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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.

Six different scenarios -

1. Money at a fixed interest rate for an unsecured purchase
2. Home Mortgage: Money at a floating rate for secured purchase for an individual
3. Money at a fixed rate for a construction loan
4. Publicly traded stock (useful for short-selling by borrowers)
5. 10-year US Treasury Bonds : Publicly traded bonds
6. An illiquid asset, (You can choose any)

Step 1 : Magnifying Risk Factors

Scenario	Leverage	Non-linearity
Money at a fixed interest rate for an unsecured purchase	leverage risk as the team is expected to earn interest from the amount lend out, but closely affected by the credit of the customers, as if they are not able to repay the balances, the loss would be amplified as only a part of or even zero repayment can be received back, especially when the date is further away from the last repayment schedule, the bank will suffer more	there is non linearity exists as the repayment amount and schedule is fixed before lending, so the expected payoff should be uniform under any situation; only if the customer defaults, a loss would be incurred, with the exact amount depending on the time they default
Mortgage Loan	<p>There can be leverage associated with the Mortgage loan.</p> <ul style="list-style-type: none"> • Leverage in the form of percentage down payments. A Lender can give the borrower an option to pay a percentage of down payments at the start of the loan. • Leverage in the form of lending from third-party. Borrowers can lend money from third parties, and take out mortgage loans with full payment. • Leverage in the form of "Limitation of Collateral". A lender may give out both remorse and non-remorse loans. In case of Non-remorse 	<p>There is Nonlinearity associated with the payoffs of Mortgage Loans, for both Lenders and Borrower's sides.</p> <ul style="list-style-type: none"> • For Lender, a borrower may default on payments, borrower may not be able to pay on time, value of collateral for loan may vary with time, Interest rates on mortgage payments may vary with time. These all introduce nonlinearity. • For Borrowers, Interest rate associated with mortgage payments may vary, Market value for Collateral may vary,

	<p>loan, borrower has only limited obligations of collateral repayment in case of default. This can be seen as leverage from the borrower's point of view.</p>	<p>he/she may default on payments, may not be able to refinance the loan, and most important inflation or recession may hit the market, in such cases nonlinearity introduced in Loans.</p>
<p>Money at a fixed rate for a business for a construction loan</p>	<p>Leverage is the use of borrowed funds to invest, and in return pay a fee(Interest) for the fund as well as the principal amount.</p> <p>Leverage Challenges</p> <ul style="list-style-type: none"> • Due to economic uncertainties, - increase in prices of construction materials, delays in the supply chain and increase in the cost of labour as well as shortages have led to growth of risks associated with construction projects. This leads to non-completion of funds provided do not suffice. Consequently, this leads to customers obtaining more funding at increased interest rates. • Lack of accountability of the acceptable use of funds has also contributed to this leverage challenge as well as Insufficient information on the progress of the projects 	
<p>Publicly traded stock</p>	<p>there is no leverage risk as what the team get in return is the borrowing fee, or just the value of the stock in the worst case scenario if the borrower default, there should not be any risk related to leverage event unless borrower uses the borrowed stock for any additional leverage or collateral use</p>	<p>there is no non linearity as the payoff is the same as value of stock plus the extra premium received from the borrowing even when stock is a linear product</p>

10-year US Treasury Bond	<p>Leverage can be associated with Treasury Bonds in different forms-</p> <ul style="list-style-type: none"> Investors can borrow money from third-party to buy some bonds in hope of profiting from them. This is not a good strategy for an investor, since bonds have low risk and with low risk they have low yield, and with interest rate payment associated with borrowed money and also if there is high inflation rate, this investment has low odds to generate high returns. 	<p>Nonlinearity in Treasury Bonds can be introduced by following-</p> <ul style="list-style-type: none"> Inflation: Inflation introduces the nonlinearity in bonds return, It changes the interest rate / Coupon payments from bonds.
An illiquid Security		<ul style="list-style-type: none">

