Capital Structure, Dividend Policy and Endogenous Bankruptcy: evidence based on a knockout model.

This work presents a structural model with endogenous barrier, like a unified framework of analysis for capital structure, dividend policy and bankruptcy items. The original idea is to evaluate the claimholders position by using a simple static replicating theory, that yields the framework less complex than the previous barrier models.

The barriers are estimated endogenously by equityholders that can make a decision for the default even before of the debt's maturity if the delta of equity falls to zero.

An empirical work is presented to extrapolate the cost of capital, the asset value and the asset risk. Several relations between the expected equity return, estimated by CAPM, and the estimates of the model's variables confirm the general evidence of corporate finance.

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Introduction.

Over the last fifty years, financial and academic communities have devoted increasing attention to the capital structure and bankruptcy items, as even the problem of optimal dividend policy. In literature generally these issues have been individually investigated, while a few theoretical and empirical works, in no-complex context of analysis, have been focused jointly on all three items. In this study, such problems are analysed in a framework to understand the interactions between them.

Modern risk analysis is part of the continuous development of financial research into the integration of different types of uncertainty (market, credit, country and operational risks). The underlying approach directly follows the advances that have been made in the field of market risks. This approach is based on the seminal works by Black & Scholes [1973] and Merton [1974], which proposed an arbitrage-free theory of option pricing or contingent claim analysis. These models can be used to assess the liability mix of a firm. The Merton model provides a more complete and complex valuation and, in addition, provides a means of pricing the default risk spread for fixed income instruments. In one single framework, it is possible to measure the impact of a change in asset volatility and a change in the level of interest rates or different maturities of debt on credit risk spreads. We can therefore calculate a firm's probability of default using a closed-form equation. The following list of works is far from complete but covers some important topics in the literature on structural models and empirical evidences about capital structure with dividend policy and bankruptcy before maturity of debt.

Merton's framework is an extreme simplification of the real world and author himself proposes also extensions of his analysis. Merton [1974] proposes the pricing of perpetual risky bond with continuous coupon payment. Later, Black and Cox [1976] propose an analysis, by using a barrier model, in order to study the effect of safety covenants on the pricing of risky zero-coupon bond. Geske [1977] presents a study about compound option. Ingersoll [1977] proposes the pricing of convertible bond issues and analyses the effect of several seniorities, assuming that in the real world the absolute priority rule is enforced.

In the last fifteen years, the increasing attention has been devoted to the link between the capital structure and credit spread. Black and Cox [1976] model in advance the idea of the default boundary for endogenizing the bankruptcy decisions. In different ways, Brennan and Schwartz [1979, 1980] study the capital structure choice in depth. Fischer et al. [1989] explore the tax advantage of debt and bankruptcy costs, as well as the optimal policy for callable bonds.

Hsia [1981] shows an unified approach between option pricing theory and capital asset pricing model to study the coherence the capital structure with Miller-Modigliani irrelevance.

Leland [1994] proposes a model for perpetual corporate debt and he studies the stockholders' optimal decision to abandoning the firm to the bondholders; of course, only coupon level is relevant for corporate default decisions. In Leland and Toft [1996], the perpetual debt assumption is relaxed and the optimal leverage ratio is studied using the smooth-pasting condition. Further, the work measures the impact of the optimal capital structure policy (included the maturity) on the credit spread. Aghion and Bolton [1992] present a dynamic model, based on the game theory, for the restructuring of debt. The structural models represent a suitable base for studying the agency problems proposed by Jensen and Meckling [1976] and by Myers and Majluf [1984]. Thus, Anderson and Sundaresan [1996] design a game framework for assessing the strategic behaviour of the equityholders by a binomial approach. Mella-Barral and Perraudin [1997] propose a real option model with the output price of a firm as underlying process and with perpetual bond paying a consistent coupon.
Mauer and Triantis [1994] assess financing and production decisions under debt covenants for the maximization of the firm value. Ericsson [1997] proposes an analysis of the asset substitution's problem. Thus, Leland [1998] explores the impact of asset substitution and the agency costs.
Jones et al. [1984] is the first empirical test for Merton approach on a sample of companies with simple capital structure. The results highlight how low theoretical spreads compared to actual spreads.
Ronn and Verma [1986], as Lardic and Rouzeau [1999], present a procedure for estimating jointly the asset value and the asset yield's volatility (unobservable parameters) of claims (equity and/or debt) which are publicly traded. Duan [1994] and Ericsson et al. [2001] propose a maximum likelihood estimation for the same state variables.
Sarig and Varga [1989] confirm the results of Merton methodology on corporate bond data. Their analysis covers also the models for stochastic interest rates [Shimko et al., 1993, Longstaff and Schwartz, 1995].
Helwege and Turner [1999] expose an analysis of market credit spreads, highlighting an increasing term structure for non investment grade assets, contrary of Merton model. Several works tend to compare the Merton model and its evolutions to the market credit spread data. Thus, Delianedis and Geske [1999] confirm the evidence proposed by Helwege and Turner [1999].
Whilst Ericsson and Reneby [2002] analyse the refinements about the endogenous bankruptcy decisions, finding that Leland and Toft [1996] model overestimates market credit spreads. Eon et al. [2003] test five structural models and they show a negligible undervaluation respect to the empirical credit spreads. Brockman et al. [2003] propose an empirical analysis taking into account the equity value as down and out call option wrote on asset value, with a specific and exogenous barrier, nevertheless they do not estimate directly the asset value and the relative volatility from market data, but they use balance sheet information.

