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MODELLING: FROM THERMAL COMFORT TO FIRM VALUE

Rute ABREU

Escola Superior de Tecnologia e Gestão do Instituto Politécnico da Guarda, Portugal

José Manuel PRADO-LORENZO
Doroteo MARTÍN-JIMÉNEZ

Universidad de Salamanca, España

Instituto Politécnico da Guarda

Nota Introdutória

A Escola Superior de Tecnologia e Gestão (ESTG) do Instituto Politécnico da Guarda IPG) congratula-se pelo facto do Professor Doutor *David Crowther*, da *London Metropolitan University*, Reino Unido ter aceite o convite para realizar uma visita de trabalho e investigação científica a decorrer entre os dias 9 a 15 de Novembro de 2002. Temos a certeza que com esta visita será possível desenvolver um debate privilegiado entre toda a comunidade Docente e Discente.

É igualmente um enorme privilégio dar início à série *Estudos e Documentos de Trabalho* com seis *papers* da autoria do Professor David Crowther. Esperemos que este seja o estímulo e o incentivo que falta para que, em particular a comunidade académica da ESTG, apresente trabalhos científicos que estimulem a discussão científica.

Não se poderá deixar de agradecer à Fundação para a Ciência e Tecnologia que, através do Fundo de Apoio à Comunidade Científica, generosamente aceitou a nossa candidatura, bem como todos aqueles que directa e indirectamente contribuíram para a sua concretização.

Constantino Rei
Professor Doutor do Departamento de Gestão
Director da Escola Superior de Tecnologia e Gestão do IPG

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Modelling: From thermal comfort to firm value

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José Manuel PRADO-LORENZO
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Abstract

Purpose: investigate the firm value and present a model based in an ISO standard that is precisely and unequivocally defined and knowing that each standard is established to assist the industry and researchers by offering a uniform method of testing.
Design/methodology/approach: The literature review allows to modelling firm value based on the thermal comfort theory and using a methodology of experimental analysis with accounting and market-oriented information from *Euronext Lisbon* firms.
Findings: The model is expressed as function of the firm value and the investors' behaviour. It uses an algorithm that details the mathematical functions of economic effects, such as: operational, investment, financing, dividend, taxation and market policy that may affect firm value.
Practical implications: the potential impact of the model shows the aggregation of natural sciences represented by physics and social sciences represented by accounting and the relation between them and, also, to promote the awareness of complexities involved in firm value.
Originality/value: provides evidence of the firm value model with thermal comfort theory.
Keywords: Value analysis, Modelling, Accounting, Thermal Comfort.
Article Type: Research Paper

1. Introduction

One research always takes longer and is more complex that one researcher should expect. This happens because each piece of information would turn out to fit another little piece and this increase with levels of complexity. Like pieces of a jigsaw puzzle, this research explores the thermal comfort model developed by Fanger (1970) and the nature of neutrality measurement. In this context, the corporate management and the accounting-oriented information in harmony with market-oriented information will enhance firm value that is essential to making a preliminary analysis and to discussing the concept of neutrality that will link thermal comfort and firm value.

For this reason, this research explores the firm value as potential information that the investor must have to integrate into his economic decision. But, each investor has a different behaviour that is related with difficulties to value the economic decision as a whole, especially because this decision usually is complex. The investor bases his decision in a firm value evaluated separately and then conjoins with emotions, belief, formal education and other information attached to each investment in order to determine his formal opinion and decision. In this sense, decision is a fundamental part and needs to be made between conflicting alternatives. As Ilinski (2001: 265) argues:

> *...the system itself is extremely complicated, it has many complex features, such as inductive reasoning and self-organization and it deals with the results of human behaviour. Reducing all of this to a simple mathematical statement would be very suspicious.*

It appears, however, that traditional valuation methods do not account properly the firm value. This may explain the gap between market price and firm value. Following this question, Plenborg (2002) exemplifies that:

> *... one sometimes hears comments to the effect that is now worth the extra effort to use the correct and precise calculation techniques when valuing companies, since there is so much uncertainty anyhow in the data that must ultimately be fed into the model (Levin and Olsson, 1998: 287).*

In this sense, the model as the concept proposed by Silverman (2001: 3) and Ahrens & Chapman (2006: 821) is based on the *research question* of modelling the firm value through the thermal comfort theory. This is an overall framework for looking at reality and is useful to show the basic elements it contains and what is the nature and status of knowledge. The model is derived from Fanger equation and is expressed as function of the firm value and the investors' behaviour and details the relative importance of mathematical functions as a result of economic effects, such as: operational, investment, financing, dividend, taxation and market policy that may affect firm value.

