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# Uncertainty and Stock Returns in Energy Markets: A Quantile Regression Approach

**Samir Cedic, Alwan Mahmoud, Matteo Manera, Gazi Salah Uddin**

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By Samir Cedic, Linköping University
Alwan Mahmoud, Linköping University
Matteo Manera, University of Milano-Bicocca, Fondazione Eni Enrico Mattei
Gazi Salah Uddin, Linköping University

## Summary

The aim of this paper is to analyze the relationship between different types of uncertainty and stock returns of the renewable energy and the oil & gas sectors. We use the quantile regression approach developed by Koenker and d'Orey (1987; 1994) to assess which uncertainties are the potential drivers of stock returns under different market conditions. We find that the bioenergy and the oil & gas sectors are most sensitive to uncertainties. Both sectors are affected by financial, euro currency, geopolitical and economic policy uncertainties. Our results have several policy implications. Climate policy makers can prioritize policies that support bioenergy in order to reduce the potentially negative effects of uncertainties on bioenergy investment. Investors aiming to diversify their portfolio should be aware that many uncertainties are common drivers of bioenergy and oil & gas returns, the connectedness between assets of these energy types could therefore increase when uncertainty increases.

**Keywords**: Uncertainty, Macroeconomic Conditions, Renewable Energy, Stock Returns, Quantile Regression

**JEL Classification**: C1, G15, Q2, Q3, Q43

*Address for correspondence*:
Matteo Manera
Department of Economics, Management and Statistics
University of Milano-Bicocca
Piazza dell'Ateneo Nuovo, 1
20126 Milan
Italy
E-mail: matteo.manera@unimib.it

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**Samir Cedic**
Department of Management and Engineering, Linköping University, Linköping, Sweden
Email: samircedic@gmail.com

**Alwan Mahmoud**
Department of Management and Engineering, Linköping University, Linköping, Sweden
Email: alwan94@hotmail.com

**Matteo Manera(*)**
Department of Economics, Management and Statistics (DEMS), University of Milano-Bicocca, Italy and Fondazione Eni Enrico Mattei (FEEM), Milano, Italy
Email: matteo.manera@unimib.it

**Gazi Salah Uddin**
Department of Management and Engineering, Linköping University, Linköping, Sweden
Email: gazi.salah.uddin@liu.se

(*) corresponding author

# Uncertainty and Stock Returns in Energy Markets: a Quantile Regression Approach

**Abstract:** The aim of this paper is to analyze the relationship between different types of uncertainty and stock returns of the renewable energy and the oil & gas sectors. We use the quantile regression approach developed by Koenker and d'Orey (1987; 1994) to assess which uncertainties are the potential drivers of stock returns under different market conditions. We find that the bioenergy and the oil & gas sectors are most sensitive to uncertainties. Both sectors are affected by financial, euro currency, geopolitical and economic policy uncertainties. Our results have several policy implications. Climate policy makers can prioritize policies that support bioenergy in order to reduce the potentially negative effects of uncertainties on bioenergy investment. Investors aiming to diversify their portfolio should be aware that many uncertainties are common drivers of bioenergy and oil & gas returns, the connectedness between assets of these energy types could therefore increase when uncertainty increases.

**Keywords:** uncertainty; macroeconomic conditions; renewable energy; stock returns; quantile regression.

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## 1. Introduction

According to the Paris climate agreement, December 12th, 2015, the negotiating parties agreed to intensify investments and to implement other actions in order to reduce carbon emissions and limit global warming to 1,5°C (UNFCCC, 2015). This implies that CO2 emissions from energy use need to be reduced by an average of 2,6% per year in the next three decades (IRENA, 2017). A transition from high-carbon energy systems to low-carbon energy, such as renewable energy (RE), is then required if the global community wants to reach the goal of reducing CO2 emissions. A disruption in RE investments caused by market, policy and geopolitical uncertainties could jeopardize the required amount of investments for energy transition (IEA, 2019). Uncertainty in government policy towards RE is a risk factor that could affect investments in RE differently from investments in the oil & gas (OG) market. Investments in RE are substantially affected by government policies in the form of subsidies, taxes and other policy changes (Marques and Fuinhas, 2012). The strong connection between RE and the technology sector is another factor that differentiates the risk between firms operating in RE and the OG industry. Heterogeneity in risk could also manifest itself between sub-sectors of RE. One source of heterogeneity could stem from the fact that government policies could be geared towards one specific sub-sector, rather than to the RE sector as a whole. Understanding the effects of uncertainty on RE markets and the connectedness between RE sectors, the OG market and other macroeconomic and financial variables is therefore of great importance if the countries of the world wish to succeed in transitioning to a RE-based energy system.

The purpose of this paper is to analyze the relationship between aggregate and firm stock returns of the RE sectors, the OG market and different types of uncertainty. Specifically, the main research questions are: i) which energy sectors stock returns are the most sensitive to uncertainty? ii) which types of uncertainty are more relevant?

To answer these questions we use weekday daily data, namely 2279 observations spanning from May 18, 2011 to February 10, 2020. Our sample consists of two RE indices, stock prices from nine RE firms and nine OG firms, six variables capturing global macroeconomic as well as financial conditions (other assets) and six uncertainty measures. The method is quantile regression estimation, as proposed by by Koenker and d'Orey (1987; 1994).

Our main contribution is that we expand on previous literature by investigating the relationship between uncertainty, macroeconomic conditions and stock returns of the RE sectors and the OG market at both aggregate and firm levels.

Our main finding is that the bioenergy (BIO) and OG sectors seem to be most sensitive to uncertainties. Our results have important policy implications for investors and climate policy makers. Since bioenergy stock returns are more sensitive to uncertainties, climate policy makers can prioritize policies that support bioenergy in order to reduce the potentially negative effects of uncertainties on bioenergy investment. Investors willing to diversify their portfolio should be aware that many uncertainties are common drivers of bioenergy and oil & gas returns, the connectedness between assets of these energy types could therefore increase when uncertainty increases.

The paper is organized as follows. Section 2 reviews the relevant literature. Section 3 presents the data and some descriptive statistics. The methodology is illustrated in Section 4, while Section 5 is dedicated to the comment of the empirical results. Section 6 presents some conclusions and policy implications.

## 2. Related literature review

There is a sizeable literature on the relationship between uncertainty, macroeconomic conditions and energy assets. For instance, Abdel-Latif and El-Gamal (2019) show that positive shocks in geopolitical risk lead to higher oil prices. They also find that negative shocks in oil prices lead to a higher geopolitical risk. Li et al. (2020) support these results by finding evidence of co-movements between geopolitical risk and crude oil prices in the short run. Whether non-linear effects exist between oil prices and geopolitical risk is investigated by Bouoiyour et al. (2019). They analyze how changes at low levels and high levels of geopolitical risk affect oil prices. The main result is that increased geopolitical risk lead to increased oil prices, both at low and high levels of oil prices.

The effect of economic, financial and oil price uncertainties on RE returns has also been subject of investigation. Ji et al. (2018) measure the impact of financial, energy and economic policy uncertainties on energy prices. The authors find a negative dependence between changes in uncertainty and energy returns. Uncertainty in economic policy is found to have a relatively weaker impact on the risks of crude oil and clean energy returns than energy and financial market uncertainties. Economic policy uncertainty affecting energy returns negatively is also supported by Kang, Perez de Gracia and Ratti (2017). The effect of oil price uncertainty on RE returns has been studied by Dutta (2017) and by Kyritsis and Serletis (2019). Dutta finds that shocks in oil price uncertainty affects returns of the RE stocks, while Kyritsis and Serletis do not document such an effect.

From this brief survey of the relevant literature we can conclude that there is a lack of studies that investigate how uncertainty affect energy stock returns, conditional on general macroeconomic conditions at the micro level. On this respect, we expand on previous literature by investigating the links between several RE sectors, the OG market at the firm level and different types of uncertainty.

## 3. Data description

The data used in this paper consist in 2279 weekday observations from May 18, 2011 to February 10, 2020. We base our sample period on the availability of data. The outcome variables in this analysis are the RE stock price indices, RE firm stock prices and OG firm stock prices. We transform all variables in log first differences, that is in percentual changes. The only exception is the geopolitical risk index (GPR), which is used in first differences. A definition of all the variables involved in the analysis is presented in Table 1. Notice that the macroeconomic conditions are summarized by those variables named as "other assets".

INSERT TABLE 1 ABOUT HERE

### *3.1 RE and OG firms*

The RE firms and OG firms we have selected are based on the top 25 energy sub-sector honorees appointed by Thomson Reuters (2020a), that is firms regarded as leaders in each of their sub-sectors. Criteria such as investor confidence, legal compliance, financial performance, innovation and robustness to shocks and geopolitical risk, are used by Thomson Reuters (2020b) to choose which energy firms are global leaders in their sub-sector. We have included three RE firms from each RE sub-sector, namely solar (SL), wind (WD) and bioenergy (BIO). We have also chosen nine OG firms, which represent the OG sector. The reason why we have selected firms that are leaders in their sub-sectors is that these firms are expected to drive the societal transition to RE based energy systems. Understanding the exposure of these firms to uncertainties and the effects of uncertainty on their stock returns is therefore of outmost importance.Nevertheless, care should be used in interpreteing the results of our analysis, , since the top leaders of the RE and the OG sectors are selected based on specific criteria including the resilience of these firms to economic and financial shocks as well as to geopolitical risk.

