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The Impact of Gold, Bond, Currency, Metals and Oil Markets on the USA Stock Market

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ABSTRACT

This study examines the impact of financial and economic variables on the industrial Dow Jones Industrial Average (DJIA) using daily data over the sample period March 1995-May 2014. Gold, Bond, Currency, Metals and Oil market were taken into consideration, and, as well as, their impact on the DJIA. The results of the model GJR-Generalized Autoregressive Conditional Heteroskedasticity proved that the purchase of gold, of decade bonds (10 years Treasury Note) and the US Dollar/Yen exchange rate affect, negatively, the returns of DJIA. On the other hand, it was made clear that the purchase of industrial metals affects, positively, the returns of DJIA. Lastly, our findings indicate that the asymmetry of the oil returns affects - extremely negatively - the DJIA returns.

Keywords: GJR-Generalized Autoregressive Conditional Heteroskedasticity, Brent Oil, Gold, Metals, Equity Market, Exchange Rates, Bond Market, Market Risk
JEL Classifications: G1, G32, R3, C5

1. INTRODUCTION

The relationship between certain macroeconomic and financial variables and the stock returns has been covered by a number of studies (e.g. Fama, 1990; Chen, 1991; Samitas and Kenourgios, 2007). The impact of macroeconomic factors on stocks are mentioned, also, by Flannery and Protopapadakis (2002), who supported that they are the most crucial indicators determining the income from shares as they have an influence on future cash flow of the society and on discount rates. King (1966) pointed out that share prices are affected by macroeconomic factors up to 50% on average, while the rest 50% is affected by micro-economic and psychological factors. This study has examined the possible impact of financial and economic variables, namely Gold price, bond value, US dollar/Yen exchange rate, oil price and industrial metal, on Dow Jones Industrial Average (DJIA) index.

Regarding the oil variable, it has played a crucial role to global economy and it is responsible for important aggregate fluctuations in the recent decades (Rasche and Tatom, 1981; Hamilton, 1983; Gisser and Goodwin, 1986). Sadorsky (1999) took into account a vector autoregression (VAR) and showed that oil prices and volatility play important roles in affecting financial activity. Nandha and Faff (2008) analyzed 35 global industry indices and found that oil price rises have a detrimental effect on stock returns in all sectors apart from mining, oil and gas industries. In addition, Park and Ratti (2008) showed that oil price shocks have a statistically significant impact on real stock returns in the US and 13 European countries, focused on the period from 1986 to 2005. O'Neill et al. (2008) showed that the impact of higher oil prices leads to reduced stock returns in the United States (US), the United Kingdom and France.

As far as the relationship between exchange rates and stock returns is concerned, Aggarwal (1981) supported that there is a positive relationship between US stock prices and exchange rate. Bartov and Bodnar (1994) revealed that there is a lagged relationship between dollar changes and stock value. Chamberlain et al. (1997)

intended to investigate the foreign exchange exposure of a sample of both US and Japanese banking firms. Their results indicate that the stock returns of a significant fraction of the US companies move with the exchange rate. Furthermore, Fang and Loo (1994) focused on the relationship between US stock returns and exchange rate for the period 1981-1990. It was revealed that exchange rate fluctuation is likely to affect the US stock from mining, food and beverage, chemical, petroleum and utilities industries. Hatemi and Irandoust (2002) using a VAR model showed that causality is unidirectionally running from stock prices to exchange rates in Swedish market.

Gold can be considered as a substitute to reduce similar types of risks in portfolios (Ciner, 2001; Mansor, 2011) and it is also used as an investment hedge against the US dollar (Joy, 2011). Mansor (2011) employed Generalized Autoregressive Conditional Heteroskedasticity (GARCH)-type models to gold and stock returns over the period 2001-2010 and showed evidence indicating a significant positive relation between gold return and once-lagged stock return. Recently, El HediArouri et al. (2015) focused on the China stock market for the period from 2004 to 2011 for an emerging market. Applying GARCH models, it was found that past gold returns play a determinant role in explaining the dynamics of conditional return of Chinese stock market. Finally, Hood and Malik (2013), using data from the US stock market over the period 1995-2010, found that in periods of low volatility and high volatility, gold does not have a negative correlation with the stock market. Hillier et al. (2006) took into account the period 1976-2004 in order to study the role of gold and commodities on equity markets. The results showed that gold had a small negative correlation with S&P 500 index.

