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Modeling volatility and correlations between emerging market stock prices and the prices of copper, oil and wheat

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ABSTRACT

Increased financial integration between countries and the financialization of commodity markets are providing investors with new ways to diversify their investment portfolios. This paper uses VARMA-AGARCH and DCC-AGARCH models to model volatilities and conditional correlations between emerging market stock prices, copper prices, oil prices and wheat prices. The dynamic conditional correlation model is found to fit the data the best and used to generate dynamic conditional correlations, hedge ratios and optimal portfolio weights. Emerging market stock prices and oil prices display leverage effects where negative residuals tend to increase the variance (conditional volatility) more than positive ones. Correlations between these assets increased considerably after 2008, and have yet to return to their pre 2008 values. On average, oil provides the cheapest hedge for emerging market stock prices while copper is the most expensive but given the variability in the hedge ratios, one should probably not put too much emphasis on average hedge ratios.

1. Introduction

Increased financial integration between countries and the financialization of commodity markets are providing investors with new ways to diversify their investment portfolios. Benefiting from these investment opportunities requires a good understanding of how financial markets and commodity markets correlate.[1] While there has been some research done looking into the volatility dynamics and correlations between equities and commodities (mostly oil or gold) there is less known about volatility and correlations between emerging market stock prices and commodities. Modeling volatility is an essential component of modern finance because good estimates of correlation and volatility are needed for derivative pricing, portfolio optimization, risk management, and hedging.

Investing in commodities is seen as a way to further diversify risk and hedge against inflation. Proponents of investing in commodities claim that if commodities have low or even negative correlations with stocks and bonds then a portfolio which includes commodities should have better diversification properties than a similar portfolio which excludes commodities (Ibbotson Associates, 2006). Portfolios which include commodities may lead to higher returns and lower risk than portfolios that do not include commodities. Moreover, commodities have long been advocated as a way to hedge against inflation (Greer, 1978). Erb and Harvey (2006) present some evidence to show that a portfolio of stocks and commodities can have higher returns and lower risk than a portfolio of stocks only. Gorton and Rouwenhorst (2006) find that commodity futures returns are negatively correlated with the returns on equities. This suggests that adding a mix of hard and soft commodities to an equity portfolio might bring about a better risk and return tradeoff than just investing in equities. Ibbotson Associates (2006) find that including commodities in the portfolio opportunity set resulted in an increased efficient frontier. Hillier et al. (2006) investigate the usefulness of using precious metals (gold, silver, platinum) to provide portfolio diversification against adverse equity price movements. They find that all three precious metals have some ability to hedge adverse equity price movements in US stocks and EAFE stocks. They also find that portfolios that contain precious metals and equities outperform portfolios that only contain equities.

The recent financialization of commodity markets is providing investors with new ways to diversify their investment portfolios (e.g. Domanski and Heath, 2007; Dwyer et al., 2011; Silvennoinen and Thorp, 2013; Vivian and Wohar, 2012). Regulatory changes and the development of new financial markets for commodities allow investors greater access to commodity markets. Traditionally the main participants in the commodity futures markets were those companies or

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[1] Increased economic growth and integration into the world economy by emerging economies brings up opportunities for investors wishing to diversify their equity investment portfolio on a more global basis by investing in a mix of developed and emerging equity markets (eg. Shapiro, 2009,chap. 15).

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individuals who had a direct interest in the production or consumption of the underlying commodity. Now, thanks to the development and adoption of commodity index funds and commodity specific exchange traded funds (ETFs) anyone with a trading account can participate in the commodities market. These developments have led to more participants and greater liquidity in the commodity markets.

This paper makes several important contributions to the literature. First, while existing papers investigate the volatility dynamics between stock prices and commodity prices most of this literature focuses on the relationship between developed economy stock markets and oil prices or the relationship between oil prices and other commodities. This paper is specifically focused on the volatility dynamics between emerging market stock prices and the prices of copper, oil, and wheat. The choice of these assets is based on their importance to the global economy. In the past several decades there has been a remarkable shift in the composition of global GDP. In 1980, for example, the advanced economies accounted for 69% of global GDP while emerging and developing countries accounted for 31%.[2] In 2010, the advanced economies accounted for 52% of global GDP while emerging and developing countries accounted for 48% of global GDP. According to The Economist (2011), which uses a somewhat broader classification of emerging economies than the one used by the IMF, emerging economies consume 60% of the world's energy, 65% of all copper and 75% of all steel. Emerging economies use 55% of the world's oil but per capita oil consumption is less than 1/5 of that in the developed economies.[3] Oil is a major fuel source used throughout the world but the biggest increases in oil consumption are expected to come from emerging economies. Copper is an important industrial commodity that moves with the business cycle. Copper is often referred to as "Dr. Copper" because of the ability of copper price movements to predict economic activity. Wheat is a major food. For example, nine of the top 10 wheat consuming nations are emerging economies[4] and these 9 countries have a combined population of 3.4 billion. Second, most of the existing literature on volatility dynamics uses bivariate GARCH models. This paper differs from previous studies by comparing the performance of the dynamic conditional correlation AGARCH (DCC-AGARCH) model of Engle (2002) with the VARMA-AGARCH model of McAleer et al. (2009), to study the dynamic correlations between emerging market stock prices, copper prices, oil prices and wheat prices. The advantage of doing this is that the correlations and volatility dynamics between all variables are included in one multivariate GARCH (MGARCH) model.

