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Empirical Analyses of Determinants of D.J.S.I. US Mean Returns

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***Abstract*—**This study investigates the relationship between 10 year bond value, Yen/U.S dollar exchange rate, non-farm payrolls (all employs) and crude oil to U.S. Dow Jones Sustainability Index. A GARCH model is used to test these relationships for the period January 1st 1999 to January 31st 2008 using monthly data. Results show that an increase of the 10 year bond and non farm payrolls (all employs) lead to an increase of the D.J.S.I returns. On the contrary the volatility of the Yen/U.S dollar exchange rates as well as the increase of crude oil returns has negative effects on the U.S D.J.S.I returns. This study aims at assisting investors to understand the influences certain macroeconomic indicators have on the companies' stock returns as reported by the D.J.S.I.

***Keywords*—**Bond value, Corporate Social Responsibility, Crude oil, D.J.S.I United States, Exchange rate, GARCH, Non-farm payrolls.

I. Introduction

THE relation between economic fundamentals and stock returns has been studied by a significant number of researchers [35], [18], [36], [5], [12], [30], [6], [49] and [31]. Reference [37] focused the study on the London Stock Returns (a sectoral Approach) and concluded that the macroeconomic factors have a significant effect on the UK stock exchange market. However, the effect depends on the sector that the company belongs to. Additionally, Samitas and Kenourgios [6] investigated the impact of macroeconomic factors on European countries stock returns and pointed out the importance of economic activity on the formation of stock returns.

As far as the bond value is concerned, Chen et al. [35] supported that the economic factors which affect future cash flows or the discount rate of those cash flows should affect the stock returns. Reference [53] investigated the relationship between stocks and bonds during crash–rebound episodes and concluded that there is a strong connection between them. Moreover, Connolly et al. [44] claimed that the uncertain stock market environment tends to decrease the movement between stock and bonds. Furthermore, d'Addona and Kind [50] found that the correlation between stocks and bonds increases due to the volatility of the real interest. The bond value is changed due to changes in the interest rates relating to strengths and weaknesses of the economy. The relation between the interest rates and the stock market has been extensively analyzed by many researchers. Particularly, Fama and Schwert [17] supported that on average, stocks react negatively to interest rates. Moreover, Nasseh and Strauss [5], investigating the relationship between stock prices and international economic activity in France, Germany, Italy, Netherlands, Switzerland and the U.K., found that a negative relation exists between stock returns and long term interest rates. Additionally, Bautista [7] concluded that the increase of interest rates hinders companies to operate in steady or secure economic environment, leading even to bankruptcy. Finally, Humpe and Macmillan [4] found that long term interest rates and consumer price index are related negatively to stock prices.

While most of the researchers agree on the importance of interest rates in the formation of stock returns, the issue of exchange rates remains controversial. References [41] and [28] claimed that the relation of stock returns and exchange rate movements is hardly significant. According to Bartram [52] there is a non linear relationship between stock returns and exchange rate movements. Furthermore, Ahmed [49], analysing the relationship of stock prices in India market and macroeconomic variables, concluded that while interest rates cause changes in stock indices, the exchange rates do not. Reference [45] claimed that the movements of exchange rates influence the level of competitiveness of a company liable in foreign currency and therefore, affect its earnings and costs. Bartov and Bodnar [15] found that there is a significant lagged relationship between dollar changes and stock value. Joseph [38], in a sample of chemical, electrical, engineering and pharmaceutical industries, stated that exchange rates and interest rates affect UK stock returns. Additionally, El-Masry [1] argued that exchange rate changes are likely to affect the stock value returns over a number of periods, affecting both future expected cash flows and future value. Finally, Diallo [23] found that the volatility of the real exchange rates has a strong negative impact on investments. Reference [31] studied the relationship between interest rate volatility and stock market returns showing that interest rates have a strong positive effect on stock returns.

