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Statement of integrity: By typing the names of all group members in the text boxes below, you confirm that the assignment submitted is original work produced by the group (excluding any non-contributing members identified with an "X" above).	
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Use the box below to explain any attempts to reach out to a non-contributing member. Type (N/A) if all members contributed. **Note:** You may be required to provide proof of your outreach to non-contributing members upon request.
N/A

Step 1: Magnifying Risks

	Leverage	Non-Linearities
Scenario 1. Money at a fixed rate for an unsecured purchase (e.g. credit card) for an individual.	● High credit card balances can lead to leverage risk, where borrowers may struggle to repay debt.	● Non-linearity can exist due to compounding interest on credit card balances, increasing debt exponentially over time.
Scenario 2. Money at a floating rate for a secured purchase (e.g. home or automobile) for an individual.	● Borrowed money to down payment ratio is high for the secured purchase, which leads to the leverage challenge.	● Mortgage loan can be considered as an option for stocks since it has the same payoff as an option. Hence, Mortgage loan.
Scenario 3. Money at a fixed rate for a business for a construction loan.	● High leverage since business is borrowing large amounts relative to equity. ● Loan amount could be 5-10 times equity.	● Business success and loan repayment depend on project completion. ● Construction delays could lead to non-linear impacts.
Scenario 4. Publicly traded Equity (e.g. common stock) – that is, securities lending of a stock.	● Leverage challenge arises when companies use substantial debt, affecting financial stability and stock performance.	● Non-linearity in stock prices as small changes in company performance or market sentiment result in disproportionately large stock price fluctuations.
Scenario 5. Publicly traded bond (e.g. treasury bond, corporate bond) – that is, securities lending of a bond.	● Leverage arises when the collateralized assets are depreciating or have a lower value than the lent bond value.	● Relationship between bond and interest rate and demand for specific bonds can create non-linear payoffs.
Scenario 6. An illiquid security – you choose the security	● Using leverage with an illiquid security can result in difficulty executing large trades. ● High bid-ask spreads to be also considered.	● Low liquidity could exaggerate price moves. ● Non-linear price movements due to infrequent trading.

Step 2. Frictional Related Challenges

	Liquidity	Regulation
Scenario 1. Money at a fixed rate for an unsecured purchase (e.g. credit card) for an individual.	● Individuals may face liquidity constraints if they rely on credit cards for essential expenses, leading to financial strain.	● Regulations surrounding personal credit and lending practices to prevent predatory lending and excessive borrowing.
Scenario 2. Money at a floating rate for a secured purchase (e.g. home or automobile) for an individual.	● Non-fungible assets and long term loan repayment can create the liquidity issue for money lenders.	● Regulations such as TILA and RESPA acts and ATR rules are protect the borrowers against the loan.[1][2]
Scenario 3. Money at a fixed rate for a business for a construction loan.	● Illiquidity if construction is delayed. ● Limited market for construction loans.	● Building codes and zoning laws. ● Environmental regulations.
Scenario 4. Publicly traded Equity (e.g. common stock) – that is, securities lending of a stock.	● Low trading volume for certain stocks can lead to liquidity constraints for investors, impacting the efficiency of trading.	● Regulations on stock trading practices, insider trading, and market manipulation to maintain market integrity.
Scenario 5. Publicly traded bond (e.g. treasury bond, corporate bond) – that is, securities lending of a bond.	● Low liquid bonds and high demand bonds can lead to liquidity challenge to lend the bonds	● Regulation challages such as disclosure of risk to the borrower,colletral requirement and reposting of transaction.
Scenario 6. An illiquid security – you choose the security)	● Low trading volume. ● Difficulty to unwind a large position. ● High bid-ask spreads.	● Compliance with regulations when trading illiquid assets. ● Mining regulations and permit requirements affecting stock.

Step 3. Identifying Additional Data

Scenario 1: Money at a fixed rate for an unsecured purchase (e.g. credit card) for an individual.

1. **Data Type:** Unemployment rate, GDP, Asset, Credit

2. **Data Processing:** Correlation between Charge-Off Rate, GDP, and Unemployment rate

3. **Data Frequency:** Daily, Quarterly and at triggered events like a missed payment

4. **Data Class:** Personal data

5. **Data Source:** Fred and Yahoo Finance

6. **Data Variety:** Actual Data, Observed Data

Scenario 2: Money at a floating rate for a secured purchase (e.g. home or automobile) for an individual

1. **Data Type:** Mortgage Loan Interest Rates

2. **Data Processing:** Time series data of mortgage rates

3. **Data Frequency:** Weekly, Monthly

4. **Data Class:** Real Estate

5. **Data Source:** Mortgage loan lender, financial institutions or banks

6. **Data Variety:** Observed Data vs FED Interest rate

Scenario 3: Money at a fixed rate for a business for a construction loan.

1. **Data Type:** Asset, Economic, Accounting

2. **Data Processing:** Construction loan portfolio performance, interest rate movements, commodity price fluctuations, cash flows and income statements of borrowers

3. **Data Frequency:** Monthly, Quarterly

4. **Data Class:** Fixed Income, Economic

5. **Data Source:** Central Banks, Government Databases

6. **Data Variety:** Observed Data, Actual Data

Scenario 4: Publicly traded Equity (e.g. common stock) – that is, securities lending of a stock.

1. **Data Type:** Stock, Accounting, Economic

2. **Data Processing:** Raw prices / yields, Levels, Returns, Volumes

3. **Data Frequency:** Daily, Intraday

4. **Data Class:** Equity

5. **Data Source:** Stock exchanges, financial statements, market data providers

6. **Data Variety:** Trade Data vs Quote Data, Actual Data vs Estimated Data

Scenario 5: Publicly traded bond (e.g. treasury bond, corporate bond) – that is, securities lending of a bond.

