NET CASH FLOW ANALYSIS AS STOCHASTIC PROCESSES THEORY APPLICTION AND THE REAL OPTIONS THEORY: A NEW APPROACH

By

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Dissertation

Presented to the Faculty of the Graduate School of Business Administration and Leadership (EGADE) of the Instituto Tecnólogico y de Estudios Superiores de Monterrey in Partial Fulfillment of the Requirements for the Degree of

Doctor of Philosophy

in

Management

Instituto Tecnlógico y de Estudios Superiores de Monterrey

December, 2006

ABSTRACT OF DISSERTATION
GRADUATE SCHOOL OF BUSINESS AND LEADSERSHIP,
INSTITUTO TECNOLÓGICO Y DE ESTUDIOS SUPERIORES DE
MONTERREY, CAMPUS MONTERREY

Degree: Doctor of Philosophy   Program: Doctoral Program in Administration

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Title: **NET CASH FLOW ANALYSIS AS STOCHASTIC PROCESSES THEORY APPLICATION AND THE REAL OPTIONS THEORY: A NEW APPROACH.**

The main contribution of this dissertation is focused on the Capital Investments Theory that influences on Real Option Theory. My Ph.D Thesis asserts that net cash flow (NCF) and the interest rate (r_t) of a investment project are stochastic processes. A new model of mean reversion for the NCF administration named "Vasicek extended" is made, among others; the Cox-Ingersoll-Ross (CIR) model for interest rate is considered.

A fundamental contribution to this thesis is considering external control variables (Z_t) which modify the Net Cash Flow trajectory. To the system of dynamic variables is joined Vector Autoregressive VAR(1) which captures the dynamic interaction of the control variables used by the council administration. We work through from a continuous to a discrete version.

Then is explained NPV from my new point of view. The modified NPV(Zt) this gives a more accurate value for valuating VPN(Zt) $+\phi$, ϕ is the real option, therefore we see a step forward on the topic.

There is a complete analysis for the discrete case and therefore a complete methodology for applying these ideas to any enterprise in any country.

This methodology is applied to the Mexican case, particularly to large enterprises which are listed in the Mexican Stock Market and a taxonomy to get a classification of their situation derivates from it. We arrive 9 naturally possible cases and any enterprise is classified into one of them.

The general model are estimated for 69 large enterprises and it shows where every enterprise is located over its corresponding quadrant, this also results as a map allowing having a clear panorama about industrial situation in Mexico.

Through the thesis development, we enter upon the information asymmetry notion to obtain the "news cash flow curve" applied to the NCF profit as another contribution. An application on 69 large enterprises listed in the Mexican Stock Market is made.

Subject Category: Finance 0508

Key words: Capital Investments Theory, Real Options, Net Present Value, Net Cash Flow, Stochastic Processes, Vector Autoregressive (VAR), Generalized Autoregressive Conditional Heteroskedasticity (GARCH), Asymmetric Information, Mexican Stock Market, Mexico.

RESUMEN

ESCUELA DE GRADUADOS EN ADMINISTRACIÓN Y DIRECCIÓN DE EMPRESAS, INSTITUTO TECNOLÓGICO Y DE ESTUDIOS SUPERIORES DE MONTERREY, CAMPUS MONTERREY

Grado: Doctor en Filosofía Programa: Programa Doctoral en Administración

Nombre del Candidato: Martha Beatriz Mota Aragón

Presidente del Comité: Belen Villalonga M.

Título: **EL ANALISIS DE LOS FLUJOS NETOS DE EFECTIVO COMO UNA APLICACION DE LA TEORIA DE PROCESOS ESTOCASTICOS Y LA TEORIA DE OPCIONES REALES: UN NUEVO ENFOQUE.**

La principal contribución de esta tesis esta dirigida a la Teoría de Inversiones de Capital que influye la Teoría de Opciones Reales. Esta disertación afirma que el flujo de efectivo neto (FNE) y la tasa de rendimiento (r_t) de un proyecto de inversión son procesos estocásticos. Se construye un modelo nuevo llamado "Vasicek extendido" de reversión en la media para la administración de los FNE, entre otros; y se considera el modelo Cox-Ingersoll-Ross (CIR) para la tasa de rendimiento.

Una contribución fundamental en esta tesis es considerar variables de control externas (Z_t) utilizadas por el consejo de administración, las cuales modifican la trayectoria de FNE. Al modelo se une un sistema de variables dinámico Vector Autoregressive VAR (1) el cual captura la interacción dinámica de estas variables de control (Z_t). Trabajamos de un modelo continuo a un modelo discreto.

Entonces es explicado VPN desde una nueva arista. VPN modificado: NPV(Zt) da un valor más exacto al valuar VPN(Zt) $+\phi$, ϕ es la opcion real, por lo que damos un paso adelante en este tema.

Hay un análisis completo para el caso discreto y por tanto una metodología completa para aplicar estas ideas en cualquier empresa y en cualquier país.

Esta metodología es aplicada al caso Mexicano, particularmente a 69 grandes empresas listadas en la Bolsa Mexicana de Valores y una taxonomía surge de esta aplicación. Se derivan 9 posibles cuadrantes y cualquier empresa es clasificada en alguno de ellos. Esto resultó en un panorama general de la situación industrial en México.

En el desarrollo de la tesis se aborda además la noción de asimetría de la información para obtener la curva de noticias aplicada al rendimiento de los FNE, como otra contribución. Se hace también una aplicación para las 69 empresas mencionadas.

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INTRODUCTION

This thesis is inspired on a series of reflections, analysis and studies on the real options theory. The constraints and problems that the theory faces, is what motivates this research thinking about assumptions such as the underlying assets price follows a continuous process, or that the interest rate of the investment project is constant and the variance known, force us to find out a solution and the answer is found at the continuous stochastic processes theory in which application, the Vector Autoregressive (VAR) and Generalized Autoregressive Conditional Heteroskedasticity (GARCH) models are used.

The main objective of the thesis is proposing and applying on large Mexican enterprises a model which explains net cash flow (NCF) random evolution and interest rate (r_t). We will study the effects given to net present value (NPV) and real options valuation.

As obvious, we start at the traditional NPV valuation technique since the valuation method of real options is based on it, it does not discredit, and it even adds the option value. With the capital investments theory and financial options theory is that we built the real options theory. The main contribution of this thesis is focused on the capital investments theory that finally influences and affects the real option value.

First, a real option theory brief review is made and proposed model effect is established in the thesis in real options theory.

Second, the stochastic processes theory is reviewed and fundamental concepts are incorporated.

Third, the methodology proposal is done. NCF stochastic process with external control variables (Z_t) is defined trough of extended Vasicek model, as well as the Cox-Ingersoll-Ross (CIR) model for determined the interest rate and finally NPV is calculate. The continuous case is delimitated and the discrete case later.

Fourth, the information asymmetry notion is incorporated to obtain the known "news curve", now applied to the cash flow profits and using data from the sample of 69 large Mexican enterprises listed in the Stock Market, the existence of volatility is empirically confirmed.

Fifth, the proposed model is applied, primarily at a virtual enterprise and later at the sample of 69 large Mexican enterprises. First with the extended Vasicek model, and then with one which includes the extended Vasicek, Hull-White (1993) and asymmetric information of Engle, R. and Ng. V. (1993) models.

Sixth, conclusions and lines of future research are exposed.

CHAPTER 1

CAPITAL INVESTMENTS AND REAL OPTIONS

I. LITERATURE REVIEW

The methodology developed with the real options was first applied to investments in natural resources; nevertheless there are applications in other fields such as Research and Development (R&D), Corporate Strategies, Mergers and Acquisitions (M&A), Innovation and High Technology, Intellectual Property Rights, Interest Rate, Capital Risk, among others, Schwartz and Trigeorgis (2000). See table 1. Copeland and Vladimir (2001) stated that real options may be applied on almost any situation where it is possible to estimate a Net Present Value (NPV) project. Merton (1988) presents an excellent review showing the ample scope of applications that the real options theory has had.

Dixit and Pindyck (1995), Amram and Kulatilaka (1999) and Trigeorgis (1988) provide conceptual arguments to develop real options on capital investment decisions. Other conceptual works are presented by Trigeorgis and Mason (1987), Brealy and Myers (2000). As well as Merton (1977) and Mason and Merton (1985) discuss connections among financial options and investment decisions.

Real options quantitative origins derivate form the works on financial options by Black-Sholes (1973) and Merton (1973). And other way, Cox, Ross and Rubinstein's (1979) study and made possible the use binomial lattices to evaluate options in discrete time. Another important work is the one of Geske (1979) who evaluates compound options with differential equations. Kulatilaka and Trigeorgis (1994) present a model in discrete time to interchange options. Dixit (1992) presents a discrete model to valuate the expected value. Pindyck (1988) shows in a continuous expected value model using dynamic programming. Dixit and Pindyck (1994) study the cost function and implication as diffusion processes; also see Quigg (1993). Cortazar (1992) makes a simulation and other numerical approximations to valuate an European real option. Among others, as we can see, there is an important number of works in real options literature which are focused in quantitative valuation, the ones mentioned are important for this research.

In the following table we might observe according to their area, some of the works developed using real options theory.

TABLE 1
Real options: Topics and some Application Areas

Area	References
Natural Resources	Brennan and Schwartz (1985), Siegel, Smith and Paddock (1987), Paddock, Siegel, and Smith (1998), Trigeorgis (1990), Schwartz (1997, 1998), Tufano (1998), Cortazar, Schwartz and Casassus (2000).
Corporate Strategies and Competition	Trigeorgis (1991, 1996), Kulatilaka and Perotti (1992), Smith and Trigeorgis (1995), Grenadier and Weiss (1997), Farzin, Huisman, and Kort (1998).
M & A and Corporate Governance, and Hysteresis effects and Firm Behavior	Smith and Triantis (1994, 1995), Hiraki (1995), Vila and Schary (1995). Pindyck (1991), Dixit and Pindyck (1994).
Industrial Organization	Imai (2000), Huisman and Kort (2000).

Development, Flexibility and Preservation	Purvis, Boggess, Moss, and Holt (1995), Wiebe, Tegene, and Kuhn (1997).
Innovation and high technology	Schwartz and Moon (2000), Bloom and Van Reenen (2001), Boer (2000), McGrath and MacMillan (2000).
Research and Development (R & D)	Newton and Pearson (1994), Childs, Otto, and Triantis (1995), Faulkner (1996), Herath yand Parkm (1999), Carter and Edwards (2001).
Manufacturing	Kulatilaka (1984, 1988, 1993), Baldwin and Clark (1994, 1996), Kamrad and Ernst (1995), Mauer and Otto (1995).
Real Estate	Stulz amd Johnson (1985), Titman (1985), Grenadier (1995, 1996), Chids, Riddiough, and Triantis (1996), Downing and Wallace (2000).
International	Dixit (1989), Kogut and Kulatilaka (1994), Bell (1995), Buckley and Tse (1996), Schich (1997).
Financial:	
Interest Rates	Ingersoll and Ross (1992), Ross (1995), Lee (1997).
Capital Risk	Sahlman (1993), Willner (1995), Gompers (1995), Zhang (1999).
Public Offers	Epstein, Mayor, Schonbucher, Whalley, and Wilmott (1998).

The review of the literature shown in the table above to show the fact that real options may be used in several fields related to investment project evaluation.

II. FUNDAMENTAL CONCEPTS

The financial option valuation theory was written in the 1970's by Black-Sholes and Merton (1973), they got a close solution for the equilibrium price of a *call* option; since then, hundreds of articles and empirical studies have been written in this direction and have been linked to the real options theory. Myers (1977) stated that corporative assets may be seen as growth options (as a *call* option) and through this he applies financial options concepts to real assets. Brabazon (1999) states that the real options concept comes from financial options research, among others.

A real option purchase is the right, but not the obligation of investing, postponing, expanding, contracting or quitting an investment project in the future. This decision has a predetermined cost called exercise price which will be paid in a determined date and which exists during the whole option life long (Copeland and Antikarov, 2001). While exercising, the option utility is the difference between the underlying assets value and the exercise price.

Considering that in general terms real options theory is an extension of the financial options theory applied to the non-financial real assets valuation, so to the capital investment (Amram and Kulatilaka, 1999), therefore we find some adaptations on the parameters to consider the valuation.

As it may be seen, the parameters that compose a financial option are:

The underlying asset price Sf, the exercise price K, the underlying volatility σ, the risk-free rate r and the option $T\text{-}t$ expiration date.

TABLE 2
Real and Financial Options Parameter Valuation

Parameters	Real option	Financial option
Sf	Cash flow present value expected in *t*	Underlying asset price
K	Project investment cost (present value) in *t*	Exercise price or accorded price
R	Risk-free rate	Risk-free rate
σ	Project cash flow volatility	Underlying volatility
T − *t*	Project maturity time	Maturity total time

Source: Adapted of Venegas, F. (2006). *Riesgos Financieros y Económicos.* Thomson, México. Chapter 69, p. 801.

At the real options language: *Sf* is the cash flow present value expected in t; *K* is the cost at present value of the project investment in t; σ is the project cash flow volatility; *r* is the risk-free rate and *T-t* is the project maturity time.

Some methodology advantages are: first, it considers uncertainty, which to get any type of growth opportunity, diversification or risk (Smith and Triantis, 1998). Thus an important methodology value is given by the possibility of according administratives abilities that from the traditional method valuation perspective of NPV is impossible to evaluate. Second, real options integrates technological and strategic factors inside a general valuation model (McGrath and McMillan, 2000), it to make possible to manage administratives abilities. Third, from the methodological viewpoint a decision process based on real options offers a systematic approximation to invest and evaluate in a high uncertainty and competence environment, creating subsequent investment opportunities, evaluated as cash flows plus a group of options (Amram and Kulatilaka 1999).

III. REAL OPTIONS VERSUS FINANCIAL OPTIONS

Assuming that the Real Option (RO) take their base from the Financial Option (FO) theory, it is important to mention differences between them because they change the RO models mathematical structure.

The FO have been used for periods, while the RO have a recent development. The RO have a long term life, T-t = years, and the FO have a short term life, usually T-t = months. The underlying asset in FO is the asset price; while in RO there is an infinite variables quantity, in our case they are the net cash flows. Since the analysis of RO considers physical assets (real), we might be careful at the underlying variables selection, because the mentioned volatility refers to the underlying asset.

The OF are regulated, although in theory, stockholders manipulate asset price for their sake. The RO are created by the enterprise and their decisions may increase the project value. The FO have relatively got a lower value (hundreds or thousands dollars per option), while the RO worth thousands, millions or billions dollars per project (strategic option) Mun (2002).

Both option types may fuse by using similar approximations; close solutions, finite differences; Brennan (1979), partial differential equations; Geske (1979), binomial and multinomial lattices; Cox, Ross and Rubinstein (1979), Trigeorgis (1991), Hull and White (1988) and Boyle (1976), who include the Monte Carlo simulation.

Finally, The FO models are based in a formal market, which make assets prices to be transparent; thus model construction is more objective. The RO are not negotiated at a formal market and financial information is just available for the administration, therefore model designing becomes subjective. Hence, the enterprise assumes the key is to valuate RO not FO. Having a particular project issued, the enterprise may create strategies that might provide by themselves future options, whose value could vary depending on how they are constructed (Mun, 2002).

As a summary, fundamental characteristics and differences of RO and FO are presented in table 3.

TABLE 3
Differences between Real Options and Financial Options

RO	FO
Recent development at corporative finance (last decade).	They have existed for more than three decades.
Longer maturity (years).	Short maturity (months).
Millions and billions dollars investment decisions.	Hundreds and thousands dollars investment decisions.
Underlying asset price is the expected project cash flows.	Underlying asset price is the stock price.
Market effects (news) are relevant on cash flow value.	Market effects (news) are irrelevant on stock price.
They are solved by using equations and binomial lattices.	They are solved by using partial differential equations and simulation
Option value might rise due to administrative decisions and new decision making flexibility at any moment.	Option value has a fix worth, it can't be manipulated by options price.
They might be identified by administrators.	They are listed in a formal market.

Source: Adapted from Mun, J. (2002): *Real options, Analysis.* J. Wiley, USA. Chapter 5, p. 100.

IV. CAPITAL INVESTMENTS

Real options theory gotten impact over capital investment decisions has demonstrated to be largely useful for the corporative, it is interesting to observe how this theory answers some questions such as: Investing on advertising or not? Investing on research and development? Expanding annual production or not? Postponing an investment project? All facts imply worthy awaiting, postponing, suspension periods, and moreover valuable opportunity cost. What is it possible to manage by this thesis focusing while considering the stochastic processes theory, in which application the VAR and GARCH models are used in the valuation of investment projects.

This research was written on the intention to contribute the capital investments theory and therefore the real options theory. Literature about capital investments may be divided in two groups; the one formed by independent investment opportunities, situations where investments considered are substantial and another which includes some models studying sequential irreversible investments, Pindyck (1988). Dixit and Pindyck (1994), Dixit (1995), Bertola (1998), Ingersoll and Ross (1992) were the first ones who considered the stochastic interest rate impact over investment opportunities. Alvarez and Koskela (2006) extended Ingersoll and Ross (1992) analysis for different interest rates and uncertain income joints.

But, how does this work impact the real options theory? This research to assume that in order to understand nowadays enterprise problems we must exclude the ultra-traditional NPV, and it shows the requirement to include stochastic processes in NCF valuation and interest rate.

The main condemnation to the traditional NPV method is that it produces a simple estimation, and this is a disadvantage, because the events that affect cash flow forecasts are highly uncertain; Myers (1987), Trigeorgis (1993), (Copeland and Vladimir, 2001). Other remarks are in Hayes and Garvin (1982) and Hayes and Abernathy (1980), who recognize that the NPV criteria sub estimates investment opportunities.

Brennan and Schwartz (1985) support that the NCF presents deep limitations due to prices volatility. Paddock, Siegel and Smith (1988) list NPV technique disadvantages.

On the other hand, Dixit and Pindick (1994) assure that:

"The simple NPV rule is not just wrong; it is often very wrong", (see chap. 5:136).

One of the fundamental drawbacks observed at the traditional NPV technique is that NCF estimation depends on a constant benefit rate and static expected flows. On several works, the method selected to solve the expected project cash flow estimation problem consists of inferring that the project generates perpetual rents in constant terms identical to the ones generated on the last exercise, and the interest rate with which they discount expected cash flows follows the CAMP rules. Copeland and Antikarov (2001), Díaz (1999,2000), Kester (1984), Gil (1991), and Smith (2001), among others.

Motivated by the argument previously exposed, we confirm that NCF and interest rate are not constants, but stochastic processes. Briefly: NPV itself is a stochastic process. A criterion distant to the one we find at ultra-traditional environment. His expression is:

$$NPV = \mathrm{E}\left[\int_0^T NCF(t)e^{-r(t)t}dt\right]$$

For checking the impact that this has over a real option value and therefore over real options theory it would be enough to apply the *modified NPV* in a capital investment opportunity, for instance, in an investment at which corporative attention is addressed to determine the moment in which the investment might be optimally exercised. For solving this we return to the concept that a real option is:

$$\overline{NPV} = NPV + \phi$$

The discrete version of the model to explain the Net Cash Flow and its internal dynamics and interest rate evolve that is proposed in the thesis is formed by A, B and C:

A) $NCF_{t+1} = \beta_0 + \beta_1 NCF_t + \alpha_1 Z_{1t} + \alpha_2 Z_{2t} + \alpha_3 Z_{3t} + \ldots + \alpha_k Z_{kt} + \varepsilon_t$,

B)

$Z_{1t+1} = (1+a_{11})Z_{1t} + a_{12}Z_{2t} + a_{13} Z_{3t} + \ldots + a_{1k}Z_{kt} + \sigma_1 V_{1t}$

$Z_{2t+1} = a_{21}Z_{1t} + (1+a_{22})Z_{2t} + a_{23} Z_{3t} + \ldots + a_{2k}Z_{kt} + \sigma_2 V_{2t}$

$Z_{3t+1} = a_{31}Z_{1t} + a_{32} Z_{2t} + (1+a_{33})Z_{3t} + \ldots + a_{3k}Z_{kt} + \sigma_3 V_{3t}$

……………………………………………………………

$Z_{kt+1} = a_{k1}Z_{1t} + a_{k2} Z_{2t} + a_{k3} Z_{3t} + \ldots + (1+a_{kk})Z_{kt} + \sigma_k V_{kt}$

C) Discrete CIR $r_t - r_{t-1} = (a - br_t) + \sigma\sqrt{r_t}\, V_t$

Summarizing, the *modified* real option is:

$$RO = \overline{NPV} = \mathrm{E}\left[\int_0^T NCF(t) e^{-r(t)t} dt\right] + \phi > 0$$

And we determine the value of ϕ with any of the methods used for valuating real options, for example through binomial lattices. The rationale behind is that with the model proposed in the thesis we go into a more accurate value rather than just doing a real option valuation. Now since NPV is stochastic and is possible to manage its behavior through a wise use of the control variables, now the firm has to set the level of Z_t in NVP=NPV(Z_t), which says the ability to generate wealth in the firm depends on the decisions of the board setting the level of control (Z_t).

CHAPTER 2

STOCHASTIC PROCESSES

The following work deals with stochastic processes, therefore with random variables that change through time, our research consists in to find a model that explains the behavior of NCF, the return (r_t) is taken from the literature (say CIR) which in turn provide us with a better understanding of NPV as an evolving random process.

The thesis model will be specifically applied on the expected net cash flow of a large enterprise; repercussion on the net present value and its impact on project valuation through the real options theory will be studied.

A model consists of a system of stochastic differential equations in order to explain the reasons why the uncertain behavior appears. To validate the model, it is necessary to take its discrete version, gather the data estimate it and see the results, a good model must be able to explain this uncertain behavior. Properties of a model might be studied by a computer simulation using Monte Carlo methods.

Even though Monte Carlo method contains a variety of topics, for this research only one procedure to generate simulations of a stochastic process will be used.

The main idea of this work is that the NPV of a project and its components, net cash flow and the interest rate of a large enterprise are modelled as diffusion processes, being at the same time continuous stochastic processes. Some ideas are in the McDonald and Siegel basic model (1986), later in Paddock, Siegel ad Smith

(1988), Dixit and Pindyck (1994), Merton (1970), Vasicek (1977), CIR (1985), Ho and Lee (1986), Longstaff (1979), Hull and White (1990), and in Mexico, Venegas (2006).

The most important contribution of this thesis is the proposal of a theoric model to work with on the analysis of cash flow and ways to manage it administration for large enterprises. We will to apply this model on the most important Mexican large enterprises.

I. WIENER PROCESSES

In discrete time, we talk about white noise as a family of random variables, with zero mean, constant variance and not correlated. In continuous time its counterpart is a Wiener process (called Standard Brownian Process as well), it consists of a time path of random variables W(t) which evolves and its change is framed by the idea of stationary and independent increments.

The most interesting study is under very short time intervals. We denote infinitesimal time intervals as Δt and look at the increments $\Delta W(t)$:

$$\Delta W(t)= W(t +\Delta t)- W(t) \text{ where the time interval } \Delta t \text{ is small}$$

The Wiener process is the essential workhorse for studying stochastic processes, many concepts are generated from this notion, therefore we must formalize the following idea: a Wiener process $\{ W(t) \}_{t\geq 0}$ defined in a probability space (Ω,F, P) is a continuous curve, that begins at the origin in which for each time $t\geq 0$ presents independent and stationary increments.

Definition: A Wiener process (called Standard Brownian Process as well) in the interval [0,T] is a stochastic process $\{W(t), 0 \leq t \leq T\}$ with the following properties:

1. $W(0)= 0$

2. Correspondence $t \dashrightarrow W(t)$ is with probability one, a continuous curve in [0,T].

3. For the whole k and for any finite collection $0 \leq t_0 \leq t_1 \leq t_2 \leq t_3 \leq \ldots \leq t_k \leq T$, the random variables that correspond to the Brownian motion process increments are independent.

$\{W(t_1)-W(t_0), W(t_2)- W(t_1), W(t_3)-W(t_2), \ldots, W(t_k)- W(t_{k-1})\}$

4. $W(t)-W(s)$ is distributed under the normal $N(0,t-s)$ $0\leq s<t\leq T$.

Some consequences from the definition are that:

1.- $W(t) \sim N(0,t)$ for $0 \leq t \leq T$.

2.- $\Delta W(t) = \sqrt{\Delta t}\, Z$ where $Z \sim NID(0,1)$

3.- $\Delta W(t)$ is independent from $\Delta W(t+\Delta t)$

4.- $\Delta W(t)$ is independent from $W(s)=W(s)-W(0)$ for $s < t$

See Glasserman, P. (2004) and Karatzas and Shreve (1991).

An important fact is that the trajectory is not differentiable either, except in a set of probability zero, it means that they are not soft curves, but infinitely wrecked.

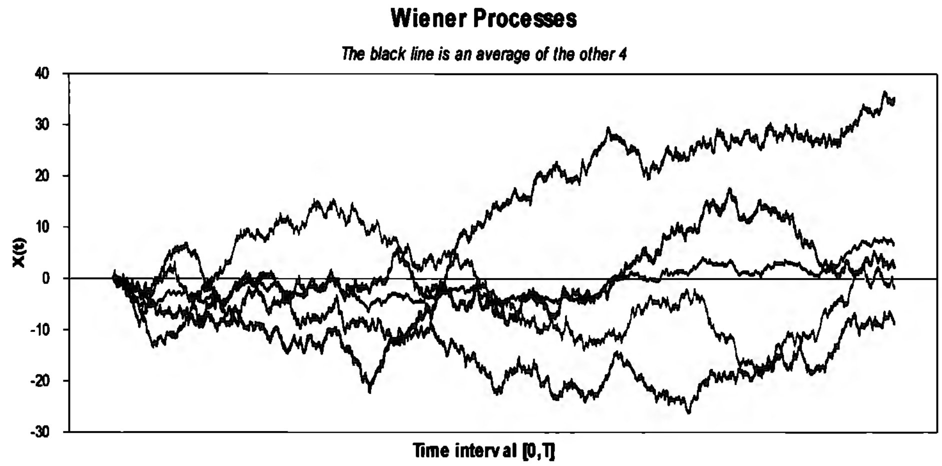
A component of the chapter has been including the analysis of simulation methods to obtain realizations of the process, using methods presented in the book of Glasserman, P. (2004). Four realizations will be generated, and its average is taken $E[X_t]$, with this, there are 5 graphs per each process. The inconvenience of setting 6 or more graphs is that it becomes incomprehensible to distinguish among the trajectories. This geometric analysis is useful to select the process which best represents NCF.

For short time intervals, the Wiener process is such that, if s< t then W(t) - W(s) is distributed under the normal N(0,t-s) in addition to the fact that these increments are independent thus we should not have concern for a correlation structure among the increments.

The Wiener process simulation may be done, see Glasserman (2004). Taking $\sigma = 13.96$ we get:

$$dX(t) = \sigma dW(t)$$
$$X(0) = 0$$
$$X(t_{i+1}) = X(t_i) + \sigma\sqrt{t_{i+1} - t_i} Z_{i+1}$$

CHART 1



In this process, due to the fact that the oscillations are so abrupt, which is not according to NCF development, this model in not able to model NCF.

So that a general case might be considered, instead of thinking of the relation $dX(t) = \sigma dW(t)$, we want to analyze a processes including a mean component:

$$dX(t) = \mu(X_t,t)dt+\sigma(X_t,t)dW(t)$$

These are called *diffusion processes.* In order to build the simulation, the discretized version in the interval [0,T] is required. To do it, we begin in m length subintervals $\Delta t = T/m$ and at each subinterval $[t, t+\Delta t]$ we take an evaluation.

Beginning from:

$$dX(t) = \mu(X_t,t)dt+\sigma(X_t,t)dW(t)$$

After some calculations one arrives at the relation:

$$X(t) = X(t+\Delta t) + \mu(X_t,t)\ \Delta t+\sigma(X_t,t)\ \sqrt{\Delta t}\ Z,$$

where Z~ NID(0,1)

This procedure is known in the literature as the Euler Method.

A point $X(0)=X_0$ is taken, for the moment T=0 , so to be able to start the iterations, moving time through the interval [0,T].

II. GENERALIZED WIENER PROCESS

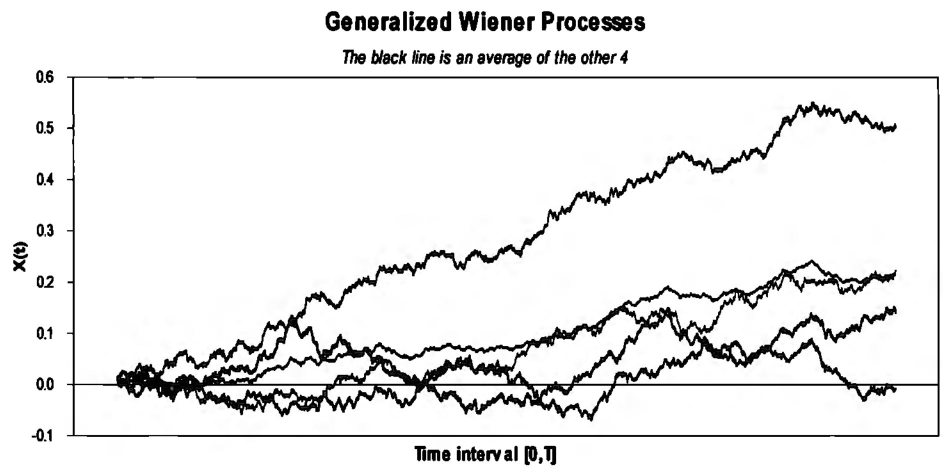
This process has a drift parameter denoted by μ and its dispersion changes into a σ factor, while its behavior equation is:

$$dX(t) = \mu dt+\sigma dW(t) \quad \text{where } W(t) \text{ is a Wiener Process}$$

Values μ =0.15 y σ = 0.96 are taken. The following recursions are used:

$$X(t_{i+1})=X(t_i)+\mu(t_{i+1}-t_i)+\sigma\sqrt{t_{i+1}-t_i}Z_{i+1}$$

CHART 2



In this process since elevations presented might be quite long, this model is not capable to show the usual ups and downs seen in NCF.

III. WIENER GEOMETRIC PROCESS

This is a very important process because the benefit from assets is a vital variable, in this case we get that the percentage changes (the benefits R(t)) are:

$$R(t)= X(t_{k+1})-X(t_k) / X(t_k) , \qquad t_k < t_{k+1}$$

They are independent and at small time intervals, they move under the normal distribution.

The movement equation is given by:

$$dX(t) = \mu X(t) dt+\sigma X(t) dW(t)$$

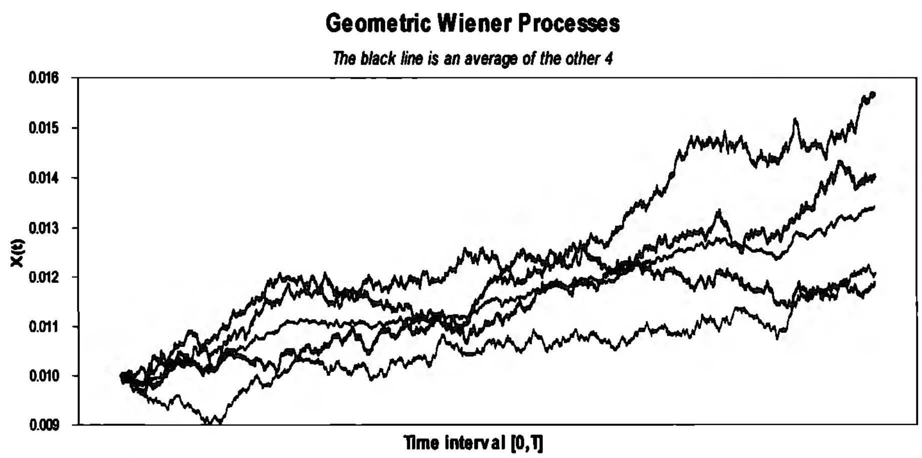
Which is equivalent to:

$$dX(t)/ X(t) = \mu\, dt + \sigma\, dW(t)$$

To make simulations we started at x (0) = 0.01 the values $\mu = 0.15$ and $\sigma = 1.96$ are taken and we use the following recursion:

$$X(t_{i+1}) = X(t_i) + \mu X(t_i)(t_{i+1} - t_i) + \sigma X(t_i)\sqrt{t_{i+1} - t_i}\, Z_{i+1}$$

CHART 3



Since NCF is not a profit, this model in not able to model NCF.

