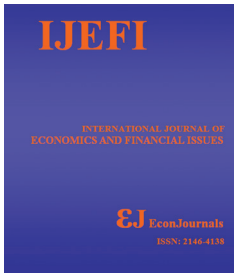

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The Impact of Dow Jones Sustainability Index on US Dollar Value

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ABSTRACT

The scope of this study is to address the impact of stock index returns on exchange rate. In particular, it aims to fill the literature gap regarding the determinant role of socially responsible companies on the exchange rate Trade Weighted U.S. Dollar Index to Major Currencies as a proxy for US dollar value. For this reason, the Dow Jones Sustainable Index World as a proxy for the world's leading companies in terms of economic, environmental and social criteria. A generalized autoregressive conditional heteroskedasticity model is employed over US dollar value to major currencies for the period January, 1999 - May, 2016 using monthly data. A number of control variables were introduced in the proposed model, namely oil prices, US interest rate, US supply money, trade balance and consumer confidence. The empirical results revealed the negative impact of stock returns of socially responsible companies on US dollar value inconsistent with proposed empirical literature. The results have significant implications for investors, portfolio managers and policymakers hedging on diversification strategies for their portfolios.

Keywords: Exchange Rate, Dow Jones Sustainability Index, Returns
JEL Classifications: G1, F2, Q40, M21

1. INTRODUCTION

The relationship between exchange rate and stock index returns has triggered the interest of economists, investors, practitioners and policy makers because of the crucial role of both in economies and businesses. Several studies have intended to point out the relationship between exchange rate and stick returns however, there is no definite conclusion about the relationship of them by incorporating a number of different statistical approaches. Prior studies have focused on different geographical regions such as America (Diamandis and Drakos, 2011), Europe (Ülkü and Demirci, 2012), Africa (Boako et al., 2016) and China (Zhao, 2010) revealing the important role of exchange rate in economies.

Unlike prior studies, this study incorporates socially responsible companies so as to investigate the effect of socially responsible stock market returns on the US dollar value. The development of socially responsible investments (SRI) has been in the center of interest for academic researchers since an early study of Moskowitz in 1972 which is considered among the first studies investigating SRI (Schröder, 2003).

SRI market has expanded dramatically in recent years. In particular, Europe is in the first place regarding the ratio of SRI relative to total managed assets followed by Canada, US, Australia and Asia with 58.8%, 31.3%, 17.9%, 16.6 and 0.8% respectively for 2014. The total amount under SRI rose from $13.3 trillion in 2012 to $21.4 trillion in 2014 revealing 61% growth in 2 years[1]. Furthermore, several financial indexes incorporate methodologies so as to select socially responsible companies, such as Dow Jones

1 Global Sustainable Investment Alliance, (2014). 2014 Global Sustainable Investment Review. Available from: http://www.gsi-alliance.org/wp-content/uploads/2015/02/GSIA_Review_download.pdf (Accessed on 29 Nov, 2016).

Sustainable Index World (DJSIW), KLD, FTSE4Good and Jantzi social index. For the purpose of the study, DJSIW approach is selected to identify the world's leading companies that operate socially responsible initiatives in their business operations.

According to Gavin (1989) and Soros (2009), stock market may affect stock exchange rates via two main channels, directly and indirectly, that explain the relationship between stock market and exchange rate. The direct channel claims that in the case of stock market boom, foreign investors will intend to buy as many domestic assets as they can. In addition, investors sell off foreign assets to buy domestic assets so as to be available to acquire domestic assets leading to appreciation of domestic currency. The indirect channel supports that when the domestic stock assets rise, it leads to higher levels of demand regarding domestic assets from domestic investors leading to increased interest rate; thus, the domestic currency will be appreciated (Koulakiotis et al., 2015; Boako et al., 2016).

