

# Problem Statement:

The interconnectedness of commodity prices and equity markets with macroeconomic variables has increased manifold in this decade. Therefore, there is an imperative need to understand systemic risk. Traditional financial research has been negligent toward crude oil and gold, which are some of the most important commodities given their key role in production and energy markets, as well as safe-haven assets. Added to this are global crises—the 2008 financial meltdown, the COVID-19 pandemic, and ongoing geopolitical tensions like that between Ukraine and Russia—further complicating the dynamics of markets, increasing volatility, and shifting the very nature of risk interdependencies.

Current methods of risk assessment, basically focusing on average market conditions, cannot be applied to catch the subtlety arising regarding various quantile levels, especially under extreme market conditions.

In this respect, our study tries to bridge this gap by using advanced machine learning and statistical inference techniques to explore both the visible and hidden relationships between oil prices and other investment instruments, thus focusing on the Quantile Time-Varying Parameter Vector Autoregression model. We localize and analyze supply and demand shocks to understand their wide-ranging specific effects on the financial markets. Our research is going to develop a comprehensive examination of the dynamics existing between commodities, forex, and market sentiments with stock indices in usual and extreme market conditions. This learning shall be presented in terms of predictive models and actionable advice for market participants, investors, and policymakers. The final objective would thereby be to deepen the knowledge about the dependencies among financial markets through the use of improved analytical methods, allowing for reasonable decision-making during enhanced uncertainty and risk.

# Literature Review

The relationship between the crude oil market and various financial markets, as well as key economic indicators, has been extensively studied, with numerous researchers employing diverse methodological approaches to explore these interactions.

Chisti et al. (2) researched an empirical inquiry into how various economic indicators, specifically foreign institutional investments, exchange rates, and crude oil prices, are interrelated and impact on stock market performance in relation to the Nifty 50 index in the Indian financial system[10]. Neely researched the impact of the Russia–Ukraine war on the prices of oil and other sanctioned commodities as did Qi Zhang et al. They all come to the conclusion that when such a big exporter goes offline either because of sanctions or because of infrastructural problems, this inevitably affects the supply of oil [1],[2]. Khan et. al (4) go one step further and analyze how extreme geopolitical events affect freight prices, which are a very important part of pricing commodities [19]. Hung (60) combined wavelet coherence analysis with a multivariate DCC-GARCH model to analyze the time-frequency dynamics between exchange rates, stock markets, and international commodities markets, in particular, gold and oil [12]. Reddy et al. (599) analyzed six macroeconomic indicators, namely inflation, interest rates, gold, silver, crude oil, and exchange rates, for their effects on sectoral performance and pointed out the complex interrelationship among various dimensions of macroeconomic factors and the outcomes in sectors. Rehman and Vo (3) examined the returns integration between commodities in precious metals, energy, and industrial metals, in an attempt to reveal the interconnectivity and interdependencies among these categories of commodities [15]. Shah et al. (2) conducted an in-depth study into the dependence between crude oil, precious metals (including gold), and foreign exchange markets using both time and frequency domains [14]. Finally, making a more solid empirical analysis, Tiwari et al. (1) evaluated the systemic risk and interdependencies across stock market indicators with the oil market of G7 economies [13]. Lastly, Wei et al. (24) combine wavelet techniques with statistics of long memory to explore long-term correlations among Chinese stock market indices and crude oil futures, looking at the effects of more recent financial crises [17]. Fu et al. (2) use wavelet analysis and Non-linear distributed lag modelling (NARDL) to study the relationship between subjective factors, consumer sentiment and inflation expectations, and energy prices, focusing on Brent crude and natural gas. Their study revealed that there is a negative relationship between consumer sentiment and energy prices and a positive relationship between inflation expectations and energy prices [20]. Shang and Hamori (1) analyzed the relationship and spillover effect between crude oil, gold, financial markets and macroeconomic indicators using a quantile time-frequency connectedness approach. Kalman filter was used within the Time-Varying Parameter Vector Autoregression (TVP-VAR) model to estimate the time-varying parameters and later apply the model for forecasting purpose suggestions [21].

In recent years, quantile connectedness has become the focus of academic inquiry. This is due to the ability to detect specific associations in different quantile tails. and severe market conditions This method is extremely valuable for analyzing financial markets and a wide range of indicators. Such detailed analysis enhances risk assessment and facilitates, as well as supports the development of bespoke risk management strategies tailored to different market stress levels (Ando and Bai 270) [3]. Quantile connectedness, such as the Quantile TVP-VAR analysis, not only helps investors detect early signs of market downturns and upswings. But it also serves as an advanced forecasting tool for anticipating market fluctuations and major economic changes. This novel approach helps protect portfolios and capitalize on emerging opportunities. In the same manner, policymakers can also leverage this approach to design responsible policies that adapt to fluctuating market conditions (Ando et al. 2402). This will increase the ability of investors, central banks and government agencies to make informed and flexible decisions. which promotes economic stability... Moreover, quantile connectedness has proven effective in assessing rare but high-impact tail risks. It provides a comprehensive approach that facilitates dynamic analysis of the market under various situations. The quantitative time-frequency method pioneered by Chatziantoniou et al. (2) shows improved integration of time-frequency quantile exposure methods [9]. This innovative framework was developed by Chatziantoniou et al. (4) and Ando et al. (1) and offered a unique ability to examine relationships within the time-frequency spectrum and across quantile ranges. Doing so, the method provides a comprehensive analysis of the interaction between financial markets and indicators under various conditions, as well as helps to gain a deeper understanding of market changes.

# Competitor Analysis

The SWOT analysis of the market competitor and the study positioning efforts are represented as follows:

**Strengths**

* Several different models provide evidence that oil prices are impacted by various factors.
* The factors that influence oil prices are numerous
* Studies proved that there are interdependencies among commodities

**Weaknesses**

* Existing studies seldom provide actionable insights during extreme market conditions, if any at all.
* Complex models are used without detailed explanation

**Opportunities**

* There are a lot of hidden market dependencies that are yet to be discovered.
* The impact of sentiment measure on oil prices is not yet well-studied
* There is limited existing research on the Australian market
* There is a demand for actionable insights, especially during extreme market conditions

**Threats**

* Studies on interdependencies and oil prices are rapidly developing, so there is a risk that this research will quickly become irrelevant.
* The interdependencies and connectedness structure are rapidly evolving, which could render the result of this study obsolete in the future.

Source Code Link (Google Colab):

Please view the current state of the Source Code and initial findings of descriptive analysis and EDA results from the following link: [Source Code](https://colab.research.google.com/drive/1lg6j-ht5tcc0BKkAhG02X2N2Lcn9Xt0p?usp=sharing)

Or: https://colab.research.google.com/drive/1lg6j-ht5tcc0BKkAhG02X2N2Lcn9Xt0p?usp=sharing

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