AI in Finance Assignment 2

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Some part of the notebook are taken from Nicholas Meyer's Fall 2023 submission

Download data on monthly trading volume for various securities from the SIFMA website https://www.sifma.org/resources/archive/research/statistics/.

1. **US Treasury Trading Volume**
2. **US GCF Repo Index, Triparty Repo, and Primary Dealer Financing (Repo/Reverse Repo)**
3. **US Equity Issuance and Trading Volumes**
4. **US Fixed Income Trading Volume**
5. **US SF Trading Volume**
6. **US Agency Trading Volume**
7. **US Corporate Bond Trading Volume**

We have done this for you

US Treasury Trading Volume

```
(32, 5)
```

US GCF Repo Index, Triparty Repo, and Primary Dealer Financing (Repo/Reverse Repo)

```
(31, 2)

(31, 4)

(127, 2)
```

US Equity Issuance and Trading Volumes

```
(32, 7)

(32, 7)
```

US Fixed Income Trading Volume

```
(31, 8)
```

US SF Trading Volume

```
(32, 5)
```

```
(32, 7)
```

```
(32, 12)
```

US Agency Trading Volume

```
(32, 6)
```

US Corporate Bond Trading Volume

```
(32, 4)
```

Go to https://fred.stlouisfed.org/ and select three macro-economic indicators. You can use a R OR PYTHON package, for example, quantmod or fredapi or make use of another package or FRED API calls.

Give a brief explanation of the three economic indicators that you chose and the rationale for selecting them

1. **Unemployment Rate:** The percentage of the labor force that is unemployed and actively seeking employment. This is a key indicator of economic health, where high eunemployment often leads to increased risk aversion, driving investors toward safer assets such as Treasuries, whill a lower unemployment rate can boost confidence in equities and corporate bonds.

2. **Inflation Rate:** Inflation is the rate of increase in prices over a given period of time, and it affects the purchasing power of money and influences the yield on bonds, the cost of capital for corporations, and the real returns on equities.
    - In this project, we will calculate the percentage change of the monthly Consumer Price Index (CPI) for All Urban Consumers to measure the monthly inflation rate.

3. **Interest Rates(Federal Funds Effective Rate):** The interest rate at which depository institutions trade federal funds with each other overnight. Since Interest rates set the cost of borrowing and the return on investments, it will influence the attractive of bonds, the demand for equities, and so on. Moreover, it will affect the valuation and trading volume across all these markets.

Load Monthly Unemployment Rate

	Date	UnemployR
0	1980-01	6.3
1	1980-02	6.3
2	1980-03	6.3
3	1980-04	6.9
4	1980-05	7.5

Load Monthly Interest Rate

	Date	InterstR
0	1980-01	13.82
1	1980-02	14.13
2	1980-03	17.19
3	1980-04	17.61
4	1980-05	10.98

Load Monthly Inflation Rate

	Date	InflaR
1	1980-01	1.430429
2	1980-02	1.282051
3	1980-03	1.392405
4	1980-04	0.998752
5	1980-05	0.988875

Merge three indicators together

	Date	InflaR	InterstR	UnemployR
0	1980-01-01	1.430429	13.82	6.3
1	1980-02-01	1.282051	14.13	6.3
2	1980-03-01	1.392405	17.19	6.3
3	1980-04-01	0.998752	17.61	6.9
4	1980-05-01	0.988875	10.98	7.5

Compute the descriptive statistics (N, mean, p25, p50, p75, standard deviation etc.,) of the trading activity for each market

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This is the Statistics of us_treasury_trading_volume
       Treasury Bills  Treasury Inflation Index Securities (TIPS)  \
count       32.000000                                   32.000000
mean       149.753267                                   19.629159
25%        132.176312                                   16.804650
50%        140.392675                                   18.896625
75%        166.445187                                   20.923462
std         27.369708                                    3.730341

       Coupon Securities       Total
count          32.000000   32.000000
mean          432.379706  604.967956
25%           387.618500  542.369537
50%           428.850125  600.867200
75%           475.413650  649.991500
std            82.374892   83.019477
--------------------------------------------------

This is the Statistics of us_repo_primary_dealer
             Total
count    31.000000
mean   4472.000762
25%    4322.638525
50%    4434.869667
75%    4614.127000
std     229.878789
--------------------------------------------------

This is the Statistics of us_repo_gcf_repo_index
               UST          MBS        Total
count    31.000000    31.000000    31.000000
mean   1010.849677  1381.128129  2391.977806
25%     882.450000  1084.365000  2038.399000
50%    1041.304000  1472.230000  2349.880000
75%    1121.102000  1703.970000  2818.420000
std     166.739038   467.151148   475.927944
--------------------------------------------------

This is the Statistics of us_repo_triparty_repo
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```
              Total
count    127.000000
mean    1872.833307
25%     1620.550000
50%     1764.870000
75%     2064.585000
std      324.190554
------------------------------------------------
```

```
This is the Statistics of us_equity_issuance
            IPOs  Secondaries   Total CS  Preferred Stock  Total Equity  \
count  32.000000    32.000000  32.000000        32.000000     32.000000
mean    7.471241    17.341072  24.812313         3.859031     28.671343
25%     2.264663     9.557643  13.542357         1.960500     16.205545
50%     5.609700    15.550035  22.592120         3.521250     27.772865
75%    12.632475    19.815112  31.681000         5.286187     33.718690
std     6.445746    11.075111  14.499293         2.555509     15.380868

           Total
count  32.000000
mean   53.483656
25%    30.450590
50%    50.507830
75%    64.601930
std    29.783730
------------------------------------------------
```

```
This is the Statistics of us_equity_trading_volume
               ICE      Nasdaq       Cboe      Other  Off Exchange       Total
count   32.000000   32.000000  32.000000  32.000000     32.000000   32.000000
mean    97.133110   95.494319  68.735683  14.819749    163.633875  439.816736
25%     78.092737   75.324364  54.439104   9.445738    115.126298  332.672425
50%     93.933451   97.760521  68.252529  10.666286    171.595495  444.240182
75%    111.391928  108.060157  77.282338  20.406228    197.897559  513.002325
std     22.166982   23.492098  17.602257   7.147068     45.301030  111.367429
------------------------------------------------
```

```
This is the Statistics of us_fixed_trading_volume
         Treasury  Agency MBS  Non-Agency MBS  Corporate Debt  Municipal  \
count   31.000000   31.000000       31.000000       31.000000  31.000000
mean   605.806374  275.584935        2.932057       37.303413  11.136000
25%    541.441825  250.699667        2.523090       32.685527   9.666500
```

```
50%    602.202000  270.821550        2.758759       37.638455  11.118000
75%    650.465750  294.104708        3.108952       40.479578  11.908000
std     84.253965   34.000580        0.830445        5.960060   2.708012

       Agency MBS       Total
count   31.000000   31.000000
mean   275.584935  938.695035
25%    250.699667  857.363880
50%    270.821550  910.941622
75%    294.104708  984.214629
std     34.000580  110.321233
--------------------------------------------------

This is the Statistics of us_sf_trading_volume
                ABS         CDO      Other  Total Asset   Agency CMO  \
count    32.000000   32.000000  32.000000    32.000000    32.000000
mean   1054.502974  578.239501   0.453563  1633.196038  1675.227849
25%     912.779859  462.290764   0.000000  1442.763726  1467.631211
50%    1011.055353  536.116068   0.000000  1594.517053  1646.223865
75%    1160.254684  685.417278   0.000000  1758.563789  1886.922802
std     293.486389  193.340134   1.568236   439.215830   395.785178

       Agency Specified Pool     Agency TBA  Agency CMBS (IO/PO)  \
count              32.000000      32.000000            32.000000
mean            22532.852671  250626.132419           784.974094
25%             18685.989299  231115.162500           558.023417
50%             23069.445245  246490.335190           667.509011
75%             25638.403258  266366.593146           873.572263
std              5177.444572   29715.396559           391.320128

       Agency CMBS (P&I)  Total Mortgage          Total
count          32.000000       32.000000      32.000000
mean          509.344962   274834.212939  276467.408976
25%           354.856120   251089.075458  252230.506256
50%           522.301771   270258.761014  271935.569667
75%           622.430848   293920.680672  295581.343137
std           197.955013    33716.205495   33917.783416
--------------------------------------------------

This is the Statistics of us_agency_trading_volume
       Fannie Mae       FHLB  Freddie Mac      Other      Total
count   32.000000  32.000000    32.000000  32.000000  32.000000
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mean     0.695290   1.407398     0.855113   1.252052   4.209854
25%      0.492091   1.079288     0.536504   0.946641   3.591945
50%      0.556993   1.314913     0.786593   1.192197   4.198491
75%      0.778576   1.735810     1.287952   1.454715   4.726881
std      0.355916   0.429006     0.493099   0.368914   1.154587
------------------------------------------------
```
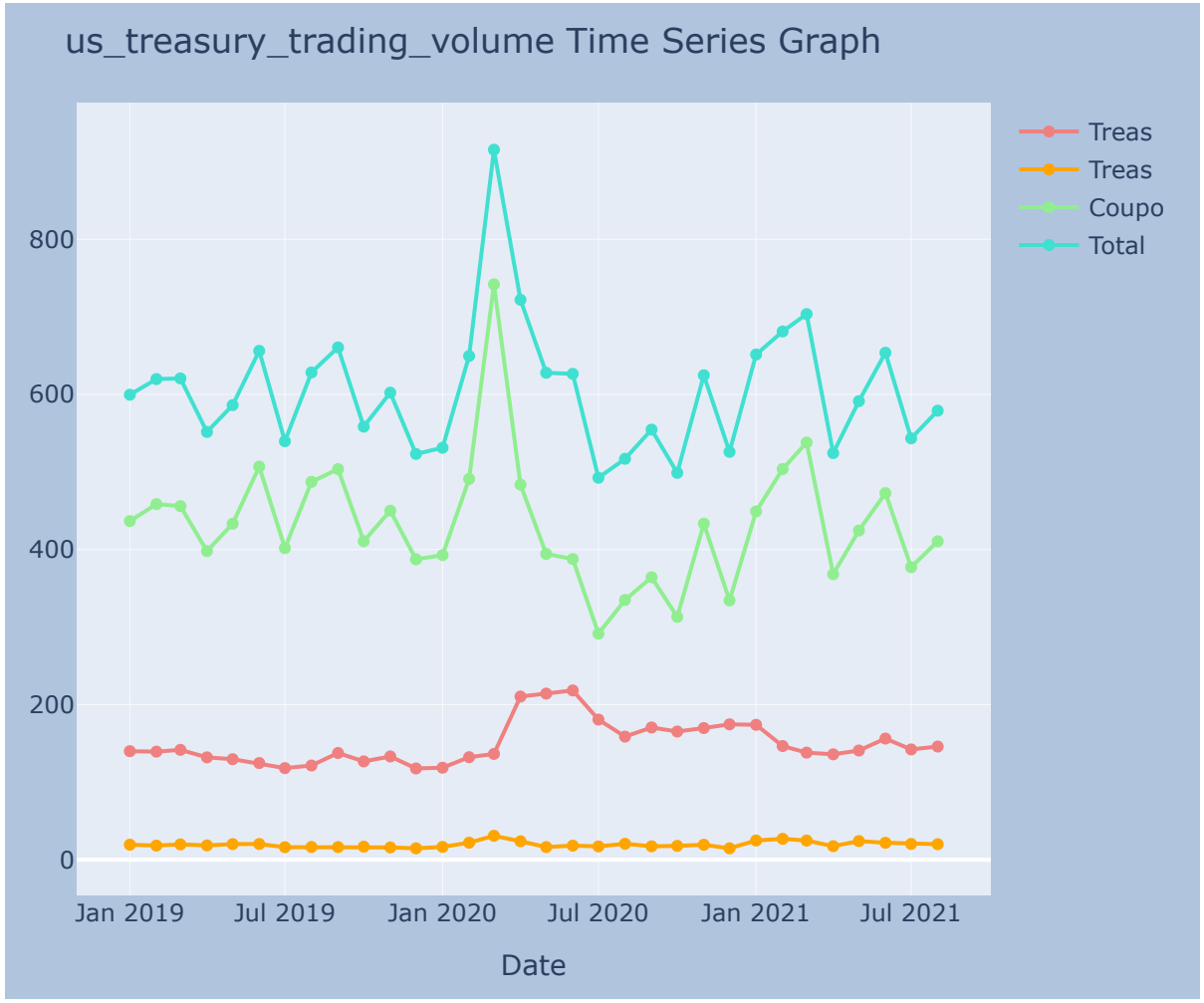
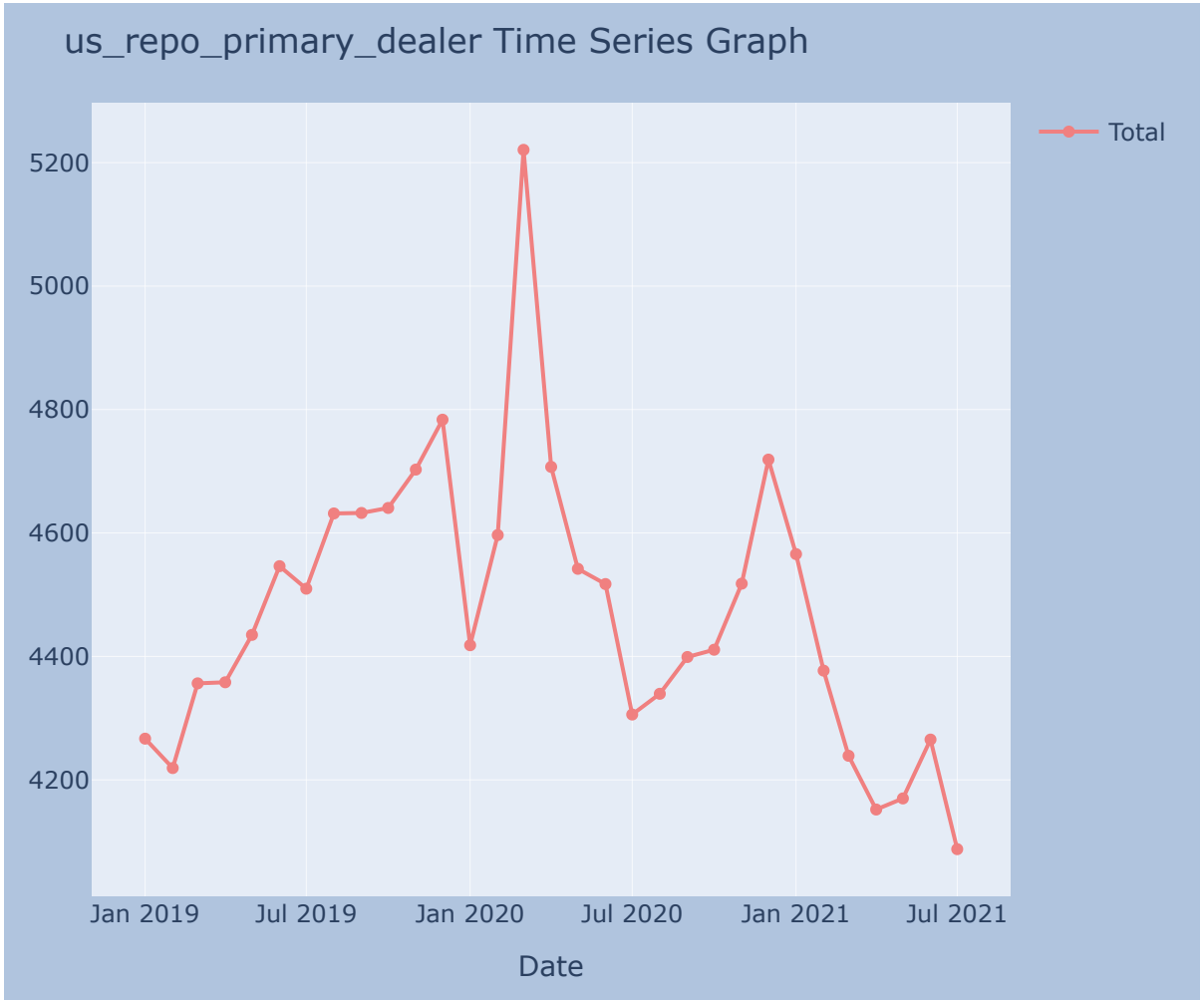
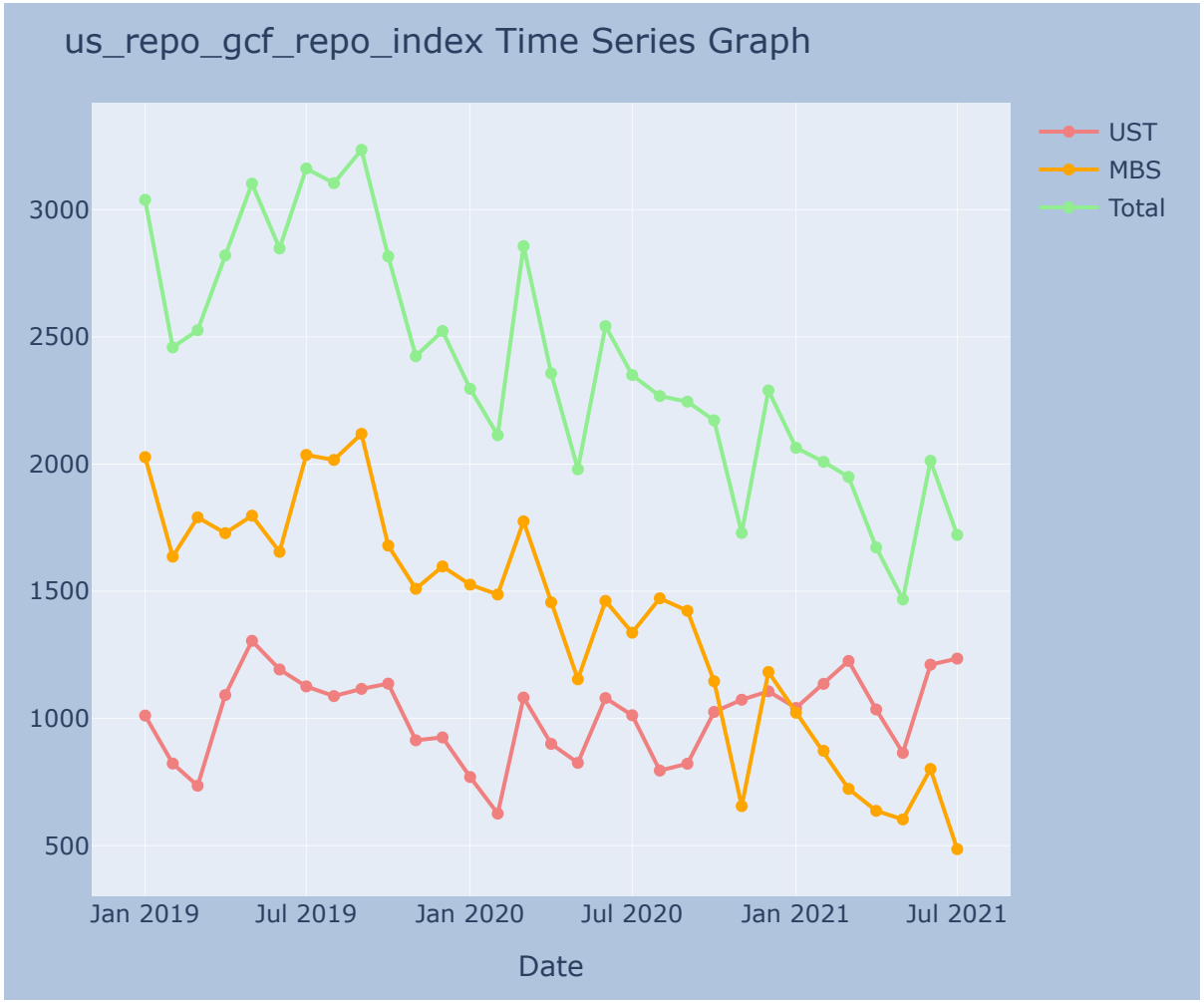
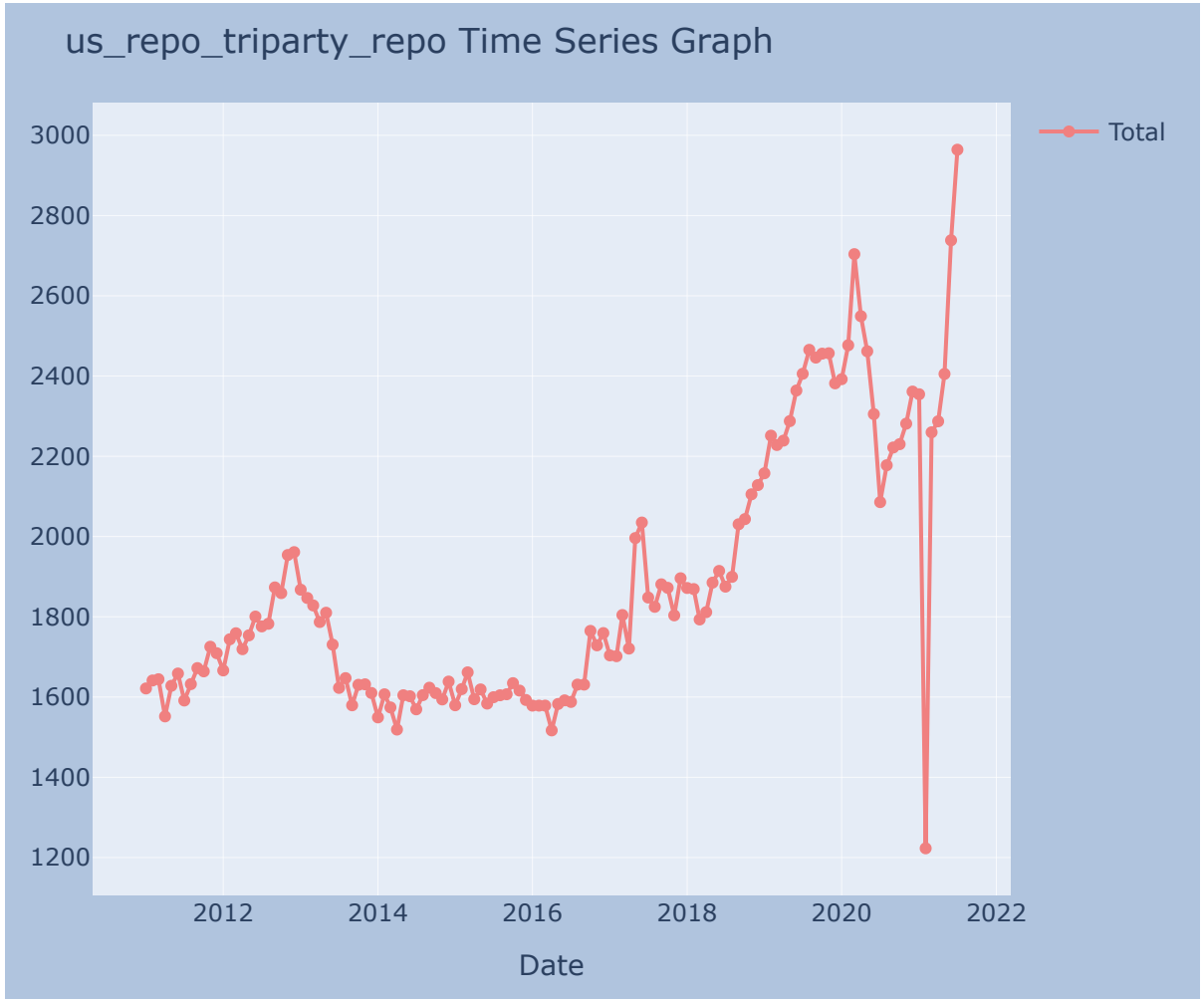

