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Research Article

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The Volatility of Oil Prices: What Factors?

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Abstract

This paper highlights a new articulation between the physical fundamentals of the oil market, the traditional financial factors and the emergence of recent financial fundamentals to explain WTI crude oil price volatility over the period 1995 M1 and 2013 M12. A first vector error correction model (VECM) identifies a co - integration relationship between WTI spot price, the import and inventory of crude oil in the United States, the dollar index and the 5-year US interest rate. A second model with the introduction of the future prices at two months and kcfsi index.

The result of our work shows a low correlation of import and inventory of crude oil in the United States with respect to short-term oil prices. But in contrast to a strong long-term correlation. The introduction of speculation and KCFSI index affects the oil price dynamics in the long and short-term. The two traditional financial factors (dollar index and the 5-year US interest rate) are found to be weakly exogenous in the long run.

Keywords: Oil price volatility; Macro-finance interface; VECM

Introduction

In the recent years, we have been witnessing an increase and a great volatility of oil prices which make the economic agents (governments, investors, etc.) very worried because a significant increase of oil prices raises the income and generates negative effects on the real economy of the oil exporting countries.

Moreover, controlling the prices has become a strategic challenge because there are many players (physical, financial) in oil global markets. However, the oil prices become a complex process due to several real factors (the amount offered by the exporting countries on the demand coming from the emerging economist, etc.) and the financial factors (change of the exchange rates, the interest rates, speculation, financial stress index, etc.).

In line with the existing literature, the transaction costs and financial stress are among the factors that lead to an asymmetric effect. Hakkio and Keeton, and Davig and Hakkio adopted this framework to demonstrate that increase in financial stress is associated with higher funding costs and greater economic uncertainty resulting in the decline of the real economic activity. Moreover, an increased financial stress makes financial investors more risk averse, which discourages investment in asset markets and leads to the fall of asset prices, including oil prices.

The explanation of the formation of oil prices and their volatility is made more difficult by the complexity of interdependencies between physical and financial markets and their fundamentals. Therefore, it is interesting to conduct an empirical assessment to find out whether these factors do influence oil prices in the same way or not.

In this work, we try to see how oil prices are affected, and the actors and the variables that determine them. To meet our goal, we try to make a co-integration analysis of two VECM models to detect the variables that could affect oil prices. This paper is organized as follows: We present the introduction in section 1. In section 2, we review the related literature. Section 3 describes the data and methodology. Section 4 presents the results and interpretations. Section 5 concludes.

Literature Review

An extensive literature exists on the respective roles of the so-called fundamental factors. For example, Hamilton 2009, tries to consider the role of the economic theory predictions, versus the role of the macroeconomic fundamentals. He explored three broad ways: the first is based on statistical regularities of prices, the second on the economic theory predictions and the third examines the fundamental determinants of demand and supply behaviour. He found that the three key features are the low price elasticity of demand, the strong growth in demand from emerging countries and the failure of global production to increase. These three elements explain the initial strong pressure on prices which may have triggered commodity speculation.

Furthermore, the study of Mu and Ye [1] showed that growth in oil demand is not the predominant reason for the dramatic oil price increases in 2002-2008. These authors analysed the relationship between China's import and oil prices in the world market using a VAR framework. The results showed that the interaction between the deviation of the real oil price from its linear trend and the growth rate of China's net oil import is statistically insignificant.

On the other hand, the impact of the exchange rates on commodities and vice versa has been largely studied by [2-4]. However, Chen [5] investigated the role of the real oil prices in predicting the real exchange rates over long time horizons. He focused on the long-horizon forecasting power of the real oil prices to explain the changes in real exchange rates.

Recent papers have documented that physical factors alone do not explain the bulk of oil price fluctuations [6]. Thereby, a new proof for the financialization of commodity markets is a phenomenon characterized by a high correlation between commodities and financial assets, presumably due to the greater participation of financial investors in commodity markets [7-13]. In the same vein, Wang Chen et al. [14] found that a financial shock is a key determinant of oil prices and its macroeconomic impact is as important as that of other underlying shocks.

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The increasing demand of non-OPEC countries (emerging countries) affects the supply/demand balance requiring higher prices. Hence, these changes in the fundamentals are recognized by speculators who take position accordingly. Increases of prices are anticipated in the futures market and then transferred to the spot market, which drives prices beyond levels justified by the existing supply/demand balance. In this context, Stevans and Sessions found that the spot oil prices are dominated by real supply, whereas for longer term contracts the crude oil price is dominated mainly by futures prices. Moreover, the relationship between the spot and futures oil prices is investigated by Kaufmann and Ullman [15], who examined the causal relationship between prices of the different crude oil blends from North America, Europe, Africa and Middle East using a VAR framework. Their results suggest that the recent rise in oil prices is generated by both changes in the market fundamentals and speculation.

