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CAN CRUDE OIL PRICE BE A PREDICTOR OF STOCK INDEX RETURN? EVIDENCE FROM VIETNAMESE STOCK MARKET

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ABSTRACT

This paper tests the predictive power of crude oil price returns in forecasting Vietnamese stock index returns. We used the VN index and HNX index to calculate stock index returns and WTI and BRENT oil prices. Using a daily sample from 4th January 2006 to 31st December 2017, our analysis focused on both in-sample and out-of-sample predictability by applying the Westerlund and Narayan (2015) feasible generalized least square (FGLS) estimator which corrects persistency heteroskedasticity and endogeneity problems. We showed that the crude oil prices are reliable predictors of Vietnamese stock index returns. In terms of in-sample predictability, thirteen out of sixteen predictive regression were significant. We found that the BRENT crude oil index is slightly more powerful than the WTI crude oil price in predicting Vietnam stock index returns with seven out of eight regressions being significant compared to six out of eight from that of the WTI oil price. In terms of out-of-sample predictability, our results were also complemented by a robustness test, i.e. competing with a constant return model which used the historical average as the predictive value.

Contribution/ Originality: This study is one of very few studies which have investigated the stock return predictability in an emerging market, i.e. Vietnam. It is important to investigate the predictive power of crude oil price on Vietnamese stock index return as the country relies on both oil exports and imports.

1. INTRODUCTION

Macro financial variables, such as gross domestic product (GDP), consumer price index (CPI), inflation rate, and the money supply (M2) are always great concerns of policymakers all around the globe. Practically, predicting macro financial variables is important for both regulators and market participants. A reliable predictive model helps policymakers to make quick and accurate decisions in order to stabilize the market when there are market fluctuations, whilst investors can make better investment decisions. The stock market index is one of the key macro financial variables. Usually, macroeconomic variables are always linked and fluctuate together. Hence, when we know the movements of stock market index, we also can predict the fluctuations of the remain variables.

This paper tests whether the crude oil price returns can be used to predict Vietnamese stock index returns. Our analysis was based on a daily sample from 4th January 2006 to 31st December 2017. For Vietnam stock index returns, we used the VN index and HNX index and for crude oil prices, we used both the WTI and BRENT oil prices. We contributed to the literature in the following ways:

First, we extended the literature on stock return predictability in an emerging market, i.e. Vietnam. Although, there is extensive literature about the stock return predictability most of them focus on the U.S. market or other developed markets.

There are a few papers on emerging markets. For example, the two works of Gupta and Modise (2012;2013) used financial variables, such as price-dividend ratio, price-earning ratio, payout ratio, Treasury bill rate and term spread, and macroeconomic variables, such as employment growth rate, inflation rate, exchange rate, money supply growth rate and crude oil price, to predict South African stock returns from 1990 to 2010. Both studies focus on both in-sample and out-of-sample and find that South African stock returns are predictable.

In a study about Indian stock return predictability using a sample of 1515 stocks during the period from 1992 to 2014, Narayan and Bannigidadmath (2015) used the book to market ratio, dividend price ratio, dividend payout ratio and earnings-price ratio to predict the stock returns. They found that Indian stock returns are predictable, although the performance of the predictors are different across in-sample and out-of-sample tests. Recently, Xue and Zhang (2017) examined the stock return predictability of the Shanghai A-share stock index during the period from 2005 to 2014 using a threshold quantile autoregressive model with a number of stock characteristics, such as liquidity, volatility, market to book ratio and investor sentiment, as the predictors and found that predictability exists in the Chinese stock market.

Second, it is not new that the oil price has an effect on stock markets. This is because of its effects on real output and hence interest rates and investors' expectations. A vast amount of research has been done on the effect of oil price and stock return including Driesprong *et al.* (2008); Park and Ratti (2008); Kilian and Park (2009); Miller and Ratti (2009); Kang *et al.* (2015); Kang *et al.* (2016) and Kang *et al.* (2017). However, Vietnam is an interesting case as this country both exports and imports crude oil at the same time. Vietnam indirectly imports crude oil via its derivatives such as gasoline, diesel, jet fuel, and so on. Hence, it is important to investigate the predictive power of crude oil price in Vietnam.