This research promotes the discussion of the new perspectives of firm value. Consequently, it is organized as follows. The first section presents the thermal comfort theory. The second section shows the adaptation model and explains the methodology used from the thermal comfort theory to firm value. The third section examines one case study (Yin, 1994) with a discussion of the findings and implications of this research.

2. Focus on Thermal Comfort Theory

Comfort can be understood as a sensory experience or sense of well-being and a psychological experience that is related to how a person feels in relation to his environment. In this concept, for example, differences such as social and climatic environment are important because the sense of comfort will be a value in a range of data. When the discussion is about environment, a person that lives in the Kuala Lumpur does not have the same environment as one living in Salamanca.

Furthermore, thermal sensation is determined by the purpose of the study. The challenge for each person is to successfully interact with his environment. For example, to physicians the thermal state of the body inside of the hospital is the major concern to maintain an optimum state, and of course is different from outside the hospital. As Parsons (2003: 54) details:

> *"...it is important to recognize that thermal sensation is how the person feels, not how the environment may be described."*

The most important research and practice about thermal comfort was developed by Fanger (1970) who defines it as:

> *"...that condition of mind which expresses satisfaction with the thermal environment."*

This definition is not easily translated into physical parameters, because comfort is difficult and hard to achieve in the same way by different persons. From the physiological perspective when there is thermal neutrality in the absence of regulatory sweating between the heat exchange of the human body and the environment, there can be significant individual variation in responses to the environment.

Another requirement in thermal comfort is that each person has to be in equilibrium. This equilibrium is the amount of heat produced or absorbed that must equal the heat dissipated. In

this sense, the thermoregulatory system should maintain the heat balance that is a fundamental condition for survival and necessary (but not sufficient) for comfort (Butera, 1998). So, the body thermoregulatory control system tries to maintain the energy balance around 37±0.5°C in healthy conditions and to do so implies two different regulatory adjustments: behavioural and physiological and psychological.

The behavioural adjustments include all modifications a person might consciously or unconsciously make which modify the body's thermal comfort. It is a process that changes the personal variables such as clothing, posture, activity and location. The physiological and psychological adjustments include all perception and reaction to sensory information which is result from exposure to thermal environment parameters. It is process generated by the human body like sweat production or dilation of blood vessels. Generally, these studies deals with the relationship between the sensations of a person and stimuli received from the environment.

The thermal comfort given by the heat balance equation used by Fanger is a function of personal and environmental parameters. The personal parameters of thermal model which relates the physical stimulus and psychological sensation are subdivided into:

i) metabolic heat production that varies according to the activity performed by the person. Knowing that the human body constantly generates excess heat and the amount of heat produced by the body is proportional to the level of activity.
ii) clothing insulation that is quite complex and involves in clothes the transfer through air spaces, conduction through solid material which varies if wet radiation exchanges between layers and because of the difficulties inherent in the handling of so many and often impossible to determine (Butera, 1998).

The environment parameters of thermal model which relates the conditions of the environment that affect the physical stimulus and psychological sensation and they could be excessively high or low and produce discomfort. They are subdivided into:

i) air temperature as the temperature of the air surrounding the human body.
ii) mean radiant temperature is the thermal radiation and the heat that radiates from a warm object.
iii) air velocity describes the speed of air moving across the human body.
iv) relative humidity is the ratio between the actual amount of water vapour in air and the maximum amount of water vapour that air can hold at that air temperature (Butera, 1998).

The thermal comfort equation provides an operational tool which measures physical parameters that will enable one person to evaluate thermal comfort under specific conditions of the environment and accounts for the energy exchange between the human body and its environment. The equation is expanded by substituting each component with a function derivable from the laws of physics. All of the functions have measurable values. The body is assumed not to be in thermal balance, the heat equation can be determine and this is continued by iteration until obtain a satisfactory degree. In practical terms, the prediction of thermal comfort is based on the human heat balance, where heat produced in the body by the metabolism is lost by convection, radiation, conduction, and evaporation.

In absence of any law or regulation dealing with thermal comfort, several international organisms have published standards that have approved specific to deal with this. A standard about thermal comfort that presents a method for predicting the thermal sensation and the degree of discomfort (thermal dissatisfaction) of people exposed to moderate thermal

environments. It also specifies acceptable environmental conditions for comfort. Thermal models of the human body and its interactions with the surrounding thermal environment are often proposed, and to some extent are used, as the basis for thermal comfort standards.