The work is organised in the following way: next section is a description of underlying model of analysis, while the remaining parts are dedicated respectively to presentations of the data sample and results of empirical study. Finally, the conclusive part highlights the principal features of this work and the possible evolutions of research.

A knockout model for corporate valuation.

In this work, a single barrier model is applied for pricing the equity value of a firm. The choice is based on the fact the shareholders do not wait the asset value falls to zero for abandoning the company; they make such a decision when the change (or delta) of equity value is equal to zero and that can occur before of the maturity. Note that the equity value is still positive and this value could be the liquidation's price.

Besides, many corporate debts are related to specific and real guarantees on the company's assets or on the equityholders's wealth. A barrier model could answer to the matter about the optimal level of guarantees for specific contexts of market and firm.

The shareholders would have define an own optimal default (or financial distress) barrier for the asset value, as rational choice in function of the market conditions. This optimization step can be replicated by same smooth pasting condition introduced in Leland [1994], so that the barrier (endogenously determined) is the asset value that yields null the partial derivative of equity regard to the asset value.

Accord to the modern financial theory, the equity value is analogous to the call option value wrote on the asset value of firm. In this work as in Brockman et al. [2003], in Leland [1994], in Leland et al. [1996] and Black et al [1976], the equity value is knock out (or down and out) call option with barrier H endogenously defined.

Unlike of previous works, in this study some theories to replicate exotic option payoffs are used in order to simplify the complexity of the analysis' structure. By replicating of knock out options with simple plain vanilla instruments, we can express the value of equity (E) with Black and Scholes options wrote on the asset value (A), with asset return (r_A), asset volatility (σ_A), asset dividend yield (y_A), debt (D) with maturity (T) as strike price and free risk rate (r_f).

By some general rules for knock out options and by static hedging (replicating) theory[2], we can define the equity value is a mix of long position in Black&Scholes

[2] Bowie and Carr [1994] propose a simple and efficient strategy to evaluate some exotic options, by using the properties of the put-call symmetry. Another or alternative approach to evaluate the exotic options with static hedging theories is put-call transformation; in this case you can see Bjerksund and Stensland [1993].

call option (C_{BS}^{D}) struck at (D) and a short position in down&in call option (C_{di}) struck at (D) with barrier (H)

$$C_{BS}^{D} = C_{do} + C_{di} = E + C_{di} \quad \Longrightarrow \quad E = C_{BS}^{D} - C_{di}$$

Where the down&in call can be replicated with (D/H) Black&Scholes put ($P_{BS}^{\frac{H^2}{D}}$) struck at (H^2/D) and (D/H) can be imaged like the inverse of the recovery rate.