Predicting financial variables is not a new research topic, but this still remains an interest of a lot of researchers and policymakers. Many previous studies focused on predicting stock returns of stock markets in general. These studies propose many variables, both macroeconomic and stock market related ones, as predictor variables in their predictive model. Macroeconomic predictors used in previous literature include the inflation rate Campbell and Vuolteenaho (2004); Gupta and Modise (2013) nominal interest rate Fama and Schwert (1977); Campbell (1987); Breen *et al.* (1989); Ang and Bekaert (2007) crude oil prices Gupta and Modise (2013); Phan *et al.* (2015). Stock market related predictors which are used to predict stock returns include the earnings – price ratio Fama and French (1988); Narayan *et al.* (2015) book-to-market ratio Kothari and Shanken (1997); Pontiff and Schall (1998); Xue and Zhang (2017) stock issuing activities Baker and Wurgler (2000); Boudoukh *et al.* (2008) term and default spreads Campbell (1987); Fama and French (1989); Gupta and Modise (2012) consumption on asset ratio (Lettau and Ludvigson, 2001) and stock market fluctuations (Guo, 2006).

Nonetheless, many studies show that although these models provide good predictions in-samples, they may not be reliable when they are used for out-samples predicting (see Bossaerts and Hillion (1999); Goyal and Welch (2003); Butler *et al.* (2005); Ang and Bekaert (2007)). Welch and Goyal (2008)) showed that many predictive models produce predictive results that are even more inaccurate than the historical average model. A possible reason for the out-of-sample unreliable predictive results is that these models do not take into account the existence of persistency, heteroskedasticity and endogeneity problems (Stambaugh, 1999); (Westerlund and Narayan, 2015).

Following this trend, our paper focused on the out-of-sample predictability by applying the feasible generalized least square (FGLS) estimator which is well known for correcting persistency, heteroskedasticity and endogeneity. Our analysis showed that crude oil prices are very useful in predicting Vietnamese stock index returns. Our results were also complemented by a robustness test, i.e. competing with a constant return model which uses the historical average as the predictive value.

We organized the remainder of this paper as follows. The next section describes our data and empirical model. The third section discusses our findings and we provide the conclusion remarks in the last section.

2. DATA

The data of Vietnam stock index returns, i.e. the VN index and HNX index, were collected from the STOXPLUS Database. We collected daily data for both the VN index and HNX index. We used the crude oil price return (OIL) as a predictor as this variable is used extensively in stock return predictability literature (for example, see Gupta and Modise (2013); Phan *et al.* (2015)). In this paper, we collected both the WTI and BRENT oil prices from the Investing.com website. Our sample started on 4th January 2006 and ended on 31st December 2017. In Figure 1, we provide plots of stock indexes and crude oil prices and returns. This figure plots the price and return series of two stock indexes, the VN index and HNX index, and two crude oil prices, the WTI and BRENT, for the period from 04/01/2006 to 12/31/2017.

