Final Report: Correlation Analysis of Global Commodities and US Stock Indices

Submitted to:

Prof. Shanti Konda

Department of Computer Science and Engineering

Report Prepared By:

Mohammed Bookwala

Student, BSc Psychology, Artificial Intelligence and Data Science

RV University: Bangalore, India

(91) 9986257789

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1. Introduction

Summary

This project presents a correlation analysis of global commodities and US stock indices. Specifically, the focus is on analyzing the relationships between **crude oil and industrial metals**, the **NASDAQ and palladium** (both showing positive correlations), as well as the **US dollar with platinum**, and the **US dollar with crude oil** (both showing negative correlations). The data for this study was primarily sourced from *Kaggle*, involving several datasets that were merged and cleaned to create the final dataset used for analysis. The data was then normalized to facilitate easy plotting, allowing multiple commodities to be visualized simultaneously.

Big Questions

The key question driving this analysis is to understand why these observed strong correlations (both positive and negative) exist and to explore the underlying dynamics of the global market that contribute to these relationships.

2. Body

2.1 Data

- **Data Overview**: The dataset was sourced entirely from *Kaggle*, including multiple datasets related to commodities and stock indices. The data included variables such as **commodity prices**, **stock indices**, and the **US dollar strength**.

- **Data Preprocessing**: All datasets were merged, and null values were removed to ensure data quality. The data types were standardized by converting relevant columns to integers or floats, and column names were renamed for consistency. The data was normalized to facilitate consistent visualizations across different commodities and indices.

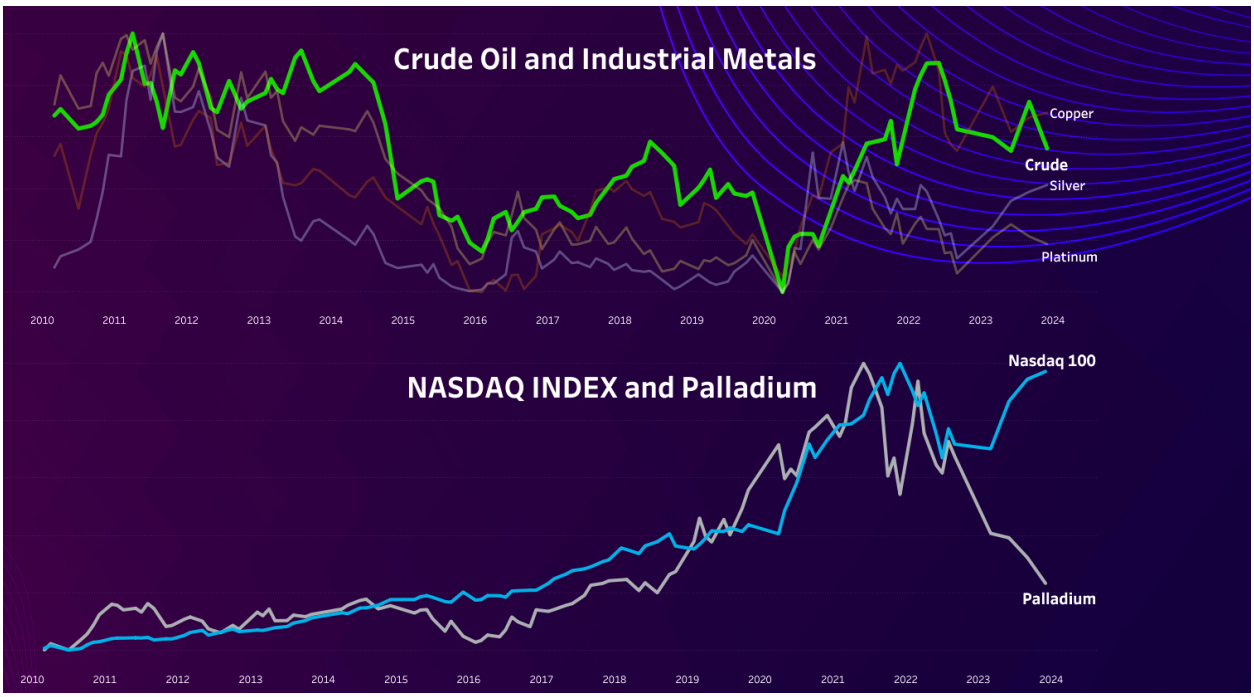
2.2 Methods

- **Statistical Methods**: The main statistical method used was the *Pearson correlation coefficient*, which allowed us to measure the strength and direction of relationships between variables. In addition, a *rolling correlation* was applied to two of the correlation pairs—**NASDAQ and palladium** (positive correlation), and **US dollar and platinum** (negative correlation)—to visualize how these relationships evolved over time.
- **Tools**: The project was implemented using **Jupyter Notebook**, leveraging Python libraries such as **pandas** for data processing, **Matplotlib** and **Seaborn** for visualizations, and **Tableau** for additional visual insights.