$$C_{di} = \frac{D}{H} P_{BS}^{\frac{H^2}{D}}$$

In static hedging theory, the aim is to hedge the long/short positions on a specific exotic option by going short/long on a portfolio of standard options (Black & Scholes); so, the value of exotic option is equal to the value of the hedge. For example, the sale of down & in call option is hedged by going long a number of standard puts with the same underlying and maturity but different strikes (or boundaries of debt). If underlying asset will stay above the barrier then both down & in call and the puts will die worthless; on the contrary, if the spot will touch the barrier then the our hedge position (standard puts) will have the same value as the standard call for the put call symmetry.[3] Thus, the owner of this hedging position will be able to sell off the standard puts and buy the standard call without incurring any out-of-pocket expense.
Now, using the put-call parity

$$E = Ae^{-y_A T} - De^{-r_f T} + P_{BS}^{D} - \frac{D}{H} P_{BS}^{\frac{H^2}{D}} =$$

$$= Ae^{-y_A T}\left[N(d_1) + \frac{D}{H} N(-q_1)\right] - De^{-r_f T}\left[N(d_2) + \frac{H}{D} N(-q_2)\right]$$

$$d_1 = \frac{\ln\left(\frac{A}{D}\right)}{\sigma_A\sqrt{T}} + \lambda\sigma_A\sqrt{T} \qquad q_1 = \frac{\ln\left(\frac{AD}{H^2}\right)}{\sigma_A\sqrt{T}} + \lambda\sigma_A\sqrt{T}$$

$$d_2 = d_1 - \sigma_A\sqrt{T} \qquad q_2 = q_1 - \sigma_A\sqrt{T} \qquad \lambda = \frac{\left(r_f - y_A + \frac{\sigma_A^2}{2}\right)}{\sigma_A^2}$$

[3] See the previous footnote.

Another reason to use static hedging theory is due to its major efficiency than the standard barrier option pricing theory. The dynamic hedging process in continuous time models is very hard task because of the discontinuity of the equity's partial derivative regard to asset value around the barrier. Besides, it is difficult to think that shareholders can hedge continuously and dynamically the own position without high trading costs; moreover this approach reduces the complexity of the work.
Thus, the partial derivative of equity regard to the asset value is

$$\frac{\partial E}{\partial A} = \left[N(d_1) + \frac{D}{H}N(-q_1)\right] e^{-y_A T}$$

If the derivative is equal to zero and setting $A = H^*$, then we can calculate the default barrier for the asset value endogenously defined. (H^*) represents the value of the firm's assets that implies an irrelevant convenience for the stockholders and hence it would have to be the max level of guarantees of the debt. Setting the barrier above on that boundary, the equityholders would lend excessive guarantees for the risk undertaken.

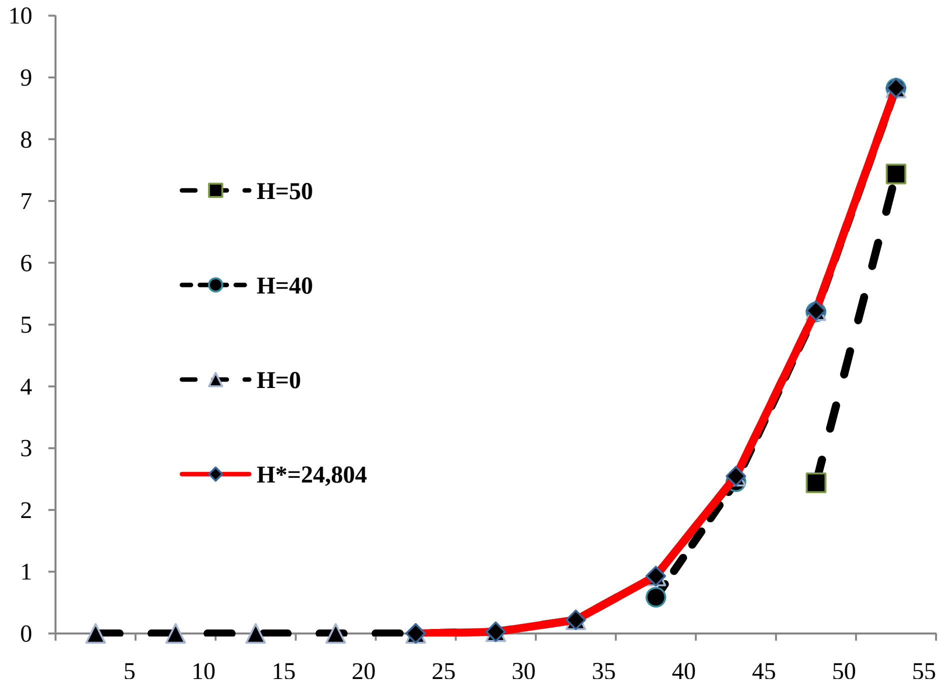
$$\frac{\partial E}{\partial A} = \left[N(d_1^*) + \frac{D}{H^*}N(-q_1^*)\right] e^{-y_A T} = 0 \qquad _{|A=H=H^*}$$