Step 2 : Frictional Risk Factors

Scenario	Liquidity	Regulation
Money at a fixed interest rate for an unsecured purchase	<ul style="list-style-type: none"> the money market should have relatively high liquidity compared to other assets the lending horizon and fixed cost of financing might make the investment less liquid as time value of money could change over time 	<ul style="list-style-type: none"> the financing team should follow local financial regulation to ensure the lending rate or maintaining adequate capital reserve for the lending event there should be related risk measures to set appropriate credit limit, borrowing rate by examining customers credit to minimize default risk
Mortgage Loan	Mortgage Bonds have liquidity relation with the market variables, such as Inflation , Interest rates	If the market does have proper regulations on mortgage loans, the Global

	<p>and others. If Interest rates become high then Mortgage Loans become liquidated because of high interest rate payments associated with them. And vice-versa is also true. Because of High Inflation Mortgage loans have Liquidity risk.</p> <p>Classic example of this is the 2008 Global Crisis, which was based on MBS (mortgage based Security), as the global crisis hit, borrowers became default which resulted in illiquid MBS.</p>	<p>Crisis might not happen. Regulation Risk has a key role in global crises.</p> <p>Regulations on mortgage loans define the type of interest rate whether it is fixed or variable, define the 5 C's of the borrower whether he/she is compatible for loan or not.</p> <p>Regulations associated with mortgage loans also act on lenders in some form. How much they can give, how much they can charge as interest rate.</p> <p>Without Regulations we will definitely have regulation risk, not only for mortgage loans but also for any type of market transaction.</p>
<p>Money at a fixed rate for a business for a construction loan</p>	<p>Liquidity is the ability to meet obligations as they arise.</p> <p>Real Estate properties are considered illiquid assets since they are not easily converted into cash. This poses a challenge when the lender expects to be paid within a specified time yet the real estate developer/ owner has not been able to convert their illiquid property into cash. This is likely to cause default.</p>	<ul style="list-style-type: none"> • Regulation is the rule or control of certain systems of operation. • Since both players (lenders and borrowers) are regulated by Central Banks, there are limits to which they have to adhere to. • Interest rates are regulated as well. Therefore, lenders have a challenge when the risk is too high but the interest rates are fixed. • Non completion of projects causes a problem since there is a limit to the amount of leverage one can engage in to avoid extreme risks.

Publicly traded stock	<ul style="list-style-type: none"> publicly traded stock should be comparatively liquid, especially for the ones with large market capitalisation which enables borrowing or selling in relatively efficient way depends on the type of stocks or market time, e.g. market cap or high volatility, the borrowing cost might be higher for some names 	the financing should be aligning with exchange regulations which provide guidelines to margin requirement, or be transparent for the transaction fee in order to protect both sides of the parties
10-year US Treasury Bond	<p>10 year US Treasury Bonds are highly traded bonds in the US, because of less time of expiration.</p> <p>Because of the high trading volume of 10 year bonds, we can say they are liquid. And since they have a low time expiration that is 10 years, they are considered as highly liquid bonds as compared to other bonds.</p>	<p>Regulations on Treasury Bonds are simple and set by the SEC in the US.</p> <p>They can be understood by any level of investors. They have defined everything related to these bonds, whether interest rates are variable or fixed, time period of coupon payments, etc.</p> <p>Since these are government bonds, they are highly regulated which makes them free from regulation risk.</p>
An illiquid Security	<p>The slow completion of projects, delays in the supply chain and volatility of other construction materials in the market causes delay in completion of projects hence illiquidity for construction projects. Due to this illiquidity, borrowers are likely to default.</p>	<ul style="list-style-type: none"> As a regulation, companies are expected to maintain a certain level of liquidity in order to be able to meet their obligations as they arise. This need be monitored to ensure adherence. Progress reports for the work being done are expected to be submitted to ensure prudent use of available resources

Step 3 and 4 : Identifying Data and “Go Get Data”1. Money at a fixed interest rate for an unsecured purchaseData source: <https://fred.stlouisfed.org/>

Data	Notes
Credit card rate	Quarterly date with earliest availability from 1994
Interest rate	Daily data with earliest availability from 1954
Capital-to-assets ratio requirement	Represent the regulation risk; quarterly data with earliest availability from 2019
Customer's credit rating	Private and individual data, proxy as FICO score; daily data with earliest availability from 2017

2. Home Mortgage:

Data	Note
Type	Asset Rate (Interest Rate)
Processing	Mortgage Yield
Frequency	Daily Return
Class	Credit lend
Source	Mortgage Lender (Commercial Banks)
Variety	Historical Date (past 10 years)

3.