Prior empirical studies revealed a controversial relation between the two variables, For instance, Lee et al. (2011) developed STCC - generalized autoregressive conditional heteroskedasticity (GARCH) model and showed significant price spillovers from stock market to foreign exchange market across four Asian countries Indonesia, Korea, Malaysia, Thailand and Taiwan for the period 2000-2008. During the financial crisis of the period of 2008-2012, Tsagkanos and Siriopoulos (2013) illustrated that there is a causal relationship between stock prices to exchange rates that is long-run in EU and short-run in the USA. By applying quintile regression Tsai (2015) found a negative relationship stock and exchange market across six Asia countries. The relationship was more obvious in the cases of extremely high or low exchange rate. Aggarwal (1981) showed a positive relationship for both of them over the period of 1974-1983, while Solnik (1987) illustrated a negative relation between monthly and quarterly real stock returns and real exchange rates with a positive relation only for the period 1979-1983. However, Smyth and Nandha (2003) found no long-run equilibrium relationship between exchange rates and stock indexes in Bangladesh, India, Pakistan and Sri Lanka for the period 1995-2001 consistent with (Ong and Izan, 1999). Similarly, Jorion (1990), and Bartov and Bodnar (1994) could not find a significant relationship between US dollar movements and stock returns of U.S. firms. Finally, Ajayi and Mougouė (1996) employed an error correction model suggested different effect of stock prices on exchange rate in short and long run. On the one hand, an increase in aggregate domestic stock price has a negative short-run effect on domestic currency value while, on the other hand, increases in stock prices have a positive effect on domestic currency value. Thus, it is intended to ascertain whether DJSIW returns affect the US dollar to major currencies.

Unlike prior studies, the aim of this study is to provide evidence of the effect of US stock price index on Trade Weighted U.S. Dollar Index: Major Currencies (TWUSDI) as a proxy for US dollar value in relation to major foreign currencies which use is relatively limited in empirical studies. In addition, it is attempted to fill the gap regarding how stock prices of socially responsible companies in terms of economic, environmental and social criteria affect the exchange rate. For this reason, the DJSIW is employed as a proxy of word leading socially responsible companies in US stock market along with Oil prices, US interest rate, US supply money, trade balance and consumer sentiment index (CSI) which are employed in the proposed model as control variables. Thus, this study intends to ascertain whether socially responsible stock returns play a crucial role of US dollar value. A GARCH model is employed over exchange rate over the period 31 January, 1999 - 31 May, 2016 using monthly data. The results of the study are valuable to US central bank in order to decide whether to intervene in the foreign exchange market. Moreover, investors or traders can acquire vital knowledge so as to determine their hedge strategy against possible losses.

The paper is organized as follows: Section 2 presents the methodology approach employed in order to ascertain the effect of stock returns on exchange rate along with the data used. Section 3 shows the main empirical results followed by discussion and the conclusion in Section 4.

2. METHODOLOGY AND DATA

The GARCH models have been widely used in financial econometric to capture the tendency of financial data distributions to show periods of high and low volatility, with periods of high volatility often clustering together. The GARCH (p,q) model has two characteristic parameters; p is the number of GARCH terms and q is the number of ARCH terms. The simplest specification is the GARCH (1, 1) model, which is stated as follow:

The mean equation $Y_t = X_t^{'}b+u_t$ (1)

Where X_t is a vector of exogenous variables.

r_t = Return of the asset at time t.

u_t = Residual returns, where Z_t is standardized residual returns (i.e., iid random variable with zero mean and σ_t^2 variance 1), and is conditional variance.

The conditional variance equation $\sigma_t^2 = c_0 + c_1 u_{t-1}^2 + c_2 \sigma_{t-1}^2$ (2)

The conditional variance equation is a function of 3 terms:

c_0: The weighted average long-term variance $c_1 u_{t-1}^2$ (the ARCH term): News about volatility from the previous period, measured as the lag of the squared residual u_{t-1}^2 from the mean equation.

$c_2 \sigma_{t-1}^2$ (the GARCH term): Last period's forecast variance as a function of the past residuals u_{t-2}, u_{t-3},….