$$d_1^* = \frac{\ln\left(\frac{H^*}{D}\right)}{\sigma_A\sqrt{T}} + \lambda\sigma_A\sqrt{T} \qquad q_1^* = \frac{\ln\left(\frac{D}{H^*}\right)}{\sigma_A\sqrt{T}} + \lambda\sigma_A\sqrt{T}$$

Unlikely, this last equation have to be solved by an iterative method to calculate the barrier value (H^*) so that the function is zero. This equation implies that the optimal barrier does not depend on asset value, but only on asset risk, asset dividend, leverage, maturity and market conditions.
Another point of interest is regard to the level or value of the guarantees that a company must have in order to borrow money. The barrier (H^*) represents this level of guarantees that, of course, affects on the payoff of equityholders.
To highlight this matter the Graph 1 shows the payoff value of equity position regard to the asset value before of the debt's maturity for several levels of guarantees. Of course, the payoff structure of equityholders are the just positive parts of each curve or line; when the asset value touches the barrier the stockholders have (and they feel convenient) to state bankruptcy.
If $H = 0$ then equity is analogous to standard call option, and stockholders will wait always the maturity for the default or the asset value equal to zero. Whilst for positive values of the barrier the payoff's structure forecasts increasing losses in function of the distance between the level of debt and the barrier and so they will

abandon the firm before of the debt's maturity. Another extreme case is when the $H = D$ and that implies a total loss of the limited liability's benefits; the valuation function of equity position becomes linear exactly like an investment on the underlying asset, but when the asset value touches the barrier the firm have to default in order to insurance the value of the bondholders' position and so the matter is a just optimal stopping problem for the each claimholder. Setting $H = H^*$ then the stockholders base their choice on the economic irrelevance measured by the ratio between the equity change and the asset change, that is the delta of equity. This boundary represents the max level of guarantees the stockholders can handle to the firm's assets.

Graph 1 – Payoff of the equity value in function of the underlying asset value for several level of guarantees (*H*). The other parameter of model are $\boldsymbol{\sigma_A} = \mathbf{20}\%$, $\boldsymbol{y_A} = \mathbf{0}\%$, $\boldsymbol{r_f} = \mathbf{5}\%$, $\boldsymbol{D} = \mathbf{50}$. The barrier (H*) represents the optimal level of guarantees (not depending on the asset value).



The region of interest for stockholders regard to the level of guarantees is on the left of the red continue line (the optimal level of guarantees), that is for $H \leq H^*$. In this area, they give adequate guarantees in function of the market and firm conditions. For $H > H^*$, the capital structure (with the associated guarantees) of the firm is not optimal for the stockholders; in fact, the lender receives an excessive level of protection for own credit exposure and that could seed the ground for a possible opportunistic behavior or moral hazard.

This structural model could represent a base in order to study the agency problems introduced by Jensen et al. [1979] and Myers et al [1984]. By recalling the previous paragraph, we can think of the classic problem of the assets' substitution. If the guarantees given are major than the optimal level, then the equityholders will be tempted to replace low risk assets with high risk activities.
In order to maximize the equity value, the stockholders ought to seek the major nonlinearity in the own valuation function by contracting the lower level of guarantees. Of course, the creditors will pretend the max level of guarantees. The final choice will be a point between the two extreme cases. This model points out the max level of guarantees that stockholders can offer to borrow money without that the their convenience (expressed by the equity's delta) becomes negative.
Finally, the model presents a framework of analysis for capital structure, dividend policy and bankruptcy (financial distress or reorganization's phase) items. Using data about price of common stock, a market index, a free risk rate of economy and balance sheet information, it is possible to evaluate jointly the effects produced by several corporate finance policies.

Estimating methodologies and data sample.

