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Long-term Dynamics between Oil Prices and Frontier Equity Markets: A Cointegration Analysis

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Author's contribution

The sole author designed, analyzed and interpreted and prepared the manuscript.

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ABSTRACT

Despite the growing importance of Frontier Markets within the investment management landscape, relatively few studies have focused on them. However, understanding their behaviors and the way they relate to oil prices is of paramount importance for financial market participants.
This paper therefore aims to investigate potential long-term relationships between oil prices and a number of frontier stock markets.
14 frontier markets are studied with weekly data covering the period ranging from December 2005 to July 2014.
Results indicate that causality exists from oil to stocks for Kazakhstan and Qatar. Interestingly, the causality also runs from stocks to oil in the case of Kazakhstan. For Kazakhstan and Qatar, evidence of positive long-term relationship is found.
These findings are important for these countries' policy makers as it provides insights into how these markets are linked to oil prices. As these findings imply some degree of market predictability, they could also be of interest to asset managers.

Keywords: Oil prices; cointegration; frontier markets; VAR; VECM.

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1. INTRODUCTION

Among all commodities, crude oil is probably the one that has the greatest impact on the state of the economy. Its price also impacts significantly financial markets. The theoretical reasons for this have been documented in the energy finance literature and several channels through which oil shocks are transmitted to stock markets have been identified. The most important one probably lies in the financial link that exists between oil prices, corporate cash flows, and the rate used in stock-valuation models to discount these cash flows. Since corporate cash-flows and discount rate reflect economic conditions (inflation, production costs, income, economic growth, etc.) which can be influenced by oil shocks [1], stock prices may thus react significantly to oil price changes. Of course, the reaction will vary depending on whether the company being examined is an oil producer or an oil consumer. Indeed, oil producers will tend to profit from an oil price increase while oil consumers will tend to suffer from it. Overall, since the great majority of companies are oil consumers, it is logical to expect a negative reaction of stock prices to oil price shocks.

In addition to this, it is important to recall that an oil price increase can lead to inflationary pressures, which in turn can potentially push central banks to raise interest rates. An increase in interest rates can have tremendous effects on firms' capital budgeting decisions, decreasing the potential return on investments and increasing the cost of debt.

Although many studies have focused on this potential relationship between oil prices and various developed equity markets, very few have examined the potential links between oil prices and Frontier stock markets [2,3]. "Frontier Markets" is a term that was coined by the International Finance Corporation (IFC) in 1992. The term is commonly used to describe the equity markets of the smaller and less accessible, but still investable, countries of the developing world. Frontier markets can be characterized as those countries that are enjoying high economic growth rates but have made limited progress to date in developing liquid capital markets, which makes them inherently riskier investments but also provides potential opportunities for investors to take advantage of privatizations and increased listings on local exchanges over time. These markets are also sought by investors because of their segmentation from world markets, making them a source of portfolio diversification [4,5]. Many frontier markets have abundant natural resources and have benefited from the rise in commodity prices over the last twenty years, principally fuelled by demand from China. This secular rise in commodity prices has led to increased government spending, infrastructure investment and higher standards of living for entire populations. The resource-based economic structure of many of these frontier markets makes it interesting to study their potential links with the oil market.

Despite the growing attention to frontier markets among the investment community, the volume of research on the topic remains limited. This paper contributes to filling this gap and aims at furthering our understanding of how oil impacts frontier equity markets by focusing on the long term dynamics between them. More precisely, the contribution of this article is twofold. First, it brings up to date previous studies on the subjects and second, it includes countries which have never been studied before in this perspective because of scarce historical data on frontier equity markets.

The remainder of this article is organized as follows. Section 2 discusses findings of previous research focusing on the relationship between oil prices and stock markets. Data and empirical analysis are presented in Section 3. Section 4 discusses these results while Section 5 concludes.

2. LITERATURE REVIEW

Numerous studies have examined the linkages between macroeconomic variables and oil prices [6,7,8]. The majority of these studies have shown the significant impact of oil price changes on economic activities. Other papers have reached the conclusion that the relationship between oil prices and economic activity is asymmetrical, with oil price increases having a larger impact on growth than oil price decreases [9,10].