1. **Data Type:** Economic, Bond market

2. **Data Processing:** Bond price, Returns, FED interest rate

3. **Data Frequency:** Daily, Weekly

4. **Data Class:** Fixed Income class

5. **Data Source:** Over the count (OTC)

6. **Data Variety:** Bond price vs Interest rate

Scenario 6: An illiquid security – you choose the security

1. **Data Type:** Asset, Economic

2. **Data Processing:** Stock prices, Financial performance, Commodity prices

3. **Data Frequency:** Daily, Monthly, Quarterly

4. **Data Class:** Equity, Economic

5. **Data Source:** Exchanges, Company Reports, Government Databases

6. **Data Variety:** Trade Data, Actual Data, Observed Data

Step 4. Go get the data

Charge-Off Rate on Credit Card Loans, All Commercial Banks (CORCCACBS)
https://fred.stlouisfed.org/series/CORCCACBS

30-Year Fixed Rate Mortgage Average in the United States:
https://fred.stlouisfed.org/series/MORTGAGE30US

HOUSEHOLD DEBT AND CREDIT REPORT:
https://www.newyorkfed.org/microeconomics/hhdc.html

Total Consumer Credit Owned and Securitized (TOTALSL) https://fred.stlouisfed.org/series/TOTALSL

Unemployment Rate (USA): UNRATE from FRED: https://fred.stlouisfed.org/series/UNRATE

Gross Domestic Product (GDP)

https://fred.stlouisfed.org/series/GDP

Delinquency Rate on Single-Family Residential Mortgages, Booked in Domestic Offices, All Commercial Banks:
 https://fred.stlouisfed.org/series/DRSFRMACBS

Federal Funds Effective Rate:
 https://fred.stlouisfed.org/series/FEDFUNDS

Producer Price Index by Commodity: All Commodities (PPIACO)
https://fred.stlouisfed.org/series/PPIACO

PPI by Commodity: Lumber and Wood Products: Lumber (WPU081)
https://fred.stlouisfed.org/series/WPU081

Total Construction Spending: Total Construction in the United States (TTLCONS)
https://fred.stlouisfed.org/series/TTLCONS

Solitario Resources Corp. (XPL)
https://finance.yahoo.com/quote/XPL

United States Treasury Yield 5 Years (^FVX):
https://finance.yahoo.com/quote/%5EFVX?p=%5EFVX

Step 5. Perform exploratory data analysis

Scenario 1: Money at a fixed rate for an unsecured purchase (e.g. credit card) for an individual.

Figure 1.
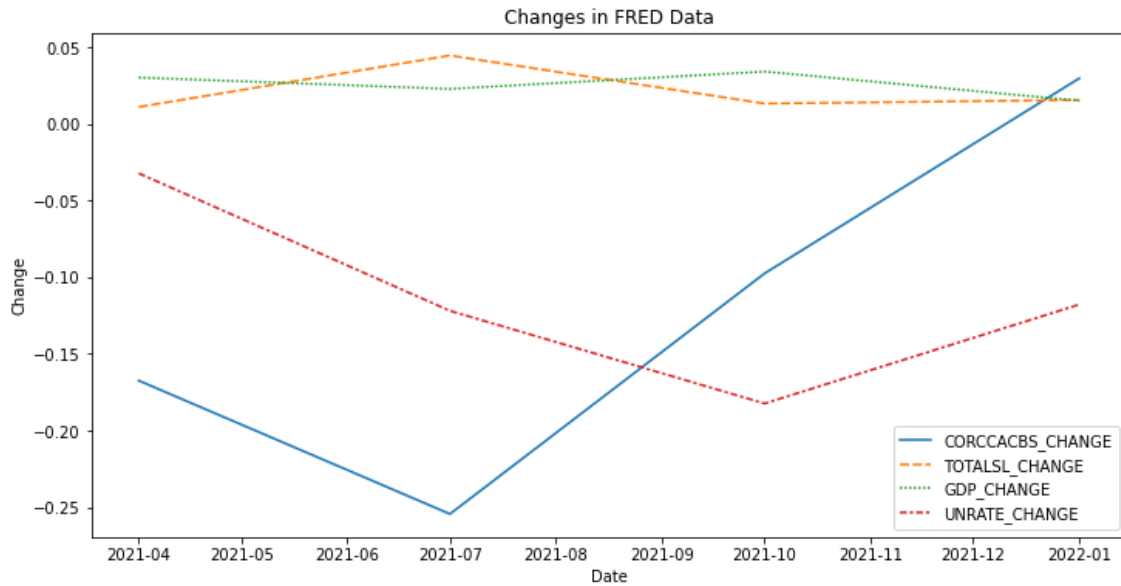
TOTALSL_CHANGE: Total Consumer Credit Owned and Securitized, Outstanding Change
UNRATE_CHANGE: Unemployment rate Change
**GDP_CHANGE:** Gross Domestic Product Change
CORCCACBS_CHANGE: Charge-Off Rate on Credit Card Loans, All Commercial Banks Change

Figure 1 shows from 1 Jan 2021 to 1 Jan 2022, Total Consumer Credit Owned and Securitized, Unemployment Rate, GDP, and Charge-Off Rate on Credit Card Loans 4 data change trends.

Figure 2.

	CORCCACBS_CHANGE	TOTALSL_CHANGE	GDP_CHANGE	UNRATE_CHANGE
CORCCACBS_CHANGE	1.0000	-0.6481	-0.4049	-0.2212
TOTALSL_CHANGE	-0.6481	1.0000	-0.3052	-0.1548
GDP_CHANGE	-0.4049	-0.3052	1.0000	-0.0918
UNRATE_CHANGE	-0.2212	-0.1548	-0.0918	1.0000

Figure 3.