```
This is the Statistics of us_corporate_bond_trading_volume
       Investment Grade  High Yield      Total
count         32.000000   32.000000  32.000000
mean          20.474942    7.538574  28.013516
25%           18.061524    6.596376  24.743864
50%           20.001900    7.076680  27.467907
75%           23.136842    8.520266  31.285500
std            3.200796    1.657068   4.734846
```

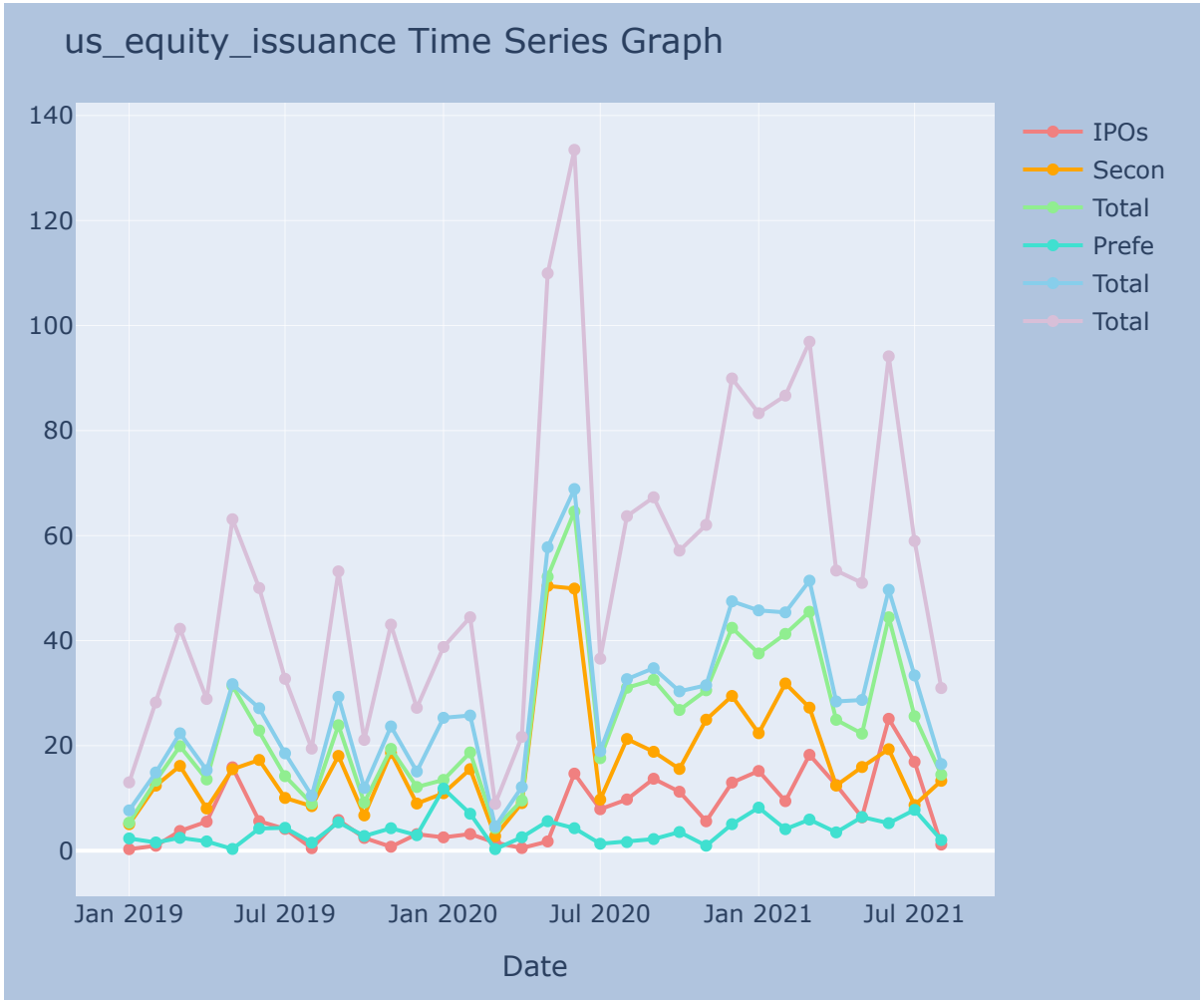
Plot the time-series data for SIFMA for the time period that each series is available (you can plot one graph for each market, with multiple series)

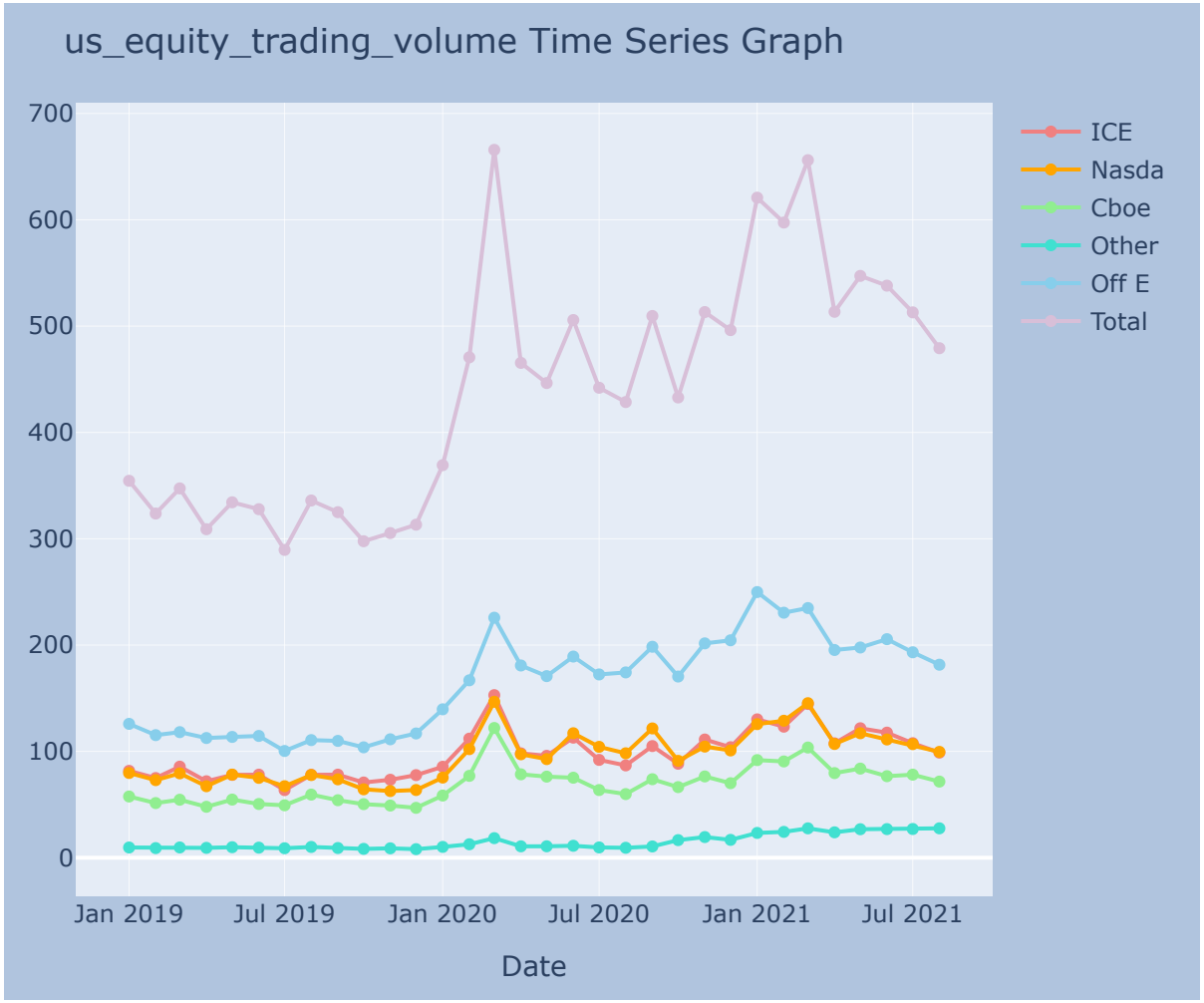

us_treasury_trading_volume Time Series Graph
Treas
Treas
Coupo
Total
800
600
400
200
0
Jan 2019
Jul 2019
Jan 2020
Jul 2020
Jan 2021
Jul 2021
Date

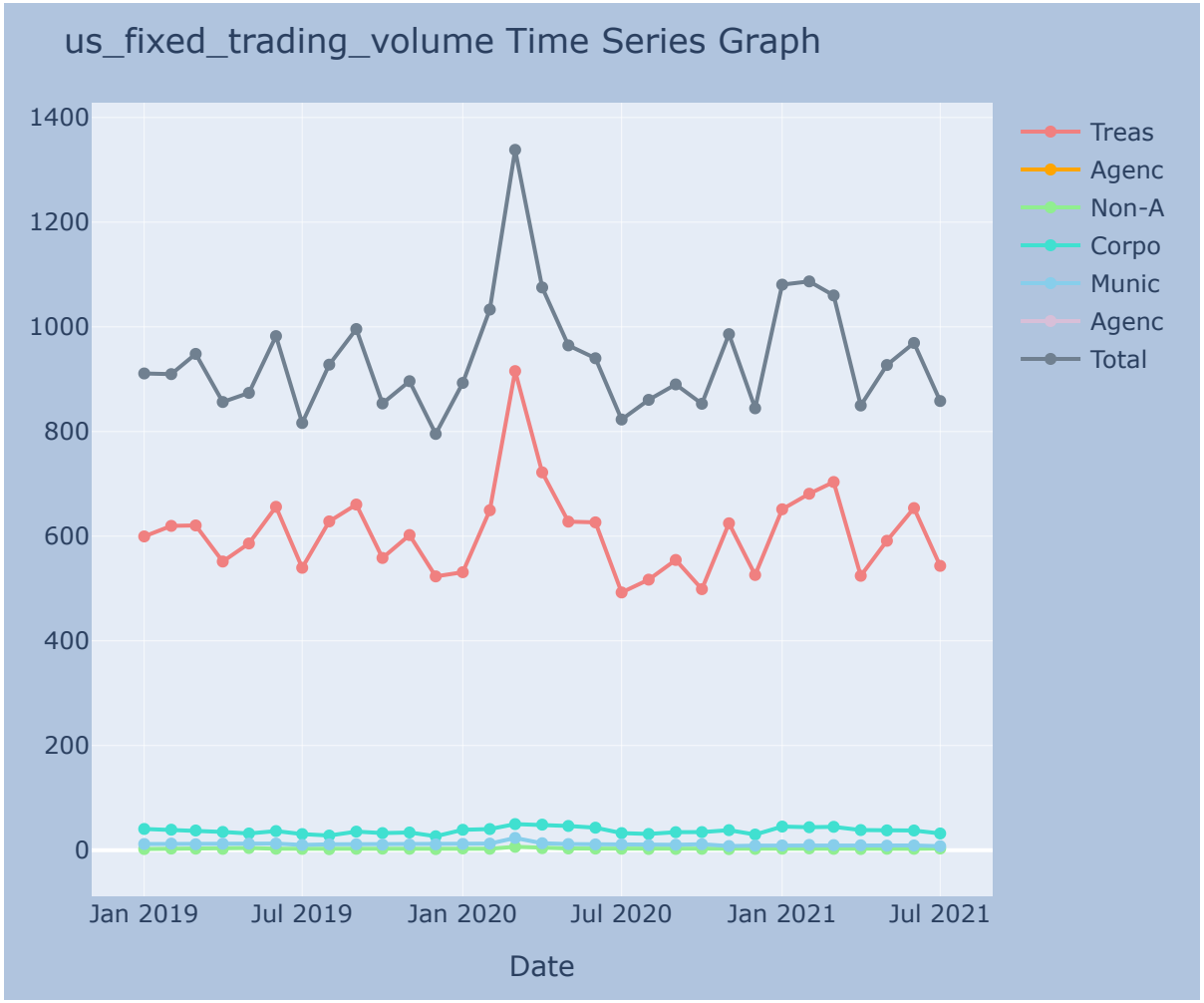

us_repo_primary_dealer Time Series Graph
Total
5200
5000
4800
4600
4400
4200
Jan 2019
Jul 2019
Jan 2020
Jul 2020
Jan 2021
Jul 2021
Date

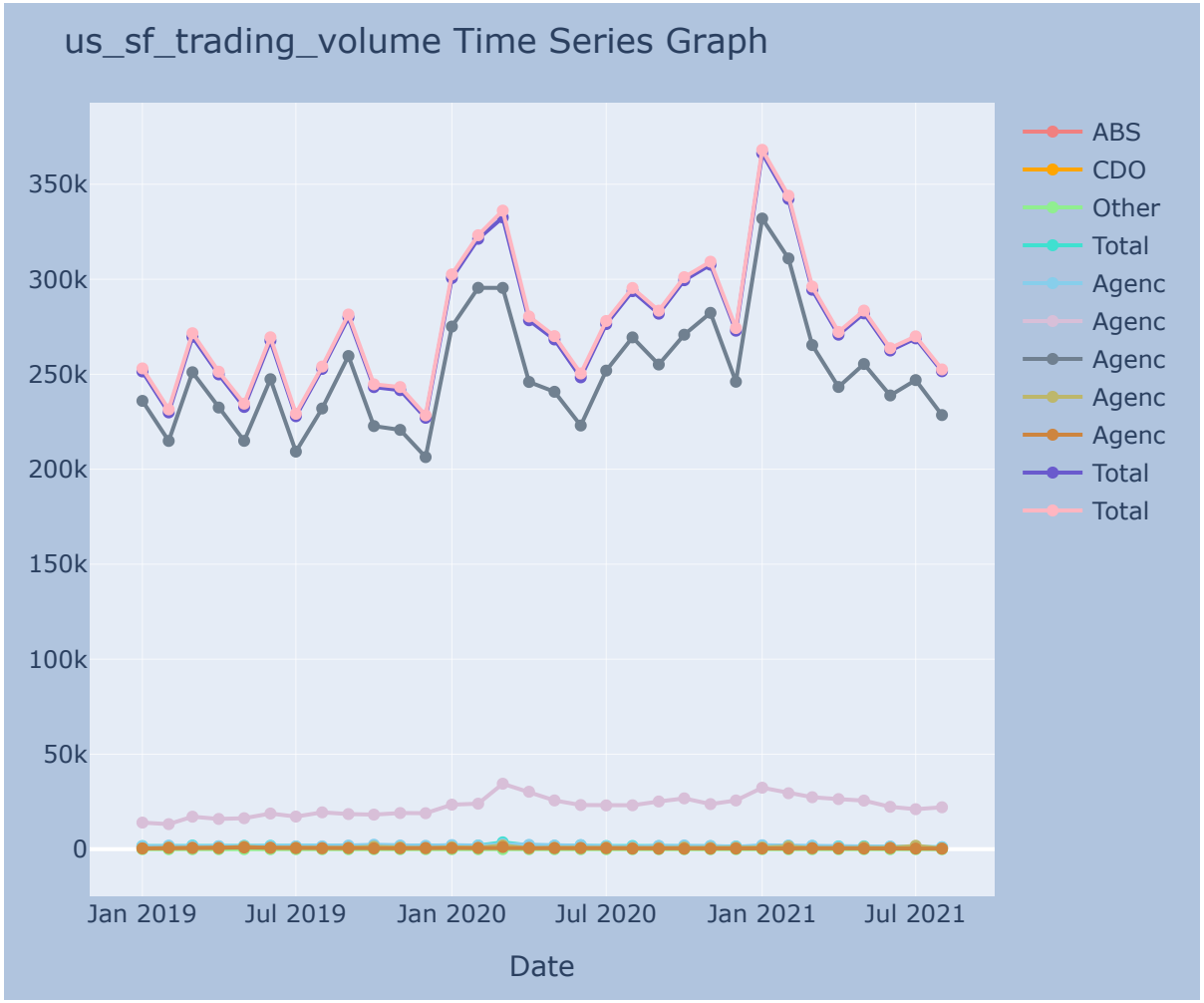

us_repo_gcf_repo_index Time Series Graph
UST
MBS
Total
3000
2500
2000
1500
1000
500
Jan 2019
Jul 2019
Jan 2020
Jul 2020
Jan 2021
Jul 2021
Date

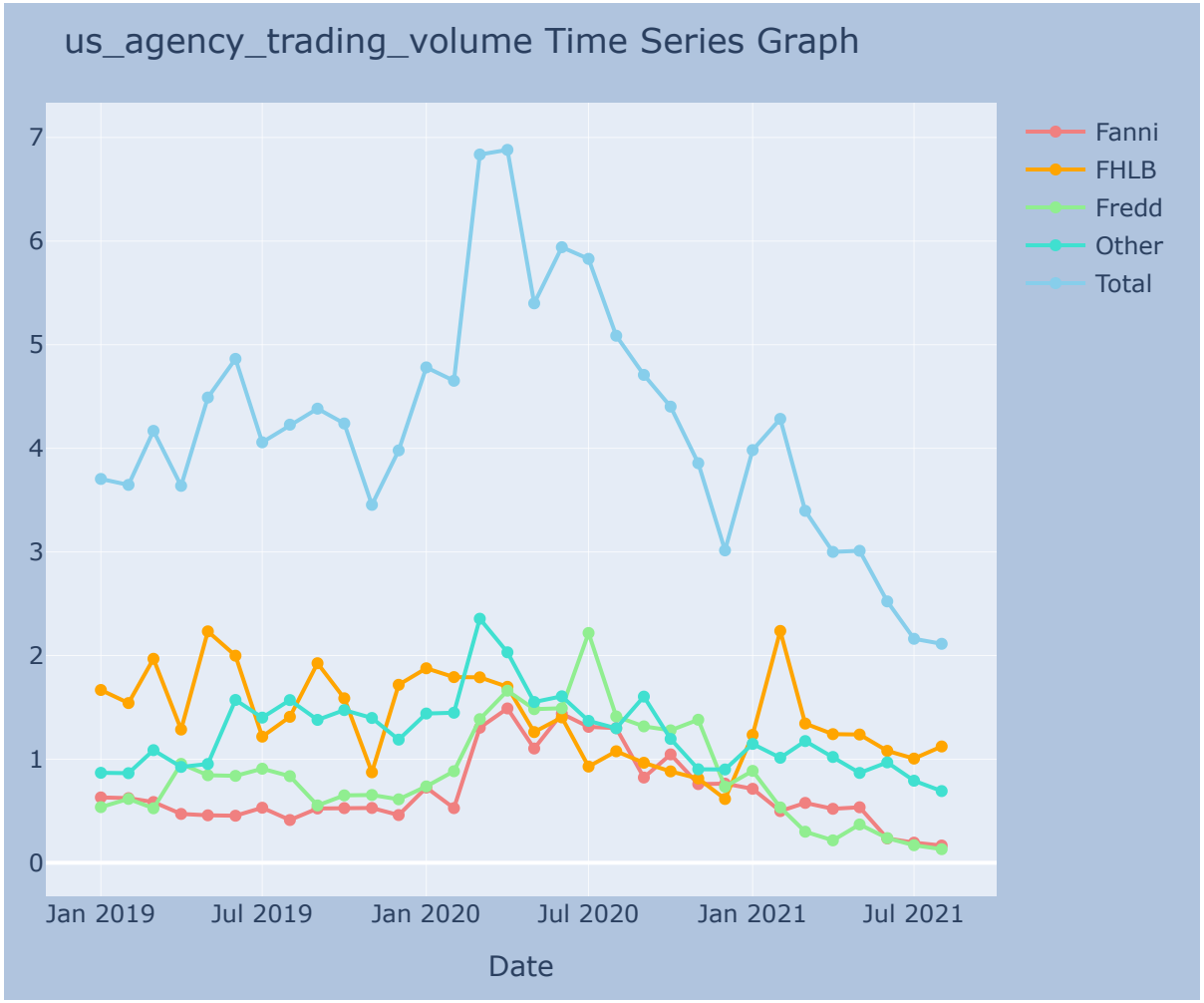

us_repo_triparty_repo Time Series Graph
Total
3000
2800
2600
2400
2200
2000
1800
1600
1400
1200
2012
2014
2016
2018
2020
2022
Date

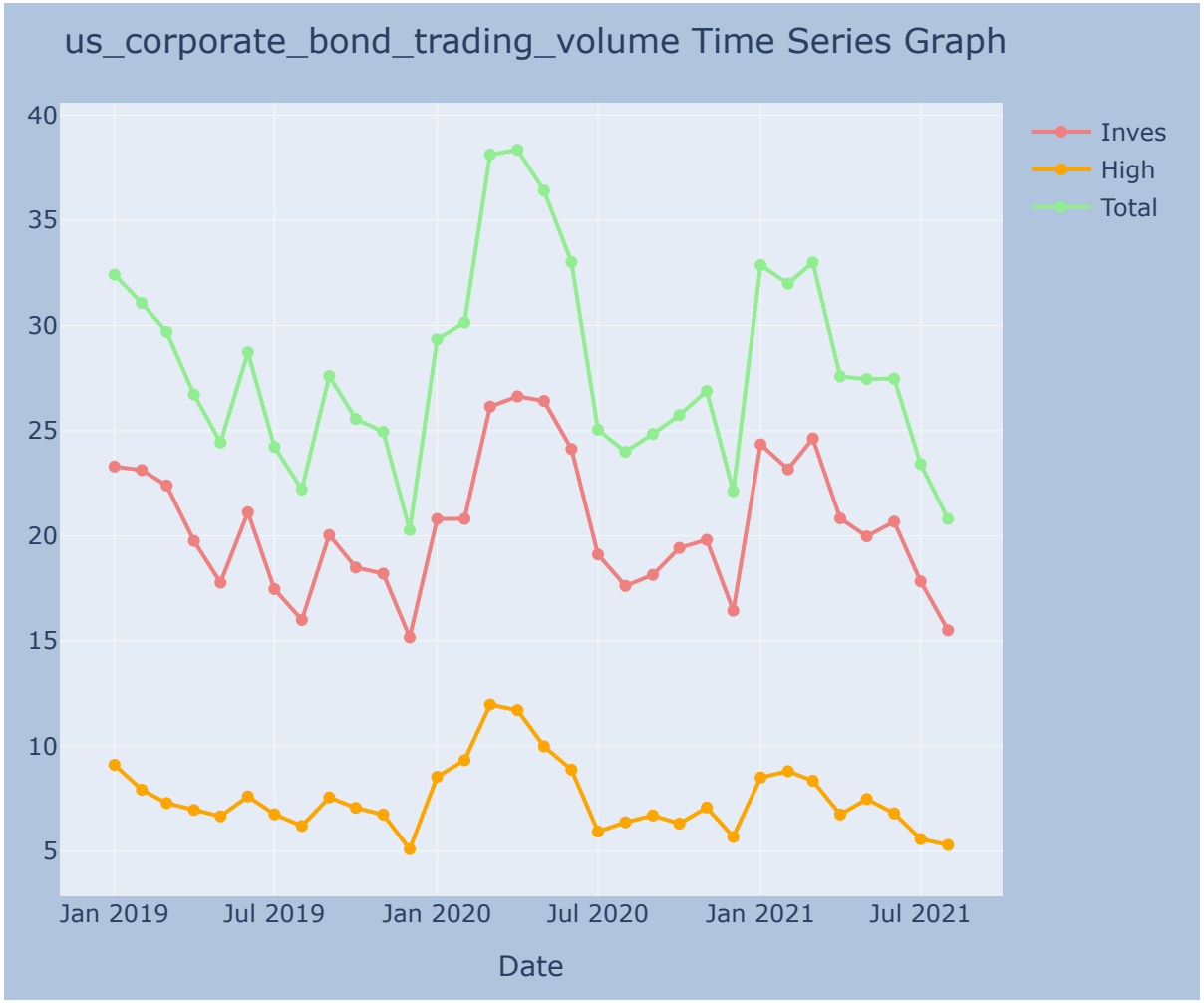

us_equity_issuance Time Series Graph
140
120
100
80
60
40
20
0
Jan 2019
Jul 2019
Jan 2020
Jul 2020
Jan 2021
Jul 2021
Date
IPOs
Secon
Total
Prefe
Total
Total


us_equity_trading_volume Time Series Graph
700
600
500
400
300
200
100
0
Jan 2019
Jul 2019
Jan 2020
Jul 2020
Jan 2021
Jul 2021
Date
ICE
Nasda
Cboe
Other
Off E
Total


us_fixed_trading_volume Time Series Graph
1400
1200
1000
800
600
400
200
0
Jan 2019
Jul 2019
Jan 2020
Jul 2020
Jan 2021
Jul 2021
Date
Treas
Agenc
Non-A
Corpo
Munic
Agenc
Total


us_sf_trading_volume Time Series Graph
350k
300k
250k
200k
150k
100k
50k
0
Jan 2019
Jul 2019
Jan 2020
Jul 2020
Jan 2021
Jul 2021
Date
ABS
CDO
Other
Total
Agenc
Agenc
Agenc
Agenc
Agenc
Total
Total


us_agency_trading_volume Time Series Graph
Fanni
FHLB
Fredd
Other
Total
7
6
5
4
3
2
1
0
Jan 2019
Jul 2019
Jan 2020
Jul 2020
Jan 2021
Jul 2021
Date



Do you see any patterns in the time-series? Is there any seasonality?

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1. U.S. Treasury Trading Volume

Observation: The total amount of Trading Volume is fluctuating over the time period, and such fluctuations are mainly due to the fluctuations of the coupon securities. Moreover, the coupon securities is the largest proportion in the Treasury Bond. Indeed, there exist certain seasonality. For every April, July, October, and December, the trading volume for coupon securities will decrease significantly. For

every February, March, August, and September, the trading volume will recover. Moreover, there is an abnormal increase in trading volume in March 2020.

Explanation:
The seasonality of Treasury Trding Volume might due to following reasons:

- Quarterly Reports & Fiscal Year Cycles: Since March, June, September, and December are all end of quarters, companies and financial institutions will often make adjustments to their portfolios (rebalancing & window dressing) to reflect their financial positions, leading to increased trading activity in the months leading up to the end of quarters, such as February, March, August, and September. Since April, July, October, and December are periods after these period for making significant adjustments, the trading volume will decrease.
- Holiday Effect: Given December has Christmas, July has Summer Months, and April is tax season, there will be less trading activity. Since the coupon securties represent a significant portion of the total outstanding U.S. Treasury debt, are regularly issued with large amounts to finance goverment operations for managing public debt, and is highly liquid, which is easily to trade, they make up the large portion of U.S Treasury bond. The peak in trading volume for Treasury coupon secueirties in March 2020 was largely driven by the extreme market conditions caused by the onset of the COVID-19 pandemic, where people are trying to avoid uncertainties and seak for a safer places to invest their money.

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2. Repo Primary Dealer

Observation: No obivous pattern is observed from Jan 2019 to July 2021. There is a significant drop at Jan 2020 and a siginifcant peak in March 2020.

Explanation:
Given primary dealers are banks and financial institutions that have been selected by the federal reserve bank to act as trading counterparties. They are responsible for participating in Treasury auctions and providing liquidity in the secondary market. The significant drop in repo activity in Jan 2020 is probabily due to the Year-End Balance Sheet Constraint where institutions aim to present a healthier balance sheet, which results in a decrease in repo activity. Moreover, after a long Christmas holiday, and the new year begins, primary dealers might take a more conservative approach when re-enter the market. Due to the limitations of data, we only see the decrease in Jan for 2 years, so I cannot consider it as an obvious pattern. If we can always observe such pattern in the future, we can be more certain about the drop in Jan.

The peak in March might due to the extreme market volatility and uncertainty brought by COVID-19. Since people demand for more liquidity, the repo market has more transcations.

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3. Repo GCF Repo

Observation: Repo GCF mainly involves US Treasury securities and agency Mortgage-Backed Securities. The total trading volume of GCF follows a decreasing trends, which is mainly due to the decrease in MBS. There is no obvious pattern in the trading volume. Moreover, it even wasn't affected by COVID-19 a lot, since it only had a small boost in March 2020, where people trying to make safer investment.

Explanation: The obvious decreasing pattern of MBS started from March 2020, the start of COVID-19. Since the interest rate was really low due to people's high demand for safe asset, more people might choose to prepay their existing MBS, leading to a net decrease in trading volume of MBS. Also, the economic disruptions caused by COVID-19 might affect consumer's ability to purchase home or qualify for new mortgages, reducing the trading of new MBS.

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4. Repo Triparty Repo

Observation: Repo Triparty Repo was relatively stable from 2012 to 2018, and started an increasing pattern after 2018. Seasonality is not obvious. There is a huge drop in about 2021 and a drastic recover after the drop.

Explanation: By 2021, as the market stablized and the economy began to recover, the operations used by Federal Reserve to ensure liquidity in financial markets might have scaled back, leading to a temporary reduction in repo volumes. Since the economy recover, the interest rate might also rise, with the rising concerns about inflation, participants might reassess their positions and reliance on short-term funding markets like repos, which reflect on the drastic changes in trading volume in repo market.

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5. Equity Issuance

Observation: Yes there seems to have some pattern before 2020, but due to the limitations of the data, we can not be certain what kind of pattern it is. There is a huge boost in equity issuance in March and April in 2020, the fluctuations in equity issuance is more severe after the huge boost, and the average amount of equity trading is higher than that before the COVID. **Explanation:** Due to the COVID-19, companies try to raise capital through equity issuance before potential further downturns. Moreover, the decreases in revenues make companies want to find ways to increase their cash reserves to prepare for uncertain economic lanscape, leading to increased equity

issuances. Moreover, to avoid increasing leverage ratios, companies preferred equity issuance instead of bond issuance. The Government also try to encourage companies to access quity markests during this period.

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6. Equity Trading Volume

Observation: Equity trading volume follows a similar pattern as equity issuance.

Explanation: Firstly, due to the increase in issuance, the trading volume will increase accordingly. Secondly, since the interest rate drop drastically, investors might want to seek for more profitable options. Thirdly, goverment and central banks aims at stablizing the economies, so they might encourage investors buying some equity.

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7. Fixed Income Trading Volume

Observation: There indeed exist some seasonalities in fixed_income drading. There is also a peak in March 2020, but it is less drastic than the fluctuations for equity issuance.