$c_1+c_2<1$: This constrain allows the process to remain stationary, with the upper limit $c_1+c_2=1$ which denotes an integrated process.

This section presents definitions of variables that they have been used in this study. In particular, TWUSDI is a weighted average of the foreign exchange value of the US dollar against a subset of the broad index currencies that circulate widely outside the country

of issue. Major currency index includes the Euro Area, Canada, Japan, United Kingdom, Switzerland, Australia, and Sweden. The TWUSDI data are retrieved by Federal Reserve Bank of St. Louis[2]. Higher values of TWUSDI mean an appreciation of the US dollar (Aloui and Aïssa, 2016).

The DJSIW compromises the world leaders, i.e., the top 10% of the largest 2,500 companies in the S&P Global BMI based on long-term economic, environmental and social criteria (DJSIW Fact Sheet, 2016[3]). Since the launch of the DJSI in 1999, a number of different socially responsible indexes have been introduced so as to satisfy a range of investors' specific expectations. Each company receives a sustainable score between 0 and 100 based on RobecoSAM Corporate Sustainability Assessment[4]. Both general and industry-specific criteria are introduced in the assessment methodology covering the economic, environmental and social pillars, while a number of questions range from 80 to 120, depending on the industry which the company operates. In addition, the industry's specifications determine the relative weights of each aforesaid pillar. Total returns of DJSIW are retrieved by the official site of DJSI[5].

West Texas Intermediate is employed as a benchmark in oil pricing available by the U.S. Energy Information Administration. Crude oil prices were obtained by US Energy Information Administration[6]. Golub (1983) and Krugman (1983a; b) provide arguments how oil prices should affect exchange rate. The reallocation of wealth from exporters to importers because of increased oil prices may have an impact on exchange rate (Golub, 1983). A number of prior empirical studies have revealed an impact of oil prices on exchange rate (Chen and Rogoff, 2003; Huang and Guo, 2007). Furthermore, this study incorporates Bond's value measures the generic government 10-year yield for US issues of treasuries as a proxy of interest rate. The relationship between interest rate and exchange rate has been under consideration of a wide range of empirical studies revealing a significant relationship (Bautista, 2003; Sensoy and Sobaci, 2014). The CSI is based on Surveys of Consumers which collects data on the consumers' attitudes and expectations summarized in the Consumer Sentiment, in order to determine the changes in consumers' willingness to buy and to predict their subsequent discretionary expenditures. This index is comprised of measures of attitudes toward personal finances, general business conditions, and market conditions or prices. In general, CSI tracks sentiment among households or consumers. The results are based on surveys conducted among a random sample of households. The final explanatory variable of US dollar to major currencies is the combination of US supply money M1 and trade balance. In particular, M1 variable is a metric of the money supply which measures the total amount of money in circulation in the US at any given time, while trade balance is considered as the difference between a country's imports and its exports. For instance, higher levels of M1 and trade balance leads to higher price levels and thus the value of US dollar is appreciated. Bond's values, CSI and US supply money M1 and trade balance data were retrieved by the online Bloomberg platform. The sample period covers 31 August, 1999 to 31 May, 2016. Monthly continuously compounded returns for the selected data are calculated as, $R_t = 100*\log(p_t/p_{t-1})$ where R_t and p_t are the daily returns and prices respectively.

3. EMPIRICAL FINDINGS

Table 1 presents the summary statistics for USD, DJSIW, BOND, OIL, CSI, TRADE_B, and M1 series. Specifically, no conclusion about the overall sign of the skewness can be reached as some series show positive skewness and some negative. Also, as expected the returns series seem to have a leptokurtic distribution. Moreover, by using the Jarque Bera statistics with a significance level of one and five percent it showed that the assumption of normality was rejected in each of the time series. Finally, the augmented Dickey - Fuller test, allowing for both an intercept and a time trend, showed that the sample series had been produced by stationary series.