Figure: CORCCACBS_CHANGE vs GDP_CHANGE

Figure: CORCCACBS_CHANGE vs UNRATE_CHANGE
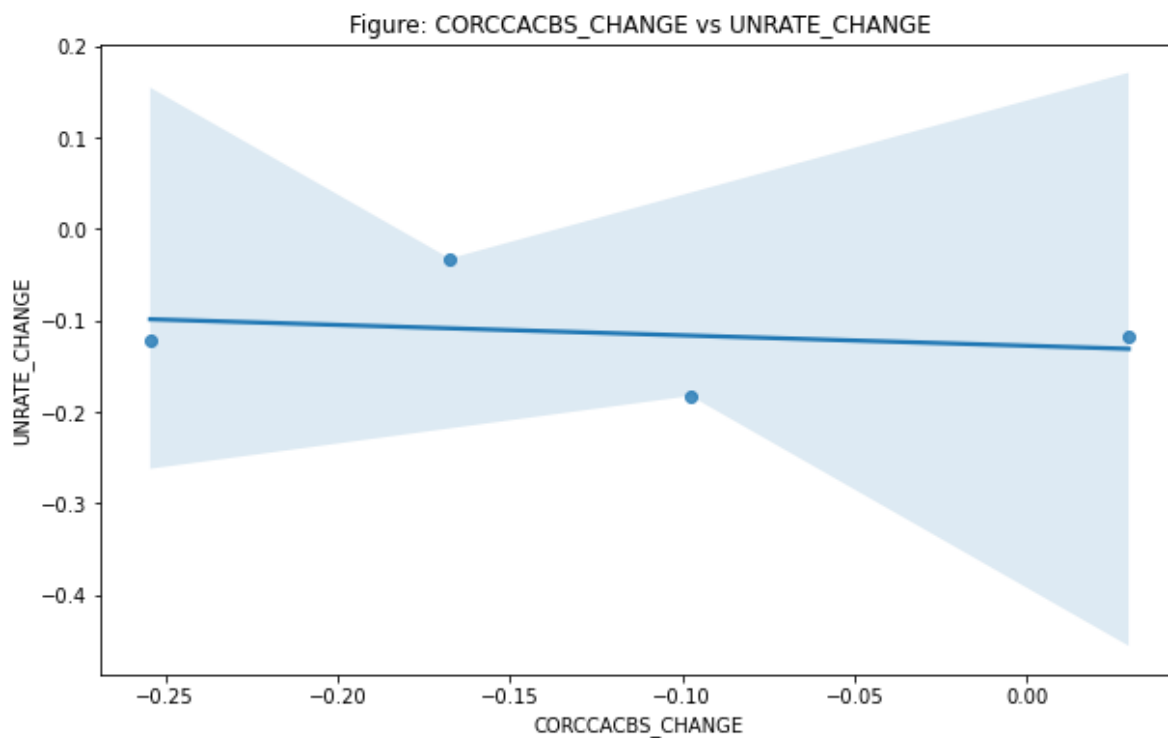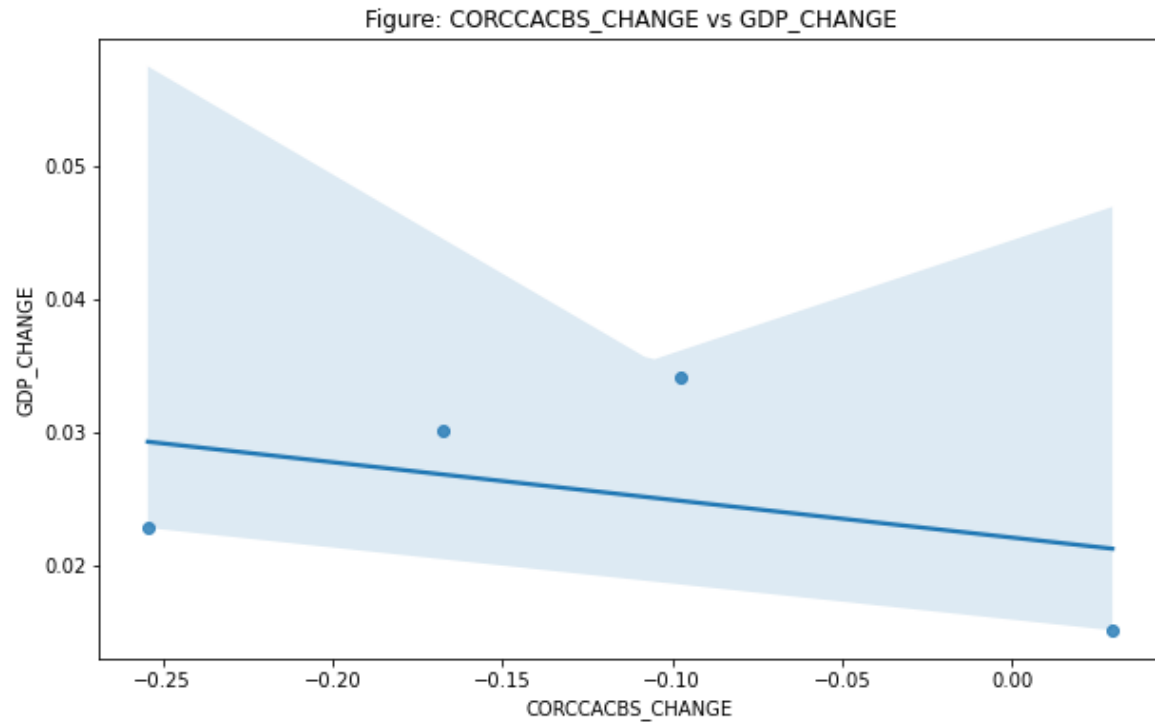
The above sheet and plot graphs show the moderately high negative correlation between the Charge-Off Rate on Credit Card Loans, All Commercial Banks (CORCCACBS) and Total Consumer Credit Owned and

Securitized. Its correlation coefficient is -0.6481. It also shows GDP is an important factor of CORCCACBS. The correlation coefficient is -0.4049.

Scenario 2: Money at a floating rate for a secured purchase (e.g. home or automobile) for an individual

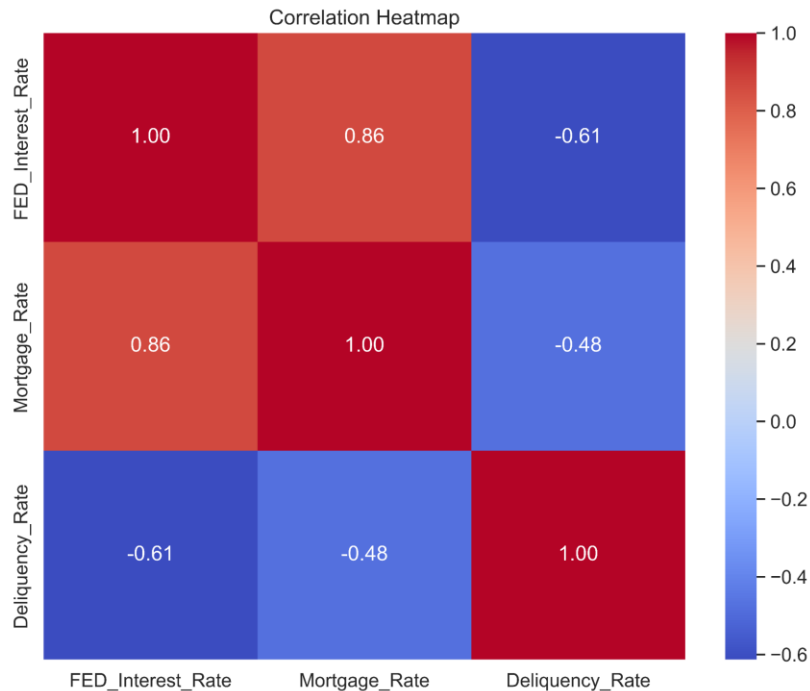**Figure 4:** Mortgage Rate vs Interest Rate

The above figure represents the correlation between the mortgage rate and the FED interest rate. Yearly data from 01-01-1991 to 01-01-2023 is taken for the plot. The Pearson and Spearman correlation between mortgage and interest rates is 0.86 and 0.84, respectively.