Other studies, such as those of Claudio Morana [12], aim at assessing the contribution of the macro-financial interactions to the recent oil price dynamics. The results indicate that while the macroeconomic shocks have been the major upward driver of the real oil price since the mid 1980, the financial shocks have also sizably contributed since the early 2000.

Based on this literature review, we seek in this paper to; highlight the possible interactions between the physical factors, the traditional and modern financial factors (speculation and kcfsi index) that can have an impact on the oil price volatility. Moreover, the persistence of the literature leads us to the question of whether there is a relationship between the oil prices and the financial stress in the long run.

The Methodology and Data Collection

Presentation of data

The period from January 1995 to December 2013 is chosen in order to take into account the occurrence of major political, financial and economic changes in the world market:

A sustained period of US economic expansion (until mid-2000).

The introduction of the Euro in 1999.

The terrorist attack to the Twin Towers in 2001.

The financial crisis in 2008.

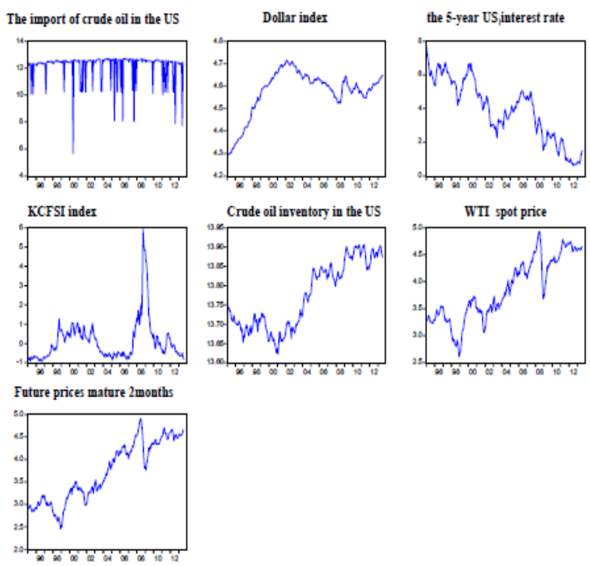
The Arab revolution in 2011.

The main factors that influence oil prices are divided into 3 categories: physical variables, the classical financial factors, the speculation and the financial shocks (Table 1 and Figure 1).

Classification	Variables	Symbols
Spot oïl price	WTI spot price	lnWTI*t*
Physical variables	The import of crude oil in the United States Crude oil inventory in the United States	Im*t* *tt*
The traditionnel Financial factors	Dollar index the 5-year US interest rate	In*It* *rt*
speculation and financial shocks	Future prices mature 2 months KCFSI	In*it* *KIt*

Note: The 5-year US interest rates are extracted from the database of the U.S.Board of Governors of the Federal Reserve System. WTI spot price, the import of crude oil in the United States, Crude oil inventory in the United States, Dollar index and Future prices at 2 months maturity, are provided by the Energy Information Administration (EIA). The data of KCFSI index are available on a monthly basis from the early 1990s until recently.

Table 1: Description of factors.



Note: The graphs of the dynamics for the seven variables are represented as follows. WTI spot price, the import of crude oil in the United States, crude oil inventory in the United States, dollar index, the 5-year US interest rate, future prices at maturity 2 months and KCFSI index.

Figure 1: Graphs of variables.

Empirical model and estimation procedure

The major interest of the VECM modeling in relation the VAR modeling is in the ability of the VECM to econometrically distinguish both (short and long term) types of dynamics. In our articles, this characteristic seems to be very interesting as it enables us to find out how the oil prices react to the cyclical fluctuations and which variables affect the long- term price dynamics. If the impact of some variables can exist only in the long term, this means that the impacts of these variables on the oil price dynamics can come out in the cointegration space.

The cointegration idea consists in the fact that, in the short term, several variables might have a diverging evolution, whereas in the long run, they evolve in the same directions. In other words, these variables develop together at the same rates and stochastic trends. A series is said to be integrated of order 1 if it has a unit root. When the series has (d) unit roots, it is said to be integrated of order d. The series of order d are said to be integrated there is a non-nil linear combination between these series, which is integrated of an order lower than d. These linear combinations are called the cointegration equation.