Standards are valid, reliable and usable with sufficient scope for practical application. These are the cases of the *American Society of Heating, Refrigerating and Air-Conditioning Engineers* (ASHRAE) that have published the standard ASHRAE 55-2001. The main objective of this standard is to specify the combinations of indoor space environment and personal factors that will produce thermal environmental conditions acceptable to 80% or more people for human occupancy within an indoor space, for example, home, office or store. This standard gives definitions, makes parameters classification and provides information for the conditions for an acceptable thermal environment.

Also, the *International Organization for Standardization* (ISO) published the standard ISO 7730 (2005). The main objective of this standard is to present a method for evaluating thermal sensation and the degree of discomfort (thermal dissatisfaction) of people exposed to moderate thermal environments. The Predicted Mean Vote and Predicted Percentage Dissatisfied indexes were developed by Fanger (1970). This standard has been criticised because of its insufficient of theoretical validity and is based on a human body energy balance and combined with an empirical fit to thermal sensation in two different indexes.

The first variable of the Fanger's model combines four environment parameters (air temperature, mean radiant temperature, air velocity and relative humidity) and two personal parameters (metabolic heat production and clothing insulation). The Predicted Mean Vote (PMV) is an empirical index expresses in the equation 1. It relates the physical stimulus and psychological sensation into an index that can be used to predict the average thermal sensation of a firm within a large group of people exposed one the same environment.

$$PMV_{jt} = f_1(\Omega_{jt}, Act_{jt}) = \Omega_{jt} \times (0{,}303\, e^{-0{,}036 \times Act_{jt}} + 0{,}032) \qquad (1)$$

Where

PMV_{jt} is the predicted mean vote

Ω_{jt} is the thermal equilibrium

Act_{jt} is the activity level of the *j* person's in moment *t*

In order to specify this theoretical consideration, the results of the Fanger model appear to be repeatable and have been generalized to the PMV index that presents a value that is distributed by the cold-to-hot thermal sensation scale showed in Table 1 that represents all the parameters that a person exposed to a certain environment.

Table 1. Thermal sensation scale used by Fanger

– 3	– 2	– 1	0	1	2	3
Cold	Cool	Slightly cool	Neutral	Slightly warm	Warm	Hot

The second variable of the Fanger's model establishes a quantitative prediction of the number of thermally dissatisfied persons (Butera, 1998: 47). The Predicted Percentage Dissatisfied (PPD) is directly determined for each PMV value and it can be thought as the probability that an average person will be dissatisfied with his or her state of thermal comfort. The PPD index is mathematical represented by the equation 2. It measures the comfort's level of the person that feels uncomfortably warm or cool in a given environment and it predicts thermally dissatisfied person within a large group.

$$PPD_{jt} = f_2(PMV_{jt}) = 1 - 0{,}95 \times e^{-(0{,}03353 \times PMV_{jt}^4 + 0{,}2179 \times PMV_{jt}^2)} \quad (2)$$

Where

PPD_{jt} is predicted percentage dissatisfied of the *j* person's in moment *t*.

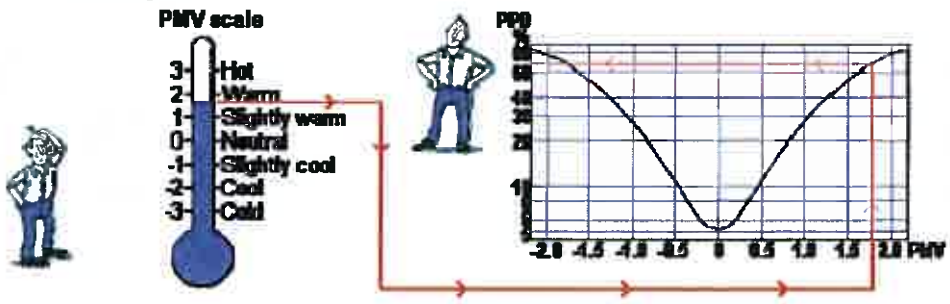
PMV_{jt} is predicted mean vote of the *j* person's in moment *t*.

The PPD index of the Fanger's model shows it is repeatable and generalized. In a theoretical perspective is possible to obtain 100% of person's with thermal comfort that this would require those very unusual and expensive methods. The PPD index presents a distribution function as Fanger (1970) and ASHRAE (55: 2001) detail:

i) sceptical person with PPD index less than 5%;
ii) category A of the neutral person with PPD index bigger than 5% and less than 6%;
iii) category B of the neutral person with PPD index bigger than 6% and less than 10%;
iv) category C of the neutral person with PPD index bigger than 10% and less than 15%;
v) over/under-valuation person with PPD index bigger than 15% and less than 75%;
vi) out-over/out-under valuation person with PPD index bigger than 75% and less than 85%.