- 'A' Represents Scenario 3 – Money at a fixed rate for a construction loan.
- 'B' Represents Scenario 4 - An Illiquid Security

Security	Identification
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Data Type	A. <ul style="list-style-type: none"> a. Asset/ Economic data b. Accounting, Economic, Ratings data B. Asset / Economic data
Data Processing	A. <ul style="list-style-type: none"> a. Raw prices, volatilities b. Raw prices/ Yields, Return B. Raw prices, Returns, Volatilities
Data Frequency	A. Varying Frequency B.
Data Classes	A. Credit Data, Fixed Income B. Equity data, Real Estate, Fixed Income, Derivatives, Equity
Data Source	A. Exchanges, Dealers B. Exchanges, Brokers, Dealers
Data Variety	A. <ul style="list-style-type: none"> a. Actual data vs. Estimated Data b. Adjusted Vs. Unadjusted Data B. <ul style="list-style-type: none"> a. Trade data vs. Quote data b. Absolute Vs. Relative Data

4. Publicly traded stock

Data source: <https://www.investing.com/>

Data	Notes
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JPM share price	Daily data with earliest availability from 2017
Trading volume	Daily data with earliest availability from 2017

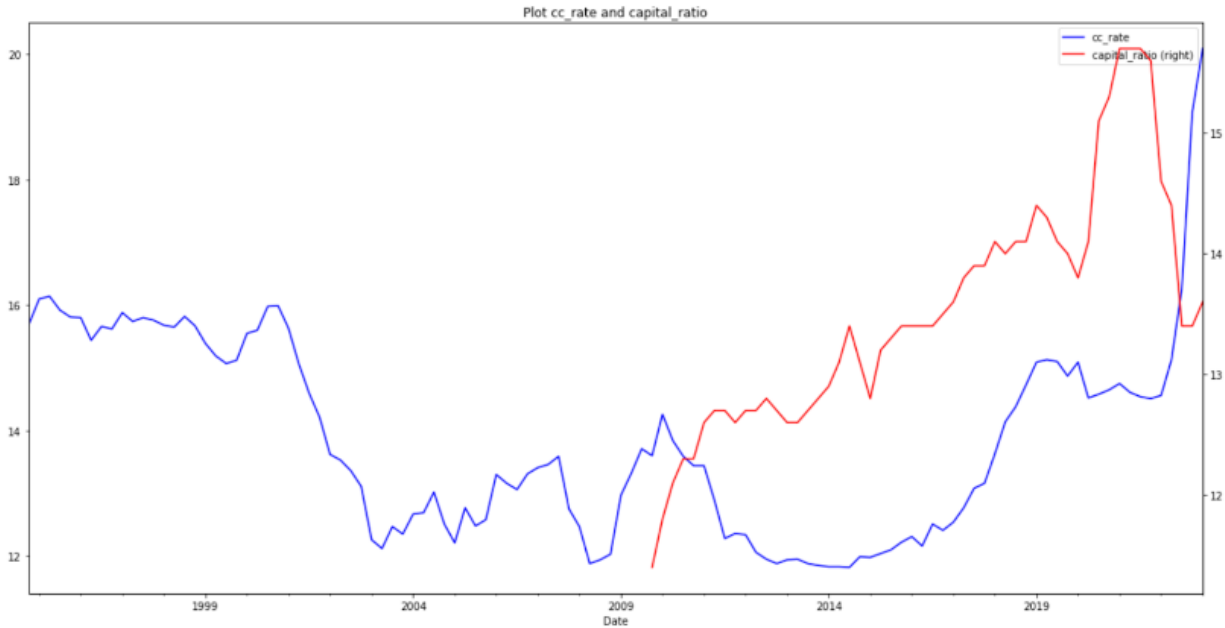
5. 10-year US Treasury Bond:

Data	Note
Type	Asset Rate (Interest Rate)
Processing	Bond Yield
Frequency	Weekly Return
Class	Bonds
Source	US Treasury Bonds
Variety	Historical Date (past 10 years)

Step 5 and 6 : Perform exploratory data analysis and Describe how the data can help to meet the challenge.