2.3 Analysis

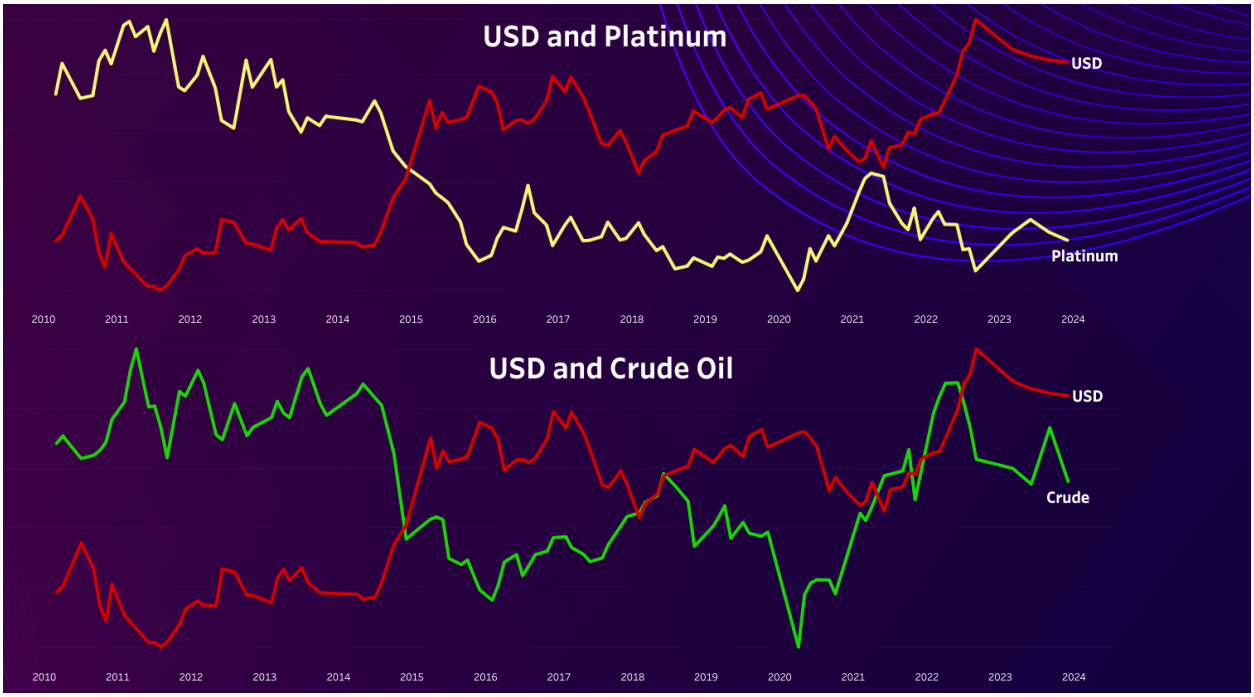
- **Question**: *Why do these correlations exist, and what dynamics drive them?*
- **Method**: Each of the four correlations was analyzed using the *Pearson correlation coefficient* to quantify the strength of the relationship.
- **Results**:
    - **Crude Oil and Industrial Metals (0.67)**: The positive correlation between crude oil and industrial metals indicates that these commodities tend to move together, largely due to their shared dependence on global economic activity. When the economy is performing well, both crude oil and industrial metals experience increased demand, driven by industrial production and manufacturing needs. This relationship is also influenced by shared supply chain factors, such as extraction and distribution costs.
    - **NASDAQ and Palladium (0.86)**: The high correlation between the NASDAQ and palladium reflects the significant role of palladium in the technology sector, particularly in electronics manufacturing. Palladium is a key component in many electronic devices, and the demand for technology products directly impacts

palladium consumption. As technology companies perform well, represented by NASDAQ's growth, the demand for palladium rises accordingly, leading to a strong positive correlation.