*3.2 Descriptive statistics*

Table 2 shows the descriptive statistics of the variables used in the empirical analysis.

A Variance Inflation Factor (VIF) test (not reported to save space, but available from the authors upon request) indicates that there is no multicollinearity between the variables.

The mean return per day is negative for the RE indices and the indices are skewed to the left. Observing the mean daily returns at firm level, we note that most of the firms have positive mean returns and negative skewness. The sector with the highest amount of positive skewness is BIO. The presence of extreme market conditions is common for the WD sector, as indicated by the high levels of kurtosis. Concentrating on uncertainty, we see that all uncertainty measures are skewed to the right. This is reasonable, since economic, financial and geopolitical uncertainties worldwide have been pervasive in the period covered by our sample. The large Jarque-Bera (JB) test values indicate that no variable is normally distributed, which is common for stock market returns. All variables are stationary at first differences, as indicated by the Augmented Dickey-Fuller (ADF) unit root tests.

INSERT TABLE 2 ABOUT HERE

From Figure 1 we can observe that the "other assets" indices, namely MSCI World price index (MSCI), Euro/USD exchange rate (FX), Nymex light crude oil futures settle price (OIL) and NYSE Arca technology 100 price index (PSE), have a large drop around 2019, which can also be observed for the RE indices. Of the four first uncertainty measures, the CBOE crude oil volatility price index (OVX) has the highest level of volatility during the sample period, followed respectively by the CBOE SPX volatility price index (VIX), the CBOE/CME FX Euro volatility price index (EUVIX) and the CBOE 10 Year US T-note volatility price index (TYVIX). The two last measures of uncertainties are the Economic Policy Uncertainty index (EPU) and the Geopolitical Risk index (GPR). While EPU is having higher spikes in the beginning of the sample period, GPR is showing higher spikes at the end of the sample period.

INSERT FIGURE 1 ABOUT HERE

## 4. Methodological framework

To investigate potential drivers of the behaviour of energy stock returns we use the quantile regression (QR) framework of Koenker and d'Orey (1987; 1994). With this approach we are

able to quantify how the distribution of the returns of the RE and the OG sectors are affected by uncertainty and some key macroeconomic variables, during different market conditions represented by the different quantiles.

Our QR model can be defined as

$$Y_{it}(\tau|A_t, U_t) = a_0 + a_1 A_t + a_2 U_t + \varepsilon_{it}, \qquad (1)$$

where $i = 1,\ldots, N$ indicates the $i$-th stock return; $t = 1,\ldots, T$ is the time index; $Y_{it}$ represents the returns of the RE indices, RE firms and OG firms, separately; $\tau$ indicates the quantile; $A_t$ represents the vector of "other assets" (global macroeconomic and financial conditions); $U_t$ is the vector of uncertainty measures; $\varepsilon_{it}$ is the error term. We estimate twenty separate QR models (N = 20): two have returns of the RE indices as the dependent variables, nine have the returns of the RE firms as the dependent variables and nine have the returns of the OG firms as the dependent variables. We divide the distributions into seven different quantiles (i.e. $\tau$ = 5%, 10%, 25%, 50%, 75%, 90%, 95%) to get a mixed variety of low, medium and high stock return conditions.

## 5. Drivers of RE and OG firm stock returns

In this section we investigate the potential drivers of energy firm returns by estimating QR models. We start with the returns of the RE indices and the RE firm stocks, in order to identify the main drivers of the RE sectors and to verify if there is a different behaviour between the RE indices and the RE firm stocks. Then we concentrate on the drivers of the OG sector by applying the QR model to the stock returns of the OG firms. Results for each sub-sector are reported in Tables 3 and 4. Lower, medium and higher quantiles represent periods with low, medium and high indices and firm returns. The complete set of the estimated QR models is available in the online Appendix.

### *5.1 Drivers of RE returns*

Table 3 reports the QR results for the RE indices and firm stock returns (columns), when the explanatory variables are the four "other assets" and the six uncertainty measures (rows).

Starting with the RE indices, it is only MSCI to exhibit a conclusive positive effect in all market conditions. The impacts of the "other assets" on the RE indices show quite contrasting

results, which makes it hard to draw general conclusions. Therefore, we proceed with the analysis of RE sub-sectors.

Our results show that global stock returns have a positive impact across all RE sub-sectors for all market conditions. A change in FX has a positive impact on the returns of each sub-sector: for SL there is an impact in normal and bullish market conditions, for WD there is an impact across all market conditions, while for BIO the effect is only in bearhish and normal market conditions. The impact during extreme market conditions confirms the result of Uddin et al. (2019), although we also find an impact in normal market conditions.

PSE changes impact the solar and wind energy sectors negatively, in bullish market conditions for solar and across all market conditions for wind. Since technology stock prices have increased for most of the sample period, changes in PSE are positive in our case. The negative impact of technology contrasts the contribution by Gupta (2017), who finds a positive effect. A potential reason to why PSE decreases SL and WD firm returns is that technology is an important input for RE firms, hence an increase in input prices boosts production costs and may lower returns. Another explanation is that investors interpret technology stocks and RE stocks as similar, since both types of stocks are sensitive to business cycles and technology is a major input for RE firms. Increased returns in PSE could lead to more investors switching from investmenting in renewables to technology investments. The BIO sector is not impacted by PSE, which could indicate that this sector is not heavily dependent on technology.

OIL changes only have a conclusive positive impact on the BIO sector across all market conditions. This supports the findings of Pham (2019), who shows that biofuel stocks are the most connected with oil prices, while WD stocks have a weaker connection. The fact that the effect is positive for the BIO sub-sector could be due to bioenergy being a closer substitute to oil and gas. Processed crude oil is mostly used in transportation, hence a substitution effect with bioenergy is expected, since biofuels, such as bioethanol and biodiesel, can rival processed crude oil in transportation (Hallmeyer and Heal, 2015). One BIO firm included in the sample also has major oil companies among its customers. If rising crude oil prices lead to higher demand for biofuels, then the positive effect is justified.

GPR changes have a positive impact for bioenergy sector in bullish markets. The fact that the effect is positive for the BIO sub-sector could be motivated by the fact that bioenergy is a closer substitute to crude oil and that an increase in GPR increases crude oil prices (Abdel-Latif & El-Gamal, 2019; Bouoiyour et al., 2019), which in turn, because of substitution effects and energy security fears, leads to substitution from crude oil to biofuels. It is also possible that the BIO sector is less sensitive to demand changes. Thus, a decreased demand in the economy,

due to increased oil prices, would not affect the bioenergy sector negatively. The reason why this effect is not seen in normal and bearish market conditions could be due to that the impact of geopolitical uncertainty on crude oil prices differs between market conditions. Another reason is that increasing crude oil prices lead to government policies sustaining for renewables in favorable market conditions. On the contrary, during bearish markets there may not be economic room for government policies supporting renewables. The policies for RE could be geared towards biofuels, since biofuels are a closer substitute to crude oil in transportation. When crude oil prices increase the transportation costs for firms and the general population increases. Supporting biofuels would therefore be a more appropriate policy decision if a government aims to alleviate the negative effects of higher transportation costs and increase substitution to renewables.

A change in VIX has a positive impact on the wind sector for bearish and normal markets but a negative impact on the bioenergy sector in normal market conditions. The positive impact for the wind sector is surprising, since changes in financial uncertainty have been shown to affect energy stock returns negatively (Ji et al. 2018). Changes in EPU affect the returns of solar and bioenergy firms, in bearish markets for solar and in both normal and bullish market conditions for bioenergy. The direction of the effect is inconclusive. The impact of changes in EUVIX is positive for bioenergy firms in normal market conditions.

We conclude that changes in exchange rates affect return of RE firms across all sub-sectors more than they affect RE indices, since FX has an effect across all quantiles. Another conclusion is that the returns of the bioenergy sector seem to be more sensitive to uncertainties than the other RE sectors, since financial, euro currency, geopolitical and economic policy uncertainty all affect the bioenergy sector.

INSERT TABLE 3 ABOUT HERE

*5.2 Drivers of OG returns*

In Table 4 we present the results of quantile regressions for the OG firms. Our findings show that MSCI returns have a positive impact on firm returns for all market conditions. This is similar to the result for RE firms. A change in FX has a positive impact on return during all market conditions, which is in line with the result for RE firms. PSE changes have a negative

impact on returns in bearish and bullish market conditions. As previously mentioned, a change in technology stock prices implies an increase in technology stock prices in our sample. An increase in the technology stock prices could arise from advancements in the technology sector, which could in turn increase returns for the RE firms. The fact that renewables are substitute to fossil fuels implies that investors may choose to invest in RE firms instead of OG firms, which lowers the returns for the latter.