In this paper, DCC-AGARCH and VARMA-AGARCH models are used to model volatility and dynamic conditional correlations between emerging market stock prices and the prices of copper, oil, and wheat. It is found that the dynamic conditional correlation model fits the data best and this model is then used to construct hedge ratios and optimum portfolio weights. The following sections of the paper set out the literature review, empirical model, data, discussion, and conclusions.

2. Literature review

This section presents a short literature review of papers that focus directly on the volatility dynamics between oil prices and other important markets like equities, metals and food. There are a number of recent papers studying volatility spillovers between equities and oil prices. Malik and Hammoudeh (2007) study the volatility transmission between the US equity market, global oil market and the Gulf equity markets of Bahrain, Kuwait and Saudi Arabia. They find volatility spillovers from the oil market to Gulf equity markets. They find evidence of bidirectional volatility spillovers in the case of Saudi Arabia. Malik and Ewing (2009) use bivariate BEKK-GARCH(1,1) models to estimate volatility transmission between oil prices and US sector stock indexes (Financials, Industrials, Consumer Services, Health Care, Technology). They find evidence of significant transmission of shocks and volatility between oil prices and some of the industry sectors. Arouri et al. (2011a) estimate bivariate GARCH models using weekly data from January 1998 to December 2009 to investigate volatility spillovers between oil and stock market sectors in the US and Europe. They find evidence of a spillover effect from oil to stock markets in Europe and a bidirectional spillover effect between oil and US stock market sectors. Arouri et al. (2011b) estimate bivariate GARCH models over the period 2005 to 2010 to determine return and volatility transmission between oil prices and stock markets in the Gulf Cooperation Council (GCC) countries. The results indicate the existence of spillovers between these markets. Arouri et al. (2012) estimate bivariate GARCH models using weekly data from January 1998 to December 2009 to investigate volatility spillovers between oil and stock markets in Europe. Analysis is conducted using a broad European stock market index as well as industry specific stock market indexes. They find evidence of volatility spillovers between oil prices and stock prices. Filis et al. (2011) use multivariate GARCH models to analyze time varying correlations between oil prices and the stock prices of oil exporting (Brazil, Canada, Mexico) and oil importing (Germany, Netherlands, USA) countries. Conditional variances between stock prices and oil prices do not vary much between oil exporting countries and oil importing countries. Chang et al. (2013) use multivariate GARCH(1,1) models to study volatility spillovers between oil prices and the stock prices of US and UK equity prices. They find no significant evidence of volatility spillovers between oil prices and equity prices. Sadorsky (2012) uses multivariate GARCH(1,1) models to investigate volatility spillovers between the stock prices of clean energy companies, technology companies and oil prices. There is some evidence of volatility spillovers between these data series. The stock prices of clean energy companies correlates more highly with technology stock prices than with oil prices which has implications for investors. Mollick and Assefa (2013) use multivariate GARCH models to study the dynamics between US stock returns and several macroeconomic and financial variables (inflation, VIX, interest rates, gold prices and exchange rates). They find that the correlation dynamics between most assets changed after the most recent financial crisis (2008–2009). Hwang et al. (2013) use DCC-EGARCH models to estimate dynamic conditional correlations between the US stock market and 10 emerging stock markets. Evidence is presented showing an increase in correlation in all countries. Results from a DCCX-MGARCH model show that an increase in the US CDS spread and TED spread decrease conditional correlations while increases in the VIX index, foreign institutional investment, and exchange rate volatility increase conditional correlations.

Guesmi and Fattoum (2014) use DCC-AGARCH models to estimate dynamic conditional correlations between oil importing countries (USA, Italy, Germany, Netherland and France) and four oil-exporting countries (United Arab Emirates, Kuwait, Saudi Arabia and Venezuela). They find that cross-market comovements as measured by conditional correlation coefficients increase positively in response to significant aggregate demand (precautionary demand) and oil price shocks due to global business cycle fluctuations or world turmoil. Furthermore, oil prices exhibit positive correlation with stock markets indicating that oil assets are not very useful for stock market risk diversification during periods of economic and financial turmoil.

Hammoudeh and Yuan (2008) use univariate GARCH models to study the volatility behavior of gold, silver and copper prices in response to crude oil and interest rate shocks. The leverage effect is significant only for copper. The impact of past oil shocks on metal prices depends upon the metal being studied. Hammoudeh et al. (2011) examine

[2] This definition of advanced economies is based on the IMF WEO (2012) classification and includes the United States, 17 countries in the Euro Area, Japan, the United Kingdom, Canada and 13 other advanced economies. All other countries are classified as emerging. Data sourced from http://www.econstats.com/weo/V012.htm.

[3] Developed economies consist of the original members of the OECD excluding Turkey. All other countries are classified as emerging.

[4] In order of largest wheat consumption: China, India, Russia, United States, Pakistan, Turkey, Iran, Egypt, Brazil, and Ukraine. Data sourced from http://www.nationmaster.com/graph/agr_gra_whe_con-agriculture-grains-wheat-consumption.