Our analysis starts with the study of the series stationarity to check if there is likely to be a cointegration between two or several variables. The method used is the Dickey-Fuller augmented test applied a regression of types:

$$\Delta X_{it} = \alpha_0 + \alpha_1 t + \alpha_2 X_{it-1} {}^{+} \alpha_{it} X_{it-2} + \varepsilon_{it} \quad (1)$$

Or

$$\Delta X_{it} = X_{it} - X_{it\ 1}$$

K: opimal number of shift

$$X_{it} = A_{i1} X_{i1-1} + A_{i2} X_{it-2} + A_{ip} X_{it-1} + \varepsilon_{it}$$

In the context of this test, we first take account the series in level

Variables	WTIt	Imt	tt	It	rt	it	KIt
			Series in level				
ADF	-1,417	-15,412	-0,892	-2,769	-1,667	-0,989	-3,212
	-0,574	0,000***	0,789	0,064*	0,447	0,757	0,021**
PP	-1,205	-15,404	-0,641	-2,859	-1,793	-0,965	-2,731
	0,673	0,000***	0,857	0,0519	0,384	0,765	0,070*
Series in first differences							
ADF	-9,716	-14,976	-12,383	-9,602	-11,216	-11,507	-6,750
PP	0,000***	0,0000***	0,0000***	0,000***	0,0000***	0,000***	0,000***
	-9,500	-9,500	-12,234	-9,531	-11,230	-11,507	-13,052
	0,000***	0,000***	0,0000***	0,000***	0,000***	0,0000***	0,000***

Notes: * A statistic significant at the 10% level; ** at the 5% level; *** at the 1% level. p values are provided in parenthesis

Table 2: Unit root test.

Variables	WTIt	It	rt	Imt	Stt	$KFSIt$	$Foi\mathfrak{l}t$
Io(c)	4.69	3,51	3,8	15.19	3,98	-0.32	4.52
Date r	nov-04	mai-97	Aout 2004	Sep 2012	mai-03	avr-08	avr-13
Io (cs)	-5,08	-4,38	-15.282	-4.288	-4.222	-4.786	-3.806
Date r **Ao**	nov-04 -5.055	mai-05 -4.412	Fevrier 2012-6.119	nov-04 -4.450	sept-97 -4.397	nov-04 -4.640	janv-05 38292
Date de r	nov-04	mai-05	oct-03	nov-04	sept-97	nov-04	Aou t 2004

Note: The null hypothesis that the time series is characterized by presence of a unit root and a constant zero with possibly rupture.

An instantaneous effect (rated AO for "Additive Outlier").

An effect with transition on the constant (c) or in both the constant and variable (v, s) Regression Dickey-Fuller

(Denoted respectively IO (c) and IO (c, s) for "Innovational Outlier ").

Table 3: Stationary test with rupture Perron 1997.

and in first difference. If the tests confirm the non -stationarity of the series, we take this sequence with first difference. The stationarity of the differentiated series revealed by the tests proves the existence of a unit root (Table 3).

However, the period from January 1995 to December 2014 which our study deals with is characterized by contrasting price changes that can be subject to potential graph. This can lead us to implement the test procedure suggested by Perron [16] which is part of the work extension of Perron and Vogelsang [17] and of those of Zivot and Andews [18]. In these tests the null Hypothesis shows that the temporal series is marked by the existence of a unit root and eventually a nil constant with a grap. We could make the distinction between an instantaneous impact (noted A0 for "Additive Outlier") and a transition effect about constant (c) or at the some true about the constant and the variable (c,s) of Ducky Fuller's regression (noted respectively IO (c) and IO (c,s) for ''Innovational Outlier")

As a first step, we identify the optimal degree of the VAR model using nested tests built upon the likelihood ratio-statistics. This leads us to retain the four-lagged VAR. The series incorporated in the model are non-stationary in level. Hence, this analysis aims to underline the existence of one or more cointegration relationships between the variable.

Actually, we know that a model consisting of r series I(1), can exist until (r-1) cointegration relation. Therefore, the issue of the number of cointegration relationships to be included in the model is crucial for the analysis because when we have more than one cointegration relationship, we will get an equation system which, to be estimated, requires being identified beforehand. In order to analyze the relationships established in the long run between the six variables of the model, we should have a defined number of long-term relationships in the model via the analysis of the matrix II analysis (see equation 3 below). There are three possible cases.

-The II Matrix is of full rank, that is, r=n, n being the number of variables and all the components (variables) of xt matrix are stationary I(0). Hence, there is no cointegration relationship.

-If the rank of II matrix is 0, there is no cointegration relationship.

-If the rank of II matrix is equal to r, there are r cointegration relationships, hence a VECM can be estimated.