This widely accepted index of thermal sensation was proposed by Fanger (1970) as a result of 3500 combinations of variables (Parsons, 2003: 207). Another aspect is that this research is based upon experimental studies develop at the Kansas State University (USA) and Technical University of Denmark and in that time was established using the imperial system, so today's research has to be adjusted to the international metric system (SI). As a conclusion, in Figure 1, the model presents the mathematical behaviour of the two variables: the predicted percentage of dissatisfied index and the predicted mean vote index as the thermal comfort function and explicitly the Fanger's Model.

Figure 1. The Fanger's Model (1970)



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In the Figure 1 to fully describe the person's experience, the results show that the Predicted Mean Vote is 1.75 and the Predicted Percentage Dissatisfied is 64%. So, the prediction of thermal sensation is away from neutrality and could be justify upon on the principle of thermal load. Each person has a different attitude to thermal sensation. This influences their decision and how they value possible outcomes. Research has shown, however, that for important decision they tend to behaviour uniformly as expresses in PPD index.

The Fanger comfort model is comprehensive but the reality is complex. The model captures this complexity that is impossible to be made by manual calculation. So, the author has to

build a software tool that will allow the model to generate the results. The relationship between the parameters was based in large number of experiments. During these experiments, it was possible to build the system of equations that control the energy balance for a person.

3. From thermal comfort theory to firm value model

In this research, complexity arises from the distance between the investor seeking the relevant information to his economic decision and the source that contains this information that is corporate management and the accounting-oriented information in harmony with market-oriented information will enhance firm value. So, investors can adopt an economic decision, if they identify and understand the problem. Also, then they discover solutions and so they act. The research problem focuses on formulation, solution and dynamic decision making. The same type of reasoning is very important when it will be applied to thermal comfort.

In this context, this research explores the thermal comfort model developed by Fanger (1970) and the nature of neutrality measurement that will enhance firm value that is essential to making a preliminary analysis and to discussing the concept of neutrality that will link firm value and thermal comfort. But it is important to understand that this methodology is not appropriate when the problem is unsolvable, which is not the case for the actual research, because the firm value is within a relatively simple subsystem (firm) of a larger complex system (economy). The author agree with Abreu (2006: 4), when she explains that the model is focus on what the system should do rather than trying to model how it works.

The thermal comfort and the firm value have many complex features, such as self-organization, inductive reasoning and reduce all to model that measure up the human behaviour with the valuation of firm. The central piece is the knowledge that people are the centre of firms and they manage them. Before explain the relation from the thermal comfort to firm value is important to focus that this research is characterised for an idea of using "social science metaphors" more than by the development of *a prior* formal theory, because it does not exists any previous research that relates both sciences. Also, as Mitleton-Kelly (2003) pointed:

> *...one way of looking at complex human systems is to examine the generic characteristics of natural complex systems and to consider whether they are relevant or appropriate to social systems.*

In the framework of thermal comfort extracting important factors while making a fewer assumptions and ignoring the unimportant ones, it will allow the author to formulate a model. The central contribution to the model is generating thermal neutrality and only few persons as possible feel any form of thermal stress. So, this research explores the thermal comfort model developed by Fanger and the nature of neutrality measurement. In this context, the corporate management and the accounting-oriented information in harmony with market-oriented information will enhance firm value that is essential to making a preliminary analysis and to discussing the concept of neutrality that will link firm value and thermal comfort.

Recent trends depend upon the production of artificial interior climates. So, human well-being and the need for a sustainable and stimulating environment is the principal concern. Also, sharing the social responsibility with future generations and delivering the application of modern research methodologies will improve the discussion and contribute to knowledge. Since, these objectives are difficult to model; certain aspects of human decision making are easier to model so they cannot simply be ignored.

Moreover, in practice, multidisciplinary involves the use of concepts, hypotheses and methods from other fields of endeavour. Such defence implies that multidisciplinary research may be illusory but, at the same time, introduces the creativity. The main question of this process was a lack of response to today's needs that creates a crucial requirement for creativity and despite criticisms the new tendency will analysed and will synthesise many problems that society faces today and urgently needs to address. As Vidal (2005) argues:

> *... experience has shown that it is a good idea in a creative problem solving process to start with divergent thinking to produce as many ideas or solutions as possible and thereafter to switch to convergent thinking to select the few most promising ideas.*

This research proposes a model of the firm value related with a formal model from thermal comfort based in physics laws. In addition, the valuation model proposed in this research should be to ensure that firm value is reasonable, consistent and reflects underlying market conditions. Thermal models and interactions of the human body with the surrounding thermal environment are based on thermal comfort standards. This insight is similar to firm value models and interactions of the investor with the economic environment that are supported in accounting information systems built with accounting standards.

