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From Accounting to Firm Value

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Abstract

This research proposes a model to determine firm value and it argues that econophysics literature examine the robustness of the relation between accounting and physics. In this sense, the research shows the development of a theoretical model of the firm value that links the financial reporting, such as: operational, investment, financial, dividends, tax and market derived from corporate strategies adopted on the firm and it promotes new opportunities for empirical research.

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1. Introduction

This paper contributes to the econophysics literature by examining the robustness of the relation between accounting (valuation) and physics (thermal comfort). The laws of physics (i.e., the first and second law of thermodynamics) have important implications on thermal comfort and it also has in valuation of the firm. It is potentially significant that considering accounting through the lens of physics will enable research to make more complete and meaningful assessment of treat complex information systems such as accounting information systems and it could therefore leads to implement strategies and policies for the development of the firm (Matos, 2009).

This understanding of the economic world is supported on econophysics literature, such as: Mirowski, (1952); Mantegna e Stantley (2000); Voit (2003) and Defilla (2007). To Burda et al. (2014), this is an "approach to quantitative economy using ideas, models, conceptual and computational methods of statistical physics". In this perspective, each research promotes, more and more, that nature began to be governed by physical laws and the

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researcher starts to wonder whether such laws are able to apply to Human or firms sphere was well. They began to think of a person made up society then maybe there was a physics of society (Ball & Ormerod, 2003).

One example is thermal comfort equation that provides an operational tool which measures personal parameters that enables 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 parameter with a mathematical function derivable from laws of physics. So, the objective of thermal comfort is provided information about the person and its environment. This framework starts knowing that the human body is assumed not to be in thermal balance. So, the heat balance equation can be determine in a continuous process made by iteration until obtain a satisfactory degree that it is classify as neutral. Also, it specifies a comfort condition that is the thermal neutrality, which means that a person must feel neither too warm neither too cold.

The question arises on the definition of comfort. To Fanger (1970) is "that condition of mind which expresses satisfaction with the thermal environment." Parsons (2003) details "it is important to recognize that thermal sensation is how the person feels, not how the environment may be described." So, 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. To evaluate the thermal comfort, Fanger (1970) was proposed one model. His research has so higher level of relevance that the International Organization for Standardization creates the ISO Standard 7730: 2005 (ISO, 2005). So, this research deals with complexity as a result of conjunction between the natural science and the social science and it applies this standard to firm value. The concept of measurement involves an approximation to the firm value through the investor's behaviour.

Inevitably, the model incorporates this behaviour and six economic effects of the firm strategy for the measurement of the firm value. It is explores a multidisciplinary context. The framework uses a thermal model interacting with value model. It is supported on accounting-oriented information conjoins with security prices. The model proposed in this research ensures that firm value is reasonable, consistent and reflects underlying market conditions. Also, there is some evidence to support that the diversity of information on valuation process was reduced. First, the standard is reliable and usable with sufficient scope for practical application, knowing that it is an analytical determination and the results allow to make interpretations. Second, the standard is precisely and unequivocally defined, because it relates with a mathematical model that has been empirical tested.

So, the model of this research is based in a theory that reliably predicts the results of experiments to which it is applicable and it is said to embody laws of physics. Others researchers have done the same in similar context (Georgescu-Roegen (1971); Cavagna et al. (1999); Ilinski (2001)). These results prove that firm value can be obtained through a thermal comfort model and it is validated by the experimental data.

Convergent to this line of research, Georgescu-Roegen (1971) argues that ''our whole economic life feeds on low entropy''. Therefore, I consider that it instigates the discussion of interrelation between physics and accounting. Under these circumstances, several debates arise while accepting that a theory that explains all the phenomena does not exist. On the one hand, the theoretical framework of this paper is based on literature about accounting, in general, and auditing, in particular (Georgescu-Roegen, 1971). On the other hand, the empirical framework reflects the practices in this field of the disclosure of Annual Report of the firm (Olesen & Parsons, 2002).

The structure of the paper is organized as follows. Section 2 gives an overview from econophysics to the accounting context. Section 3 goes from accounting to firm value model. Finally, the section 4 presents the conclusion and developments for future research.