In this study, the bond value is considered as a proxy of interest rate. The correlation between stock and bond is always in the core of many financial decisions; namely, risk management and optimal allocation of financial assets (d'Addona and Kind, 2006). Bautista (2003) pointed out that the high interest rate can cause hinders for the companies to operate in a steady economic environment, leading even to bankruptcy. Fama and Schwert (1977) showed that, on average, stocks react negatively to interest rates. In addition, Elyasiani and Mansur (1998) employed GARCH-M methodology in order to investigate the relationship between bank stock returns and volatility. The results indicated that the interest rate has a direct impact on the first and the second moments of the stock returns distribution, respectively. Moreover, the long-term interest rate has a negative and significant impact on the bank stock return.

Finally, the industrial metal index is used in this paper as a proxy of economic growth. Metal commodities, incorporating either raw or partially processed materials that will be transformed into finished goods, are often the most significant source of export earnings for many developing countries (Chen, 2010). Jacobsen et al. (2013) illustrated that industrial metal price movements forecast economic growth. In particular, during the recession period, the increase of commodity prices can be considered as a positive signal of increasing subsequent economic activity. Thus, it is intended to record the importance of industrial metals on the stock return.

The present study surveys the effect of predetermined variables on the US stock market. In particular, five variables are incorporated in the proposed model, namely Gold price, 10 years Bond value, US dollar/Yen exchange rate, Oil price and Metal Index, while the index employed as a proxy for stock returns is DJIA. The econometric framework used for our study involves a GARCH model by incorporating data for the period from March 21st, 1995 to May 30th, 2014. The results support that DJIA index is influenced by various economic and financial variables. Furthermore, the most important finding indicating that the third moment of oil returns distribution, that is the asymmetry, affects-extremely negatively - the DJIA returns.

The rest of the paper is organized as follows: Section 2 presents the methodological considerations followed by data. Section 4 illustrates the empirical findings. The last section illustrates the conclusions.

2. METHODOLOGICAL CONSIDERATIONS

Usually, stock price time series have some abnormal behavior such as volatility clustering and leptokurtosis. However, Engle' model (1982) and its extension to the GARCH model (Bollerslev, 1986), allow the fat tails often observed in financial distributions and impose an autoregressive structure on the conditional variance. In addition, there are some new developments in times series analysis such as GJR-GARCH introduced by Glosten et al. (1993) that take into account the aforementioned abnormal characteristics. The estimation of GJR-GARCH model emerges from the joint estimation of a mean and conditional variance equation (Nelson, 1991; Engle and Ng, 1991).

The GJR(p,q) model has p GARCH coefficients associated with lagged variances, q ARCH coefficients associated with lagged squared innovations, and q leverage coefficients associated with the square of negative lagged innovations. The general form of the GJR(p,q) model is:

$$Y_t = X_t'\theta + u_t \quad (1)$$

Where, X_t is a vector of exogenous variables and u_t is the error term

$$\sigma_t^2 = k + \sum_{i=1}^{p} \gamma_i \sigma_{t-1}^2 + \sum_{i=1}^{q} a_i u_{t-1}^2 + \sum_{i=1}^{q} \xi_i \mathrm{I}(u_{t-j} < 0) u_{t-1}^2 \quad (2)$$

The indicator function $I(u_{t-j}<0)$ equals 1 if $u_{t-j}<0$, and 0 otherwise. Thus, the leverage coefficients are applied to negative innovations, giving to negative changes additional weight.

For stationarity and positivity, the GJR model has the following constraints:

- $k>0$
- $\gamma_i \geq 0$, $\alpha_j \geq 0$
- $\alpha_j + \xi_j \geq 0$
- $\sum_{i=1}^{p} \gamma_i + \sum_{j=1}^{q} a_i + \frac{1}{2}\sum_{j=1}^{q} \xi_j < 1$

The GARCH model is nested in the GJR model. If all leverage coefficients are zero, then the GJR model reduces to the GARCH model. This means that you can test a GARCH against a GJR model using the likelihood ratio test.

The GJR-GARCH (1,1) model, which is used for our research is stated as follows:

The mean equation is:

$Y_t = X_t'\theta + u_t$

The conditional variance equation is:

$$\sigma_t^2 = k + \gamma\sigma_{t-1}^2 + \alpha u_{t-1}^2 + \xi \mathrm{I}(u_{t-j} < 0)u_{t-1}^2 \quad (3)$$

Where u_t GED($0,\sigma_t^2$), is assumed to follow the Generalized Error Distribution (GED). We employ the GED because of its ability to accommodate leptokurtosis.