In the model, each investor adopts a different behaviour related with a *j* firm's value. So, in order to fully describe the *j* firm's experience presented in Figure 1, the author describe the firm value function. The results of the model demonstrate several values each one for a different year of the analysis. In general, the *j* firm, in moment *t* has the firm value in the minimum point of the equation 3 represented by ξ_{jt}. The generalized objective function can be written as follows:

$$\xi_{jt} = (FVI_{jt} , IBI_{jt}) \qquad (3)$$

Where

ξ_{jt} is firm value of the *j* firm's in moment *t*.

FVI is firm value index of the *j* firm's in moment *t*.

IBI is investor behaviour index of the *i* person's in moment *t*.

The first variable of the firm value model combines six economic effects, such as: the operational, the investment, the financing, the dividend, the taxation and the market policy. The Firm Value Index (FVI) is an empirical index that is expressed in the equation 1, with a distribution between] -3 , 3 [. The second variable of the firm value model establishes a mathematical relation of the neutral predictable value of the firm with one investor within a large group represented by the equation 2. The Investor Behaviour Index (IBI) is directly determined for each value of the FVI that is expressed in the equation 2, with a distribution between] 5, 100 [.

The propensity for investors to absorb and assimilate firm value and this knowledge acquisition has a direct impact on his decision. The investor must evaluate the information disclosure by the firm and the market in order to determine the best option to be adopted. It can be thought as the probability that an average investor will be dissatisfied with the value of firm that invest or could invest. So, they must analyse the information as outsiders and before taking an economic decision. But as Myers & Majluf (1984: 215) explains the investor could act as a passive or active economic agent. So the 5% of sceptical person's in the thermal comfort Fanger's model is related with similar explanation, but is hard to build a completely convincing theory explaining why they would always do so.

The author applied iterative model and in the process it could have different situations and for each of them, the author has conditions, expressed in the following description:

If $\xi_{jt} = (0,0)$ (4)

then $\xi_{jt} = (0, 5)$

otherwise $\xi_{jt} = (NPE_{jt} \in]-3, 3[, DPI_{jt} \in]5, 100[)$

In one hand, accounting is based in principles and standards and, in other hand, physics is based in laws. The thermal comfort model is applied to persons exposed for a long period at specific conditions in the environment and with particular parameters. This could be reflected in the firm perspective in the application of the continuity principle which is consistent with generally accepted accounting principles (GAAP). So, similar aspect is applied to firms because the GAAP are uniform minimum rules, guidelines and procedures that define accepted accounting practice and firms use to compile their accounting information.

Contrary to traditional science density in accounting is a result of trends in different accounting standards around the world that affect all firms and conscious choices made by firms on business mixes and how they structure and present the results of their operations, investments and financing choices. Following the point of view proposed by Allen & Strathern (2005: 729):

> *...contrary to traditional science in which the natural laws are independent of who knows them, in social and economic systems, knowledge of system behaviour decays over time, and is in any case used up when it triggers new behaviour in the system.*

The objective of thermal comfort is to provide information about the person. The objective of valuation is to provide information about the firm. As more and more of nature began to reveal it governed by physical laws, researchers started to wonder whether such laws applied in the human sphere was well. They began to think of the human individuals made up society then maybe there was a physics of society (Ball & Ormerod, 2003). In other words, by testing the firm value with different variables, the author can move towards understanding not only of the emergent behavioural rules for firms and investors, but also how to learn these rules. That is, how much to experiment and with which parameters and whether any new dimensions of attributed space can be invaded.

The thermal comfort model is based in modern physics. Creativity and emergence characterise the real, open, non-linear systems of the firms that make up our economy. Each parameters has been observed and tested and the model generates index about the human comfort, even in the cases that without logical fail to consistently represent the reality. Of course it is difficult to perceive the impacts of firm value change directly the investor behaviour. Therefore, it is important that researchers try to mediate this perception to the economic agents.

The model proposed should represent the neutral value of economic decisions as a required measure between the firm value and the investor behaviour in a specific moment of time and space. The methodology for valuing the economic decision depends on how difficult it is to determine the price market for the firm. In the simplest case, a firm can find the price market in the stock market which reflects the last price reported on secondary market. The apparent simplicity contrasts to those firms that do not have price market, because are not actively

traded in stock market or only have an historical price basis that is just unsatisfactory and without take into account a variety of relevant data.