OIL changes have a positive impact on returns across all market conditions. This contrasts with the result for RE firms, where only the BIO sector is positively affected. Changes in GPR have a impact on returns for the OG firms, but mostly in bullish market conditions. The direction of the effect is unclear. This is in line with the results for the BIO sector. The reason to why this effect does not appear in normal and bearish market conditions could again be due to the impact of geopolitical uncertainty on crude oil prices, which differs between market conditions. A possible explanation of the inconclusiveness of this effect is that the OG firms in our sample have a bias, since one of the criteria used by Thomson Reuters (2020b) to choose the top industry leaders in the OG sector is their robustness to geopolitical risk.

A change in VIX impacts the OG firms across all quantiles, but the direction of the effect is unclear. The fact that financial uncertainty seems to affect more the OG firms than the RE firms could be due to the larger financialization of the oil market. EPU changes affect the returns of the OG firms, although the direction of the effect and the identification of the market conditions under which the impact takes place cannot be not uniquely determined. EUVIX variations seem to affect returns in normal market conditions, but the direction is inconclusive. The presence of an effect in normal market conditions is in line with the result for BIO returns.

INSERT TABLE 4 ABOUT HERE

From the results commented above we can draw the conclusion that RE and OG firm returns are mostly impacted similarly by “other assets”. The largest differences are found in that changes in crude oil prices impact the OG firms more severely. We can also conclude that the returns of the OG firms are impacted by uncertainties in a similar way as the BIO firms, since financial, euro currency, geopolitical and economic policy uncertainty affected both OG and BIO firms.

## 6. Conclusions and policy implications

In this paper we have investigated which types of uncertainty are potential drivers of the behaviour of stock returns of renewable energy and oil & gas firms, by estimating quantile regression models to distinguish between different stock market conditions.

The synthetic answer to our research question is that the bioenergy sector and oil & gas sector stock returns are most sensitive to uncertainties. More specifically, we have showed that:

(1) geopolitical risk changes have a positive impact for bioenergy sector in bullish markets and an unclear impact on the oil & gas sector;

(2) a change in financial uncertainty has a positive impact on the wind sector for bearish markets, a negative impact on the bioenergy sector in normal market conditions and an unclear impact on oil & gas sector in bullish markets;

(3) changes in economic policy uncertainty affect the returns of solar energy, bioenergy firms and oil & gas firms, in bearish markets for solar and in both normal and bullish market conditions for bioenergy, although the identification of the market conditions under which there is an effect is inconclusive for oil & gas firms and the direction of the effect is not unique for all sectors;

(4) changes in volatility of the Euro has a positive impact on bioenergy returns in normal market conditions and an unclear impact on oil & gas firms in normal market conditions.

Our results have several policy implications. Since bioenergy stock returns are more sensitive to uncertainties, climate policy makers can prioritize policies that support the bioenergy sector in order to reduce the potentially negative effects of uncertainties on bioenergy investment. Investors willing to diversify their portfolio should be aware that many uncertainties are common drivers of bioenergy and oil & gas returns, the connectedness between assets of these energy types could therefore increase when uncertainty increases.

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# Figures and Tables

**Table 1**. *Variables, definitions and their sources*

| Variable | Definition | Source |
|---|---|---|
| *RE indices* | | |
| ECO | WilderHill Clean Energy price index | Thomson Reuters Datastream |
| SPGCE | S&P Global Clean Energy price index | Thomson Reuters Datastream |
| *Solar energy firms* | | |
| CASO | Canadian Solar stock price | Thomson Reuters Datastream |
| RIEN | Risen Energy stock price | Thomson Reuters Datastream |
| MOTE | Motech Industries stock price | Thomson Reuters Datastream |
| *Wind energy firms* | | |
| SGRE | Siemens Gamesa RE stock price | Thomson Reuters Datastream |
| SUZN | Suzlon Energy stock price | Thomson Reuters Datastream |
| VEST | Vestas Windsystems stock price | Thomson Reuters Datastream |
| *Bioenergy firms* | | |
| CREN | CropEnergies stock price | Thomson Reuters Datastream |
| GREP | Green Plains stock price | Thomson Reuters Datastream |
| PATH | Pacific Ethanol stock price | Thomson Reuters Datastream |
| *Oil & gas firms* | | |
| BHAR | Bharat Petroleum stock price | Thomson Reuters Datastream |
| BP | British Petroleum stock price | Thomson Reuters Datastream |
| CHEV | Chevron Corporation stock price | Thomson Reuters Datastream |
| CONO | ConocoPhilips stock price | Thomson Reuters Datastream |
| EXMO | ExxonMobil stock price | Thomson Reuters Datastream |
| GAZP | Gazprom stock price | Thomson Reuters Datastream |
| INOIL | Indian Oil stock price | Thomson Reuters Datastream |
| RDS | Royal Dutch Shell stock price | Thomson Reuters Datastream |
| EQUI | Equinor stock price | Thomson Reuters Datastream |
| *Other assets* | | |
| MSCI | MSCI World price index | Thomson Reuters Datastream |
| OIL | NYMEX Light Crude Oil futures settle price | Thomson Reuters Datastream |
| FX | Euro to US Exchange rate | Thomson Reuters Datastream |
| PSE | NYSE Arca Technology 100 price index | Thomson Reuters Datastream |
| *Uncertainty measures* | | |
| VIX | CBOE SPX Volatility price index | Thomson Reuters Datastream |
| OVX | CBOE Crude Oil Volatility price index | Thomson Reuters Datastream |
| TYVIX | CBOE 10 Year US T-note Volatility price index | Thomson Reuters Datastream |
| EUVIX | CBOE/CME FX Euro Volatility price index | Thomson Reuters Datastream |
| EPU | Economic Policy Uncertainty index | Economic Policy Uncertainty |
| GPR | Geopolitical Risk index | Geopolitical Risk Index |

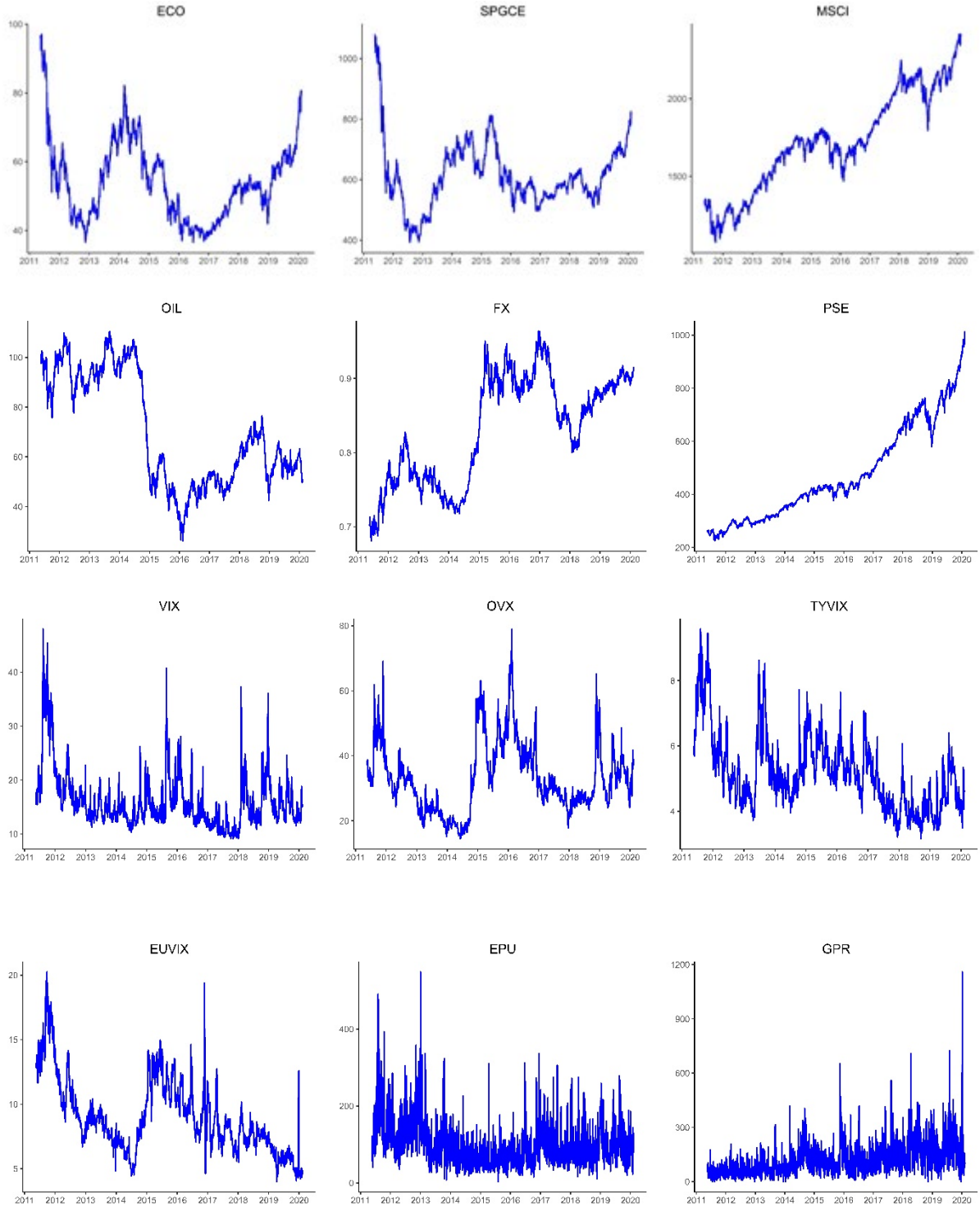
*Notes:* daily observations over the period 2011-05-18 to 2020-02-10.