The leverage effect occurs when $\xi>0$. The condition for a non-negative variance requires $k\geq 0$, $\gamma\geq 0$, $\alpha\geq 0$, $\alpha+\xi>0$.

When $R_t - \hat{R}_t < 0$, then $u_t<0$, which means that the observed return R_t is less than the estimated return (in other words, the mean return). Consequently, when $I(u_{t-j}<0)$ equals 1, the negative change u_{t-1}^2 at time t-1 correlates with the volatility at time t.

In this model, the good news ($u_{t-1}>0$) is related to the bad news ($u_{t-1}<0$) and it has a different effect on the conditional variance. If $u_{t-1}>0$, it implies that at time t-1 we had good news, which had a positive effect on the return (over the mean return), and this is why the residual is positive. Good news reflects on the coefficient α (ξ absorbs the effect of the bad news). However, bad news has an effect on α+ξ, because if $I(u_{t-j}<0)$ equals 1, then the equation becomes:

$$\sigma_t^2 = k + \gamma\sigma_{t-1}^2 + \alpha u_{t-1}^2 + \xi u_{t-1}^2 * 1 = k + \gamma\sigma_{t-1}^2 + (\alpha+\xi)u_{t-1}^2 \quad (4)$$

When $\xi>0$, we have the leverage effect, which means that bad news has a greater effect on conditional volatility.

3. DATA

This study examines daily observations of DJIA Index, Gold Bullion LBM U$/Troy Ounce, US Benchmark 10 years DS Government Index - Clean Price Index, the US Dollar/Yen exchange rate, FTSE USA Industrial MET - Price Index and Brent Crude Oil expressed in US Dollars per barrel over a time period from March 21st, 1995 to May 30th, 2014. The DJIA is a price-weighted average of 30 significant stocks traded on the New York Stock Exchange and the Nasdaq. The dataset were extracted from Thomson Reuters DataStream. The analysis of the study focuses on returns as all price series were non stationary in levels.

Market prices index are transformed to daily returns $R_t = \mathrm{Log}\frac{p_t}{p_{t-1}}$

Where: R_t is daily return of used indexes for day t, p_t is current day closing price, p_{t-1} is closing price of the previous day, and Log is Natural Logarithm.

4. EMPIRICAL FINDINGS

Table 1 presents the descriptive statistics of daily returns in order to understand the nature and distributional characteristics for the DJIA index, Gold Bullion LBM U$/Troy Ounce index (Gold), US Benchmark 10 years DS Government index - Clean Price index (Bond), US Dollar/Yen exchange rate (D/Y), and FTSE USA Industrial MET-Price index (metals) return time series. The sample mean returns of these series are close to zero and the null hypothesis cannot be rejected, which defines that the mean returns are not statistically different from zero. Also, the Jarque–Bera statistics lead to the conclusion that essential departures from normality occur while the series are slightly asymmetric and leptokurtic. The high kurtosis values suggest that big shocks of either sign are more probable to be presented. Moreover, the Augmented Dickey-Fuller test, which allows both an intercept and a time trend, proved that the sample series had been produced by stationary series.

Moreover, the third moment of the Brent crude oil (Oil) return series was examined because it was found that the daily returns to the third power of the oil index (Oil3) affect the conditional mean of the DJIA index. It should also be mentioned that - at the 5% significance level -the hypothesis that the mean of the Oil series is equal to zero is not rejected, which suggests that the third central moment of this series influences the conditional mean of the Oil variable.

Table 2 shows the sample autocorrelation function and partial autocorrelation function for daily returns and squared daily returns of Oil time series. The Ljung – Box statistics show an autocorrelation on daily returns and strong autocorrelations in the squared daily returns, thus indicating conditional heteroskedasticity (Bollerslev, 1987).