With regard to the influence of the oil factor on the national economies, Rotemberg and Woodford [29] found that when oil prices rise there is a reduction in U.S output after five to seven quarters. Sadorsky [43] supported that the economic activity is affected by oil prices and oil price volatility but, changes in the economic activity have little impact on oil prices. Brown and Yücel [54] claimed that oil, being the most important raw material affects economies substantially. Moreover, Hamilton [24], [25] found that nine out of 10 U.S. recessions since World War II resulted from an increase in oil prices, except from the 1960 recession. Leduc and Sill [51] showed that there is a fall of real US output because of the increase of the oil prices. More particularly, the effect of oil prices in stock markets has been analyzed by some researchers

such as [27] who concluded that the increase of oil prices is associated with the decline of the stock market. Moreover, Jones and Kaul [9] found that there is a negative relation between aggregate stock returns and oil price changes. Additionally, Ciner [8], adopting nonlinear causality tests, showed that oil shocks affect stock index returns. Reference [32] studying the determinants of stock returns of Canadian oil and gas companies, revealed a significant relationship between stock returns and oil price movements. On the other hand, other researchers questioned the relationship between oil price changes and stock returns. The studies of Chen et al. [35] and [59], who concentrated on the U.S market and Japanese market respectively, revealed ambiguous results.

In reference to the non farm payroll (all employs) it is a reliable indicator of the economic growth, as it represents the total number of paid U.S workers of any business, excluding the following employees: general government employees, private household employees, employees of nonprofit organizations that provide assistance to individuals and farm employees. Although this economic indicator has not been used by many researchers in investigating stocks, it represents the health of an economy, as the Federal Reserve Bank of San Francisco [20] has stated, showing at a certain period the numbers of jobs that are added in the U.S.

This paper examines the impact of macroeconomic factors on the formation of U.S. D.J.S.I returns. Specifically, the relation of the 10 year bond value, Yen/U.S dollar exchange rate, non-farm payrolls (all employs) and crude oil prices with the returns of D.J.S.I United States is being investigated. The D.J.S.I is composed of companies that integrate Corporate Social Responsibility (CSR) policy in their operations. The contribution of this study to the international literature is twofolded. Firstly, the investigation of relationship between companies that integrate CSR activities (D.J.S.I United States returns) and economic indicators is innovative and secondly, this study concerns macroeconomic factors that have not been extensively explored in influencing the returns of a stock market.

The structure of this paper is as follows. Section II presents the Dow Jones Sustainability Index of the United States. Section III introduces the concept of the Corporate Social Responsibility. Section IV describes the data collection and in section V the methodology and empirical findings are presented. Section VI summarizes the paper.

II. Dow Jones Sustainability United States Index

The D.J.S.I was launched for the first time in 1999, consisting of the leading companies that compromise CSR activities around the world. The D.J.S.I family is constituted by five indexes: the Dow Jones Sustainability World Index, the Dow Jones STOXX Sustainability Index, the Dow Jones EURO STOXX Sustainability, the Dow Jones Sustainability North America Index and the Dow Jones Sustainability United States Index [13]. As regards the U.S. D.J.S.I, it is a subset of the Dow Jones Sustainability North America Index (D.J.S.I North America), introduced in September 23rd, 2005. The D.J.S.I North America includes the financial performance of the top 20%, in terms of sustainability, of the 600 biggest North American companies, including Canada, Mexico and the United States and it is reviewed annually and quarterly. The D.J.S.I United States refers to the U.S companies that are included in the D.J.S.I North America. The D.J.S.I is the only SRI index that proposes not only general criteria but also sector specific criteria for each industry in order to take into consideration the special challenges and trends of each sector [14]. According to D.J.S.I United States Components in February 29th 2008, 98 U.S companies are included [34]. Fig. 1 presents the number of companies representing each industry composing the D.J.S.I United States.

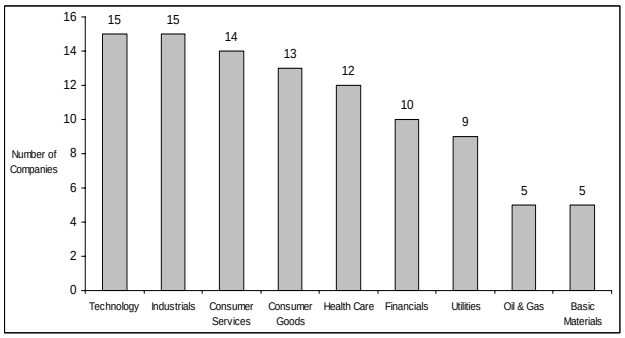

Fig. 1 Number of companies of each industry that constitute the D.J.S.I United States in February 29th, 2008