Oil prices not only affect and help to predict relevant macroeconomic variables (i.e., real economic activity, trade balance or inflation rates, among others) but they may also exert an impact on financial variables (i.e., stock market returns and exchange rates). Yet surprisingly, there have been relatively few attempts to study the relationship between oil price variations and stock markets until recently. Jones and Kaul [11]

were the first to test the reaction of international stock markets (Canada, UK, Japan, and USA) to oil price shocks, based on the standard cash-flow dividend valuation model. They find that for Canada and the US, this reaction can be entirely accounted for by the impact of the oil shocks on cash flows. Huang et al. [12], using an unrestricted Vector Autoregressive (VAR) model, show a significant link between the stock returns of certain American oil companies and oil price changes. However, there is no evidence of a link between oil prices and market indices such as the S&P 500. Sadorsky [13], by contrast, applies an unrestricted VAR model with GARCH effects to US monthly data and shows a significant relationship between oil price changes and aggregate stock returns. Ciner [14], using non-linear causality tests, provides empirical evidence that oil shocks significantly affect stock index returns in the US in a non-linear manner, and that the returns also have impacts on crude oil futures. Park and Ratti [15] show that oil price shocks have a statistically significant impact on real stock returns contemporaneously and/or within the following month in the U.S. and 13 European countries over the period running from January 1986 to December 2005 and that Norway, as an oil exporter, shows a statistically significantly positive response of real stock returns to an oil price increase. Zhu et al. [16] use a panel threshold cointegration approach to investigate the relationship between crude oil shocks and stock markets for the OECD and non-OECD panel from January 1995 to December 2009 and find evidence of nonlinear cointegration as well as the existence of bidirectional long-run Granger causality between crude oil shocks and stock markets for these OECD and non-OECD countries. However, they find that short-run Granger causality between them is bidirectional under positive changes in the deviation and unidirectional under negative ones and that the speed of adjustment toward equilibrium is faster under negative changes in the deviation than that under positive ones.

Even though the bulk of studies have focused on developed economies, some recent papers have turned their attention to emerging markets. Malik and Hammoudeh [17] show that Gulf equity markets are sensitive to volatility from the oil markets, while stock market volatility spills over into the oil markets only in Saudi Arabia. Arouri, Bellalah, and Nguyen [18] show that, on the basis of short-term analysis, strong positive links are found in some GCC (Gulf Cooperation Council) countries between oil prices and stock markets, and that this causality generally runs from oil prices to stock markets. Asaolu and Ilo [2] show that the Nigerian stock market return and oil price are tied together in the long-run but that, contrary to expectation, oil shocks negatively impact the Nigeria stock market, despite Nigeria being an oil exporting country. Asteriou and Bashmakova [19] investigate the relationship between oil price risk and stock market returns for the emerging equity markets of Central and Eastern European countries and find that oil price is an important factor in determining stock returns. Fang and You [20] study how oil prices affect large emerging countries stock prices and find mixed results. More recently, Gomes and Chaibi [3] study the potential volatility spillovers between oil price changes and many frontier stock markets and find various cases of volatility and shock transmission between oil and stock, usually from oil to stocks but also sometimes from stocks to oil.

3. DATA, METHODOLOGY AND EMPIRICAL RESULTS

3.1 Data Set

Data price series were obtained from Morgan Stanley Capital International (MSCI) and the Energy Information Administration (EIA). In this paper, my data set consists of fourteen national stock indices (MSCI indices for Argentina, Bahrain, Jordan, Kazakhstan, Kenya, Kuwait, Lebanon, Mauritius, Nigeria, Oman, Pakistan, Qatar, Saudi Arabia and the United Arab Emirates), two broad equity indices (MSCI World and MSCI Frontier Markets) as well as a measure of oil spot prices (Brent Crude Oil). These countries were selected for inclusion into the database because of their relatively long (for frontier markets) data on stock markets. Weekly data were preferred to daily data in order to limit the unnecessary noise usually encountered at the daily frequency, as wells as to avoid time-difference problems with international markets. The period covered ranges from 2 December 2005 to 25 July 2014, yielding 452 price observations per series. Fig. 1 depicts the historical time-paths of the log prices of crude oil and stocks in the GCC countries. Their evolutions are broadly indicative of the long-term dependencies that may exist between them.

In order to examine the data properties, two unit root tests (Augmented Dickey - Fuller - ADF -

and Phillips - Perron - PP) are conducted on these series (in level and in first differences). Results are reported in Table 1. As expected, differentiated series are all stationary according to both tests (at the 1% level), while the series in level integrated of order one (a few exceptions - Bahrain, Jordan and Kazakhstan - appear to be stationary according to one unit root test, but not according to the other), in line with what is usually observed for stock market prices. Series in levels will be used to assess potential long-term dependencies between variables.

3.2 Empirical Analysis

In this section, I examine the long-run relationship between frontier stock markets and oil prices by testing for cointegration and then examining convergence towards the long-term target for series that happen to be cointegrated.