The preliminary statistical results, the Akaike Information Criterion (or the Schwartz Bayesian Criterion) and the application of the LR test on the GJR-GARCH(p,q) model demonstrated the final specification for the estimation of the mean and the volatility of the DJIA series is the following specification:

Mean equation:

$$DGIA_t = b_0 + b_1 Gold_t + b_2 Bond_t + b_3 D/Y_t + b_4 Metals_t + b_5 Oil^3 + u_t \quad (5)$$

Variance equation:

$$\sigma_t^2 = k + \gamma\sigma_{t-1}^2 + \alpha u_{t-1}^2 + \xi \mathrm{I}(u_{t-j} < 0)u_{t-1}^2 \quad (6)$$

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

Diagnostic tests were performed in order to establish goodness of fit and appropriateness of the model. First, it was examined if the standardized residuals and squared standardized residuals of the estimated model were free from serial correlation. As can be seen in Table 3, the LB(n) statistics for standardized residuals proved

Table 1: Sample statistics

Statistics	DJ	Gold	Bond	D/Y	Metals	Oil3
Observations	5008	5008	5008	5008	5008	5008
Mean	0.000282	0.000235	0.000064	−0.000027	0.000139	−0.00000046
Median	0.000269	0.0000	0.0000	0.0000	0.0000	0.000000
SD	0.0115	0.0106	0.0047	0.0070	0.0229	0.000131
Skewness	−0.1588	−0.3241	−0.1181	0.49	−0.22	−7.013
Kurtosis	11.128	10.21	5.85	9.71	10.28	563.455
Jarque-Bera	13806.3	10945.1	1707.6	161359.4	11109.7	65585299
ADF	−53.86	−70.82	−69.3	−72.38	−70.97	−72.50

ADF: Augmented dickey-fuller, SD: Standard deviation

Table 2: Test for serial dependence in first and second moments of DJIA variable

Returns				Squared returns			
Lags	Autocorrelation	Partial correlation	LB(n)	Lags	Autocorrelation	Partial correlation	LB(n)
1	−0.061	−0.061	18.926	1	0.2	0.2	104.05
2	−0.04	−0.044	26.99	2	0.408	0.383	538.99
3	0.01	0.005	27.537	3	0.198	0.087	641.55
4	−0.003	−0.003	27.569	4	0.286	0.121	855.26
5	−0.023	−0.023	30.333	5	0.331	0.235	1142.1
6	−0.009	−0.012	30.717	6	0.314	0.159	1400.8
12	−0.016	−0.015	46.799	12	0.294	0.099	2941
24	−0.023	−0.023	75.283	24	0.254	0.097	4639.5
36	−0.001	−0.014	104.39	36	0.123	−0.039	5722.6

LB(n) are the n-lag Ljung-Box statistics for $DJIA_t$ and $DJIA_t^2$ respectively. LB(n) follows Chi-square distribution with n degree of freedom; the sample period contains 5008 daily returns. DJIA: Dow Jones Industrial Average

Table 3: Diagnostics on standardized and squared standardized residuals

Residuals				Squared residuals			
Lags	Autocorrelation	Partial correlation	LB(n)	Lags	Autocorrelation	Partial correlation	LB(n)
1	−0.021	−0.021	2.1288	1	−0.008	−0.008	0.2823
2	−0.006	−0.007	2.3162	2	0.023	0.023	3.0132
3	−0.032	−0.033	7.5507	3	0.011	0.011	3.5857
4	−0.015	−0.016	8.628	4	0.004	0.003	3.6528
5	−0.02	−0.021	10.546	5	−0.009	−0.009	4.0473
6	0.024	0.021	13.321	6	0.02	0.02	6.0907
12	0.009	0.007	16.698	12	−0.013	−0.013	8.9144
18	−0.023	−0.022	26.315	18	0.001	0.002	13.847
24	−0.019	−0.016	33.173	24	−0.025	−0.025	22.405
36	0.007	0.006	53.934	36	−0.001	−0.002	25.644

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 5008 elements

that in most cases they are not statistically significant and the LB(n) statistics for standardized squared residuals show that the ARCH effect has disappeared. The Durbin Watson statistic (2.08) and the ARCH LM test concerning five lags in the residuals (N^*R^2=4.085) confirm the aforementioned results. Furthermore, the coefficient estimation v=1.478 for tail thickness regulator with 0.0365 standard error confirms the pertinence of the GED assumption. More specifically, the assumption of normal distribution is rejected, which verifies the theory for thick tails in the stock returns. An LR test of the restriction v=2 (for v=2 the D is essentially the normal distribution) against the unrestricted models clearly leads to this conclusion.