2. From econophysics to accounting context

Fanger's model is an application of the firm value (de Dear & Brager (2002); Mattessich, (1995)). In other words, by testing the firm value with different variables, we can move towards understanding not only of the emergent behavioural rules for firms and investors, but also to learn from these rules. In this section, the aim is present the firm value model. From the accounting information system and the market information system, it was selected the "a" most relevant input variables from a set of "b" variables ($a \leq b$). All these variables were individual tested and each one it was justify the more relevant in terms of economic effect to a specific thermal comfort variable. The general debate of this research is centred on the emphasis in physics versus accounting and it is nonetheless important.

But, what is important to the debate is that it indicates that value is created by management decisions, policies and strategies as evidence of six economic effects that generate two variables of the firm value model. To determine this model is essential to combine the firm value effect with the investor behaviour index of the j firm in moment t. The meaning and mathematical representation of these variables in the Fanger's model were explicit supported on reflections about the variables selection process.

Much discussion about these and the information systems are undertaken within the context of value model, but more essential is the consistency of different strategies and policies that has been adopted by firms. We accept that those analyses are difficult to identify and that there are problems in their justification based on the literature, especially, we could not find any research that meets these requirements.

The model proposed in this research should be to ensure that firm value is reasonable, consistent and reflects underlying market conditions. So, investors should be able to make use of results of the model as a means for judging the value of the firm and it is used as reference point. The model, generates the firm value in the minimum point of the Eq. 3, represented by ξjt with i as an investor's that adopts a different behaviour related with a j firm's value in moment t.

In order to fully describe the firm experience presented in Eq. 1, the authors describe the value function, knowing that FVEjt is firm value effect of the j firm in moment t and IBIjt is investor behavior index of the j firm in moment t. The generalized objective function can be written as follows:

$$\xi_{jt} = (FVEjt, IBIjt) \quad (1)$$

The null hypothesis is represented by the Eq. (2).

$$H0 : \xi jt = 0 \text{ then}$$
$$\xi jt = f(FVEjt, IBIit) = (0, 5) \quad (2)$$

But as Stewart (1991) explains the investor could act as a passive or active economic agent and Penman (2001) detail the skeptical behavior of the investor and in this model represents 5% of investors with similar explanation of the Fanger's model. The alternative hypothesis is represented by the Eq. (3).

$$Ha : \xi jt \neq 0, \text{ then}$$
$$\xi jt \neq f(FVEjt, IBIit)$$
$$\xi jt = \{ FVEjt \in]-3,3[, IBIit \in]5,100[\} \quad (3)$$

This model and mathematical process increases the knowledge of the reality, because accounting is based in principles and physics is based in laws. So, the few comprehensive principles and laws clarify all aspects of nature. Furthermore, its formulation brings together and it explains all such diversity phenomena. At the same time, a law is always subject to adjustment, replacement, or constraints that oblige to develop more experiments.

3. From accounting to firm value model

The firm value model provides a starting point for further valuation analysis and it facilitates the information process between investors and stakeholders. The danger is thinking that the firm value is inevitable complete since the model is applied, but problems particularly arise because for each firm is often impossible to determine value. Usually, the literature proposes several corporate finance models to obtain an approach of the firm value (Stewart, 1991; Penman, 2001; Damodaran, 2002).

For this reason, it is appropriate to treat the data from accounting and the market information system as a provider of faithful information to reflect the future prospects of the business. Additionally, researchers have been concerned with observing accounting practices, normative and policy regulation. Such perspective does not affect the model itself, because accounting requires to be prepared in accordance with a trusted set of generally accepted accounting principles.

All variables have been iteratively selected to measure several economic and finance strategies of the firm (Bowman & Ambrosini, 2007). More important, the investors understand that it is impossible to summarize the

value of complex firms with diverse economic activities in global market into a single measure. It was used an algorithm that generates the policies derived from firm strategies, such as:

Operational corporate strategy. Valuation based on accounting data usually started with a basic accounting constructs that is earnings and by giving a summary of how the business incurred its revenues and expenses due to both operating and non-operating activities. In the model, the j firm's activity level is represented by the after tax result in moment t and this dimension is represented by Actjt as Berger & Ofek (1995), Barth et al. (1998), Barth (2000), Ohlson (1995), Ou & Sepe (1995). Consistent with findings on experimental analysis, the range is, theoretically and conceptually, between 46 of the minimum and 232 of the maximum.