To estimate the capital structure's factors from market and balance sheet information, we define a set of variables available. The unknown variables are the asset value, the asset return and its volatility and of course the endogenous barrier. To estimate these four unknown variables, we can implement a system of four non linear equations coherent between them.

$$E = Ae^{-y_A T}\left[N(d_1) + \frac{D}{H^*}N(-q_1)\right] - De^{-r_f T}\left[N(d_2) + \frac{D}{H^*}N(-q_2)\right]$$

$$\sigma_E = \frac{\partial E}{\partial A}\frac{A}{E}\sigma_A$$

$$k_E = r_f + \frac{\partial E}{\partial A}\frac{A}{E}\left(r_A - r_f\right)$$

$$\frac{\partial E}{\partial A} = 0 \quad {}_{|A=H=H^*}$$

For the estimate of the expected equity return can be used the capital asset pricing model. The second and third equations are respectively derived by Ito's lemma and by Hsia [1981].

The empirical investigation considers a 25 US industrial firms belonging to the Dow Jones index. Because of the diverse nature of the financial industry, the attention has restricted to industrial firms, as in the literature. The data has collected from DataStream and the sample covers a 12-years period between 1996 and 2007. For each firm, the data set consists of their balance sheet and market price information. In the first case, the information is relative to current and non current liabilities, while the latter type concerns the daily quoted values for the common stock price.
As mentioned above, it is necessary to provide an estimation of the volatility of the equity. For this study, the volatility has been estimated considering all daily quoted values relative to the year previous the valuation date. Another window for calculation the volatility would probably express a different weight for the past information. Using these time series and historical returns of market index, as S&P500, we can calculate the beta of equity and so the expected return (with a constant market premium equal to 9.8%). The asset dividend yield is estimated by dividend paid to equityholders, while the maturity of debt (total liabilities) is fixed to one. This last choice reflects partially the ordinary time of a rating outlook.
Finally, the Libor rate for the US market is an estimation for the level of interest rates.
The table 1 show the averages for the variable of data sample; each value is expressed per share in order to eliminate the frequent adjustments in market capitalization data. The Table 2 presents the standard deviation of same data.

Table 1 – Mean values for price, dividend paid, expected return of equity, historical volatility of equity return, beta of equity, free risk rate, no current liabilities and current liabilities recorded at the end of each year of sample.

$Time$	$price$	div	k_E	v_E	β_E	r_f	NCL	CL
1996	27,016	0,5032	0,14295	NaN	0,86799	0,057891	21,77	19,419
1997	34,19	0,5608	0,15549	0,29073	0,97753	0,059687	18,09	16,575
1998	42,614	0,6072	0,1336	0,33859	0,84299	0,050984	18,909	18,571
1999	51,347	0,6632	0,13531	0,35273	0,71741	0,065	17,942	18,034
2000	46,724	0,7152	0,12436	0,44957	0,65669	0,06	17,844	19,28
2001	43,777	0,7392	0,080169	0,36302	0,56882	0,024425	21,259	19,087
2002	34,999	0,7652	0,10434	0,38346	0,91683	0,014494	25,664	19,653
2003	42,943	0,8316	0,10993	0,26184	0,97302	0,014569	30,214	21,385
2004	44,143	0,9216	0,089306	0,2041	0,59496	0,031	30,265	22,93
2005	42,972	1,0184	0,10939	0,19752	0,62248	0,048388	27,987	24,005
2006	50,449	1,118	0,13864	0,19761	0,87083	0,053294	16,338	17,145
2007	56,175	1,2596	0,1193	0,21343	0,78632	0,042238	25,909	20,566

The cost of capital for stockholders (k_E) is estimated by Capital Asset Pricing Model and the statistics show the sample averages and the standard deviations for year. The expected equity return seems to highlight several changes without a specific address. The volatility of equity return does not offer any contributes to explicate the behaviour of the cost of capital.

Table 2 – Standard deviation values for price, dividend paid, expected return of equity, historical volatility of equity return, beta of equity, free risk rate, no current liabilities and current liabilities recorded at the end of each year of sample.