As far as the results of the model GJR-GARCH (1,1) are concerned, it should be mentioned that the P value of the coefficient of the mean and variance equation is <0.05 and the adjusted R^2 is >0.51. Specifically, Table 4 presents the results for the mean equations. The gold coefficient (−0.0638) is negative, a fact that proves that gold is a feedback hedge for stocks as it works not only as a good diversification instrument for stock investments but also as a "safe havens" in times of stress. Moreover, the coefficient of the decade bonds is negative (−0.0957), a fact that is in accord with the international bibliography, as the increase of the interests' rate affects the returns of the stocks negatively. Furthermore, the increase of the exchange value between dollar and yen negatively affects (−0.1327) the stock returns, as investors have grown increasingly concerned that the rising dollar will hurt the earnings of the US multinational companies of DJIA. A stronger dollar makes exports of US products more expensive compared to those produced overseas and, therefore, this reduces the value of US profits earned in foreign currencies.

On the other hand, the industrial metal index which is used as a proxy for the economic growth is positively correlated with the stock returns. Finally, the asymmetric distribution of oil returnsseems to affect -extremely negatively - the stock returns.

In Table 5, the results for the variance equation are presented. We observe that the value of the γ coefficient (0.936), which reflects the

Table 4: Mean equations

$DGIA_t = b_0 + b_1 Gold_t + b_2 Bond_t + b_3 D/Y_t + b_4 Metals_t + b_5 Oil_t^3 + u_t$					
b_1	b_2	b_3	b_4	b_5	b_6
0.00024*	−0.0638*	−0.0957*	−0.1327*	0.3045*	−2.937*
(8.85E-05)	(0.008598)	(0.020076)	(0.013364)	(0.004339)	(0.896511)

Standards errors are shown in parentheses. *Indicates statistical significance at the 1% level

Table 5: Variance equations

$\sigma_t^2 = k + \gamma\sigma_{t-1}^2 + \alpha u_{t-1}^2 + \xi I(u_{t-j} < 0)u_{t-1}^2$			
a_0	a_1	a_2	a_3
6.20E-07*	0.935558*	0.028289*	0.052077*
(1.39E-07)	(0.006852)	(0.0082)	(0.011544)

Standards errors are shown in parentheses.*Indicates statistical significance at the 1% level

influence of, is much higher than the value of α coefficient (0.028), which correlates the price variation of the present day to the price variation of the previous day. This results in the volatility of oil returns being persistent over time and, consequently, the volatility shocks (information) are slowly assimilated to the oil market. Furthermore, the ξ coefficient is positive (0.052) which implies that negative shocks provoke a larger response than positive shocks of equal magnitude. The price of DJIA normally rises as a result of good economic prospects. Therefore, negative changes in the price of stocks are associated with negative financial news which means that the volatility is transmitted from the other markets to the stock market, leading to an increased volatility.

5. CONCLUSION

In this study the role of basic financial indicators and economic indicators on the US stock market were examined using a GJR-GARCH model. Specifically, the influence of gold, 10 years bonds, US Dollar/Yen exchange rate, industrial metals price index and the asymmetry of oil distribution on the DJIA market were examined. Gold is the most important store of value today and its value plays an important role towards the modulation of the stock prices while, in the framework of portfolio management, investors restructure their portfolio all the time depending on the financial situation. A recession or a downturn in an economy boosts the investor’ run to the safety of gold, a fact that affects the stock returns because, among other things, they redeem them to invest on gold too.

Regarding the effect of bonds, we should mention that, historically, falling bond prices (rising bond yields) have been associated with the rising of equity prices, as stronger economic fundamentals drove investors to stocks and away from bonds, and weaker economic growth produced the reverse.

As far as the exchange rate between dollar and yen is concerned, its negative influence is due to the fact that the strong dollar makes US goods and services -mostly of the big export US companies - more expensive in comparison to the offerings of competitors. It also has the effect of reducing the value of corporate profits from overseas operations. It so happens, thus, that the financial ambience for US firms becomes more demanding and its eventual outcome is highly likely to have an adverse impact on their profit margins. More so, the high international price of the US currency is almost bound to adversely affect significant sections of the US economic enterprises that operate in overseas environments.

Moreover, a positive effect of the metal indicator on the stock market returns is predictable, since the increase of metal prices is a sign of economic growth. Finally, the asymmetry of the oil distribution was proved to affect, extremely negatively, the stock returns, because of the risk drawn to the investors by the broad dispersion of the oil returns in the right side of the distribution. This broad dispersion of the oil returns influence the risk sentiment of investors and, as a result, the stock prices are falling.

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