Figure 5: Delinquency Rate vs FED Interest Rate
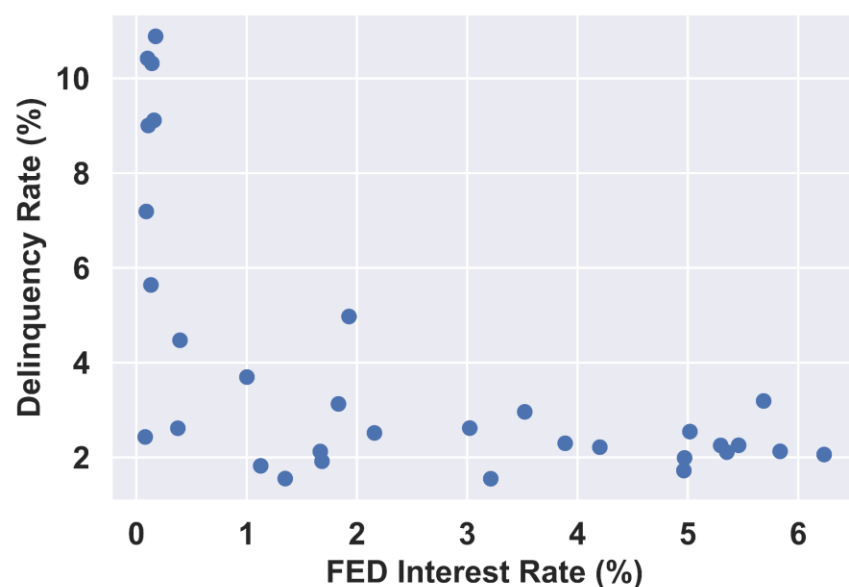
The above figure represents the correlation between the delinquency rate and the FED interest rate. Yearly data from 01-01-1991 to 01-01-2023 is taken for the plot. The Pearson and Spearman correlation between mortgage and interest rates is -0.61 and -0.56, respectively.
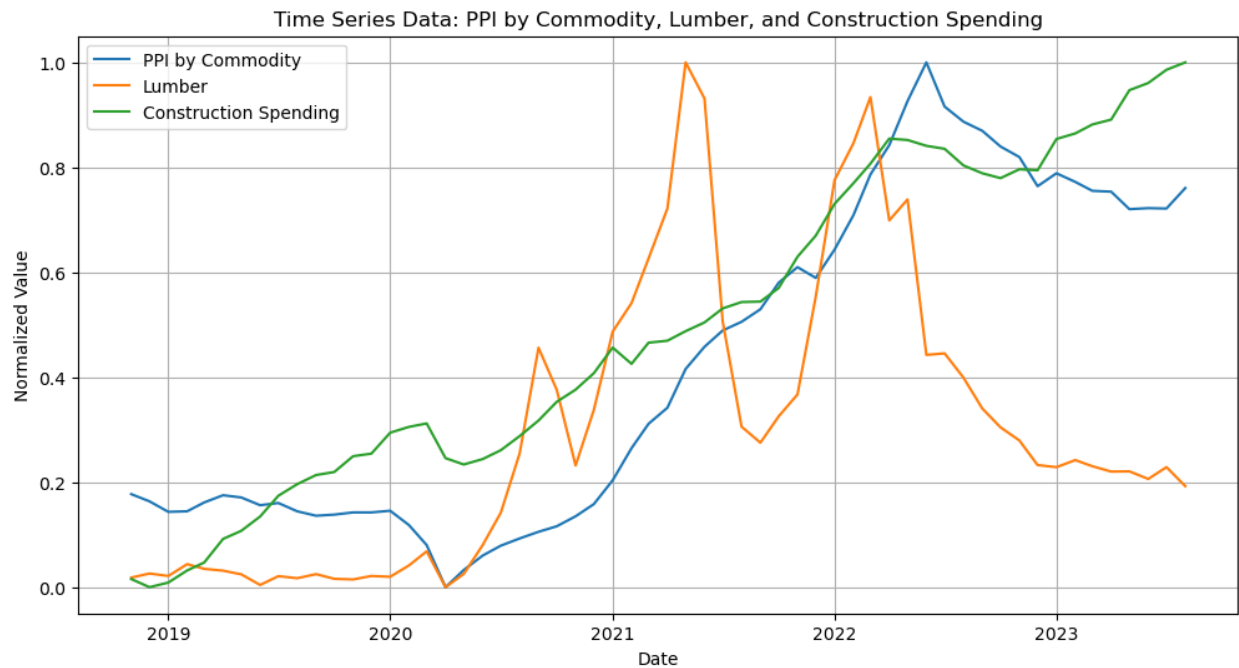
Figure 6. Correlation Matrix

The correlation matrix is shown in the above figure. The delinquency rate is negatively correlated to both the mortgage rate and the FED interest rate. At the same time, the mortgage rate is highly correlated to the FED interest rate.
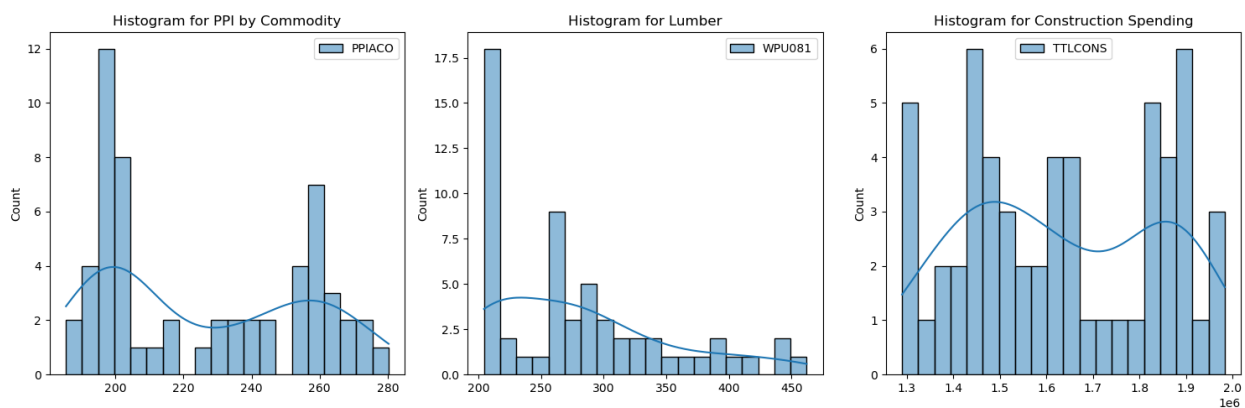
Scenario 3: Money at a fixed rate for a business for a construction loan

Figure 7.