Of all diffusion processes, there is a very useful group for applications, therefore we will mention some of them. As it is possible to build processes by selecting a formula for: $\mu(X_t,t)$ and $\sigma(X_t,t)$ at the diffusion equation:

$$dX(t) = \mu(X_t,t)dt+\sigma(X_t,t)dW(t)$$

IV. ORNSTEIN-UHLENBECK PROCESS

This process is very important in financial theory because it has interesting properties, the one we are interested in is the mean reversion (it means that it tends to oscillate around E[X(t)]), it's defined as the process X(t) whose trajectory is guided by $dX(t) = -\lambda X(t)dt+\sigma dW(t)$ where $\lambda > 0$ (it is also may defined as $d X(t) = (m-\lambda X_t)dt+\sigma dW(t)$).

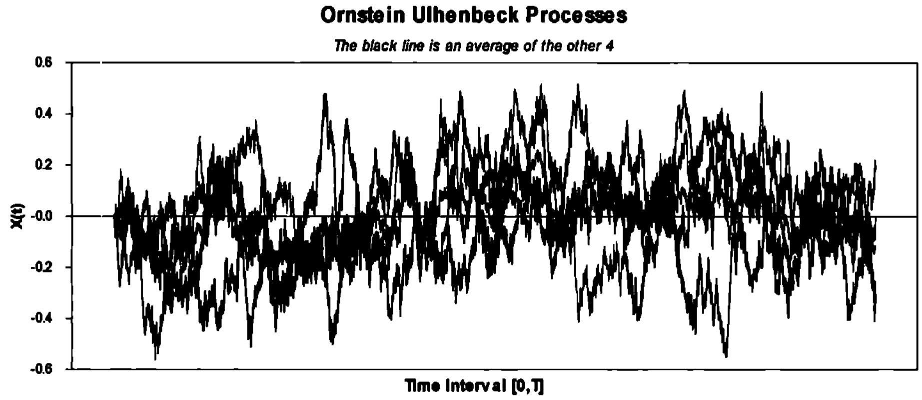
This model is used to represent assets that fluctuate around zero, because if X(t) takes negative values, the factor $-\lambda$ intervenes making $dX(t) > 0$ thus X(t) begins growing. At a similar way if X(t) takes positive values, the factor $-\lambda$ intervenes making $dX(t) < 0$ thus X(t) begins decreasing; this is the central idea of the mean reversion. Consult Neftci (2000) p. 271 and Gourieroux and Jasiak (2001) p. 249 and 289.

The process Ornstein-Uhlenbeck has the discrete version:

$$X(t_{i+1}) =X(t_i) -\lambda X(t_i)*(t_{i+1}-t_i) +\sigma*\sqrt{(t_{i+1}-t_i)} *Z_{i+1}$$

$\lambda = 10.84$ and $\sigma = 0.96$ are taken.

CHART 4



Since oscillations do present mean reversion, this model is able to model NCF regarding that showed oscillations are a characteristic in itself, even though their convergence line is toward zero which is not expected for NCF.

V. HEATH, JARROW AND MORTON MODEL (1992)

In the context of Vasicek (1977) or CIR (1985) short-term interest rate is determined, and from this, it is possible to build the structure of the benefits curve. At the system developed by Heath, Jarrow and Morton (1992), the complete benefits curve is produced.

This model known as the No Arbitrage model belongs to another alternative used to model short-term interest rates, and it is largely used to valuate interest rates derivates.

In this model, the short rate dynamics is also continuous, but some parameters of the model are allowed to be a function of time; nevertheless this is a limitation on the interest rates behavior future prediction, that not always correspond to reality.

This model applies the forward rate over the structure of interest rates in order to determine the accurate prices of assets that are sensitive to interest rates fluctuations.

The benefit curve indicates the relation between the spot rate of the zero coupon bonds (asset) and its maturity (expiration). Therefore the resulting curve follows a behavior that can be determined, and may be used to discount cash flows.

In HJM the forward rate, expressed by $\{f(t,u), 0 \leq t \leq u \leq T^*\}$ where T^* is the maturity moment (they might be 20, 30 years from the beginning), the way to read f(t,u) is to think about a family of curves. For each time t there is a curve (a variable) f(t,u) with a maturity at the moment T. The value f(t,T) is the instant free-risk rate, gotten at the moment T.

The short-term rate is: $r(t)= f(t,t)$

It means that the benefits rate curve evolution is:

To the time $t=0$ the curve forward is given by $f(0,\cdot)$,

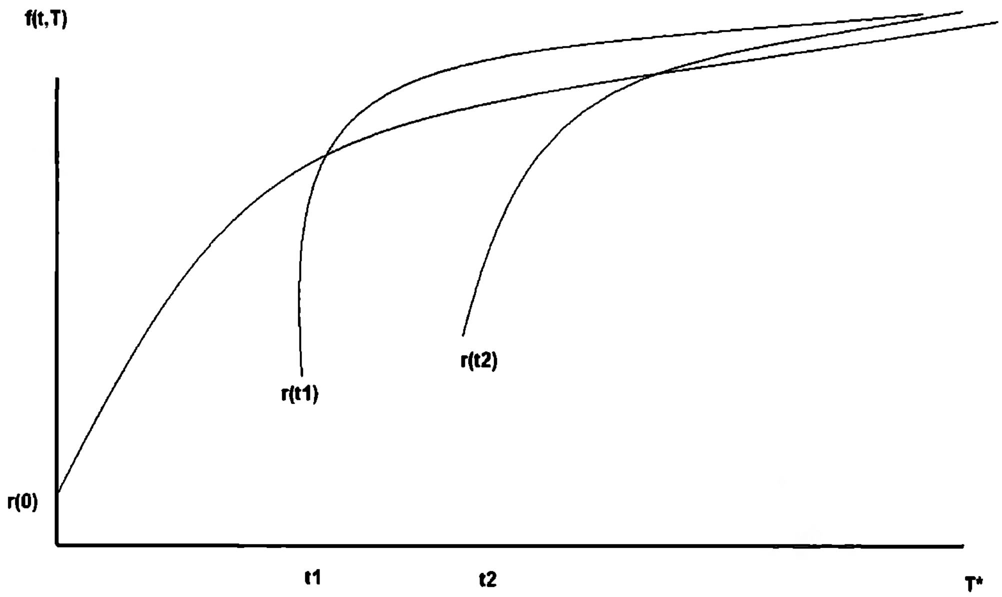
The short rate is $r(0) = f(0,0)$

To the time $0< t=T$, the curve forward is now $f(t,\cdot)$ and

The associate short rate is $r(t) = f(t,t)$

CHART 5

HJM Forward Curve Evolution



The diffusion model of HJM is on the procedure below:

$$Df(t,T)=\mu(t,T)dt+\sigma_1(t,T)dW_1(t)+\ \sigma_2(t,T)dW_2(t)+\ \sigma_3(t,T)dW_3(t)$$

It models the forward rate evolution under a neutral to risk measure, since under this measure W is a Standard Brownian Process.

Up to this moment, the development is quite general for the present research so that we will focus on a unique factor and $\sigma_1(t,T) = \sigma$, the elucidation is now that every increase dW_t is able to move all points at the forward curve $\{f(t,u), 0 \le t \le u \le T^*\}$, in Glasserman, (2004) p.153 they expose the demonstration that in this case necessarily $\mu(t,T)= \sigma^2(T-t)$, it is substituted in the model HJM and we get:

$$f(t,T) = f(0,T) + \frac{1}{2}\sigma^2\left[T^2 - (T-t)^2\right] + \sigma\, dW_t$$

The identity r(t)=f(t,t) is incorporated and we get :

$$dr(t) = \left(\frac{\partial}{\partial T} f(0,T)\bigg|_{T=t} + \sigma^2 t \right) dt + \sigma dW_t$$

In this case, the model HJM agree with Ho-Lee model (1986) with a calibrated motion.

VI. PARTICULAR PROCESSES

We show from the general relation:

$$dX(t) = \mu(X_t,t)dt + \sigma(X_t,t)\, dW(t),$$

That if we take:

$\mu(X_t,t) = a(b - X^{\alpha}{}_t)$

$\sigma(X_t,t) = \sigma X^{\beta}{}_t$

We turn up to the Differential Stochastic Equation:

$$dX(t) = a(b - X^{\alpha}{}_t)dt + \sigma X^{\beta}{}_t\, dW(t)$$

This way we get a group of different processes according to the alfa and beta values, so that the theory and empirical research has shown the development of various models which are remarkable because of their properties.

In the next table we show a summary of the models mentioned, that can derivate from the stochastic differential equation above.

TABLE 4
Particular Processes

Model	Parameters	b, a_t	Process
Merton (1970)	$\alpha = 0 \quad \beta = 0$	$\mu + 1, 1$	$dX_t = \mu dt + \sigma dW_t$ μ, σ are constant
Vasicek (1977)	$\alpha = 1 \quad \beta = 0$	b, a	$dX_t = a(b - r_t)dt + \sigma dW_t$ a, b, σ are constant
CIR (1985)	$\alpha = 1 \ \beta = ½$	b, a	$dX_t = a(b - X_t)dt + \sigma\sqrt{X_t}$ dW_t a, b, σ are constant
Ho y Lee (1986)	$\alpha = 0 \ \beta = 0$	2, h_t	$dX_t = h_t dt + \sigma dW_t$ σ is constant
Longstaff (1979)	$\alpha = ½ \ \beta = ½$	b, a	$dX_t = a(b - \sqrt{X_t})dt + \sigma\sqrt{X_t}$ dW_t a, b, σ are constant
Hull and White (1990)	$\alpha = 1 \ \beta = 0$	b_t, a	$dX_t = a\,(b_t - X_t)\,dt + \sigma dW_t$ b_t, σ are a time function

Source: Venegas, F. (2006). *Riesgos Financieros y Económicos.* Thomson, México. Chapter 53, p. 572.

Note: The book of Hull, J. (1993). Options, futures and other derivative securities 2nd, Prentice Hall p. 404, refers to Hull and White model as: $dX(t) = (b(t) - a\,X(t))dt + \sigma dW(t)$, which we take back in this research.

A relevant case for this work, is generated by taking:

$\alpha = 1$ $\beta = 0$ $\mu(X_t,t) = a(b - X_t)$ y $\sigma(X_t,t) = \sigma$

We get the Vasicek process (1977). This equilibrium model presents mean reversion to a constant value. Later we also take the CIR (1985) and Hull-White (1993) models.

VII. THE VASICEK MODEL (1977)

At the financial theory literature, we can find an important development area, that includes several studies over interest rate structure models (they valuate fixed rent instruments). On this line of research, several models at a continuous time have been proposed for the short rate study, among them, we can point the equilibrium model and the No arbitrage model. The first ones in their modality of a factor, have been largely used on the empiric literature; see Vasicek (1977) and CIR (1985). For the two factors procedure; see Longtaff and Schwartz (1992).

On the other hand, on the second group of models, the classical examples are Heath, Jarrow and Morton (1992) and Ho-Lee (1986).

In this work we suppose that NCF follows a stochastic process through the Vasicek model (1977), which is well known as mean reversion process and we are going to propose its extension.

This model has the following procedure:

$$dX(t) = a(b - X_t)dt + \sigma\, dW(t)$$

Where $a > 0$, $b > 0$, $\sigma > 0$ are positive constants.

This process has mean reversion, because it belongs to the Ornstein-Uhlenbeck family, specifically:

$dX(t)$ is positive if $b > X(t)$ thus $dX(t) = a(b - X(t))dt$ is positive, therefore $X(t)$ increases.

$dX(t)$ is negative if $b < X(t)$ thus $dX(t) = a(b - X(t))dt$ is negative, so $X(t)$decreases.

The convergence speed is on the parameter a, while the level where equilibrium is taken is represented by b.

At Vasicek, the long-term level, b, is where the process is moving to (the long term interest rate is called b) and the force with which the process r_t is led is the parameter a.

At this model it is possible that $X(t)$ takes negative values.

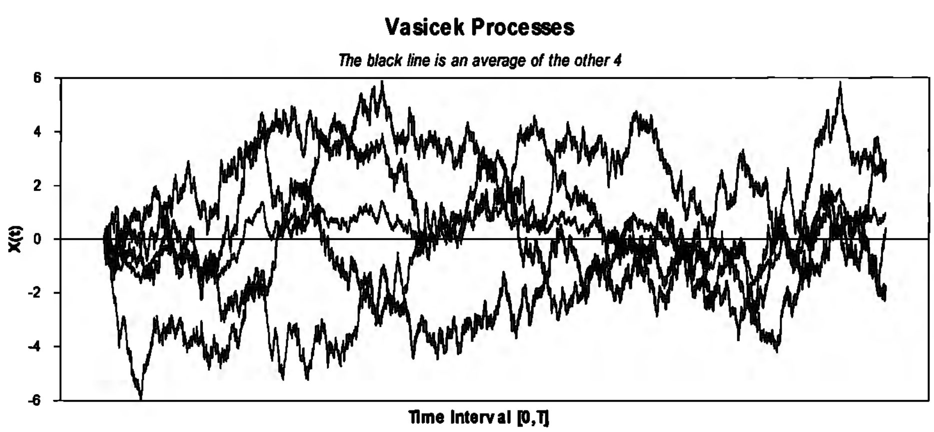
Its discretized version is:

$$X(t_{i+1})=X(t_i)+ a(b - X(t_i))*(t_{i+1}-t_i) +\sigma*\sqrt{(t_{i+1}-t_i)} *Z_{i+1}$$

a, b, σ are positive constants.

Values are taken for the simulations are: a = 3.0, b = 0.5, σ = 5.4.

CHART 6



This model is able to affect NCF due to oscillations showed, because it is a characteristic at NCF, on the other hand, it is ability for taking negative values is a huge attractive because through this NCF may be modeled; an other important characteristic in long term convergence towards b parameter.

VIII. THE COX-INGERSOLL AND ROSS MODEL (1985)

Another remarkable case for this work is the CIR process which is generated from the table 4, taking:

$\alpha = 1$ $\beta = ½$ $\mu(X(t),t) = a(b - X(t))$ y $\sigma(X(t),t) = \sigma \sqrt{X(t)}$

This is one of the first interest rate equilibrium models at a continuous time of a factor that describes the rates temporary structures. Assuming that these follow a stochastic process where their parameters are a function of itself but they are independent in time, Fernandez (1999).

This research supports the CIR hypothesis, it means that the investment project interest rate behavior is not constant (as the traditional NPV analysis assumes) which is acceptable at the stock market, specifically on fixed rent instruments in the short term at a stable economy; nevertheless, the interest rate medium and log term has an evolving behavior modeled by CIR.

This model captures the short-term interest rate dynamics with mean reversion, and it is based in the following diffusion equation:

$$dX(t) = a(b - X(t))dt + \sigma\sqrt{X(t)}dW(t)$$

Where a, b, σ are constant parameters.

"a" is the force with which r_t trajectory is led towards the equilibrium level "b".

The CIR process has the property that if $r(0) > 0$ therefore $r(t) \geq 0$ all t and also $2ab \geq \sigma^2$ therefore $r(t) > 0$ all t with a probability one. See Glasserman (2004) p. 120.

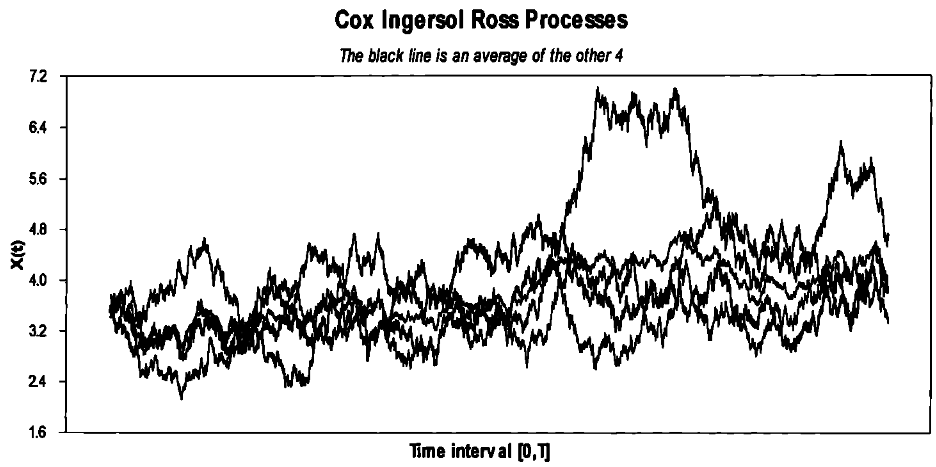
The most important characteristic on this model is that terms structure always generates positive interest rates, differently than the model proposed by Vasicek (1977) that can generate negative interest rates with a positive probability for some parameter values; this is the main reason that motivates us to select the CIR model and not the Vasicek model one for the NPV internal interest rate estimation of the project in this research.

We consider $a = 2.5 \quad b = 3.5 \quad \sigma = 0.96$

By using the discretization, we get:

$$X(t_{i+1}) = X(t_i) + a(b - X(t_i))(t_{i+1} - t_i)d + \sigma\sqrt{X(t_i)}\sqrt{t_{i+1} - t_i}\,Z_{i+1}$$

CHART 7



Therefore this process will be used for the interest rate at the NPV formula.

IX. HULL-WHITE MODEL (1993)

The Hull-White process we will use is taken from Hull, J. (1993), consult the 2nd ed. p.404. It is known that this model can be interpreted as the Vasicek model with a mean reversion time dependent on the rate a.

$$dX(t) = (Q(t)-aX(t))dt + \sigma dW(t)$$

a, σ are constant.

For this research we will be interested in taking Q(t) as a polynomial in t of q grade, so that:

$$Q(t)= b_0+b_1t+b_2t^2+b_3t^3+b_4t^4+\ldots+b_qt^q \qquad b_q\neq 0$$

The most frequent case in applications is when q= 1, therefore we are interested in the process:

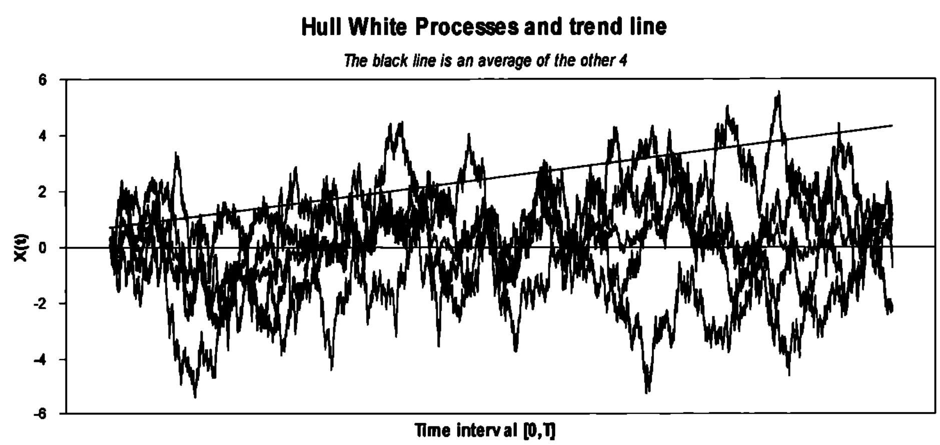
$$dX(t) = (b_0+b_1t - aX(t))\, dt +\sigma\, dW(t)$$

The discrete version for simulations is:

$$X(t_{i+1})= X(t_i)+ (b_0+b_1t_i - aX(t_i))(t_{i+1}-t_i) +\sigma*\sqrt{(t_{i+1}-t_i)} *Z_{i+1}$$

$a = 1.0$ $\sigma= 2.06$ $b_0= 0.1026$ $b_1 = 0.0003078$

CHART 8



As it can be seen, this model proposes a tendency line which reflects an increasing systematic behaviour in NCF, therefore, the ability for capturing this tendency line is essential.

From all the information above, the processes we will use are: The Vasicek, CIR and Hull-White models, because these are the ones that best match the analysis we will make.

CHAPTER 3

THE PROCESS FOR NET CASH FLOW

1st part: Continuous Case

I. DIFFUSION PROCESSES WITH CONTROL VARIABLES

One of the most important contributions of this research is the novelty of processes with control variables (Z_t) as shown below:

$$dX(t) = \mu(Z_t,X_t,t)dt+\sigma(Z_t,X_t,t)dW(t)$$

Where (Z_t) is a vector of external variables, it's required the new component Z_t behavior not to intervene on the process dynamics, therefore the control condition is defined as: (Z_t,X_s) which are independent variables in every pair s,t.

It is important to point out that this presumption does not affect the Ito`s Lemma in which now the following process has been gotten:

$dX(t) = \mu(Z_t,X_t,t)dt+\sigma(Z_t,X_t,t)dW(t)$ and a function $F(Z_t,X_t,t)$ thanks to control variables independence define $G(X_t,t)=F(Z_t,X_t,t)$ and apply the Ito`s Lemma in the same way, the consequence is important due to the fact that it allows to take advantage the whole already made theory.

In the Ito`s Lemma, we are not using the derivation according to Z_t the labor of this component is to affect the mean variance term position, so it suggests the analysis and observation of processes which are led at a long-term level established by the exogenous condition Z_t.

In the model:

$$dX(t) = \mu(X_t, t)dt+\sigma(X_t, t)dW(t)$$

X_t life goes oscillating around given parameters without the possibility to intervene on its evolution, while at the proposed model:

$$dX(t) = \mu(Z_t,X_t,t)dt+\sigma(Z_t,X_t,t)dW(t)$$

The oscillations level, procedure and convergence are modified while involving a variation in any component $Z_t =(Z_1, Z_2,\ldots, Z_k)$.

II. THE MODEL PROPOSED ON THIS THESIS

The Vasicek model $dX(t) = a(b - X_t)d_t + \sigma\, dW(t)$ where parameters must agree with $a> 0$, $b> 0$, $\sigma> 0$, we are taking $b=F(Z_t)$ and it's clear that the modified model:

$$dX(t) = a(F(Z_t) - X_t)d_t + \sigma\, dW(t)$$

Being Z_t a constant for the model and $b=F(Z_t)>0$, therefore accomplishing the condition of the Vasicek diffusion process maintaining all its properties. The link $b=F(Z_t)$ only modifies the long-term convergence.

We take $X(t) = NCF(t)$

$$dNCF(t) = a(F(Z_t) - NCF(t))dt + \sigma\, dW(t)$$

Accepting the linear formulation, we assume that the cash flow is affected by the components $Z_t = (Z_{1t}, Z_{2t}, Z_{3t}, \ldots, Z_{kt})$ through a linear model:

$$F(Z_t)=\gamma_0+ \gamma_1 Z_{1t}+\gamma_2 Z_{2t}+\gamma_3 Z_{3t}+\ldots+\gamma_k Z_{kt}$$

For which reason the model for NCF proposed at the continuous case is:

$$dNCF(t) = a(\gamma_0+ \gamma_1 Z_{1t}+\gamma_2 Z_{2t}+\gamma_3 Z_{3t}+\ldots+\gamma_k Z_{kt}- NCF(t))d_t + \sigma\, dW(t)$$

Now the condition $b > 0$ has been transported to the condition: $0 < \gamma_0 + \gamma_1 Z_{1t}+\gamma_2 Z_{2t}+\gamma_3 Z_{3t}+\ldots+\gamma_k Z_{kt}$ for all Z_t

Notice that if it fulfils $\gamma_1 = \gamma_2 = \gamma_3 = \ldots = \gamma_k = 0$, it is reduced to $b = \gamma_0$ to the original Vasicek model.

III. CONTROL VARIABLES DYNAMICS

To close the proposed model, we shall offer control variables formulation recommending a dynamic among them, this forces us to go further.

In a similar way, we take a linear specification, and the following system is proposed:

$$dZ_{1t} = (a_{11}Z_{1t}+a_{12}\, Z_{2t}+a_{13}\, Z_{3t}+\ldots+a_{1k}Z_{kt})dt +\sigma_1\, dW_{1t}$$

$$dZ_{2t} = (a_{21}Z_{1t}+a_{22}\, Z_{2t}+a_{23}\, Z_{3t}+\ldots+a_{2k}Z_{kt})dt+\sigma_2\, dW_{2t}$$

$$dZ_{3t} = (a_{31}Z_{1t}+a_{32}\, Z_{2t}+a_{33}\, Z_{3t}+\ldots+a_{3k}Z_{kt})dt+\sigma_3\, dW_{3t}$$

$$\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots$$

$$dZ_{kt} = (a_{k1}Z_{1t}+a_{k2}\, Z_{2t}+a_{k3}\, Z_{3t}+\ldots+a_{kk}Z_{kt})dt +\sigma_k\, dW_{kt}$$

This system of stochastic differential equations, models the internal dynamics among the variables: (Z_{1t}, Z_{2t}, Z_{3t},...,Z_{kt}) that regulate NCF, and due to their independence, they are not affected by NCF, so the behavior of this system is autonomous from the preceding diffusion process. *It has the property that an equilibrium point of this system influences it establishing the long-term condition of NCF.*

IV. INCORPORATING CIR TO THE MODEL

The main objective of the research involve NPV for which it is missing to answer the following question: How will we discount the r_t interest rate? A clear alternative is taking the CIR model (1985).

$$dr(t) = (a-br(t))dt+\sigma\sqrt{r(t)}dW(t)$$

Another alternative is taking HJM (1992) at its general form:

$$dr(t) = \mu(t,T)dt+\sigma(t,T)^{d}dW(t)$$

Here the Brown process has "d" factors, it means:

$dW_{dt} =(dW_{1t}, dW_{2t}, \ldots, dW_{dt})$ indicated by the "d" subindex.

But this is a technical complexity for the interest rate that doesn't move toward the job direction, since the focal point is located on NCF, for this reason we've decided to take the CIR alternative.

V. MODEL PROPOSED AT THE CONTINUOUS CASE

Summarizing, which is the model proposed on this thesis for the continuous case? Now that we have gotten every part of the set, we have got to join them and make them match.

The model proposed to analyze the cash flow evolution of a large enterprise is the three blocks system (A, B, C):

A) $dNCF(t) = a(\gamma_{0+} \gamma_1 Z_{1t}+\gamma_2 Z_{2t}+\gamma_3 Z_{3t}+\ldots+\gamma_k Z_{kt}- NCF(t))dt + \sigma\, dW(t)$

B) $dZ_{1t} = (a_{11}Z_{1t}+a_{12} Z_{2t}+a_{13} Z_{3t}+\ldots+a_{1k}Z_{kt})dt +\sigma_1\, dW_{1t}$

$dZ_{2t} = (a_{21}Z_{1t}+a_{22} Z_{2t}+a_{23} Z_{3t}+\ldots+a_{2k}Z_{kt})dt +\sigma_2\, dW_{2t}$

$dZ_{3t} = (a_{31}Z_{1t}+a_{32} Z_{2t}+a_{33} Z_{3t}+\ldots+a_{3k}Z_{kt})dt +\sigma_3\, dW_{3t}$

....

$dZ_{kt} = (a_{k1}Z_{1t}+a_{k2} Z_{2t}+a_{k3} Z_{3t}+\ldots+a_{kk}Z_{kt})dt +\sigma_k\, dW_{kt}$

C) $dr(t) = (a-br(t))dt+\sigma\sqrt{r(t)}dW(t)$

A) Notice the difference between the original Vasicek model and the model proposed.

At the Vasicek model, the mean oscillates around a stationary constant during the whole process life, while at the model proposed the oscillations level is modified through the intervention of a variation in any Z_1, Z_2,...Z_k.

B) It is important to point out the role played by Vector Autoregressive (VAR) system at the thesis.

Thanks to VAR(p) model it is possible to project the future control variables and anticipate their value observed at the future. This value is substituted on the extended Vasicek model. The central idea toward this direction is projecting NCF and therefore projecting NPV. Projection is able to reply to the same questions that real options do, but through a different path "fortelling". It means it projects (Zt) variables and it brings these projections to present value to a proposed interest rate (pessimistic, optimistic or conservant). This way we get tree values for NPV, so the enterprises has tree possible for decision making; thus we get a clear forecast about haw NPV will evolve.

It is important to highlight that uncertainty is not eliminated, this will always subsist, it is the one which contains any parameter, nevertheless it is reduced and the one that remains is a prognostic own uncertainty.

C) In the case of the interest rate analysis, literature offers a variety of alternatives (see table 4). For our work we take the CIR model (1985).

For an enterprise, its cash flow financial administration is vital because real growth alternatives to be developed in the future depend on its proper foresight. So if the administration council disposes of several tools to be opened or closed, the enterprise may adjust itself according to its needs and finally it may be able to react over the market conditions. *The enterprise cash flow is a mean reversion process, but now the mean is under the administration control.*

VI. NET PRESENT VALUE (NPV) IS A ESTOCHASTIC PROCESS

Taking back the NCF evolving process, we think that not only the NCF model is important, but the notion that NCF is an evolving process forces us to realize that: *There is a clear evolution in the ability of producing wealth in the enterprise*, this ability determines its effective life which is extended by new investment projects: Research and Development (R&D), Mergers and Acquisitions (M&A), Technological Innovation, new products at new markets, etc.

On finances, these decisions are made through an assured management of the control variables package (Z_t), establishing the pathway through which the enterprise is led by its administration council.

CF is the enterprise cash flow and this research takes advantage of the Vasicek model, having as a purpose to calculate the net cash flows and the CIR model to calculate the investment project interest rate. According whit this, we know that if NCF(t) and r(t) are stochastic processes, this involves a clear inference: *NPV* is an stochastic process with control variables (Zt).

The large enterprise has cash flows and returns that oscillate around its mean, so that the expression:

$$NPV = \mathrm{E}\left[\sum_{t=0}^{T} \frac{NCF_t}{(1+r_t)^t} \right]$$

Must be considered as a discrete version of the continuous process:

$$NPV = \mathrm{E}\left[\int_0^T NCF(t)e^{-r(t)t}dt\right]$$

The formula interpretation is to measure today (t=0) the present net value at the moment of expiration T, where $0 \leq T$.

The important requests for the task planner are:

1- How manage the control variables Z_t in order to guaranty that any realization fulfils the condition: $NPV(Z_t) > 0$ with probability one? A conjecture is that it is enough to demand that: $\gamma_0 > 0, \gamma_1 \geq 0, \gamma_2 \geq 0, \gamma_3 \geq 0, \ldots, \gamma_k \geq 0, Z_{it} \geq 0$ for every i,t.

2- How to deal with the control variables to find the values for each component of Z_t, that maximize the net present value? It means to find Z_t so that: Max E $[NPV_t(Z_t)]$ is attained.

Let us analyze the general proposal.