Explanation: The seasonal pattern might due to Quarterly Reports & Fiscal Year Cycles where investors try to rebalance their portfolios. The peak in trading volume was largely driven by COVID-19, where people try to search for safty. Since fixed income securities, particularly government bonds, are often considered safer during times of market stress, people will involve more trading in fixed income securities. Moreover, the need for liquidity among investors also increase trading volume of fixed income market, where people can liquidate their holdings and raise for cash quickly.

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8. Structured Finance Trading Volume

Observation: There is a noticeable spike in trading volume for structured finance products around March 2020, followed by a gradual decline with some fluctuations. A recurring pattern of increased trading volume can be seen at the end of each quarter, particularly in March, June, September, and December.

Explanation: The increase in trading volume in March 2020 is mainly due to the COVID-19 pandemic, which caused significant market volatility and led investors to actively adjust their positions. The seasonal pattern observed, with higher trading volumes at the end of each quarter, could be attributed to institutional portfolio rebalancing and adjustments for regulatory or reporting requirements. After the initial surge, the trading volume declined as markets stabilized, though regular fluctuations persisted due to ongoing market activities.

9. Agency Trading Volume

Observation: There is a clear peak in the trading volume for U.S. agency securities around March 2020, followed by a significant decline that continues through to mid-2021. The individual components such as Fannie Mae (Fanni), Freddie Mac (Fredd), and FHLB show varying levels of trading volume, with a notable dip after the initial peak. The overall trading volume seems to decrease consistently after the peak, with some fluctuations along the way.

Explanation: The spike in trading volume around March 2020 likely reflects the market's response to the COVID-19 pandemic, as investors sought safety in agency securities, which are generally considered low-risk. The subsequent decline can be attributed to a normalization in market conditions as the initial panic subsided and the Federal Reserve's interventions provided sufficient liquidity. The fluctuations observed in specific agencies like FHLB and Freddie Mac might indicate periodic adjustments or rebalancing by investors in response to economic developments and changing interest rates, but the overall trend points to a reduced demand for agency securities as the market stabilized.

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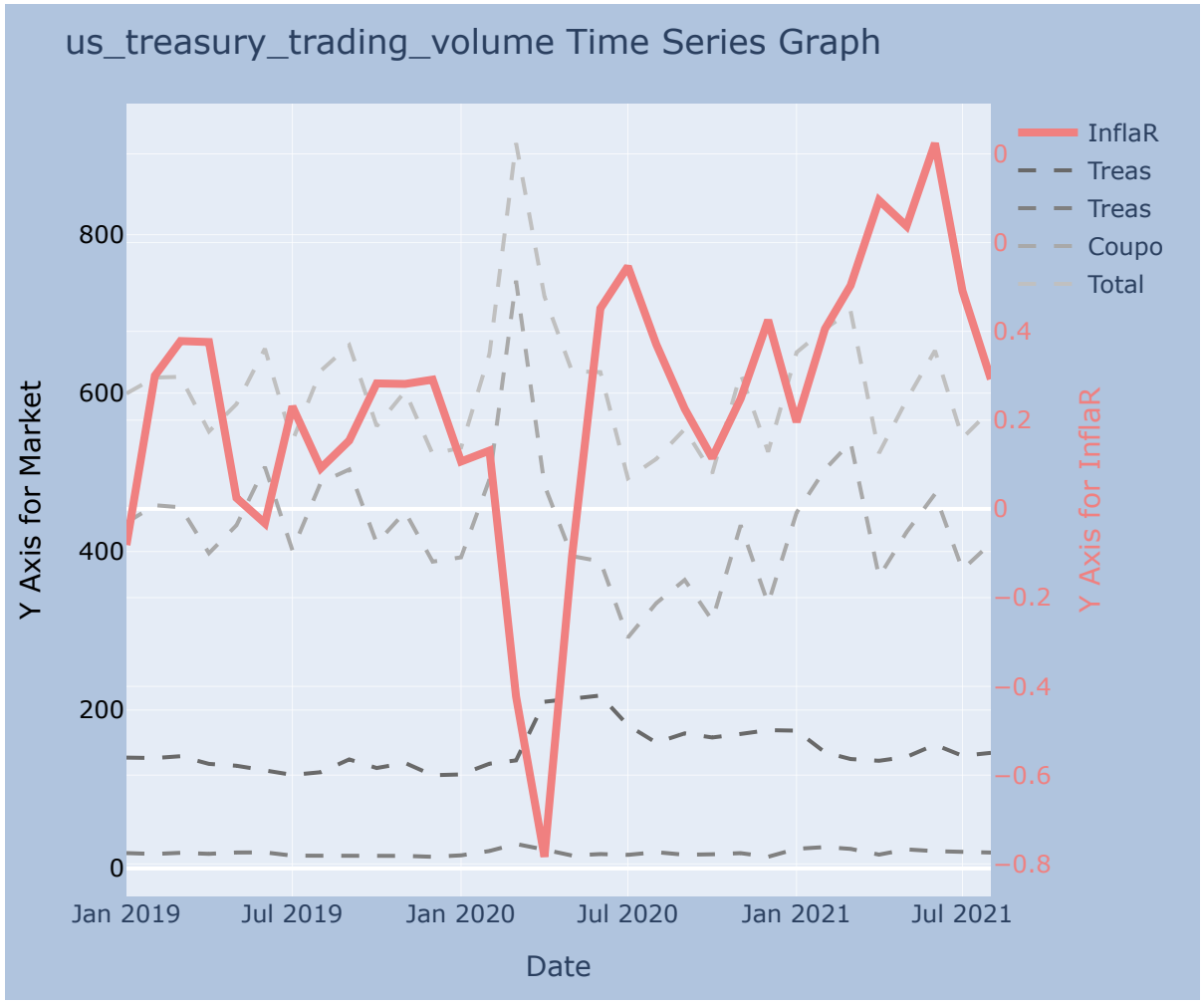
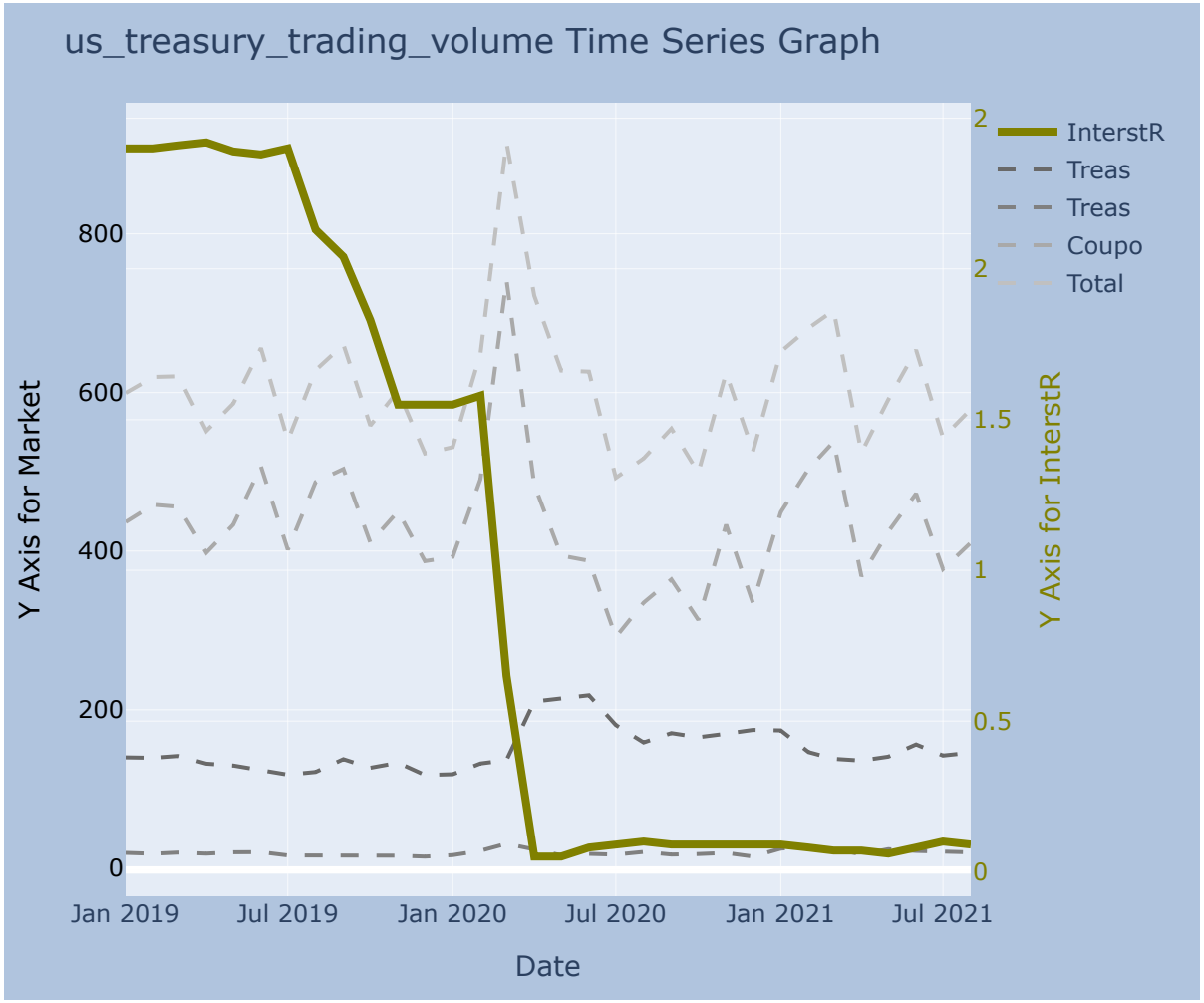
10. Corporate Bond Trading Volume

Observation: The trading volume of the U.S. corporate bond market shows a significant peak around March 2020, followed by a noticeable decline through to mid-2021. Both investment-grade (Inves) and high-yield (High) bonds exhibit this trend, though the high-yield bonds show a sharper drop after the peak. The overall trading volume decreases steadily after the initial spike, with some fluctuations, but the general trend is downward.

Explanation: The spike in trading volume in March 2020 is mainly caused by COVID-19 pandemic, where market uncertainty drove a increase in trading activity as investors reassessed their exposure to corporate credit risk. The subsequent decline in trading volume likely reflects a stabilization in market conditions as the initial panic eased and companies adjusted to the new economic realities. The sharper drop in high-yield bonds might indicate investors are trying to avoid riskier assets as the economic impact of the pandemic became clearer. The overall pattern suggests that after the initial reaction to the crisis, trading activity gradually decrease as markets normalized and investor confidence slowly returned.

Plot the data along with each of the macro-economic indicators that you selected?


us_treasury_trading_volume Time Series Graph
Y Axis for Market
Y Axis for InflaR
Date
InflaR
Treas
Treas
Coupo
Total
800
600
400
200
0
0
0
0.4
0.2
0
−0.2
−0.4
−0.6
−0.8
Jan 2019
Jul 2019
Jan 2020
Jul 2020
Jan 2021
Jul 2021


us_treasury_trading_volume Time Series Graph
Y Axis for Market
Y Axis for InterstR
Date
InterstR
Treas
Treas
Coupo
Total
0
200
400
600
800
0
0.5
1
1.5
2
2
Jan 2019
Jul 2019
Jan 2020
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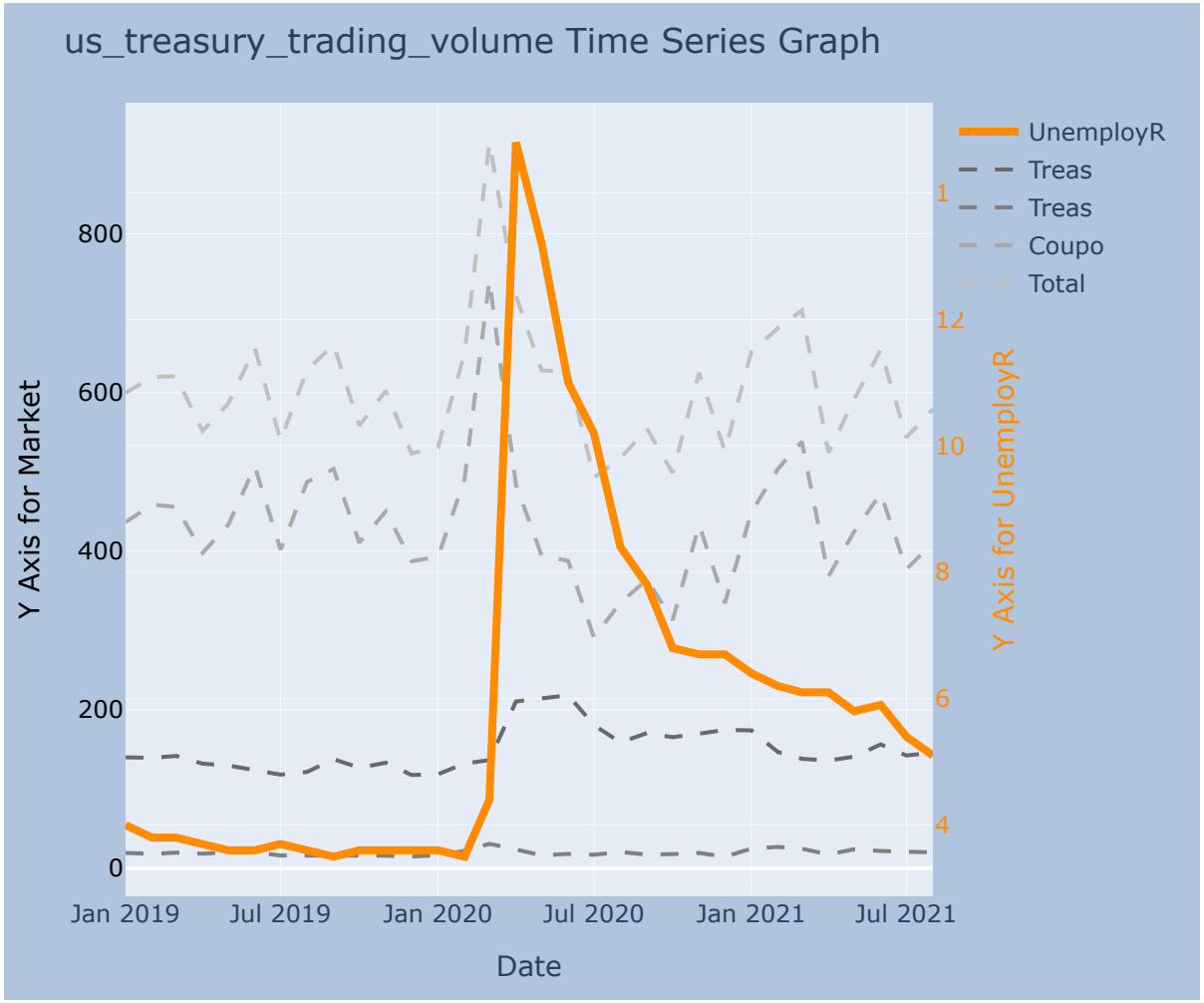