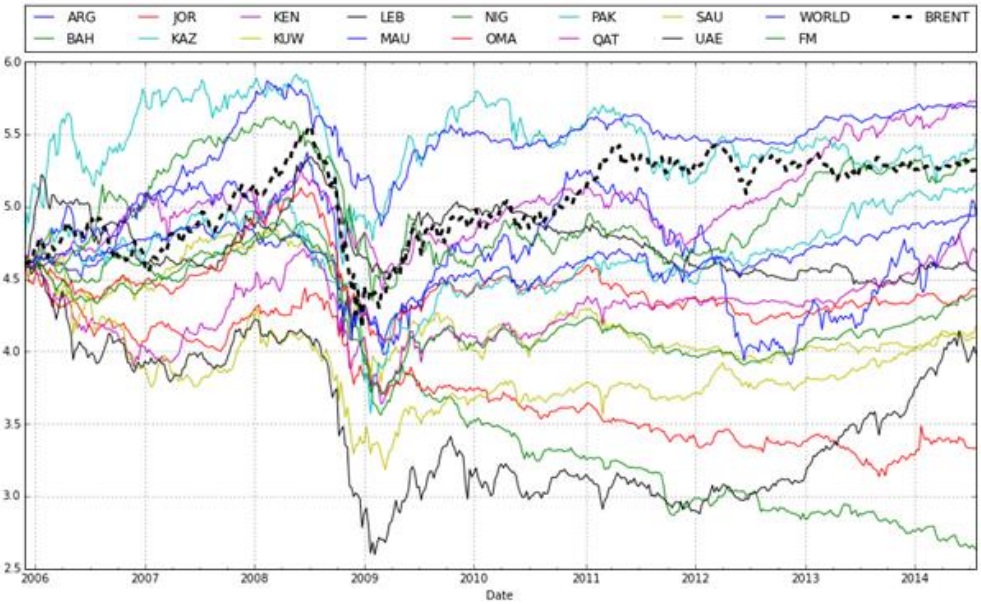

Fig. 1. Oil prices and stock market indices (in logarithms)

Table 1. Unit-root tests on log-prices

	In levels		In first differences	
	ADF	**PP**	**ADF**	**PP**
ARG	0.186	-1.826	-13.639***	-22.133***
BAH	-2.759**	-1.657	-11.299***	-18.363***
JOR	-2.340*	-2.519	-15.125***	-22.947***
KAZ	0.287	-4.236*	-13.344***	-21.142***
KEN	1.500	-1.410	-13.938***	-20.962***
KUW	-0.778	-1.845	-14.351***	-20.896***
LEB	-0.195	-3.018	-12.851***	-18.416***
MAU	1.521	-1.916	-14.034***	-19.363***
NIG	0.679	- 1.544	-13.885***	-20.213***
OMA	-0.362	-1.769	-13.828***	-22.452***
PAK	0.457	-1.659	-13.112***	-18.591***
QAT	-0.075	-2.621	-14.217***	-20.730***
SAU	-0.693	-2.054	-14.540***	-21.164***
UAE	-0.862	-0.956	-14.347***	-20.027***
WORLD	0.546	-1.384	-14.185***	-22.058***
FM	-0.481	-0.958	-11.042***	-18.112***
BRENT	0.599	-2.424	-14.977***	-22.638***

*Note: *, **, *** denote rejection of the null hypothesis at the 10%, 5%, and 1% levels respectively*

Two time series are said to be cointegrated if they share a common stochastic drift along which they move together on a non-stationary path. In other words, two variables are cointegrated if a linear combination of them yields a stationary variable.

In order to test for cointegration, I use the Engle-Granger methodology [21] which is based on analyzing the stationarity of error term series obtained from the equation derived with level values of time series that are not stationary on the level but become stationary when their first difference is taken. If the error term series is stationary, it means there is a cointegration relationship between the two mentioned series. In order to conduct this procedure, the following regression is estimated for each stock market:

$$\log S_{i,t} = \propto_i + \beta_i \log Oil_t + \varepsilon_{i,t} \quad (1)$$

where $S_{i,t}$ represents the level of series *i* at time *t*, Oil_t represents the level of the Brent crude oil time series at time *t*, β_i is the factor relating this crude oil series to the stock market series *i*, $\propto_i$ is the regression intercept for stock series *i* and $\varepsilon_{i,t}$ is an error term.