The time series chart shows an overall upward trend for PPI, lumber prices, and construction spending over the period, with lumber being the most volatile.
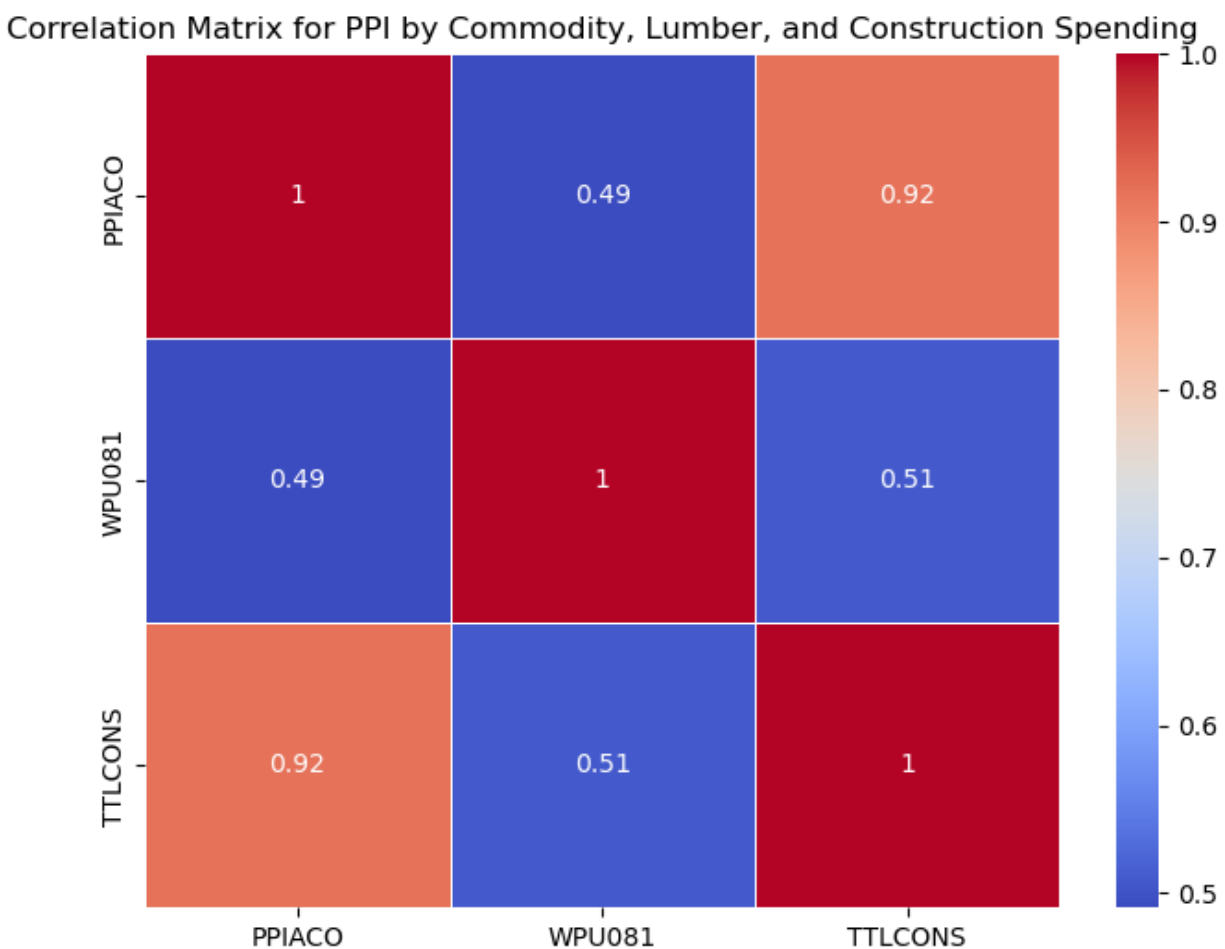
Figure 8.

PPI by Commodities histogram is slightly skewed right indicating a tail of higher price levels.
Lumber Histogram: The lumber price histogram has a long right tail showing the distribution is strongly skewed right due to extreme price spikes.

Construction Spending Histogram: Construction spending appears to follow a normal distribution centered around the mean of 1.6 million dollars.

Figure 9.

Correlation Matrix for PPI by Commodity, Lumber, and Construction Spending

	PPIACO	WPU081	TTLCONS
PPIACO	1	0.49	0.92
WPU081	0.49	1	0.51
TTLCONS	0.92	0.51	1

There is a very strong positive correlation between PPI and lumber prices, and moderate positive correlations between construction spending and the price indicators.

Scenario 4: Publicly traded Equity (e.g. common stock) – that is, securities lending of a stock.

Figure 10.

|	SOXX_Return	APPL_Return	AMD_Return	AMDvlo_Change	INTCvlo_Change	SOXXvlo_Change
SOXX_Return	1.000	0.724	0.677	-0.004	-0.033	-0.074
APPL_Return	0.724	1.000	0.515	-0.043	-0.118	-0.087
AMD_Return	0.677	0.515	1.000	0.186	-0.017	-0.074
AMDvlo_Change	-0.004	-0.043	0.186	1.000	0.321	0.187
INTCvlo_Change	-0.033	-0.118	-0.017	0.321	1.000	0.231
SOXXvlo_Change	-0.074	-0.087	-0.074	0.187	0.231	1.000

Figure 4 list down the correlation between Apple, AMD and iShares Semiconductor ETF(SOXX) returns change and correlation of AMD, Intel and SOXX transaction volumes change.

Figure 11.

Skewness: [2.90698633]
Kurtosis: [14.78762743]
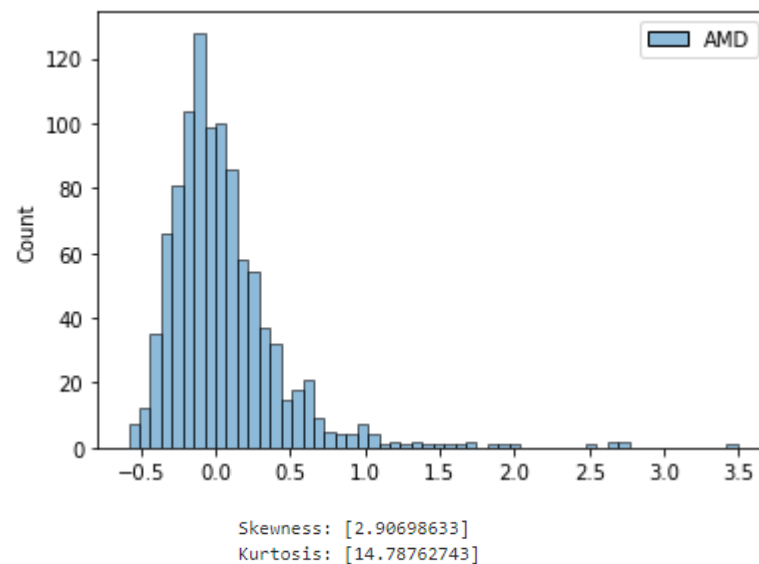
Histplot shows AMD stock volume change got: 1. Skewness: [2.90698633] 2. Kurtosis: [14.7872743] With 95.00% confidence.