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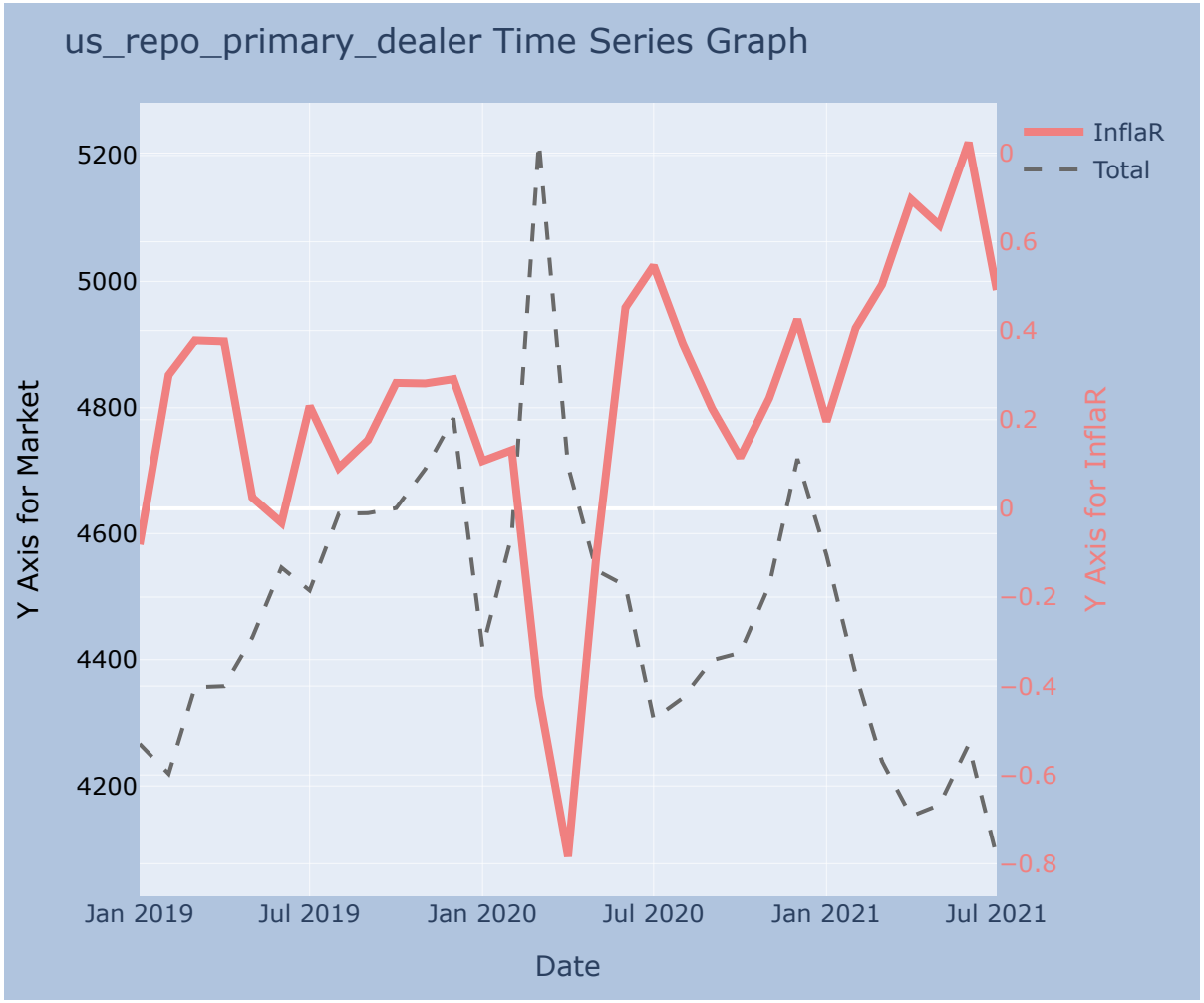
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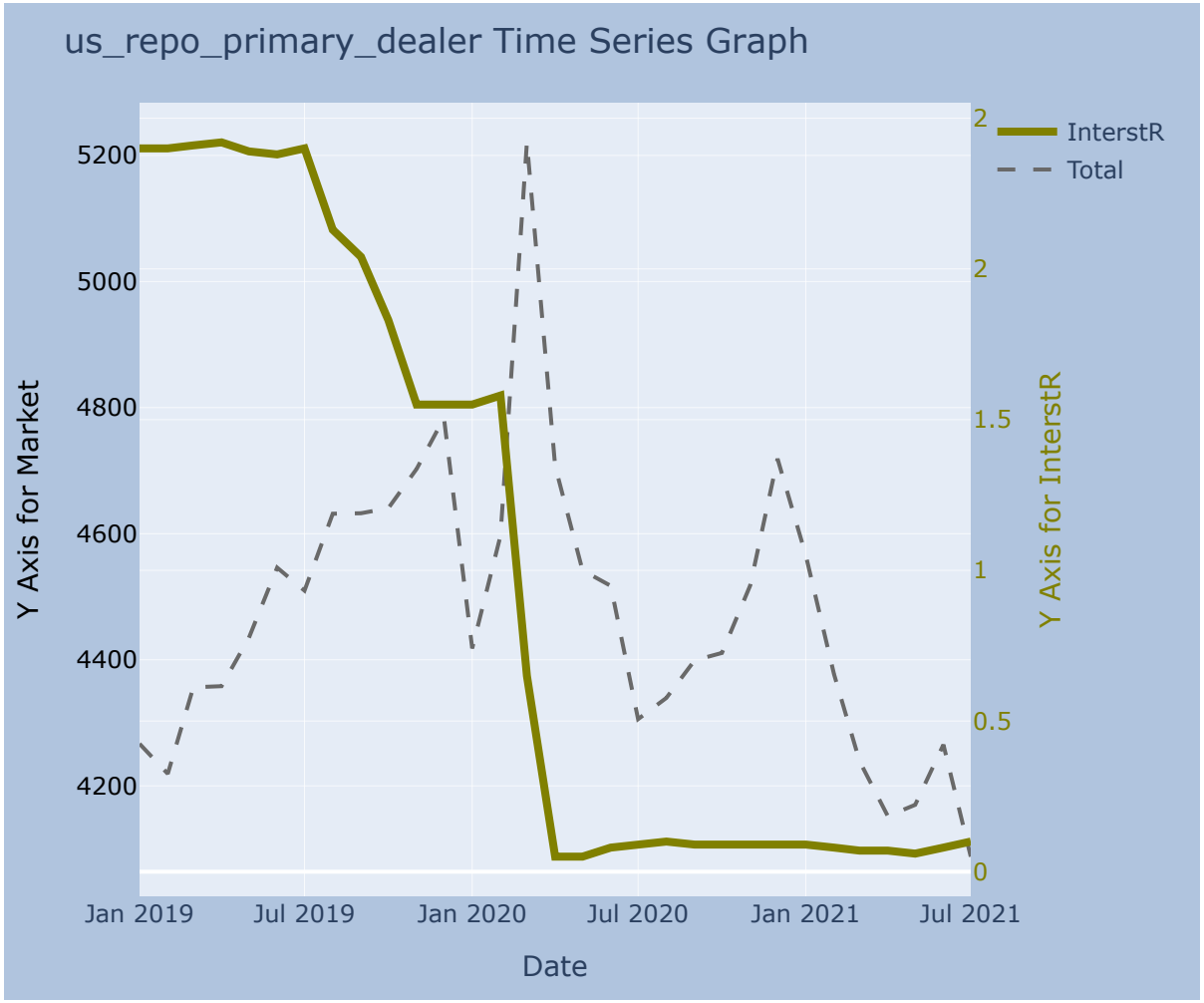
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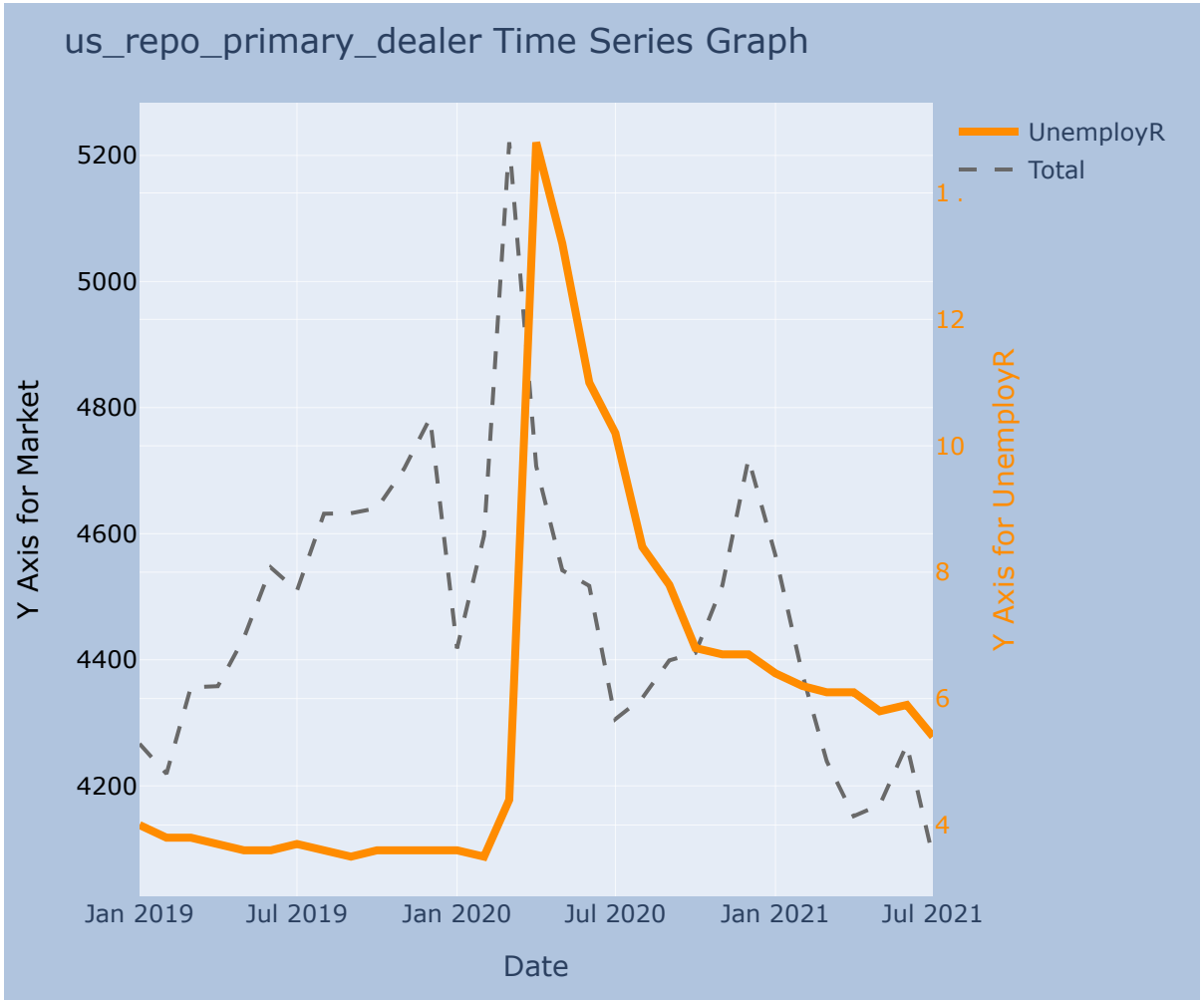
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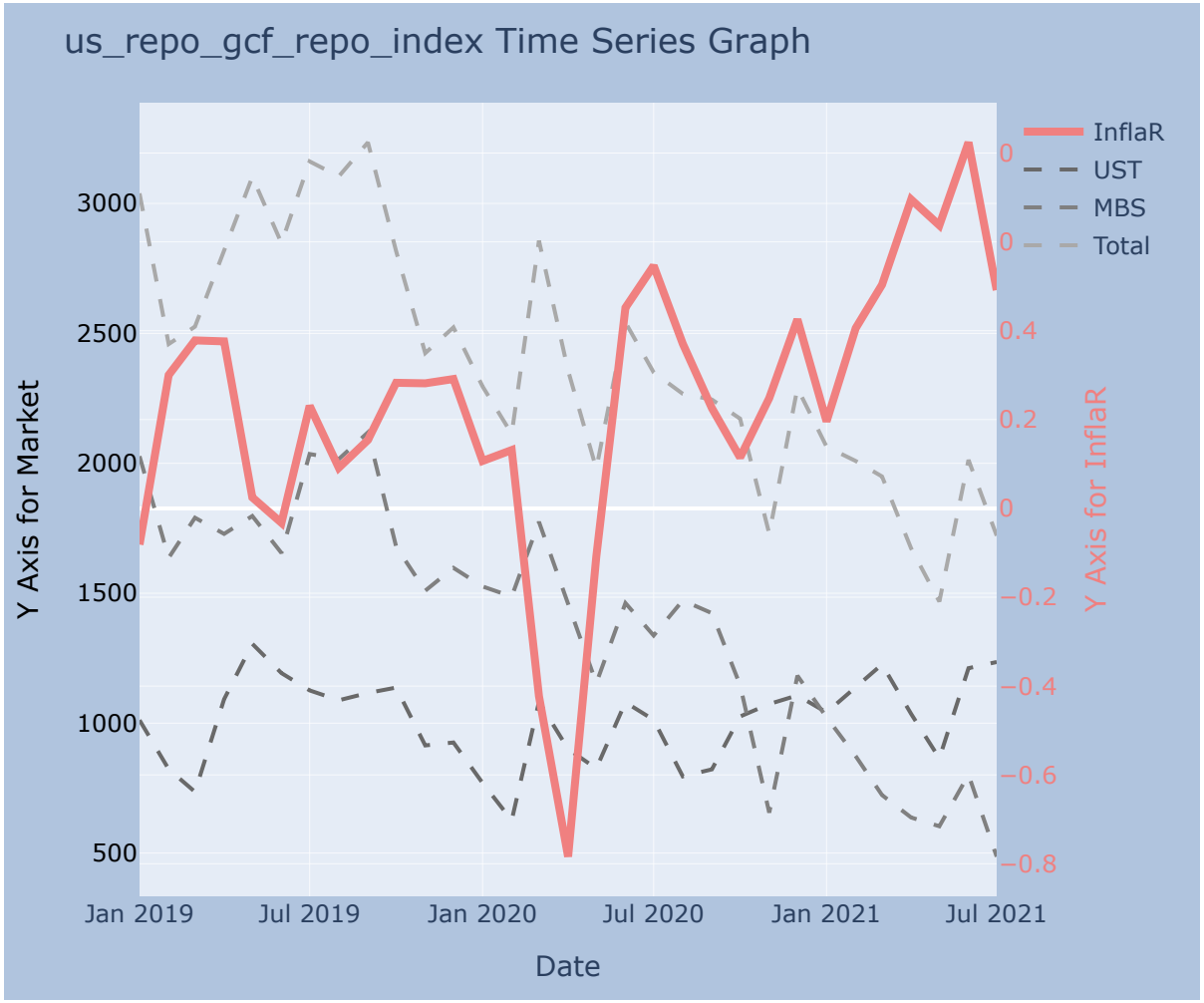
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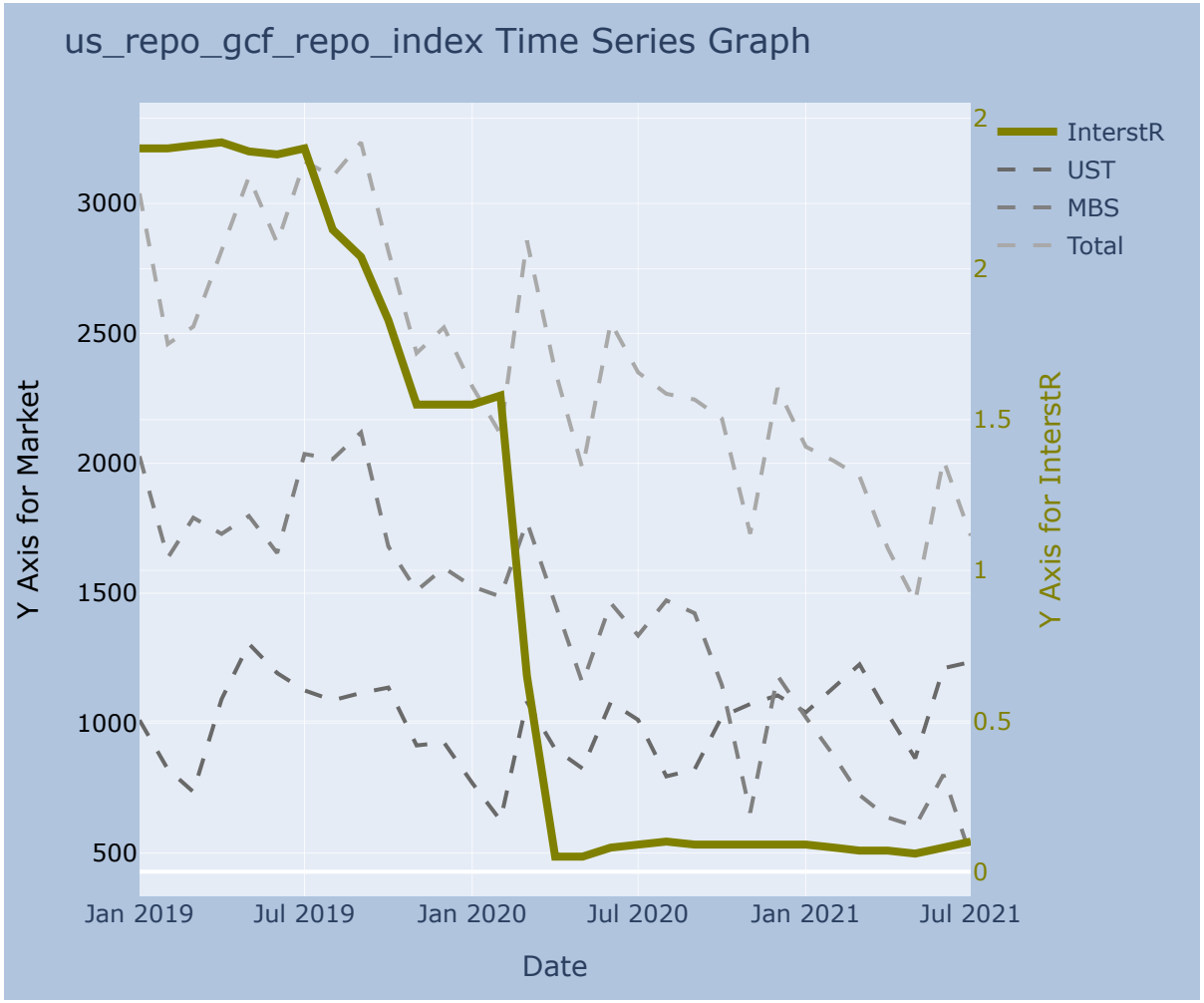
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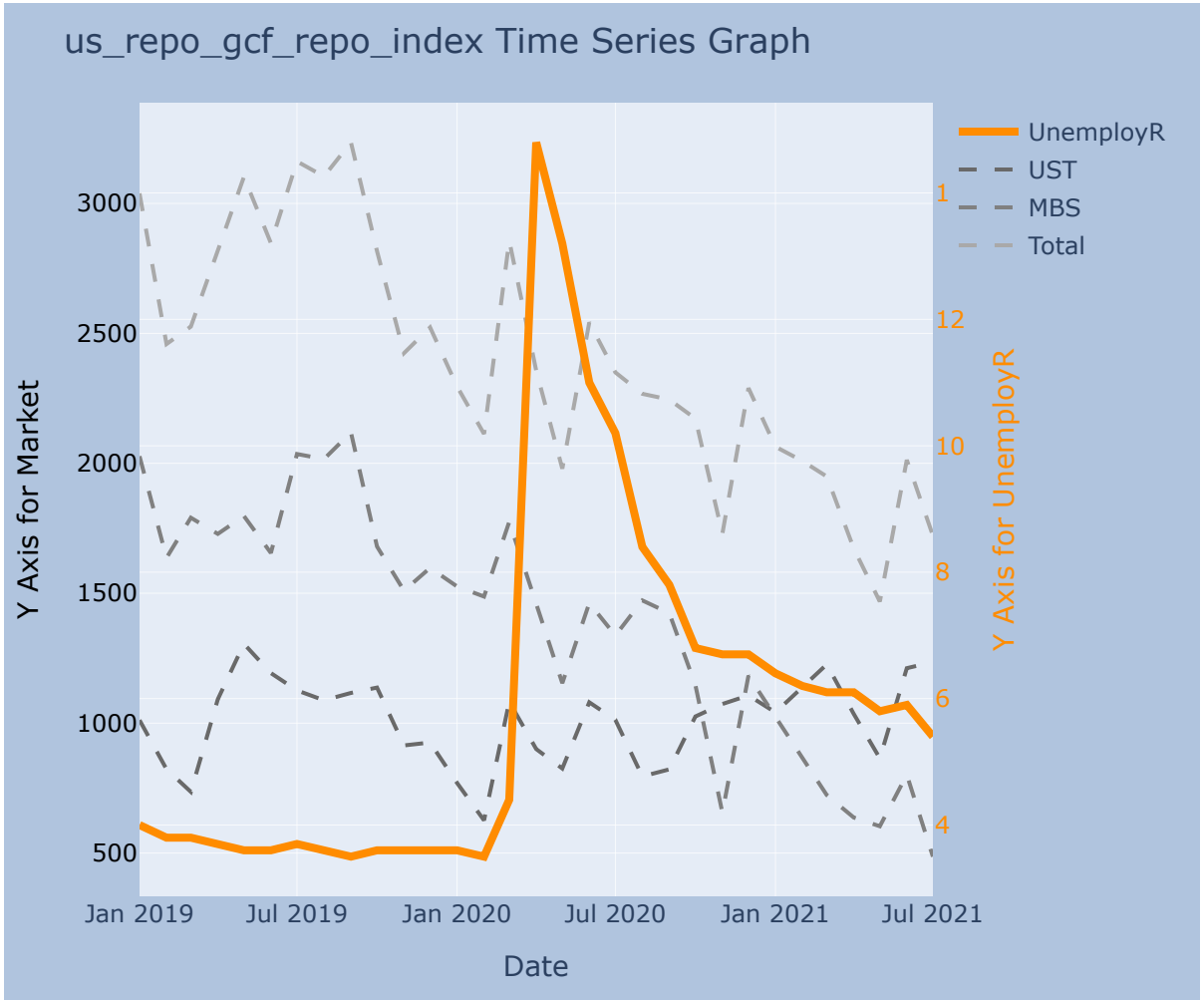
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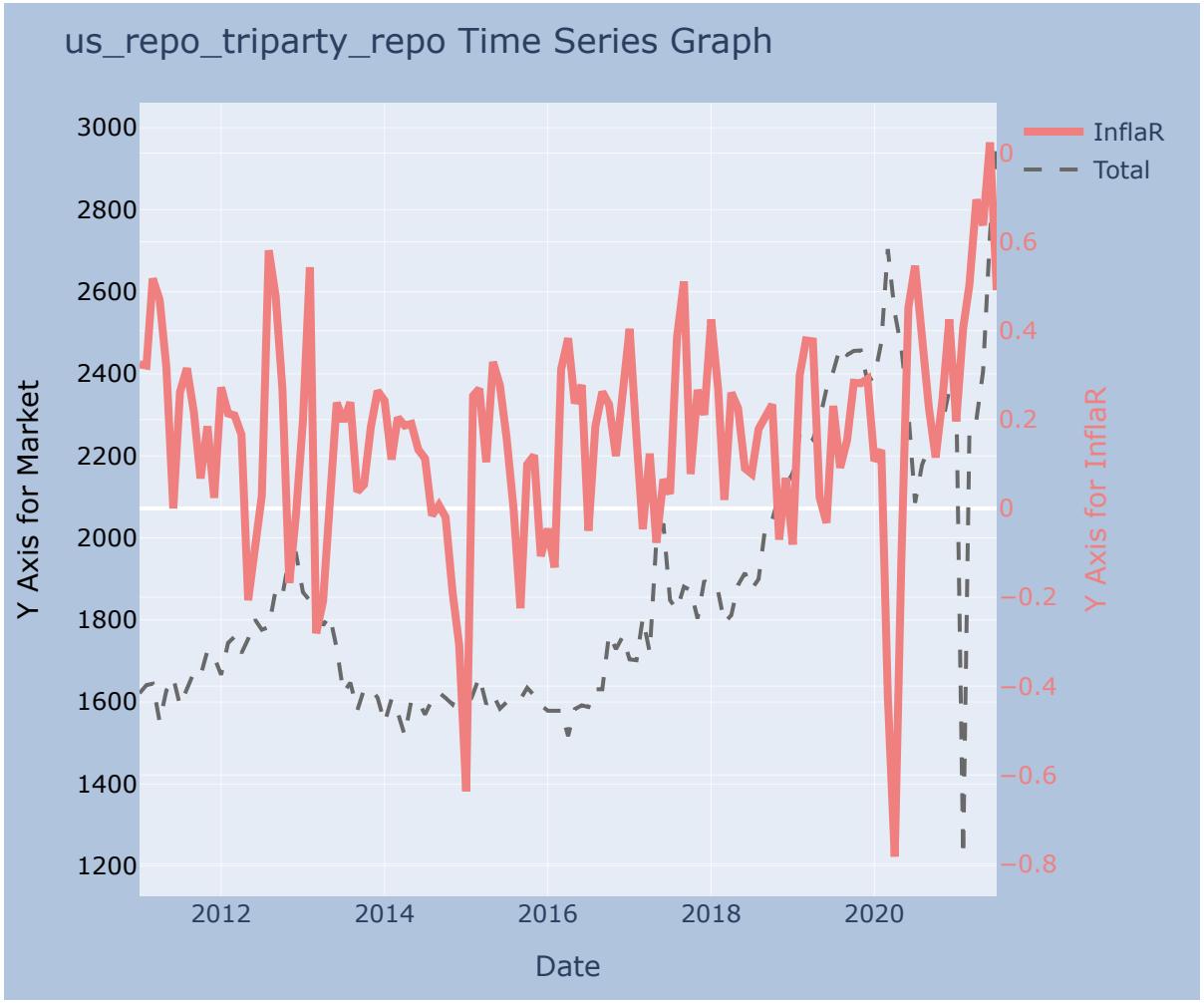
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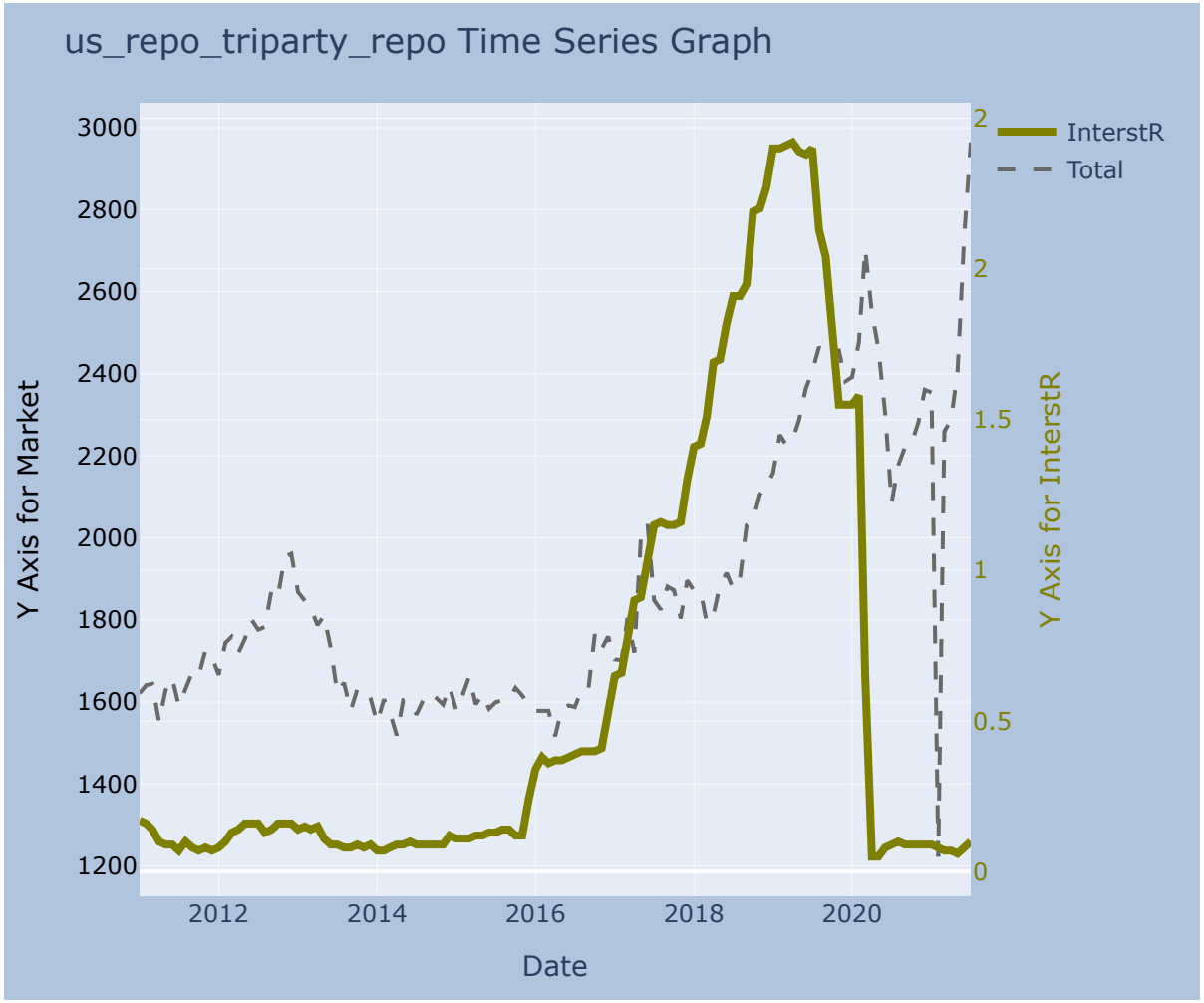
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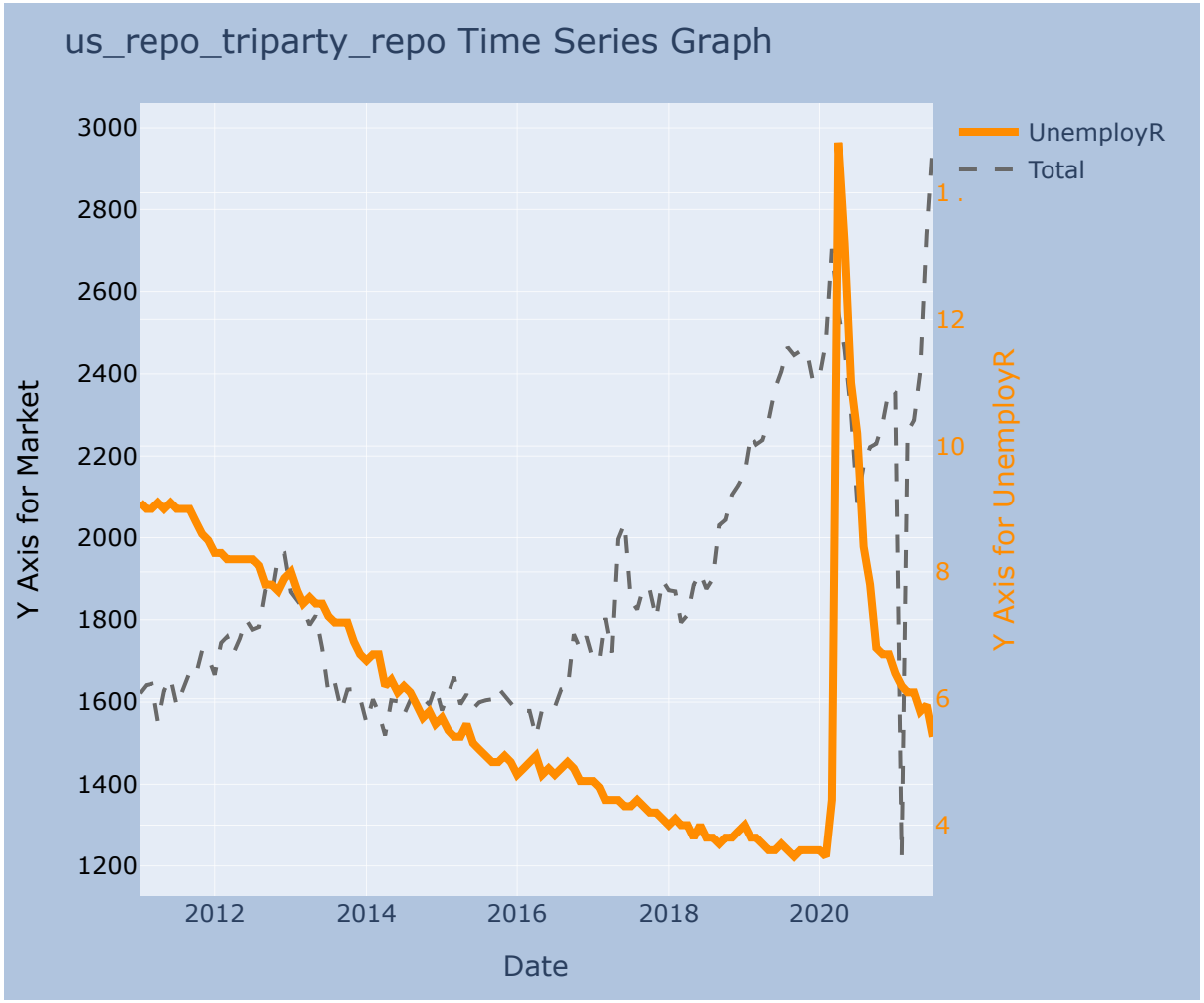
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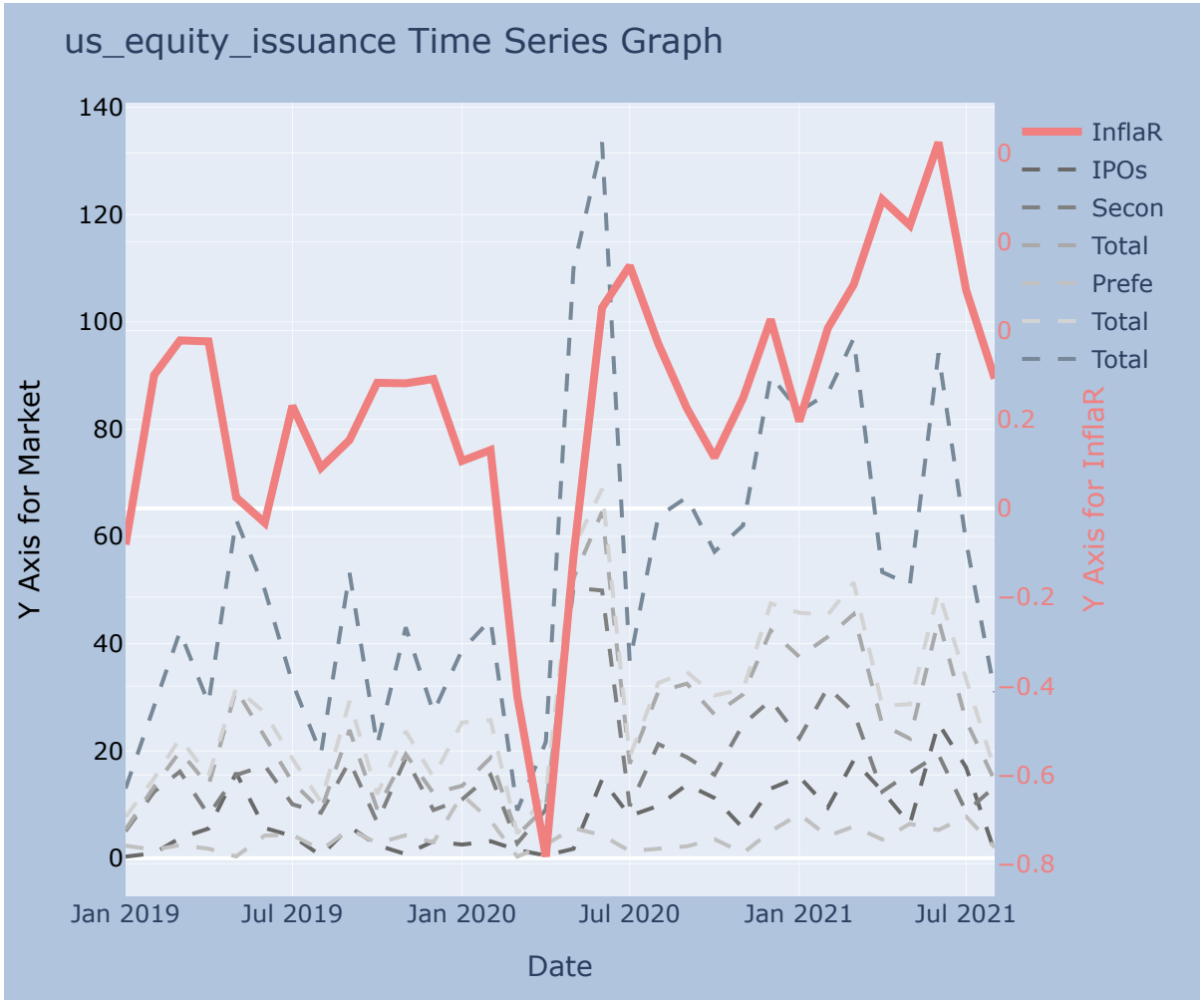
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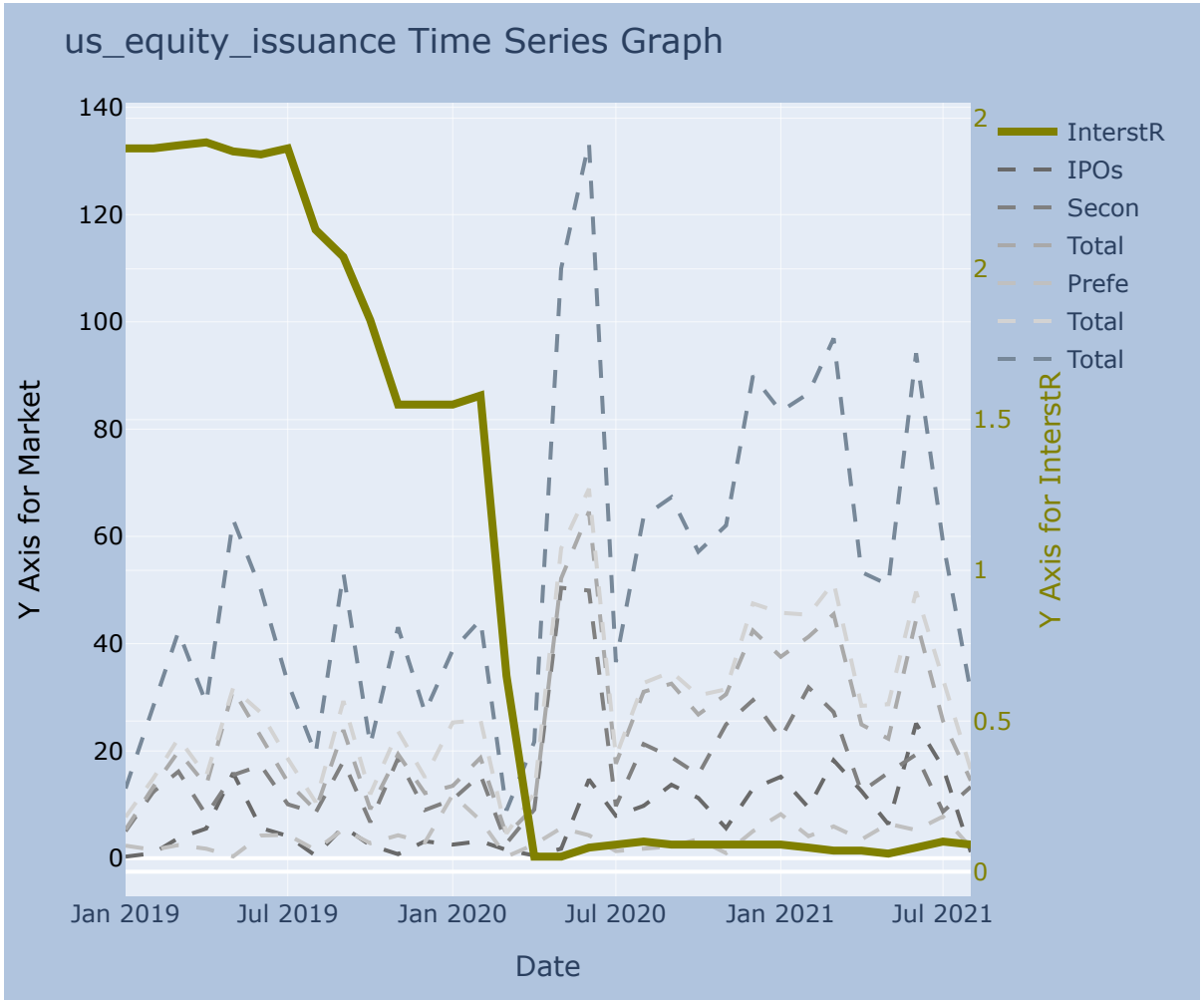
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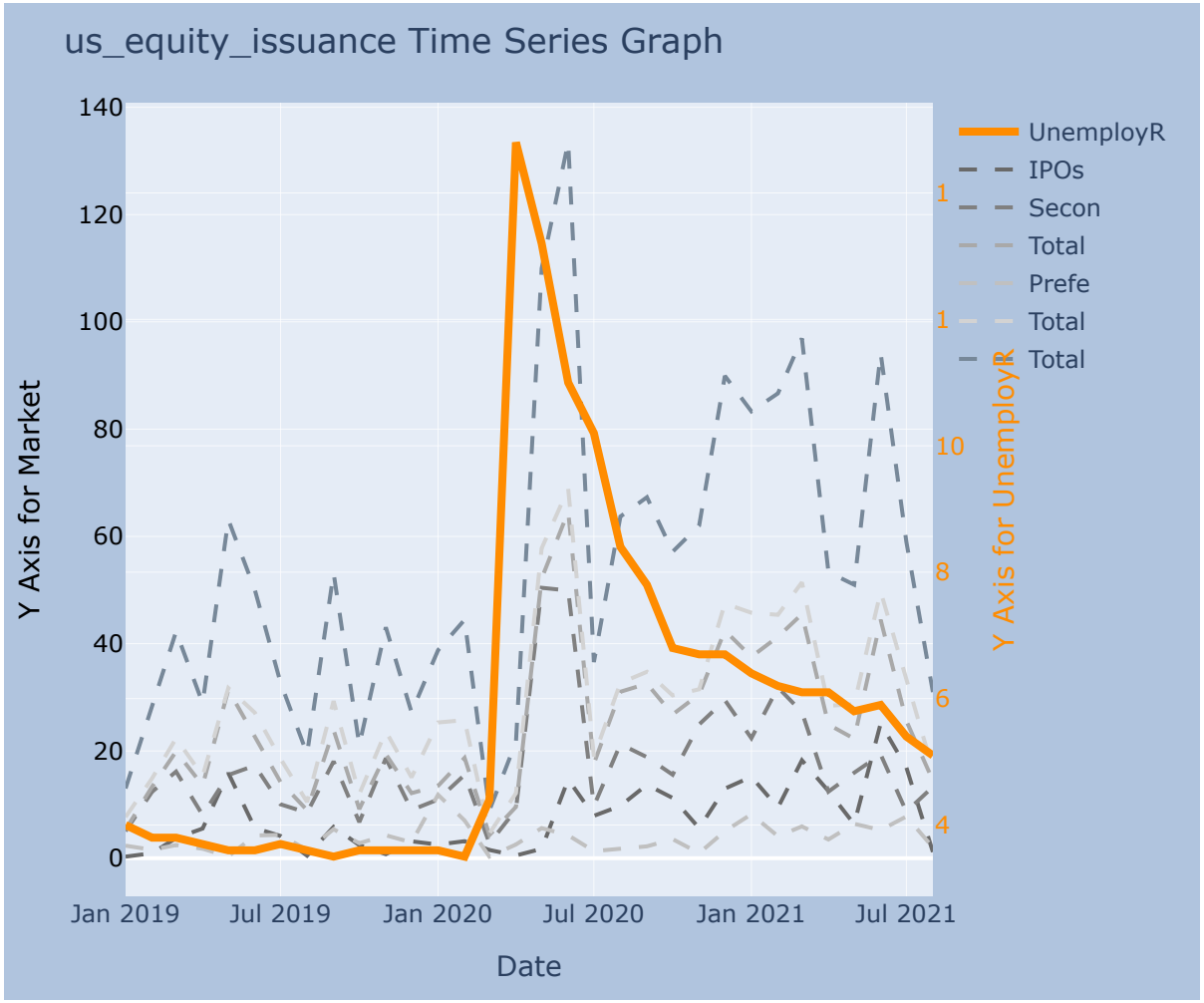
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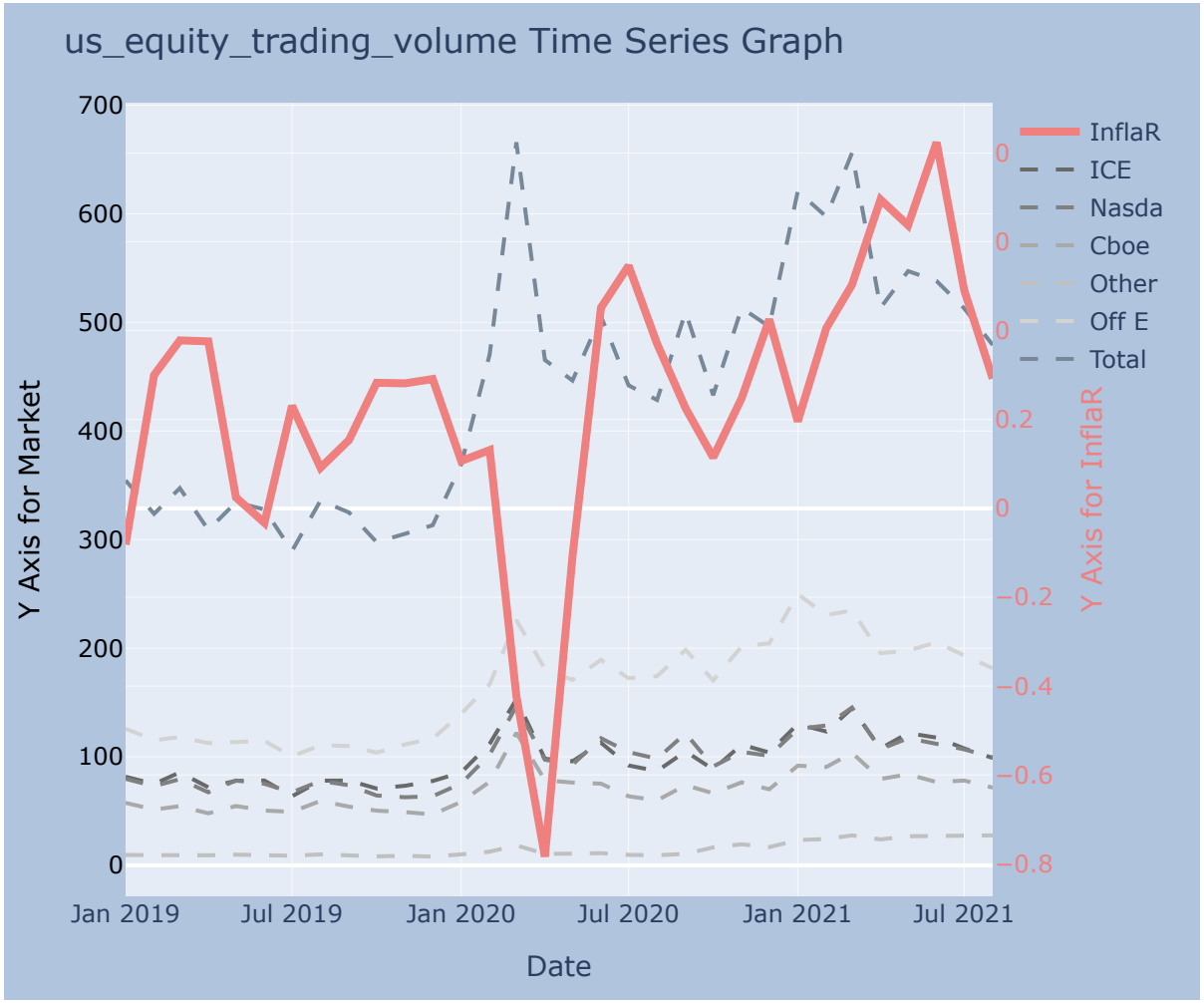
us_equity_trading_volume Time Series Graph
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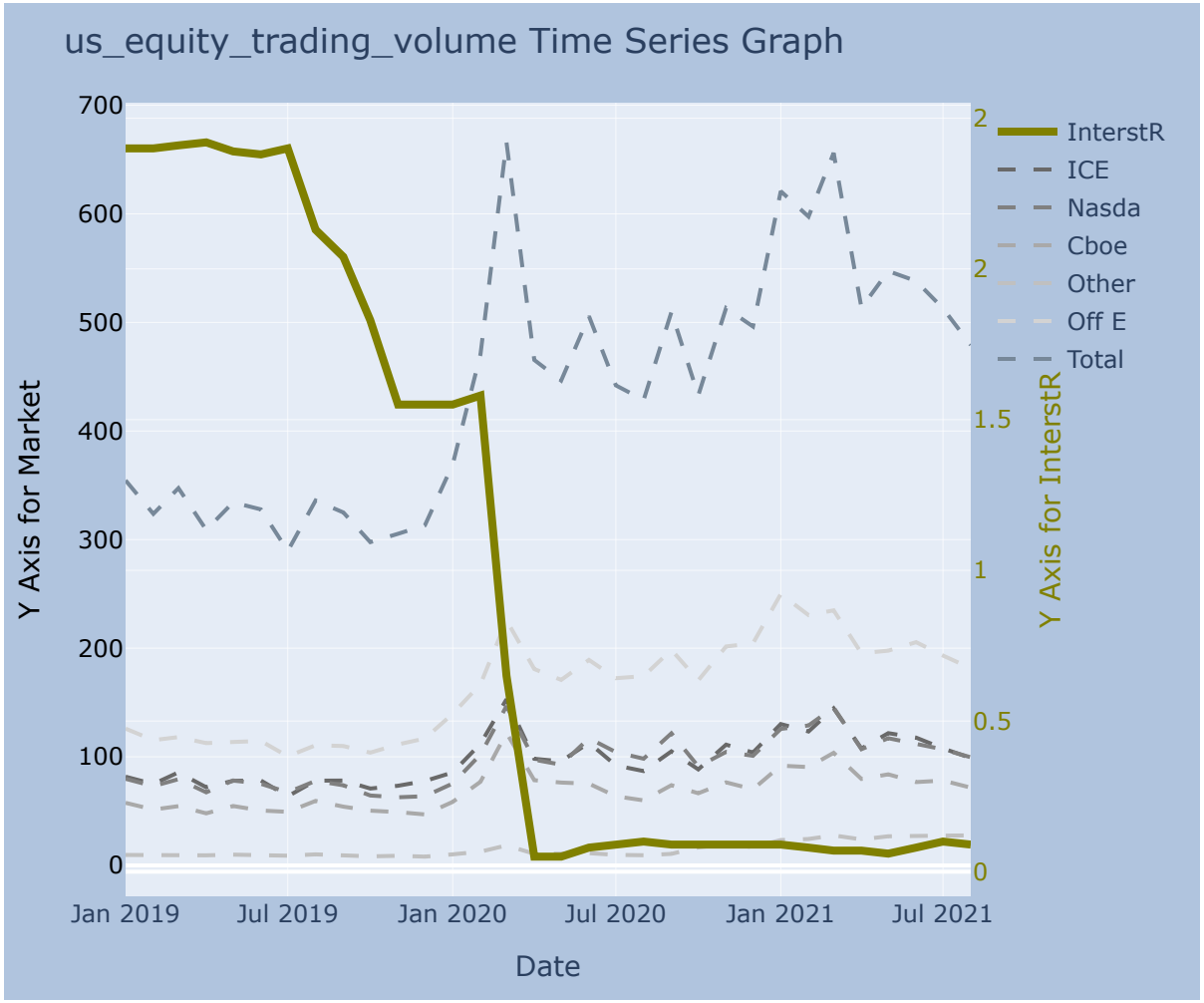
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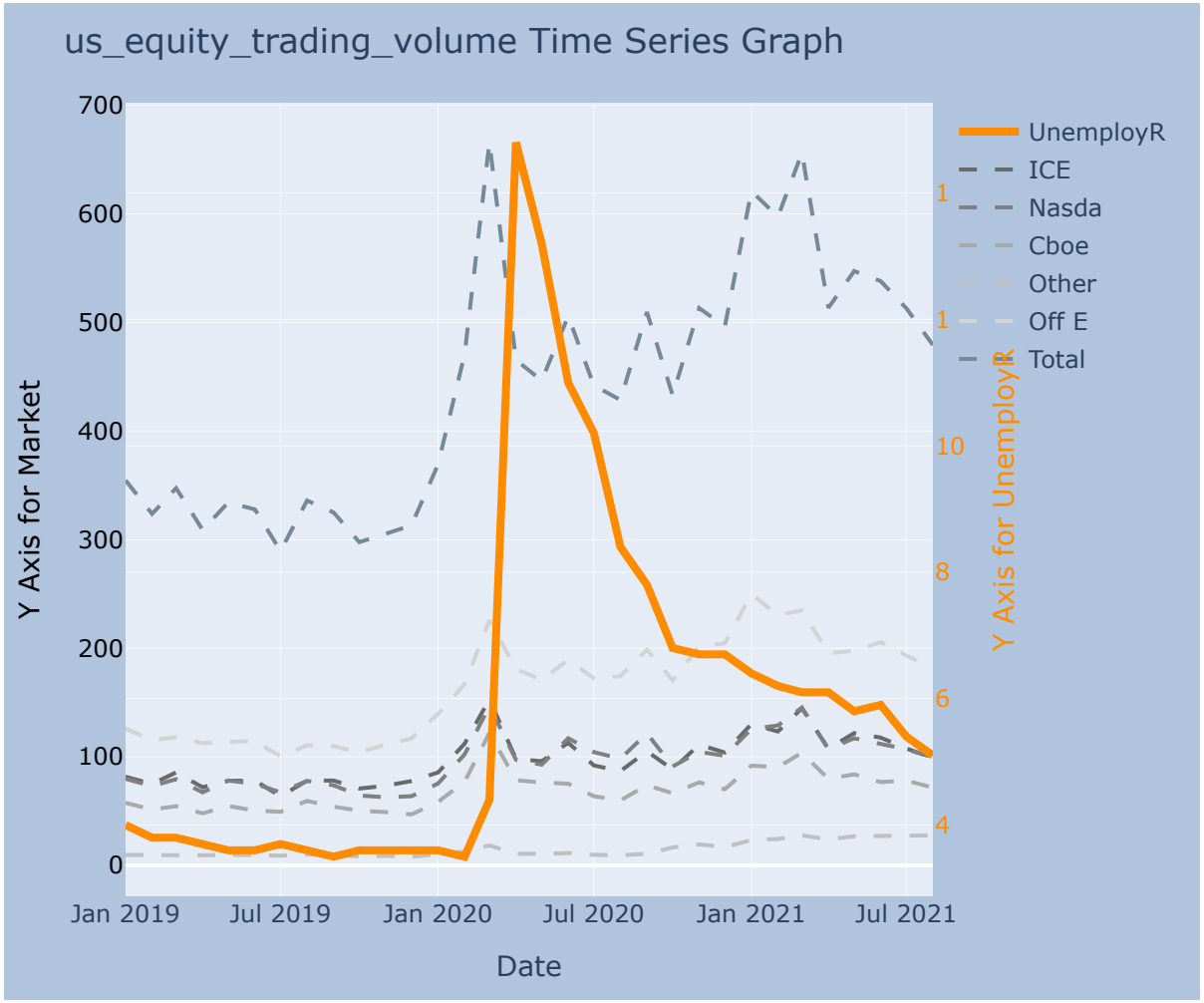
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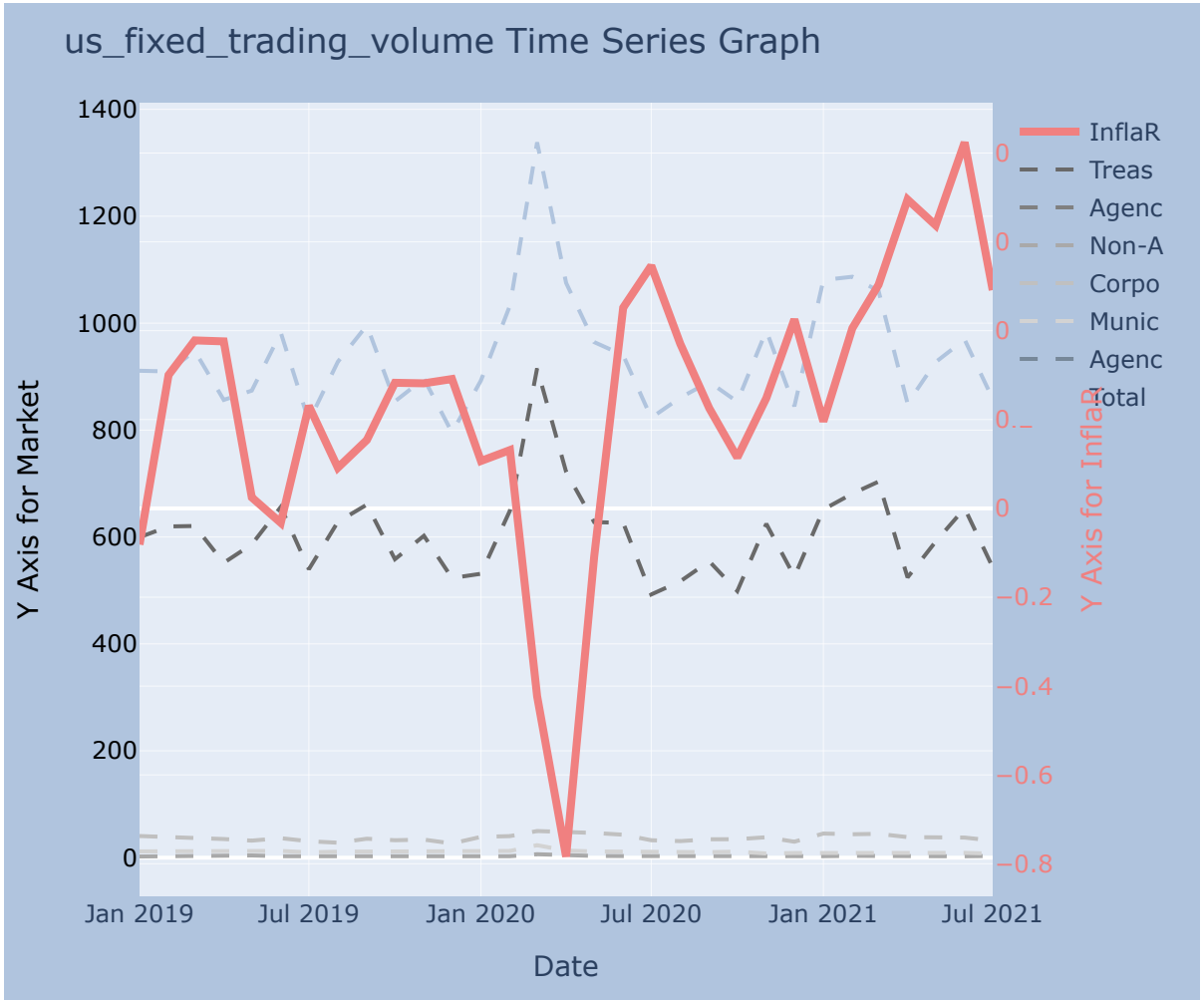
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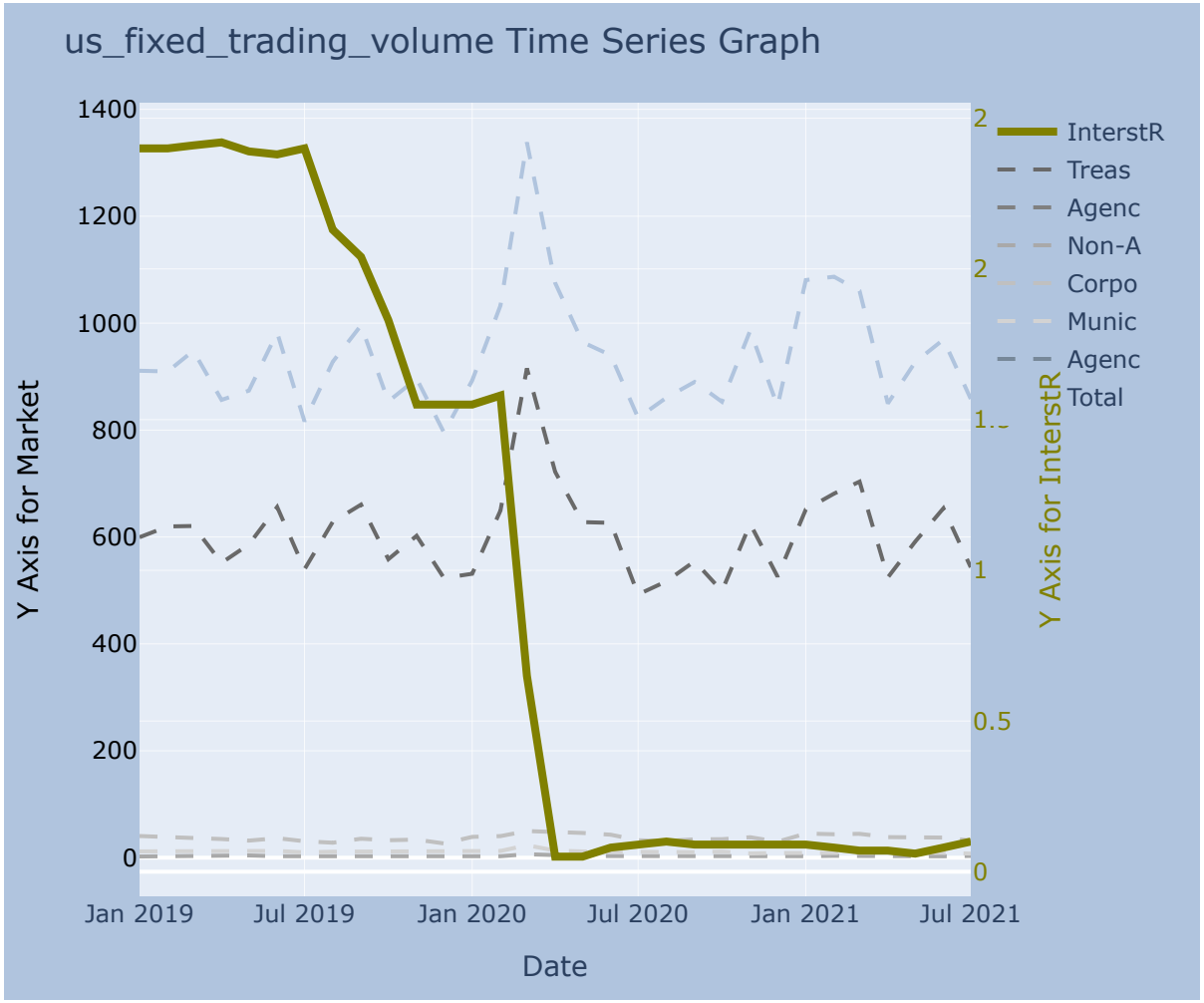
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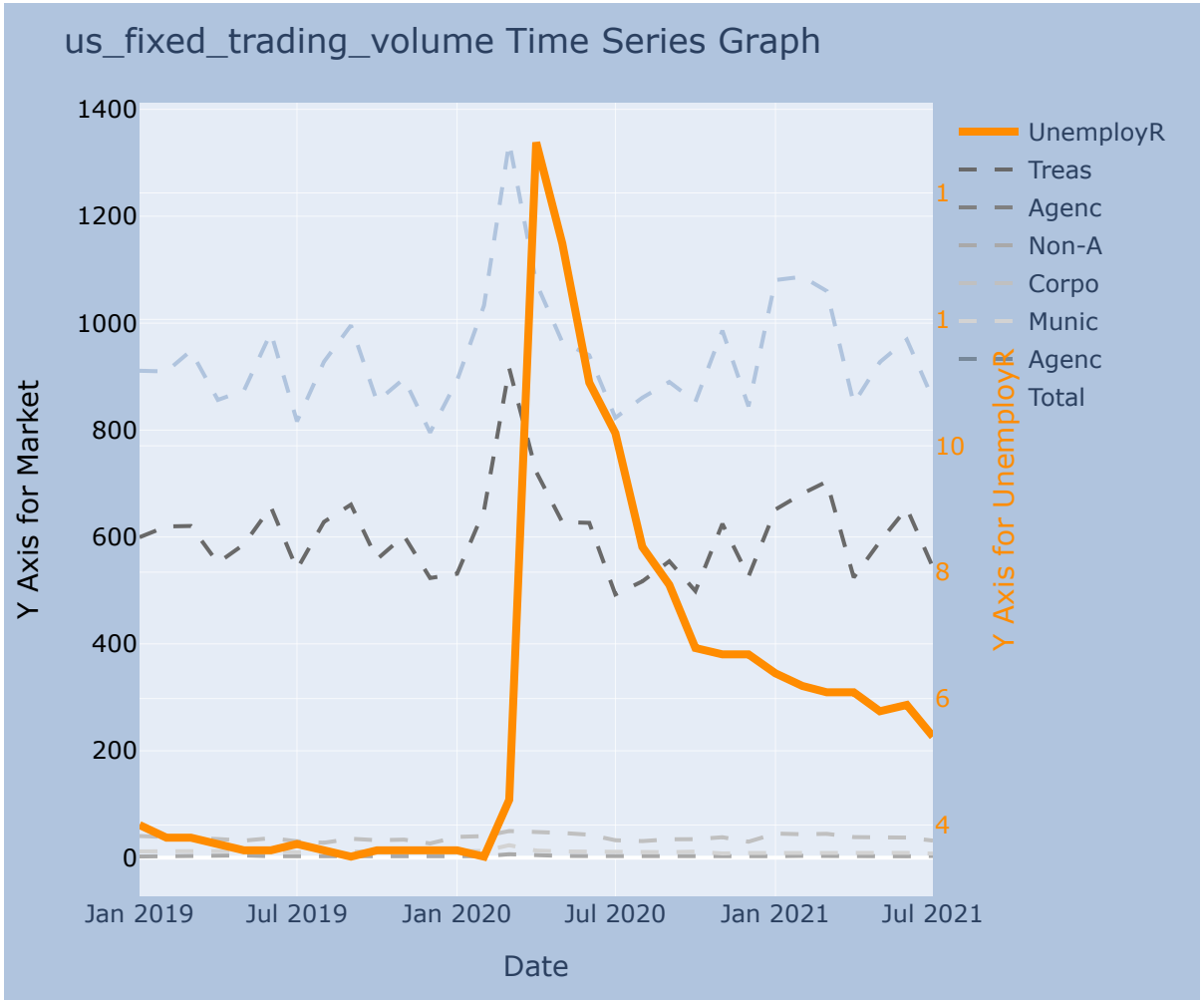
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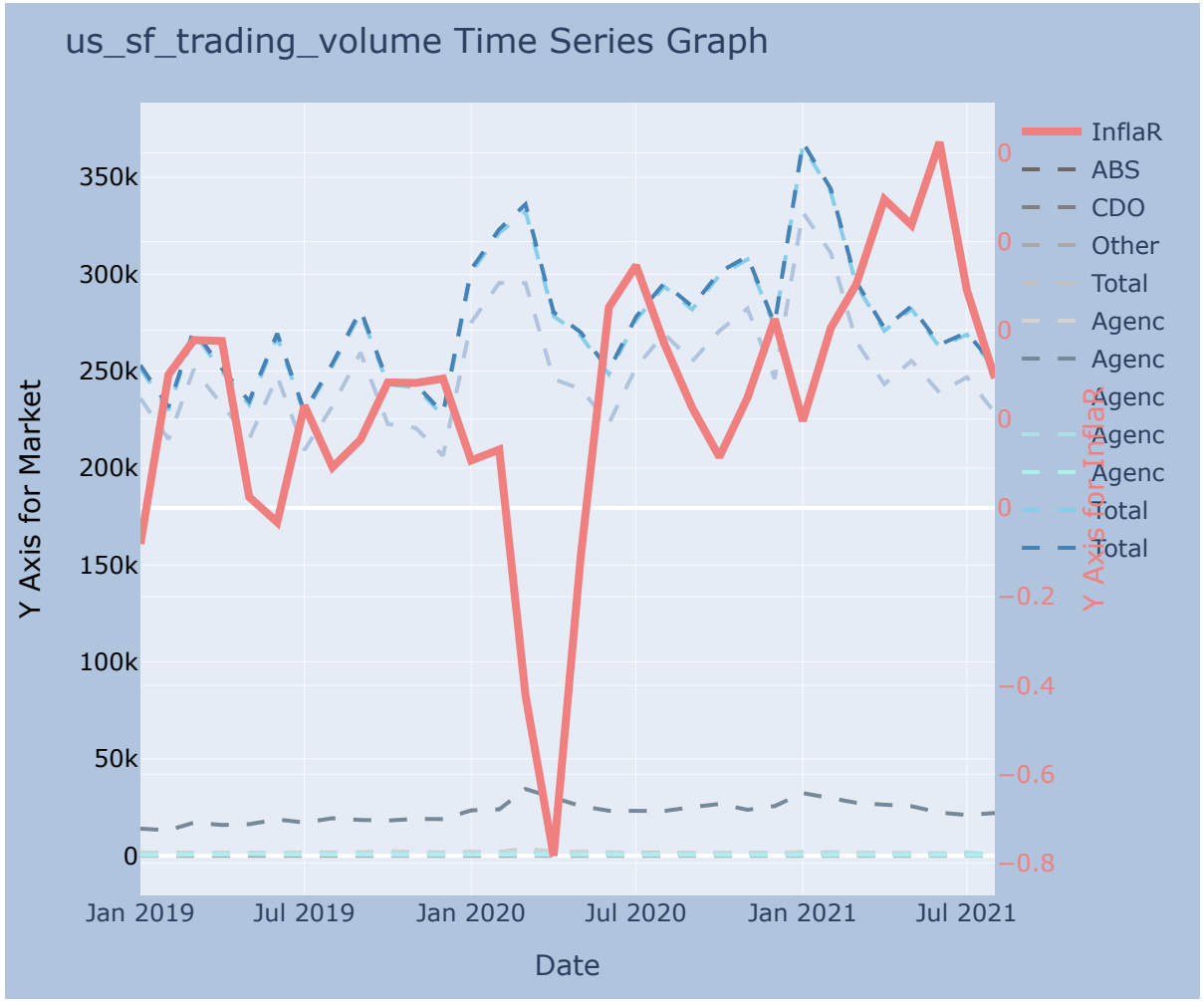
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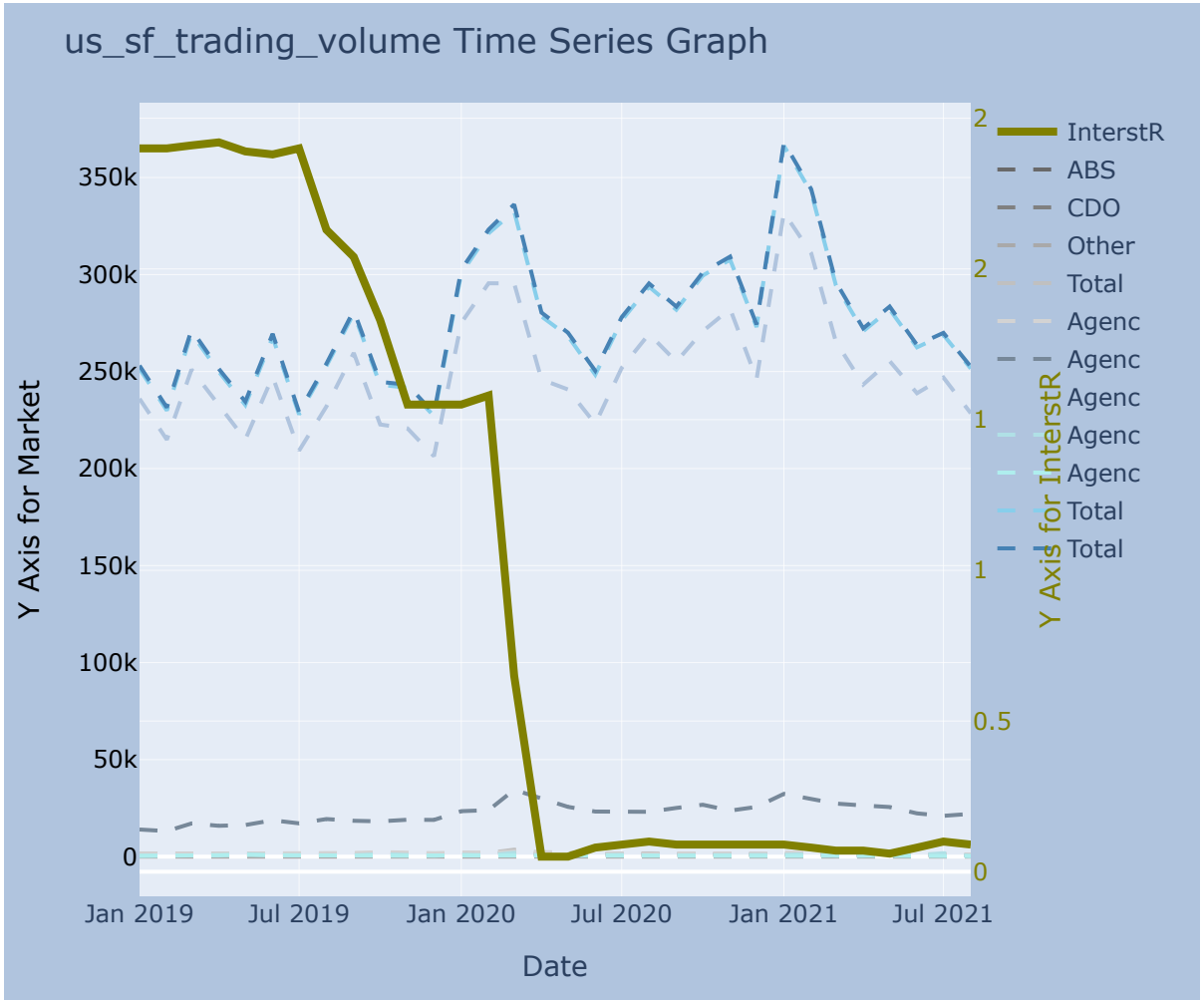
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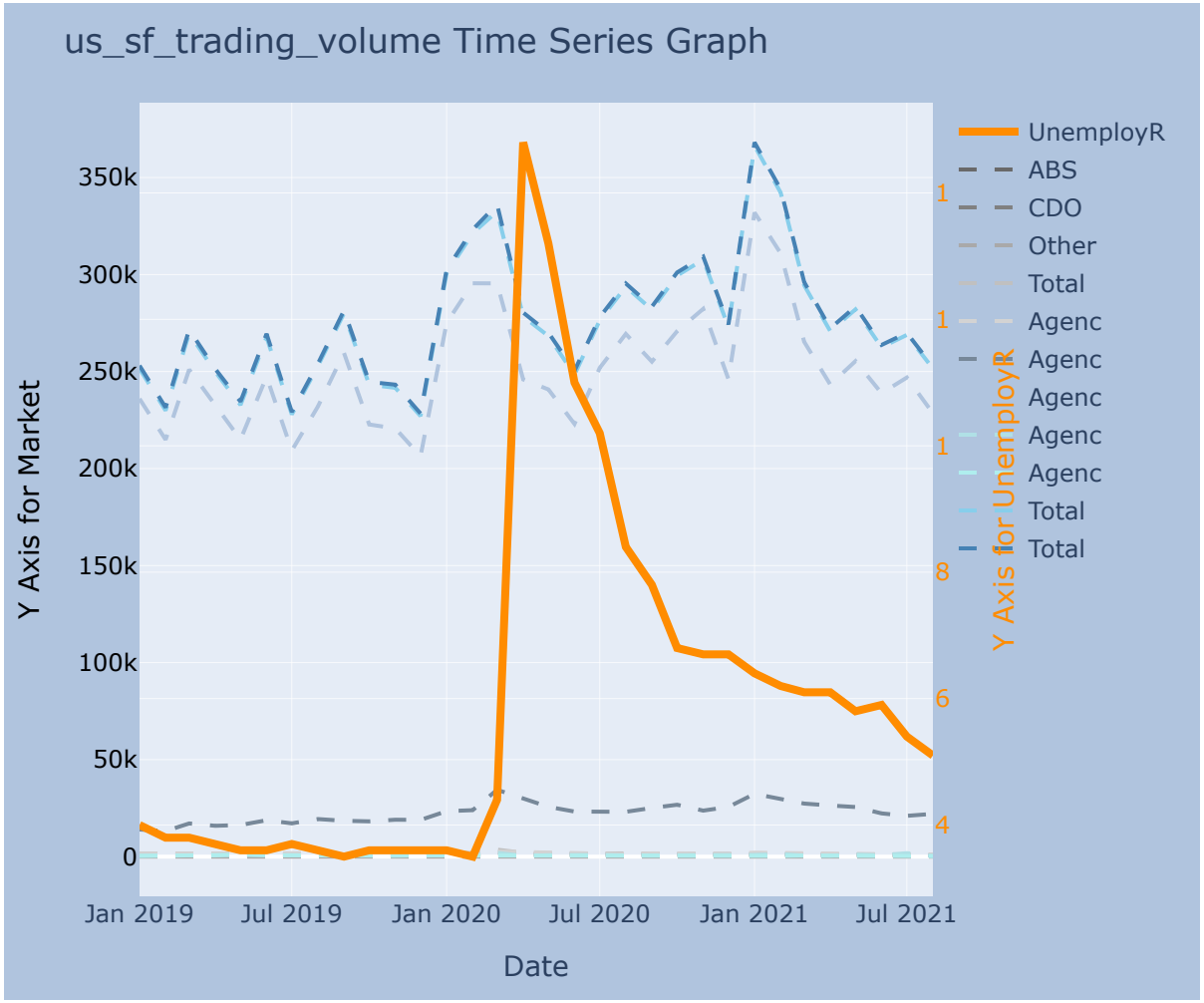
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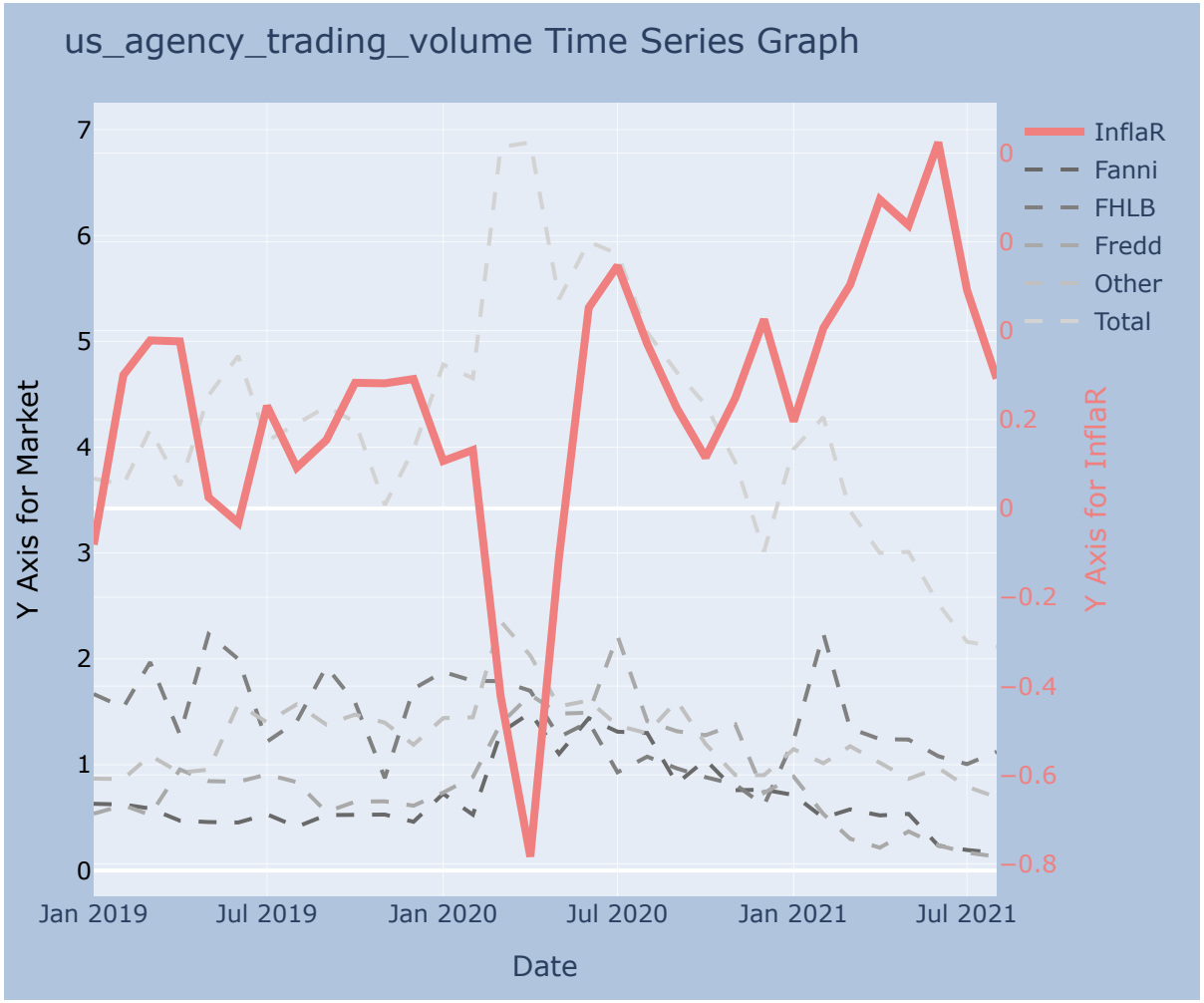
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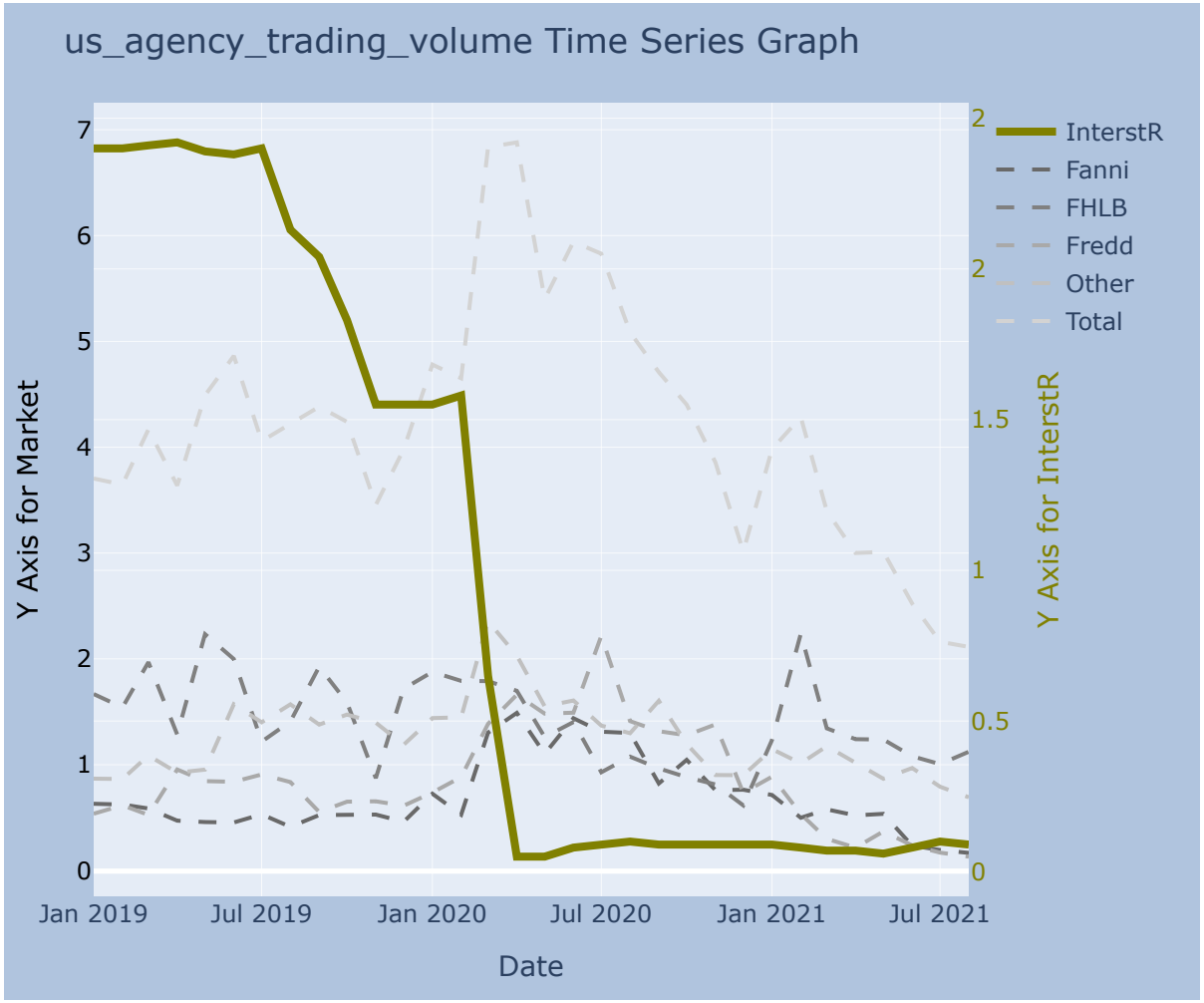
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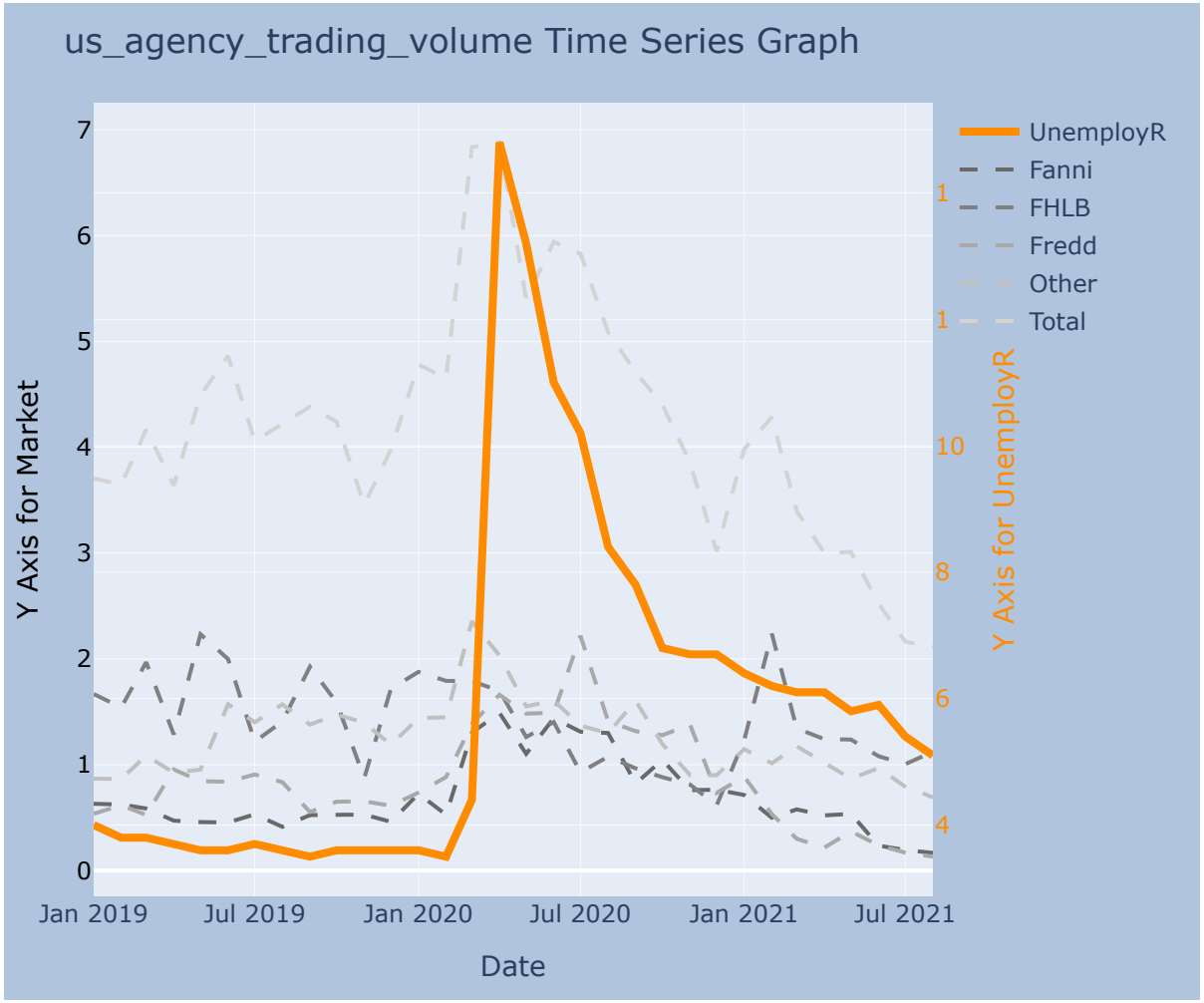
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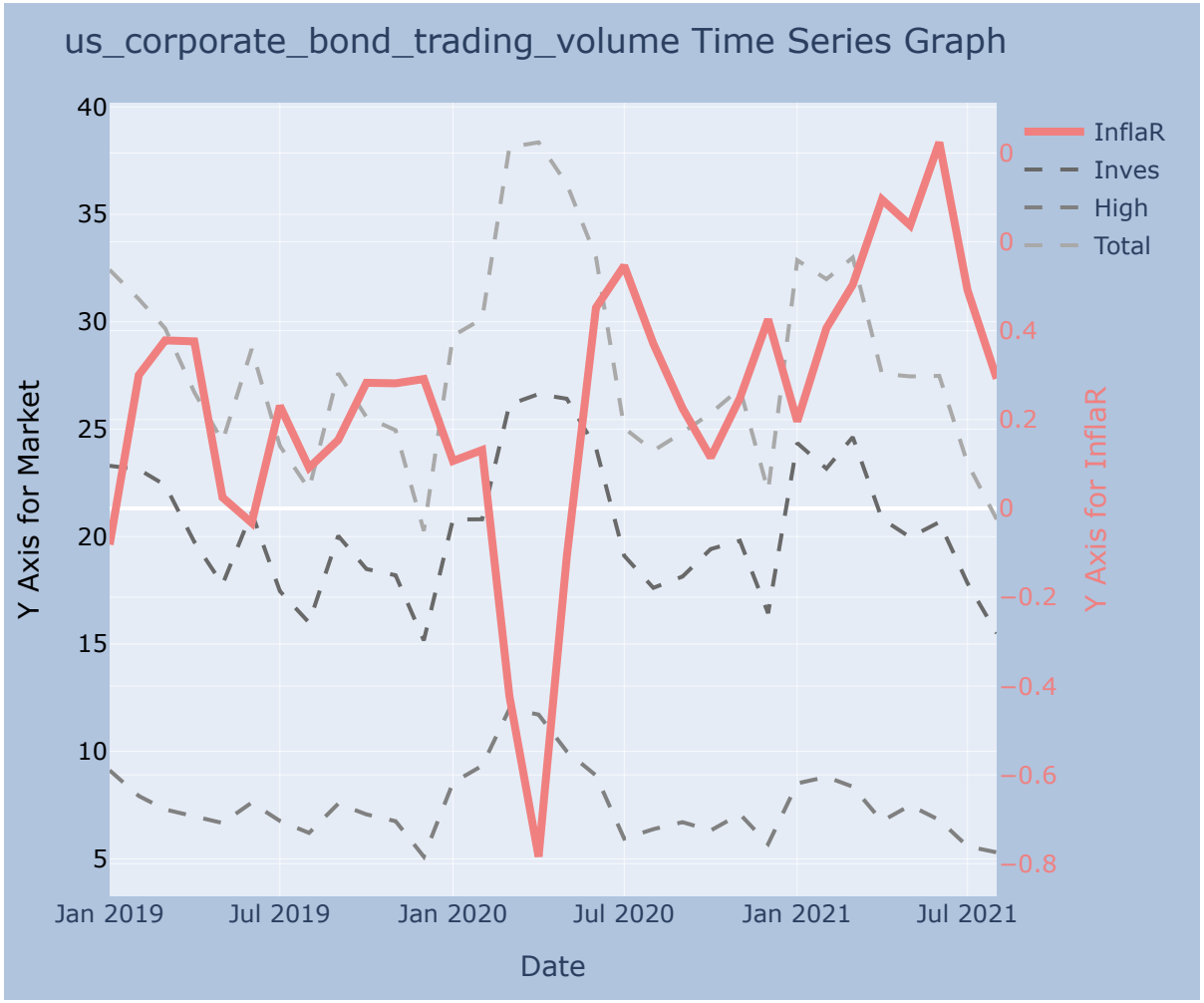
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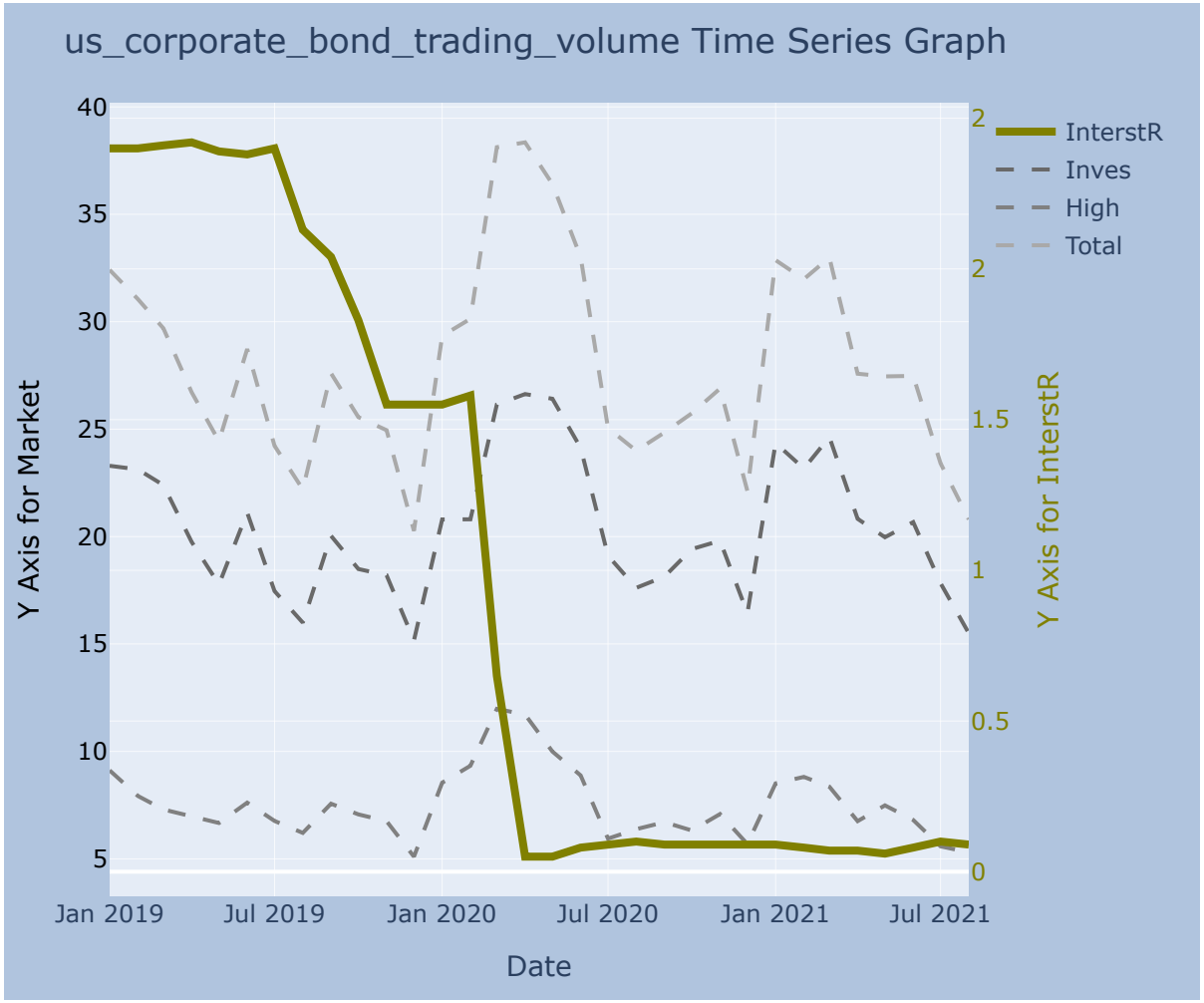
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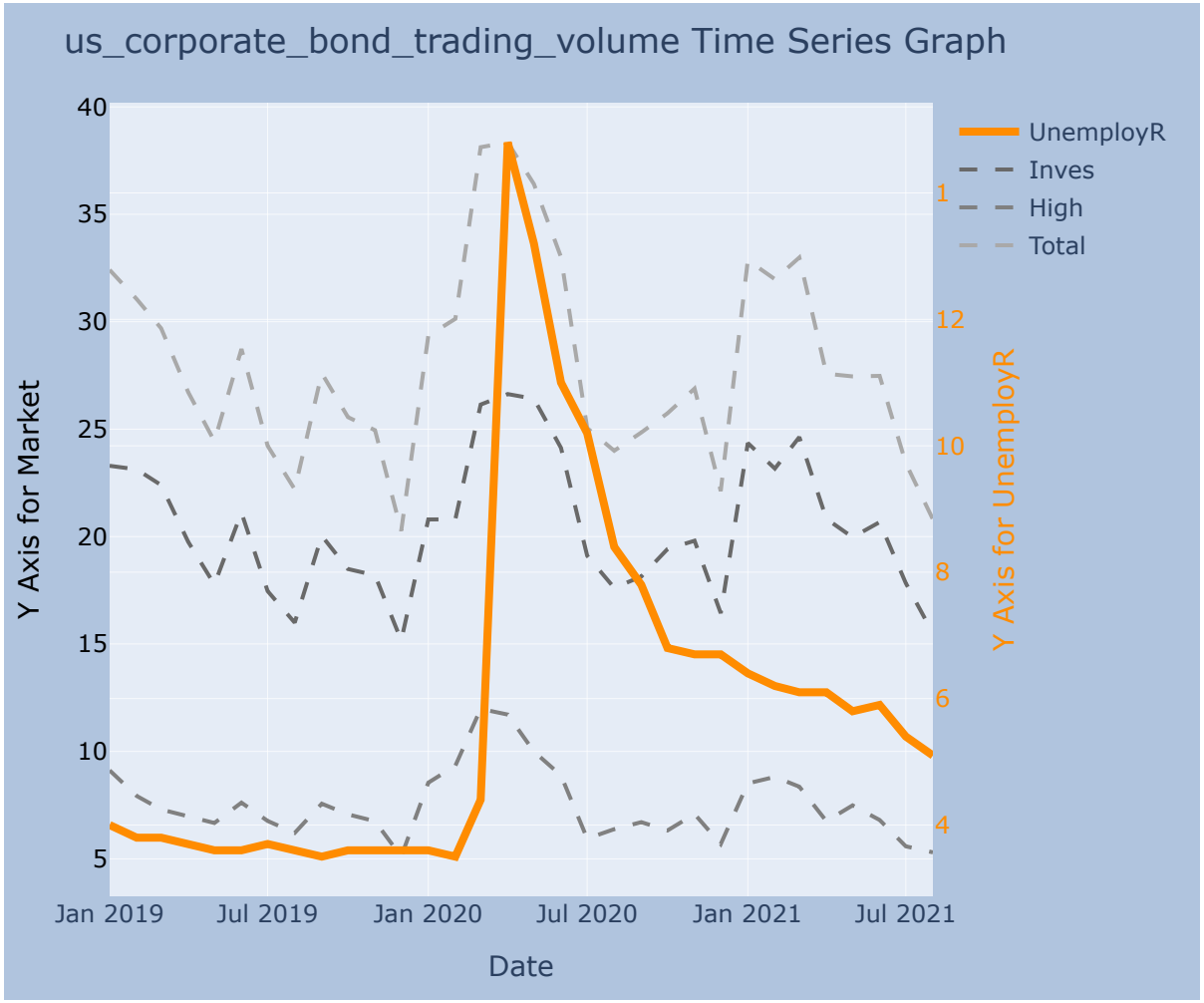

Are there any patterns that you can observe? Give a brief explanation for your findings

1. Treasury Trading Volume

Interest Rate

Observation: Interest Rate drop drastically at the point when Trading volume of Treasury bond reach its peak.

Explanation: Since people were massively demand treasury bond, the interest rate fall. And interest rate continuously remain low due to the post-effect of pandemic, where people still want to seek for safe investment.

Inflation Rate

Observation: Inflation change behaves in totally opposite way as the Treasury trading volume.

Explanation: Early in the pandemic, inflation rates dropped as economic activity slowed sharply. This environment of low inflation, combined with near-zero interest rates, made Treasuries more attractive, leading to increased trading volumes.

Unemployment Rate

Observation: Unemployment rate increase as the increase in trading volume of treasury trading volume which are all due to the pandemic. Unemployment rate gradually recover after 2020 March.

Explanation: When unemployment went up during the COVID-19 pandemic, more people bought U.S. Treasuries because they are considered safe investments. As the economy started to get better and fewer people were unemployed, the amount of trading in Treasuries began to go down from the high levels seen during the crisis.

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2. Equity Issuance

Unemployment

Observation: There is a small gap between the peak of unemployment rate and the issuance of equity. Though their overall pattern is similar, the fluctuations in equity issuance is more drastic than the unemployment rate.

Explanation: It takes some times for corporates to realize the effect of Covid and their financial positions, and find out ways to raise more capitals. Firstly, they might consider cut some more labor cost, and then take more risk in selling out more equities.

Interest rate