Table 2 shows the sample autocorrelation function (ACF) and partial ACF for daily returns and squared daily returns of the DJSIW series. It can be observed that the Ljung - Box statistics provide strong evidence of autocorrelation on monthly returns and also some evidence of autocorrelations in the squared daily returns, indicating conditional heteroskedasticity (Bollerslev, 1986).

Table 3 illustrates the correlation of the employed variables in the proposed model. The correlation coefficients between the different independent variables is low indicating that there is no tendency in the examined model to present a multicollinearity problem.

In summary, it seems the DJSIW return series is best described by an unconditional leptokurtic distribution and possesses significant conditional heteroskedasticity. This renders the ARCH models a very good choice for modelling the DJSIW return series.

The preliminary statistical results and the application of the LR test on the GARCH(p,q) model demonstrated the final specification for the estimation of the mean and volatility for the DJSI series. The specification is:

Mean equation:

$$USD_t = b_1+b_2USD_{t-1}+b_3BOND_t+b_4CRUDE_t+b_5DJSI_4+b_6CSI_{t+1} +b_7M1*TRADE\_B+u_t \quad (3)$$

Variance equation:

$$\sigma_t^2 = c_0 + c_1u_{t-1}^2 + c_2\sigma_{t-1}^2 \quad (4)$$

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

2 Data for TWUSDI available at: https://fred.stlouisfed.org/series/TWEXMPA (accessed on 10 Aug, 2016).

3 DJSIW Fact Sheet (2016) available at: http://djindexes.com/mdsidx/downloads/fact_info/Dow_Jones_Sustainability_World_Index_Fact_Sheet.pdf (accessed on 10 Aug, 2016).

4 CSA Guide - RobecoSAM's Corporate Sustainability Assessment Methodology, available at: http://www.sustainability-indices.com/images/corporate-sustainability-assessment-methodology-guidebook.pdf (accessed on 10 Aug, 2016).

5 Data for DJSIW available at: http://www.sustainability-indices.com/index-values/ (accessed on 10 Aug, 2016).

6 Data for Crude oil available at: https://www.eia.gov/dnav/pet/pet_pri_spt_s1_d.htm (accessed on 10 Aug, 2016).

A few diagnostic tests were developed in order to establish goodness of fit and appropriateness of the model. First of all, it was examined whether the standardized residuals and squared standardized residuals of the estimated model were free from serial correlation. In Table 4, the LB(n) statistics for standardized residuals are not statistically significant and the LB(n) statistics for standardized squared residuals show no ARCH remaining structure. The Jarque-Bera statistic (3.07) indicate that the residuals are normally distributed, fact that is also confirmed by the coefficient estimation v = 1.96 for tail thickness regulator with 0.36 standard error. An LR test of the restriction v = 2 (for v = 2 the GED distribution is essentially the normal distribution) against the unrestricted models clearly supports this conclusion.

The results presented in Table 5 show that the formation of the current exchange rate of US dollar is dependent on by the exchange rate price of previous month indicating the impact of the exchange trade trend. In addition, the coefficient of the DJSIW, used as

Table 1: Sample statistics

Statistics measures	USD	DJSIW	Bond	Oil	CSI	TRADE_B	M1
Mean	−0.0004	0.0022	−0.0058	0.0039	−0.0005	0.0060	0.0053
Median	0.0006	0.0098	0	0.0153	−0.0033	0.0066	0.0047
Maximum	0.0647	0.1185	0.2498	0.2139	0.1276	0.3286	0.0592
Minimum	−0.0478	−0.2199	−0.3028	−0.332	−0.1992	−0.2662	−0.0325
SD	0.0173	0.0508	0.0841	0.0898	0.0538	0.0793	0.0101
Skewness	0.0847	−0.7263	−0.21422	−0.842	−0.3637	−0.1264	1.5785
Kurtosis	3.5296	4.4571	4.7392	4.416	3.7658	4.7980	10.9509
Jarque-Bera	2.5894	35.451	26.8709	40.517	9.3438	27.6132	612.9227
Observations	201	201	201	201	201	201	201
ADF	−10.03	−12.41	−13.93	−10.40	−11.93	−7.64	−14.75

