the methodology proposed here.

Nevertheless, the conclusions above are still tentative, since they cannot be definitively confirmed based only on a pilot study with an empirical application reduced to five companies. Therefore, further empirical investigation is needed to validate these findings. It is suggested that the approach proposed here be implemented with larger samples of firms in different economic sectors and for

different types of investments. The validity of the proposed methodology and corroboration (or not) of the main conclusions can only be achieved by testing the adaptation of this approach to different contexts in this way.

In any case, this paper is expected to provide a contribution to the current literature by providing the development of an investment decision model that can be used by any for profit-firm, entailing the consideration of nonfinancial value creation criteria into the investment valuation process. This novel approach aims to achieve more effective decision-making in order to select the investment alternatives that maximize total value creation or firms' market value.

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