Investment corporate strategy. Valuation based on accounting data generally adjusted the biases introduced by conservatism (historical cost and depreciation charges) of the accounting policy adopted and it details the level of significant resources invested in their assets that must be used productively. In the model, it is based on the fixed assets represented by the ratio of net fixed assets divided by total of asset and the j firm's and this dimension is represented by AIjt as Berger & Ofek (1995), Zhang (2000), Sorescu & Spanjol (2008). Consistent with findings on experimental analysis, the range is, theoretically and conceptually, 0 of the minimum and 0.31 of the maximum, knowing it is not feasible when deriving comparative statistics due to division by zero.

Market corporate strategy. Valuation based on accounting data generally recognized the market-book ratio as an indicator of the level of risk In the model, the ratio is determined by the market price divide by the book value and this dimension is represented by Mercjt as Beaver et al.(1970), Bernard (1994), Penman (1996), Christensen & Feltham (2003). Consistent with finding on experimental analysis, the range is, theoretically and conceptually, between 10 as the minimum and 30 is the maximum.

Financial corporate strategy. Valuation based on accounting data generally founded in financial policy one of the most essential issues, because of the conjoin effects of liabilities and equity analysis and the need to split the value and gains and losses associated to them in order to adopt independent decisions. In the model, the financial autonomy is one hundred less the financial leverage and this dimension is represented by AFjt as Leland (1994), Bowman (1980), Feltham et al. (2007). Consistent with finding on experimental analysis, the range is, theoretically and conceptually, between 30 as the minimum and 70 as the maximum.

Taxation corporate strategy. Valuation based on accounting data generally defined an income tax based on fiscal adjustments of the accounting information. In the model, the government chooses the level of tax that determines the protection of the firms and fiscal equity and the dimension is represented by IRCjt as Brennan (1970), Manzon & Plesko (2002), Mills et al. (2003) and Jalbert (2002). Consistent with findings on experimental analysis, the range is, theoretically and conceptually, 0 of the minimum and 100 of the maximum, knowing it is not feasible when deriving comparative statistics due to division by zero.

Dividend corporate strategy. Valuation based on accounting data generally established dividend policy as a traditionally instrument between the firm and the investor. In the model, the level of dividends is established by each firm and it is consistent with findings on the literature (Penman (1997); Rees (1997); Akbar & Stark (2003)) and the dimension is represented by Djt. Consistent with findings on experimental analysis, the range is, theoretically and conceptually, between 30 as the minimum and 40 as the maximum.

The development of the firm value model was supported in interactive equation system. The author carried out a calibration process with respect to the empirical data and to make appropriate each accounting variable versus each physics variable. Then, the results were classified as empirically tested. Then, the model establishes a mathematical relation of the firm value effect (as Eq. 1) with a range distribution between [-3 till 3] with the investor behavior index with a range distribution of 5 till 100 (as Eq. 2). The ωijt are the economic effects of the firm that affect the model of the j firm value in moment t. The goal of the j firm, given by the Eq. 4, is minimize the value equilibrium (Ωjt) through a combination of Eq. 5-17. The author show that Ωjt equal to 0 based in an iterative process, given by the Eq. (4) and several values of the economic effects are presented on the analysis, knowing that Actjt is the j firm activity level:

$$\Omega jt = MIN\ (Actjt - \omega 1jt - \omega 2jt - \omega 3jt - \omega 4jt - \omega 5jt - \omega 6jt - \omega 7jt) \quad (4)$$

s.a.