$Time$	$price$	div	k_E	v_E	β_E	r_f	NCL	CL
1996	13,049	0,41215	0,019273	NaN	0,19666	0	30,536	23,188
1997	14,482	0,4571	0,020764	0,040625	0,21188	0	27,974	24,574
1998	16,498	0,47581	0,021897	0,048773	0,22344	0	33,394	34,453
1999	17,651	0,50372	0,031038	0,062644	0,31671	0	34,746	39,013
2000	16,529	0,50072	0,042941	0,096701	0,43817	0	38,462	50,343
2001	19,5	0,5034	0,031178	0,1081	0,31814	0	51,384	46,459
2002	15,52	0,50251	0,027802	0,086842	0,28369	0	64,053	51,062
2003	16,864	0,49711	0,026419	0,066551	0,26958	0	84,672	56,348
2004	18,255	0,47596	0,015809	0,05814	0,16132	0	88,884	62,007
2005	18,13	0,49645	0,019046	0,064993	0,19435	0	81,792	69,644
2006	20,636	0,46716	0,025134	0,064532	0,25647	0	23,825	30,773
2007	24,647	0,51393	0,019678	0,057601	0,20079	0	41,268	29,225

Next section presents the results of the estimation's process of the unknown variables and some general tests for studying the behaviour of (k_E) regard to the same variables that we suppose to be more explicative.

Results.

The analysis have produced several estimates regard to capital structure, dividend policy and the endogenous default barrier.
Table 3 and Table 4 present the mean and standard deviation for the four unknown variables: the asset value, the asset return and its volatility and the optimal recovery rate endogenously determined by the stockholder.

Table 3 – Mean values for asset value, the asset return, its volatility, asset dividend yield and the optimal recovery rate for the stockholder.

$Time$	A	r_A	y_A	v_A	R
1996	NaN	NaN	NaN	NaN	NaN
1997	66,847	0,14428	0,0082476	0,18787	0,38901
1998	78,231	0,1235	0,0083538	0,24119	0,30406
1999	85,059	0,13177	0,0085019	0,26415	0,30012
2000	81,687	0,12025	0,0093243	0,36545	0,22906
2001	83,149	0,071042	0,010321	0,2801	0,30084
2002	79,664	0,07987	0,011963	0,28554	0,29637
2003	93,796	0,086631	0,011948	0,18943	0,39577
2004	95,714	0,082329	0,014007	0,14724	0,44192
2005	92,508	0,10411	0,015708	0,13021	0,45877
2006	82,194	0,13137	0,015977	0,14187	0,45185
2007	103,46	0,11154	0,017341	0,14656	0,45517

Table 4 – Standard deviations for asset value, the asset return, its volatility and the optimal recovery rate for the stockholder.

$Time$	A	r_A	y_A	v_A	R
1996	NaN	NaN	0,41215	NaN	NaN
1997	54,234	0,029009	0,4571	0,073773	0,097106
1998	69,238	0,027589	0,47581	0,088279	0,13747
1999	74,865	0,032419	0,50372	0,08035	0,12298
2000	85,954	0,043761	0,50072	0,13987	0,1365
2001	98,448	0,029135	0,5034	0,11882	0,13702
2002	114,92	0,030911	0,50251	0,11349	0,1382
2003	142,34	0,030039	0,49711	0,07322	0,11872
2004	147,2	0,017733	0,47596	0,064413	0,088401
2005	141,21	0,019237	0,49645	0,045414	0,060533
2006	54,345	0,024519	0,46716	0,051698	0,071839
2007	67,02	0,021547	0,51393	0,043642	0,050659

For analysing the underlying relations among the estimates and the sample data, we perform some linear regressions. In specific way, we want to study how the CAPM expected equity returns (k_E) are related to the cost of capital (r_A) estimated, leverage or dividend policy or asset volatility. Again, we can think of the relation between the equity returns and the endogenous recovery rate implied, defined like the ratio H^* to D.

The CAPM expected equity return highlights (Table 5) a low relation with leverage. The coefficients estimated are not significant and R^2 is very low. Accord to financial theory, the cost of capital affects strongly by a positive relation (Table 6), so as the asset volatility nevertheless the effect is more weak (Table 7). The relation equity return and dividend yield seems negative but the coefficient estimated are not always significant (Table 8).

Table 5 – Statistics of linear regression model with c1 as constant and c2 as beta of the regression, t test for zero-coefficients with related p-values and square r. Linear regression between equity return and the leverage.