Please Refer to the attached Jupyter Notebook.

Scenario 1:



From 2015 to 2019, there are similar trends between the capital-to-asset ratio and credit card interest rate series. However, when the capital-to-asset requirement ratio starts to climb from around 14% in 2020 to nearly 16% in late 2021, there is not much response observed from the credit card interest rate adjustment. Adjustment comes in only from 2022 mainly due to the rise in interest rate. Though during the period when interest rate has been relatively stable in 2015-2019, credit card rate might increase due to the capital ratio requirement.

Scenario 2:

As leverage increases, companies are able to get hold of funds that they would otherwise not have. Therefore, they are able to engage in activities they would otherwise not, and construct more unlike when their funds were limited. Companies engaging in these projects need to calculate the cost of product as well as the margin of error that may occur in the process to ensure that projects are done to completion. This way, default cases will be fewer.

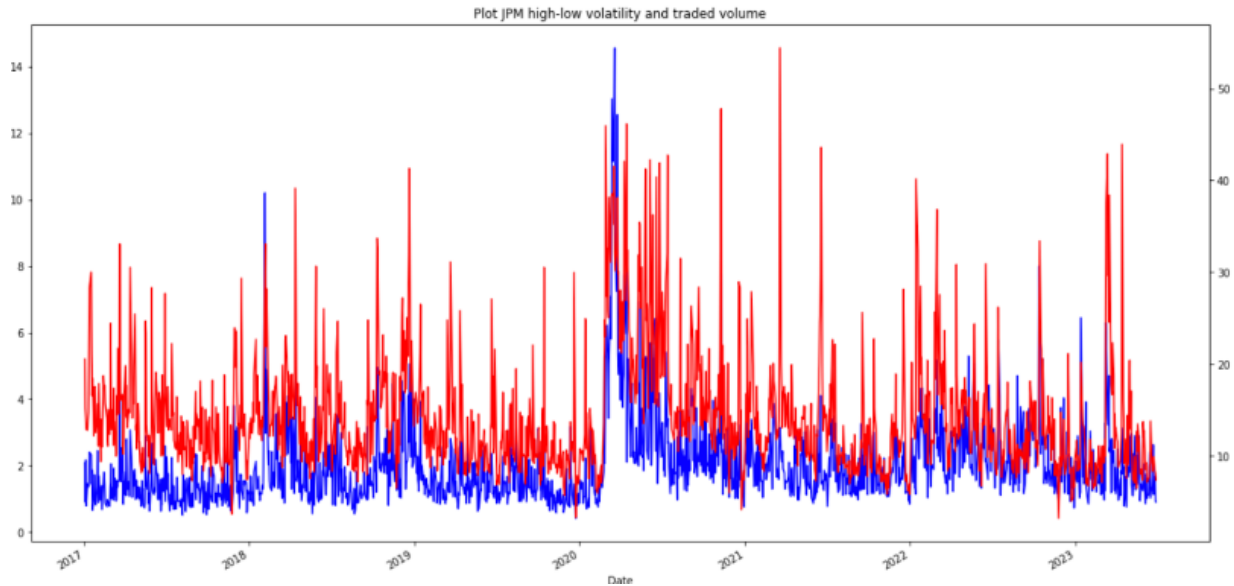
Scenario 3:

From the analysis we can see that there is a strong correlation between the Mortgage rate and GDP of the country. From the analysis it comes out 0.99965, which is a nearly perfect correlation between two variables. We can say mortgage rates are strongly correlated to GDP.

It is very important to take the GDP of a country as one of the variables in inclusion of Mortgage rate in the Portfolio of a client.