ω1jt = (Mjt - Wjt) (5)

Where Mjt is the j firm's revenues and Wjt is the j firm's expenses, all in moment t.

$$\omega 2jt = 3{,}05 \times 10^{-3} \times \left[5733 - 6{,}99 \times \mathrm{Rai}_{jt} - \left(\mathrm{AF}_{jt} \times 1000 \times e^{\left(16{,}6536 - \frac{4030183}{\mathrm{Merc}_{jt}+235}\right)} \right) \right] \quad (6)$$

Where AFjt is the j firm's financial autonomy assets and Mercjt is the j firm's market value, all in moment t.

ω3jt = 0,42 X [(Mjt - Wjt) - 58,15] (7)

Where Mjt is the j firm's revenues and Wjt is the j firm's expenses, all in moment t.

$$\omega 4jt = 1{,}70 \times 10^{-5} \times \mathrm{Act}_{jt} \times \left[5867 - \left(\mathrm{AF}_{jt} \times 1000 \times e^{\left(16{,}6536 - \frac{4030183}{\mathrm{Merc}_{jt}+235}\right)} \right) \right] \quad (8)$$

Where AFjt is the j firm's financial autonomy assets and Mercjt is the j firm's market value, all in moment t.

$$\omega 5jt = 0{,}0476 \times \mathrm{Act}_{jt} - 0{,}0014 \times \mathrm{Act}_{jt} \times \mathrm{Merc}_{jt} \quad (9)$$

Where Mercjt is the j firm's market value, in moment t.

Knowing that AIjt is the j firm's fixed assets, πjt is the j firm's value approximation error and Djt is the j firm's dividends, all in moment t, then:

1. AIjt is less than 0,078 then in Eq [10]:

$$\omega 6jt = 3{,}96 \times 10^{-8} \times (1{,}00 + 1{,}29 \times \mathrm{AI}_{jt}) \times ((\pi_{jt} + 273)^4 - (\mathrm{D}_{jt} + 273)^4) \quad (10)$$

2. AIjt is bigger than 0,078 then in Eq [11]:

$$\omega 6jt = 3{,}96 \times 10^{-8} \times (1{,}05 + 0{,}645 \times \mathrm{AI}_{jt}) \times ((\pi_{jt} + 273)^4 - (\mathrm{D}_{jt} + 273)^4) \quad (11)$$

Knowing that AIjt is the j firm's fixed assets, IRCjt is the j firm's tax rate, πjt is the j firm's value approximation error and Mercjt is the j firm's market value, all in moment t:

In Eq [12] it will be: $\omega 7jt = (1{,}00 + 1{,}29 \times \mathrm{AI}_{jt}) \times (2{,}38 \times (\pi_{jt} \quad \mathrm{Merc}_{jt})^{0{,}25} \times (\pi_{jt} \quad \mathrm{Merc}_{jt}))$ (12)

Knowing that AIjt is less than 0,078 and with Eq. [13]: $12{,}1 \times \mathrm{IRC}_{jt}^{0{,}5} \times (\pi_{jt} - \mathrm{Merc}_{jt})^{0{,}25} < 2{,}38$ (13)

In Eq [14] it will be: $\omega 7jt = (1{,}00 + 1{,}29 \times \mathrm{AI}_{jt}) \times (12{,}1 \times \mathrm{IRC}_{jt}^{0{,}5} \times (\pi_{jt} \quad \mathrm{Merc}_{jt}))$ (14)

Knowing that AIjt is less than 0,078 and with Eq [15]: $12{,}1 \times \mathrm{IRC}_{jt}^{0{,}5} \times (\pi_{jt} - \mathrm{Merc}_{jt})^{0{,}25} \geq 2{,}38$ (15)

In Eq [16] it will be: $\omega 7jt = (1{,}05 + 0{,}645 \times \mathrm{AI}_{jt}) \times (2{,}38 \times (\pi_{jt} \quad \mathrm{Merc}_{jt})^{0{,}25} \times (\pi_{jt} \quad \mathrm{Merc}_{jt}))$ (16)

Knowing that AIjt is bigger than 0,078 and with Eq [17]: $12{,}1 \times \mathrm{IRC}_{jt}^{0{,}5} \times (\pi_{jt} - \mathrm{Merc}_{jt})^{0{,}25} < 2{,}38$ (17)