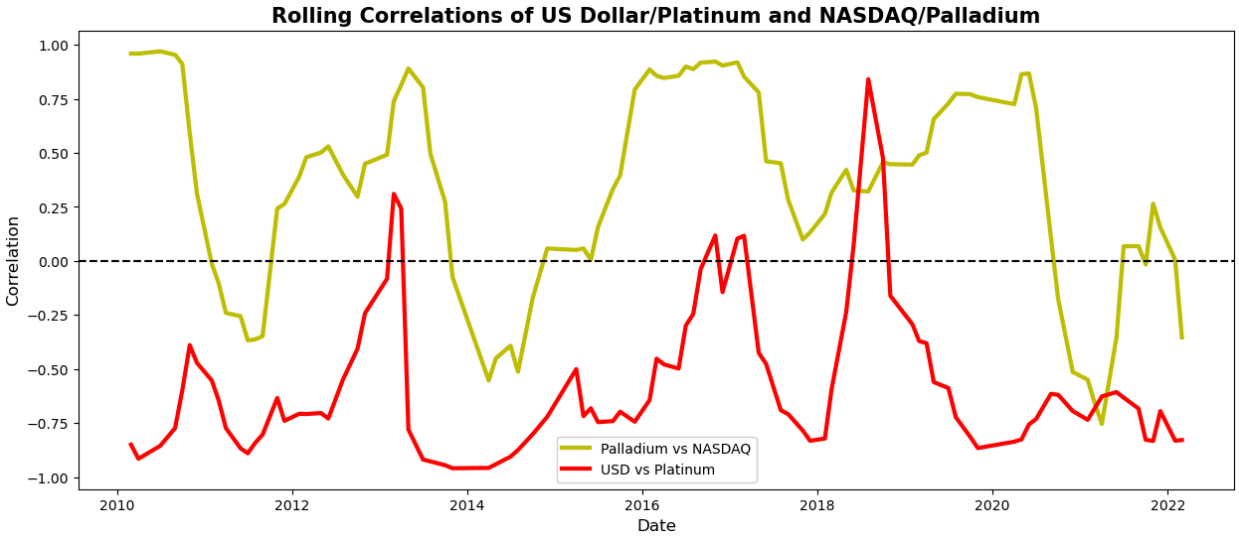
- **US Dollar and Platinum (-0.91)**: The strong negative correlation between the US dollar and platinum suggests that platinum prices typically fall when the US dollar strengthens. This inverse relationship is common among precious metals, as a stronger dollar makes commodities like platinum more expensive for foreign investors, reducing demand. Platinum's use in industrial applications, such as automotive catalytic converters, also means its price is sensitive to economic shifts that are influenced by currency fluctuations.
- **US Dollar and Crude Oil (-0.62)**: The negative correlation between the US dollar and crude oil indicates that crude oil prices generally decrease when the US dollar strengthens. Since crude oil is traded globally in US dollars, a stronger dollar makes oil more expensive for other countries, leading to reduced demand and lower prices. This relationship is also influenced by global supply and

demand dynamics, as well as geopolitical factors that can impact both the currency and oil prices.



- **Rolling Correlation Analysis**: *Rolling correlations* for **NASDAQ/palladium** and **US dollar/platinum** were calculated to understand how these relationships fluctuated over time, highlighting periods when the correlations were stronger or weaker.

- **Conclusion for Each Correlation**: The analysis suggests that positive correlations are driven by common economic factors, such as industrial demand, while negative correlations reflect the inverse impact of dollar strength on commodity prices. Each relationship is influenced by global market forces, including supply-demand dynamics and economic policies.