**Table 2**. *Summary statistics*

| | Mean (%) | Std. dev (%) | Skewness | Kurtosis | JB | ADF (c) | ADF (ct) |
|---|---|---|---|---|---|---|---|
| *Indices* | | | | | | | |
| ECO | −0.008 | 1.618 | −0.292 | 2.589 | 670.656*** | -21.827[4]*** | -21.937[4]*** |
| SPGCE | −0.013 | 1.200 | −0.410 | 3.888 | 1510.888*** | -17.232[6]*** | -17.376[6]*** |
| *Solar energy firms* | | | | | | | |
| CASO | 0.037 | 4.017 | 0.149 | 4.824 | 2223.764*** | -32.604[1]*** | -32.597[1]*** |
| RIEN | 0.002 | 3.008 | −0.161 | 2.768 | 740.025*** | -33.528[1]*** | -33.540[1]*** |
| MOTE | −0.108 | 2.634 | 0.037 | 2.411 | 554.652*** | -31.085[1]*** | -31.080[1]*** |
| *Wind energy firms* | | | | | | | |
| SGRE | 0.038 | 2.696 | −0.079 | 5.952 | 3374.293*** | -33.313[1]*** | -33.308[1]*** |
| SUZN | −0.134 | 3.741 | 0.033 | 12.109 | 13948.970*** | -30.937[1]*** | -30.932[1]*** |
| VEST | 0.065 | 2.893 | −0.391 | 11.111 | 11802.830*** | -28.484[2]*** | -28.494[2]*** |
| *Bioenergy firms* | | | | | | | |
| CREN | 0.027 | 2.372 | −0.299 | 4.959 | 2374.763*** | -15.757[7]*** | -15.781[7]*** |
| GREP | 0.006 | 2.940 | 0.164 | 4.577 | 2005.212*** | -31.789[1]*** | -31.798[1]*** |
| PATH | −0.188 | 5.414 | 0.856 | 10.240 | 10254.443*** | -33.529[1]*** | -33.526[1]*** |
| *Oil & gas firms* | | | | | | | |
| BHAR | 0.068 | 2.082 | −0.582 | 7.734 | 5819.576*** | -33.900[1]*** | -33.894[1]*** |
| BP | 0.002 | 1.403 | −0.093 | 2.784 | 741.574*** | -16.183[8]*** | -16.180[8]*** |
| CHEV | 0.003 | 1.317 | −0.187 | 2.806 | 763.373*** | -23.303[4]*** | -23.302[4]*** |
| CONO | 0.002 | 1.706 | −0.074 | 3.436 | 1126.341*** | -33.819[1]*** | -33.812[1]*** |
| EXMO | −0.014 | 1.166 | −0.185 | 3.033 | 889.124*** | -23.559[4]*** | -23.603[4]*** |
| GAZP | 0.005 | 1.602 | 0.224 | 8.634 | 7111.756*** | -32.360[1]*** | -32.407[1]*** |
| INOIL | 0.016 | 1.928 | −0.276 | 5.032 | 2438.749*** | -34.838[1]*** | -34.832[1]*** |
| RDS | −0.002 | 1.296 | −0.247 | 3.786 | 1387.902*** | -24.701[3]*** | -24.701[3]*** |
| EQUI | 0.003 | 1.555 | 0.141 | 2.602 | 652.417*** | -36.063[1]*** | -36.056[1]*** |
| *Other assets* | | | | | | | |
| MSCI | 0.024 | 0.789 | −0.649 | 5.166 | 2672.364*** | -23.494[4]*** | -23.492[4]*** |
| OIL | −0.030 | 2.055 | 0.104 | 3.758 | 1360.192*** | -34.942[1]*** | -34.935[1]*** |
| FX | 0.012 | 0.521 | −0.012 | 2.138 | 441.353*** | -34.177[1]*** | -34.177[1]*** |
| PSE | 0.060 | 1.055 | −0.409 | 3.466 | 1224.942*** | -23.598[4]*** | -23.615[4]*** |
| *Uncertainty measures* | | | | | | | |
| VIX | −0.003 | 7.697 | 1.148 | 7.358 | 5667.621*** | -15.058[15]*** | -15.055[15]*** |
| OVX | −0.001 | 4.870 | 0.951 | 10.369 | 10569.785*** | -20.563[6]*** | -20.560[6]*** |
| TYVIX | −0.008 | 4.699 | 0.366 | 2.782 | 789.096*** | -13.972[15]*** | -13.969[15]*** |
| EUVIX | −0.043 | 6.215 | 0.142 | 78.247 | 582325.664*** | -15.169[13]*** | -15.167[13]*** |
| EPU | 0.017 | 51.650 | 0.068 | 2.284 | 499.314*** | -19.859[14]*** | -19.855[14]*** |
| GPR | 1.629 | 8131.854 | 0.076 | 6.058 | 3495.431*** | -17.827[17]*** | -17.825[17]*** |

*Notes:* All variables contain 2278 daily observations over the period 2011-05-19 to 2020-02-10. All variables are represented in first differences and all variables, except GPR, are transformed in logs. JB is the Jarque-Bera. ARCH (10) is the Autoregressive Conditional Heteroskedasticity test with 10 lags. LB(10) is the Ljung-Box test for the squared residuals with 10 lags. ADF (c) and ADf (ct) is the Augmented Dickey-Fuller unit root test with a constant and with a constant and trend, respectively, and includes the optimal lag length in the brackets that minimizes the Akaike Information Criterion (AIC). *, ** and *** indicate significance at 10%, 5% and 1%, respectively.

**Figure 1**. *Series in levels*




*Notes:* All variables contain 2279 daily observations over the period 2011-05-18 to 2020-02-10. The values of the indices are presented on the vertical axis and time period is indicated on the horizontal axis. The meanings of the acronyms heading the columns and the rows of this table can be found in Table 1.

**Table 3.** *Quantile regressions – RE indices and firms*

| | ECO | SPGCE | CASO | RIEN | MOTE | SGRE | SUZN | VEST | CREN | GREP | PATH |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $\tau$ | LMH | LMH | LMH | LMH | LMH | LMH | LMH | LMH | LMH | LMH | LMH |
| **MSCI** | +++ | +++ | +++ | +/+ | +++ | +++ | +++ | +++ | +++ | +++ | +++ |
| **OIL** | +++ | /// | ++/ | /// | /-/ | /-/ | +// | /// | /// | +++ | +++ |
| **FX** | /+/ | /// | /+/ | //+ | +++ | +++ | ++/ | +++ | ++/ | +// | /++ |
| **PSE** | +++ | --- | /+/ | //- | /-- | --- | /-/ | --- | --/ | ++/ | /// |
| **VIX** | --/ | +++ | /-/ | /// | /// | ++/ | //+ | ++/ | /// | /-- | /-/ |
| **OVX** | -// | /// | /// | /// | /// | +// | /// | /// | /// | /// | /// |
| **TYVIX** | /// | --/ | /// | -// | /// | -// | /// | /// | /// | /// | /// |
| **EUVIX** | /// | /-/ | /// | /// | /// | /// | /-/ | -// | /// | /+/ | /+/ |
| **EPU** | /// | /// | /// | -// | +// | /// | /+/ | /// | /-- | //+ | /+/ |
| **GPR** | /// | /// | /// | /// | /// | /// | /// | --/ | /-/ | //+ | //+ |

*Notes:* This table is a summary of the quantile regressions that is presented in the online Appendix. The QR are represented in equation (1). L stands for Low and represents the quantiles 5, 10 and 25, M stands for medium and represents quantile 50 and H stands for High and represents the quantiles 75, 90 and 95. If two quantiles or more for the categories L and H have the same relation and the relation is significant at least 10%significance level, then: i) the cell is given "-" if the relationship is negative; ii) the cell is given "+" if the relationship is positive; iii) the cell is given the sign "/" otherwise. The meanings of the acronyms heading the columns and the rows of this table can be found in Table 1.