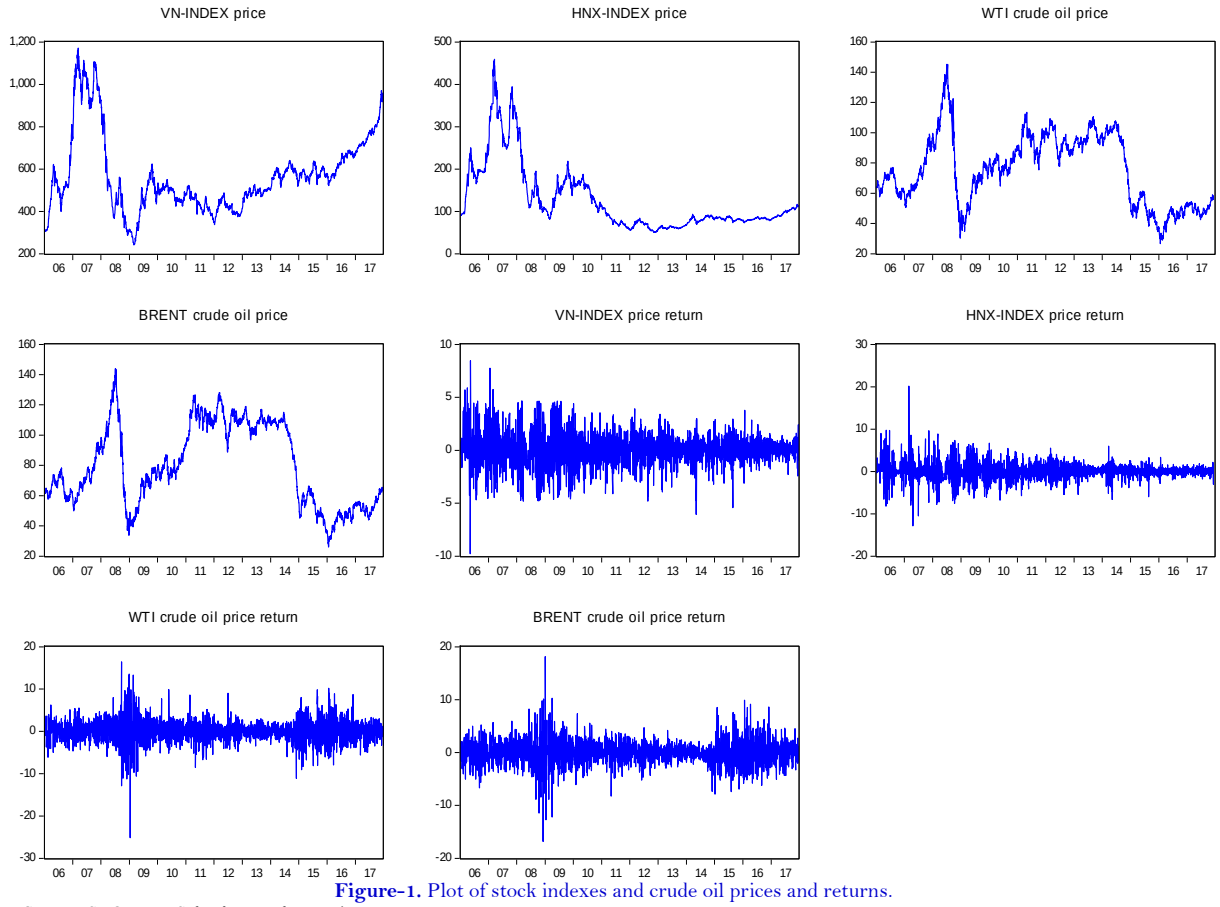

Figure-1. Plot of stock indexes and crude oil prices and returns.
Source: STOXPLUS database and Investing.com.

3. METHODOLOGY

Following Phan *et al.* (2018) and the stock return predictability literature, we started our analysis by using the conventional predictive regression model in which the crude oil prices are treated as a predictor:

$$R_t = \alpha + \beta OIL_{t-1} + \epsilon_t, \qquad (1)$$

Where R_t was the stock index return on day t and OIL_{t-1} was the crude oil price return on day t-1. The OLS regression assumes that the disturbance terms of the following AR(1) process have zero mean and uncorrelated with the error terms in the predictive regression expressed by Equation 1:

$$OIL_t = \mu(1-\rho) + \rho OIL_{t-1} + \varepsilon_t, \quad (2)$$

$$\epsilon_t = \gamma\varepsilon_t + \eta_t, \quad (3)$$

Where $|\rho| \leq 1$. Conventionally the two error terms, which are independently and identically distributed, in Equation 1 and Equation 2 are assumed to have zero mean and do not correlate with each other, i.e. $\gamma = 0$. If this assumption does not hold, there is an endogeneity problem in the OLS regression, in other words, the predictor is endogenous. Apart from the potential endogeneity, the regression in Equation 1 can also face persistency and heteroskedasticity problems (Stambaugh, 1999); (Lewellen, 2004); (Westerlund and Narayan, 2012). In our paper, we examined whether the OLS predictive regression suffers from endogeneity, persistency and heteroskedasticity.