In another perspective, investors have difficulties to value the economic decision as a whole, especially because this decision usually is complex. Again, the investor based his decision in a firm value evaluated separately and then conjoins with emotions, believes, formal education and asymmetric information attach to each investment and so it would be able to present his opinion. Modelling investors' decision making as based on mental accounts can explain several anomalies, frequently reported in behavioural finance (Rockenback, 2004). In this behavioural analysis is usually applied the tendency to subdivide the investment decision into small decision units is often observed. Instead of looking at the economic decision as a whole problem, the investor faces the economic decision as part of the problem treated separately.

Similarly, Hirshleifer et al. (2004) argue that investors with limited attention tend to overvalue and to undervalue firms and processing power cause systematic errors that affect market prices. However, some investors would value firm A more highly than firm B. The author do not think that investors sometimes are irrational, so it be will presented an argument that the proposed model should consider these aspects in valuation of the firm. Thus the latter firm's value for both introduced complexity and it will be necessary to find the sources of and the reasons for complexity in financial statements, and then look different ways in which the firm value and the investor behaviour can be adapt in valuation models.

This research furthers this by instigating a discussion of the interrelation between accounting and physics, while accepting that a theory that will explain all the phenomena does not exist. It is argued that some of the issues are difficult to address with an observation but it could be clarified using both theories as a conjoint perspective. There are some difficulties with the assumptions made, the hypothesis developed as well as the language used, the concepts managed and the interpretations applied in the accounting and the physics perspective.

4. A new look at firm value

From the perspective of the investor, valuation models are not able to really calculate the value of a firm. For this reason, this research explores the firm value as potential information that the investor must have in order to make his economic decision. But, each investor has a different behaviour that is related to difficulties to value the economic decision as a whole, especially as this decision usually is complex. The investor bases his decision concerning firm value initially upon calculation alone and then also takes into account emotions, beliefs, formal education and other information attached to each investment and thereby arrives at his formal opinion and decision. In this sense, decision is a crucial part and needs to be made between conflicting alternatives.

Similarly, the empirical models show the introduction of simplifying assumptions on firm value that impact on estimates of the value. The assumptions made, the hypotheses developed, the language used as well as interpretations applied in the measurement of economic decisions require instruments of certain specificity. It is conventional, and surely uncontested, to claim that taking measurements requires instruments of measurement such as methods, models and approaches equal to all the situations.

It has been perceive and interpret the thermal comfort model by identifying variables, techniques and results obtained in the context of physics. In this scenario, each variable is a

function that produces an effect and is measurable. Thus, the firm value equation represents a set of economic effects that analyze the firm. In Table 2 is presented all six variables of the information system of the firm value model. It was used an algorithm as a result of mathematical functions of economic effects, such as: operational, investment, financing, dividend, taxation and market policy of the firm. All the variables are derived from the literature and they have been iteratively selected to measure strategic economic and finance dimensions of the firm.

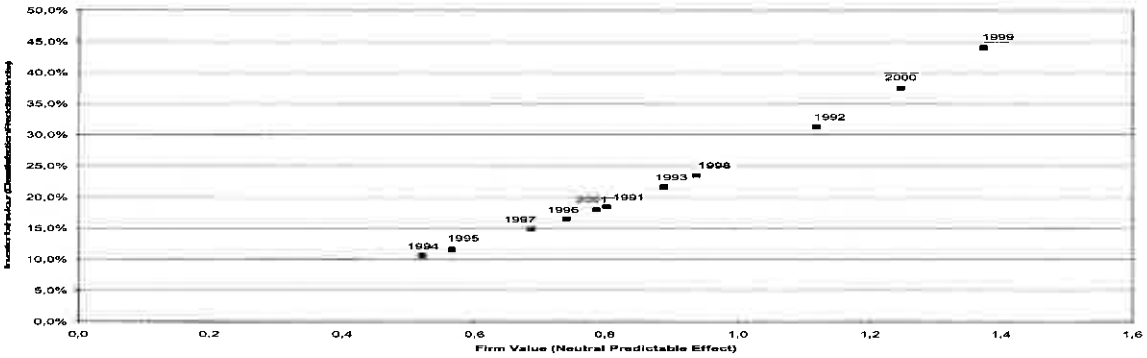
Table 2. Variables of the firm value model

Policy	Economic effect	Variable	Mathematical Function
operational	Activity level	Act_{jt}	$= f_1 [Act_{jt}] = [Rai_{jt} + \varepsilon]$
investment	Fixed assets level	AI_{jt}	$= f_2 [AI_{jt}] = [AI_{jt} \times \gamma]$
financing	Financial autonomy ratio	Afi_{jt}	$= f_4 [Afi_{jt}] = [1 - (Pas_{jt} / (FP+Pas)_{jt})]$
dividend	Dividends paid	Div_{jt}	$= f_6 [Div_{jt}] = [\alpha_{jt} + (Div_{jt})^{\gamma}]$
market	Market-to-book ratio	Mer_{jt}	$= f_3 [Mer_{jt}] = [\beta \times (P_{jt} / B_{jt})^{\gamma}]$
taxation	Income tax rate	Fis_{jt}	$= f_5 [Fis_{jt}] = [\lambda - (IRC_{jt}) \times \gamma]$