The net present value is the stochastic process that describes an enterprise life, it describes a project value:

$$NPV_T = \mathrm{E}[\ \int_0^T NCF(t)e^{-r(t)t}dt\ ]$$

Where NCF is a process that evolves according to market conditions and it is represented by a diffusion process:

$$dNCF(t) = \mu(Z_t, NCF_t, t)dt+\sigma(Z_t, NCF_t, t)dW(t)$$

The particular case used at this work is a mean reversion process:

$$dX(t) = a(F(Z_t) - X(t))dt + \sigma\, dW(t)$$

The evolution of the joint Z_t dynamics is given by a Stochastic Differential Equation System:

$$dZ_{1t} = (a_{11}Z_{1t}+a_{12}Z_{2t}+a_{13}Z_{3t}+\ldots+a_{1k}Z_{kt})dt +\sigma_1\, dW_{1t}$$

$$dZ_{2t} = (a_{21}Z_{1t}+a_{22}Z_{2t}+a_{23}Z_{3t}+\ldots+a_{2k}Z_{kt})dt +\sigma_2\, dW_{2t}$$

$$dZ_{3t} = (a_{31}Z_{1t}+a_{32}Z_{2t}+a_{33}Z_{3t}+\ldots+a_{3k}Z_{kt})dt +\sigma_3\, dW_{3t}$$

$$\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots$$

$$dZ_{kt} = (a_{k1}Z_{1t}+a_{k2}Z_{2t}+a_{k3}Z_{3t}+\ldots+a_{kk}Z_{kt})dt +\sigma_k\, dW_{kt}$$

The interest r(t) rate is a CIR diffusion process:

$$dr(t) = (a-br(t))dt+\sigma\sqrt{r(t)}dW(t)$$

This is the thesis main contribution, the elucidation made for NPV and its analysis in this work is different from the traditional NPV approach, which assumes that future is predictable using past experience. As a fact, NCF uncertainty is not explicitly modeled, it just discounts expected cash flows. Mathematically, this is the same to taking the maximum from an conjunction mutually exclusive alternatives, so that NPV = $Max_{(t=0)}$ [0, $E_0 V_T$ - X] and to compare all possible alternatives in order to determine their value $E_0 (V_T - X)$ and to select the best among them, (Copeland and Murrin 2000). NPV is determinist.

This thesis takes a different perspective, here NPV is an evolving process where the action of (Z_{1t}, Z_{2t}, Z_{3t},...,Z_{kt}) affects the long-term position. The proposal is planned to highlight explicitly *the importance that corresponds to the enterprise direction decisions.* It is conceived as a planning tool that allows to administrate the enterprise cash flows and to compose investment projects wisely and to reduce its risk levels by diminishing the uncertainty factor. We believe that these bequests might be expanded to the market, supporting the corporative financial theory.

2^{nd} Part: Discrete Case

VII. DISCRETE MODEL FOR NET CASH FLOW (NCF)

From the basic equation we get:

$$dNCF(t) = a(\gamma_0 + \gamma_1 Z_{1t} + \gamma_2 Z_{2t} + \gamma_3 Z_{3t} + \ldots + \gamma_k Z_{kt} - NCF(t))dt + \sigma\, dW(t)$$

Where a $\gamma_0, \gamma_1, \gamma_2, \gamma_3, \ldots, \gamma_k$ and $\sigma>0$ are constant.

Discretizing so that $t_{i+1} - t_i = 1.0$, since the observations we have in practice are of constant length the time intervals, we get:

$$NCF_{t+1} - NCF_t = a(\gamma_0 + \gamma_1 Z_{1t} + \gamma_2 Z_{2t} + \gamma_3 Z_{3t} + \ldots + \gamma_k Z_{kt} - NCF_t) + \sigma V_t$$

Where $\{V_t\}$ is a family of normal random variables NID N(0,1).

Reestablishing terms:

$$NCF_{t+1} = a(\gamma_0 + \gamma_1 Z_{1t} + \gamma_2 Z_{2t} + \gamma_3 Z_{3t} + \ldots + \gamma_k Z_{kt}) + (1-a)NCF_t + \sigma V_t$$

In order to estimate this model, the unrestricted version is taken:

$$NCF_{t+1} = \beta_0+\beta_1 NCF_t + \alpha_1 Z_{1t}+\alpha_2 Z_{2t}+\alpha_3 Z_{3t}+\ldots+\alpha_k Z_{kt} + \varepsilon_t$$

$$\varepsilon_t \sim NID(0,\sigma^2)$$

And identification relations are used:

$\beta_0 = a\gamma_0$, $\beta_1 = 1-a$, $\alpha_1 = a\,\gamma_1$, $\alpha_2 = a\,\gamma_2$, $\alpha_3 = a\,\gamma_3$, ..., $\alpha_k = a\,\gamma_k$

Being $\varepsilon_t = \sigma V_t$, $\varepsilon_t \approx NID(0,\sigma^2)$

It means that we estimate: β_0 β_1 α_1 α_2 α_3 ,..., α_k and by using these relations, estimations for: a , γ_0, γ_1 , γ_2 , γ_3 ,..., γ_k might be found.

VIII. VECTOR AUTOREGRESSIVE (VAR) MODEL FOR CONTROL VARIABLES

For the control variables block we get:

$$dZ_{1t} = (a_{11}Z_{1t}+a_{12} Z_{2t}+a_{13} Z_{3t}+\ldots+a_{1k}Z_{kt})dt +\sigma_1 \, dW_{1t}$$

$$dZ_{2t} = (a_{21}Z_{1t}+a_{22} Z_{2t}+a_{23} Z_{3t}+\ldots+a_{2k}Z_{kt})dt +\sigma_2 \, dW_{2t}$$

$$dZ_{3t} = (a_{31}Z_{1t}+a_{32} Z_{2t}+a_{33} Z_{3t}+\ldots+a_{3k}Z_{kt})dt +\sigma_3 \, dW_{3t}$$

....

$$dZ_{kt} = (a_{k1}Z_{1t}+a_{k2} Z_{2t}+a_{k3} Z_{3t}+\ldots+a_{kk}Z_{kt})dt +\sigma_k \, dW_{kt}$$

Discretizing so that $t_{i+1} - t_i = 1.0$ in each row.

$$Z_{1t+1} - Z_{1t} = (a_{11}Z_{1t} + a_{12}Z_{2t} + a_{13} Z_{3t}+\ldots\ldots+a_{1k}Z_{kt})dt +\sigma_1\delta_{1t}$$

$$Z_{2t+1} - Z_{2t} = (a_{21}Z_{1t} + a_{22}Z_{2t} + a_{23} Z_{3t}+\ldots\ldots+a_{2k}Z_{kt})dt +\sigma_2 \, \delta_{2t}$$

$$Z_{3t+1} - Z_{3t} = (a_{31}Z_{1t} + a_{32} Z_{2t} + a_{33} Z_{3t} + \ldots\ldots + a_{3k}Z_{kt})dt + \sigma_3 \delta_{3t}$$

$$\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots$$

$$Z_{kt+1} - Z_{kt} = (a_{k1}Z_{1t} + a_{k2} Z_{2t} + a_{k3} Z_{3t} + \ldots\ldots\ldots + a_{kk} Z_{kt})dt + \sigma_k \delta_{kt}$$

By simplifying we get:

$$Z_{1t+1} = (1+a_{11})Z_{1t} + a_{12}Z_{2t} + a_{13} Z_{3t} + \ldots\ldots + a_{1k}Z_{kt} + \sigma_1\delta_{1t}$$

$$Z_{2t+1} = a_{21}Z_{1t} + (1+a_{22})Z_{2t} + a_{23} Z_{3t} + \ldots\ldots + a_{2k}Z_{kt} + \sigma_2 \delta_{2t}$$

$$Z_{3t+1} = a_{31}Z_{1t} + a_{32} Z_{2t} + (1+a_{33})Z_{3t} + \ldots\ldots + a_{3k}Z_{kt} + \sigma_3 \delta_{3t}$$

$$\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots$$

$$Z_{kt+1} = a_{k1}Z_{1t} + a_{k2} Z_{2t} + a_{k3} Z_{3t} + \ldots\ldots\ldots\ldots + (1+a_{kk})Z_{kt} + \sigma_k \delta_{kt}$$

Which provides a VAR(1) $Z_{t+1} = (I+A) Z_t + \sigma\delta_t$

Where δ_t is a normal N(0,I) multivariate $\sigma=(\sigma_i)$ $i = 1,2,\ldots k$, is a column vector with every equation deviations. The column vector Z_t has the following components: $Z_{1t}, Z_{2t}, Z_{3t},\ldots Z_{kt}$. $B = I + A$ Will be taken because of its notational simplicity.

IX. COMPLETE DISCRETE MODEL

The complete discrete model has three blocks as well:

A) $NCF_{t+1} = \beta_0+\beta_1 NCF_t + \alpha_1 Z_{1t}+\alpha_2 Z_{2t}+\alpha_3 Z_{3t}+\ldots+\alpha_k Z_{kt} + \varepsilon_t$,

B)

$$Z_{1t+1} = (1+a_{11})Z_{1t} + a_{12}Z_{2t}+ a_{13} Z_{3t}+\ldots\ldots+a_{1k}Z_{kt} +\sigma_1 V_{1t}$$

$$Z_{2t+1} = a_{21}Z_{1t} +(1+a_{22})Z_{2t}+ a_{23} Z_{3t}+\ldots\ldots+a_{2k}Z_{kt} +\sigma_2 V_{2t}$$

$$Z_{3t+1} = a_{31}Z_{1t} + a_{32} Z_{2t}+(1+a_{33})Z_{3t}+\ldots +a_{3k}Z_{kt} +\sigma_3 V_{3t}$$

$$\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots$$

$$Z_{kt+1} = a_{k1}Z_{1t} +a_{k2} Z_{2t}+a_{k3} Z_{3t}+\ldots\ldots\ldots+(1+a_{kk})Z_{kt} +\sigma_k V_{kt}$$

C) CIR discrete $r_t - r_{t-1} = (a-br_t) + \sigma\sqrt{r_t}\, V_t$

X. MODEL SIMULATION

At the proposed formulation:

$$NCF_{t+1} = \beta_0+\beta_1 NCF_t + \alpha_1 Z_{1t}+\alpha_2 Z_{2t}+\alpha_3 Z_{3t}+\ldots+\alpha_k Z_{kt} + \varepsilon_t$$

$$\varepsilon_t \sim NID(0,\sigma^2)$$

The Vasicek component must be taken into account:

$$NCF_{t+1} = \beta_0 + \beta_1 NCF_t + \varepsilon_t$$

It is captured in β_0, β_1 .

Notice that if we make a hypothesis test, and we accept the null hypothesis, H0: $\alpha_1 = \alpha_2 = \alpha_3 = \ldots = \alpha_k = 0$, the Vasicek model emerges. In case of accepting the hypothesis, it would mean that the variables used do not exercise any control over NCF, so, they are incapable to affect its trajectory.

An expected flow incorporates Vasicek basic idea by relating NCF(t+1) to NCF(t), but it also gives the opportunity of an intervention made by the administration council, through the components $Z_1, Z_2, Z_3, \ldots, Z_k$.

This variables has their own dynamics, that are model through a VAR(p) system, which captures in the time the variables dynamic interaction, and it is being considered by the administration council for its control. This is the importance of proposing the VAR(1) model.

The whole model for applications is:

$$NPV_T = \mathrm{E}\left[\ \sum_{t=0}^{T} \frac{NCF_t}{(1+r_t)^t}\ \right]$$

Taking:

$$NCF_{t+1} = \beta_0 + \beta_1 NCF_t + \alpha_1 Z_{1t} + \alpha_2 Z_{2t} + \alpha_3 Z_{3t} + \ldots + \alpha_k Z_{kt} + \varepsilon_t$$

$$\varepsilon_t \sim NID(0, \sigma^2)$$

$$Z_t = BZ_{t-1} + \sigma\delta_t$$

For the interest rate the discretized CIR model is taken:

$$r_t - r_{t-1} = (a - br_t) + \sigma\sqrt{r_t}\, V_t$$

This is the model at its general formulation; let us provide a simple example to illustrate its operation, that we are going to show the usefulness for the case.

The enterprise administration council has Z_1, Z_2, Z_3,…,Z_k exogenous variables under its command, and wants to influence over its cash flow. The performance of the exogenous variables determines the ability to generate wealth.

We take for the example the net income, working capital and net interests as NCF the model components, among others. See Kaplan and Ruback (1995), Higgins, R. (1998).

The model to simulate is:

$$NPV_T = \mathrm{E}[\ \sum_{t=0}^{T} \frac{NCF_t}{(1+r_t)^t}\ ]$$

We take:

$$NCF_t = \beta_0 + \beta 1 * NCF_{t-1} + \beta_2 Z_{1t} + \beta_3 * Z_{2t} + \beta_4 * Z_{3t} + e_t$$

$$\begin{pmatrix} Z_{1t} \\ Z_{2t} \\ Z_{3t} \end{pmatrix} = \begin{pmatrix} B_{11} & B_{12} & B_{13} \\ B_{21} & B_{22} & B_{23} \\ B_{31} & B_{32} & B_{33} \end{pmatrix} \begin{pmatrix} Z_{1t-1} \\ Z_{2t-1} \\ Z_{3t-1} \end{pmatrix} + \begin{pmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \end{pmatrix}$$

At the proposed analysis, the series data record is required:

Net income, working capital variations, net interests, NCF and interest rate; These five data lists are essential.

In this work, the three series will be artificially generated: Net income, working capital variations and net interests; it is important to underline that its variations are stationary processes. The interest rate is generated through the CIR model, and NCF is generated through a model propose on the thesis.

And the equations to be used are:

$Z_1 = d(\text{net income}_t) = 0.006 + 3.5 * dw_{1t}$

Z_2=d(working capital variations$_t$) = 0.002 + 2.5*dw_{2t}

Z_3=d(net interests$_t$) = 0.001+ 1.1*dw_{3t}

For the interest rate, discretized CIR is used:

$$r_t = r_{t-1} \ (a-br_t) + \sigma\sqrt{r_t}\ V_t$$

Lets us say that the data (normalized to make apparent the co-movements at the cost that centred data has negative values) has the following graphs:

CHART 9
Co-movements: Working Capital, Net Incomes, Net Interests and Net Cash Flow

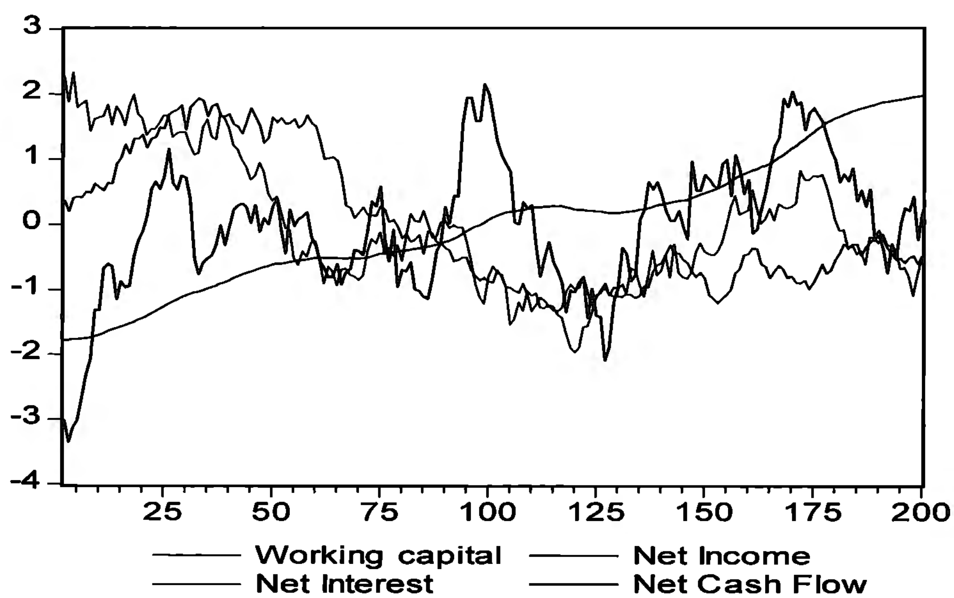
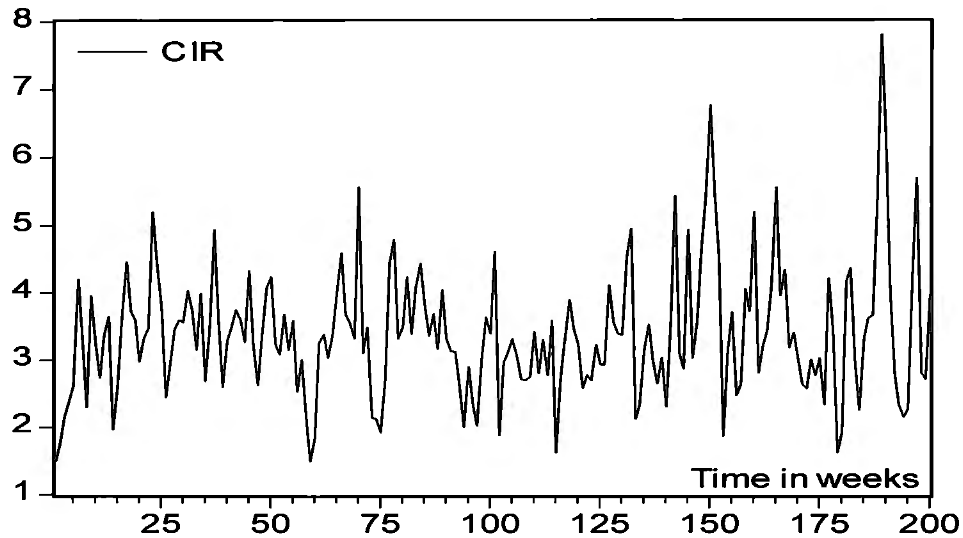


CHART 10
The Interest Rate is given by the CIR Model



All the series have been artificially generated: Net Income (Z1), Working capital (Z2) and Net Interests (Z3); it is important to underline that its variations are stationary processes. NCF is generated through our model proposed in the thesis.

And the equations used are:

D(net income(t)) = 0.003*net income(t-1) -0.001+0.4*W_{1t}

D(working capital(t)) = 0.003*working capital(t-1)+ 0.4*W_{2t}

D(net interests(t)) = -0.003*net interests(t-1)-0.001+0.4*W_{3t}

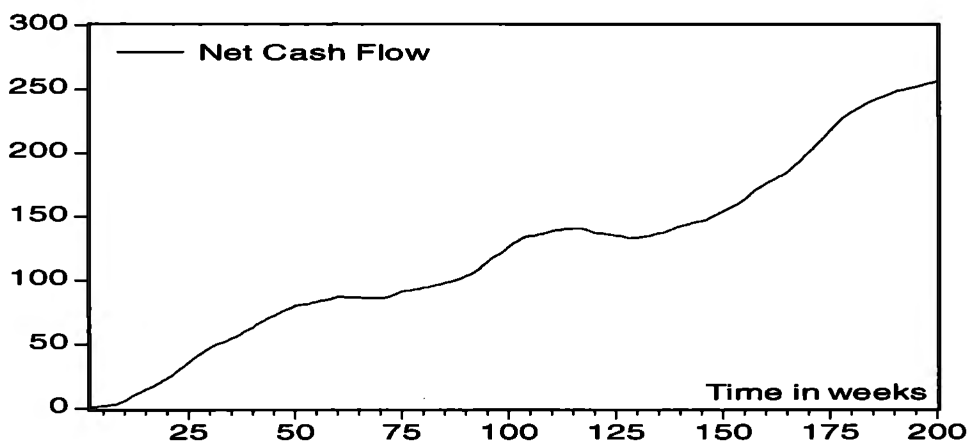
For the yield, the discretized CIR is used:

$D(r_t) = (a - br_t) + \sigma\sqrt{r_t}\, V_t$

D(CIR) = 0.5*(3.5-CIR(t-1))+0.4sqr(cir(t-1))*W4t

We pretend that the enterprise administration council has the data for the variables: Net Cash Flow (denoted by NCF), Net Incomes derived from sales (denoted by Z1), working capital (denoted by Z2), Net interests from financial positions (denoted by Z3) and finally the yield (denoted by CIR). On the other hand we can estimate the thesis model for NCF.

CHART 11
The Net Cash Flow in millions of current US dollars



A natural question is to explain the level and movements of the net cash flow, due to the management shown in the working capital, net interest and net income. So that the link between NCF and the exogenous variables is given by:

NCF(t)= NCF(t-1)-0.095*Working Capital+0.688*Net income+ 0.392*Net interest

Now how to emerge an explanation that shows the dynamic link between Working Capital, Net income and Net interest, by the VAR model:

Working Capital(t)=0.97*Working Capital(t-1)+0.03* Net Income(t-1)+0.04* Net Interest (t-1)

Net Income(t)= 0.002*Working Capital (t-1) +0.98* Net Income (t-1) -0.01* Net Interest (t-1)

Net Interest(t)= -0.005*Working Capital(t-1)-0.029* Net Income(t-1)+0.977* Net Interest(t-1)

Up to this moment, the model explanation: How will the administration council use it?

A) Through impulse-response analysis.

B) Through variance decomposition.

C) Through NCF forecasts.

These are the instruments to evaluate the impact on NCF due to a specific enterprise policy.

A) THE IMPULSE-RESPONSE ANALYSIS

The scheme is that an innovation-like impulse is presented in the it component and the response is charted, which is the record of how this shock will affect the rest of the system components.

Along the first row we have the response of the working capital when the shock comes from:

1. The working capital itself the immediate effect is the 100 percent response but as time goes by decreases to a 80% response.

2. The net incomes first have a low percentage but increases to a 20%.

3. Net interest has a similar role increases its importance in the working capital when time elapses.

Along the second row we have the response in income due to

1. Working capital has no role.

2. Lagged net incomes have an important role because do not decrease from the floor of 80% response.

3. Net interest has an increasing negative response to incomes.

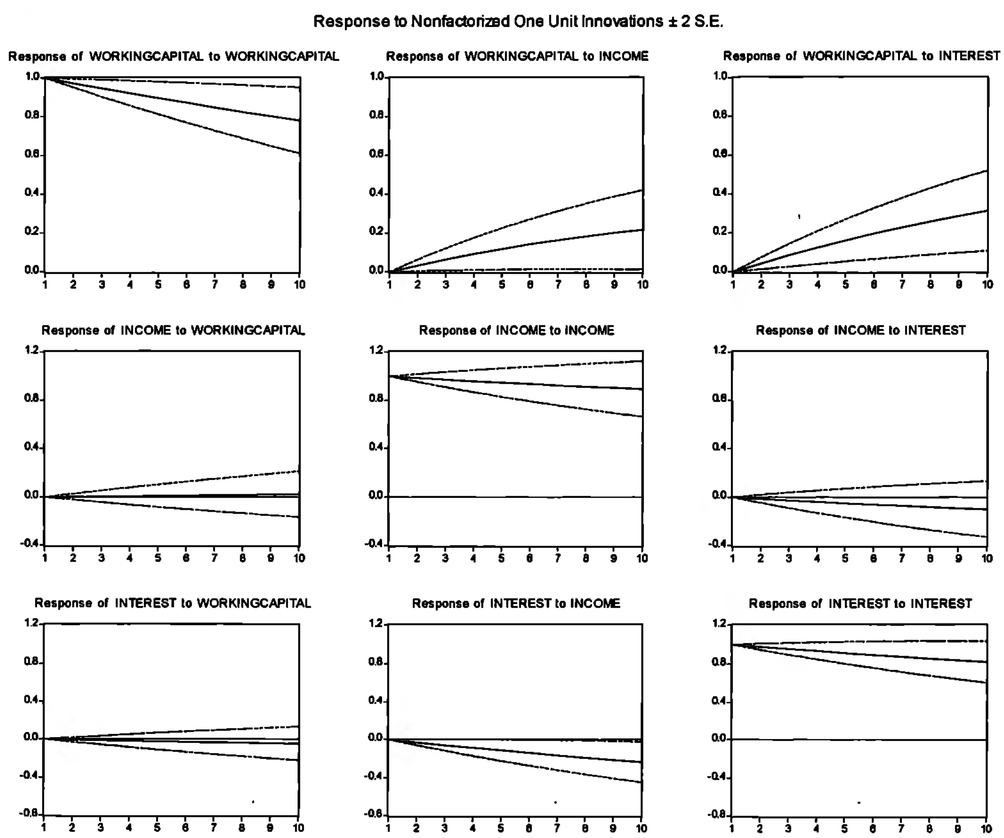
Along the third row we have the response in interests due to

1. Working capital has no role.

2. Lagged net incomes have a negative role because decreases.

3. Net interest has an increasing negative response to incomes despite that starts around 90% response to an 80% level. See the following charts:

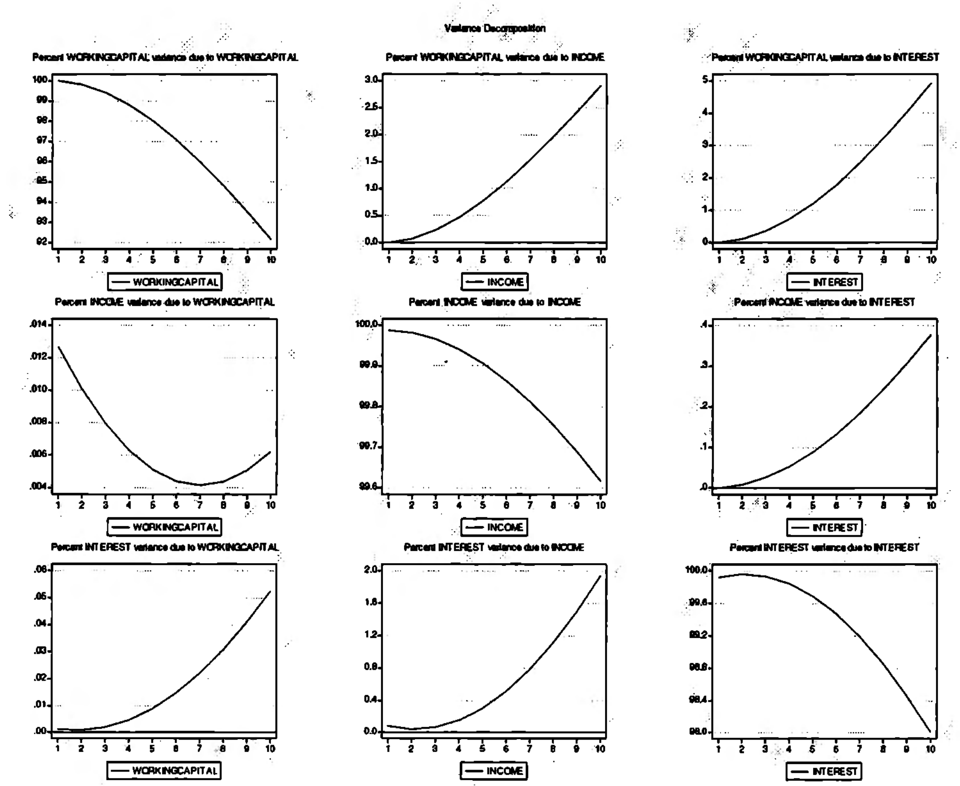
CHART 12
The Impulse-Response Analysis



B) THE VARIANCE DECOMPOSITION

Now the idea is to look at how a shock on the it component will affect the variance evolution on each one of the components. For the enterprise, it is to be able to analyze how an unexpected interest rates raise may affect the net interests paid or income, and how it influences on the variance of the remaining components. The total variability is 100% and it is disintegrated for each component.

CHART 13
The Variance Decomposition



We learn from the above set of graphs what:

Along the first row we have the variance evolution of the working capital when the shock comes from:

The working capital itself the immediate effect is the 100 percent response but as time goes by decreases to a 92% response.

The income and interest have an increasing role in the future variability of the working capital incomes affect up to a 30% meanwhile interests up to a 50%.

Along the second row we have the variance response in income due to

1. Working capital has a decreasing role but comes up again.

2. Lagged net income has almost decreasing because decreases from the level 100% to a 99% response.

3. Net interest has an increasing response to incomes.

Along the third row we have the variance response in interests due to

1. Working capital has no role, because increases but it sustains under no significative figures.

2. Lagged net income has a poor role because increases only to a 2%.

3.- Net interests has an important short run role but goes to a decreasing level as time goes by, seems to be the "hot money" solution if a shortage is faced thus the enterprise burns his short run assets.

C) FORECASTS GENERATION

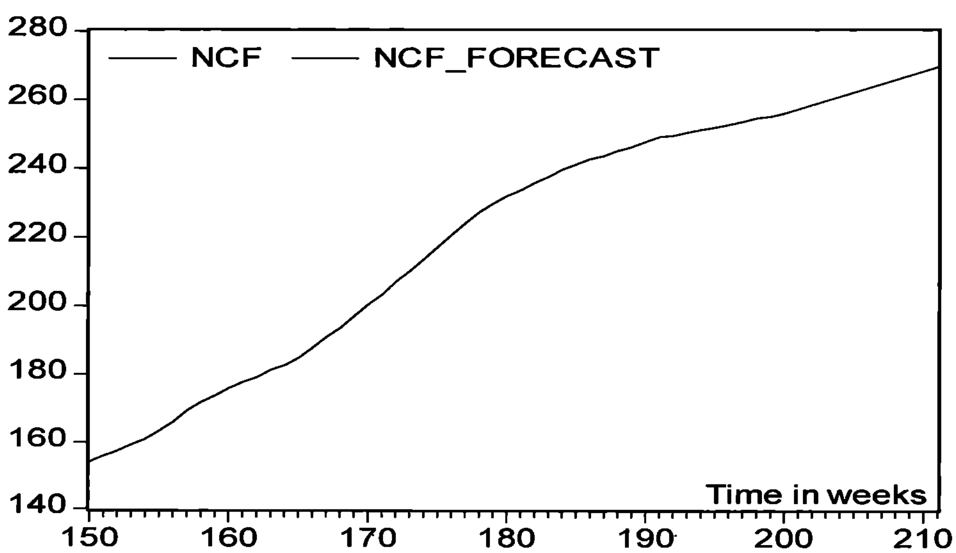
It is possible to generate forecasts for the control variables record evolution and how this impacts DCF future evolution at the same time. Lets do the analysis for an horizon of eleven periods.

TABLE 5
NCF Forecasts Generation

Date	NCF_Forecast	WorkingCapital	Net Income	N. Interest
201	**257.339**	-2.539	4.388	-5.29
202	**258.559**	-2.559	4.388	-5.286
203	**259.782**	-2.578	4.387	-5.283
204	**261.007**	-2.596	4.387	-5.28
205	**262.235**	-2.614	4.386	-5.276
206	**263.466**	-2.631	4.385	-5.273
207	**264.699**	-2.648	4.384	-5.269
208	**265.935**	-2.664	4.383	-5.266
209	**267.173**	-2.679	4.382	-5.262
210	**268.414**	-2.694	4.381	-5.259
211	**269.656**	-2.708	4.38	-5.255

To sum up the graph with the data NCF and NCF_forecast is shown:

CHART 14
NCF and the NCF_forecast



By the other hand one gets a forecast of any model capable to explain the short interest rate, say the CIR model, and have the series:

Date	Expected return
201	**3.02**
202	**2.451**
203	**3.294**
204	**4.731**
205	**3.537**
206	**4.238**
207	**4.521**
208	**4.014**
209	**3.15**
210	**2.844**
211	**3.15**

The model in my thesis is capable to forecast NPV using:

$$NPV_T = \mathrm{E}[\ \sum_{t=1}^{T} \frac{NCF_t}{(1+r_t)^t}\ ]$$

The component Discounted Cash Flow:

$$DCF_t = \mathrm{E}[\ \frac{NCF_t}{(1+r_t)^t}\ ]$$

Is shown and gives only positive terms thus the Net Present Value is positive at all dates.