Figure 12.
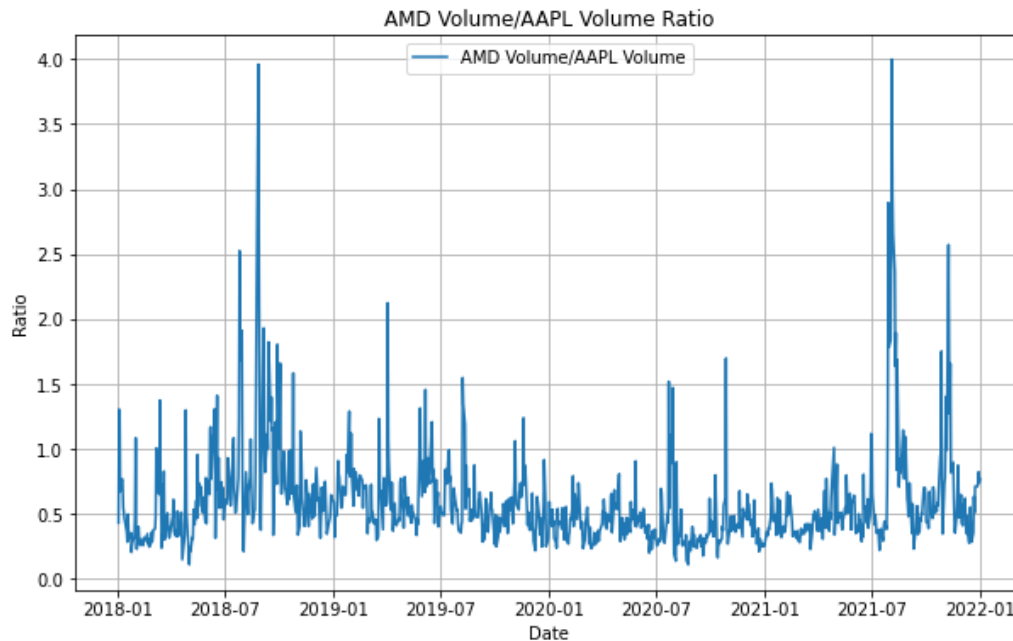
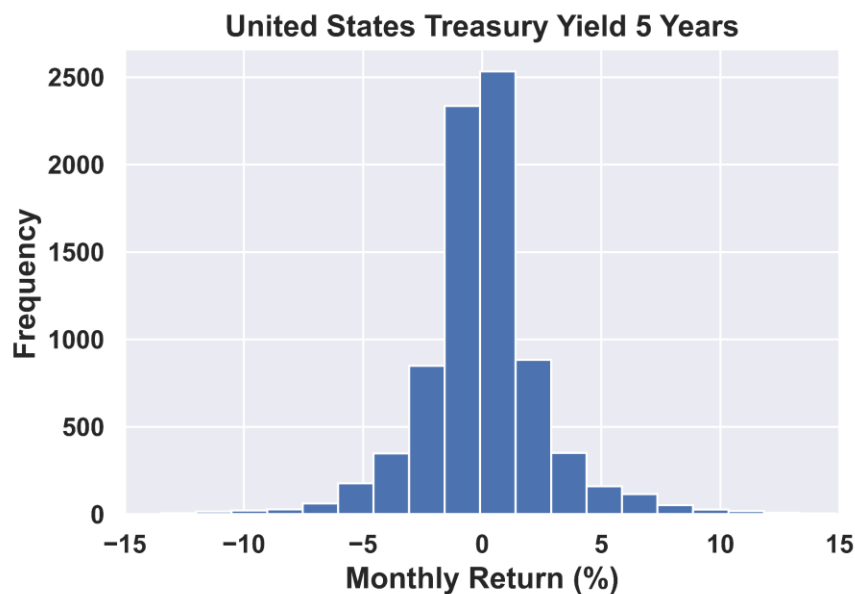Average ratio of AMD stock daily transaction volume divided by Apple stock daily transaction volume (1 Jan 2018 to 1 Jan 2022).

Scenario 5: Publicly traded bond (e.g. treasury bond, corporate bond) – that is, securities lending of a bond.

Figure 13. Return Histogram of treasury bond

The above figure represents the return histogram of the US treasury bond. Its average return is 0.03%, and std. deviation is 2.95. The distribution is positively skewed with a skewness of 0.91. Additionally, distribution is leptokurtic with kurtosis 20.41, which indicates the outlier returns.

Figure 14. Volatility of Treasury Bond
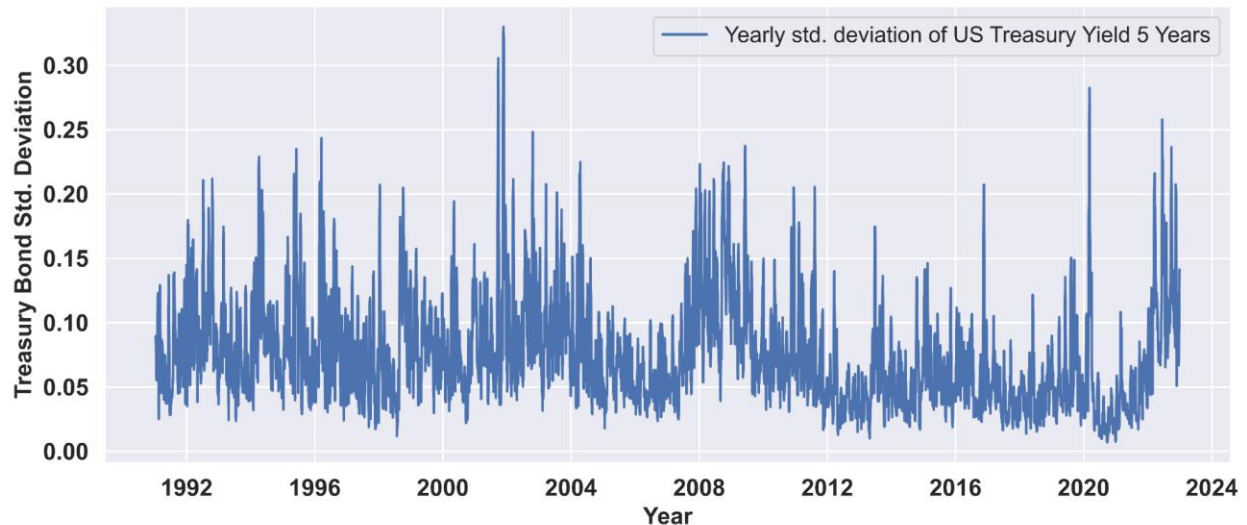
The above figure represents the volatility of US Treasury bonds. From the figure, we can state that the volatility of the bond is almost constant, and its median is 0.066.