III. Corporate Social Responsibility

CSR has gathered significant interest in the last years as numerous independent non-governmental organizations, governments, companies and practitioners are involved in its promotion. There is no widely accepted definition for the concept of CSR, as authors define it in different ways. Reference [22] proposed a concept for the social responsibility of the businessman: "*… the obligations of businessmen to pursue those policies, to make those decisions, or to follow those lines of action which are desirable in terms of the objectives and values of our society*", stating that CSR is no panacea for all problems of society. Carroll [3] supported that companies have four different social responsibilities: economic, legal, ethical, and philanthropic. Sims [48] defined CSR as "*the continuing commitment by business to behaving ethically and contributing to economic development while improving the quality of life of the workforce and their families as well as of the community and society at large*". Vos [26] defined the concept of CSR as "*the obligations or duties of an organization to a specific system of stakeholders*", posing two significant questions: firstly, "*What are the responsibilities of an organization?*" and secondly "*To whom is the organization responsible?".* By investigating companies' CSR actions, it is clear that each company acts in response to CSR norms in its own unique way, concentrating on special dimensions of CSR. The main concept of CSR is whether companies will comply only with the legitimacy or will move beyond the compliance to the legitimacy. Adopting

CSR policy means a number of benefits for companies [42], [58], [11], [2], [39], even if the nature of the benefits depends on the sector to which companies belong to.

IV. Data Collection

For the empirical analysis, monthly observations of the D.J.S.I (U.S), Yen/U.S dollar exchange rate, non farm payrolls and crude oil price are used. The sample period covers January 1st 1999 to January 31st 2008. The data of the month closing prices of D.J.S.I United States are provided by the official web site of Dow Jones Sustainability Indexes[1], the 10 year bond return is available on Yahoo – Finance[2], the Yen/US dollar exchange rate[3] and total non farm payrolls (all Employees)[4] are provided by the Federal Reserve Bank of St. LOUIS and finally the crude oil prices are provided by the Energy Information Administration (Official Energy Statistics from the U.S.A. Government)[5].

Monthly continuously compounded returns for the selected data are calculated as, Rt=100*log (pt/pt-1) where Rt and pt are the monthly returns and prices respectively. Preliminary diagnostic tests show that the same month returns of the non farm payrolls (RPt), and the previous month results of the 10 year bond returns (RBt-1) and the crude oil returns (RCOt-1) are influencing the returns of the D.J.S.I. United States (RDt). Moreover, it was found that the volatility of the Yen/U.S dollar exchange rate returns (RY2t) is affecting the returns of the RDt. It should be noted that at the 1% significance level, the hypothesis that the mean return of the RY2t-1 is equal to zero is not rejected, which implies that $\sum (RY_i - \overline{RY})^2 = \sum RY_i^2$. Therefore, the squared returns of the RYt-1 were used as proxy variable for the volatility of Yen/U.S dollar exchange rate.

V. Methodology and Empirical Findings

Table I presents the summary statistics for RDt, RY2t, RBt, RPt and RCOt series. The sample means returns of RDt and RCOt are positive and statistically significant while the means returns of RY2t, RBt, RPt are not rejected since they are equal to zero. Also, according to the Jarque-Bera statistics and the value of kurtosis[6], there are significant departures for normality hypothesis only for the RY2t, RBt series. Moreover, the Dickey-Fuller test is employed to determine whether there is a unit root suggested that the return series have been produced by stationary series.

Table II shows the sample autocorrelation function (ACF) and partial autocorrelation function (PACF) for monthly returns and squared monthly returns for RDt variable. It can be observed that while there is no significant autocorrelation in simple returns at any lag, on the contrary there is generally a significant autocorrelation in squared monthly returns at all lags.

TABLE I
Sample Statistics for RD_T, RY^2_T, RB_T, RP_T and RCO_t Return Series

Statistics	RD_t	RY_t^2	RB_t	RP_t	RCO_t
Observations	108	108	108	108	108
Mean	0.003	0.0005	-0.0023	0.0007	0.0185
Median	0.010	0.0002	-0.004	0.0008	0.026
Std. Dev.	0.044	0.0007	0.060	0.0012	0.078
Skewness	-0.269	1.868	0.628	-0.257	-0.466
Kurtosis	3.018	6.379	4.618	2.929	3.011
Jarque-Bera	1.301	114.160	18.877	1.209	3.914
Augmented Dickey-Fuller (ADF)	-11.425	-9.315	-8.881	-2.481	-9.595