Discounted Cash Flow

21.71049577
3.281126207
0.241952727
0.136410173
0.012756502
0.001692887
0.000665734
0.000731745
0.000381041
4.28826E-05

As is expected, we also have NPV forecasts conditioned to a possible interest rate trajectory. A predictable disapproval we might immediately confront is that we are pretending volatility on the constant error which is not congruent with the risk notion.

Finally, it is important to observe that analysis for Vector Autoregressive model (VAR) is at the time series literature and it is largely used in empirical researches for to capture evolution and interdependence among multiple time series, it is possible to extend the NCF analysis. Consult Enders, W. (2003), Hamilton, J. (1995) and Lutkepohl, H. (1995).

CHAPTER 4

THE EXISTENCE OF VOLATILITY

I. INFORMATION ASYMMETRY

This work states that volatility is not constant which amounts to reject the idea that σ is constant along the whole period, and this compels us to use some techniques of dependent time volatility models.

We will incorporate the stochastic volatility model in order to get a time dependent risk and a "news curve".

The idea is that trough a system such as the following:

$$dX_t = \mu(X_t, Z_t, t)dt + \sigma(X_t, t)dW_{1t}$$
$$d\sigma_t^2 = (w - \theta\sigma_t^2)dt + \alpha\sigma_t dW_{2t}$$

The second component called: Stochastic Volatility Model, when a discrete version is required, it corresponds to a Generalized Autoregressive Conditional Heteroskedasticity model GARCH(1,1), see Wilmott (2000).

Since these ideas were developed inside the time series theory, we will work with the discrete version called GARCH (1,1).

$$\sigma_{t+1}^2 = \omega + \beta\sigma_t^2 + \alpha\varepsilon_t^2$$

ARCH models usage has been quite significant for the results gotten at the Assets Price Theory, among the most important theories which have found empirical implementations using GARCH, we get: The Capital Asset Pricing Model (CAMP); Sharpe (1964), Lintner (1975), the Arbitrage Pricing Theory (APT); Ross (1976a), (1976b), Black (1973), the Intertemporal Capital Asset Pricing Model (ICAMP); Merton (1973), The CAMP, addressed to consumption; Breeden (1979).

Getting back to Merton (1973), who built over the Intertemporal Model (ICAMP) in order to illustrate the relationship among the stock market returns and the volatility, and the GARCH-M model usage as an implementation of CAMP to show that investors risk- adverse demand an extraordinary risk premium identical to the additional risk; Merton (1980), argued the positive linear relationship between expected returns and the market portfolio variance, and it provides the conditions under which the extraordinary returns hedging component is quite small.

Engle, Lilien and Robins (1987) developed the GARCH-M model to estimate these linear relationship using the risk-aversion parameter to measure the variance impact over the returns, and a positive association was found; nevertheless other researches have attested a negative relationship between returns and the variance, Campbell (1987), Guo (2002) and Ng (1991).

Despite of the advantages gotten, these models present some imperfections. The GARCH (p,q) model, has been used on other studies, Kupiec (1990), however, asymmetric dynamics is not totally captured, because the conditional variance is only linked to past conditional variances and to square innovations, therefore the returns sign, does not play an important role on volatilities.

Inadequacy of the standard GARCH models is one of the main motivations for the development of other extensions GARCH models. The GARCH threshold (TGARCH) by Glosten, Jagannathan and Runkle (1993) who stated that relationship between volatility and expected returns might be negative, as well as Nelson (1989) and Zakoian (1994), and the EGARCH model by Nelson (1991).

II. THE EXTENDED MODEL: VASICEK WITH ASYMMETRIC INFORMATION

We mention Engle, R. and Ng, V. (2000): "Bad news impact conditional variance strongly more than good news". The model interest parameter is $\gamma > 0$. The test of hypothesis $\gamma = 0$, is important, if the null one were accepted it would mean there no asymmetry at the news curve and the enterprise is reacting equally at good news and to bad news.

As we know, at GARCH models, volatility depends on the past returns magnitude and their correspondent signs. Let us formulate some ideas in order to be able of stating that at an enterprise: *There are good news when a cash flow raise shows up and bad news when a cash flow diminishing does.*

Speaking specifically we will work on volatility associated to NCF_t and we will also observe how the risk level is impacted at NCF_t when a negative shock appears, it is bad news, and vice versa. Once the shock has showed up, it affects NCF_t on an increase or a decrease.

At these models, as usual, the following decomposition is made:

$$r_t = E[r_t \mid \psi_{t-1}] + \varepsilon_t \qquad Var[\varepsilon_t \mid \psi_{t-1}] = h_t$$

The first relation tells us that the return has an expected component, having all the available information ψ_{t-1} up to the time t-1 and the innovation $\varepsilon_t = (\varepsilon_{it})$ i = 1,...,T, which is not directly noticeable. At the second moments there is the conditional variance, denoted by h_t is gotten because all the available information is used ψ_{t-1} up to the time t-1. Offered information includes good and bad news.

Now we will incorporate the asymmetric information notion to obtain the branded news curve applied to cash flow returns. When considering the conditional variance as a time dependent risk measured, we get:

$$NCF_t = E[NCF_t \mid \psi_{t-1}] + \varepsilon_t \qquad Var[\varepsilon_t \mid \psi_{t-1}] = \sigma_t^2$$

Where ψ_{t-1} is the information conjunction, which is required for model the σ^2_t trajectory that is the conditional variance of the innovation ε_t, with the information contained at ψ_{t-1}.

This allows us to know that: When the enterprise observes the moment t-1, it knows the cash flow has two components; the first part is the expected level for NCF_t the information ψ_{t-1} given, as we already know:

$$E[NCF_t|\psi_{t-1}] = \beta_0 + \beta_1 NCF_{t-1} + \alpha_1 Z_{1t-1} + \alpha_2 Z_{2t-1} + \alpha_3 Z_{3t-1} + ... + \alpha_k Z_{kt-1}$$

This relation tells us, we expect to observe NCF_t, due to the fact that the variables Z_{1t-1}, Z_{2t-1}, Z_{3t-1},...,Z_{kt-1} have been taken in addition to the innovation inherent to the market activity ε_t, they both configure:

$$NCF_t = E[NCF_t \mid \psi_{t-1}] + \varepsilon_t$$

But, the administration council knows ε_t value, might be quite distant from zero, in which case it is called a shock, the administration council will be considering the proper contribution for the market activity when take the risk component, which is:

$Var[\varepsilon_t \mid \psi_{t-1}] = \sigma_t^2$ while taking explicitly the function:

$$\sigma_t^2 = \omega + \alpha\varepsilon_{t-1}^2 + \beta\sigma_{t-1}^2 + \gamma \cdot I(\varepsilon_{t-1} < 0)$$

Which provides the clue for an extended model in the thesis. Engle and Ng (2000) supposed positive parameters, this is: $\omega>0$, $\alpha>0$, $\beta>0$, $\gamma>0$.

It is important to highlight that the non-anticipated, non-planned cash flow is:

$$\varepsilon_t = NCF_t - [\beta_0 + \beta_1 NCF_{t-1} + \alpha_1 Z_{1t-1} + \alpha_2 Z_{2t-1} + \alpha_3 Z_{3t-1} + \ldots + \alpha_k Z_{kt-1}]$$

III. INFORMATION FOR THE ADMINISTRATION COUNCIL

We shall notice how the administration council is informed: When the news is good, we get $\varepsilon_{t-1} > 0$ thus the cash flow $NCF_t = E[NCF_t \mid \psi_{t-1}] + \varepsilon_{t-1}$ arrives with a pleasant gift from the market, so that the risk is:

$$\sigma_t^2 = \omega + \alpha\varepsilon_{t-1}^2 + \beta\sigma_{t-1}^2$$

Because the indicator $I(\varepsilon_{t-1} < 0) = 0$ is not in use, the contribution to conditional variance from ε_{t-1} is just α.

When there are bad news, $\varepsilon_{t-1} < 0$ the cash flow:

$NCF_t = E[NCF_t \mid \psi_{t-1}] + \varepsilon_t$ arrives with an unfortunate information from the market, so that the risk is:

$$\sigma_t^2 = \omega + \alpha\varepsilon_{t-1}^2 + \beta\sigma_{t-1}^2 + \gamma \cdot I(\varepsilon_{t-1} < 0)$$

Since the indicator $I(\varepsilon_{t-1} < 0) = 1$ is in use, at this last case, contribution to conditional variance from ε_{t-1} is $\alpha + \gamma$.

That is why it has an associated equation of corporative news, defined by Engle, R and Ng, V. (2000):

$$\sigma_t^2 = A + \alpha\varepsilon_{t-1}^2 \quad \text{for} \quad \varepsilon_{t-1} > 0$$
$$\sigma_t^2 = A + (\alpha + \gamma)\varepsilon_{t-1}^2 \quad \text{for} \quad \varepsilon_{t-1} < 0$$

Where,

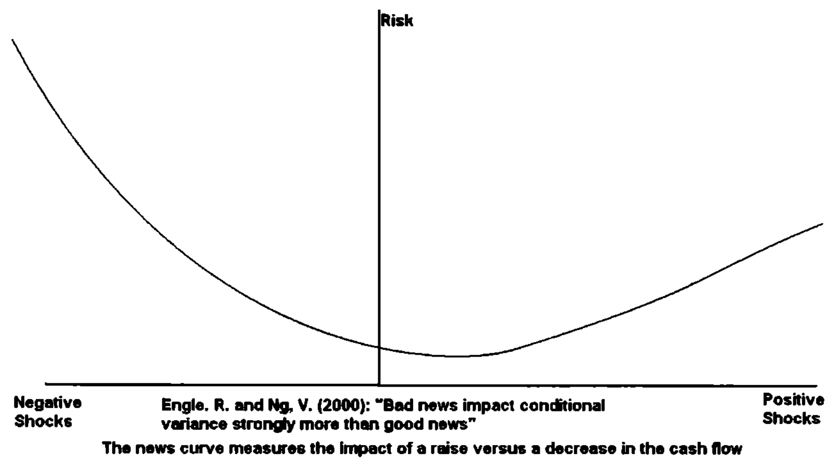
$$A = \omega + \beta\sigma^2$$

The election of σ^2, was through the relation:

$\text{Plim}\sigma_t^2 = \sigma^2$ therefore: $\sigma_t^2 \xrightarrow{p\lim} \sigma^2$

The asymmetric curve shape according to these authors is presented as:

CHART 15



Summarizing, this method allows analyzing if NCF has an asymmetric volatility and thus a news curve, certainly it is understood as: Good news at a cash flow increments and bad news at a decrease.

Notice that there is not any guaranty of getting positive parameters, this is: $\omega>0$, $\alpha>0$, $\beta>0$, $\gamma>0$, and otherwise, making an unrestricted estimation, it could show which gamma has the "wrong sing" $\gamma < 0$, but if it accomplishes α-$\gamma > 0$, the curve gets "inverted", this might be gotten because the estimation applied; maximum likelihood (ML), results a function which represents flat zones having as a consequence the appearing of wrong signed estimations.

IV. MEASURES TO THE EXTENDED MODEL

We will measure the model proposed in the work as: Vasicek with Asymmetric Information. It will be a simplified version since there is not any available information about the control variables of the 69 large enterprises of the sample.

The program used for all estimations is the Regression Analysis Time Series (RATS) whose author is Doan, T. (2006), published at http//:www.estima.com. It is known as advanced econometrics software. Formulation used at RATS is:

$$NCF_t = \beta_0 + \beta 1 * NCF_{t-1} + \varepsilon_t$$

$$\sigma_t^2 = \omega + \alpha\varepsilon_{t-1}^2 + \beta\sigma_{t-1}^2 + \gamma \cdot I(\varepsilon_{t-1} > 0)$$

And the associated equation of corporative news, defined above.

For the analysis of residuals the ones called standardized residuals were used which are the most reliable.

Analysis for the 96 large enterprises of the sample is presented. For easing text handling, results from all of them are sent to appendix 1; as an example and for making a quick contents review is presented following case ALFAA.

The right column contains estimations over asymmetry (gamma), as well as the analyzed period volatility (sigma2 = σ^2). When gamma value is significant, it is marked with an asterisk.

TABLE 6
Analysis of ALFA_A Stock

Analysis*	ALFAA*		
Vasicek parameters	Beta0	Beta1	
	-333.25	1.05	
T-statistics	-10.10	2079.56	
Vasicek			
News parameters	Alfa	Beta	**Gamma**
	0.21	-0.69	0.95
News T-statistics	23.12	-44.81	28.93
News parameters	Omega	A	**Sigma2**
	1719722.00	1719721.24	1.11
Used observations	2098.00		

We observed that ALFA_A has a positive gamma and therefore its news curve is asymmetric. Which indicates that bad news comes with a negative shock and rebounds in higher conditional volatility that good news with a positive shock.

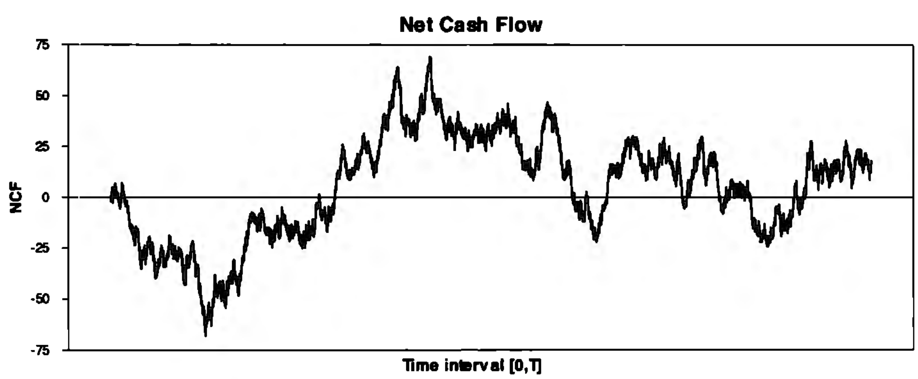
CHAPTER 5

PROPOSED MODEL APPLICATION

I. VIRTUAL ENTERPRISE: THREE USAGES FOR THE MODEL

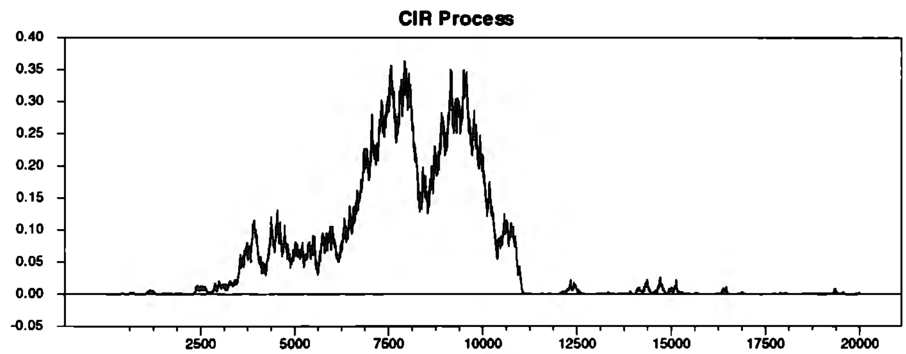
A) Let us suppose that the management is just concerned with the level of the net cash flow, this is surely the simplest case to review: $F(Z_t) = \gamma_0$ which is the Vasicek process. Taking advantage of the mean reversion which has the Vasicek process, the simulation gives the chart shown below:

CHART 16



Use CIR to bring back the flows into present values and it graph is following:

CHART 17



To reach the correct expression for the net present value:

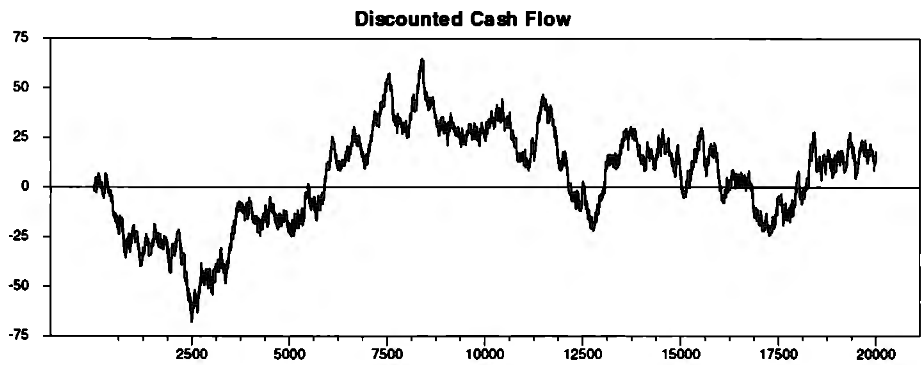
$$NPV_T = E[\sum_{t=0}^{T} \frac{NCF_t}{(1+r_t)^t}] = \sum_{t=0}^{T} E[\frac{NCF_t}{(1+r_t)^t}]$$

Starting with the cash flow at date t (NCF_t) discounts at the rate r_t is into present value, thus one focus on its expected value:

$$Expected\_Discounted\_NetCashFlow = E[DCF_t] = E[\frac{NCF_t}{(1+r_t)^t}]$$

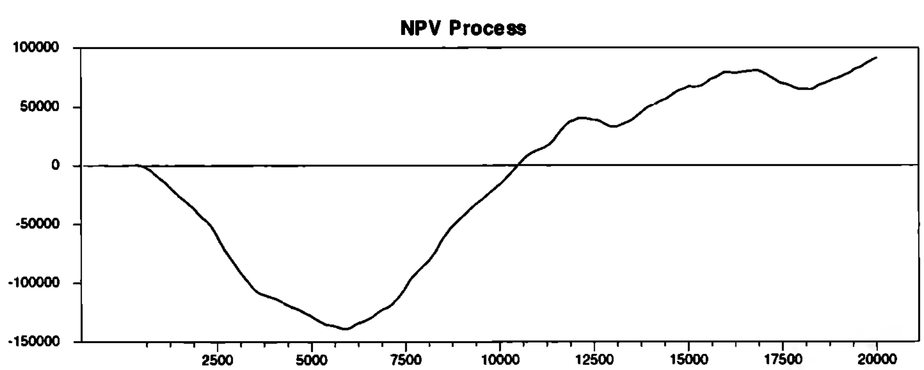
And the result, states the value today of a future cash flow, the chart is:

CHART 18



NPV_T is a process which accumulates positive/negative values from $EDNCF_t$ so that In this thesis NPV must be a stochastic in the sense is an evolutive process and goes with the evolution of two stochastic process: The cash flow itself (in this example is a Vasicek process) and the interest rate process which is a financial market phenomena (here is the CIR process). The NPV_T process for a moving value of T where NPV_T is positive (the proyect is acepted) and periods where turns negative linked with a rejection.

CHART 19



B) Let us suppose another simple case, taking the data net incomes as the only variable. Incomes are simulated as a Brownian movement with the following displacement:

$$dincomes(t) = \gamma_0 + \gamma_1 t dt + \sigma dW(t)$$

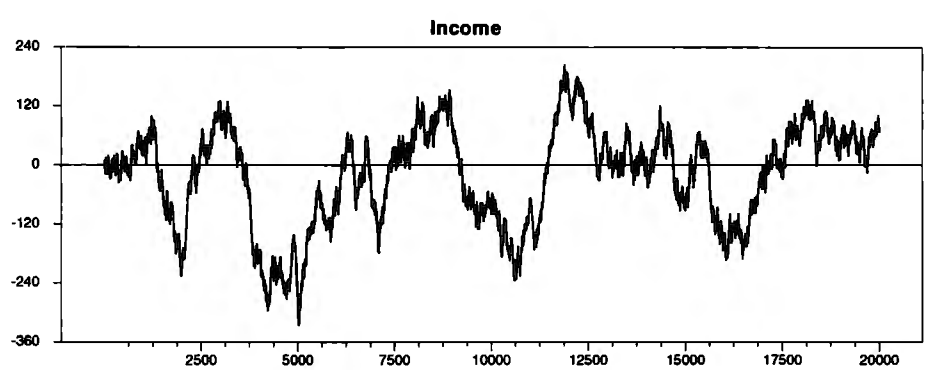
discretizing we get:

$t_{i+1} - t_i = 0.0001$, $\gamma_0 = -0.0004$, $\gamma_1 = 0.0002$, $\sigma = 3.7$

$incomes(t_{i+1}) = incomes(t_i) - 0.0004 + 0.0002*0.0001*t_i + 3.7*\sqrt{0.0001}*V_t$

Thus, an $incomes_t$ process simulation generates the following chart:

CHART 20



Applying the idea that NCF is an evolving process, modeled by the process proposed at the thesis, its chart of NCF is the smooth blue line:

CHART 21

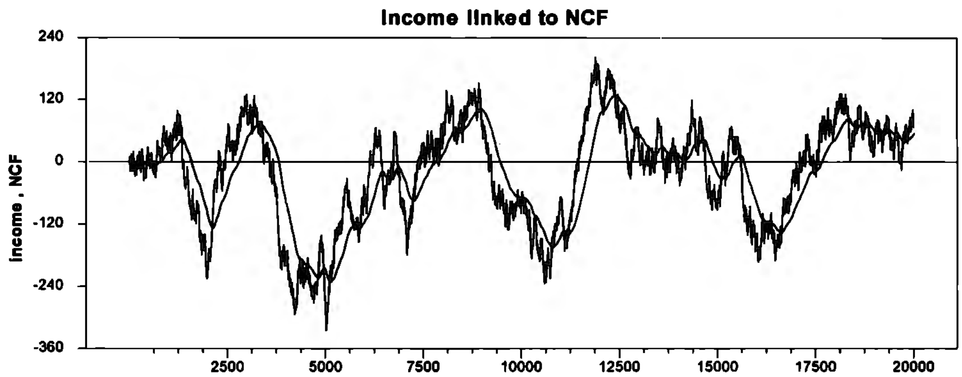


CHART 22

To compute the expression:

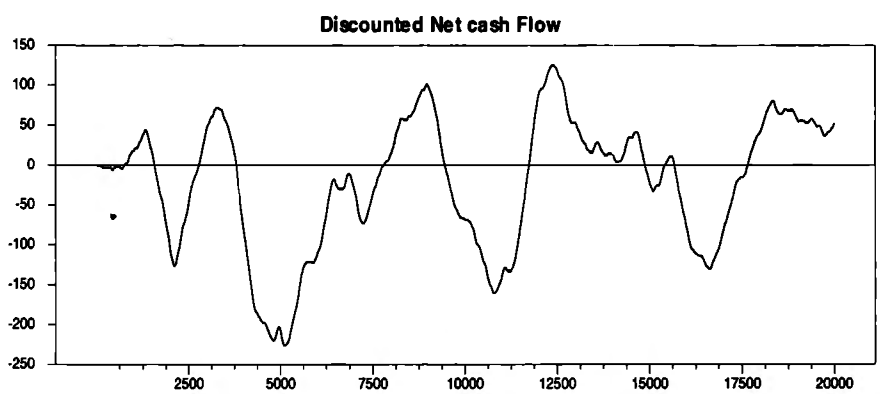
$$NPV_T = E[\sum_{t=0}^{T} \frac{NCF_t}{(1+r_t)^t}]$$

Every component is brought to expected present value:

$$E[DCF(t)] = E[\frac{NCF_t}{(1+r_t)^t}]$$

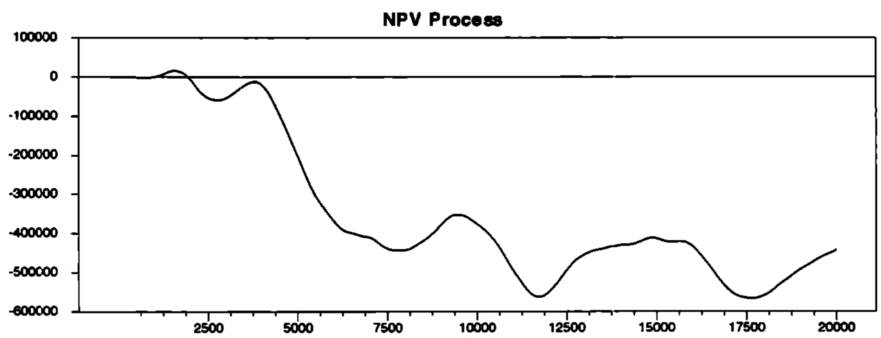
And the chart of the EDNCF process is:

CHART 23



The NPV_T process (now the sub index T is variable), is the gathering up to the moment T of the last series and it has the chart:

CHART 24



It is evident this project must be rejected.

C) Taking Hull-White (1993), the process is:

$$dNCF(t) = a(\gamma_0 + \gamma_1 t - NCF_t)dt + \sigma\, dW(t)$$

CHART 25

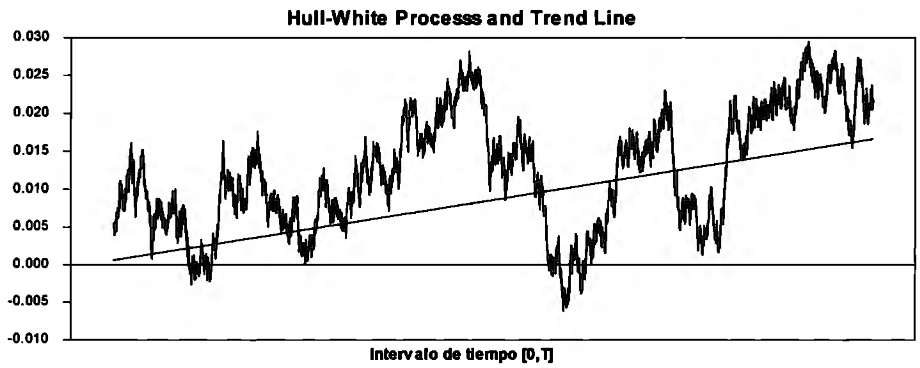
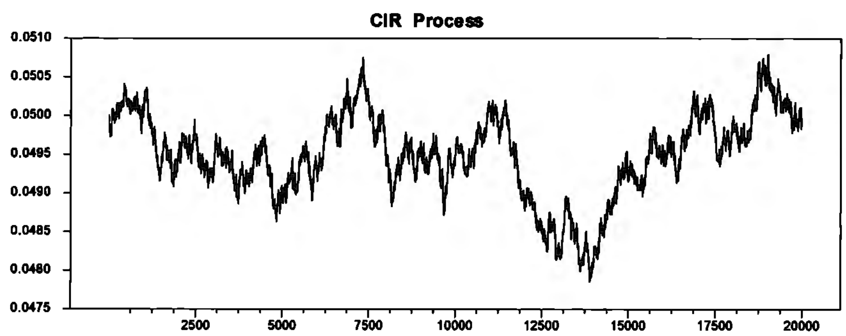


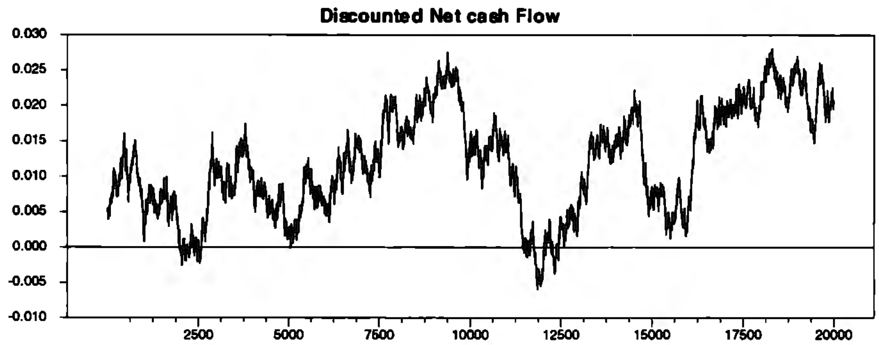
CHART 26



The chart is now:

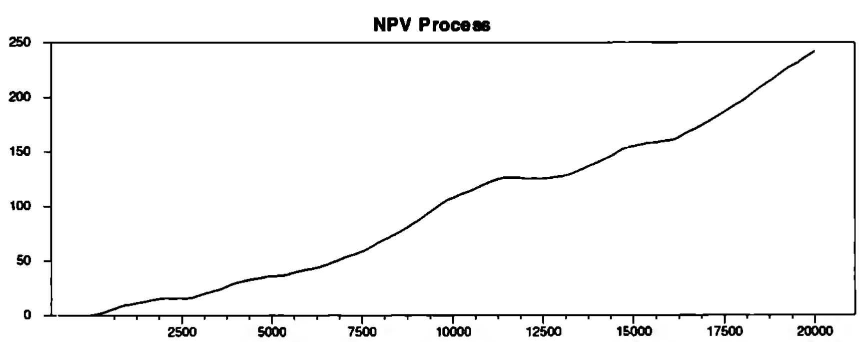
$$E[DCF_t] = E[\frac{NCF_t}{(1+r_t)^t}]$$

CHART 27



NPV_T is the process which accumulates is now:

CHART 28



In this case the project is accepted in all T.

II. MEXICAN LARGE ENTERPRISES: PROPOSED MODEL APPLICATION

We will apply these ideas in Mexican large enterprises which are listed in the Stock Market and that are the most representative.

The objective is to make a general review of the situation by those enterprises, this originates a map of cash flow movements and therefore it will provide a vision of their real possibilities as economical growth engines. On the other hand, from the investor viewpoint, we are interested in an analysis of these enterprises in order to build a stock portfolio with enterprises whose cash flow has a solid tendency to grow.

Obtaining data from all these enterprises which are listed in the stock market to make the proper estimations, was not completely possible, due to the fact that many of them do not hold financial reports in a formal data base and they only publish every three months the financial information required by the Law; nevertheless globalization and world wide competence will force large enterprises to generate fundamental statistic information, and through this, a proper and accurate decision making from the administration council will be supported.

The analysis is started on the argument that an enterprise operating at the Mexican Stock Market depends on its NPV_T. As the enterprise expects to maintain a trajectory achieving the condition $NPV_T > 0$, it has to manage its net cash flow properly. In order to accomplish this, it must know how to select its control variables, this is the package $Z_t=(Z_{1t}, Z_{2t},\ldots, Z_{kt})$ with which it could guaranty the cash flow to be increasing, it means $0<NPV_t<NPV_{t+1}<NPV_{t+2}<\ldots$ for the life of the project.

$$NPV_T = \mathrm{E}[\ \int_0^T NCF(t)e^{-r(t)t}dt\ ]$$

Where the control variables act over NCF_t through the diffusion process:

$$dNCF(t) = a(F(Z_t) - NCF_t)dt + \sigma(t)\, dW(t)$$

Where $NCF_t = F(Z_t)$ in equilibria (is when the management posses control over their cash flow) and $\sigma(t) \sim GARCH(1,1)$ is the news effect.

