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Linking the gas and oil markets with the stock market: Investigating the U.S. relationship

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ABSTRACT

Energy markets can represent a strategic advantage when they are supporting each other, and specifically when energy segments are complementary enough to support economic development and growth. In this light, a high and strategic interest relies on the possible interactions between energy market segments as well as their impact on a given country's financial market. The proposed research focuses on the interaction between the U.S. natural gas and U.S. crude oil markets on one side and their dependencies with the U.S. stock market on the other side. After controlling for structural changes or breaks, we characterize previous dependencies with the multivariate copula methodology. First, we assess the joint link prevailing between the natural gas and crude oil markets. Then, we characterize the joint risk structure prevailing between previous energy markets and the U.S. stock market. Finally, we assess the joint dependence structure between the natural gas, crude oil and stock markets.

1. Introduction

Energy markets illustrate a strategic area for government policies as well as country development and growth (Elder and Serletis, 2010; Krichene, 2007). Therefore, it is often interesting to assess the extent to which some energy sources evolve and how complementary they can be for a country. Indeed, energy markets can represent a strategic advantage when they are supporting each other and specifically when energy segments are complementary enough to support economic development and growth. In this light, a high and strategic interest relies on the possible interactions between energy market segments as well as their impact on a given country's financial market (Barsky and Kilian, 2002, 2004; Hamilton, 1985; Kilian, 2009). In particular, the cross or joint dependencies between specific energy market segments on one side, and the joint dependencies between such energy markets and the stock market are of huge significance. The main focus consists of investigating two specific practical and strategic research questions. The first question attempts to assess if an energy market segment can offset or compensate the weaknesses of another energy market segment. Specifically, the complementary nature of specific energy markets constitutes a strategic and competitive advantage for a given country while avoiding economic slowdowns resulting from energy shortages or weaknesses. For example, the substitutability between crude oil and natural gas are of huge significance for the sustainability of the energy policy and the economic development of a country. The second question attempts to determine the extent to which an energy market segment can contribute to strengthen the stock market or to impair its stability and/or evolution. The impact of energy markets on the stock market is also important because the stock market is a non-negligible financing means for firms. If stocks happen to become highly volatile following energy-based disturbances, firms happen to become riskier and will therefore have to increase the proposed rewards in order to attract investors. Particularly, the variance risk premium required by risk-averse investors will increase (Merton, 1973, 1980). Such phenomenon corresponds to the well-known volatility feedback reported by Campbell and Hentschel (1992) among others. By the way, firms will also undergo an increase in their financing costs. Such features usually impair the evolution and development of firms subsequent to an increased cost of capital. Moreover, the linkages between energy commodities and the financial stock market is a cornerstone for the finance profession. Incidentally, energy commodities have become a famous asset class, which is widely used for portfolio diversification purposes, hedging prospects or speculative use (e.g. futures on energy commodities, which are traded on the NYMEX or ICE exchanges for example; de Roon et al., 2000; Gorton and Rouwenhorst, 2006).

The proposed research paper focuses on the interaction between the U.S. natural gas and U.S. crude oil markets on one side and their

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dependencies with the U.S. stock market on the other side. Indeed, energy and commodity markets are known to interact with each other. In this light, there exists a research stream investigating a causal relationship across the energy/commodity markets (Asche et al., 2006; Brown and Yücel, 2008; Halova, 2011; Hartley et al., 2008; Onour, 2009; Villar and Joutz, 2006) or from the commodity/energy market towards the stock market (Chen, 2010; Chiou and Lee, 2009; Driesprong et al., 2008; Filis, 2010; Filis et al., 2011; Kilian, 2009; Lee and Chiou, 2011; O'Neill et al., 2008; Park and Ratti, 2008; Reboredo, 2008) and vice versa. In our case, we target to characterize previous dependencies along two dimensions. The two dimensions refer to two- and three-dimensional analyses. First, we assess the joint link prevailing between the natural gas and crude oil markets. In particular, we investigate the existence and the nature of a possible dependency. Second, we characterize the joint risk structure prevailing between previous energy markets and the U.S. stock market. In this light, we analyze prevailing linkages along with the two research questions above-mentioned. For this purpose, we consider daily natural gas and crude oil prices as well as daily quotes of a well-chosen stock market index such as the Standard and Poor's 500 index. Moreover, our study takes place in a multivariate universe employing the copula methodology, and is comprised of two stages. The copula methodology is a useful tool allowing for assessing various nonlinear joint dependencies on a simultaneous basis. The first stage of our study is based on a two-dimension copula study, which analyzes dependencies between the natural gas and crude oil markets on one side, and dependencies between such energy markets and the stock market on the other side. As an extension, the second stage considers a three-dimensional copula setting, which assesses the joint dependence structure between the natural gas, crude oil and stock markets. Hence, we characterize the simultaneous interaction between natural gas, crude oil and stock markets.