Observation: There is also a small gap between the lowest point of interest rate and the peak of unemployment rate.

Explanation: Individual person can make decisions fasters than corporates which need collective decisions. Moreover, since people demand safer assets, such as Treasury bonds, which drove down interest rate, the bond issued by corporate might be less attractive, so that they need to use more ways to raise capitals afterward.

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3. Equity Trading Volume

Interest rate

Observation: The minimal for the interest rate and the peak of trading volume of equity happens in relative same time.

Explanation: These two extreme values all capture the immediate reactions of people trying to seek for safer assets, and probabily want to get rid of current equity they hold.

Inflation rate

Observation: The drastic drop for the inflation rate and the peak of trading volume of equity happens in relative same time.

Explanation: During covid, the ecomonic is really uncertain, so that people and companies were all making conservative decisons, such as buying less goods and saving more money, which casue the inflation rate dropped. Moreover due to such conservative strategies, companies will issue more equity for cash to prepare for future uncertainties, and such pattern is a result of public reaction toward covid.

Unemployment rate

Observation: There is a small gap between the peak of trading volume and unemployment rate.

Explanation: Individual investors might react faster than corporate so that they will handle the uncertainty from covid by selling out equity and buying safer assets, but corporate, which require collective decision making, will react to covid a bit later than individual investors.

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4. Fixed Income Trading Volume and Economic Uncertainty

Interest rate

Observation: During 2019 to 2021, as interest rates dropped sharply in response to the COVID-19 pandemic, fixed income trading volumes saw significant fluctuations, with a notable increase in activity in early 2020.

Explanation: When the Federal Reserve lowered interest rates to near-zero levels to support the economy, it made existing bonds with higher interest rates more attractive, leading to increased trading activity as investors sought these higher-yielding securities. Additionally, the low interest rates encouraged more bond issuance as companies sought cheaper financing, further boosting trading volumes in the fixed income market.

Unemployment rate

Observation: The unemployment rate surged in 2020 due to the pandemic but gradually declined in 2021 as the economy began to recover. During periods of high unemployment, fixed income trading volumes were elevated, particularly in safe-haven assets like government bonds.

Explanation: The spike in unemployment created significant economic uncertainty, prompting investors to flock to the relative safety of fixed income securities, especially government bonds, which are seen as low-risk. This flight to safety resulted in higher trading volumes in 2020. As unemployment began to decrease and economic conditions stabilized in 2021, the demand for these safe-haven assets decreased, leading to a normalization of fixed income trading volumes.

Inflation rate

Observation: The inflation rate initially dropped during the early stages of the pandemic but started to rise in late 2020 and into 2021. During this period, fixed income trading volumes showed volatility.

Explanation: The initial drop in inflation during the pandemic led to an environment where bonds, particularly government securities, were seen as safer investments, increasing trading volumes. However, as inflation began to rise in 2021, concerns over decreasing bond value due to inflationary pressures caused shifts in trading activity. Investors started to reassess their bond portfolios, particularly long-term bonds, which are more sensitive to inflation, leading to further fluctuations in fixed income trading volumes.

---

5. Corporate Bond Trading Volume

Interest rate

Observation: During 2019 to 2021, as interest rates were cut sharply in response to COVID-19, corporate bond trading volume initially increased, especially in early 2020.

Explanation: Lower interest rates made borrowing cheaper for companies, leading to more bond issuances as businesses sought to raise funds. Investors were attracted to bonds because low interest rates elsewhere made corporate bonds a relatively more attractive investment, increasing trading volumes.