Time	**c1**	**c2**	**t stat b1**	**t stat b2**	**p-value 1**	**p-value 2**	**R2**
1996	NaN	NaN	NaN	NaN	NaN	NaN	NaN
1997	0,17131	-0,040295	20,03	-2,0783	4,6813e-016	0,049025	0,15811
1998	0,13857	-0,014502	16,797	-0,71442	2,0893e-014	0,48216	0,021709
1999	0,15174	-0,058188	15,276	-2,0442	1,56e-013	0,052543	0,15376
2000	0,13033	-0,02098	8,5976	-0,48241	1,2194e-008	0,63407	0,010017
2001	0,075955	0,013215	6,7137	0,44983	7,5504e-007	0,65705	0,0087209
2002	0,09953	0,012962	9,0646	0,51117	4,7145e-009	0,6141	0,011233
2003	0,10714	0,00827	10,72	0,33029	2,0263e-010	0,74417	0,0047209
2004	0,085641	0,011423	14,386	0,72941	5,4737e-013	0,47312	0,022609
2005	0,099218	0,031536	13,861	1,6565	1,1825e-012	0,1112	0,10659
2006	0,12565	0,043332	13,151	1,5808	3,4784e-012	0,12758	0,098001
2007	NaN	NaN	NaN	NaN	NaN	NaN	NaN

Table 6 – Statistics of linear regression model with c1 as constant and c2 as beta of the regression, t test for zero-coefficients with related p-values and square r. Linear regression between equity return and the cost of capital of the firm.

Time	c1	c2	t stat b1	t stat b2	p-value 1	p-value 2	R2
1996	NaN	NaN	NaN	NaN	NaN	NaN	NaN
1997	0,08183	0,51051	5,3191	4,8798	2,1211e-005	6,285e-005	0,50868
1998	0,066138	0,54624	4,3571	4,5494	0,0002312	0,00014311	0,47365
1999	0,01652	0,90144	1,8123	13,405	0,083015	2,354e-012	0,88652
2000	0,012674	0,92871	1,503	14,061	0,14645	8,7926e-013	0,89579
2001	0,013429	0,93945	1,6415	8,7923	0,1143	8,1756e-009	0,7707
2002	0,06129	0,53905	4,7793	3,5906	8,0695e-005	0,0015453	0,35919
2003	0,063992	0,53022	4,7803	3,6239	8,0495e-005	0,0014241	0,36346
2004	0,043437	0,55714	3,5573	3,8393	0,0016762	0,00083785	0,39057
2005	0,064786	0,42843	3,29	2,302	0,0032062	0,03073	0,18725
2006	0,037519	0,76968	1,9899	5,4519	0,05862	1,5314e-005	0,56376
2007	NaN	NaN	NaN	NaN	NaN	NaN	NaN

Table 7 – Statistics of linear regression model with c1 as constant and c2 as beta of the regression, t test for zero-coefficients with related p-values and square r. Linear regression between equity return and asset risk.

Time	c1	c2	t stat b1	t stat b2	p-value 1	p-value 2	R2
1996	NaN	NaN	NaN	NaN	NaN	NaN	NaN
1997	0,12682	0,15256	12,774	3,0932	6,2819e-012	0,0051291	0,29379
1998	0,10811	0,10569	9,0169	2,2588	5,1886e-009	0,033684	0,18156
1999	0,073086	0,23555	4,1535	3,6897	0,00038401	0,0012115	0,37183
2000	0,066214	0,1591	3,0987	2,906	0,0050632	0,0079607	0,26855
2001	0,021646	0,20894	2,156	6,3125	0,04178	1,929e-006	0,63403
2002	0,065267	0,13685	5,0275	3,2302	4,3571e-005	0,0037014	0,31208
2003	0,069928	0,21114	5,6587	3,461	9,2468e-006	0,0021204	0,34245
2004	0,076783	0,08505	9,9847	1,7717	7,8689e-010	0,0897	0,12008
2005	0,10607	0,025466	8,8312	0,29175	7,5532e-009	0,77309	0,0036872
2006	0,095866	0,30146	8,0014	3,7904	4,2761e-008	0,00094538	0,38448
2007	NaN	NaN	NaN	NaN	NaN	NaN	NaN

Table 8 – Statistics of linear regression model with c1 as constant and c2 as beta of the regression, t test for zero-coefficients with related p-values and square r. Linear regression between equity return and equity dividend yield.