The general model proposed is a vector auto regression (VAR) model which consists of the following variables:

$$X_{it} = A_{i1} - X_{i1-1} + A_{i2} - X_{it-2} + A_{ip} - X_{it-1} + \varepsilon_{it}$$

With Xi = (WTI spot price, The import of crude oil in the United States, Crude oil inventory in the USA, Dollar index, the 5-year US interest rate, Future prices mature 2months and kcfsi index).

$$A_{ij} = \text{the coefficient matrix } (7*7, i=1, 2\ldots\ldots p) \quad (2)$$

ε_{it} = Vector errors (7*1)

We write equation (1) as a model VECM "vector error correcting model"

$$\Delta X_i = \Gamma 1 \, \Delta X_i t + \Gamma 2 \, \Delta X_{it-2} + \ldots\ldots + \Gamma p \, \Delta X_{it-p+1} + \alpha \, \Pi \, X_{it-1} + \varepsilon_{it} \quad (3)$$

Model (3) consists of two main blocks related to two types of relations. The first block, consisting of Γ matrices, tells us about the short-term relations of the system. The second block, consisting of

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the Π matrix, informs us about the long-term relations. α is the error correction term.

Result and Interpretation

Stationarity and Johansen Cointegration tests

We reject the null hypothesis of non stationarity on the entire sample 1995 M1 to 2013 M 12, through two tests: ADF and PP, in all cases in first differences (that is to say that all series are integrated of order 1, I(1)). Therefore they can be co-integrated.

However, the period to which the analysis is marked by changes contrasting prices that can be labeled with any disruptions. This led us to implement the testing procedure proposed by Perron 1997, which is in extension of the work of Perron and Vogelsang [17] and those of Zivot and Andrews [18].

For the WTI spot price, the unit root a test (Table 2) with rupture highlights the type of ruptures Io (c s) during the second half of 2004. Three factors are put forward to explain this break. The first is the strong global demand emanating particularly from China. The second is the weak oil stocks and the lack of investment in refining capacity in the United States. The third is the cold snap in Europe and in the USA in the early 2005 or the observed dramatic nature of purchases.

For the financial stress index, the unit root tests with structural break show the break of type (IO) c in April 2008. This year shows that the positive KCFSI reached high level. During this period, the crisis surrounding the collapse of Bear Stearns and the investors had already raised concern about the quality of the subprime mortgages. The series also has a unit root test with structural break of type IO (c, s) in November 2004. During this period, the financial shocks contributed widely to the cycle of economic activity.

From the above results, the unit root test with break for the 5-year US interest rate highlights breaks of type A0 in October 2003, type IO (c) in August 2004 and type IO (c,s) in February 2012 .

The results indicate that the most significant structural breaks detected over the period M1 1995-M12 2014 correspond to the list of financial and currency crises.

Johansen Cointegration tests

First, we determine the optimal degree of the VAR model using statistical tests based on likelihood ratio. This approach leads us to retain a VAR with 4 delays. The series included in the model (lnWTIt, mt, Stk$t$, InDlt, rt, lnFoit and KCFSIt) is not-stationary, then the analysis is to highlight the existence of one or more co-integration relationships between variables (Table 4).

The eigenvalue and trace tests enable us to determine the number of long-term relationships and indicate the existence of two cointegration relationships. In addition, the system must be modeled in the form of a VECM comprising six variables, four lags, and two relations of cointegration.

VECM estimation result

Long term block estimation for models 1 and 2: Two models are estimated, Model 1 is reduced with physical variables (the level of imports and crude oil inventory in the US (thousands of barrels) and traditional financial factors (the US dollar index and the interest rate to 5 years in the United States). Model II takes into account the modern financial variables (future prices at two months maturity and the index of financial stress kcfsi).

Unrestricted Cointegration Rank Test		Trace	0,05	
No.of CE(s)	**Eigen value**	**Statistic**	**Criticul Value**	**Prob****
None	0.243493	182.3738	159.5297	0.0016***
At most 1	0.188996	121.2631	125.6154	0.0894*
At most 2	0.113092	75.38664	95.75366	0.5291
At most 3	0.091809	49.10364	69.81889	0.6762
At most 4	0.057782	28.01374	47.85613	0.8131
At most 5	0.042362	14.97912	29.79707	0.7814
Unrestricted Co integration Rank Test(Maximum Eigen value)		**Max-Eigen**	**0,05**	
No.of CE(s)	**Eigen value**	**Max-Eigen**	**Criticul value**	**Prob****
None	0.243493	61.11065	52.36261	0.0051***
At most 1	0.188996	45.87649	46.23142	0.0545*
At most 2	0.113092	26.28300	40.07757	0.6831
At most 3	0.091809	21.08990	33.87687	0.6774
At most 4	0.057782	13.03462	27.58434	0.8830
At most 5	0.042362	9.479414	21.13162	0.7920

Table 4: Johansen Cointegration tests.