ADF: Augmented Dickey-Fuller, DJSIW: Dow Jones Sustainable Index World, CSI: Consumer sentiment index

Table 2: Test for serial dependence in first and second moments of USD series

Returns				Squared returns			
Lags	Autocorrelation	Partial correlation	LB(n)	Lags	Autocorrelation	Partial correlation	LB(n)
1	0.331	0.331	22.417	1	0.043	0.043	0.3727
2	0.05	−0.067	22.933	2	0.183	0.181	7.2228
3	0.025	0.033	23.061	3	−0.014	−0.029	7.2631
4	0.141	0.141	27.169	4	0.023	−0.009	7.373
5	0.021	−0.084	27.258	5	0.072	0.082	8.4561
6	0.007	0.033	27.267	6	−0.024	−0.035	8.5792
12	−0.141	−0.139	37.767	12	0.053	0.027	13.393
24	−0.065	−0.008	56.909	24	−0.006	−0.009	21.298
36	0.111	−0.024	73.105	36	0.107	0.101	36.8

LB(n) are the n-lag Ljung-Box statistics for USD_t and respectively. LB(n) follows Chi-square distribution with n degree of freedom; the sample period contains 197 monthly returns

Table 3: Correlation matrix

	USD	BOND	Oil	DJSIW	CSI (1)	M1_TRADE_B
USD	1	−0.0297	−0.3789	−0.3573	−0.0000	0.0359
BOND	−0.0297	1	0.2650	0.2925	0.1468	0.1691
CRUDE	−0.3789	0.2650	1	0.2306	0.0484	0.0969
DJSIW	−0.3573	0.2925	0.2306	1	0.0380	−0.0726
CSI (1)	−0.0000	0.1468	0.0484	0.0380	1	0.1567
M1_TRADE_B	0.0359	0.1691	0.0969	−0.0726	0.1567	1

DJSIW: Dow Jones Sustainable Index World

Table 4: Diagnostics on standardized and squared standardized residuals

Residuals				Squared residuals			
Lags	Autocorrelation	Partial correlation	LB(n)	Lags	Autocorrelation	Partial correlation	LB(n)
1	0.086	0.086	1.2191	1	0.086	0.086	1.2191
2	−0.052	−0.06	1.6594	2	−0.052	−0.06	1.6594
3	−0.006	0.004	1.6657	3	−0.006	0.004	1.6657
4	0.07	0.068	2.4869	4	0.07	0.068	2.4869
5	0.012	−0.001	2.5092	5	0.012	−0.001	2.5092
6	−0.009	−0.003	2.5239	6	−0.009	−0.003	2.5239
12	−0.064	−0.09	6.6095	12	−0.064	−0.09	6.6095
24	−0.006	−0.035	16.823	24	−0.006	−0.035	16.823
36	−0.119	−0.048	29.272	36	−0.119	−0.048	29.272

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 200 elements

Table 5: Mean equations

$USD_t=b_1+b_2USD_{t-1}+b_3BOND_t+b_4CRUDE_t+b_5CSI_{t+1}+b_6DJSI+b_7M1*TRADE\_B+u_t$						
b_1	b_2	b_3	b_4	b_5	b_6	b_7
0.000402	0.272552*	0.034748*	−0.0606*	0.042724**	−0.12617*	1.439918**
(0.001076)	(0.065918)	(0.012778)	(0.01198)	(0.020108)	(0.023185)	(0.652856)

Standards errors are shown in parentheses. *Indicates statistical significance at the 1% level. **Indicates statistical significance at the 5% level, DJSIW: Dow Jones Sustainable Index World, CSI: Consumer sentiment index

a proxy for the global stock market condition under socially responsible criteria, indicates the important role of economic expectations on US dollar value significant at 1% level. In addition, the mean return of the USD series has statistically significant higher return at the 1% level when the returns of 10 years bond have increased implying that interest rates have reduced. Also, the coefficient of next month of CSI is statistically significant at 5% level suggesting a crucial impact on US dollar. Furthermore, both the sign and the statistical significance of oil prices show a negative effect on US dollar value. Finally, the effect of trade balance along with supply money M1 is found statistically insignificant.