After pilot testing these variables on the sample firms, the results of this model identify the impact of the firm value with the conjoin effect of the neutral predictable effect as the firm value and the corresponding dissatisfaction predictable index as the investor's behaviour. As pointed out by the Fanger model, there has been an indicator that identifies the value of the company j time t with informational content. It is intended to draw attention to the validity of the model and the relationship of the equation of the firm (Ω_{jt}) in a narrow perspective, identifying the neutral point of the valuation for the firm.

This research was validating on a panel data of firms on the *Euronext Lisbon* as the Portuguese Stock Market. The population has been identified as all firms with officially quoted shares in the stock market and each observation is related with a firm in a specific year. So, the unit of analysis is the firm has conducted a thorough analysis of the contents of the 2.805 *Boletím of Cotizacão*, from December 31, 1991 until December 31, 2001, while with a population of 291 firms and after a process of depuration ends with 114 firms and 1.079 observations. From this sample, it was selected the case study of the firm $\xi_{(4918)}$ presented in Figure 2, 3 e 4, because it is a quoted firm in the Portuguese stock market, on the period of 1991-2001, and it shows several strategic variables incorporated in the equation of the model leading to an evolution of the positive trend of neutral value of the firm.

Figure 2. Distribution of the firm $\xi_{(4918,\ 1991\text{-}2001)}$ value model



The $\xi_{(4918,\ 1991\text{-}2001)}$ firm value model has the distribution function of the:

1. firm value index equal to $FVI_{(4918,\ 1991\text{-}2001)}$ €] 0,518 , 1,314 [.
2. investor behaviour index equal to $IBI_{(4918,\ 1991\text{-}2001)}$ €] 10,6% , 44,1% [.

Figure 3. Distribution of the firm value and share price of the firm $\xi_{(4918,\ 1991\text{-}2001)}$

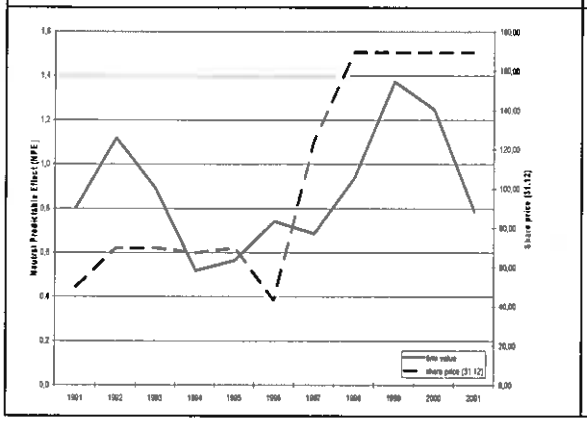
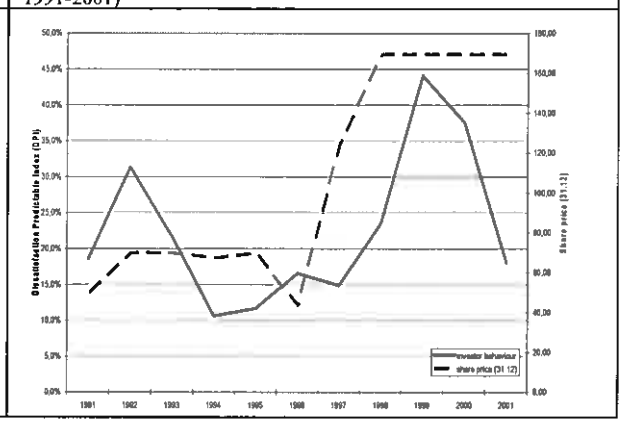


Figure 4. Distribution of the investor behaviour and share price of the firm $\xi_{(4918,\ 1991\text{-}2001)}$



The results of the model in relation with the firm show a connection between the level of activity and the distribution of the neutral value of the firm as a result of the economic effects proposed in the equation of the model. The strong tendency of strategic decisions of the firm such as:

1 – **Operational policy**, despite the changes recorded during the period, the firm obtains, in each year, an increasing activity level and positive net result in each year.