Unemployment rate

Observation: The sharp rise in unemployment during early 2020 coincided with a peak in corporate bond trading volume.

Explanation: The increase in unemployment signaled a severe economic downturn, prompting both companies and investors to reassess risks. Companies issued more bonds to secure financing in uncertain times. As unemployment started to improve in 2021, trading volume in corporate bonds gradually decreased as market conditions stabilized.

Inflation rate

Observation: Inflation dropped in the early months of the pandemic, while corporate bond trading volume rose and then gradually declined in 2021.

Explanation: The drop in inflation reflected weak demand and economic uncertainty, which initially caused a rush into safer assets, including high-quality corporate bonds. As inflation remained low, central banks kept interest rates low, maintaining bond trading volume. However, as inflation concerns grew in 2021, the market adjusted, leading to reduced trading volumes as investors reassessed risks.

---

6. Agency Trading Volume

Interest rate

Observation: As interest rates dropped during COVID-19, agency trading volume initially increased.

Explanation: Lower interest rates made safer investments like agency securities more attractive, so more people traded them. This drove up trading volume, especially as the market reacted to economic uncertainty.

Unemployment rate

Observation: When inflation fell at the start of COVID-19, agency trading volume went up.

Explanation: Lower inflation meant the value of money stayed more stable, making agency securities appealing as a secure investment. More people traded these securities to protect their money, increasing the trading volume.

Inflation rate

Observation: As unemployment rose during COVID-19, agency trading volume also increased.

Explanation: Higher unemployment created fear about the economy, leading investors to seek safe places for their money. Agency securities, seen as low-risk, became popular, which caused a spike in trading volume.

---

7. Structured Finance trading Volume

Inflation rate

Observation: Inflation rates were low during the early stages of COVID-19, which corresponded with higher structured finance trading volumes.

Explanation: Low inflation made structured finance products more attractive because their fixed returns looked better compared to other investments. As inflation remained low, investors continued to trade these products, but volumes decreased as the market adjusted to new conditions.

---

8. Repo trading Volume

Interst rate

Observation: When interest rates dropped sharply during the COVID-19 pandemic, repo trading volumes, especially in GCF and primary dealer repos, increased.

Explanation: Lower interest rates made borrowing cheaper, leading to more activity in the repo market as banks and other institutions sought short-term funds at favorable rates.

Inflation rate

Observation: Inflation initially fell during the pandemic, but repo trading volumes spiked despite this.

Explanation: Even though inflation was low, the uncertainty caused by the pandemic led to a high demand for short-term funds, driving up repo trading volumes. Investors and institutions were more focused on securing liquidity rather than worrying about inflation during this period.

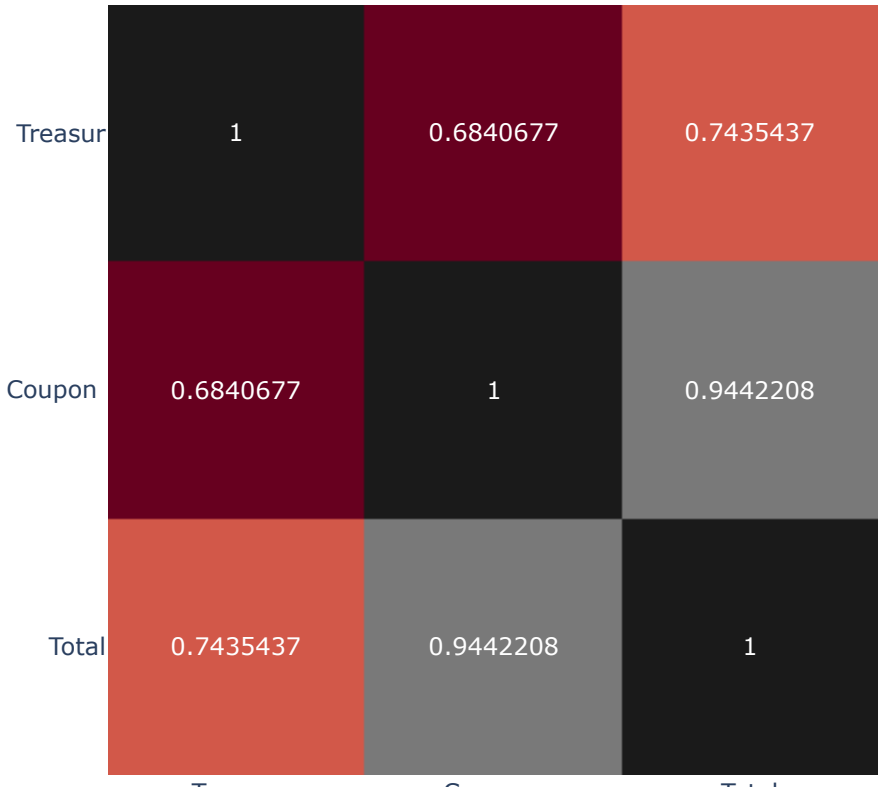
Macro-economic relationships

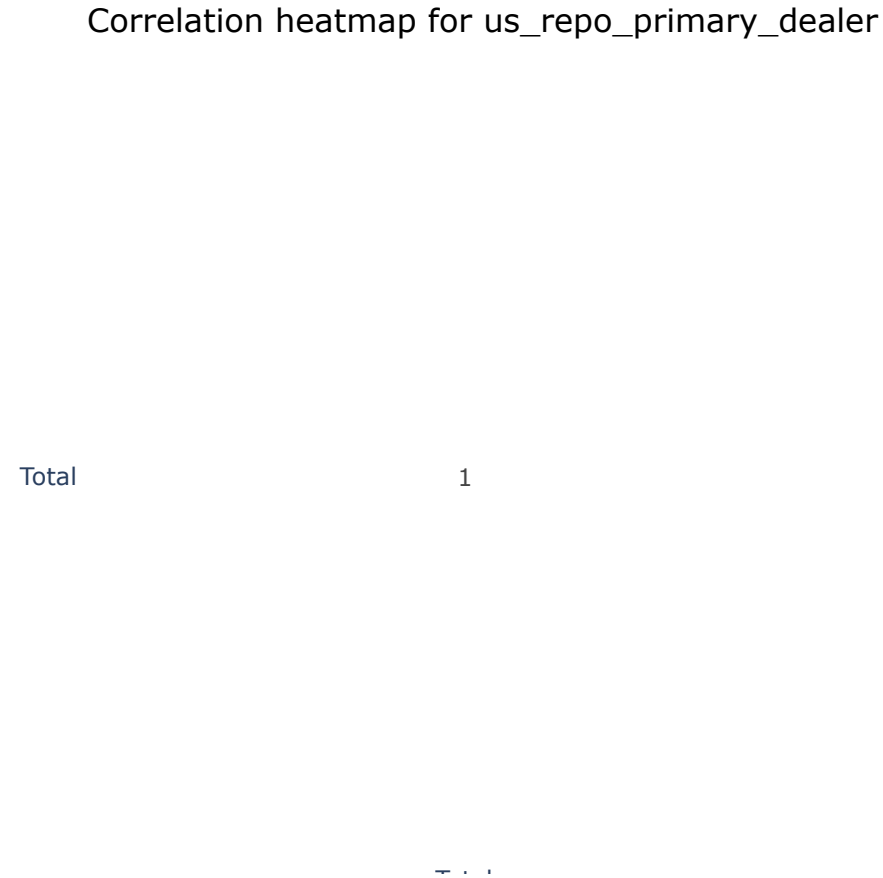
Unemployment: As more people lost their jobs, the economy weakened. To help, the central bank lowered interest rates to make borrowing cheaper and stimulate the economy.

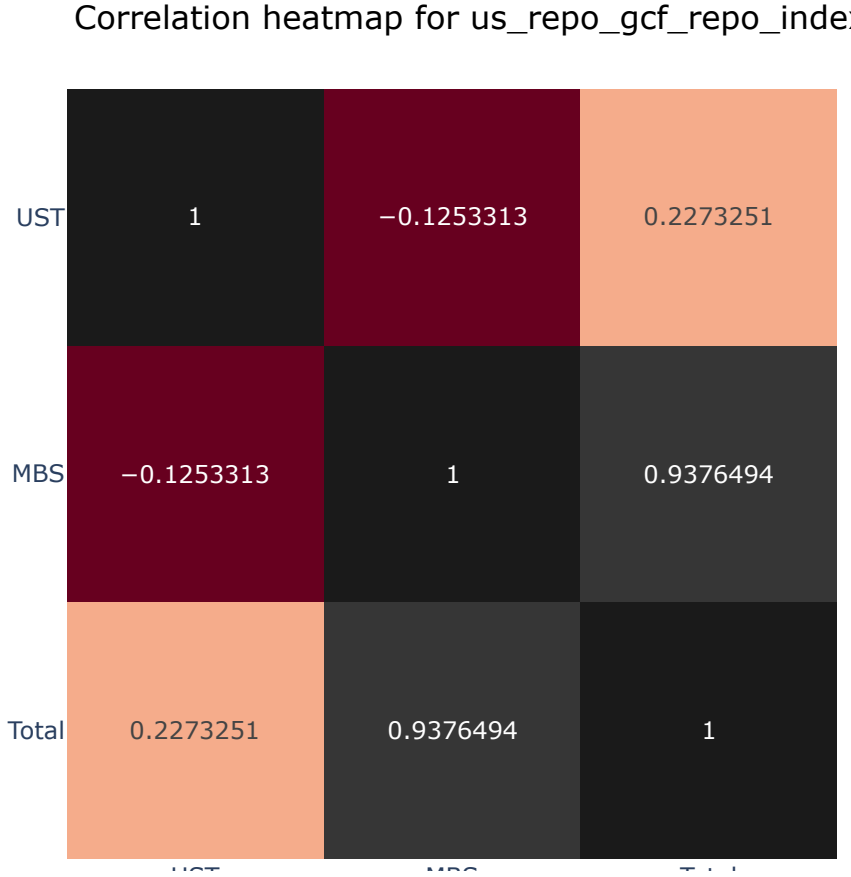
Interest Rate: Lower interest rates were meant to boost spending and investment, which eventually led to rising inflation as the economy began to recover in 2021.

Inflation Rate: High unemployment reduced consumer spending, keeping inflation low. As people got back to work and the economy recovered, demand increased given people feel more confident about the economy, pushing prices up and causing inflation to rise.

What is the correlation across various securities in that particular market (say across various treasury based on tenor)?


Correlation heatmap for us_treasury_trading_volume
Treasur
Coupon
Total
1
0.6840677
0.7435437
0.6840677
1
0.9442208
0.7435437
0.9442208
1


Correlation heatmap for us_repo_primary_dealer
Total
1

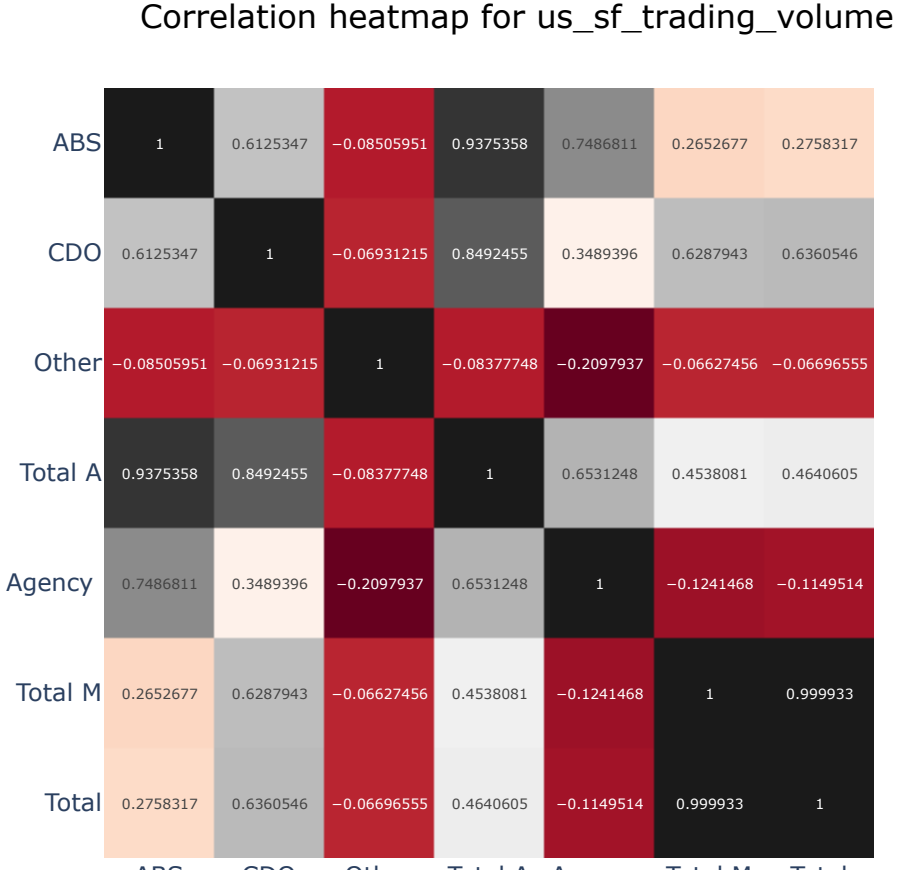

Correlation heatmap for us_repo_gcf_repo_index
UST