In Table 6 the results for the variance equation are presented. The value of the c_2 coefficient (0.82) is to high indicating that shocks to conditional variance take a long time die out, so volatility is "persistent."

4. CONCLUSION

This study intends to investigate the relationship between stock returns and exchange rate. In particular, it focuses on the impact of stock index returns on US dollar value. The innovation of the study is that it incorporates companies that incorporate socially responsible initiatives in their operations. During the last decades, investors have started to take into account socially responsible criteria in their investment decision. As SRI funds are increased both globally and in the US, it is crucial to ascertain the role of stock returns on the exchange rate. However, according to our knowledge, there is no empirical study that investigates the impact of socially responsible stock returns on exchange rate. Thus, for the purpose of the study, DJSIW's stock returns are employed as a proxy for socially responsible companies. A GARCH model is used over US dollar value to major currencies in order to ascertain whether DJSIW's stock returns affect the exchange rate in US.

The results revealed a negative effect of stock returns of socially responsible companies on the exchange rate US to major currencies inconsistent with empirical literature. It seems that the global companies that composite the DJSIW operate and invest in different geographical regions affect the US dollar value. On the one hand, higher levels of DJSIW seems to decrease the US value dollar as global companies, probably, transfer their profit overseas unloading their US dollars into local currencies. On the other hand, as lower levels of DJSIW considered as a proxy of unstable global business environment tend to increase the value of US dollar. Investors and companies seem to trust the US economy in unstable periods by transferring foreign currency reserves and converting into US dollar. The negative effect of DJSIW stock returns on US dollar value is crucial to international investors and managers to understand the link between stock market and exchange rate. In

Table 6: Variance equations

$\sigma_t^2 = c_0 + c_1u_{t-1}^2 + c_2\sigma_{t-1}^2$		
c_0	c_1	c_2
2.27E-06	−0.04055*	1.029391*
(2.49E-06)	(0.009409)	(0.000122)

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

particular, it is useful in cases they intend to hedge and diversify strategies against future crises in developed economies. As regards the effect of oil prices on exchange rate, the results suggest a negative relationship between them. The reallocation of wealth among countries leads to lower levels of US dollar value (Golub, 1983). However, this relationship can be more complex as it is based on the assumptions about trade balances, trade elasticities, capital flows and speculation (Krugman, 1983a; b). As far as CSI is concerned, the impact of CSI on the US dollar value is positive as it is obvious that high consumer confidence for the US economy will have a direct impact on the US dollar value. CSI is considered a lead regressor as the current confidence of consumers is expressed in the next month CSI after the relevant current questionnaires are collected. On the one hand, higher levels of consumer confidence of US citizens reflects the positive prospects of the US economies in the near future. This fact motivates both internal and foreign investors to create or develop businesses in the US economies so as to benefit from the US market enforcing the value of the US dollar. On the other hand, when CSI decreases, consumers worry for the future and decrease consuming levels and save more. Thus, it is possible the US dollar value to be devaluated as a result of declining consumer confidence. Finally, the results suggested a negative relationship between interest rate and exchange rate. An important issue for the explanation of the variables is that the US is still considered as a safe haven in an economically uncertain world (Martin and Berend, 2007). Thus, this fact can be an overriding determinant for the value of US dollar value in relation to major currencies.

Future studies could expand independent variables, such as the country's level of government and consumers' debt as the US recently has boomed to new high levels. Additionally, future studies should be undertaken considering developed and developing economies in order to ascertain similarities and differences between them.

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