In order to tackle these three problems, Westerlund and Narayan (2015) proposed a feasible generalized least square (FGLS) estimator which considers the possibility of heteroskedasticity of the regressor and the regression error. This model has been widely used by the literature to test the predictability of stock returns.[1] Following this trend, the FGLS estimator of β is applied into regression in Equation 1 and provides an augmented regression as followed:

$$R_t = \alpha - \gamma\mu(1-\rho) + \beta_{adj} OIL_{t-1} + \gamma\Delta OIL_t + \eta_t, \quad (4)$$

Where $\beta_{adj} = \beta - \gamma(\rho - 1)$ (See Narayan *et al.* (2014); Phan *et al.* (2015); Sharma (2016); Devpura *et al.* (2017); Han *et al.* (2017); Kuo (2018); Phan *et al.* (2018); Salisu *et al.* (2018b) and Salisu *et al.* (2018b)).

4. EMPIRICAL RESULTS AND DISCUSSION

4.1. Descriptive Statistics and Preliminary Results

First, we report descriptive statistics, including the mean, standard deviation (SD), skewness, kurtosis, Jarque-Bera test, augmented Dickey-Fuller test, coefficient of autocorrelation AR(1), and heteroskedasticity (ARCH) test, for the VN index, HNX index, and the WTI and Brent oil price returns in Table 1. Panel A reports the statistics for the whole sample from January 4, 2006 to December 31, 2017. Panel B, C and D report the statistics of three different sample periods, which cover 25%, 50% and 75% of the full sample respectively. These samples are used as in-sample period later in this paper.

While the movements of the VN index and HNX index are similar in the whole sample period, their returns take different values. The VN index returns have a daily average of 0.0037% and the HNX index has a lower average daily average of 0.07%. In terms of volatility, the VN index series have higher degree of volatility than that of the HNX index. Similarly, the WTI and BRENT oil prices share the same trend from 2006 to 2017. The average WTI oil price return is -0.003% while the value of the BRENT oil price return is 0.002%. There is not much different in oil price return volatilities measured by the WTI and BRENT crude oil price.

We also reported the persistency of the stock index returns and oil price returns measured by the autoregression AR(1) coefficient in the second last column of Table 1. We noticed that all return series are weakly persistent with the AR(1) coefficients are lower than 30%. The same characteristic is applied for the other three sub-samples. The *p*-values of autoregressive conditional heteroskedasticity (ARCH) effect test are shown in the last

[1] See Narayan, Sharma, Poon and Westerlund (2014); Phan, Sharma and Narayan, (2015); Sharma, (2016); Devpura, Narayan and Sharma, (2017); Han, Lv and Yin, (2017); Kuo, (2018); Phan, Sharma and Tran, (2018); Salisu, Ademuyiwa and Isah, (2018a) and Salisu *et al.* (2018b).

column of Table 1. All index returns were reported to have strong ARCH effect across our full sample and all sub-sample periods.

Table-1. Descriptive statistics.

Variables	Mean	SD	Skew.	Kurt.	JB	ADF	AR(1)	ARCH(1)
Panel A: Full sample								
VN index return	0.037	1.478	-0.098	5.607	0.000	-44.395	0.226	0.000
HNX index return	0.007	1.908	0.340	11.179	0.000	-48.516	0.140	0.000
WTI return	-0.003	2.355	-0.244	11.553	0.000	-57.814	-0.034	0.000
BRENT return	0.002	2.073	0.025	9.484	0.000	-54.553	0.024	0.000
Panel B: January 2006-December 2008								
VN index return	0.004	2.036	0.035	4.083	0.000	-20.505	0.298	0.000
HN index return	0.018	2.774	0.460	8.348	0.000	-22.765	0.200	0.008
WTI return	-0.045	2.668	0.153	8.744	0.000	-28.296	-0.032	0.000
BRENT return	-0.069	2.297	-0.589	9.141	0.000	-27.973	-0.004	0.007
Panel C: January 2006-December 2011								
VN index return	0.009	1.834	0.023	4.171	0.000	-29.763	0.275	0.000
HN index return	-0.028	2.448	0.412	7.927	0.000	-33.054	0.176	0.000
WTI return	0.028	2.608	-0.433	12.780	0.000	-40.173	-0.017	0.000
BRENT return	0.036	2.262	-0.156	10.486	0.000	-39.238	0.006	0.000
Panel D: January 2006-December 2014								
VN index return	0.025	1.633	-0.067	4.850	0.000	-37.913	0.275	0.000
HN index return	-0.004	2.154	0.339	9.128	0.000	-41.841	0.176	0.000
WTI return	-0.007	2.287	-0.442	14.903	0.000	-49.864	-0.017	0.000
BRENT return	-0.004	1.976	-0.160	12.268	0.000	-47.961	0.006	0.000