For simplicity, the function $F(Z_t)$ has been taken with a linear specification:

$$F(Z_t) = \gamma_0 + \gamma_1 Z_{1t} + \gamma_2 Z_{2t} + \gamma_3 Z_{3t} + \ldots + \gamma_k Z_{kt}$$

The interest rate r_t is a diffusion process:

$$dr_t = \mu(r_t,t)dt + \sigma(r_t,t)dW_t$$

Unfortunately, public information about enterprises condition, does not include information about the exact value NCF_t, in addition there are no control variables publicated, the Law considers that is internal information of every enterprise, so we has to create a “proxy” for calculating NCF from the published information, at the beginning the following relation was selected:

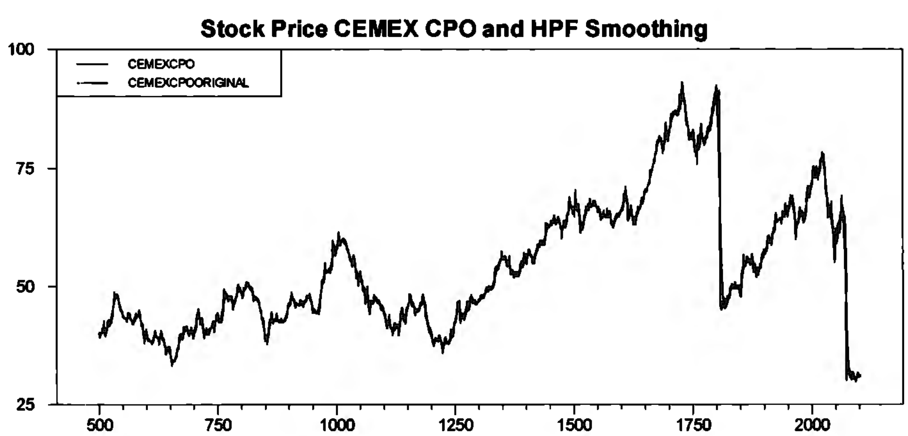
NCF= stock price (the last quote)*daily operated volume.

However this did not work properly, because the oscillations of price and operated volume might be quite violent, that is: from one day to another the operated volume goes from 10.30 million titles to only 1000 titles, or the stock price falls persistently due to a general downturn in the market, that could even be originated by a world general fall.

Thus, what we need is a way of lessening these oscillations but without eliminating them; so that the volume operated and prices may slightly move.

Taking the series CEMEX CPO for the 2102 days from Monday June 1st 1988 up to Monday August 28th 2006, we get an example of the variation suffered by the smoothing procedure.

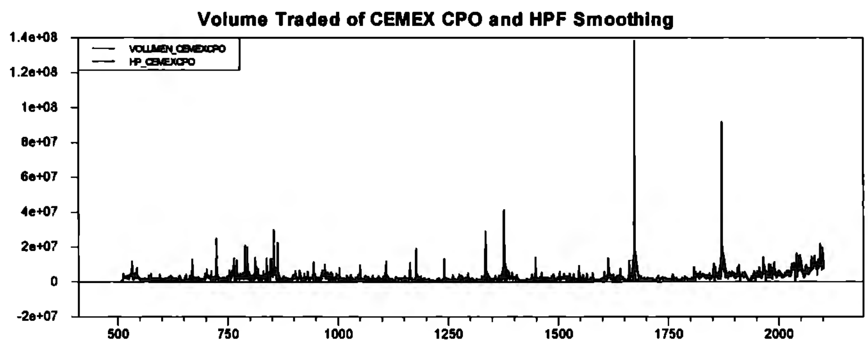
CHART 29



This chart represents the stock price.

And applying the same technique for the operated volume we get:

CHART 30



The smoothing procedure used is the well known Hodrick Prescott Filter (HPF), which consists of finding $\{S_t\}$ that makes the following expression minimum:

$$\sum_{t=1}^{T} (y_t - s_t)^2 + \lambda \sum_{t=2}^{T-1} ((s_{t+1} - s_t) - (s_t - s_{t-1}))^2$$

The data required consist only of the series history $\{y_t\}$ and the filter constructs the softened series $\{S_t\}$.

The value for λ is established by the analyst. Following the Hodrick Prescott recommendation we took in the thesis λ=100 for stock prices and λ = 50 for volume traded. It is well known that if $\lambda \rightarrow \infty$ the softening chart becomes into a straight line which means that for stock prices, we took the route recommended by the authors and for volume, a largest oscillation was accepted.

So as an alternative for the market data, the soft version was used, which contains paused movements of NCF, responding to market signals, thus:

NCF= smoothed stock price * smoothed volume traded

In the rest of the chapter, we will concentrate on making a review for the most important large enterprises of Mexican Stock Market.

Data were taken from FINSAT (www.finsat.com.mx) which is a Mexican news agency that provides market results day after day.

It was required all cases to have the same length 2102 days from Monday June 1st 1988 up to Monday August 28 2006; even though only enterprises that may be called transnational, may present a complete record.

The whole market was taken, even when there are many enterprises which do not operate full weeks, they are cases where prices remain constant and the volume is zero, this implies we cannot count on the variable NCF.

To choose the enterprises, we must consider using some of the ideas exposed at Ludlow, J., and Mota, B. (2006). Where are published stocks with more than 2000 consistent published days.

TABLE 7
Stocks with very high activity in the Mexican Financial Market

Published days	Stock	Published days	Stock
2102	ARA	2076	HILASAL_A
2102	BIMBO_A	2076	KIMBER_A
2102	CEMEX_CPO	2076	KOF_L
2102	CIEB	2075	VITRO_A
2102	COLLADO	2074	LIVEPOL_1
2102	CONTAL	2073	TELMEX_L
2102	DESCB	2072	TELECOM_A1
2102	GCORVI_UBD	2071	SANLUIS_CPO
2101	BACHOCO_UBL	2071	SIMEC_B
2101	GEO_B	2070	VALLE_V
2100	GCARSO_A1	2069	SORIANA_B
2098	ALFA_A	2069	TELMEX_A
2098	FEMSA_UBD	2068	MASECA_B
2098	FEMSA_UBD	2067	TVAZTCA_CPO
2098	TLEVISA_CPO	2066	ICA
2098	FEMSA_UBD	2064	GMODELO_C
2095	COMERCI_UBC	2062	PEÑOLES
2094	AUTLAN_B	2051	ICH_B
2088	CYDSASA_A	2050	GIGANTE
2077	GRUMA_B	2048	KIMBER_B
2076	HOGAR_B	2008	MOVILA_B

As well there is a table with stocks with very high activity are listed.

TABLE 8
The 62 Stocks of the Sample

ALFA	CNCI_B	GIGANTE	IMSA_UBC	TELMEX_A
AMTEL_A1	COMERCI_UBC	GISSA	KIMBER_A	TELMEX_L
AMX_A	CONTAL	GMEXICO_B	KOF_L	TLEVISA_CPO
AMX_L	CYDSASA_A	GMODELO_C	MASECA_B	TS
ARA	DESC_B	GRUMA_B	MOVILA_B	TVAZTCA_CPO
ARCA	ELEKTRA	GSANBOR_B1	NAFTRAC_02	URBI
ASUR_B	FEMSA_UBD	HILASAL_A	PENOLES	USCOM_B1
BACHOCO_UBL	GCARSO_A1	HOGAR_B	SANLUIS_CPO	VALLE_V
BIMBO_A	GCC	HOMEX	SARE_B	VITRO_A

C	GCORVI_UBL	HYLSAMX_B	SAVIA_A	WALMEX_V
CEL	GEO_B	HYLSAMX_L	SIMEC_B	
CEMEX_CPO	GFINBUR_O	ICA	SORIANA_B	
CIE_B	GFNORTE_O	ICH_B	TELECOM_A1	

There are some changes since the following six titles we will not include:

CNCI_B

HYLSAMX_L

IMSA_UBC

SARE_B

SAVIA_A

HYLSAMX_B

And we add the following thirteen stocks:

AUTLAN B

CABLE CPO

CINTRA A

CMOCTEZ

COLLADO

GFINTER O

GFMULTI O

INVEX O

IXEGF O

KIMBER B

LIVEPOL1

PINFRA

SARE B

Finally we will work with 69 enterprises, in each case we will point out the number of days incorporated.

III. MEXICAN LARGE ENTERPRISES: GROWTH, CONVERGENCE AND ASYMMETRY

Let's consider the general case:

$$dNCF(t) = d(F(Z_t) - NCF_t)dt + \sigma(t)\, dW(t)$$

$$\text{where } \sigma(t) \sim GARCH(1,1)$$

$$F(Z_t)=\gamma_0 + \gamma_1 Z_{1t}+\gamma_2 Z_{2t}+\gamma_3 Z_{3t}+\ldots+\gamma_k Z_{kt}$$

Now we go over the specific case where $Z_{1t}= t$

Taking $F(Z_t) = \gamma_0+ \gamma_1 t$

The process is: $dNCF(t) = d(\gamma_0+ \gamma_1 t - NCF_t)dt+ \sigma(t)\, dW(t)$

Basically, it is the Hull-White model with a GARCH (1, 1) below are put three graphs of simulated NCF processes where the GARCH effect is clearly observed.

CHART 31

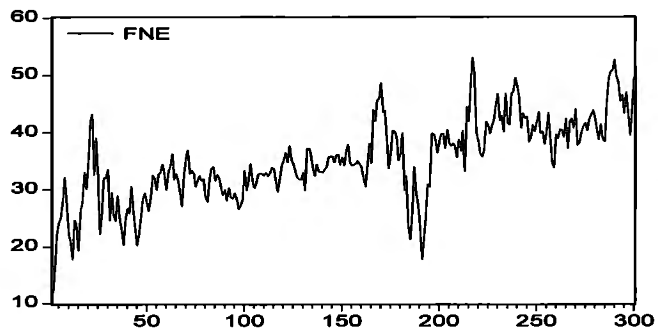


CHART 32

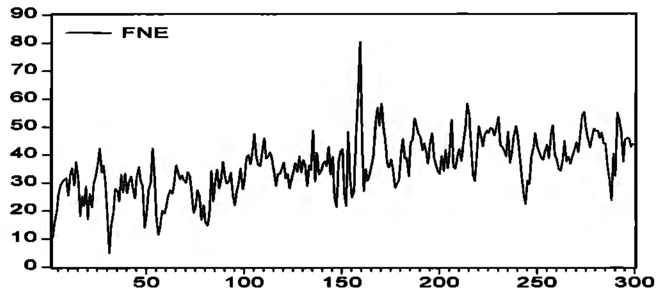
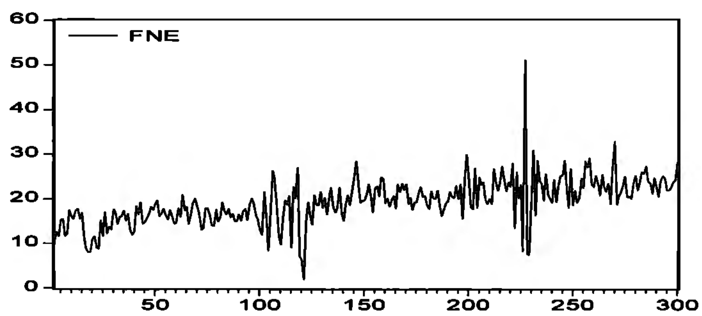


CHART 33



Thus, we will use this last specification for the 69 enterprises and through this we will get a behavioral map of large Mexican enterprises listed in the Mexican Stock Market.

From the basic equation we get:

$$dNCF(t) = d(\gamma_0 + \gamma_1 t - NCF_t)d_t + \sigma(t)\, dW(t)$$

Where d , γ_0 ,γ_1 are constant to identify and estimate.

Discretizing we get:

$$NCF_{t+1} - NCF_t = d(\gamma_0 + \gamma_1\, t - NCF_t) + \sigma(t)\, V_t$$

Where $\{V_t\}$ is a family of normal independent random variables N(0,1).

Rearranging terms:

$$NCF_{t+1} = d(\gamma_0 + \gamma_1\, t) + (1 - d)NCF_t + \sigma(t)\, V_t$$

In order to estimate this model we take the unrestricted version:

$$NCF_{t+1} = \lambda_0 + \lambda_1 NCF_t + \lambda_2 t + \varepsilon_t$$

$$\varepsilon_t = \sigma(t)\, V_t$$

$$\sigma(t)^2 = \omega + \alpha\varepsilon(t-1)^2 + \beta\sigma(t-1)^2 + \gamma I(\varepsilon(t-1) < 0)$$

We use the identification relations:

$\lambda_0 = d\gamma_0$, $\lambda_1 = 1 - d$, $\lambda_2 = d\, \gamma_1$

Where:

(d) is the convergence parameter

(γ_0) is the support parameter

(γ_1) is the tendency parameter

(γ) is the asymmetry parameter

In the following table, we can observe results for the 69 analyzed stocks. Convergence, tendency and asymmetry columns are important and they are commented below.

TABLE 9
Results from the 69 Analyzed Stocks

STOCKS	Lamda 0	Lamda 1	Lamda 2	Conv. (d)	Tendency (γ_1)	Asymmetry (γ)
ALFAA	-0.594*	0.997*	0.001*	0.003	0.376	-0.049
AMTELA1	3730.683*	0.876*	3.798*	0.124	30.721	2.495**
AMXA	0.602	0.972*	0.013*	0.028	0.475	-0.414**
AMXL	387.169	1.012*	-1.343*	0.012	-112.088	-0.048
ARA	-30.412*	1.170*	0.174*	0.17	1.023	1.049**
ARCA	-2737.404*	1.003*	4.045*	0.003	1219.71	1.467**
ASURB	-2.67	1.019*	0.011*	0.019	0.568	-1.248**
AUTLANB	0.001*	1.218*	-0.000*	0.218	0	-0.274**
BACHOCOUBL	-0.016*	0.950*	0.000*	0.05	0.001	0.372**
BIMBOA	-138.207*	0.894*	0.498*	0.106	4.683	-0.431**
C01	1107.336*	1.011*	-5.460*	0.011	-491.221	2.122**
CABLECPO	-451.746*	1.091*	0.477*	0.091	5.244	0.157**
CEL	-20.547	1.018*	0.042	0.018	2.278	0.592**
CEMEXCPO	-1543.609*	0.900*	8.578*	0.1	85.896	-0.136**
CIEB	-14.466*	0.964*	0.019*	0.036	0.532	0.151**
CINTRAA	-39.074*	1.101*	0.059*	0.101	0.583	0.321**

STOCKS	Lamda 0	Lamda 1	Lamda 2	Conv. (d)	Tendency (γ_1)	Asymmetry (γ)
CMOCTEZ	32.872*	1.125*	-0.050*	0.125	-0.397	-0.678**
COLLADO	0.014	1.156*	0	0.156	-0.001	0.465**
COMERCIUBC	137.054*	0.824*	0.215*	0.176	1.218	-2.189**
CONTAL	95.512*	0.977*	-0.070*	0.023	-3.01	0.027**
CYDSASAA	0.986*	1.199*	-0.001*	0.199	-0.007	0.371**
DESCB	-0.397*	1.023*	0.001*	0.023	0.023	-0.340**
ELEKTRA	126.145*	0.927*	3.679*	0.073	50.393	1.842**
GCARSO_A1	17.743*	1.002*	-0.117*	0.002	-74.306	0.519**
GCC	-5.849*	0.993*	-0.003	0.007	-0.448	-0.390**
GCORVIUBD	-0.002	0.987*	0.000*	0.013	0.003	-0.417**
GEOB	-5.646	1.051*	-0.400*	0.051	-7.906	1.279**
GFINTERO	35.601*	0.864*	-0.031*	0.136	-0.23	-0.463**
GMEXICO_B	-194.548*	1.008*	2.321*	0.008	287.457	-0.368**
GMODELO_C	2.613*	0.989*	-0.046*	0.011	-4.339	4.327**
GFMULTIO	12.723*	0.542*	-0.012*	0.458	-0.027	-0.128**
GFNORTEO	0.212*	0.985*	-0.001*	0.015	-0.09	-0.834**
FEMSA_UBD	-20.625*	0.628*	0.039*	0.372	0.105	0.105**
GIGANTE	0.103*	0.932*	-0.000*	0.068	-0.002	-0.455**
GINBURO	-371.170*	0.814*	1.431*	0.186	7.674	-0.446**
GISSA	20.111*	0.935*	-0.016*	0.065	-0.242	-0.158**
GRUMAB	158.505*	0.965*	-0.120*	0.035	-3.417	1.949**
HOGARB	-1.334*	1.023*	0.001*	0.023	0.046	0.779**
SANBORB1	2.240*	0.981*	-0.004*	0.019	-0.217	1.921**
HILASALA	0.016*	0.943*	-0.000*	0.057	0	-0.544**
HOMEX	338.797*	0.925*	1.622*	0.075	21.645	-1.306**
ICA	-89.459*	0.889*	0.439*	0.111	3.952	-0.427**
ICHB	-27.838*	0.853*	0.156*	0.147	1.061	-0.060**
INVEXO	0.005*	1.147*	-0.000*	0.147	-0.001	-1.685**
IXEGFO	2.620*	0.784*	-0.008*	0.216	-0.038	0.278**
KIMBERA	1.940*	1.010*	-0.007*	0.01	-0.65	2.619**
KIMBERB	-1.404*	1.016*	0.005*	0.016	0.325	0.413**
KOFL	0.068*	0.712*	0.018*	0.288	0.061	-0.672**
LIVEPOL1	-0.447*	0.864*	0.002*	0.136	0.015	0.052**

STOCKS	Lamda 0	Lamda 1	Lamda 2	Conv. (d)	Tendency (γ_1)	Asymmetry (γ)
MASECAB	-1.409*	1.085*	-0.005*	0.085	-0.061	0.708**
NAFTRAC	95.594	1.005*	-0.27	0.005	-50.636	-0.265**
MOVILAB	-1.679*	1.421*	0.001*	0.421	0.003	0.070**
PENOLES	-17.078*	0.926*	0.106*	0.074	1.422	-0.117**
PINFRA	255.345*	1.021*	-1.169	0.021	-55.907	0.641**
SANLUISCPO	0.002	1.062*	0.000*	0.062	0	-0.604**
SAREB	-424.372*	0.911*	2.650*	0.089	29.618	21.263**
SIMECB	-0.007*	1.034*	0.000*	0.034	0.001	-1.287**
SORIANAB	-65.545*	0.869*	0.820*	0.131	6.235	0.151**
TELECOMA1	157.850*	0.959*	0.317*	0.041	7.689	-0.096**
TELMEXA	-1.702*	0.927*	0.017*	0.073	0.231	0.036**
TELMEXL	556.004*	1.018*	-2.056*	0.018	-111.742	0.450**
TLEVISACPO	4186.627	0.846*	4.570*	0.154	29.624	-2.316**
TS	-50.301*	1.319*	0.072*	0.319	0.226	1.184**
TVAZTCACPO	-31.663*	0.919*	0.275*	0.081	3.378	-0.707**
URBI	2243.095*	0.479*	34.092*	0.521	65.472	1.459**
USCOMB1	161.367*	0.747*	-0.157*	0.253	-0.622	-0.11
VALLEV	0.046*	0.912*	-0.000*	0.088	-0.001	1.051**
VITROA	12.789*	0.998*	-0.038*	0.002	-20.852	-1.523**
WALMEXV	1909.146*	0.977*	0.635*	0.023	27.691	-0.127

First we must remember that the series used as NCF are obtained from the proxy multiple (stock price) * (operated traded), therefore the results obtained are an estimate of the correct value.

On the other hand, in the real life, enterprises have just one NCF record; in this thesis we have an NCF series for every stock, and we even have a couple of series for some cases, for instance from enterprises such as Kimberly and Telmex:

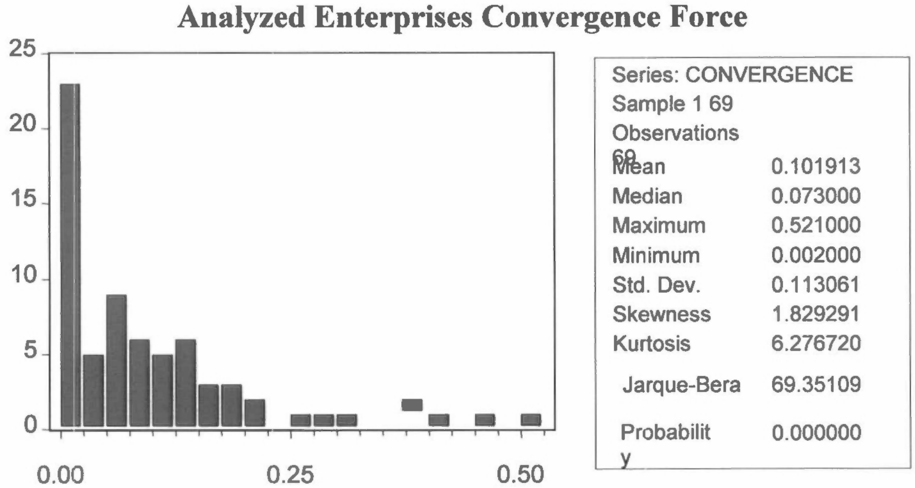
AMX_A	KIMBER_A	TELMEX_A
AMX_L	KIMBER_B	TELMEX_L

Stocks of series type A, B, L, CPO, O, UBD etc. have different characteristics under investor view therefore their marketability goes independently one another.

It is evident these have different contents to offer in themselves and they are part of the corporative portfolio, so their trajectory estimated as NCF is independent and necessarily different.

In the convergence column we analyze the *d* parameter (convergence force), which means that bigger *d* is, stronger the tendency to find NCF convergent value is, so it explains how large the "rift" between results obtained and results planned is.

CHART 34
Analyzed Enterprises Convergence Force



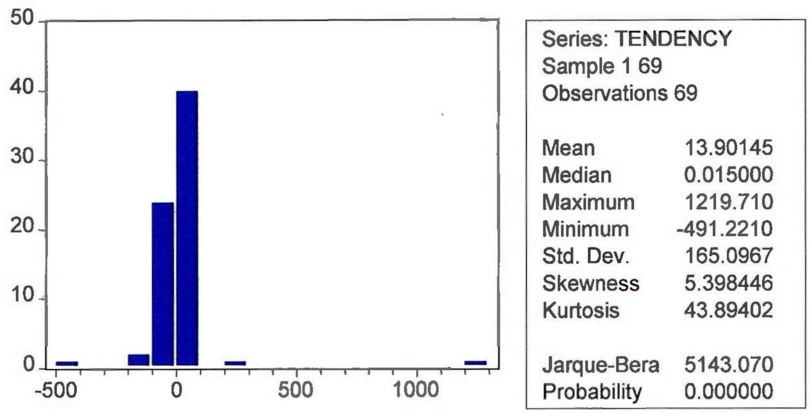
The graph above shows that a significant number of enterprises which do not have an important convergence force (their effect is feeble), there are few stocks which his record show an elevated value, for example: URBI (0.521), GFMULTIO (0.458), MOVILAB (0.421), FEMSA_UBD (0.372) y TS (0.319). This means their NCF follow a suitable trajectory, consequently the enterprise is managing its variables correctly or it is efficient while manipulating them.

It is noteworthy to look at enterprises whose convergence is close to zero, this indicates that the *d* parameter value is small and therefore its effect is weak, it means the "rift" between results obtained and planned results is large.

We notice that main enterprises that participate in the financial market are not the ones that present the largest value for the *d* parameter.

Tendency parameter capture if NCF is increasing, if NCF is stable or if NCF decreases. If it is increasing ($\gamma_1>0$), we get an enterprise that grows. If NCF is stationary ($\gamma_1=0$) we find a mature enterprise in the market. If NCF is decreasing ($\gamma_1<0$) we get an enterprise having problems, if these are financial ones, it might have to issue debt to face its commitments.

CHART 35
Analyzed Enterprises Tendency Parameter



It is commonly observed that most of the stocks (enterprises) are mature on the market. Three of them from the total present stable flows, 44 an increasing tendency and 21 decreasing tendency. And groups draw to a close as it is showed below:

Just three stocks: HILASALA, SANLUISCPO and AUTLANB record a stationary NCF, it means a ($\gamma_1=0$).

In cases when ($\gamma_1>0$), three groups are identified: At a first group with an increasing tendency the following stocks are found: GMEXICO_B (287.457), CEMEX CPO (85.896), URBI (65.472), ELEKTRA (50.393), AMTELA1(30.721), SAREB (29.618), TLEVISACPO (29.624), WALMEXV (27.691), and HOMEX (21.645).

At a second group we locate ten more stocks with a weightless increasing tendency (with values between 1 and 8) and at the third group we have 16 series which present an increasing tendency with values close to 0.

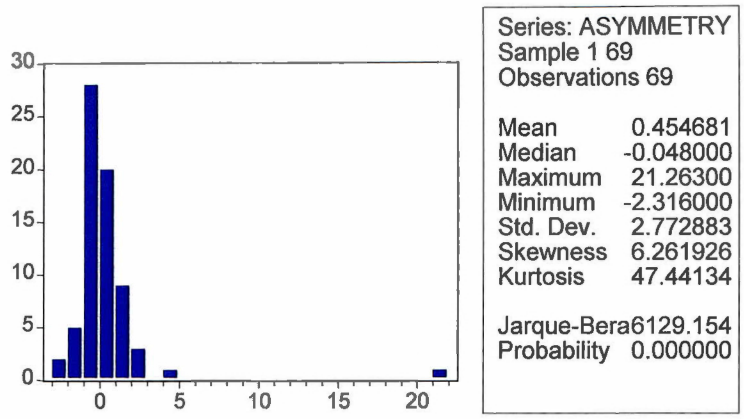
ARCA is also classified in (γ_1>0) as an exceptional case since γ_1=1219.71 so is suspiciously high (otherwise grows steadily). As showed, this figure is a case where the model exploded.

At series with a remarkable decreasing tendency, when (γ_1<0): CO1 (-491.221), AMXL (-112.088), TELMEXL (-111.742), GCARSO_A1 (-74.306) stand out. At a second group: PINFRA (-55.907), NAFTRAC (-50.636) and VITRO (-20.852). At a third group with a γ_1 value close to -0.5, we get 16 series. And with γ_1 values between -1 and -8, four cases.

Asymmetry parameter (γ) measures the news impact on the enterprise and it is linked to the news curve; there are times when the parameter value is "wrong", it means gamma is negative, it is due to the Maximum Likelihood (ML) function used, presents flat surfaces so the program gets a value on the negative component wrongly.

In table 9 it may be seen the asymmetry column presents 69 stocks whose values have an asterisk, this means the associated t-Student test informs that we can not reject the null hypothesis, therefore the parameter is significant. ALFAA, AMXL, USCOMB1 y WALMEXV cases, which do not have any asterisk, record asymmetry.

CHART 36
Analyzed Enterprises Asymmetry Parameter



In the chart enterprises may be observed a positive gamma>0, so these are the cases that comes with a strong "news effect", nevertheless a wrong group is also presented the one with gamma<0, this is figured out as a model failure and it is a clear reference when just a "proxy" has been used, instead of NCF series real data from each stocks.

By taking ±0.5 as a bench mark to separate when the effect is remarkable, and observing that any of the 69 enterprises has a tendency value that will be positive (it grows) null (stationary) or negative (it decreases); at asymmetry something analogue happens, the gamma parameter might be positive (there is a "news effect"), null (-0.5<gamma<0.5) remains stable, the curve is symmetrical, it means it reacts equally to good or bad news; or negative (inverse effect). The curve is inverted, this means the model failed.

This leads to 9 cells with all the possible combinations in which we classify the 69 analyzed enterprises showed in table 10: Tendency versus Asymmetry. Inside of each the nine cells is located the corresponding convergence parameter value. Convergence does not show any tendency to lay in any cell or region.

TABLE 10
Classification of Large Enterprises which are listed in Mexican Stock Market with dimensions "Tendency versus Asymmetry"

Tendency (Gamma$_1$)	Asymmetry Gamma > 0.5	-0.5 < Gamma < 0.5	Gamma < -0.5
Trend >0.5	ARkA 0.003 URBI 0.521 ELEKTR 0.073 AMTELA1 0.124 SAREB 0.089 CEL 0.018 ARA 0.170 TS 0.319 HOGARB 0.023	GMEXICO_B 0.008 CEMEXCPO 0.100 WALMEXV 0.023 TELECOMA1 0.041 GINBURO 0.186 SORIANAB 0.131 CABLECPO 0.091 BIMBOA 0.106 ICA 0.111 PENOLES 0.074 ICHB 0.147 CINTRAA 0.101 CIEB 0.036	TLEVISACPO 0.154 HOMEX 0.075 TVAZTCACPO 0.081 COMERCIUBC 0.176 ASURB 0.019
-0.5 < Trend < 0.5	VALLEV 0.088 MASECAB 0.085 SANBORB1 0.019 KIMBERA 0.010	AMXA 0.028 ALFAA 0.003 KIMBERB 0.016 TELMEXA 0.073 FEMSA_UBD 0.372 DESCB 0.023 LIVEPOL1 0.136 MOVILAB 0.421 GCORVIUBD 0.013 BACHOCOU 0.050	KOFL 0.288 SIMECB 0.034 SANLUISCPO 0.062 HILASALA 0.057 INVEXO 0.147 GFNORTEO 0.015 CMOCTEZ 0.125

		BL AUTLANB 0.218 COLLADO 0.156 GIGANTE 0.068 CYDSASAA 0.199 GFMULTIO 0.458 IXEGFO 0.216 GFINTERO 0.136 GISSA 0.065 GCC 0.007	
Trend<-0.5	GRUMAB 0.035 GMODELO_C 0.011 GEOB 0.051 PINFRA 0.021 GCARSO_A1 0.002 C01 0.011	USCOMB1 0.253 CONTAL 0.023 NAFTRAC 0.005 TELMEXL 0.018 AMXL 0.012	VITROA 0.002

Only 19 enterprises present a "news effect" as it may be read at Engle, R. and Ng, V. (2000), 33 cases have a very weak effect, 13 of them have the inverted effect and 4 of them do not have any effect.

What we have learned from this exercise is related to the enterprises with a larger potential for increasing their NCF and for replying to market inconstancies, the most notable, shown by pairs as Tendency ($\gamma 1$) / Asymmetry (γ), among them are: URBI (65.47/1.45), ELEKTRA (50.39/1.82), AMTELA1 (30.72/2.49) and he exceptional ARKA (1219/1.46), SAREB fulfills this relationship (29.61/21.26), nevertheless its asymmetry parameter (21.26) is so high, it indicates that bad news affect largely cash flows behavior.

Among mature enterprises whose cash flow oscillates around their long term level: VALLE V, MASECA B, SANBOR B1, KIMBER A.

The enterprises with (γ>0), which have a decreasing NCF (γ_1<0) are: GRUMA_B (-3.41/1.9), GMODELO_C (-4.83/4.3), GEO_B (-7.90/1.2), PINFR_A (-55.90/0.64), GCARSO_A1 (-74.30/0.51), TELMEX (-111.74/0.45), C01 (-491.22/2.1).

At the last table we find all possible model combinations, which is formed with the Vasicek extended, Hull-White coupled with Asymmetric Information. We have the base model with its sub-models, we might say it is nested. It is clear that under this viewpoint it remains too much work to be done since the base model permits building other models or sub-models to be studied or confirmed with hypothesis tests. As seen, a way to synthesize the large results group that derivates from this research is through these three models, because a simultaneous estimation of all parameters is advisable at econometrical terms.

IV. INTERPRETATION OF THE DIFFERENT SHAPES TAKEN BY NEWS CURVE

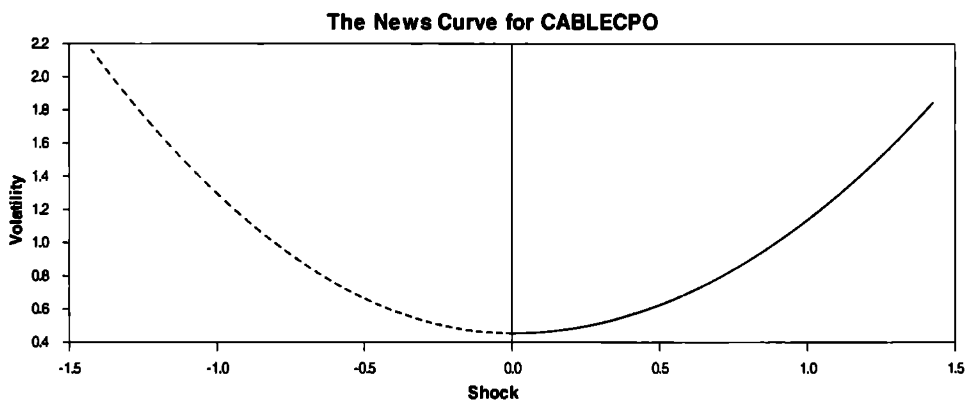
Enterprises whose news curve seems symmetrical, so their "news effect" is feeble are:

1. With a grow tendency (γ_1>0) in their NCF: GMEXICO_B, CEMEX_CPO, WALMEX_V, TELECOM_A1, GINBUR_O, SORIANA_B, CABLE_CPO, BIMBO_A, ICA, PEÑOLES. Important consolidated firms are found

in this group, characterized by their aggressive growing strategies. CEMEX CPO, ICA and PEÑOLES belong to the construction economic sector. WALMEX V and SORIANA B are retail enterprises and TELECOM A1 together with CABLE CPO located at the telecommunication sector.