**Table 4.** *Quantile regressions - OG firms*

| | BHAR | BP | CHEV | CONO | EXMO | GAZP | INOIL | RDS | EQUI |
|---|---|---|---|---|---|---|---|---|---|
| $\tau$ | LMH | LMH | LMH | LMH | LMH | LMH | LMH | LMH | LMH |
| MSCI | ++/ | +++ | +++ | +++ | +++ | +++ | +++ | +++ | +++ |
| OIL | --/ | +++ | +++ | +++ | +++ | +++ | /-- | +++ | +++ |
| FX | +// | +++ | +++ | +++ | +++ | ++/ | +++ | +++ | +++ |
| PSE | -// | --- | /// | /// | /// | --- | //- | --- | --- |
| VIX | /// | ++ + | --- | --- | --- | ++ + | /// | ++/ | ++ + |
| OVX | --/ | //+ | /// | /// | /// | /// | /-/ | /+/ | /// |
| TYVX/ | /// | /// | +++ | /++ | +++ | /// | //+ | /// | /// |
| EUVIX | /// | /-/ | /+/ | /++ | +++ | /// | /-/ | /// | /// |
| EPU | /// | +// | +// | /+/ | +// | /-/ | /// | /// | /// |
| GPR | /// | //- | /// | //+ | /+/ | //+ | //- | /-/ | /// |

*Notes:* This table is a summary of the quantile regressions that is presented in the online Appendix. The QR are represented in equation (1). L stands for Low and represents the quantiles 5, 10 and 25, M stands for medium and represents quantile 50 and H stands for High and represents the quantiles 75, 90 and 95. If two quantiles or more for the categories L and H have the same relation and the relation is significant at least 10%significance level, then: i) the cell is given "-" if the relationship is negative; ii) the cell is given "+" if the relationship is positive; iii) the cell is given the sign "/" otherwise. The meanings of the acronyms heading the columns and the rows of this table can be found in Table 1.

# Online Appendix

# Online Appendix

Tables A1-A5 in this Appendix complement Tables 3-4 in the paper by reporting the complete set of estimated QR models. Notice that, since the dependent variable is in logarithmic form but not GPR, the presented values for GPR was transformed by taking the inverse-logarithm of the GPR coefficient, according to the formula: $\%\Delta Y = (e^{\boldsymbol{\beta}12\Delta GPR} - 1) \times 100$.

## Table A1

**a)**

| **ECO** | $\tau = 0{,}05$ | $\tau = 0{,}10$ | $\tau = 0{,}25$ | $\tau = 0{,}50$ | $\tau = 0{,}75$ | $\tau = 0{,}90$ | $\tau = 0{,}95$ |
|---|---|---|---|---|---|---|---|
| Intercept | −0,017*** | −0,012*** | −0,006*** | 0,000** | 0,006*** | 0,012*** | 0,016*** |
| MSCI | 0,665*** | 0,802*** | 0,783*** | 0,876*** | 0,862*** | 0,817*** | 0,744*** |
| OIL | 0,112*** | 0,084*** | 0,071*** | 0,073*** | 0,078*** | 0,043** | 0,012 |
| FX | 0,059 | 0,111 | 0,092* | 0,132*** | 0,133** | 0,100 | −0,050 |
| PSE | 0,532*** | 0,470*** | 0,431*** | 0,323*** | 0,440*** | 0,547*** | 0,624*** |
| VIX | −0,029** | −0,017* | −0,023*** | −0,021*** | −0,005 | −0,002 | −0,009 |
| OVX | −0,002 | −0,024*** | −0,015*** | −0,005 | −0,008** | −0,012 | −0,007 |
| TYVIX | 0,011 | 0,000 | 0,000 | 0,000 | 0,008 | 0,015* | 0,016 |
| EUVIX | −0,006 | 0,001 | 0,003 | 0,003 | -0,002 | −0,007 | 0,002 |
| EPU | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,001 |
| GPR | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 |

**b)**

| **SPGCE** | $\tau = 0{,}05$ | $\tau = 0{,}10$ | $\tau = 0{,}25$ | $\tau = 0{,}50$ | $\tau = 0{,}75$ | $\tau = 0{,}90$ | $\tau = 0{,}95$ |
|---|---|---|---|---|---|---|---|
| Intercept | -0,013*** | -0,010*** | -0,005*** | 0,000 | 0,004*** | 0,009*** | 0,012*** |
| MSCI | 1,355*** | 1,355*** | 1,350*** | 1,345*** | 1,363*** | 1,351*** | 1,444*** |
| OIL | -0,009 | 0,022 | 0,017* | 0,009 | 0,011 | 0,008 | 0,022 |
| FX | -0,137 | -0,075 | -0,056 | -0,018 | 0,051 | 0,002 | -0,013 |
| PSE | -0,031 | -0,096* | -0,168*** | -0,175*** | -0,182*** | -0,139*** | -0,173** |
| VIX | 0,032*** | 0,019*** | 0,012*** | 0,011*** | 0,013*** | 0,012** | 0,013 |
| OVX | -0,015 | -0,004 | -0,004 | -0,002 | 0,007 | 0,006 | 0,006 |
| TYVIX | -0,032*** | -0,013** | -0,016*** | -0,014*** | -0,012*** | -0,008 | -0,009 |
| EUVIX | -0,008 | -0,005 | -0,001 | -0,004* | -0,006 | -0,005 | 0,002 |
| EPU | -0,002** | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 |
| GPR | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | 0,001 |

**c)**

| **CASO** | $\tau = 0{,}05$ | $\tau = 0{,}10$ | $\tau = 0{,}25$ | $\tau = 0{,}50$ | $\tau = 0{,}75$ | $\tau = 0{,}90$ | $\tau = 0{,}95$ |
|---|---|---|---|---|---|---|---|
| Intercept | -0,053*** | -0,037*** | -0,017*** | 0,000 | 0,016*** | 0,037*** | 0,055*** |
| MSCI | 0,592 | 1,182*** | 1,546*** | 1,283*** | 1,285*** | 1,795*** | 1,226 |
| OIL | 0,236 | 0,133** | 0,125*** | 0,124*** | 0,148*** | 0,010 | 0,040 |
| FX | 0,367 | 0,163 | 0,461** | 0,278*** | 0,137 | 0,259 | 0,178 |
| PSE | 0,731 | 0,445** | 0,204 | 0,244*** | 0,414*** | 0,072 | 0,454 |
| VIX | -0,052 | -0,024 | -0,020 | -0,038*** | -0,008 | -0,014 | -0,044 |
| OVX | -0,017 | -0,049* | -0,021 | -0,007 | -0,014 | -0,051 | -0,048 |
| TYVIX | -0,022 | -0,021 | -0,004 | -0,001 | -0,010 | 0,016 | 0,061 |
| EUVIX | -0,029 | -0,012 | -0,008 | -0,001 | -0,020*** | -0,025 | 0,005 |
| EPU | -0,004 | -0,002 | -0,001 | 0,001 | 0,000 | 0,004 | 0,002 |
| GPR | 0,004 | 0,002** | -0,000 | -0,001 | -0,003*** | -0,001 | -0,003 |

**d)**

| **RIEN** | $\tau = 0{,}05$ | $\tau = 0{,}10$ | $\tau = 0{,}25$ | $\tau = 0{,}50$ | $\tau = 0{,}75$ | $\tau = 0{,}90$ | $\tau = 0{,}95$ |
|---|---|---|---|---|---|---|---|
| Intercept | -0,050*** | -0,033*** | -0,012*** | 0,000 | 0,013*** | 0,033*** | 0,048*** |
| MSCI | 1,221* | 0,950*** | 0,627*** | 0,028 | 0,825*** | 1,115*** | 0,957 |
| OIL | 0,040 | -0,035 | -0,027 | 0,001 | 0,004 | 0,059 | 0,050 |
| FX | -0,168 | -0,202 | 0,051 | 0,005 | 0,359** | 0,931*** | 0,759 |
| PSE | -0,169 | -0,268 | -0,133 | 0,001 | -0,230* | -0,420* | -0,009 |
| VIX | 0,073 | 0,026 | 0,005 | 0,001 | 0,009 | 0,029 | 0,065 |
| OVX | 0,021 | 0,007 | -0,002 | 0,000 | 0,009 | 0,038 | 0,074 |
| TYVIX | -0,099* | -0,057* | -0,009 | 0,000 | 0,005 | -0,005 | -0,073* |
| EUVIX | -0,008 | 0,008 | 0,011*** | 0,000 | -0,011 | -0,027 | -0,007 |
| EPU | -0,011*** | -0,004* | -0,001 | 0,000 | 0,000 | -0,004 | -0,004 |
| GPR | -0,004 | -0,002 | -0,001 | 0,000 | 0,000 | -0,002 | -0,003 |

*Note:* ***, ** and * indicates significance at 1%, 5% and 10% significance levels respectively. $\tau$ indicates quantile level.