Rolling Correlations of US Dollar/Platinum and NASDAQ/Palladium
Correlation
Date
Palladium vs NASDAQ
USD vs Platinum
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
2010
2012
2014
2016
2018
2020
2022

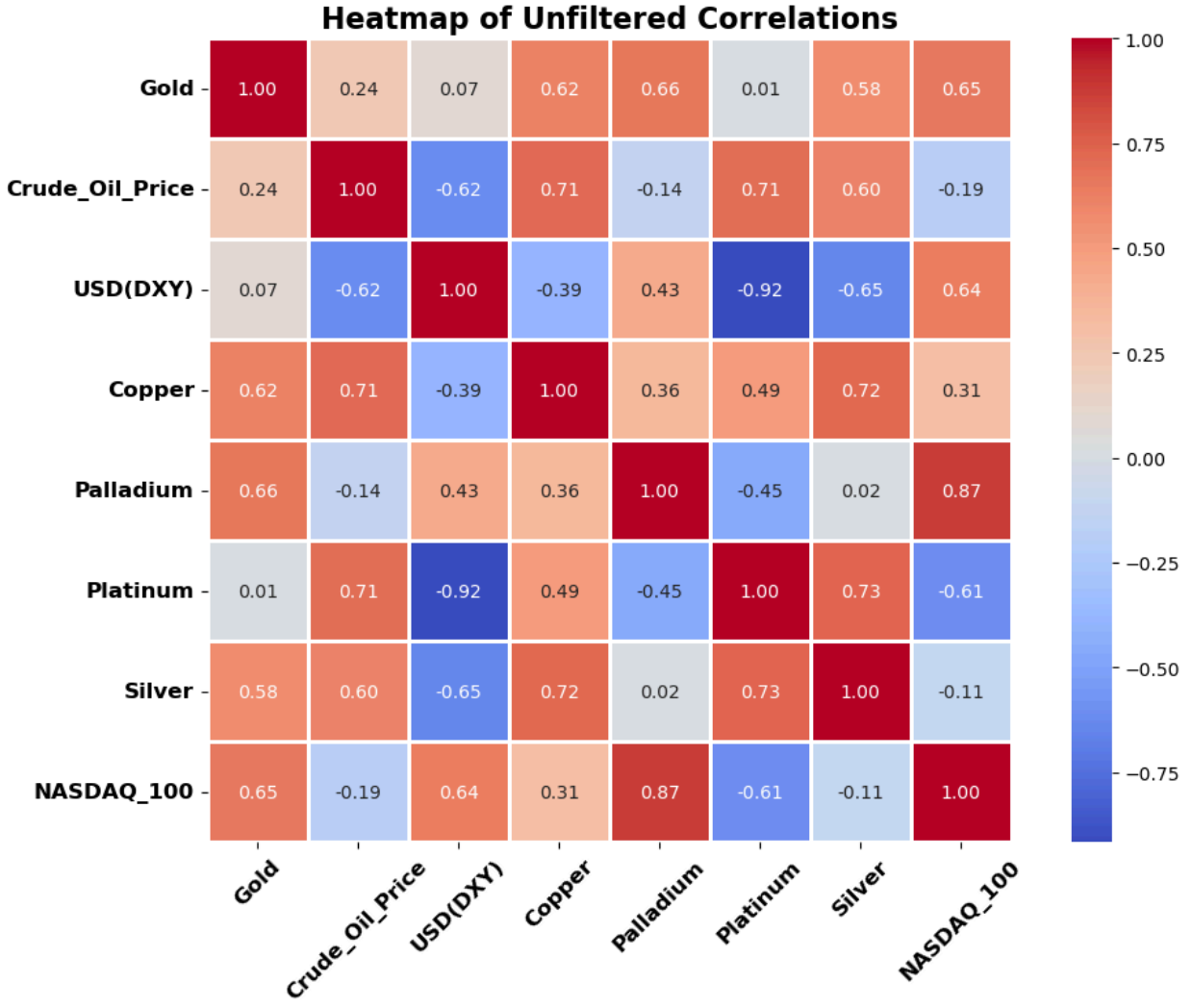

Heatmap of Unfiltered Correlations
Gold 1.00 0.24 0.07 0.62 0.66 0.01 0.58 0.65
Crude_Oil_Price 0.24 1.00 -0.62 0.71 -0.14 0.71 0.60 -0.19
USD(DXY) 0.07 -0.62 1.00 -0.39 0.43 -0.92 -0.65 0.64
Copper 0.62 0.71 -0.39 1.00 0.36 0.49 0.72 0.31
Palladium 0.66 -0.14 0.43 0.36 1.00 -0.45 0.02 0.87
Platinum 0.01 0.71 -0.92 0.49 -0.45 1.00 0.73 -0.61
Silver 0.58 0.60 -0.65 0.72 0.02 0.73 1.00 -0.11
NASDAQ_100 0.65 -0.19 0.64 0.31 0.87 -0.61 -0.11 1.00
Gold
Crude_Oil_Price
USD(DXY)
Copper
Palladium
Platinum
Silver
NASDAQ_100
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75