The results of endogeneity test of oil price return are reported in Table 2. The endogeneity test results for the predictive regression model were reported. The residuals from Equation 1 were regressed against the residuals from Equation 2:

$$\epsilon_t = \gamma \varepsilon_t + \eta_t$$

The predictive regression suffers from endogeneity problem if the null hypothesis that $\gamma = 0$ is rejected. ***, **, and * denote the statistical significance at the 1%, 5%, and 10% levels, respectively. Based on the two stock index returns, the VN-index and HNX-index, and the two oil price returns, the WTI and BRENT, there were sixteen predictive regressions across four sample periods. We found endogeneity existing in all predictive regressions except the one using the WTI oil price return in Panel B, which covers the period from January 2006 to December 2008.

The preliminary analysis reported the existence of persistency, heteroskedasticity, and endogeneity in our sample. Therefore, the standard ordinary least square (OLS) model was no longer applicable in this case. As Westerlund and Narayan (2015) proposed, our analysis employed the feasible generalized least square estimator in examining the effect of the oil price index return on the Vietnam stock index return.

4.2. In-Sample Predictability Results

Table 3 reports the in-sample forecasting regression results. This table reports in-sample predictability results. The coefficient of the predictors is reported. *, **, and *** denote significance at the 10%, 5% and 1% levels, respectively. The crude oil price returns, both the WTI and BRENT, perform quite well as the predictors of stock index returns. There is evidence of significant predictability in most of the in-sample periods, except the three in Panel B, from January 2006 to December 2008. In summary, the performance in forecasting stock index returns is different among the two crude oil predictors. The BRENT crude oil index is slightly more powerful than the WTI

crude oil price in predicting the Vietnam stock index returns and seven out of eight regressions erre significant compared to six out of eight from that of the WTI oil price.

Table-2. Endogeneity test results.

Stock index	WTI crude oil		BRENT crude oil	
	γ	p-value	γ	p-value
Panel A: Full sample				
VN-index	0.030***	0.006	0.062***	0.000
HNX-index	0.036**	0.012	0.073***	0.000
Panel B: January 2006-December 2008				
VN-index	0.032	0.236	0.090***	0.004
HNX-index	0.058	0.117	0.111***	0.010
Panel C: January 2006-December 2011				
VN-index	0.037**	0.034	0.079***	0.000
HNX-index	0.055**	0.020	0.097***	0.000
Panel D: January 2006-December 2014				
VN-index	0.038***	0.009	0.077***	0.000
HNX-index	0.053***	0.007	0.094***	0.000

Table-3. In-sample predictability results.

Stock index	WTI crude oil		BRENT crude oil	
	Coefficient	p-value	Coefficient	p-value
Panel A: Full sample				
VN-index	0.060***	0.000	0.067***	0.000
HNX-index	0.047***	0.000	0.063***	0.000
Panel B: January 2006-December 2008				
VN-index	0.015	0.340	0.017	0.337
HNX-index	0.022	0.173	0.037**	0.040
Panel C: January 2006-December 2011				
VN-index	0.048***	0.000	0.057***	0.000
HNX-index	0.034***	0.001	0.043***	0.000
Panel D: January 2006-December 2014				
VN-index	0.052***	0.000	0.063***	0.000
HNX-index	0.035***	0.001	0.049***	0.000