Model 1:

$$\Delta \ln \mathrm{Wti_t} = \sum_{i=1}^{3} \alpha_{1i} \Delta \ln Wti_{t-1} \sum_{i=0}^{3} \alpha_{1i} \Delta 1mp_{t-1} + \sum_{i=0}^{3} \alpha_{1i} \Delta Stk_{t-1} + \sum_{i=0}^{3} \alpha_{1i} \Delta r_{t-i} + \delta ECT_{t-1} + {}^{U}{}_{t}$$

Model 2

$$\Delta \ln \mathrm{Wti_t} = \sum_{i=1}^{3} \alpha_{1i} \Delta \ln Wti_{t-1} \sum_{i=0}^{3} \alpha_{1i} \Delta 1mp_{t-1} + \sum_{i=0}^{3} \alpha_{1i} \Delta Stk_{t-1} + \sum_{i=0}^{3} \alpha_{1i} \Delta r_{t-i} + \sum_{i=0}^{3} \alpha_{1i} \Delta \ln Foil_{t-1} + \sum_{i=0}^{3} \alpha_{1i} \Delta KCFSI_{t-1} \delta ECT_{t-1} + {}^{U}{}_{t}$$

Note: T-statistics are provided in parenthesis []. An intercept C is included in the test equation

WTIt =−60,43535 − 1,629Imp$t$ + 5,9542Stk$t$ + 0,4066DIt + 0,053rt + εi

WTI = 47,78 + 0,321361mp$t$ − 3,606311 Stk$t$ − 0,722796 DIt − 0,016438rt + 1,405862Foil$t$ −0,093889KCFSIt + εi

In model 1, the two physical variables import and inventory crude oil in the United States are very significant and highly correlated with oil prices. It is found that the crude oil stock increase in the US by 1% reduces the oil prices by more than 5.954264%. An increase in the import of crude oil by 1% increases the oil price by 1.629971 %. This strong long-term correlation between the import and crude oil inventory in the US and an oil price is due to the sharp increase in oil imports by the Asian emerging countries after 2000. This result is consistent with the work of Cristina Bencivenga, Rita L D'Ecclesia and Umberto Triulzi [19].

The equilibrium relationship shows that oil prices are negatively and not significantly affected by the traditional financial factors such as the US dollar index and the 5-year interest rate. This result is inconsistent with the studies of Bénassy-Quéré et al. [20] and Coudert et al. [21] who provided evidence for a long-term relationship between real oil prices and the dollar index over the 1974 -2004 period.

In Model 2, we try to see the impact of speculation and KCFSI index on oil prices. According to the estimation of the long-term block for Model II, it is noted that oil prices are not only trained by the physical variables, but also by speculation and the financial shocks. An increase of speculation by 1% increases oil prices by more than 0.09388%. These relationships are normally attributed to the transaction costs, the role of traders and the effects of the market microstructure [22-

24]. As a result, speculation in the futures market is supported to be the main cause of long term of fluctuating oil prices. These results are in agreement with the studies of [25-29]. However, this result is not confirmed by Krugman [30] and Smith [28] who reject the hypothesis of the speculation role in the oil markets.

According to Table 5, an increase in the financial stress index by 1% decreases oil prices down by more than -1.405862%. Model 2 emphasizes that such unexpected worsening of the financial situation causes a statistically significant increase in oil prices. This result seems to give some support to the idea that oil markets are highly motivated by the changing conditions in the financial markets that affect financial investment. Therefore this phenomenon is characterized by a high degree of correlation between commodities and financial assets probably because of the greater involvement of financial investors in commodity markets. In contrast, in the crisis period, financial stress tends to have a smaller short-run and a higher long–run volatility. Nevertheless, it also appears that oil prices and financial stress are dominated by a persisitent long-run volatility. This result is interestingly similar to that of Nazlioglu et al. [31]. However, this result is confirmed by Wang Chen, Shgeyuki Hamori and Takuji Kinkyo [14] who find that the increase in the kcfsi index cause a decrease in the oil prices.

The estimated coefficients in the Tables 6 and 7 correspond to the adjustment speed of the long term targeted system variables. There is a principal which states that any variables deviation in relation to its equilibrium value should be corrected using the error correction mechanism which exists in the estimations by means of a negative adjustment speed. The estimated coefficients in our table have values compatible with what is expected in the way that they can be positive or negative when they are systematically associated with one variable which has a long term negative relationship coefficient, which then creates a negative adjustment speed.

As a consequence, our cointegration relationship is important as it actually exercises its role of error correcting in the dynamics of the long term oil real price. Therefore, an increase in the oil prices creates a disequilibrium, which leads to a significant reduction of oil price.

All the other variables are important and can be affected by the adjustment mechanisms, by incorporating financial variables (WTI futures prices at 2 months maturity, KCFSI index) in model 2; the adjustments speed will be higher than that of model 1.