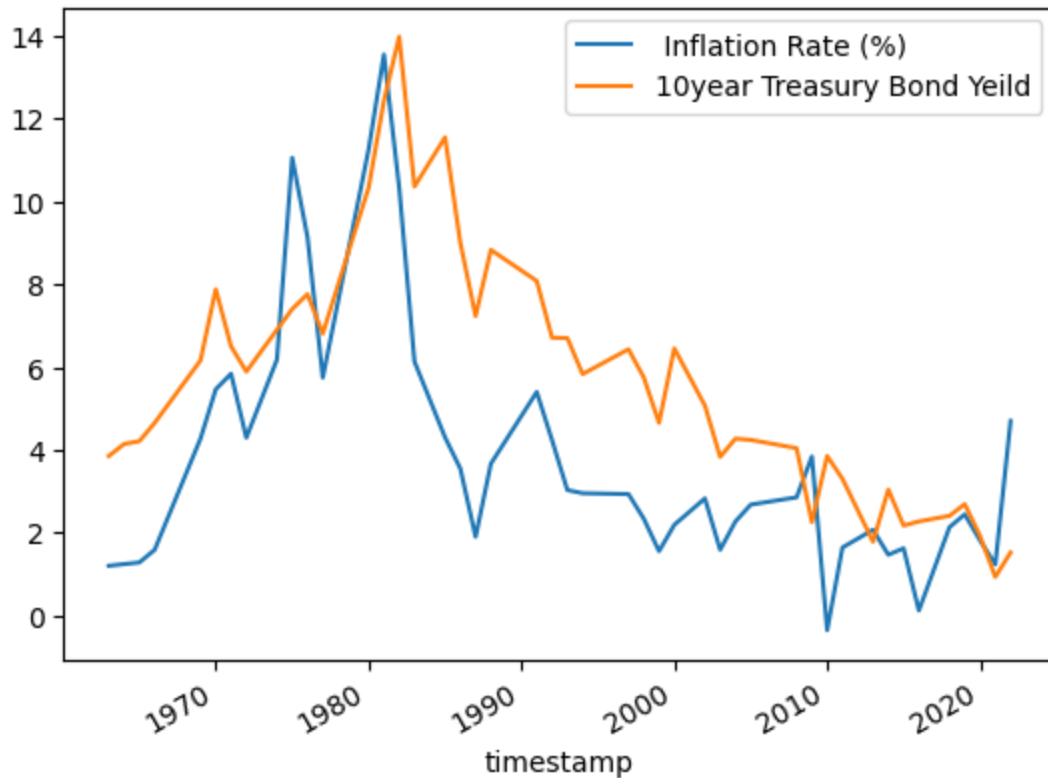
We can also see that 10 year Treasury bonds have a strong correlation with the mortgage rate in the country (USA). It is about 0.9094, which is less strong as compared to GDP of the country but its worth as one of features in calculation of Mortgage rate.

Scenario 4:



Volatility proxy of the stock is created by comparing the price difference between daily high and low (in percentage) and plot against the daily traded volume. Whenever there is a spike in the volatility, a spike in the volume traded could be related. However, it is not necessarily true on the other way round that when the volume is higher than usual, it might not represent there is high volatility or huge difference between the daily high-low. Hence, the firm might use the daily traded volume data not only to examine the liquidity, but might also use it to predict price volatility of the stock to prevent loss or increase lending premium.

Scenario 5:



From analysis we find that the correlation between Inflation and Bonds is positive and about 0.730522, which is a pretty good conclusion. As Inflation increases bond yield also increases, which we already know because of increase in interest rate in market.

We can also see that bonds and GDP of a country has almost no correlation or we can say it is very less positively correlated.

Scenario 6:

Real Estate are considered illiquid because they are not easily convertible to cash. This makes them a less desirable investment as this is risky. They are also affected much by volatility as economic changes affect them largely. Most Real Estate developers use leverage for these types of projects hence they are highly susceptible to loss as well as default. It is for this reason that they are highly regulated to ensure that there are no extreme values.