According to the second step of the procedure presented above, two unit root tests (Augmented Dickey - Fuller – ADF – and Phillips - Perron – PP) are then conducted on the residual series resulting from these regressions in order to assess their stationary properties. If the residuals series is stationary i.e. I(0), it means that the two mentioned variables are cointegrated and have a long-term, or equilibrium relationship between them. As a result, provided the residuals from our regression are stationary, the conventional regression methodology is applicable to data involving non-stationary time series. Therefore, for cases in which the residuals are stationary, coefficients estimated from equation (1) will be meaningful (not spurious). Results are reported in Table 2.

We can observe from Table 4 that the only residual series that appear to be stationary according to both unit root tests are those related to Kazakhstan and Qatar. Therefore, these two countries stock markets appear to be cointegrated with oil prices. Estimation of the long-term relationship between Brent oil prices and stock market prices in Kazakhstan and Qatar yields the two following equations (all coefficient estimates are statistically significant at the 1% level).

$$\log KAZ_t = 4.4645 + 0.1969 \log Oil_t \quad (2)$$

$$\log QAT_t = 1.4092 + 0.5706 \log Oil_t \quad (3)$$

According to these equations, a 10% increase in oil prices leads to increases in the Kazakhstan and Qatar stock markets of 1.97% and 5.71% respectively.

Table 2. Unit-root tests on residual series

	ADF	PP
ARG	-1.456	-1.769
BAH	-0.923	-2.006
JOR	-1.731*	-2.323
KAZ	-2.731***	-4.437***
KEN	-1.104	-1.601
KUW	-1.510	-1.825
LEB	-2.056**	-3.006
MAU	-2.349**	-2.217
NIG	-1.442	-1.468
OMA	-1.483	-1.782
PAK	-1.898*	-1.926
QAT	-4.209***	-3.624**
SAU	-2.821***	-2.085
UAE	-1.983**	-1.028
WORLD	-1.2906	-1.0638
FM	-1.4181	-0.9715

*Note: *, **, *** denote rejection of the null hypothesis at the 10%, 5%, and 1% levels respectively*

Now that we know that Kazakhstan and Qatar stock markets are cointegrated with oil prices, it is sensible to construct a Vector Autoregressive (VAR) model in price levels to assess whether one of these variables Granger-causes the other (which should normally be the case). The results are presented in Table 3 below and confirm the causality relationship. Oil appears to Granger-cause stock markets in Kazakhstan (at the 1% level) and Qatar (at the 5% level), which is consistent with our previous findings and sensible from an economic standpoint. Interestingly, it appears that the Kazakhstan stock market also Granger-causes oil prices (even though the statistical significance – 10% level – is lower in this direction), emphasizing a bidirectional relationship in that particular case.

Table 3. Results of the granger causality tests on prices (*P*-Values)

	Oil to stocks	Stocks to oil
KAZ	0.004	0.054
QAT	0.013	0.191

Now that we have clearly established the cointegrating relationship between Kazakhstan and Qatar equity markets and oil prices, we can further our analysis by using a Vector Error Correction Model (VECM). This model is designed to be used with non-stationary variables that are known to be cointegrated, and estimates the speed at which a dependent variable returns to equilibrium after a change in an independent variable.

By introducing the cointegration relationships previously found (cf. equations 2 and 3) into the VAR specification, we can force the long-term behavior of these price variables to converge onto their long-term cointegration relationship while allowing for short-term adjustment dynamics.

The used bivariate VEC model is as follows:

$$\mathrm{D.log}\,S_t = \delta_{s0} + \delta_{ss1}\mathrm{D.log}\,S_{t-1} + \delta_{so1}\mathrm{D.log}\,Oil_{t-1} + z_s(S_{t-1} - \alpha - \beta Oil_{t-1}) + \epsilon_t^s \quad (4)$$

$$\mathrm{D.log}\,Oil_t = \delta_{o0} + \delta_{os1}\mathrm{D.log}\,S_{t-1} + \delta_{oo1}\mathrm{D.log}\,Oil_{t-1} + z_o(S_{t-1} - \alpha - \beta Oil_{t-1}) + \epsilon_t^o \quad (5)$$

Where *S* represents the national equity market series being examined, *Oil* represents the Brent crude oil price series and z_s and z_o are the short-term adjustment parameters for the stock and oil equations respectively, measuring the response of each variable to the degree of deviation from long-run equilibrium in the previous period. The expected sign of the z coefficients depends on the sign of the β coefficients as we expect – $z\beta$< 0. In our case, the β coefficients being positive (cf. equations (2) and (3)), we expect the z coefficients to be negative. The results for Kazakstan and Qatar are reported in Table 4.