Scenario 6: An illiquid security – you choose the security.

Figure 15. The price chart shows the historical daily prices for XPL displaying a clear overall downtrend over the period, along with some volatility and extreme price swings.

Historical Prices of XPL

Figure 16. The returns histogram demonstrates a distribution skewed to the right with fat tails indicating a higher probability of extreme positive and negative returns.
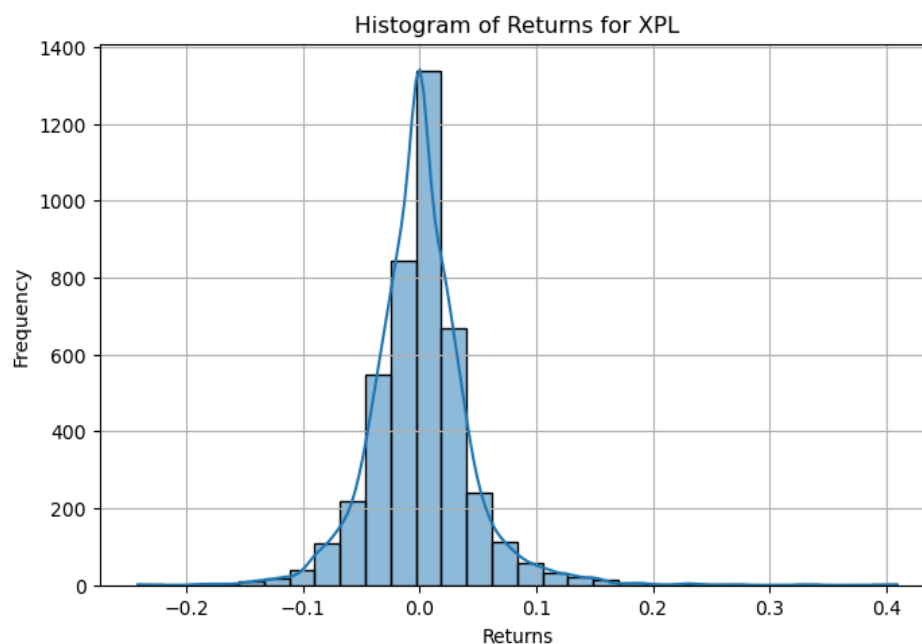

Histogram of Returns for XPL

Figure 17. The volume chart indicates consistently low daily trading volumes over the period, mostly below 100,000 shares per day, reflecting very low liquidity.
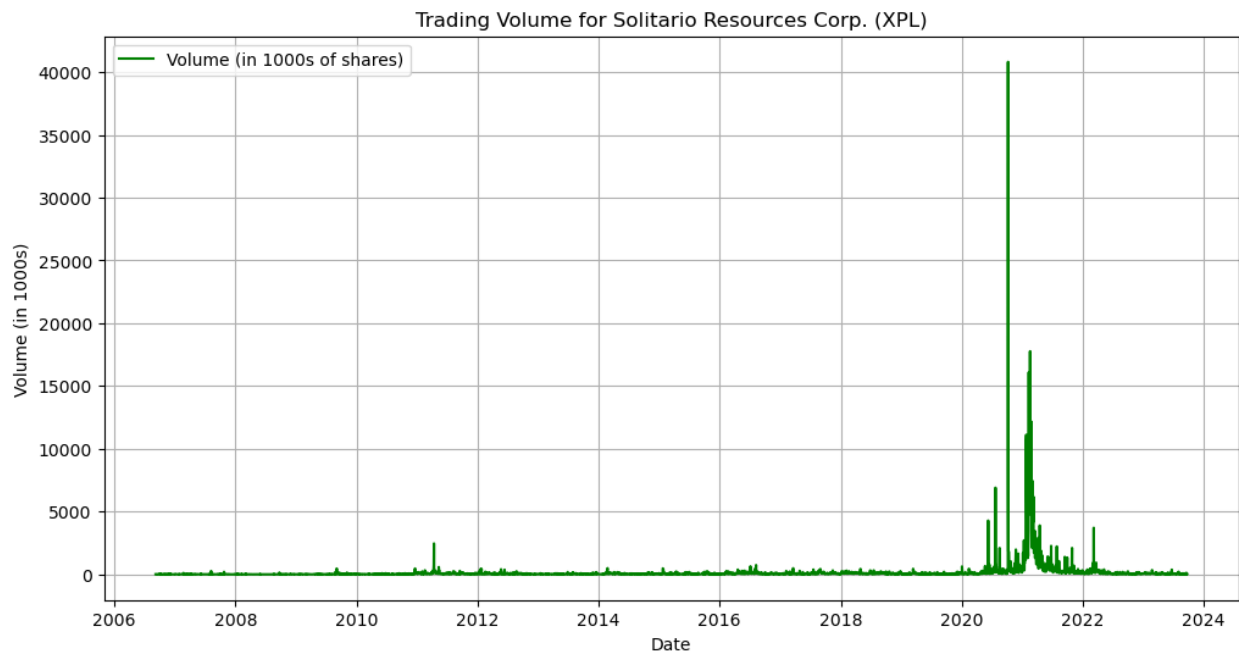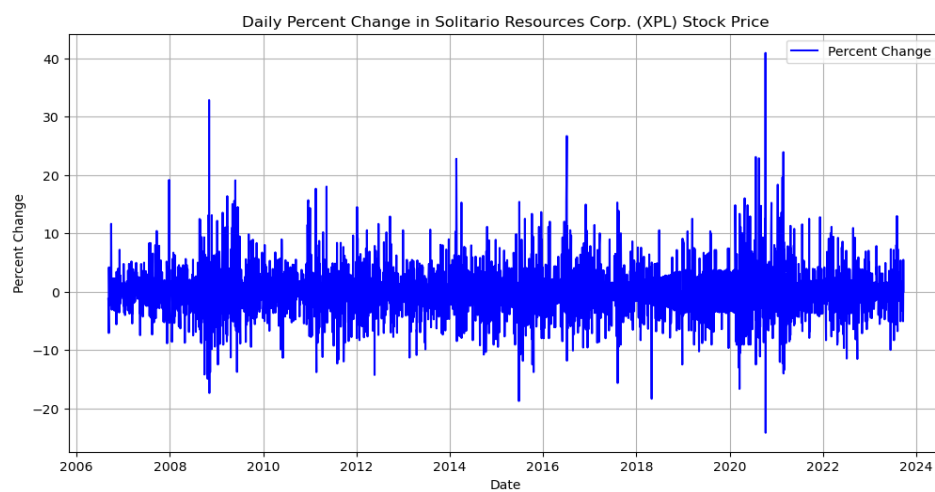
Figure 18. The daily percent change chart exhibits some large spikes of over 10% change along with gaps between trading days showing risks of non-linear price jumps from low liquidity.