## Table A2

**a)**

| **MOTE** | $\tau = 0{,}05$ | $\tau = 0{,}10$ | $\tau = 0{,}25$ | $\tau = 0{,}50$ | $\tau = 0{,}75$ | $\tau = 0{,}90$ | $\tau = 0{,}95$ |
|---|---|---|---|---|---|---|---|
| Intercept | -0,044*** | -0,029*** | -0,014*** | -0,001*** | 0,010*** | 0,028*** | 0,044*** |
| MSCI | 1,720*** | 1,336*** | 1,270*** | 0,843*** | 0,809*** | 1,186*** | 1,624*** |
| OIL | -0,004 | 0,042 | -0,056 | -0,035* | -0,034 | -0,037 | 0,003 |
| FX | 1,169*** | 0,686*** | 0,250* | 0,268*** | 0,299** | 0,658*** | 1,697*** |
| PSE | -0,605 | -0,322 | -0,368*** | -0,193*** | -0,291** | -0,571** | -0,850*** |
| VIX | 0,064 | 0,035 | 0,027* | 0,009 | -0,007 | -0,013 | -0,016 |
| OVX | -0,003 | -0,002 | -0,004 | -0,004 | -0,014 | 0,004 | 0,026 |
| TYVIX | -0,108 | -0,031 | -0,012 | 0,009 | 0,002 | -0,004 | -0,010 |
| EUVIX | -0,032 | -0,019 | 0,006 | 0,004 | 0,004 | 0,034 | 0,043 |
| EPU | 0,006* | 0,003* | 0,003** | 0,000 | 0,001 | 0,001 | -0,001 |
| GPR | 0,000 | -0,001 | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 |

**b)**

| **SGRE** | $\tau = 0{,}05$ | $\tau = 0{,}10$ | $\tau = 0{,}25$ | $\tau = 0{,}50$ | $\tau = 0{,}75$ | $\tau = 0{,}90$ | $\tau = 0{,}95$ |
|---|---|---|---|---|---|---|---|
| Intercept | -0,034*** | -0,026*** | -0,012*** | 0,000 | 0,012*** | 0,027*** | 0,038*** |
| MSCI | 2,672*** | 2,660*** | 2,370*** | 2,416*** | 2,654*** | 2,908*** | 2,826*** |
| OIL | -0,033 | 0,012 | -0,010 | -0,040** | -0,023 | -0,016 | -0,028 |
| FX | 0,334 | 0,712*** | 0,631*** | 0,738*** | 0,750*** | 1,124*** | 1,162*** |
| PSE | -0,656*** | -0,687*** | -0,470*** | -0,689*** | -0,873*** | -0,956*** | -0,784*** |
| VIX | 0,044* | 0,036** | 0,039*** | 0,015* | 0,016 | 0,034** | 0,022 |
| OVX | 0,033 | 0,033* | 0,021** | 0,000 | 0,016 | -0,005 | 0,016 |
| TYVIX | -0,042* | -0,052*** | -0,031** | -0,009 | -0,012 | 0,020 | 0,036 |
| EUVIX | -0,026 | -0,014 | -0,002 | -0,003 | -0,013 | -0,020 | -0,007 |
| EPU | 0,000 | 0,002 | -0,001 | 0,000 | 0,000 | -0,001 | 0,000 |
| GPR | -0,001 | -0,001 | -0,001** | 0,000 | -0,001 | 0,001 | 0,001 |

**c)**

| **SUZN** | $\tau = 0{,}05$ | $\tau = 0{,}10$ | $\tau = 0{,}25$ | $\tau = 0{,}50$ | $\tau = 0{,}75$ | $\tau = 0{,}90$ | $\tau = 0{,}95$ |
|---|---|---|---|---|---|---|---|
| Intercept | -0,052*** | -0,039*** | -0,019*** | -0,002*** | 0,013*** | 0,037*** | 0,056*** |
| MSCI | 1,206*** | 1,136*** | 1,339*** | 0,881*** | 0,939*** | 0,994** | 1,312** |
| OIL | 0,261*** | 0,173** | 0,023 | 0,008 | 0,021 | 0,031 | 0,081 |
| FX | 0,231 | 0,519* | 0,438** | 0,293*** | 0,400** | 0,462 | 0,648 |
| PSE | -0,167 | -0,347 | -0,484*** | -0,314*** | -0,335* | -0,043 | -0,233 |
| VIX | 0,062* | 0,038 | 0,024 | 0,014 | 0,005 | 0,080** | 0,057* |
| OVX | -0,036 | -0,022 | -0,011 | -0,003 | -0,020 | -0,053 | 0,004 |
| TYVIX | 0,024 | 0,013 | -0,004 | 0,001 | -0,001 | -0,041 | -0,065 |
| EUVIX | -0,007 | -0,016 | 0,004 | -0,009*** | -0,005 | -0,017 | 0,022 |
| EPU | -0,003 | -0,002 | 0,001 | 0,001** | 0,000 | 0,007** | 0,008 |
| GPR | 0,001 | 0,002** | 0,000 | -0,001 | -0,001 | 0,001 | -0,004 |

**d)**

| **VEST** | $\tau = 0{,}05$ | $\tau = 0{,}10$ | $\tau = 0{,}25$ | $\tau = 0{,}50$ | $\tau = 0{,}75$ | $\tau = 0{,}90$ | $\tau = 0{,}95$ |
|---|---|---|---|---|---|---|---|
| Intercept | -0,038*** | -0,025*** | -0,011*** | 0,000 | 0,011*** | 0,027*** | 0,039*** |
| MSCI | 2,317*** | 2,287*** | 2,168*** | 2,008*** | 2,136*** | 2,391*** | 2,551*** |
| OIL | -0,008 | -0,074 | -0,061** | -0,029 | -0,045 | -0,095 | -0,149** |
| FX | 0,702** | 0,594*** | 0,505*** | 0,637*** | 0,497*** | 0,434* | 0,379 |
| PSE | -0,325 | -0,528*** | -0,512*** | -0,489*** | -0,687*** | -0,942*** | -1,073*** |
| VIX | 0,060** | 0,025 | 0,034*** | 0,020** | 0,015 | -0,014 | -0,025 |
| OVX | 0,029 | 0,018 | 0,006 | 0,014 | 0,017 | 0,011 | 0,055* |
| TYVIX | -0,019 | -0,015 | -0,008 | -0,008 | -0,018 | -0,007 | -0,004 |
| EUVIX | -0,052*** | -0,029 | -0,022** | -0,003 | 0,002 | 0,003 | -0,031 |
| EPU | 0,000 | 0,000 | 0,001 | 0,000 | -0,001 | 0,000 | -0,003** |
| GPR | -0,005*** | -0,003*** | -0,001* | -0,001* | 0,000 | -0,001 | 0,001 |

*Note:* ***, ** and * indicates significance at 1%, 5% and 10% significance levels respectively. $\tau$ indicates quantile level.

## Table A3

**a)**

| **CREN** | $\tau = 0{,}05$ | $\tau = 0{,}10$ | $\tau = 0{,}25$ | $\tau = 0{,}50$ | $\tau = 0{,}75$ | $\tau = 0{,}90$ | $\tau = 0{,}95$ |
|---|---|---|---|---|---|---|---|
| Intercept | -0,034*** | -0,025*** | -0,011*** | 0,000 | 0,011*** | 0,027*** | 0,037*** |
| MSCI | 1,395*** | 1,287*** | 0,938*** | 0,714*** | 0,742*** | 0,837*** | 0,360 |
| OIL | -0,023 | 0,001 | -0,019 | -0,004 | 0,050 | 0,019 | -0,054 |
| FX | 0,636** | 0,577*** | 0,333*** | 0,412*** | 0,411*** | 0,129 | -0,241 |
| PSE | -0,401 | -0,465*** | -0,209** | -0,138** | -0,108 | -0,195 | -0,003 |
| VIX | -0,003 | 0,006 | 0,018 | 0,011 | 0,016 | 0,008 | -0,035 |
| OVX | 0,025 | 0,006 | -0,004 | 0,002 | 0,009 | 0,008 | 0,015 |
| TYVIX | -0,022 | -0,019 | -0,010 | -0,002 | 0,005 | 0,004 | 0,006 |
| EUVIX | -0,022 | -0,011 | 0,002 | -0,001 | -0,011 | -0,018 | -0,033 |
| EPU | 0,001 | 0,000 | -0,001 | -0,001** | -0,002** | -0,002 | -0,002** |
| GPR | -0,001 | 0,000 | 0,000 | -0,001*** | -0,001 | 0,000 | 0,001 |

**b)**

| **GREP** | $\tau = 0{,}05$ | $\tau = 0{,}10$ | $\tau = 0{,}25$ | $\tau = 0{,}50$ | $\tau = 0{,}75$ | $\tau = 0{,}90$ | $\tau = 0{,}95$ |
|---|---|---|---|---|---|---|---|
| Intercept | -0,040*** | -0,029*** | -0,013*** | 0,000 | 0,013*** | 0,028*** | 0,041*** |
| MSCI | 1,090*** | 1,114*** | 0,890*** | 0,599*** | 0,602*** | 0,658*** | 0,988*** |
| OIL | 0,405*** | 0,346*** | 0,266*** | 0,254*** | 0,302*** | 0,319*** | 0,357*** |
| FX | 0,626** | 0,387* | 0,309** | 0,086 | 0,063 | 0,240 | 0,311 |
| PSE | 0,351 | 0,306** | 0,313** | 0,370*** | 0,293*** | 0,226 | -0,064 |
| VIX | -0,006 | -0,003 | -0,009 | -0,034*** | -0,035*** | -0,050** | -0,039 |
| OVX | 0,028 | 0,022 | -0,008 | -0,005 | -0,006 | 0,004 | 0,014 |
| TYVIX | -0,036 | -0,033 | -0,013 | 0,002 | 0,016 | 0,020 | 0,009 |
| EUVIX | 0,027 | 0,017 | 0,007 | 0,016*** | 0,006 | 0,005 | -0,027 |
| EPU | 0,002 | 0,001 | 0,000 | 0,000 | 0,002*** | 0,004** | 0,003 |
| GPR | 0,001 | 0,001 | 0,001 | 0,001 | 0,002*** | 0,002** | 0,001 |