2.

CHART 37



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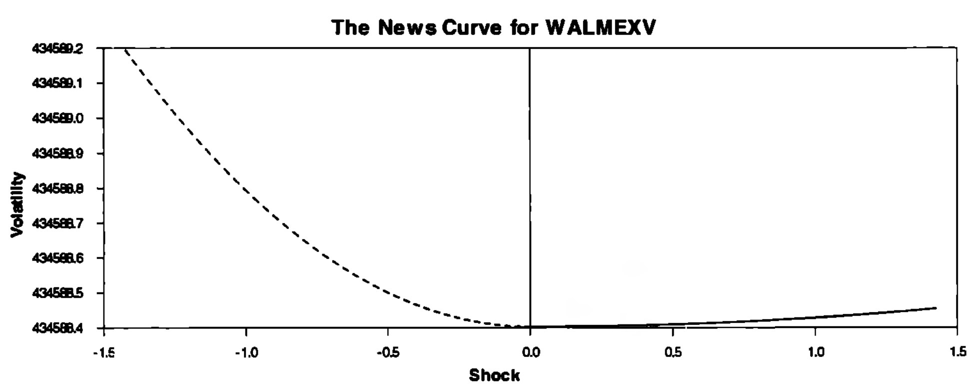

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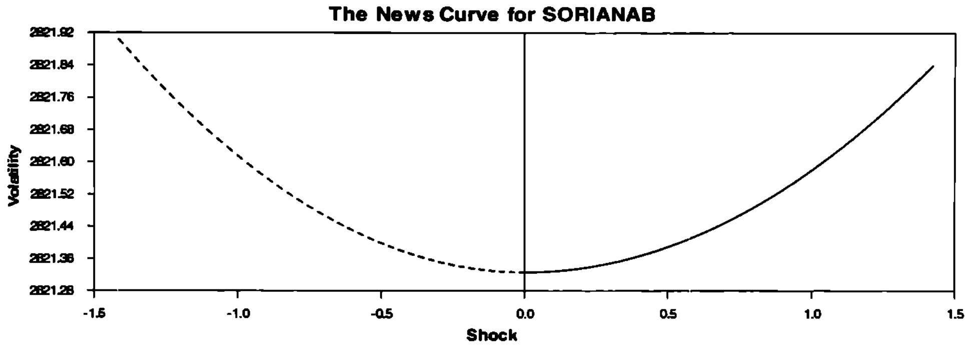

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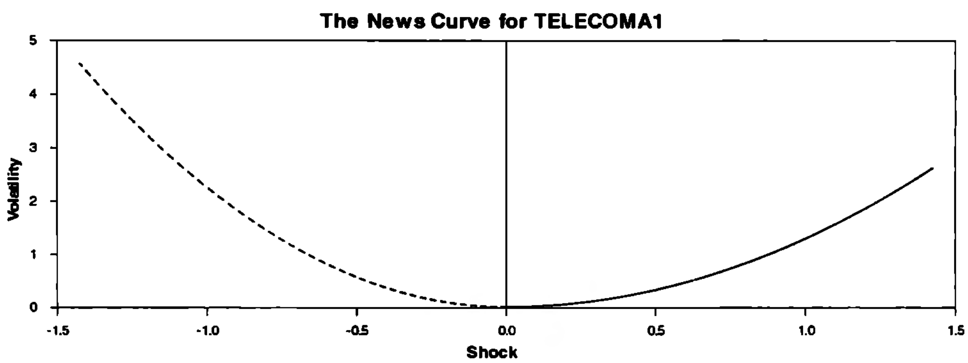

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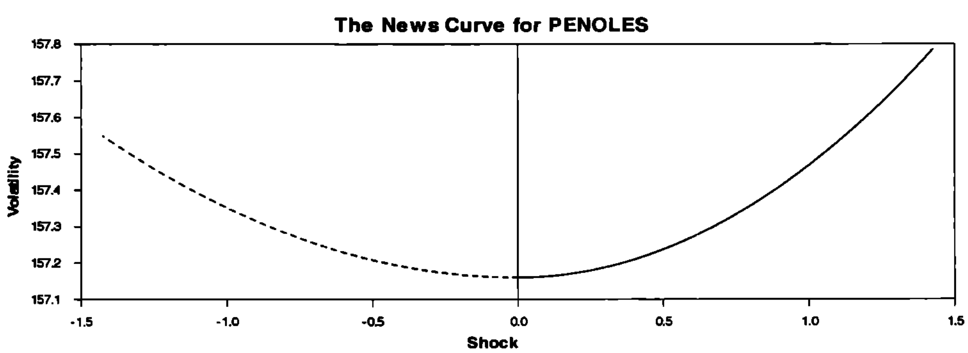

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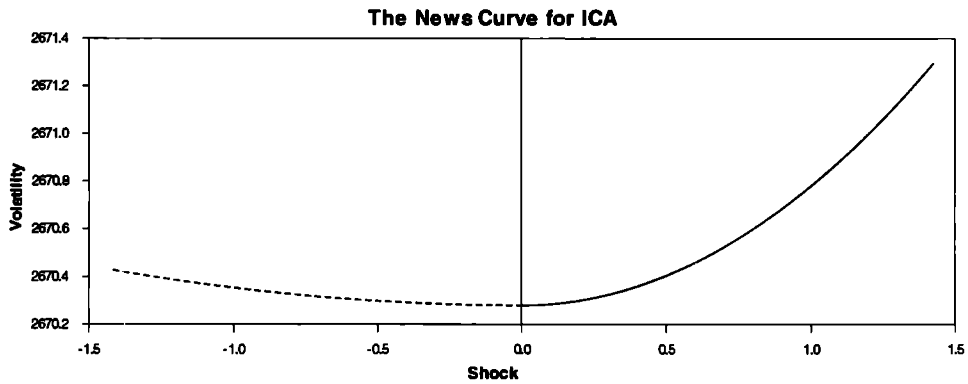

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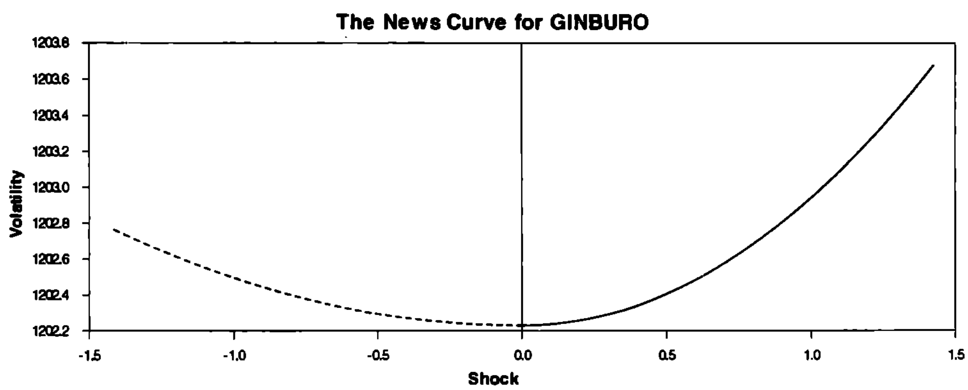

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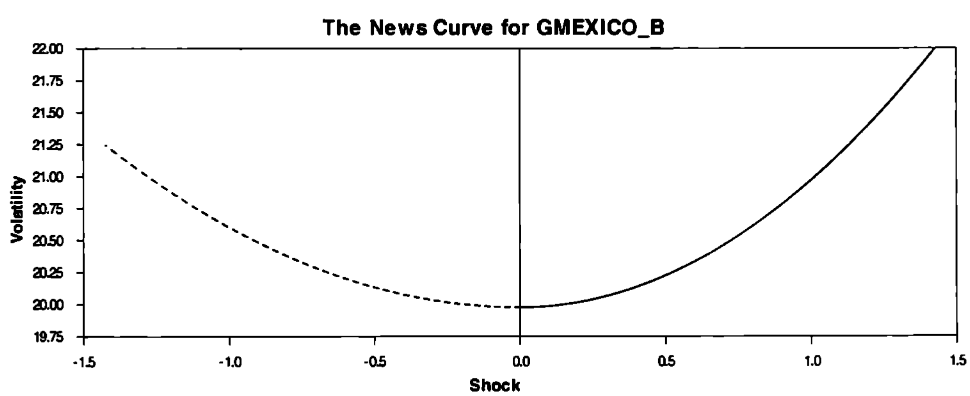

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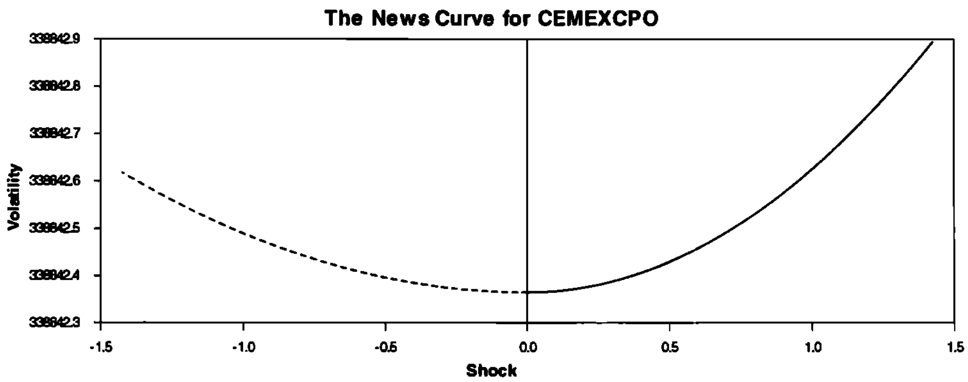

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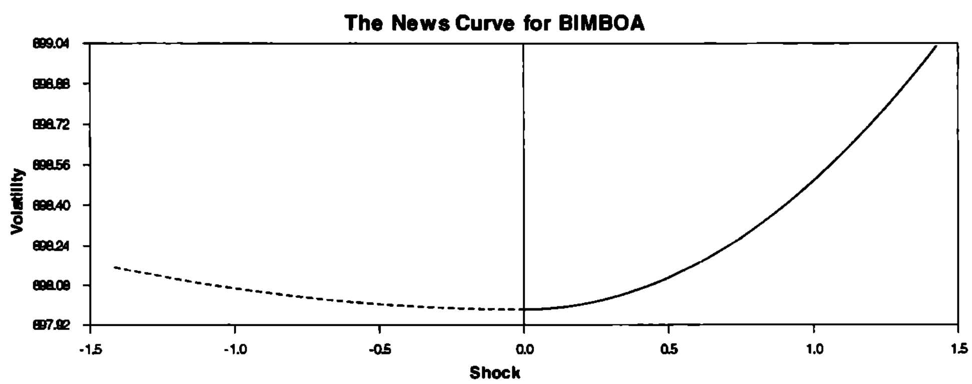
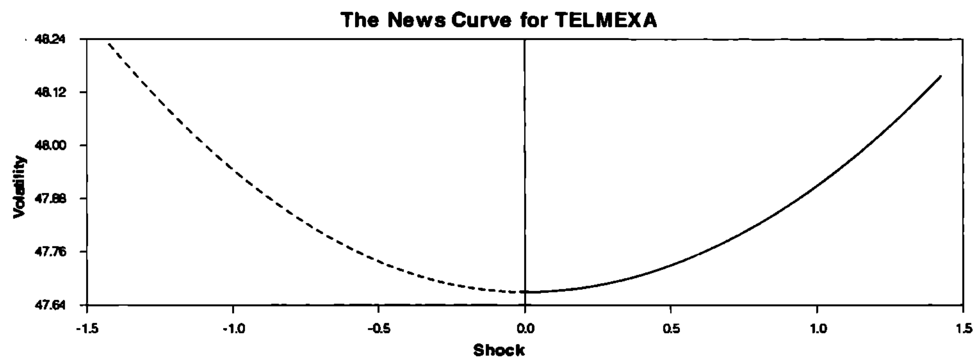


2.With a stationary cash flow near to (γ_1=0), they are mature enterprises whose NCF oscillations are around their long term level are: AMXA, ALFA_A, KIMBER_B, TELMEX_A, FEMSA_UBD, DESC_B, LIVEPOL_1, MOVILA_B, GCORVI_UBD, BACHOCO_UBL, AUTLAN_B, COLLADO, GIGANTE, CYDSASA_A, GFMULTI_O, IXEGF_O, GFINTER_O, GISSA, GCC. At this group we identify three important "middle sized" financial groups, as well as important transnational consolidated enterprises (ALFA_A, FEMSA_UBD) structurally complex.

CHART 47



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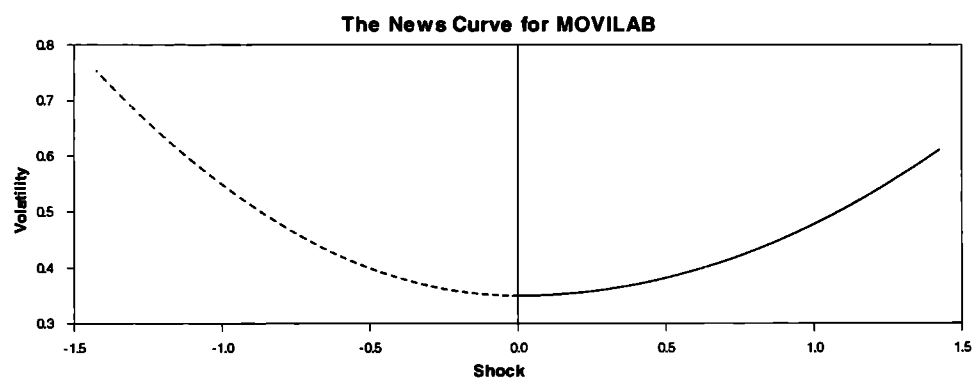

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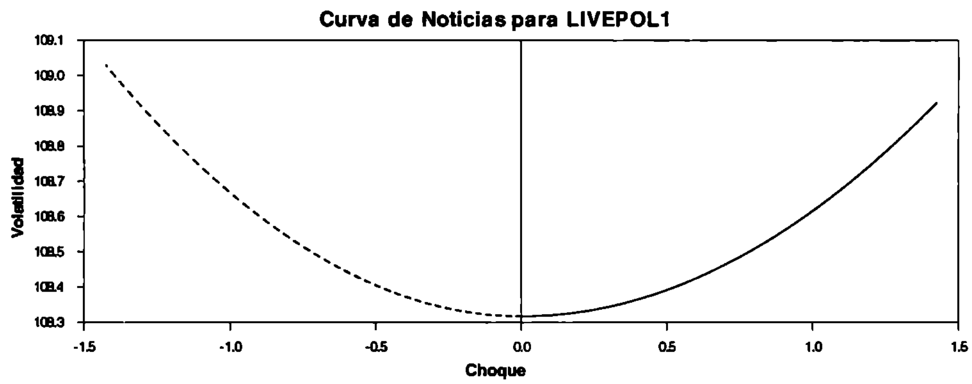

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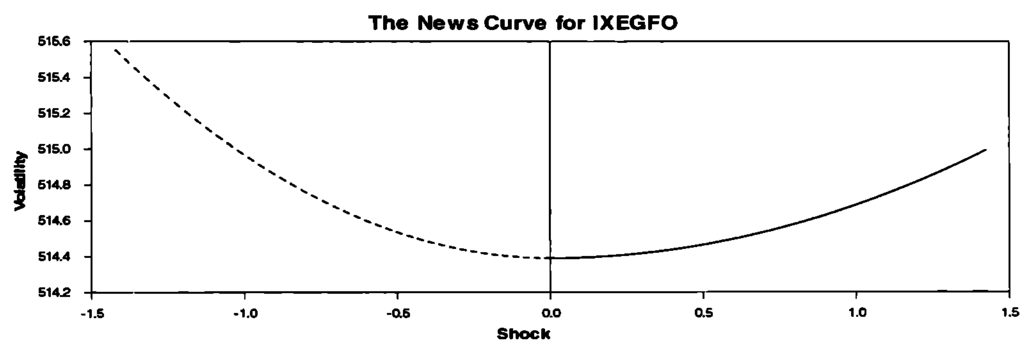

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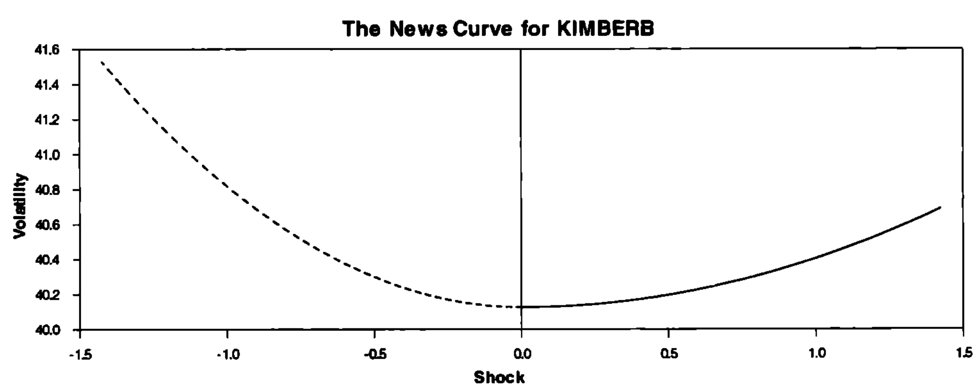

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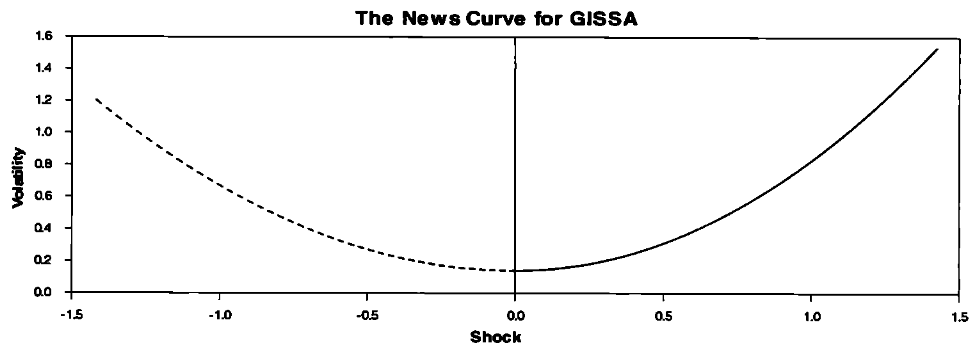

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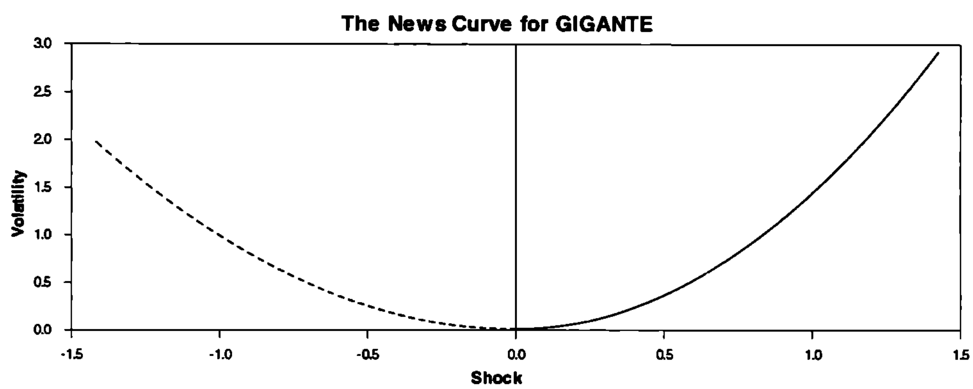

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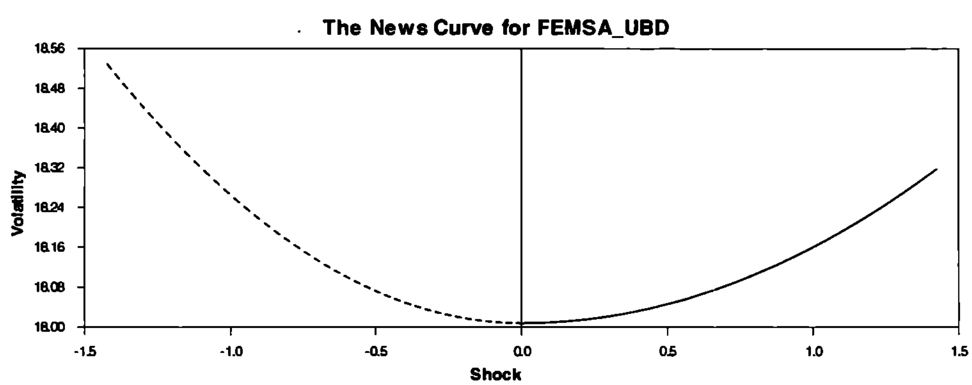

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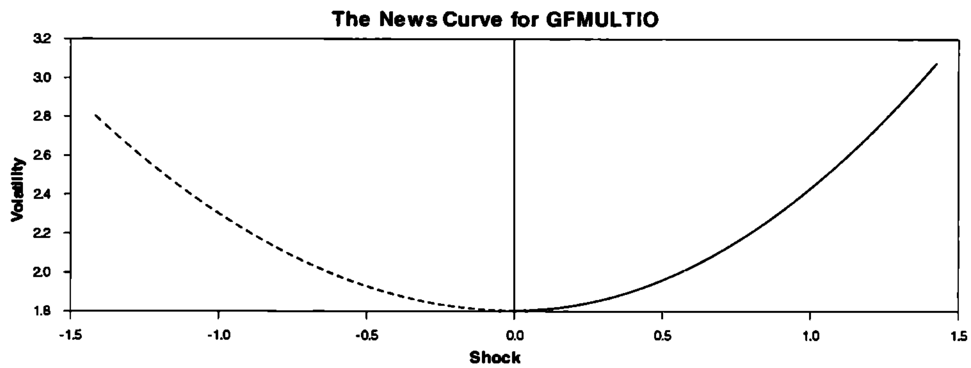

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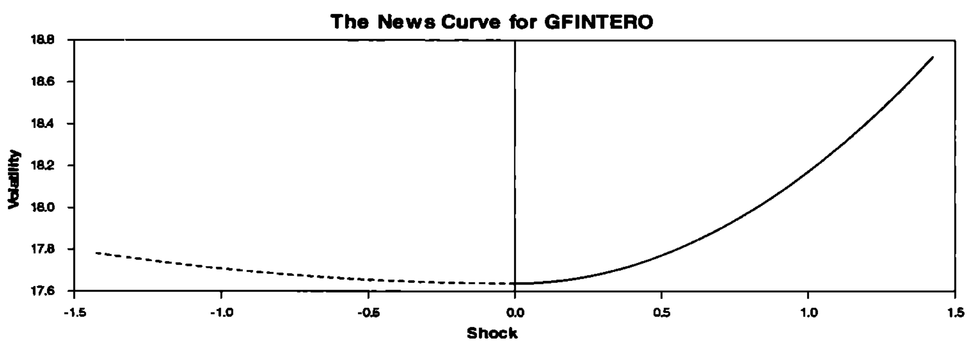

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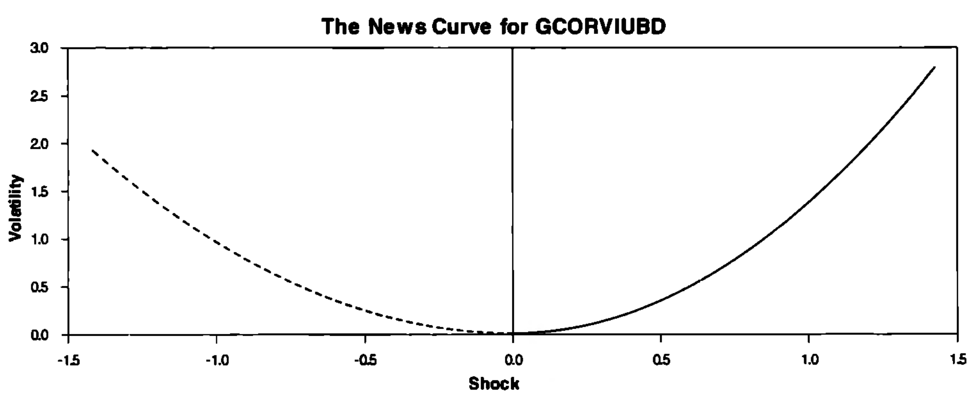

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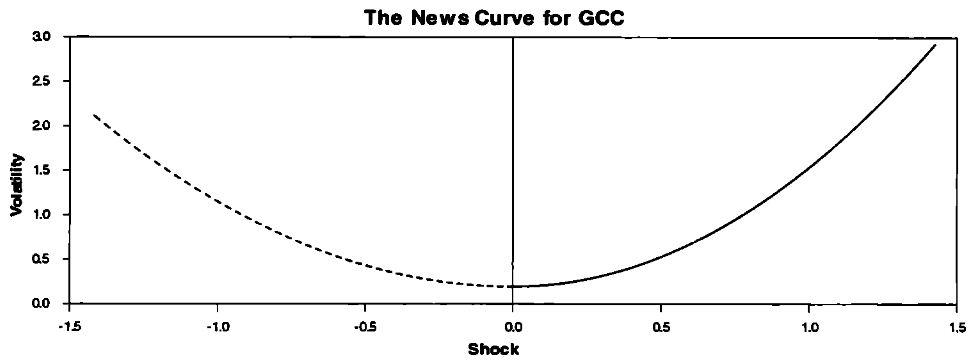

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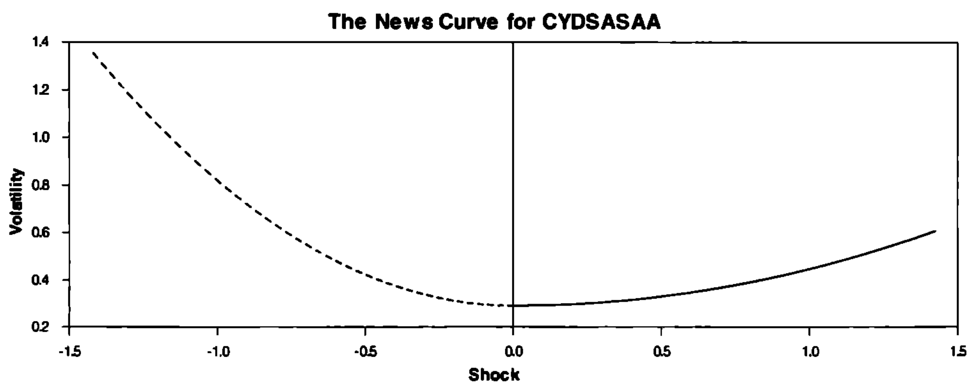

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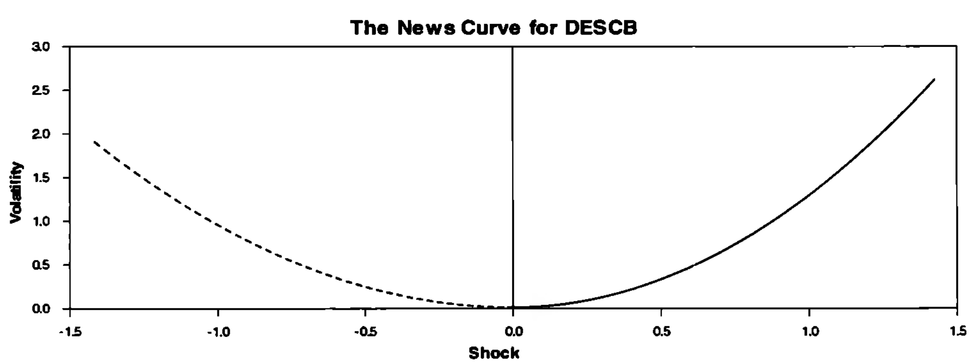

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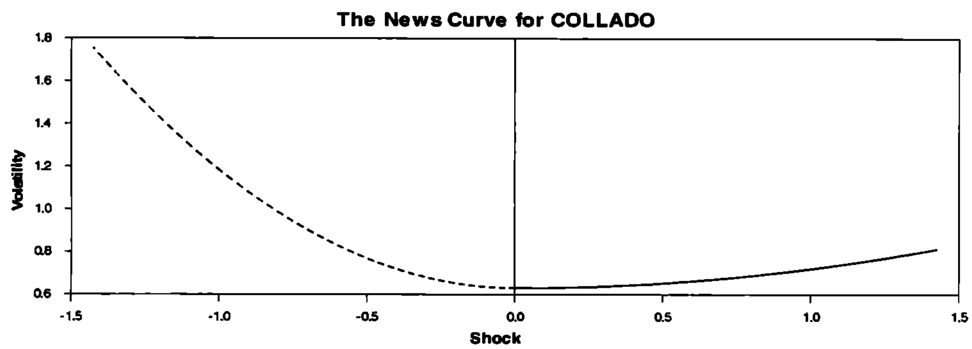

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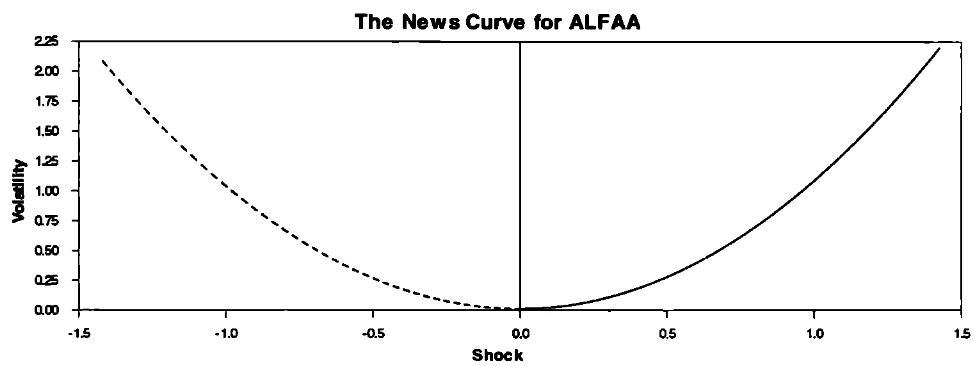

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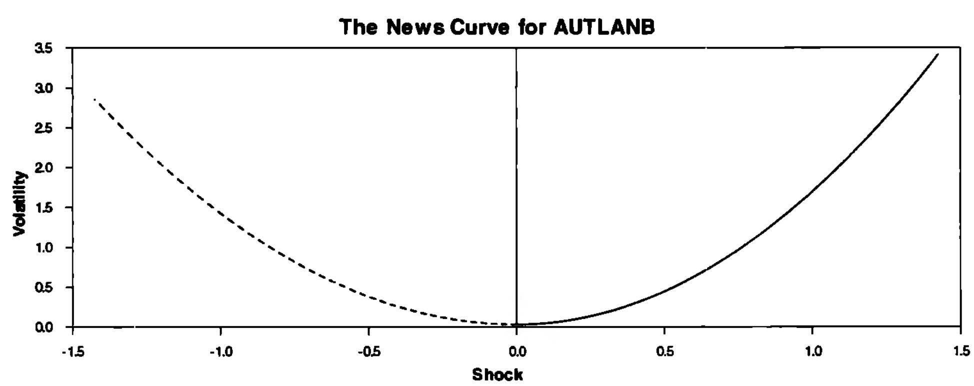


CHART 64

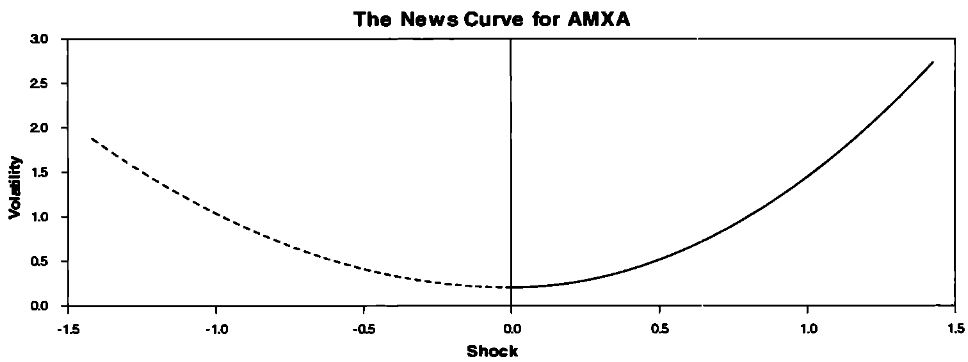
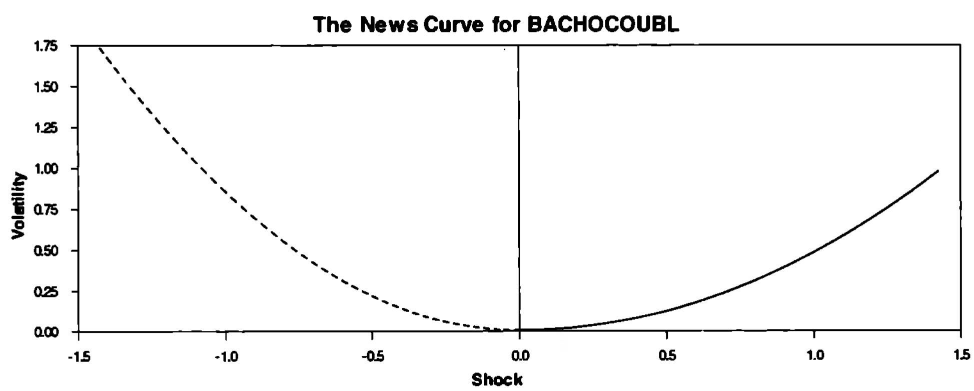


CHART 65



3.With a decreasing NCF ($\gamma_1<0$) their liquid resources usage is creating a challenge are: USCOM_B1, CONTAL, NAFTRAC, TELMEX_L and AMX_L.