In Eq [18] it will be: $\omega 7jt = (1{,}05 + 0{,}645 \times \mathrm{AI}_{jt}) \times (12{,}1 \times \mathrm{IRC}_{jt}^{0{,}5} \times (\pi_{jt} \quad \mathrm{Merc}_{jt}))$ (18)

Knowing that AIjt is bigger than 0,078 and with Eq [19]: $12{,}1 \times \mathrm{IRC}_{jt}^{0{,}5} \times (\pi_{jt} - \mathrm{Merc}_{jt})^{0{,}25} \geq 2{,}38$ (19)

These functions are incorporated into this framework from the Fanger's model. All are assumed to be independent one of another. It is important to notice that converting the following elements into economic possible concepts would require theoretical framework that it does not exist, so these details are beyond the focus and the scope of this paper. In the model, it is necessary an iterative process to have results final of the FVE and IBI. So, the approximation error is determined to each firm j, in a specific moment t, where Actjt is the j firm's activity level, AIjt is the j firm's fixed assets, ω6jt and ω7jt is the j firm's parameters, all in moment t and this dimension is represented by πjt in the Eq. [20].

$$\pi_{jt} = f_{11}(Act_{jt}, AI_{jt}, \omega_{jt}^{6}, \omega_{jt}^{7}) = 35{,}7 - (0{,}0275 \times Act_{jt}) - AI_{jt} \times (\omega_{jt}^{6} + \omega_{jt}^{7}) \quad (20)$$

The propensity for the investor 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. The investor must analyze the information as outsiders and before taking an economic decision.

Table 1. Hypothesis of the firm value model

Hypothesis	Variables of the hypothesis test		Variables of the model	
1	Economic activity sector	Divisions (CAE)	firm value effect of	investor behavior
2	Firm size	number of workers (TAM)	the j firm in moment	index of the j firm in
3	Moment	year	t	moment t

It is now quite straightforward to test the hypothesis of the firm value model that drawn the empirical data set and the firm value distribution. The steps are as follows:

1. Determine the best fit of the Fanger's model to the data, estimating both the scaling parameters and cutoff parameters.
2. Calculate the FVEjt as the firm value effect of the j firm in moment t and IBIjt as the investor behavior index of the j firm in moment t for the goodness-of-fit of the best fit Fanger's model to the data.
3. Generate, for all the firms of the sample, a large number of data using the procedure above, and fit them according to the section 1 and 2.
4. Calculate to each firm the three variables of the hypothesis and generate the analysis of variance (ANOVA) statistics for the data sets

The issue is whether decision usefulness in and by itself that provides sufficient and appropriate focus for the firm value that it is affected by structure and culture that change from one firm to another and this places different demands upon the accounting information system (Yin, 2008). It is particularly important firms disclose accounting-oriented information to fully report their economic and financial situation. Furthermore, market-oriented information becomes available to investors that help them in the 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 and this model will help them in a near future (Helay & Palepu, 2013; Penman , 2013).

4. Conclusion

This research demonstrates the relevance of physics to accounting based in develop of the firm value model that has two variables: the firm value effect of the j firm in moment t and the investor behaviour index of the i investor's in moment t. Also, this research would be easier to justify if exist a theory, a framework, a hypothesis and specific accounting variables that can be used to both models: Fanger's model and firm value model. Experience shows that these aspects had been important elements and limitations that could not be forgotten. But, some changes are obviously desirable and this research is important enough so it presents three debates.

Also, this research contributes to the econophysics literature by examining the robustness of the relation between physics and accounting. Indeed, the firm value is an application of the Fanger's thermal comfort model, because it is precisely and unequivocally defined as the International Organization for Standardization (ISO, 2005) standard 7730: 2005. In reality, the firm value is a mathematical function of six economic effects: operational, investment, financial, dividends, tax and market derived from corporate strategies adopted of the firm that provides a case study that it has been validated and understandable.

The future developments of the firm value model will be application for all economic sectors, all sizes of firms and for all years and it shows that social science could have progressively be future oriented research that it will reflect the society in its continuous dynamic. 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.

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