Catégorie	Variables	Model 1	Model 2
	WTI spot price (-1)	1	1
Physical variable	The imports of crude oil in the United States(--1)	1.629971 (0.19433) [8.38771]*	-0.321361 (0.04101) [-7.83634]*
	Crude oil inventory in the US(-1)	-5.954264 (2.13882) [-2.78390]*	3.606311 (0.67709) [5.32619]*
Conventional financial factors	The US dollar index (-1)	-0.406660 (1.36423) [-0.29809]	0.722796 (0.30302) [2.38534]*
	The 5-year intéret rate (-1)	-0.053960 (0.11376) [-0.47432]	0.016438 (0.02386) [0.68898]
Speculation and financial shocks	Future prices for maturities of two months (-1)		0,093889 (0.02468) [3.80408]*
	KCFSI index (-1)		-1.405862 (0.08575) [-16.3951]*
	C	60,43535	-47 .78

Table 5: Long-term block Estimate for the model I and II.

D (WTI)	D(DI)	D(rt)	D(Imp)	D(Stk)
-0.014138***	0.000292	0.001453	-0.550172***	0.001960***
[-2.786115]	[0.535221]	[0.087995]	[-7.271110]	[2.630530]
0.0058	0.5931	0.9300	0.0000	0.0092

Note: In brackets are the t-statistics. Significance estimated at 1%, 5% and 10% respectively is indicated by ***, ** and *.

Table 6: Speed of adjustment towards the long-term target for Model 1.

D (WTI)	D(DI)	D(Intérêts)	D(Imp)	D(Stk)	D(KCFSI)	D (Foil)
0.043365**	0.000451	0.001874	1.734238***	-0.010044***	-0.356156***	0.031779
[2.219756]	[0.210829]	[0.028193]	[5.362172]	[-3.355840]	[-3.924855]	[1.599350]
0.0275	0.8332	0.9775	0.0000	0.0009	0.0001	0.1113

Note: In brackets are the t-statistics. Significance estimated at 1%, 5% and 10% respectively is indicated by ***, ** and *

Table 7: Speed of adjustment towards the long-term target for Model 2.

	WTI_t : Model 1	WTI_t : Model 2
WTIt (-1) WTIt (-2) Imp$t$ (-1) Imop$t$(-2) Stk$t$ (-1) Stk$t$ (-2) DIt (-1) DIt (-2) Int$t$ (-1) Int$t$ (-2) Foil$t$ (-1) Foil$t$ (-2) KCFSIt (-1) KCFSIt (-2)	1.259434 (0.06680) [18.8542]* -0.330783 (0.06575) [-5.03111]* -0.002470 (0.00456) [-0.54176] -0.008318 (0.00454) [-1.83141] -0.009764 (0.44963) [-0.02172] 0.408314 (0.45483) [0.89773] -1.514313 (0.60172) [-2.51662]* 1.572839 (0.59256) [2.65431]* 0.032250 (0.02071) [1.55734] -0.032866 (0.02080) [-1.58006]	1.861784 (0.20546) [9.06162]* -0.863774 (0.21429) [-4.03088]* -0.000279 (0.00448) [-0.06236] -0.006288 (0.00447) [-1.40816] 0.032482 (0.45936) [0.07071] 0.333368 (0.44434) [0.75026] -1.233599 (0.62479) [-1.97442]* 1.331134 (0.61772) [2.15491]* 0.020278 (0.02128) [0.95281] -0.019629 (0.02144) [-0.91533] -0.677469 (0.21614) [-3.13440]* 0.623909 (0.22374) [2.78851]* -0.042891 (0.01588) [-2.70091]* 0.040149 (0.01540) [2.60698]*

Table 8: Short term block estimation for models 1 and 2.

Short term block estimation for models 1 and 2: Estimated short-term block in model 1: up to two delays: Variables estimated T-1 and variables estimated T-2.v (Table 8).

The short-term relationship in models 1 and 2 provides information on the significance of the estimated coefficients of all the endogenous variables to two delays. Among the significant coefficients, we find that the signs obtained for a given variable remain mostly unchanged in successive periods. In model 1, the US dollar exchange rate is the only significant variable with a negative value of 1.572839 of two lags.

In Model 2, we see that variables such as the financial stress index, the index of the dollar and the futures price at two months maturity, are significant in the short term. These results are in agreement with studies of Marco J. Lombardi and Ine Van Robaysy [32] who found that the financial investors in the futures market can however destabilize oil spot prices in the short run.

In addition, an increase in financial stress has an impact on short-term oil prices, increased by a stress induced a decrease financier lower oil prices, as it allows a. The same goes for speculation, variable oil price at two months maturity is significant at three and two months of delays.

The interest rate does not affect oil prices in the short and long term. This result is similar that of Alquest et al [33] who found no statistically significant relationship between the real interest rate and oil price.

The transmission of information

Forecast error variance decomposition is then conducted for up to 12 months (Table 8).