TABLE II
Test for Serial Dependence in First and Second Moments of RDt

	Returns			Squared Returns		
Lags	Auto correlation	Partial Autocorrelation	LB(n)	Autocorrelation	Partial Autocorrelation	LB(n)
1	-0.098	-0.098	1.0587	0.228	0.228	5.7704
2	-0.025	-0.035	1.1288	0.21	0.166	10.701
3	0.106	0.101	2.4029	0.067	-0.012	11.21
4	-0.085	-0.067	3.2246	0.033	-0.014	11.334
5	0.147	0.142	5.7283	0.344	0.359	24.969
6	0.052	0.066	6.043	0.399	0.332	43.55
12	-0.012	-0.06	9.5619	0.25	0.081	65.812
24	0.133	0.095	32.024	-0.001	-0.176	101.64
36	-0.022	0.057	39.115	-0.032	-0.046	115.64

LB(n) are the n-lag Ljung-Box statistics for RD_t and RD_t^2 respectively. LB(n) follows chi-square distribution with n degree of freedom; the sample period contains 108 yearly returns.

In order to take into account the autocorrelation in squared returns of RDt variable as well as its asymmetric feature, the GJR-GARCH (p,q) process has been used in estimating its conditional average mean and volatility return. The Autoregressive Conditional Heteroscedastic (ARCH) model developed by Engle [46] and later generalized (GARCH) by [55] is widely used to describe the mean and time varying conditional volatility of time series. This model allows the fat tails which are often observed in financial distributions and imposes an autoregressive structure on the conditional variance and therefore is capable of capturing the volatility

[1] It is available a historical perspective of the D.J.S.I World since December 31, 1998, data available at: http://www.sustainability-index.com/07_htmle/data/djsina.html (free registration is needed)
[2] Data from Yahoo-finance available at: http://finance.yahoo.com/q/hp?s=%5ETNX
[3] Data available at: http://research.stlouisfed.org/fred2/series/EXJPUS/downloaddata?cid=95
[4] Data available at: http://research.stlouisfed.org/fred2/series/PAYEMS/downloaddata?cid=11
[5] Data available at: http://tonto.eia.doe.gov/dnav/pet/pet_pri_spt_s1_m.htm
[6] For normal distribution the value of kurtosis is three.

clustering7. The specification GJR-GARCH(p,q) of the GARCH model applied in this study is able to account for the different volatility reactions in positive and negative changes (shocks) of return series. Besides, the GJR-GARCH model, according to [47], and [21], is ideal for analyzing the volatility of a stock market. The GJR-GARCH model is popular among many researchers for the study of index volatility [57], [33], [10], [40], [16]. Also, Léon [31] studying macroeconomic factors, such as interest rates, which affect stock market returns, used a GARCH model. The application of the LR test on the GJR-GARCH(p,q) model, demonstrated that in most cases there was no asymmetry and no relation of the volatility of the present period with that of the previous period and as a result the model fell into a GARCH(0,1) model. The final specification proposed to estimate the mean and volatility of the RDt series is the following:

Mean equation:

$$RD_t=b_1+b_2RY^2_t+b_3RB_{t-1}+b_4RP_t+b_5RCO_{t-1}+u_t \quad (1)$$

Variance equation:

$$\sigma_t^2 = a_1 + a_2\sigma_{t-1}^2 \quad (2)$$

$u_t \sim GED(0, \sigma_t^2)$,

The estimations of the mean and the conditional variance σt2 of the return series for the RDt are based on the following variables and parameters:

- RY2t reflects the volatility of the Yen/U. S dollar exchange rate returns
- RBt, reflects the returns of the 10 year bond and, indirectly, the changes of interest rate.
- RPt is the variable which measures the non farm payrolls in U.S.A.
- RCOt reflects the returns of the crude oil.
- ut are residuals which are assumed to follow the GED (generalized error distribution).
- The volatility σ_{t-1}^2 is a function of the residuals ut-2, ut-3,…, which means that older news have a greater influence than that of the previous month

Diagnostic tests for the appropriateness of the model are based on the LB test statistics. The results show that the GARCH (0, 1) fits the data, given that none of the LB statistics of the standardized residuals and the standardized squared residuals are significant (Table III).