CHART 66

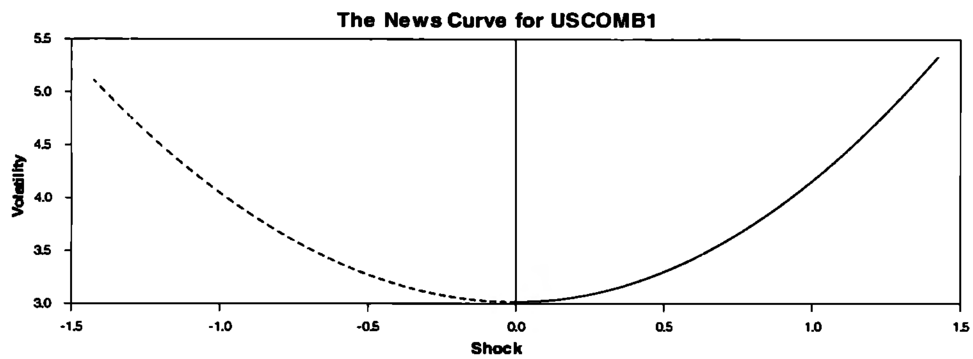


CHART 67

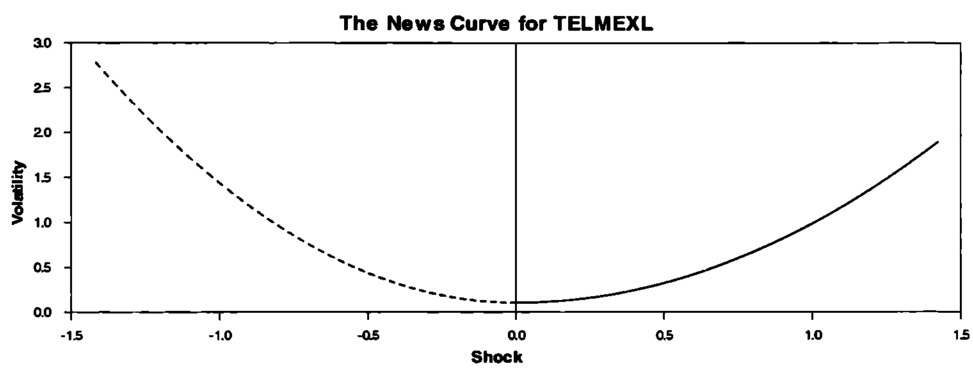


CHART 68

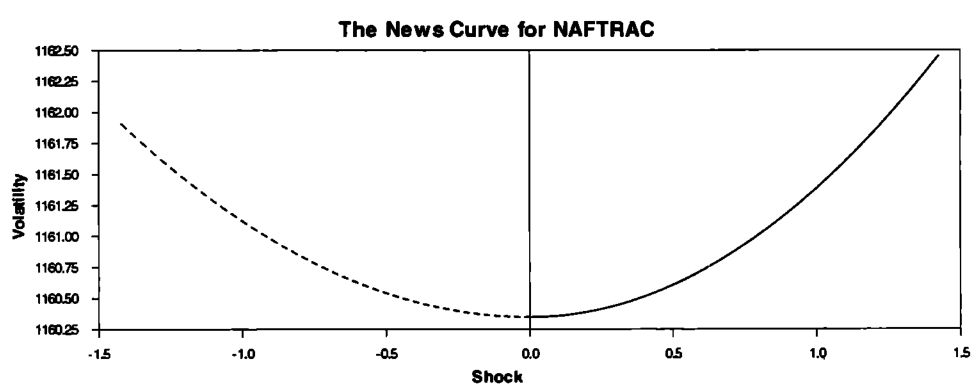


CHART 69

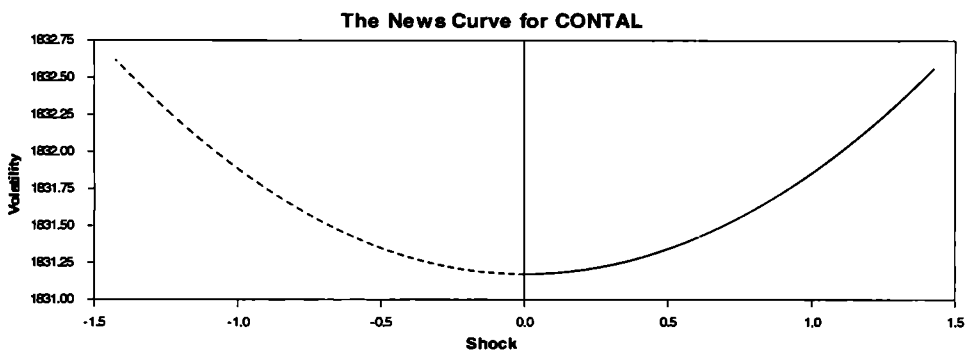
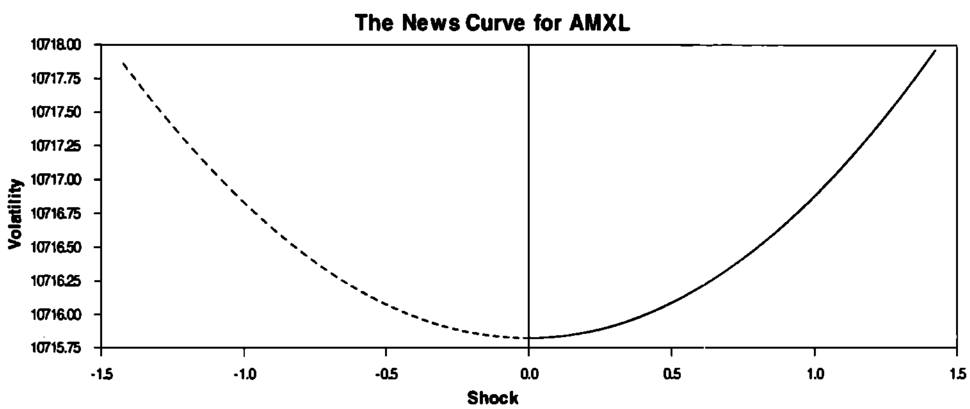


CHART 70



On the other hand, enterprises whose news curve seems asymmetrical so their "news effect" is strong are: TELEVISA_CPO, HOMEX, TVAZTCA_CPO, COMERCI_UBC, ASUR_B, KOF_L, SIMEC_B, SANLUIS_CPO, HILASAL_A, INVEX_O, GFNORTE_O, CMOCTEZ, VITRO_A. In this group, we locate the two most important communication enterprises in Mexico, which in reality represent the communications sector.

CHART 71

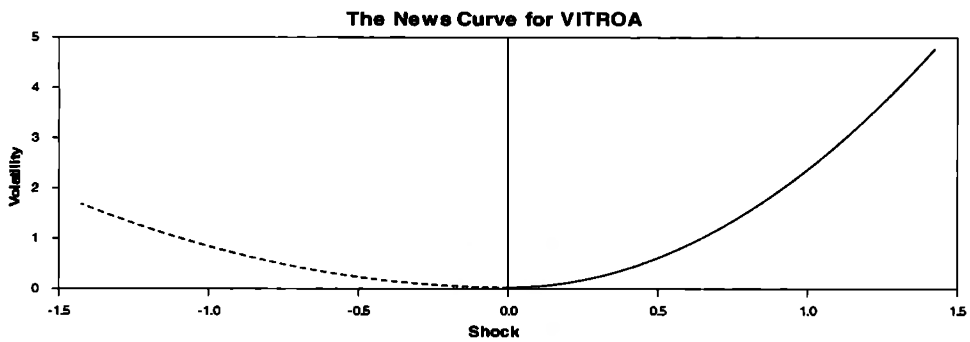


CHART 72

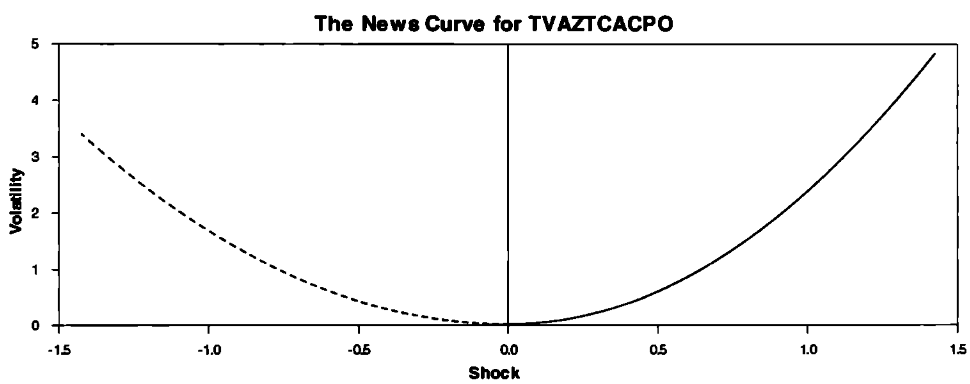


CHART 73

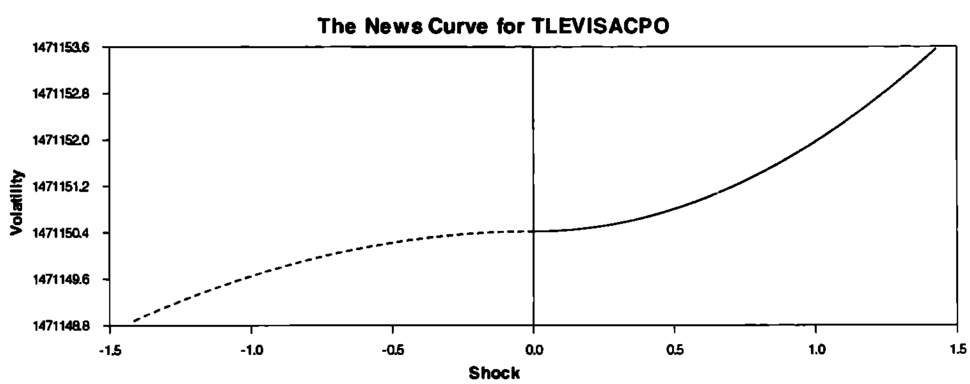


CHART 74

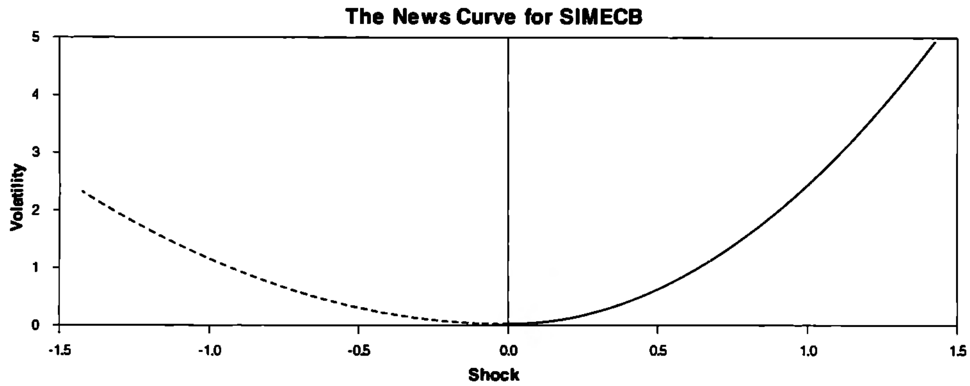
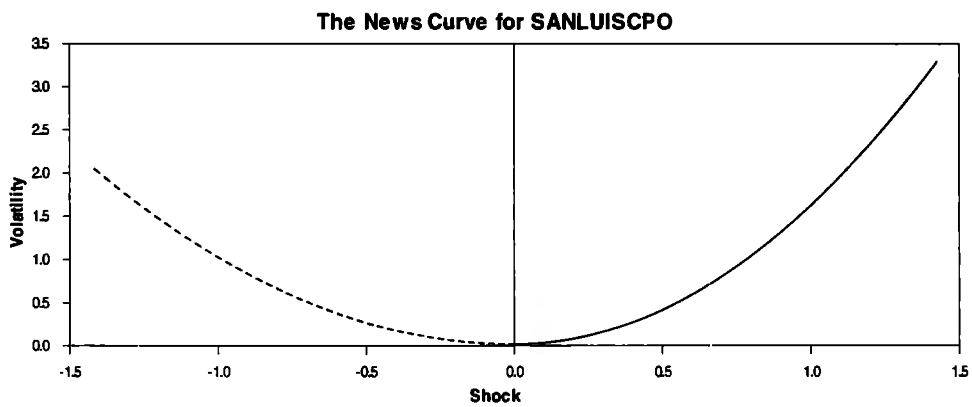


CHART 75



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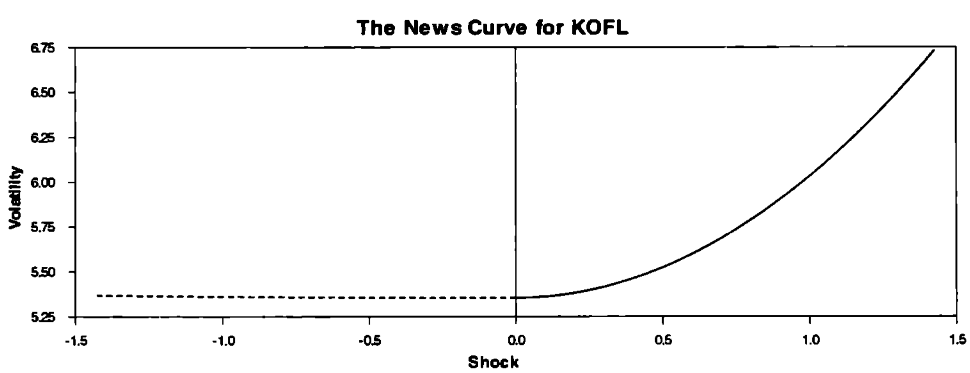

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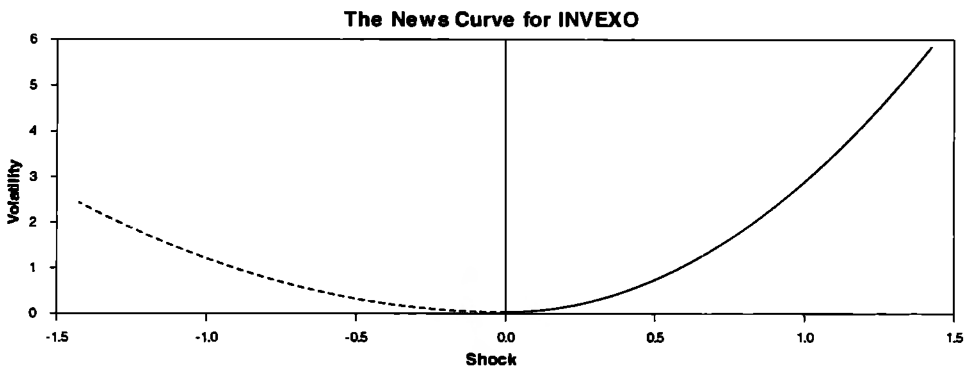


CHART 78

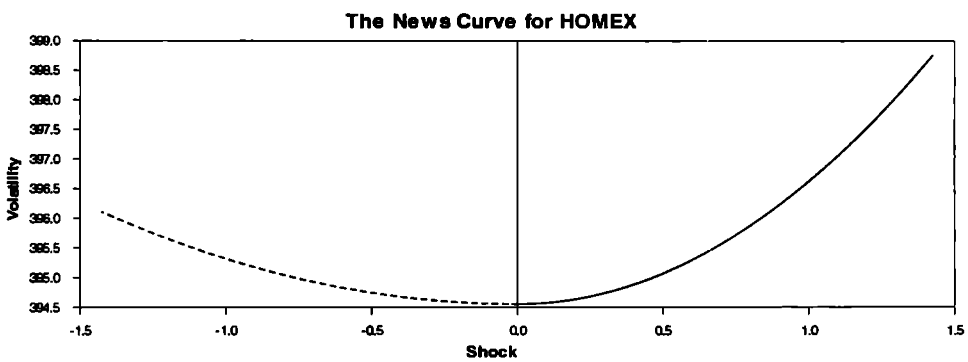


CHART 79

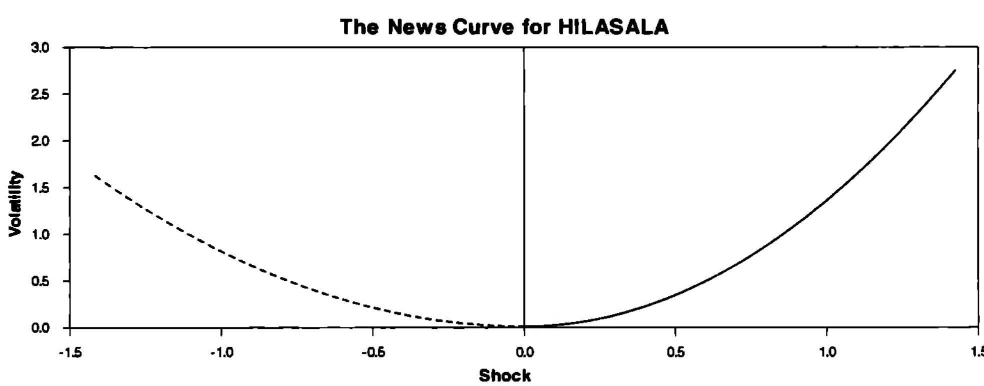


CHART 80

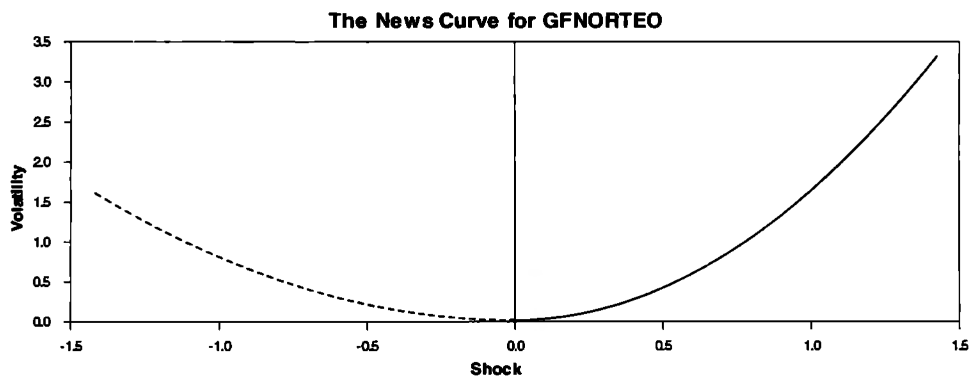


CHART 81

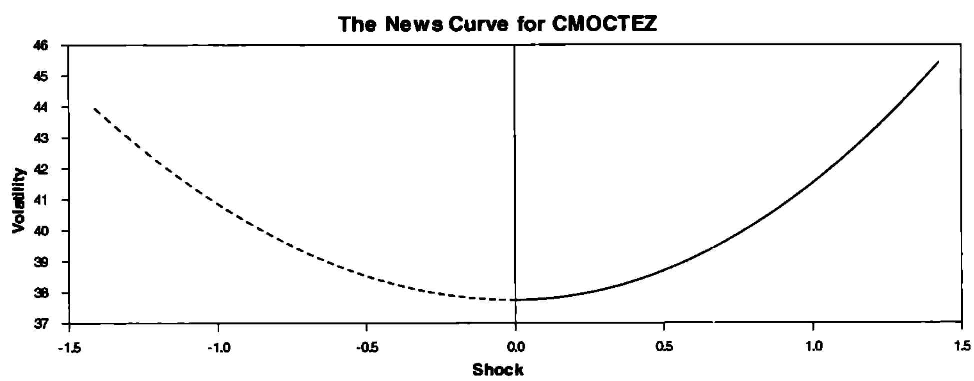


CHART 82

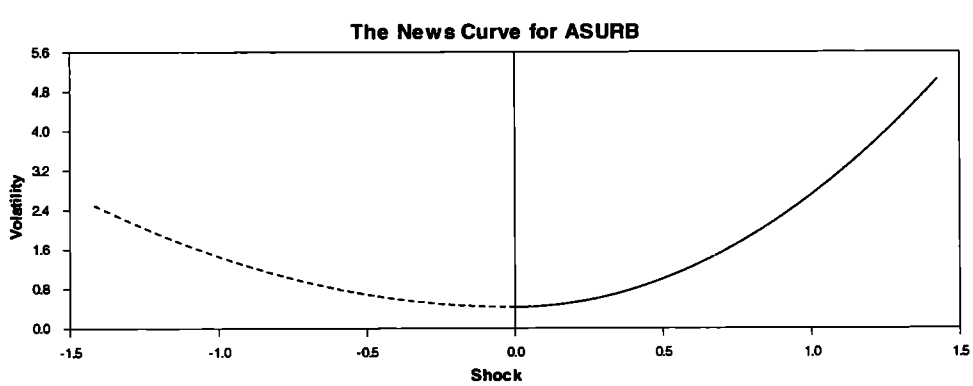
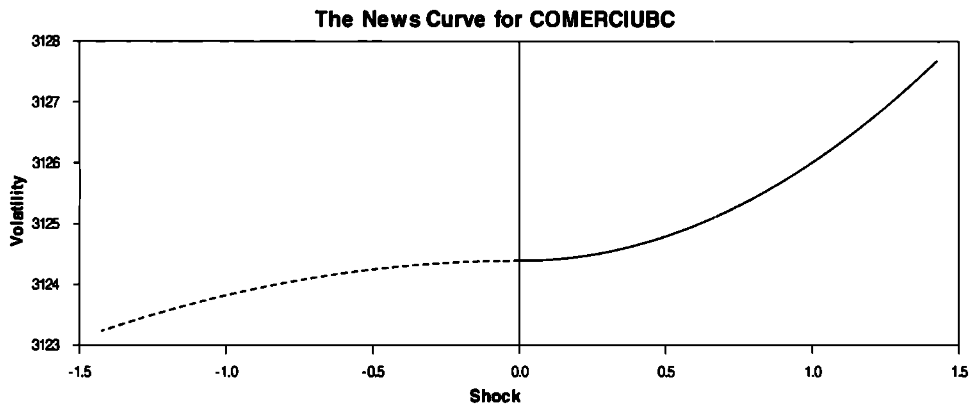


CHART 83



Results from this analysis are important since now is apparent a map about the large Mexican enterprises from a NPV focus. Our results are preliminary due to the constructed "Proxy" due to the lack of real data. With a thick market data from USA or Europe we might be able to predict NPV value accurately and therefore having a real option with more accurate value.

Nevertheless, what we learn and get from this exercise regarding the proposed model, is quite important:

The model is able to predict NCF behavior for large enterprises.

The model is able to read whether the enterprise has a growing NCF.

The model is able to locate the long run level for its NCF.

The model is able to state whether there is a "news effect" in the enterprise.

The model is able to measure efficiency, it means, convergence force.

The work provides a taxonomy for large enterprises which are listed in any stock market. The classifying directions are four: Convergence force (d), asymmetry (gamma) and tendency (gamma1) and long run level (support line).

It is important to highlight that the methodology developed is able to compare global competitive, via performing an exercise with enterprises from several countries and find out how they are located within the same multinational array. The taxonomy is able to gather industries in the same cell identifing enterprises that are global economic growth engines and in this sense influencing global macroeconomic aspects.

The outstanding feature is that the work is proficient to show how: *The enterprise measures its strategies to increase its ability of creating wealth in a random world, but this implies a new approach in the use of the techniques in capital investments theory and real options theory.* This focus requires the rejection of the traditional net present value theory.

Finally, in this thesis we assert: "The enterprise cash flow is an evolving process with mean reversion, but now the mean is under the administration control therefore the management may asses ways to determine the useful life of a project and might be extended by new investment projects, with a different real option valuation method".

Capital Investments is a critical topic for any long run analysis in the enterprises. We now might say: Wealth creation requires decisions and strategies that works so risk management and the ideas exposed have a long way to go in years to come.

CHAPTER 6

CONCLUSIONS AND FUTURE RESEARCH LINES

This research was written on the intention to contribute in Capital Investments Theory and consequently Real Options Theory. We have used the Stochastic Process Theory. Pindyck (1988), Dixit and Pindyck (1994), Dixit (1995), Bitola (1998), Ingersoll and Ross (1992), Venegas (2006) among others, advanced the knowledge in this area. This research takes concepts of this theory to review the traditional Net Cash Flow concept and therefore in the Net Present Value. A fundamental contribution to this thesis is considering external control variables (Z_t) which modify the Net Cash Flow trajectory. This gives a more accurate value for both: The modified NPV(Zt) and so while valuating VPN(Zt) $+\phi$, ϕ is the real option, therefore we see a step forward on the topic.

The present work has fulfilled its objective, step into the problems that Capital Investments Theory has to answer: Deal with real questions by analyzing the notion of Net Present Value from a new approach, here we have been proposed that the NPV is a stochastic process given by an integral instead of a summatory. This is because we should consider a continuous cash flow of future incomes. This idea goes in a different path from traditional ideas. This notion has shown capable to deal with a stochastic cash flow and unstable interest rates, tools are developed to manage enterprise possibilities in a global and changing world.

$$NPV_T = \mathrm{E}[\ \int_0^T NCF(t)e^{-r(t)t}dt\ ]$$

The interpretation of the formula is measure today (t=0) the net present value at the moment of expiration T, where 0 < T.

Now NCF is a stochastic process that the administration council looks forward and guides the evolution. This thesis leans on Stochastic Processes Theory with the possibility of generating a large range of models applied to financial areas. We have used diffusion processes with control variables (Z_t) and showed that these processes not only explain NCF evolution, but also guides it. The analysis about how to use control variables on diffusion processes is of the form:

$$dNCF_t = \mu(Z_t, NCF_t, t)dt+\sigma(Z_t, NCF_t, t)dW_t$$

Our model case is

$$dNCF_t = a(F(Z_t) - NCF_t)d_t + \sigma(t)\,dW_t$$

We have used the Vasicek model (1977) which is a diffusion process and due to its affinity with the purpose of this work had showed been applicable, but the possibility of studying more processes and proposing new ones is not excluded, still more. Only by focusing in the component $F(Z_t)$ formulation, proposing non-linear relations, we get the possibility of entering upon complex schemes.

Control variables could easily possess their own dynamics, and differential equations system (dZ=AZ+σdW) is taken as a "bench mark", here, it is possible to model a great variety of behaviors inside the enterprise administration.

Recall that in a VAR model, the variables can be project to future dates, using this knowledge with the control variables turns that NCF values could be anticipated. This has a main practical importance for enterprises, because with the anticipated cash flow values and interest rates scenarios it is possible to consider an analysis of a net present value kind (5, 6, 7 years future) conditioned to a given interest rate, therefore we arrive to menu of NPV valuations depending on an information available set.

There is a complete analysis for the discrete case and therefore a complete methodology for applying these ideas to any enterprise in any country.

This methodology is applied to the Mexican case (see table 10), particularly to large enterprises which are listed in the Mexican Stock Market and a taxonomy to get a classification of their situation derivates from it. We arrive 9 naturally possible cases and any enterprise is classified into one of them. The model is capable to identify enterprises that grow in their NCF. It would be interesting to compare with other results such as estimating their CAMP betas, are they aggressive?, We identify as well, which enterprises are mature and have a cash flow oscillating around its long term level, in addition to classifying which ones decrease.

The general model are estimated for 69 large enterprises and it shows where every enterprise is located over its corresponding quadrant, this also results as a map allowing having a clear panorama about industrial situation in Mexico.

According to the enterprises taxonomy presented like a consequence from this research, it is possible to select the enterprise efficient group in México. This way, it might be easily detected which sectors are economic development generators and which ones are not. Important of this classification is also the possibility to observe a sector that keeps vulnerabilities and thus find corrective measures.

Identifying which enterprises are growth engines in Mexico given that they provide employment and investment and they contribute to the gross national product, this is important due to the fact that some easing incentives for industry economic development could be proposed, reaching higher competitiveness and international development. This way, the thesis aims influence and help on our macroeconomic affairs.

In microeconomic terms, this research is important for enterprises willing to realize an investment project, because the model proposed is able to offer a more accurate valuation while considering NPV(t), NCF(t) and r(t) as stochastic processes and also while capturing control variables (Z_t) information exactly in it. The important point is that the administration council defines clearly the variables (Z_t) that affects its cash flows.

Por example, this model has the ability to answer question coming from banking institutions as well, for instance, estimating the growth parameter of enterprises. This is an important point, because it is possible to select a portfolio of stocks to which a bank may lend facing lower credit risk.

As it might be clear, this research concludes that for understanding actual enterprise problems, we must lay out the ultra traditional NPV and instead include stochastic process in the valuations related to cash flow and interest rate questions. In short, NPV is a stochastic process where discounted cash flow follows a trajectory according to control variables (Zt), a very distant criterion to the one observed from the ultra traditional viewpoint.