Although changes in the explanatory power of the various factors during the period between January 1995 and August 2013 are analyzed in Tables 5 and 9, the long and short- term relationship reflects only the degree of synchronized changes but does not fully explain the significant causal relationship between the oil price and the main factors. Thus, it is difficult to identify the real factors driving the volatility of oil prices. Therefore, Table 9 presents the variance decomposition results. The reported figures indicate the percentage of the forecast error in each variable that can be attributed to innovations in other variables.

In column 1, in the first month, 100% of the variability in the evolution of oil prices is explained by their own innovations. After 6 months, approximately 85.51% of the variability is explained by their own innovations. After 12 months, about 77.11% of the variability of oil prices is explained by their own innovations. This finding shows that the price of oil in the current period is closely linked to the future

				WTI*t* :			
Period	**WTI*t***	**Im*t***	***Stkt***	**DI*t***	r_t	***Foilt***	**KCFSI**
1	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
3	92.69578	0.727379	0.667435	1.379406	0.584767	1.859494	2.085740
6	85.51405	1.409812	4.823156	1.857201	0.780948	2.447091	3.167746
9	80.82974	1.331081	9.689321	1.722895	0.676536	2.253099	3.497332
12	77.11846	1.219269	13.47054	1.675248	0.711059	2.186482	3.618939
				Im*t* :			
Period	**WTI*t***	**Im*t***	***Stkt***	**DI*t***	r_t	***Foilt***	**KCFSI**
1	8.06E-07	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000
3	0.017894	98.65822	0.027023	0.393917	0.098298	0.528346	0.276301
6	0.212106	97.87875	0.181484	0.434929	0.161945	0.721386	0.409403
9	0.238541	97.53750	0.325916	0.433606	0.176338	0.759659	0.528440
12	0.266856	97.37673	0.398495	0.432900	0.178658	0.760202	0.586162
				***Stkt*:**			
Period	**WTI*t***	**ITablet**	***Stkt***	**DI*t***	r_t	***Foilt***	**KCFSI**
1	0.235100	1.050065	98.71483	0.000000	0.000000	0.000000	0.000000
3	0.236354	2.777799	95.33759	0.120308	0.007680	1.445792	0.074474
6	1.618284	4.390150	80.13961	1.545295	0.550128	11.54469	0.211844
9	2.533546	5.123045	64.51066	4.162868	1.679623	21.69348	0.296775
12	2.209073	5.278896	55.70203	6.390632	2.648161	27.36185	0.409359
				DI*t* :			
Period	**WTI*t***	**Im*t***	***Stkt***	**DI*t***	r_t	***Foilt***	**KCFSI**
1	3.046939	0.217948	1.831621	94.90349	0.000000	0.000000	0.000000
3	3.707343	0.050102	5.040511	88.78517	0.013478	0.142262	2.261131
6	3.724620	0.075898	11.24148	81.91185	0.161897	0.168125	2.716133
9	3.361849	0.058636	16.64860	76.65134	0.341589	0.297444	2.640536
12	2.743781	0.058520	20.54434	73.47220	0.437131	0.257186	2.486846
				r*t* :			
Period	**WTI*t***	**Im*t***	***Stkt***	**DI*t***	r_t	***Foilt***	**KCFSI**
1	4.346608	0.048979	0.426129	3.066243	92.11204	0.000000	0.000000
3	5.558632	0.110948	2.726129	1.743044	89.79224	0.029701	0.039306
6	4.380085	0.056943	3.740683	1.013416	90.37758	0.077579	0.353720
9	3.346972	0.053461	3.893532	0.758725	90.95080	0.366598	0.629913
12	3.365064	0.067252	3.690800	0.648526	90.69635	0.682679	0.849327
				***Foilt* :**			
Period	**WTI*t***	**Im*t***	***Stkt***	**DI*t***	r_t	***Foilt***	**KCFSI**
1	90.87568	0.112092	0.015317	0.174866	0.114320	8.707725	0.000000
3	90.73081	0.320130	0.693368	2.349828	1.318256	2.602423	1.985188
6	85.94630	0.639194	4.882865	2.583678	1.662167	1.243907	3.041889
9	81.63815	0.578868	9.674776	2.213951	1.515535	0.987715	3.391002
12	77.64835	0.521184	13.47255	2.019620	1.348920	1.443458	3.545918
				KCFSI:			
Period	**WTI*t***	**Im*t***	***Stkt***	**DI*t***	r_t	***Foilt***	**KCFSI**
1	1.878330	0.490128	0.388578	4.388342	7.158380	0.540738	85.15550
3	1.111803	1.335927	6.955660	8.920825	8.936648	0.267175	72.47196
6	0.942979	1.586980	12.71004	8.335256	7.065713	0.340074	69.01896
9	3.117051	1.485706	15.07439	7.407061	5.657805	0.486877	66.77110
12	7.367754	1.320518	15.10651	6.727694	5.656709	0.474336	63.34648

Notes: The results are based on the forecast error decomposition over the horizon of 12 month and units are in Percentages.