TABLE III
LB TEST FOR THE STANDARDIZED RESIDUALS OF THE GARCH (0, 1) MODEL

	Standardized residuals			Squared standardized residuals		
lags	Autocorrelation	Partial autocorrelation	LB(n)	Autocorrelation	Partial autocorrelation	LB(n)
1	-0.097	-0.097	1.0394	0.019	0.019	0.0396
2	-0.124	-0.135	2.7581	-0.014	-0.014	0.0613
3	0.07	0.044	3.3088	-0.195	-0.195	4.333
4	0.033	0.029	3.4293	-0.129	-0.127	6.2052
5	0.072	0.096	4.0223	0.136	0.14	8.3285
6	-0.033	-0.011	4.1444	0.128	0.094	10.224
12	0.027	0.012	4.6177	0.115	0.053	17.339
24	0.061	0.096	11.372	-0.096	-0.1	26.755
36	0.05	0.051	21.392	-0.004	0.05	35.463

Notes: LB(n) are the n-lag Ljung-Box statistics for the residual series. LB(n) follows chi-square variable with n degree of freedom; the series of residual contains 107.

The adjusted R2 (0.106) and the estimated F statistic (2.8) indicate the overall statistically significant influence of independent variables in the changes of the D.J.S.I. United States returns (RDt). Results presented in Table IV show that the volatility of Yen/U.S dollar exchange rate returns (RY2t) exert negative influence in the conditional mean return of the D.J.S.I. The volatility of Yen/U.S dollar weakens the confidence in U.S values and generally the U.S market, creating unstable environment for companies. Also, the same month returns of the non farm payrolls (RPt) and the previous months' 10 year bond (RBt-1) returns have statistically significantly positive impact on the conditional means return of the D.J.S.I. The positive relation between non farm payroll (all employees) and D.J.S.I United States is explained as the new employees added in the U.S economy increase U.S production and result in economic growth. As regards to the effect of Bond Value, its valuation is based on interest rates. Therefore, the D.J.S.I United States returns increase when the interest rate decreases, encouraging higher levels of capital flows to the stock market [31]. With regard to the lag of interest rates in this model, the investors probably delay their investment decisions in order to be sure on the new level of interest rates, thus, when there are high levels of uncertainty, investors become more cautious and therefore, delay their investment decisions. Finally, the increase of the previous month's crude oil returns (RCOt-1) has significant negative effect on the conditional mean returns of the D.J.S.I. The crude oil is a basic cost variable in companies and as a result its increasing price affects their profits and thus their returns. However, the lag reaction of the D.J.S.I United States returns in the above increase can be attributed to the adjustment process of companies to the new information coming from such economic indicators as [56] have been observed.

In Table V the results of the variance equation are presented. The value of the α2 coefficient (0.9798), which reflects the influence of σ_{t-1}^2, i.e. the older information

[7] Volatility shocks persist over time.

(residuals ut-2, ut-3,…), is positive and statistically significant, implying that the volatility shocks (information) are slowly assimilated to the particular market.

TABLE IV
MEAN EQUATION

$RD_t=b_1+b_2RY^2_t+b_3RB_{t-1}+b_4RP_t+b_5RCO_{t-1}+u_t$

b_1	b_2	b_3	b_4	b_5
0.013*	-19.808*	0.150*	5.718**	-0.113*
(0.0046)	(4.6394)	(0.0486)	(2.2704)	(0.0443)

Notes: Standards errors are shown in parentheses. *indicates statistical significance at the 1% level. **indicates statistical significance at the 5% level.

TABLE V
VARIANCE EQUATION

$\sigma_t^2 = a_1 + a_2\sigma_{t-1}^2$

a_0	a_1
-3.08E-09	0.9798*
(1.41E-05)	(0.01172)

Notes: Standards errors are shown in parentheses. *indicates statistical significance at the 1% level. **indicates statistical significance at the 5% level.

VI. CONCLUDING REMARKS

The study investigates how macroeconomic indicators can influence a portfolio of companies that adopt CSR in their business operations using a GARCH model. More precisely, this paper explores the relationship between the D.J.S.I United States total returns and macroeconomic domestic and international economic variables as 10 year bond value, Yen/US dollar exchange rate, non-farm payroll and crude oil prices adopting the GARCH model. According to the results, the increase of 10 year bond value of the previous month leads to increase the D.J.S.I United States returns and the Yen/US dollar exchange rate volatility decreases the D.J.S.I United States returns. Additionally, there is a positive relation between non farm payroll and D.J.S.I United States and finally, the increase of crude oil prices of previous month decrease the D.J.S.I United States returns. This paper concludes that these macroeconomic factors affect significantly the stock returns of companies that integrate CSR policy, even if such companies are more resistant to risks and crises [19].

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