In order to review the impact on a real option value and therefore on real options theory, it would be enough to apply *modified NPV with external variables (Zt)* on a capital investment opportunity; we take back the idea that a real option is: $\overline{NPV} = \text{NPV} + \phi > 0$ and we ask whether the real option is such that $\text{NPV} < 0$, ϕ is call/put option such that $\overline{\text{NPV}} = \text{NPV} + \phi > 0$. Determine the value in ϕ at any of the methods used to valuate real options, for example through valuation of binomial lattices of Cox, Ross and Rubinstein (1979), etc.

We change the path by taking more steps before a decision is reach, instead we see the relation: $\overline{\text{NPV}(Z_t)} = \text{NPV}(Z_t) + \phi$ and we start in the same place with $\text{NPV} < 0$, and ϕ is a call/put option , now we suggest:

1.- Find a suitable Z_t such that $\text{NPV}(Z_t) > 0$.

2.- If for all possible sets { Zt } $\text{NPV}(Z_t) < 0$,

then find a couple $\{Z_t, \phi\}$ such that $\overline{\text{NPV}(Z_t)} = \text{NPV}(Z_t) + \phi > 0$.

The simple idea that takes ultra traditional NPV ignores:

1. The {Zt} set is actually acting over the cash flow estimates.

2. NPV is a stochastic processes not a deterministic one.

The firm has only one realization of the process and must take into account this fact.

Uncertainty is set to null thus eliminating the main concern to face in applied work.

The idea is that with the model proposed in the thesis, we approach a more accurate value while making the real option valuation. In short, NPV is stochastic due to the discounted cash flow behavior and is possible to guided it through control variables Z_t.

Typical questions emerged from administration council while making a capital investment decision can be answered from traditional viewpoint: VPN>0, from real options perspective traditional: $VPN+\phi>0$, or even from a new approach proposed in this thesis; $VPN(Z_t)+\phi>0$ as information joint associated to Z_t.

Classical real options inquiries investing in research and development; expanding or not annual production; postponing an investment project, etc. these are questions on the structure $\overline{NPV} = \text{NPV}(Z_t) + \phi > 0$. With this approach, accepting or rejecting an investment project depends on variables Z_t trajectories.

Finally, this thesis rejects the possibility of constant volatility, thus, a Stochastic Volatility Model was proposed (Wilmott, 1998), in order to have a risk dependence on time and a *news curve* emerges:

$$d\sigma_t^2 = (w - \theta\sigma_t^2)dt + \alpha\sigma_t dW_{2t}$$

The component of volatility model in its discrete version corresponds to a GARCH (1,1) model. We take explicitly the asymmetric function by Glosten, Nathan and Rankle (1993) as well in Rabemananjara and Zakoian (1993).

$$\sigma_t^2 = \omega + \alpha\varepsilon_{t-1}^2 + \beta\sigma_{t-1}^2 + \gamma \cdot I(\varepsilon_{t-1} < 0)$$

Where, ε is the positive or negative news which will affect the NCF result, thus we incorporate Asymmetric Information notion to obtain the news curve applied to cash flow return: "*There are good news (positive) when there is a cash flow rise and bad news (negative) when there is a decrease*" this allows to answer whether the NCF has an asymmetric volatility and therefore a news curve. See Engle and Ng (2000).

FUTURE RESEARCH LINES

1. To develop a methodology that permits to choose the set of control variables Z_t in such a way that is able to support real questions in Capital Investments Theory.

2. Give the general conditions for a linear function that ensures positiveness in the component $F(Z_t)$ in the diffusion model $dNCF(t) = a(F(Z_t) - NCF_t)dt + \sigma(t)\, dW(t)$
3. A question that evidently is not possible to be answered by now is: State the family of functions F and (Z_t) control variables which guarantees a positive NPV.
4. How to manage control variables to every Z_t component which maximize the NPV, it means in each time t, find Z_t so that: Max E $[NPV_T(Z_t) \mid \Omega_t]$ where Ω_t is the available information set for the enterprise at the moment t. Certainly! The answer must be express as an action rules; this is a Corporative Finance topic.
5. Any short interest rate model is compatible with the model proposal in the thesis, so it is important to validate this, simulation exercises must be done.
6. The possibility of including complex structures of information asymmetric notion on net cash flow analysis, might generate a future research line from another perspective for Corporative Finances.
7. The VAR model is a very well known topic in Time Series Theory, but it has not been used in cash flows analysis. VAR usage in this thesis is a beginning of what could be done, subjects as: Impulse-Response Analysis, Variance-Decomposition could come with interesting results in Capital Investments Theory.

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APPENDIX 1. Analysis for Stock Vasicek Model with Asymmetric Information

analysis*	AMTELA1*		
Vasicek parameters	Beta0	Beta1	
	890.31	0.90	
T-statistics Vasicek	24.11	1956.78	
News parameters	Alfa	Beta	Gamma
	1.24	-0.60	-1.26
News T-statistics	19.51	-48.88	-11.94
News parameters	Omega	A	Sigma2
	580813.40	580812.76	1.07
Used observations	1098.00		

Analysis*	AMXA*		
Vasicek parameters	Beta0	Beta1	
	3.69	0.99	
T-statistics Vasicek	4.33	645.99	
News parameters	Alfa	Beta	Gamma
	1.27	0.19	-0.37
News T-statistics	13.64	8.87	-3.50
News parameters	Omega	A	Sigma2
	14.80	14.99	1.00
Used observations	1397.00		

Analysis*	AMXL*		
Vasicek parameters	Beta0	Beta1	
	108916.54	0.71	
T-statistics Vasicek	739.49	1069.77	
News parameters	Alfa	Beta	Gamma
	0.68	-0.89	0.46
News T-statistics	55.95	-111.85	20.05
News parameters	Omega	A	Sigma2
	76341949.67	76341948.20	1.66
Used observations	1415.00		

Analysis*	ARA*		
Vasicek parameters	Beta0	Beta1	
	56.61	0.97	
T-statistics Vasicek	102418427328.50	70216.06	
News parameters	Alfa	Beta	Gamma
	0.40	-0.50	0.18
News T-statistics	122.08	-89.02	35.23
News parameters	Omega	A	Sigma2
	143577.01	143576.41	1.20
Used observations	2102.00		

Analysis*	ARCA*		
Vasicek parameters	Beta0	Beta1	
	276.53	0.81	
T-statistics Vasicek	52.81	961.97	
News parameters	Alfa	Beta	Gamma
	1.90	0.02	-0.46
News T-statistics	53.44	5.05	-7.46
News parameters	Omega	A	Sigma2
	1692.13	1692.15	0.79
Used observations	1192.00		

Analysis*	ASURB*		
Vasicek parameters	Beta0	Beta1	
	2.29	0.99	
T-statistics Vasicek	1.97	631.76	
News parameters	Alfa	Beta	Gamma
	1.23	0.23	-0.41
News T-statistics	14.80	11.60	-4.19
News parameters	Omega	A	Sigma2
	23.16	23.38	1.00
Used observations	1500.00		

Analysis*	AUTLANB*		
Vasicek parameters	Beta0	Beta1	
	-1.37	1.33	
T-statistics Vasicek	-158254.87	27314288.34	
News parameters	Alfa	Beta	Gamma
	0.01	-0.40	0.77
News T-statistics	1160653.53	-329441.92	275647.17
News parameters	Omega	A	Sigma2
	29.80	29.32	1.19
Used observations	2094.00		

Analysis*	BACHOCOUBL*		
Vasicek parameters	Beta0	Beta1	
	-36.33	0.85	
T-statistics Vasicek	-1954172828.60	4758710095.12	
News parameters	Alfa	Beta	Gamma
	2.26	0.01	-1.37
News T-statistics	428962374.05	1771902703.84	-112147686.38
News parameters	Omega	A	Sigma2
	305.27	305.28	0.51
Used observations	2101.00		

Analysis*	BIMBOA*		
Vasicek parameters	Beta0	Beta1	
	1899.87	0.87	
T-statistics Vasicek	170.78	261.09	
News parameters	Alfa	Beta	Gamma
	1.39	0.01	-0.40
News T-statistics	43.89	1.96	-7.49
News parameters	Omega	A	Sigma2
	131982.90	131982.90	0.85
Used observations	2102.00		

Analysis*	C*		
Vasicek parameters	Beta0	Beta1	
	134.69	0.96	
T-statistics Vasicek	6.55	288.13	
News parameters	Alfa	Beta	Gamma
	1.22	0.25	-0.51
News T-statistics	13.82	11.13	-5.36
News parameters	Omega	A	Sigma2
	11814.48	11814.73	1.00
Used observations	1283.00		

Analysis*	CABLECPO*		
Vasicek parameters	Beta0	Beta1	
	5.79	-0.07	
T-statistics Vasicek	3.49	-9.04	
News parameters	Alfa	Beta	Gamma
	0.31	-0.25	-0.12
News T-statistics	28.61	-33.91	-17.40
News parameters	Omega	A	Sigma2
	5088.24	5087.82	1.68
Used observations	1141.00		

Analysis*	CEL*		
Vasicek parameters	Beta0	Beta1	
	-32.46	0.97	
T-statistics Vasicek	-2190.07	69585.87	
News parameters	Alfa	Beta	Gamma
	0.58	-0.39	-0.52
News T-statistics	427821.09	-340277.34	-228403.79
News parameters	Omega	A	Sigma2
	140437.00	140436.90	0.26
Used observations	685.00		

Analysis*	CEMEXCPO*		
Vasicek parameters	Beta0	Beta1	
	2.66	0.99	
T-statistics Vasicek	22.75	3658.35	
News parameters	Alfa	Beta	Gamma
	1.22	0.29	-0.33
News T-statistics	14.33	13.45	-3.75
News parameters	Omega	A	Sigma2
	0.27	0.55	0.95
Used observations	2102.00		

Analysis*	CIEB*		
Vasicek parameters	Beta0	Beta1	
	277.27	0.92	
T-statistics Vasicek	0.00	648.02	
News parameters	Alfa	Beta	Gamma
	0.41	-1.00	1.05
News T-statistics	83.81	-31772.85	123.59
News parameters	Omega	A	Sigma2
	2675578.77	2675578.24	0.53
Used observations	2102.00		

Analysis*	CINTRAA*		
Vasicek parameters	Beta0	Beta1	
	-33.28	0.95	
T-statistics Vasicek	-1328.83	15799.19	
News parameters	Alfa	Beta	Gamma
	0.33	-0.53	0.40
News T-statistics	78.85	-321.26	80.62
News parameters	Omega	A	Sigma2
	162513.46	162513.16	0.56
Used observations	1979.00		

Analysis*	CMOCTEZ*		
Vasicek parameters	Beta0	Beta1	
	-12.68	0.70	
T-statistics Vasicek	-15552234718.42	5425.36	
News parameters	Alfa	Beta	Gamma
	0.19	-0.12	-0.13
News T-statistics	17161.88	-7635.28	-11921.16
News parameters	Omega	A	Sigma2
	86497.51	86497.36	1.21
Used observations	1988.00		

Analysis*	COLLADO*		
Vasicek parameters	Beta0	Beta1	
	10.89	1.47	
T-statistics Vasicek	1818.18	5344.97	
News parameters	Alfa	Beta	Gamma
	0.20	-0.71	0.92
News T-statistics	224.00	-7878.06	490.66
News parameters	Omega	A	Sigma2
	2371.63	2371.43	0.28
Used observations	2102.00		

Analysis*	COMERCIUBC*		
Vasicek parameters	Beta0	Beta1	
	320.55	1.04	
T-statistics Vasicek	216.82	22394.24	
News parameters	Alfa	Beta	Gamma
	0.13	-1.00	1.50
News T-statistics	808.57	-219714.66	27438.08
News parameters	Omega	A	Sigma2
	16327773.51	16327773.27	0.24
Used observations	2095.00		

Analysis*	CONTAL*		
Vasicek parameters	Beta0	Beta1	
	0.14	0.99	
T-statistics Vasicek	9.58	9166.51	
News parameters	Alfa	Beta	Gamma
	4.63	0.02	-3.35
News T-statistics	883.68	80.08	-2559.67
News parameters	Omega	A	Sigma2
	0.03	0.05	1.13
Used observations	2102.00		

Analysis*	CYDSASAA*		
Vasicek parameters	Beta0	Beta1	
	2.35	0.76	
T-statistics Vasicek	458092568.73	1272.97	
News parameters	Alfa	Beta	Gamma
	1.50	-0.44	-2.14
News T-statistics	230.50	-181.80	-499.00
News parameters	Omega	A	Sigma2
	1954.58	1954.47	0.25
Used observations	2088.00		

Analysis*	DESCB		
Vasicek parameters	Beta0	Beta1	
	15.90	0.97	
T-statistics Vasicek	4.90	2357.11	
News parameters	Alfa	Beta	Gamma
	0.22	-0.21	-0.01
News T-statistics	37.04	-36.16	-0.42
News parameters	Omega	A	Sigma2
	14319.08	14318.80	1.34
Used observations	2102.00		

Analysis*	ELEKTRA*		
Vasicek parameters	Beta0	Beta1	
	63.30	0.98	
T-statistics Vasicek	3.49	634.99	
News parameters	Alfa	Beta	Gamma
	1.20	0.17	-0.34
News T-statistics	16.04	7.62	-3.74
News parameters	Omega	A	Sigma2
	8178.58	8178.75	1.00
Used observations	1594.00		

Analysis*	GCARSO_A1*		
Vasicek parameters	Beta0	Beta1	
	17.54	1.00	
T-statistics Vasicek	14.79	2154.35	
News parameters	Alfa	Beta	Gamma
	0.78	0.41	0.84
News T-statistics	80.61	77.02	79.89
News parameters	Omega	A	Sigma2
	355.29	355.62	0.80
Used observations	2100.00		

Analysis*	GCC*		
Vasicek parameters	Beta0	Beta1	
	14.81	1.00	
T-statistics Vasicek	0.00	686.95	
News parameters	Alfa	Beta	Gamma
	0.20	-0.52	0.64
News T-statistics	6100.28	-637949.56	12966.51
News parameters	Omega	A	Sigma2
	43083.99	43083.29	1.35
Used observations	1053.00		

Analysis*	GCORVIUBD*		
Vasicek parameters	Beta0	Beta1	
	83.87	0.90	
T-statistics Vasicek	215.91	216.36	
News parameters	Alfa	Beta	Gamma
	2.42	0.60	-1.87
News T-statistics	120.00	43.09	-34.98
News parameters	Omega	A	Sigma2
	845.60	845.91	0.51
Used observations	2102.00		

Analysis*	GEOB*		
Vasicek parameters	Beta0	Beta1	
	582.35	0.94	
T-statistics Vasicek	0.00	8881.90	
News parameters	Alfa	Beta	Gamma
	4.29	-1.00	-6.59
News T-statistics	1899.49	-89567.51	-1423.27
News parameters	Omega	A	Sigma2
	59209169.98	59209169.86	0.11
Used observations	2101.00		

Analysis*	GFINTERO*		
Vasicek parameters	Beta0	Beta1	
	-0.11	0.81	
T-statistics Vasicek	-9.54	140.01	
News parameters	Alfa	Beta	Gamma
	0.65	0.08	4.63
News T-statistics	103.70	6.68	544.56
News parameters	Omega	A	Sigma2
	0.47	0.52	0.60
Used observations	1787.00		

Analysis*	GMEXICO_B*		
Vasicek parameters	Beta0	Beta1	
	34.55	1.00	
T-statistics Vasicek	1.02	489.41	
News parameters	Alfa	Beta	Gamma
	0.86	0.52	-0.30
News T-statistics	16.35	28.88	-4.93
News parameters	Omega	A	Sigma2
	2720.70	2721.23	1.02
Used observations	970.00		

Analysis*	GMODELO_C*		
Vasicek parameters	Beta0	Beta1	
	-3.64	1.00	
T-statistics Vasicek	-21.06	9209.98	
News parameters	Alfa	Beta	Gamma
	1.72	0.14	4.28
News T-statistics	14.34	37.78	16.67
News parameters	Omega	A	Sigma2
	23.83	23.95	0.79
Used observations	2064.00		

Analysis*	GFMULTIO*		
Vasicek parameters	Beta0	Beta1	
	19.58	1.39	
T-statistics Vasicek	8.80	1262.67	
News parameters	Alfa	Beta	Gamma
	1.27	-0.01	1.60
News T-statistics	972.10	-15.52	2311.78
News parameters	Omega	A	Sigma2
	20919.67	20919.67	0.05
Used observations	1829.00		

Analysis*	GFNORTEO*		
Vasicek parameters	Beta0	Beta1	
	140.40	0.98	
T-statistics Vasicek	181737739.55	4902.12	
News parameters	Alfa	Beta	Gamma
	1.07	-0.91	-0.34
News T-statistics	1594.93	-1285.43	-10203.81
News parameters	Omega	A	Sigma2
	21809681.94	21809681.65	0.31
Used observations	1853.00		

Analysis*	FEMSA_UBD*		
Vasicek parameters	Beta0	Beta1	
	0.16	0.17	
T-statistics Vasicek	9.42	9373.03	
News parameters	Alfa	Beta	Gamma
	3.77	0.01	-1.08
News T-statistics	705.35	1851.36	-292.36
News parameters	Omega	A	Sigma2
	0.08	0.09	0.65
Used observations	2098.00		

Analysis*	GIGANTE*		
Vasicek parameters	Beta0	Beta1	
	0.10	0.93	
T-statistics Vasicek	2.77	2000.59	
News parameters	Alfa	Beta	Gamma
	2.15	0.09	-1.10
News T-statistics	14.63	9.74	-7.48
News parameters	Omega	A	Sigma2
	1.23	1.29	0.69
Used observations	2050.00		

Analysis*	GINBURO*		
Vasicek parameters	Beta0	Beta1	
	30.18	0.98	
T-statistics Vasicek	840735579,38	2896.66	
News parameters	Alfa	Beta	Gamma
	0.36	-0.37	0.02
News T-statistics	157.47	-170.07	285929626.12
News parameters	Omega	A	Sigma2
	130315.68	130315.19	1.31
Used observations	1813.00		

Analysis*	GISSA*		
Vasicek parameters	Beta0	Beta1	
	3.94	0.96	
T-statistics Vasicek	7.44	409.67	
News parameters	Alfa	Beta	Gamma
	1.21	0.30	-0.46
News T-statistics	11.97	10.14	-3.97
News parameters	Omega	A	Sigma2
	3.06	3.36	1.00
Used observations	987.00		

Analysis*	GRUMAB*		
Vasicek parameters	Beta0	Beta1	
	0.90	0.98	
T-statistics Vasicek	22.82	2269.07	
News parameters	Alfa	Beta	Gamma
	1.34	0.19	-0.57
News T-statistics	15.92	19.59	-5.73
News parameters	Omega	A	Sigma2
	0.72	0.91	0.98
Used observations	2077.00		

Analysis*	HOGARB*		
Vasicek parameters	Beta0	Beta1	
	-0.12	0.73	
T-statistics Vasicek	-27769288.29	49198867.58	
News parameters	Alfa	Beta	Gamma
	0.36	-0.02	-0.69
News T-statistics	4728483.35	-10603962.99	-4518747.70
News parameters	Omega	A	Sigma2
	1046.90	1046.89	0.95
Used observations	2076.00		

Analysis*	SANBORB1*		
Vasicek parameters	Beta0	Beta1	
	0.21	0.99	
T-statistics Vasicek	1.12	5235.14	
News parameters	Alfa	Beta	Gamma
	3.66	0.14	-2.85
News T-statistics	244.61	76.27	-130.86
News parameters	Omega	A	Sigma2
	4.52	4.63	0.77
Used observations	1846.00		

Analysis*	HILASALA*		
Vasicek parameters	Beta0	Beta1	
	-0.87	1.07	
T-statistics Vasicek	-11689.28	10884.28	
News parameters	Alfa	Beta	Gamma
	0.66	-0.52	-0.28
News T-statistics	35181.27	-1264.67	-324.87
News parameters	Omega	A	Sigma2
	200.71	200.41	0.59
Used observations	2076.00		

Analysis*	HOMEX*		
Vasicek parameters	Beta0	Beta1	
	279.71	0.96	
T-statistics Vasicek	5.90	209.79	
News parameters	Alfa	Beta	Gamma
	1.18	0.20	-0.52
News T-statistics	8.42	3.99	-3.50
News parameters	Omega	A	Sigma2
	33168.09	33168.29	1.00
Used observations	552.00		

Analysis*	ICA*		
Vasicek parameters	Beta0	Beta1	
	31.11	0.85	
T-statistics Vasicek	11.74	12442.86	
News parameters	Alfa	Beta	Gamma
	0.30	-0.31	0.02
News T-statistics	1553.33	-1639.09	17622.75
News parameters	Omega	A	Sigma2
	290895.79	290895.21	1.87
Used observations	2066.00		

Analysis*	ICHB*		
Vasicek parameters	Beta0	Beta1	
	0.86	0.77	
T-statistics Vasicek	16.19	6005.64	
News parameters	Alfa	Beta	Gamma
	0.98	0.07	1.52
News T-statistics	52.11	896.71	16.28
News parameters	Omega	A	Sigma2
	5.93	5.99	0.86
Used observations	2051.00		

Analysis*	INVEXO*		
Vasicek parameters	Beta0	Beta1	
	-0.41	1.21	
T-statistics Vasicek	-246906328.96	2610.45	
News parameters	Alfa	Beta	Gamma
	0.15	-0.29	0.28
News T-statistics	92.09	-11847.09	84.57
News parameters	Omega	A	Sigma2
	91.31	90.90	1.44
Used observations	1736.00		

Analysis*	IXEGFO*		
Vasicek parameters	Beta0	Beta1	
	-14.35	0.99	
T-statistics Vasicek	-527712215.16	5683.85	
News parameters	Alfa	Beta	Gamma
	0.10	-0.16	0.13
News T-statistics	60.21	-33.62	20.98
News parameters	Omega	A	Sigma2
	24803.00	24802.91	0.56
Used observations	1813.00		

Analysis*	KIMBERA*		
Vasicek parameters	Beta0	Beta1	
	59.29	0.99	
T-statistics Vasicek	3.49	1891.90	
News parameters	Alfa	Beta	Gamma
	0.51	-0.55	0.08
News T-statistics	42.80	-46.19	6583.73
News parameters	Omega	A	Sigma2
	396555.68	396555.02	1.21
Used observations	2076.00		

Analysis*	KIMBERB*		
Vasicek parameters	Beta0	Beta1	
	0.20	1.00	
T-statistics Vasicek	7.05	6812.94	
News parameters	Alfa	Beta	Gamma
	9.00	0.02	-7.09
News T-statistics	58.28	64.21	-41.52
News parameters	Omega	A	Sigma2
	0.38	0.39	0.71
Used observations	2048.00		

Analysis*	KOFL*		
Vasicek parameters	Beta0	Beta1	
	0.06	1.03	
T-statistics Vasicek	467898629.33	2478.25	
News parameters	Alfa	Beta	Gamma
	1.23	0.20	-0.10
News T-statistics	101.52	17.58	-50191422627.49
News parameters	Omega	A	Sigma2
	2.16	2.32	0.85
Used observations	2076.00		

Analysis*	LIVEPOL1*		
Vasicek parameters	Beta0	Beta1	
	10.11	0.81	
T-statistics Vasicek	993747121.19	1455.17	
News parameters	Alfa	Beta	Gamma
	0.20	-0.15	-0.08
News T-statistics	34.69	-24.03	-6.87
News parameters	Omega	A	Sigma2
	609.66	609.47	1.26
Used observations	2074.00		

Analysis*	MASECAB*		
Vasicek parameters	Beta0	Beta1	
	25.20	0.94	
T-statistics Vasicek	15.93	926.93	
News parameters	Alfa	Beta	Gamma
	0.13	-1.00	1.16
News T-statistics	29.81	-369445.63	139.86
News parameters	Omega	A	Sigma2
	186703.67	186703.04	0.63
Used observations	2068.00		

Analysis*	NAFTRAC*		
Vasicek parameters	Beta0	Beta1	
	73.32	1.00	
T-statistics Vasicek	1.16	660.82	
News parameters	Alfa	Beta	Gamma
	1.03	0.27	-0.26
News T-statistics	10.55	8.44	-2.36
News parameters	Omega	A	Sigma2
	117783.66	117783.94	1.00
Used observations	1109.00		

Analysis*	MOVILAB*		
Vasicek parameters	Beta0	Beta1	
	0.14	1.54	
T-statistics Vasicek	8205732.90	283968001.23	
News parameters	Alfa	Beta	Gamma
	-0.36	-0.69	2.01
News T-statistics	-1631009416.46	-1171764731.67	1641917921.48
News parameters	Omega	A	Sigma2
	9524.40	9524.30	0.14
Used observations	2008.00		

Analysis*	PENOLES*		
Vasicek parameters	Beta0	Beta1	
	53.48	0.93	
T-statistics Vasicek	16.19	66022.61	
News parameters	Alfa	Beta	Gamma
	0.34	-0.24	-0.20
News T-statistics	264.13	-254.52	-133.72
News parameters	Omega	A	Sigma2
	15407.19	15406.84	1.50
Used observations	2062.00		

Analysis*	PINFRA*		
Vasicek parameters	Beta0	Beta1	
	247.42	1.00	
T-statistics Vasicek	19464.88	306177.01	
News parameters	Alfa	Beta	Gamma
	0.75	-0.74	1.02
News T-statistics	5593.50	-17322858.24	765.76
News parameters	Omega	A	Sigma2
	88931.80	88931.23	0.77
Used observations	175.00		

Analysis*	SANLUISCPO*		
Vasicek parameters	Beta0	Beta1	
	-1.42	1.08	
T-statistics Vasicek	-1820718108.15	10280.82	
News parameters	Alfa	Beta	Gamma
	-0.05	-0.84	1.81
News T-statistics	-125913249.81	-976894.03	3986081.90
News parameters	Omega	A	Sigma2
	22054.02	22053.79	0.27
Used observations	2071.00		

Analysis*	SAREB*		
Vasicek parameters	Beta0	Beta1	
	2504.99	0.72	
T-statistics Vasicek	92582.09	41158.79	
News parameters	Alfa	Beta	Gamma
	1.04	-0.50	0.28
News T-statistics	789.70	-9410.84	3444.11
News parameters	Omega	A	Sigma2
	1165593.27	1165592.88	0.77
Used observations	722.00		

Analysis*	SIMECB*		
Vasicek parameters	Beta0	Beta1	
	0.63	1.07	
T-statistics Vasicek	35.93	41676.82	
News parameters	Alfa	Beta	Gamma
	0.10	-0.20	0.20
News T-statistics	267.06	-3185.79	236.14
News parameters	Omega	A	Sigma2
	754.35	754.14	1.08
Used observations	2071.00		

Analysis*	SORIANAB*		
Vasicek parameters	Beta0	Beta1	
	-59.46	1.02	
T-statistics Vasicek	-5.01	1300.70	
News parameters	Alfa	Beta	Gamma
	0.32	-0.45	0.27
News T-statistics	27.32	-37.83	13.10
News parameters	Omega	A	Sigma2
	155781.67	155781.13	1.19
Used observations	2069.00		

Analysis*	TELECOMA1*		
Vasicek parameters	Beta0	Beta1	
	2682.90	0.84	
T-statistics Vasicek	170.71	7384.05	
News parameters	Alfa	Beta	Gamma
	0.29	-1.00	1.15
News T-statistics	138.21	-380550.72	241.26
News parameters	Omega	A	Sigma2
	113863914.31	113863913.66	0.65
Used observations	2072.00		

Analysis*	TELMEXA*		
Vasicek parameters	Beta0	Beta1	
	0.04	0.96	
T-statistics Vasicek	5.73	1098.26	
News parameters	Alfa	Beta	Gamma
	1.02	0.26	-0.22
News T-statistics	31.24	24.24	-3.16
News parameters	Omega	A	Sigma2
	0.00	0.28	1.09
Used observations	2069.00		

Analysis*	TELMEXL*		
Vasicek parameters	Beta0	Beta1	
	1191.86	0.99	
T-statistics Vasicek	2122557212.87	4033.49	
News parameters	Alfa	Beta	Gamma
	0.31	-0.40	0.18
News T-statistics	2006.99	-2234.42	44327.35
News parameters	Omega	A	Sigma2
	20104656.54	20104656.06	1.21
Used observations	2073.00		

Analysis*	TLEVISACPO*		
Vasicek parameters	Beta0	Beta1	
	37.56	1.00	
T-statistics Vasicek	640197430.55	7071.71	
News parameters	Alfa	Beta	Gamma
	0.25	-0.24	-0.03
News T-statistics	7051.38	-5997.42	-5958.12
News parameters	Omega	A	Sigma2
	4746918.74	4746918.44	1.22
Used observations	2098.00		

Analysis*	TS*		
Vasicek parameters	Beta0	Beta1	
	-34.83	1.03	
T-statistics Vasicek	-7.19	879.96	
News parameters	Alfa	Beta	Gamma
	0.21	-0.84	1.36
News T-statistics	26.78	-909.05	112.78
News parameters	Omega	A	Sigma2
	37159.25	37158.47	0.93
Used observations	935.00		

Analysis*	TVAZTCACPO*		
Vasicek parameters	Beta0	Beta1	
	-86.66	1.04	
T-statistics Vasicek	-1743700390.08	236554.21	
News parameters	Alfa	Beta	Gamma
	0.23	-0.77	1.07
News T-statistics	211.79	-586.07	225.45
News parameters	Omega	A	Sigma2
	399380.24	399379.33	1.19
Used observations	2067.00		

Analysis*	URBI		
Vasicek parameters	Beta0	Beta1	
	98.37	0.97	
T-statistics Vasicek	0.86	246.57	
News parameters	Alfa	Beta	Gamma
	1.05	0.08	-0.20
News T-statistics	10.42	2.83	-1.36
News parameters	Omega	A	Sigma2
	105026.33	105026.41	1.00
Used observations	587.00		

Analysis*	USCOMB1*		
Vasicek parameters	Beta0	Beta1	
	0.02	0.99	
T-statistics Vasicek	1.34	770.54	
News parameters	Alfa	Beta	Gamma
	1.34	0.25	-0.39
News T-statistics	21.66	11.26	-8.73
News parameters	Omega	A	Sigma2
	0.00	0.24	0.94
Used observations	1048.00		

Analysis*	VALLEV*		
Vasicek parameters	Beta0	Beta1	
	-0.00	1.07	
T-statistics Vasicek	-2.17	3242.13	
News parameters	Alfa	Beta	Gamma
	0.27	0.21	0.06
News T-statistics	68.71	2058.80	7.01
News parameters	Omega	A	Sigma2
	0.00	0.74	3.44
Used observations	2070.00		

Analysis*	VITROA*		
Vasicek parameters	Beta0	Beta1	
	-24.93	1.04	
T-statistics Vasicek	-5.59	503.99	
News parameters	Alfa	Beta	Gamma
	0.25	-0.43	0.37
News T-statistics	24.42	-24.32	13.08
News parameters	Omega	A	Sigma2
	42496.81	42496.30	1.19
Used observations	2075.00		

Analysis*	WALMEXV*		
Vasicek parameters	Beta0	Beta1	
	3432.40	0.97	
T-statistics Vasicek	38.03	5951.94	
News parameters	Alfa	Beta	Gamma
	0.57	-0.98	0.82
News T-statistics	2045.20	-5905.51	1099.34
News parameters	Omega	A	Sigma2
	28926305.65	28926304.78	0.88
Used observations	1571.00		