**c)**

| **PATH** | $\tau = 0{,}05$ | $\tau = 0{,}10$ | $\tau = 0{,}25$ | $\tau = 0{,}50$ | $\tau = 0{,}75$ | $\tau = 0{,}90$ | $\tau = 0{,}95$ |
|---|---|---|---|---|---|---|---|
| Intercept | -0,079*** | -0,054*** | -0,027*** | -0,002*** | 0,018*** | 0,048*** | 0,075*** |
| MSCI | 0,585 | 0,778* | 1,082*** | 1,224*** | 1,464*** | 0,858* | 1,127 |
| OIL | 0,529*** | 0,487*** | 0,393*** | 0,347*** | 0,362*** | 0,260*** | -0,054 |
| FX | 0,496 | 0,156 | 0,413*** | 0,387** | 0,594** | 0,653* | 0,795 |
| PSE | 0,232 | 0,304 | -0,179 | 0,019 | -0,100 | 0,492 | 0,604 |
| VIX | -0,017 | 0,003 | -0,028 | -0,032** | -0,014 | 0,026 | 0,098 |
| OVX | -0,004 | 0,006 | -0,008 | 0,023 | 0,024 | 0,004 | 0,020 |
| TYVIX | 0,022 | 0,007 | -0,013 | -0,013 | 0,036 | 0,005 | -0,091 |
| EUVIX | 0,021 | 0,022 | 0,049*** | 0,035*** | 0,028 | -0,023 | 0,007 |
| EPU | -0,004 | -0,001 | 0,003 | 0,002* | -0,001 | 0,000 | 0,000 |
| GPR | -0,003 | 0,002 | 0,001 | 0,000 | 0,001 | 0,004** | 0,007* |

**d)**

| **BHAR** | $\tau = 0{,}05$ | $\tau = 0{,}10$ | $\tau = 0{,}25$ | $\tau = 0{,}50$ | $\tau = 0{,}75$ | $\tau = 0{,}90$ | $\tau = 0{,}95$ |
|---|---|---|---|---|---|---|---|
| Intercept | -0,031*** | -0,022*** | -0,011*** | 0,000 | 0,012*** | 0,026*** | 0,034*** |
| MSCI | 1,025*** | 0,581*** | 0,692*** | 0,240*** | 0,271 | 0,330 | 0,387 |
| OIL | -0,144*** | -0,094** | -0,051** | -0,033* | -0,033 | -0,043 | -0,005 |
| FX | 0,367* | 0,263* | 0,225** | 0,087 | 0,081 | 0,118 | 0,362* |
| PSE | -0,533*** | -0,323** | -0,363*** | -0,096 | -0,086 | -0,191 | -0,274* |
| VIX | -0,037* | -0,025 | -0,007 | 0,002 | 0,010 | 0,000 | 0,008 |
| OVX | -0,062*** | -0,045** | -0,031*** | -0,021*** | -0,038** | -0,025 | -0,017 |
| TYVIX | 0,049** | 0,008 | 0,004 | 0,004 | 0,002 | -0,009 | -0,049** |
| EUVIX | 0,015 | 0,003 | 0,001 | -0,002 | -0,015 | -0,005 | 0,005 |
| EPU | 0,002 | 0,000 | 0,000 | -0,001 | 0,000 | 0,001 | 0,002 |
| GPR | 0,000 | -0,001 | -0,001* | 0,000 | -0,001 | -0,001 | -0,001** |

*Note:* ***, ** and * indicates significance at 1%, 5% and 10% significance levels respectively. $\tau$ indicates quantile level.

## Table A4

**a)**

| **BP** | $\tau = 0{,}05$ | $\tau = 0{,}10$ | $\tau = 0{,}25$ | $\tau = 0{,}50$ | $\tau = 0{,}75$ | $\tau = 0{,}90$ | $\tau = 0{,}95$ |
|---|---|---|---|---|---|---|---|
| Intercept | -0,017*** | -0,012*** | -0,006*** | 0,000 | 0,006*** | 0,013*** | 0,017*** |
| MSCI | 1,515*** | 1,567*** | 1,544*** | 1,525*** | 1,490*** | 1,697*** | 1,667*** |
| OIL | 0,187*** | 0,186*** | 0,176*** | 0,159*** | 0,196*** | 0,200*** | 0,211*** |
| FX | 0,656*** | 0,696*** | 0,583*** | 0,568*** | 0,550*** | 0,622*** | 0,654*** |
| PSE | -0,529*** | -0,491*** | -0,517*** | -0,500*** | -0,483*** | -0,567*** | -0,556*** |
| VIX | 0,007 | 0,018** | 0,016*** | 0,022*** | 0,024*** | 0,028*** | 0,019 |
| OVX | -0,002 | -0,014 | -0,006 | -0,004 | 0,011* | 0,011 | 0,021** |
| TYVIX | -0,010 | -0,015* | -0,004 | -0,007 | -0,017*** | 0,004 | 0,006 |
| EUVIX | 0,004 | 0,003 | 0,001 | -0,003** | -0,007* | -0,006 | -0,001 |
| EPU | 0,002* | 0,001* | 0,000 | 0,000 | -0,001 | -0,001 | -0,002 |
| GPR | 0,000 | 0,000 | -0,001** | 0,000 | -0,001** | -0,001** | -0,001 |

***b)***

| **CHEV** | $\tau = 0{,}05$ | $\tau = 0{,}10$ | $\tau = 0{,}25$ | $\tau = 0{,}50$ | $\tau = 0{,}75$ | $\tau = 0{,}90$ | $\tau = 0{,}95$ |
|---|---|---|---|---|---|---|---|
| Intercept | -0,013*** | -0,010*** | -0,005*** | 0,000 | 0,004*** | 0,010*** | 0,015*** |
| MSCI | 0,729*** | 0,767*** | 0,782*** | 0,745*** | 0,766*** | 0,757*** | 0,678*** |
| OIL | 0,245*** | 0,211*** | 0,210*** | 0,205*** | 0,192*** | 0,221*** | 0,249*** |
| FX | 0,087 | 0,107* | 0,074* | 0,167*** | 0,209*** | 0,154* | 0,163 |
| PSE | -0,012 | 0,043 | -0,016 | -0,036 | 0,012 | 0,025 | 0,072 |
| VIX | -0,027*** | -0,019*** | -0,022*** | -0,027*** | -0,025*** | -0,030*** | -0,026** |
| OVX | -0,010 | -0,014* | 0,001 | -0,001 | -0,002 | -0,002 | -0,008 |
| TYVIX | 0,017 | 0,021*** | 0,019*** | 0,014*** | 0,020*** | 0,031*** | 0,019 |
| EUVIX | 0,008 | 0,005 | 0,003 | 0,005** | 0,005 | 0,010* | 0,006 |
| EPU | 0,002** | 0,002*** | 0,001 | 0,000 | -0,001 | 0,001 | 0,001 |
| GPR | 0,001 | 0,000 | 0,000 | 0,000 | 0,000 | 0,001* | 0,000 |

**c)**

| **CONO** | $\tau = 0{,}05$ | $\tau = 0{,}10$ | $\tau = 0{,}25$ | $\tau = 0{,}50$ | $\tau = 0{,}75$ | $\tau = 0{,}90$ | $\tau = 0{,}95$ |
|---|---|---|---|---|---|---|---|
| Intercept | -0,018*** | -0,014*** | -0,007*** | 0,000* | 0,007*** | 0,013*** | 0,019*** |
| MSCI | 0,583*** | 0,715*** | 0,736*** | 0,604*** | 0,784*** | 0,743*** | 0,802*** |
| OIL | 0,391*** | 0,393*** | 0,341*** | 0,346*** | 0,355*** | 0,418*** | 0,455*** |
| FX | 0,195* | 0,166** | 0,137** | 0,191*** | 0,244*** | 0,370*** | 0,386*** |
| PSE | 0,101 | 0,019 | -0,010 | 0,022 | -0,075 | 0,012 | -0,131 |
| VIX | -0,033*** | -0,034*** | -0,023*** | -0,030*** | -0,030*** | -0,027*** | -0,046*** |
| OVX | -0,004 | -0,001 | -0,001 | 0,004 | 0,001 | 0,002 | 0,015 |
| TYVIX | 0,014 | 0,006 | 0,006 | 0,008* | 0,013* | 0,029** | 0,029** |
| EUVIX | 0,014 | 0,012 | 0,006 | 0,004* | 0,009** | 0,013* | 0,014 |
| EPU | 0,002** | 0,000 | 0,001 | 0,001* | 0,000 | 0,001 | 0,002*** |
| GPR | 0,001 | 0,002 | 0,001** | 0,000 | 0,001*** | 0,001** | 0,001** |