4.3. Out-of-Sample Predictability Results

As Welch and Goyal (2008) argued that many stock return predictive models are outperformed by the simple historical average model, it is important to examine the power of our model in predicting the stock index returns in out-of-sample periods. In this section, we report out-of-sample the importance of the crude oil price returns in forecasting stock return in comparison with a constant return model. In detail, we compared the mean square errors of two forecasting models: the crude oil price based predictive model and the model using the historical average as predicted value. We used 25%, 50% and 75% of the sample, corresponding with the periods from January 2006 to December 2008, January 2006 to December 2011 and January 2006 to December 2014, as the in-sample periods to generate algorithmic forecasts of the Vietnam stock index returns respectively for the remaining 75%, 50% and 25% of the sample.

As suggested by Narayan *et al.* (2015) the reliability of our predictive model was evaluated using the out-of-sample *R*-squared (OOR^2). In detail, the OOR^2 examined the difference in the mean squared errors from the oil price predictor model and the historical average model. Additionally, we employed the mean squared forecasting error (MSFE) – adjusted statistic, developed by Clark and West (2007) to test whether the out-of-sample *R*-squared is significantly different from zero, i.e. test the null hypothesis $OOR^2 = 0$ against the alternative $OOR^2 \neq 0$. The competition model was concluded to be superior to the benchmark model in forecasting the stock index return if the coefficient of OOR^2 is positive.

Table 4 reports our out-of-sample forecasting results. This table reports out-of-sample results, i.e. comparing the crude oil return based predictive model with the historical average model. 25%, 50%, and 75% in-sample periods were used to generate forecasts for the remaining 75%, 50% and 25% of the sample. The Clark and West's MSFE-adjusted statistic, denoted with an asterisk, tests the null hypothesis $OOR^2 = 0$ against the alternative $OOR^2 \neq 0$; *, **, and *** denote rejection of the null hypothesis at the 10%, 5%, and 1% levels of significance, respectively. In general, the competition model provides better forecasting results than the benchmark model does in most of the sub-sample periods. In other words, the OOR^2 coefficient was positive in the majority of our regression models. In particular, the model using the WTI crude oil price return as the predictor was superior to the benchmark one, i.e. historical average model, in all the out-of-sample periods, except the one for the HNX index return for the period from January 2006 to December 2011. When using the BRENT crude oil price as the predictor, we could not conclude that the competition model provided a better result than the benchmark one in predicting the HNX index return in the January 2006 to December 2011 period and the January 2006 to December 2014 period.

Table-4. Out-of-sample predictability results.

Stock index	WTI crude oil		BRENT crude oil	
	OOR (%)	p-value	OOR (%)	p-value
Panel A: January 2006-December 2008				
VN-index	2.536***	0.000	2.078***	0.000
HNX-index	1.970***	0.000	1.311***	0.000
Panel B: January 2006-December 2011				
VN-index	0.988***	0.000	0.101***	0.000
HNX-index	-0.026***	0.000	-0.859***	0.000
Panel C: January 2006-December 2014				
VN-index	3.812***	0.000	0.613***	0.000
HNX-index	1.330***	0.000	-1.877***	0.000

5. CONCLUDING REMARKS

The purpose of this paper was to test whether the crude oil price returns could be used to predict Vietnamese stock index returns. We based our analysis on a daily sample from 4th January 2006 to 31st December 2017, which included both the VN index and HNX index and both the WTI and BRENT oil prices. Our analysis focused on the out-of-sample predictability and the data was truncated as 25%, 50% and 75% level for in-sample regressions and then the remainder in each case was used for out-of-sample predictability tests. We showed that our data featured persistency, heteroskedasticity and the endogeneity problem, hence the feasible generalized least squares estimator of Westerlund and Narayan (2015) was used in our predictive regressions.

In summary, the crude oil prices were proved to be very useful in predicting Vietnamese stock index returns in both the in-sample and out-of-sample periods. In terms of in-sample predictability, thirteen out of sixteen predictive regression were significant with the BRENT crude oil index being slightly more powerful than the WTI crude oil price in predicting the Vietnam stock index returns. In terms of the out-of-sample predictability, our model provided better forecasting results than the historical average model in most of the sub-sample periods.

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