Analyzing these results, we observe that the short-term adjustment parameter z_s is negative and significant at the 1% level for both countries. This indicates a mean-reversion process of these two equity markets towards the long-term equilibrium defined by the oil market. We can also note that z_o coefficients are not statistically different from zero, thereby indicating that the oil market does not converge towards the long-term equilibrium defined by either Kazakhstan or Qatar stock markets. These results are in line with what could be expected following our previous causality tests.

To sum up my results, I find that Kazakhstan and Qatar stock markets are cointegrated with oil prices. When investigating the causality, it appears that oil prices Granger-cause stock markets in both countries. Also, it is worth emphasizing that the Kazakhstan stock market appears to Granger-cause oil prices. Finally, an analysis of the long-term relationship between oil prices and these two countries stock markets - through a Vector Error Correction Model (VECM) framework - shows that Kazakhstan and Qatar stock markets mean revert towards the long-term equilibrium defined by the oil market.

Table 4. Convergence to long-term equilibrium

	KAZ	QAT
δ_{s0}	0.2268***	0.0063**
	(0.0643)	(0.0025)
δ_{ss1}	0.0310	0.0158
	(0.0477)	(0.0482)
δ_{so1}	0.0594	0.0828*
	(0.0599)	(0.0392)
z_s	-0.0345***	-0.0399***
	(0.0098)	(0.0110)
δ_{o0}	-0.0763	-0.0024
	(0.0547)	(0.0031)
δ_{os1}	0.0359	0.0894
	(0.0417)	(0.0614)
δ_{oo1}	-0.0889*	-0.0968
	(0.0507)	(0.0492)
z_o	0.0119	0.0246
	(0.0084)	(0.0137)

*Note: *, **, *** indicate significance at the 10%, 5%, and 1% levels respectively. Standard errors are in parentheses*

4. DISCUSSION

From an economic point of view, the cointegration relationship between Oil prices and Kazakhstan and Qatar stock markets is not totally surprising given the importance of oil for these two countries. Kazakhstan holds about 4 billion tons of proven recoverable oil reserves and is expected to enter the world's top ten oil producing nations by 2015. In 2012, the energy sector accounted for about a quarter of its output (25.2%) and represented almost 80% of its exports. As for Qatar, the country is a major oil player with proven oil reserves of 15 billion barrels and the energy sector accounted for 57.8% of its GDP in 2012.

What's more, there are economic grounds to explain the bi-directional relationship between the Kazakhstan stock market and oil prices.

The causality from oil to stocks can be linked to the fact that Kazakhstan, in addition to being an oil power itself, has close ties with Russia, another energy producing country. Not only are these two countries privileged trade partners but an oil pipeline actually links the two countries, meaning Russia's energy infrastructures and related businesses are also linked to Kazakhstan. Accordingly, oil prices will have an impact on Kazakhstan both directly and through its links with Russia.

The causality from the Kazakhstan stock market to oil prices can be explained through the relation between Kazakhstan and another of its trade partners and major oil consumer: China. In 2008, the financial crisis hit most economies worldwide including China (though to a lesser extent than advanced economies) which suffered from its export-centered economic model (its main export market, the USA, was on the verge of recession). China's slowdown was one of the reasons that explained the oil price collapse of 2008/2009. Kazakhstan being linked with China through trade, its stock market presumably suffered from China's slowdown, which in turn prompted the oil crash.

5. CONCLUSION

This paper furthers our understanding of the linkages between oil prices and frontier equity markets. Aggregate stock market data representing fourteen frontier markets, as well as two broad equity indices (MSCI World and MSCI Frontier Markets) are used. My analysis uses weekly data from 2 December 2005 to 25 July 2014, and provides a study of potential long-term relationships between oil prices and Frontier equity markets (+ the MSCI World Index).

Results indicate that causality exists from oil to stocks for Kazakhstan and Qatar. Interestingly, the causality also runs from stocks to oil in the case of Kazakhstan. For these two countries, an error-correction analysis (VECM) provides evidence of long-term relationship with oil prices as the two stock markets appear to mean-revert to the long-term equilibrium defined by the oil market. This is no surprise given the extent to which the economies of these two countries depend on oil.

The findings of this study should be of great interest to researchers, regulators, and policy makers. For investors and asset managers, the significant relationships between oil prices and some stock markets imply some degree of predictability that could be used in portfolio allocation decisions. In all, this paper improves our knowledge of how stock markets relate to oil prices.

Avenues for further research could include an extension of this study aimed at assessing potential linkages between Frontier markets and other commodities.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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