2 – **Investment policy**, although over the period 1991-2001 has made regular investments, the big decision has been adopted in 2001, with increasing of the fixed asset more than 80% against the previous year, which was financed through loans. The fixed asset investment in 2001 is opposite with current asset investment, which may reflect problems of operational activity. Also, it does not appear that the investment has been subject by any allowance, because does not appear in accruals and deferred.

3 – **Financing policy**, there is an increase in equity in 1992, completely covered by the incorporation of reserves and the net result of 1991, allowing the firm to consolidate its own equity.

4 – **Dividend policy**, between 1993 and 2000, the firm makes the dividend distribution corresponding to the net result legally permitted, i.e., each accounting year, the firm incorporated in the equity the percentage that corresponding to the required legal reserve. In the year 2001, the firm does not distribute dividends, perhaps as a precautionary measure to a sustainable policy for financing, given by the reduction in the net result of that year and the increase in liabilities through investment.

5 – **Market policy**, during the period, the highest and lowest value of the book-to-market equity's role as a risk proxy with 2.518 in 1998 and with 0.644 in 1995.

6 – **Taxation policy**, during the period, the average was 38.2% that justify the general tendency of the Income Tax in Portugal.

In this sense, it appears that the general trend of the firm has a positive value, despite of pointing out to a good structure of fixed assets and a balanced financial autonomy. So, it has an estimated value higher than neutral value of the firm and an evidence of positive trend. It should highlight that in the year 2003 has been known the information of the sale of the firm to new investments.

Valuation allows to determine an approach of the firm value. This insight helps investors and analysts to understand that the value of firm generated by application of the valuation model proposed in the literature is affected by firm characteristics and accounting-oriented information as well as by market-oriented information. Furthermore, organisational structure and culture will trend to vary from one firm to another, thus placing different demands upon the accounting information system (Crowther, 2004: 13). In this sense, firms disclose financial statements that report their economic and financial situation. Additionally, market information becomes available to investors that will aid their decision-making process knowing that markets have normally sellers and buyers and their agreement point is achieved at the market price. At the same time, the interpretation of all the information is crucial.

Discussion

This research introduces a firm value model based on the thermal comfort theory proposed by Fanger (1970) model and it is conducted for each firm that captures the value in relation with Time and Space. Also, the most important part of starting a jigsaw puzzle and firm value model is having time and space. Time because each firm value is related with a specific moment of financial statements and market information, so this is already true in a static case. But, it applies particularly to the case of a dynamic perspective of time and for this reason the complexity increases. In this situation, value is difficult to design, enact and carry though (Baumgartner et al., 2004: 9). Space because the investor behaviour is related with personnel opinion of the valuation itself and the firm is located in an economy with environmental effects in the investment decisions that considerably extends the sphere of economic and social decision making process.

In the spirit of this research, it would be appropriate to look in future research at an empirical perspective rather than trying to discuss, disseminate and exchange ideas about new perspectives of firm value and thermal comfort. The emphasis is about firm value as a result of more scarcity in the future of capital and environment so their value will increase. At the same time, it demonstrates the need for additional research and highlights the relative importance of investor decision and their potential impact. Inevitably, the author deals with complexity as a result of the conjunction between the natural science and the social science.

A strong and powerful need has emerged from society in general and firms in particular. Perhaps, globalisation only increases the rapidly changing decisions-making process. So, the justification for all is the need to be foreseen for future consequences of present and past actions, events and trends. The contribution of this model comes from how it will be used by investors and researchers.

First, the investor needs to understand the impact of his economic decisions that are related with firm value. The main conclusion is that firm value could be observed as neutral value without being affected by over or undervaluation. This allows to avoid dangerous investment errors, because it recognizes that the firm value is influence by bias and far from the neutral value. The model has to be analysed either independently or in combination in a specific moment such as firm value and investor behaviour.

Second, the researchers discuss the conceptual framework associated with social and natural science. It could improve the understanding and use of this exploratory model to develop the interdisciplinary knowledge that reflects the main aspects from thermal comfort and valuation that need to be brought together the cumulative field and require expertise. This question is

also rich in interpretation and transformation and, particularly, the emergence of ideas promote creative thinking and provide the ideal context for valuable developments. Social science and accounting could have progressively be future oriented research that will reflect the society in its continuous dynamic.

The first piece of jigsaw puzzle was to build the firm value model exists as a fundamental element that accurately portrays the economic decisions taken by investors. So, this information should be available to effectively reduce uncertainty and failures and potentially help investors to adopt the right decision in the exact moment and location…

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Escola Superior de Tecnologia e Gestão
Instituto Politécnico da Guarda
Av. Dr. Francisco Sá Carneiro, 50
6300-559 Guarda
Portugal
Tel. + 351 271 220 120 | Fax + 351 271 220 150