Table 9: Forecast error variance decomposition.

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pricing decisions, which confirms the finding of Yousefi and Wirjanto [34].

As indicated in column 1, in general, oil prices are affected by exchange rate to a minimum. In the second month, about 0.28% of the variability in the evolution of oil prices is explained by an exchange rate shock. The greater variability of 1, 37% in the sixth months is explained by an exchange rate shock. The exchange rate shocks have no significant impact on the evolution of oil prices in the short and long term. This is consistent with the view of some studies, such as that of Reboredo [35] which indicates that the link between the exchange rates and oil prices is generally low.

Overall, financial factors were the main factors influencing oil price volatility. In the short run, speculation still makes the greatest contribution, whereas in the long run, the 5-year US interest rate and Crude oil inventory in the US make the greatest contributions to oil price volatility. From Table 9, the percentage contribution of WTI itself to volatility decreases with time. 77, 11% of WTI volatility can be explained by itself and almost 14, 68% can be explained by physical variables, 2, 38% by conventional financial variables and 5, 79 by speculation and financial shocks.

On the contrary, the contributions of WTI to volatility speculation and kcfsi index exceed 7% in 12 months indicating that crude oil price volatility has great influence when the crude oil price is higher.

The fluctuations in the KCFSI are mostly caused by its own shock (i.e. financial shock) at all time horizons. The combined contribution of the other shocks to KCFSI fluctuations accounts for approximately 36, 62% after 12 months. Interestingly, we find that the share of KCFSI fluctuations caused by other factors changes over time. For example, the Crude oil inventory in the US accounts for a larger share of KCFSI fluctuations than the Future prices at 2months maturity until 12 months.

Granger causality tests 1996

According to the correlation matrices given by VECM, simultaneous causal structure is formed between the various factors and WTI (Figure 2).

The causality concept by Granger 1996 implies that a variable causes the other variable if the former variable has a predictive power for forecasting the latter variable.

We note the existence of bidirectional causality between the 5-year interest rate and WTI spot price [<=>], and futures prices at 2 months maturety and WTI spot price [< = >]. Additionally, we find a unidirectional causality from the US dollar index, crude oil inventory and kcfsi index to the WTI spot price [=>]. This result is inconsistent with the empirical literature that has evidence that the causality runs from oil price variations to exchange rate changes [5,20,21,36-41]. On the other hand, this result is consistent with that of Zhang and Wei [42] which suggest that the exchange rates transmit exogenous shocks to energy futures prices.

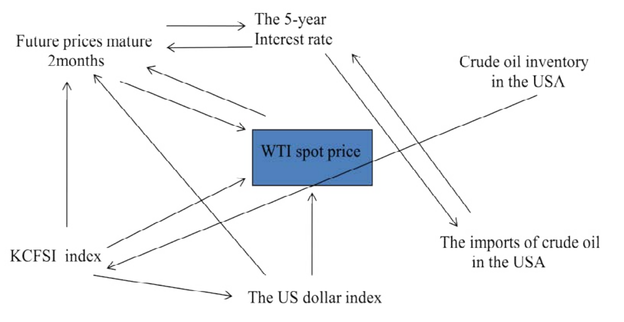

Figure 2: Shows the transmission of information between WTI and other financial and economic factors. Crude oil inventory in the US, Dollar index, the. 5-year US interest rate, Future price mature 2 months and KCFSI index.

Conclusion

The aim of this study is to underline the variables that affect the oil price volatility. More precisely, it focuses on the role that can be played by the physical, classical and contemporary financial variables. These monthly series cover the period from January 1995 to December 2013.

To properly integrate the dynamic dimension in our study, we conducted an analysis using a vectorial model of error correction. Two models are taken into account. The first is a reduced model comprising two categories of variables, a physical variable and traditional financial factors. The second model takes into account the future prices at two maturities and the index of the financial stress KCFSI. A four lag VECM is estimated. The estimation of the short-term block shows that all the financial variables, excepting the 5-year US interest rate, are significant at two lags. On the hand, the long term block for both models is in conformity with the theory in the way that the adjustment speed is affected by signs compatible with the existence of the error correction mechanism. Regarding model 1, the variables that mostly affect oil price volatility are the physical variables (imports and inventory of crude oil in the United States). In model 2, the oil prices are also positively affected by speculation and financial stress index.

Furthermore, our results also suggest that the relationship between financial and physical factors and oil prices can change through time (in the short and long term) which provides an opportunity for regime-switching models to examine.

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