**d)**

| **EXMO** | $\tau = 0{,}05$ | $\tau = 0{,}10$ | $\tau = 0{,}25$ | $\tau = 0{,}50$ | $\tau = 0{,}75$ | $\tau = 0{,}90$ | $\tau = 0{,}95$ |
|---|---|---|---|---|---|---|---|
| Intercept | -0,012*** | -0,009*** | -0,005*** | 0,000* | 0,004*** | 0,009*** | 0,013*** |
| MSCI | 0,638*** | 0,659*** | 0,705*** | 0,681*** | 0,672*** | 0,647*** | 0,549*** |
| OIL | 0,174*** | 0,169*** | 0,160*** | 0,146*** | 0,143*** | 0,185*** | 0,224*** |
| FX | 0,138 | 0,133** | 0,109*** | 0,130*** | 0,143*** | 0,131** | 0,151 |
| PSE | -0,049 | -0,056 | -0,034 | -0,019 | -0,026 | 0,010 | 0,066 |
| VIX | -0,043*** | -0,038*** | -0,025*** | -0,027*** | -0,030*** | -0,032*** | -0,044*** |
| OVX | 0,000 | -0,007 | -0,004 | -0,004 | -0,003 | 0,000 | 0,002 |
| TYVIX | 0,016* | 0,017*** | 0,014*** | 0,015*** | 0,017*** | 0,024*** | 0,034*** |
| EUVIX | 0,009 | 0,007* | 0,009*** | 0,006*** | 0,006* | 0,011** | 0,014** |
| EPU | 0,002** | 0,001** | 0,001* | 0,000 | 0,000 | 0,000 | 0,002** |
| GPR | 0,000 | 0,000 | 0,000 | 0,000* | 0,000 | 0,000 | 0,000 |

*Note:* ***, ** and * indicates significance at 1%, 5% and 10% significance levels respectively. $\tau$ indicates quantile level.

## Table A5

**a)**

| GAZP | $\tau = 0{,}05$ | $\tau = 0{,}10$ | $\tau = 0{,}25$ | $\tau = 0{,}50$ | $\tau = 0{,}75$ | $\tau = 0{,}90$ | $\tau = 0{,}95$ |
|---|---|---|---|---|---|---|---|
| Intercept | -0,022*** | -0,016*** | -0,008*** | 0,000 | 0,007*** | 0,016*** | 0,023*** |
| MSCI | 1,571*** | 1,187*** | 1,196*** | 1,170*** | 1,177*** | 1,157*** | 1,062*** |
| OIL | 0,031 | 0,050** | 0,042*** | 0,070*** | 0,064*** | 0,119*** | 0,111*** |
| FX | 0,406*** | 0,162 | 0,198*** | 0,174*** | 0,091 | 0,073 | -0,003 |
| PSE | -0,379*** | -0,262*** | -0,242*** | -0,283*** | -0,297*** | -0,319*** | -0,263* |
| VIX | 0,036*** | 0,020** | 0,025*** | 0,021*** | 0,020*** | 0,024** | 0,009 |
| OVX | 0,003 | -0,008 | 0,002 | 0,007 | -0,012 | -0,016 | -0,001 |
| TYVIX | -0,001 | 0,000 | -0,005 | -0,007 | 0,008 | 0,001 | 0,000 |
| EUVIX | 0,005 | 0,010 | 0,002 | 0,002 | -0,004 | -0,015 | -0,019 |
| EPU | 0,001 | 0,000 | 0,000 | -0,001** | -0,001 | -0,001 | -0,001 |
| GPR | -0,001 | 0,000 | 0,000 | 0,000 | 0,001 | 0,001** | 0,002* |

**b)**

| INOIL | $\tau = 0{,}05$ | $\tau = 0{,}10$ | $\tau = 0{,}25$ | $\tau = 0{,}50$ | $\tau = 0{,}75$ | $\tau = 0{,}90$ | $\tau = 0{,}95$ |
|---|---|---|---|---|---|---|---|
| Intercept | -0,029*** | -0,022*** | -0,010*** | 0,000 | 0,010*** | 0,022*** | 0,032*** |
| MSCI | 0,365 | 0,543*** | 0,479*** | 0,244*** | 0,325** | 0,400** | 0,485** |
| OIL | -0,057 | -0,057* | -0,043 | -0,046*** | -0,083*** | -0,104** | -0,089 |
| FX | 0,118 | 0,293** | 0,289*** | 0,124** | 0,141 | 0,361** | 0,669*** |
| PSE | -0,017 | 0,082 | -0,136 | -0,058 | -0,111 | -0,263* | -0,370* |
| VIX | 0,008 | 0,028** | 0,001 | 0,007 | 0,000 | -0,019 | -0,029 |
| OVX | -0,012 | -0,018 | -0,001 | -0,012*** | -0,018** | -0,023 | 0,009 |
| TYVIX | -0,012 | -0,009 | 0,005 | 0,002 | -0,005 | 0,031* | 0,042* |
| EUVIX | -0,018 | -0,015** | -0,007 | -0,013*** | -0,010 | -0,004 | -0,005 |
| EPU | 0,001 | 0,000 | 0,000 | 0,000 | 0,000 | -0,001 | -0,002 |
| GPR | -0,001 | -0,001 | 0,000 | 0,000 | 0,000 | -0,002* | -0,002* |

**c)**

| RDS | $\tau = 0{,}05$ | $\tau = 0{,}10$ | $\tau = 0{,}25$ | $\tau = 0{,}50$ | $\tau = 0{,}75$ | $\tau = 0{,}90$ | $\tau = 0{,}95$ |
|---|---|---|---|---|---|---|---|
| Intercept | -0,015*** | -0,011*** | -0,005*** | 0,000 | 0,005*** | 0,010*** | 0,014*** |
| MSCI | 1,707*** | 1,738*** | 1,486*** | 1,409*** | 1,394*** | 1,509*** | 1,656*** |
| OIL | 0,195*** | 0,151*** | 0,165*** | 0,155*** | 0,180*** | 0,208*** | 0,200*** |
| FX | 0,905*** | 0,947*** | 0,816*** | 0,789*** | 0,810*** | 0,836*** | 1,007*** |
| PSE | -0,647*** | -0,609*** | -0,449*** | -0,461*** | -0,501*** | -0,644*** | -0,706*** |
| VIX | 0,019* | 0,012 | 0,019*** | 0,014*** | 0,010*** | 0,001 | 0,011 |
| OVX | -0,014 | 0,001 | 0,003 | 0,010** | 0,016*** | 0,011 | -0,001 |
| TYVIX | -0,013 | -0,009 | -0,005 | -0,005 | -0,005 | 0,004 | 0,001 |
| EUVIX | 0,010 | 0,007*** | 0,001 | -0,003 | -0,004 | -0,001 | 0,010 |
| EPU | 0,000 | 0,001 | 0,001* | 0,000 | -0,001** | -0,001 | -0,001 |
| GPR | -0,001 | -0,001 | -0,001*** | -0,001** | 0,000 | 0,000 | 0,000 |

**d)**

| EQUI | $\tau = 0{,}05$ | $\tau = 0{,}10$ | $\tau = 0{,}25$ | $\tau = 0{,}50$ | $\tau = 0{,}75$ | $\tau = 0{,}90$ | $\tau = 0{,}95$ |
|---|---|---|---|---|---|---|---|
| Intercept | -0,019*** | -0,014*** | -0,007*** | 0,000 | 0,007*** | 0,014*** | 0,021*** |
| MSCI | 1,663*** | 1,401*** | 1,400*** | 1,397*** | 1,497*** | 1,505*** | 1,724*** |
| OIL | 0,218*** | 0,232*** | 0,207*** | 0,190*** | 0,209*** | 0,218*** | 0,170*** |
| FX | 0,456*** | 0,342*** | 0,416*** | 0,436*** | 0,498*** | 0,533*** | 0,475*** |
| PSE | -0,454*** | -0,302*** | -0,310*** | -0,366*** | -0,476*** | -0,477*** | -0,655*** |
| VIX | 0,053*** | 0,040*** | 0,030*** | 0,029*** | 0,027*** | 0,032*** | 0,029* |
| OVX | -0,014 | -0,006 | 0,000 | 0,005 | 0,018** | 0,004 | -0,010 |
| TYVIX | 0,002 | -0,010 | -0,005 | -0,008 | -0,011* | -0,013 | -0,020 |
| EUVIX | 0,013 | 0,009 | 0,002 | 0,002 | 0,000 | 0,011 | 0,028* |
| EPU | 0,000 | 0,000 | 0,000 | 0,000 | 0,000 | -0,001 | -0,001 |
| GPR | 0,000 | 0,000 | -0,001 | 0,000 | 0,000 | 0,000 | 0,000 |

*Note:* ***, ** and * indicates significance at 1%, 5% and 10% significance levels respectively. $\tau$ indicates quantile level.

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**Fondazione Eni Enrico Mattei**
Corso Magenta 63, Milano – Italia

Tel. +39 02.520.36934
Fax. +39.02.520.36946

E-mail: letter@feem.it
**www.feem.it**