Our paper is organized as follows. Section 2 introduces the literature review while Section 3 presents the stock market and energy data under consideration as well as related stylized facts. Section 4 introduces the econometric tools under consideration while Section 5 exhibits and comments corresponding estimation results. First, a structural break test is proposed to investigate possible regime changes in energy spot prices and stock market index over the sample horizon. Ignoring regime changes impairs the estimation process because obtained parameter estimates do not reflect changes across possible regimes and therefore lack the required temporal variation. Second, a copula methodology in a two- and three-dimensional framework is proposed to investigate the dependence structure between energy commodities and the U.S. stock market. Finally, Section 6 introduces concluding remarks and possible future extensions.

2. Literature review

We introduce various acknowledged links between U.S. energy commodities such as crude oil and natural gas on one side, and linkages between energy commodities and the U.S. stock market on the other side. By the way, some key stylized features are also introduced in the light of strategic policymaking.

2.1. Crude oil and natural gas commodities

Possible links between crude oil and natural gas markets have been largely debated so far. Various conclusions have been raised, which either confirm or contradict existing linkages between those two energy markets. Such conclusions depend broadly on the nature of envisioned linkages, the country/region under consideration, the duration of analysis as well as the various listed connecting channels between energy markets (e.g. market liberalization, deregulation). Amongst the opponents to potential relationships, Bachmeier and Griffin (2006) focus on the possible market integration of U.S. crude oil and natural gas energy markets among others. They exhibit a weak integration of crude oil and natural gas markets. Differently, Hartley et al. (2008) focus on short-run departures from the long-run relationship between natural gas and crude oil prices. They find an indirect link between the two commodity prices. In this light, product inventories, seasonal factors and supply shocks drive previous short-run departures (i.e. price decoupling in the short term). In the same line, Ramberg and Parsons (2012) investigate accurately crude oil and natural gas price decoupling. They conclude that the relationship between crude oil and natural gas prices is far from being stable over long time windows. They also observe temporary violations to such relationship over identified stable periods (i.e. temporary price decoupling). As an extension, Brigida (2014) exhibits a temporary decoupling of U.S. crude oil and natural gas prices in the early 2000s. However, crude oil and natural gas prices exhibit a long-run relationship in the presence of regime changes (i.e. time-varying long-run relationship).

Hence, dependency between commodity markets is well acknowledged nowadays, at least in the long run. Indeed, the oil and gas markets are known to interact with each other with a major causality relationship from the oil market to the gas market (e.g. price shocks and volatility spillovers; Ben Sita and Abosedra, 2012). Usually, price shocks spread out from the oil market to the gas market over time (Ewing et al., 2002; Pindyck, 2004). Such linkages question the substitutability between oil and gas commodities (e.g. supply and demand mechanisms) as well as the need for a competitive management of energy commodities. Incidentally, the power generation industry and other sector-specific firms rely on either gas or oil-derived products over time. In particular, such firms can use alternatively oil or gas as a power source, which requires managing substitution opportunities (EIA, 2008). Analogously, the transportation industry also uses natural gas as a transportation fuel (EIA, 2010). Hence, the capability to switch from diesel to natural gas contributes to the price competition between crude oil and natural gas (as long as oil and gas are perceived as equivalent energy sources). In this light, a price increase in oil will lead these firms to switch to gas, increasing therefore the demand for gas. As a result, gas prices will grow. Symmetrically, the gas supply will then increase so as to satisfy the demand for gas, and therefore gas prices will fall. However, another reverse mechanism causing an increase in gas prices can also occur. The substitutability between oil and gas will generate a competition for resources, which will lead to a competition for energy efficiency, engendering thus extra costs (e.g. cost of new facilities, funding innovations, investing in new projects). In the end, the gas price will grow in order to account for the resulting competition-related costs.

Such dependency is also important for portfolio management practices since commodities are often considered as a specific asset class, which is strategically selected for portfolio diversification prospects. For example, a multi-spread strategy encompassing commodities and classic asset classes such as stocks or bonds can improve significantly portfolio performance (Kim et al., 2011). Hence, investors can benefit from investments across market segments among which the commodity asset class (Vivian and Wohar, 2012).

Moreover, the oil and gas markets are known to influence the macroeconomy through various channels. Specifically, price shocks such as dramatic increases impact economic fundamentals such as GDP (i.e. economic growth), consumption, interest rates, inflation and the production of goods and services among others (Ben Sita and Abosedra, 2012; Hamilton, 1983, 1996, 2005, 2009; Hammes and Willis, 2005; Hooker, 2002; Kilian, 2008; Lardic and mignon, 2006; Zhang, 2008). In particular, oil price shocks increase inflation through their impact on goods and services (e.g. imbalances between supply and demand; Kilian, 2008, 2009). Furthermore, gas prices impact the utilities industry, and especially firms relying on gas as a power source (U.S. Energy Information Administration). The strength and nature of the relationship between energy commodities and the economy depend on the country's status with respect to energy commodity exportation or importation (Filis et al., 2011). Hence, energy commodity