Time	c1	c2	t stat b1	t stat b2	p-value 1	p-value 2	R2
1996	0,15905	-0,94534	26,157	-3,1482	1,2974e-018	0,004502	0,30115
1997	0,17218	-1,1164	25,303	-2,9002	2,7158e-018	0,0080688	0,26777
1998	0,15645	-1,6104	27,725	-4,8723	3,5372e-019	6,4038e-005	0,50791
1999	0,16359	-2,1155	17,923	-3,7089	5,2027e-015	0,0011557	0,37425
2000	0,15205	-1,8221	10,577	-2,3067	2,6235e-010	0,030423	0,18788
2001	0,10039	-1,164	8,8167	-2,0698	7,7804e-009	0,04988	0,15702
2002	0,10866	-0,19537	9,5931	-0,43982	1,664e-009	0,66417	0,0083404
2003	0,12359	-0,6855	12,196	-1,5642	1,5975e-011	0,13144	0,096146
2004	0,095691	-0,287	14,698	-1,1202	3,5009e-013	0,27421	0,051732
2005	0,1041	0,19501	16,332	1,0345	3,8006e-014	0,31168	0,044458
2006	0,15352	-0,63465	11,944	-1,2556	2,4266e-011	0,22186	0,06415
2007	0,1198	-0,020662	12,399	-0,057556	1,1478e-011	0,9546	0,00014401

Unlike, the recovery rate implied seems to have a good explicative capacity (Table 9) and the negative relation is not a surprise because for high level of risk is associated a low level of recovery.

Table 9 – Statistics of linear regression model with c1 as constant and c2 as beta of the regression, t test for zero-coefficients with related p-values and square r. Linear regression between equity return and endogenous recovery rate.

Time	c1	c2	t stat b1	t stat b2	p-value 1	p-value 2	R2
1996	NaN	NaN	NaN	NaN	NaN	NaN	NaN
1997	0,19461	-0,10057	12,35	-2,5561	1,2418e-011	0,017659	0,22122
1998	0,15558	-0,072305	15,808	-2,4431	7,5854e-014	0,022655	0,20604
1999	0,18031	-0,14994	13,17	-3,5419	3,3767e-012	0,0017405	0,35294
2000	0,15326	-0,12619	9,6159	-2,1001	1,5922e-009	0,04689	0,1609
2001	0,12745	-0,15715	11,275	-4,5803	7,5825e-011	0,00013249	0,47703
2002	0,13073	-0,089035	10,666	-2,3669	2,2342e-010	0,026731	0,19587
2003	0,1577	-0,12071	9,8072	-3,0968	1,1024e-009	0,0050863	0,29426
2004	0,11801	-0,064948	7,5423	-1,8693	1,1608e-007	0,074363	0,13189
2005	0,13062	-0,046267	4,3511	-0,71296	0,00023468	0,48304	0,021623
2006	0,22667	-0,19483	8,18	-3,2152	2,9216e-008	0,0038363	0,31009
2007	NaN	NaN	NaN	NaN	NaN	NaN	NaN

Thus, the results show a good correspondence between Capital Asset Pricing estimates and those based on the barrier model.
Finally, the estimates invo

Conclusions.

This work has presented a knock out model, with endogenous barrier, like a unified framework of analysis for capital structure, dividend policy and bankruptcy items. The original idea is to evaluate the claimholders position by using a simple static replicating theory, that yields the framework less complex than the previous barrier models.
The barriers are estimated endogenously by equityholders that can make a decision for the default even before of the maturity of debt if the delta of equity vanish.
An empirical work is presented to extrapolate the cost of capital, the asset value e the asset risk. Several relation between the expected equity return, estimated by CAPM, and the estimates of barrier model variable confirm the general evidence of corporate finance.
The addresses of future researches can be taught as well on theoretical side as on empirical that. In first case, the model could be extend in order to take into account the bankruptcy (financial distress) costs, by designing a specific rebate

parameter/function. On the other side, we can improve our empirical work by collecting a large sample of firms and we can propose a more sophisticated statistic analysis than simple linear regressions.

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