Table 2.3.1 Pairwise Correlation Matrix ($p<0.05$)

X	Y	method	alternative	n	r	CI95%	p-unc	BF10	power
Gold	Crude_Oil_Price	pearson	two-sided	103	0.2438642846	[0.05 0.42]	0.01305	2.569	0.705216784
Gold	Copper	pearson	two-sided	103	0.6226214461	[0.49 0.73]	0	4.382e+09	0.9999999588
Gold	Palladium	pearson	two-sided	103	0.6634958393	[0.54 0.76]	0	3.735e+11	0.9999999993
Gold	Silver	pearson	two-sided	103	0.5803232493	[0.44 0.7]	0	8.409e+07	0.9999986777
Gold	NASDAQ_100	pearson	two-sided	103	0.6519021217	[0.52 0.75]	0	9.867e+10	0.9999999976
Crude_Oil_Price	USD(DXY)	pearson	two-sided	103	-0.6228054879	[-0.73 -0.49]	0	4.464e+09	0.9999999595
Crude_Oil_Price	Copper	pearson	two-sided	103	0.7080962069	[0.6 0.79]	0	1.152e+14	1
Crude_Oil_Price	Platinum	pearson	two-sided	103	0.7058035296	[0.59 0.79]	0	8.356e+13	1
Crude_Oil_Price	Silver	pearson	two-sided	103	0.6036592894	[0.46 0.71]	0	6.919e+08	0.9999997872
USD(DXY)	Copper	pearson	two-sided	103	-0.3856749658	[-0.54 -0.21]	0.00006	359.271	0.9831945957
USD(DXY)	Palladium	pearson	two-sided	103	0.4337138793	[0.26 0.58]	0	3749.229	0.9965805898
USD(DXY)	Platinum	pearson	two-sided	103	-0.9178502475	[-0.94 -0.88]	0	6.83e+38	1
USD(DXY)	Silver	pearson	two-sided	103	-0.6453685198	[-0.75 -0.52]	0	4.78e+10	0.9999999954
USD(DXY)	NASDAQ_100	pearson	two-sided	103	0.6399684078	[0.51 0.74]	0	2.661e+10	0.999999992
Copper	Palladium	pearson	two-sided	103	0.3551779516	[0.17 0.51]	0.00023	98.142	0.9616106993
Copper	Platinum	pearson	two-sided	103	0.4907275584	[0.33 0.62]	0	1.042e+05	0.9997014735
Copper	Silver	pearson	two-sided	103	0.7166013618	[0.61 0.8]	0	3.895e+14	1
Copper	NASDAQ_100	pearson	two-sided	103	0.309124864	[0.12 0.47]	0.00149	17.846	0.8942846576

Palladium	Platinum	pearson	two-sided	103	-0.45205 36357	[-0.59 -0.28]	0	1.02e+04	0.998325 0193
Palladium	NASDAQ_100	pearson	two-sided	103	0.866976 0085	[0.81 0.91]	0	1.12e+29	1
Platinum	Silver	pearson	two-sided	103	0.733160 4263	[0.63 0.81]	0	4.774e+15	1
Platinum	NASDAQ_100	pearson	two-sided	103	-0.60983 23484	[-0.72 -0.47]	0	1.245e+09	0.999999 8733

3. Conclusion

Summary of Findings

The analysis uncovered significant positive and negative correlations between global commodities and US stock indices. **Crude oil and industrial metals**, as well as **NASDAQ and palladium**, showed strong positive correlations driven by economic demand, while the **US dollar's** inverse relationship with **platinum** and **crude oil** highlighted the impact of currency strength on commodity prices.

Implications

Understanding these correlations provides insights into how different assets interact within the global economy. It helps to speculate on how commodities are interlinked and how they respond to broader economic changes.

Future Work

Future research could explore the use of **machine learning** and **deep learning algorithms** for forecasting trends and detecting anomalies. Additionally, these methods could help identify anomalies linked to geopolitical or economic events, providing further depth to the analysis.