Step 6. Describe how the data can help to meet the challenge

Scenario 1: Money at a fixed rate for an unsecured purchase (e.g. credit card) for an individual.

For Scenario 1. We focus on Charge-Off Rate on Credit Card Loans and Total Consumer Credit Owned and Securitized (CORCCACBS) which is a important indicator of liquidity. From Figures 1, 2,3 data, we can figure out that the two main factors linked to CORCCACBS are the unemployment rate, which implies low or no incoming source. Another important facotor is the GDP which is the measurement of nation's overall economy. As mentioned in GWP1, surprised that based on analyzed data, Fed funds rate variance does not affect the public's borrowing action.

Scenario 2: Money at a floating rate for a secured purchase (e.g. home or automobile) for an individual

As shown in Figure 6, the correlation between delinquency rate is negatively correlated to both the mortgage and interest rates. Delinquency measures the default risk on the mortgage loan as individuals miss two or more loan repayments. Hence, The negative relationship between delinquency rate and interest rate can be utilised to measure default risk on the mortgage loan. The relationship between mortgage loans and FED interest rates is also highly positive. Hence, it can be utilised to set the mortgage loan rate and counter the default risk.

Scenario 3: Money at a fixed rate for a business for a construction loan

The strong positive correlation (0.93) between PPI by Commodity and Lumber prices indicates volatility in lumber costs is a major driver of changes in overall construction input prices. This suggests monitoring lumber price trends could help anticipate risks from potential cost overruns in construction projects. The lumber price distribution is more volatile and skewed than PPIACO and construction spending. The long right tail reflects the risk of extreme price spikes. Managing lumber price volatility is key to mitigating construction lending risks.

While construction spending is positively correlated with PPIACO and lumber prices, the weaker correlation suggests factors beyond just input costs also impact activity. Assessing project timelines and demand levels can provide additional context.

In summary, the PPIACO and lumber price data is useful for assessing construction cost risks, while also monitoring project-specific factors and construction spending trends. The data suggests managing lumber price volatility is critical in construction lending.

Scenario 4: Publicly traded Equity (e.g. common stock) – that is, securities lending of a stock.

For Scenario 4. We continue to focus on AMD stock which was analyzed in GWP1. In GWP2, we believe that transaction volume is a good indicator of liquidity. We listed down the correlation between Apple, AMD, and iShares Semiconductor ETF(SOXX) returns change and correlation of AMD, Intel, and SOXX transaction volumes change, found that the AMD transaction volume change has a weak correlation with Intel even both of them control the overall CPU market. So, we analyzed the daily transaction volume ratio between AMD and Apple. Based on data from 1 Jan 2018 to 1 Jan 2022, the average daily transaction ratio is above 0.59. Considering Apple is a super high liquid stock, We believe AMD is not illiquid security.

Scenario 5: Publicly traded bond (e.g. treasury bond, corporate bond) – that is, securities lending of a bond.

The return distribution of the treasury bond indicates the average monthly return is 0.03%. Additionally, The volatility graphs show the constant volatility; its median is 0.066. These data are useful for calculating value at risk (VaR) and setting margins before lending a bond to mitigate the default risk on the lending bond. However, a Treasury bond is considered risk-free, but there is a chance of credit risk associated with the borrower. We also consider the FED interest rate data for bond yield data analysis as they are associated.

Scenario 6: An illiquid security – you choose the security

The trading volume chart reveals consistently low daily volume for XPL, often less than 100,000 shares. This low liquidity poses substantial risks if leverage is applied. The percent change chart shows extreme price swings over 10% on certain days that are likely exaggerated by the low volume and infrequent trading. These non-linear price jumps could be greatly magnified by leverage due to the illiquidity.

Furthermore, the likely high bid-ask spread that comes with low volume would result in high transaction costs that leverage would further amplify. As a mining company, XPL also faces complex industry regulations and permitting processes that could suddenly impact valuation and trading liquidity.

In summary, the low liquidity, non-linear price changes, high spreads, and regulatory issues associated with XPL make it a very risky candidate for applying leverage. Caution should be exercised if utilizing leverage with such an illiquid underlying asset.

References:

[1] Truth in Lending Act (TILA): Consumer Protections and Disclosures. Investopedia.com

[2] How the Real Estate Settlement Procedures Act (RESPA) Works investopedia.com

[3] Charge-Off Rate on Credit Card Loans, All Commercial Banks, Federal Reserve Economic Data https://fred.stlouisfed.org/series/CORCCACBS

[4] Total Consumer Credit Owned and Securitized (TOTALSL), Federal Reserve Economic Data https://fred.stlouisfed.org/series/TOTALSL

[5] Unemployment Rate (USA), Federal Reserve Economic Data https://fred.stlouisfed.org/series/UNRATE

[6] Gross Domestic Product (GDP), Federal Reserve Economic Data https://fred.stlouisfed.org/series/GDP

[7] 30-Year Fixed Rate Mortgage Average in the United States: https://fred.stlouisfed.org/series/MORTGAGE30US

[8] Delinquency Rate on Single-Family Residential Mortgages, Booked in Domestic Offices, All Commercial Banks: https://fred.stlouisfed.org/series/DRSFRMACBS

[9] Federal Funds Effective Rate: https://fred.stlouisfed.org/series/FEDFUNDS

[10] US Treasury Yield: https://finance.yahoo.com/quote/%5EFVX?p=%5EFVX