MBS
Total
1
−0.1253313
0.2273251
−0.1253313
1
0.9376494
0.2273251
0.9376494
1

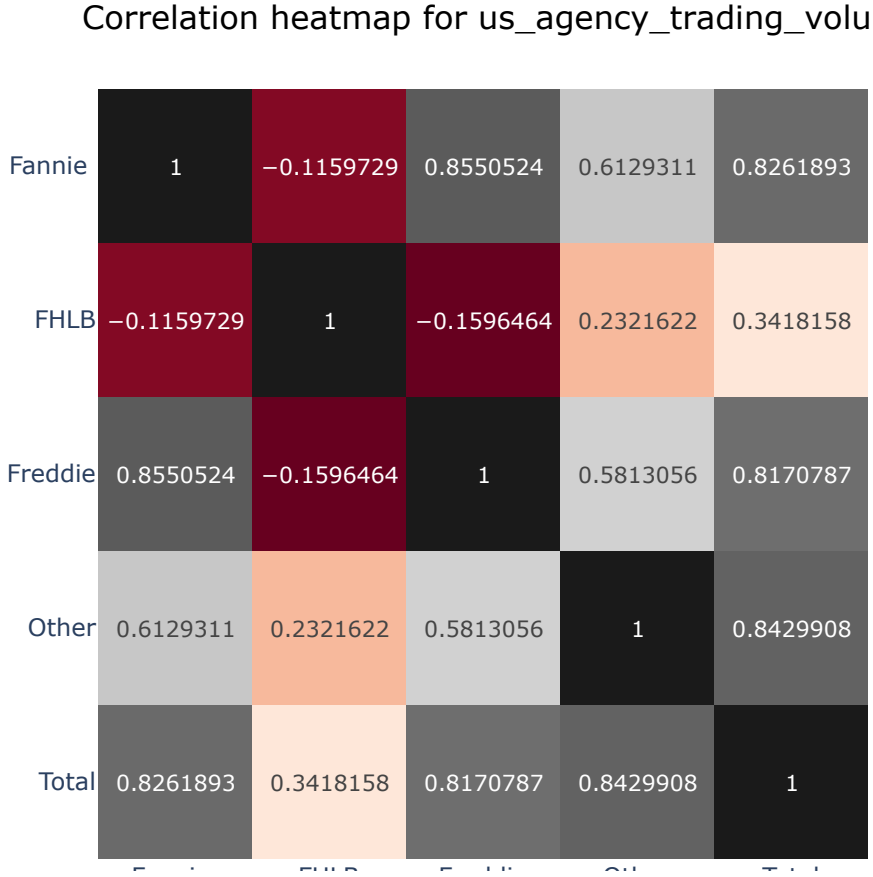
Correlation heatmap for us_repo_triparty_repo

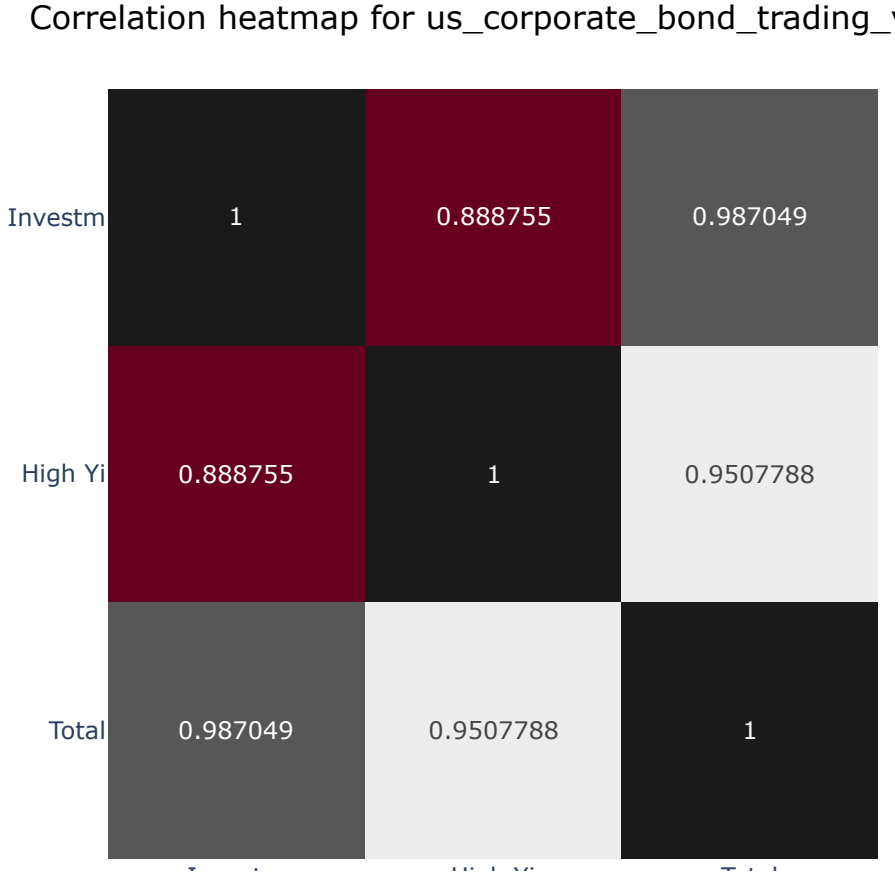

Correlation heatmap for us_equity_issuance
IPOs
Seconda
Total C
Preferr
Total E
Total
1 0.3223525 0.6907809 0.2209182 0.6878932 0.6915262
0.3223525 1 0.9071417 0.2214106 0.8919347 0.9022256
0.6907809 0.9071417 1 0.2673323 0.987101 0.996576
0.2209182 0.2214106 0.2673323 1 0.4181584 0.3460872
0.6878932 0.8919347 0.987101 0.4181584 1 0.996958
0.6915262 0.9022256 0.996576 0.3460872 0.996958 1


Correlation heatmap for us_equity_trading_volume
ICE
Nasdaq
Cboe
Other
Off Exc
Total
1 0.959094 0.967409 0.743057 0.9207995 0.9765022
0.959094 1 0.9420866 0.7017082 0.9402556 0.978247
0.967409 0.9420866 1 0.7004536 0.8906421 0.9565775
0.743057 0.7017082 0.7004536 1 0.7645603 0.7818078
0.9207995 0.9402556 0.8906421 0.7645603 1 0.978227
0.9765022 0.978247 0.9565775 0.7818078 0.978227 1

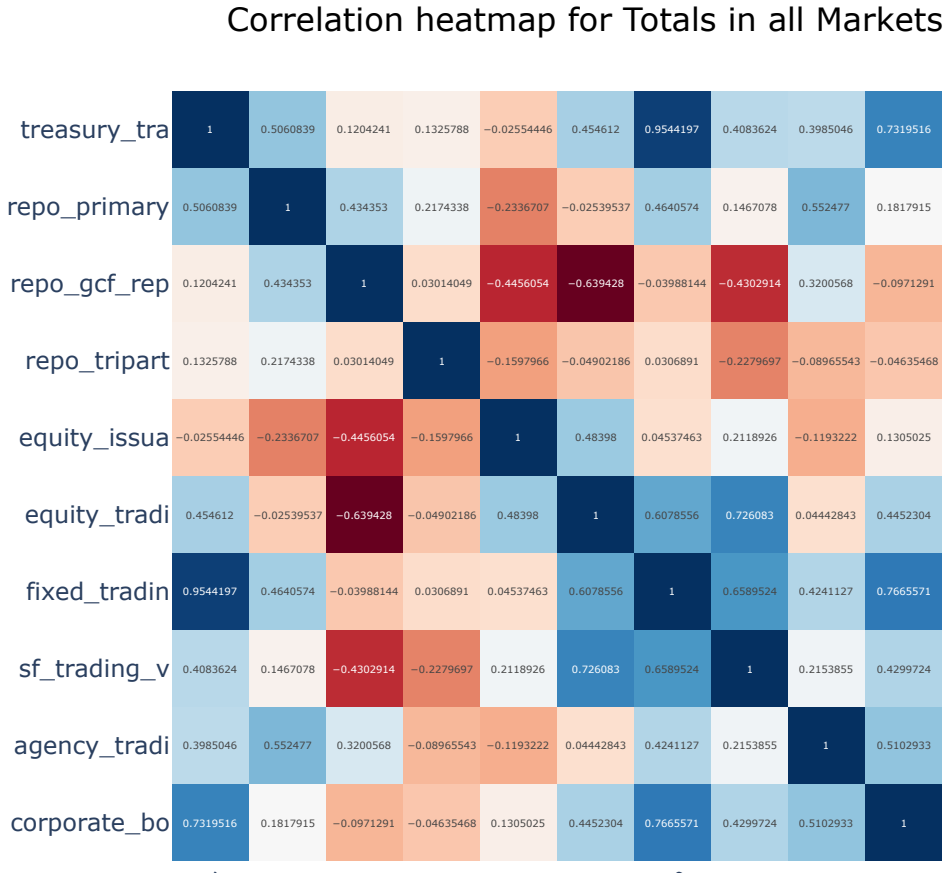

Correlation heatmap for us_fixed_trading_volume
Treasur
Agency
Non-Age
Corpora
Municip
Total
1 0.4015486 0.6670945 0.7264195 0.6468215 0.9544197
0.4015486 1 0.2738211 0.5445481 0.1190451 0.6530601
0.6670945 0.2738211 1 0.5417246 0.7894614 0.6586508
0.7264195 0.5445481 0.5417246 1 0.4123314 0.7975889
0.6468215 0.1190451 0.7894614 0.4123314 1 0.5933831
0.9544197 0.6530601 0.6586508 0.7975889 0.5933831 1


Correlation heatmap for us_sf_trading_volume
ABS
CDO
Other
Total A
Agency
Total M
Total
1 0.6125347 −0.08505951 0.9375358 0.7486811 0.2652677 0.2758317
0.6125347 1 −0.06931215 0.8492455 0.3489396 0.6287943 0.6360546
−0.08505951 −0.06931215 1 −0.08377748 −0.2097937 −0.06627456 −0.06696555
0.9375358 0.8492455 −0.08377748 1 0.6531248 0.4538081 0.4640605
0.7486811 0.3489396 −0.2097937 0.6531248 1 −0.1241468 −0.1149514
0.2652677 0.6287943 −0.06627456 0.4538081 −0.1241468 1 0.999933
0.2758317 0.6360546 −0.06696555 0.4640605 −0.1149514 0.999933 1


Correlation heatmap for us_agency_trading_volume
Fannie
FHLB
Freddie
Other
Total
1
−0.1159729
0.8550524
0.6129311
0.8261893
−0.1159729
1
−0.1596464
0.2321622
0.3418158
0.8550524
−0.1596464
1
0.5813056
0.8170787
0.6129311
0.2321622
0.5813056
1
0.8429908
0.8261893
0.3418158
0.8170787
0.8429908
1



What is the correlation in the trading activity across various security markets (consider the aggregate trading volume in each security market for the cross-market correlations)? Discuss your observations



Cross-Market Trading Activity Correlations: Observations and Implications

1. Treasury Trading Volume

Observation: Total trading volume for treasury market is highly correlated with total trading volume for fixed income market, with a high positive correlation coefficient above 0.9. It is related to trading volume of corporate bond. It barely related to repo gcf market and repo triparty market.

Explanation: Treasuries are a major part of the fixed income market. Since Treasuries are government-issued bonds, they represent a large and highly traded segment of the fixed income market, so they are highly correlated. Since both corporate bonds and treasury are part of the fixed income market, investors often allocate funds between these two based on their risk preference and market condition. Also, they are all sensitive to changes in interest rate and will be influenced similarly. The repo markets (GCF and triparty) are primarily used for short-term borrowing and lending of cash against securities as collateral. These markets focus on providing liquidity rather than on trading the securities themselves. Therefore, changes in Treasury trading volumes have little impact on repo market activity, leading to a low correlation.

---

2. Equity Issuance Volume

Observation: Equity Issuance does not have a strong correlation with any of the market. But it has a noticable negative correlation with the repo gcf market.

Explanation: During COVID-19, the negative correlation between equity issuance and the repo GCF market was strengthened. As the pandemic created uncertainty, investors involve more in repo market for liquidity and safety, reducing their demand for risky assets like equities. This led to a decrease in equity issuance while repo market activity increased. Conversely, as market conditions stabilized later, equity issuance began to recover, and the demand for short-term repos decreased, reinforcing the negative correlation between the two during the pandemic.

---

3. Equity Trading Volume

Observation: Equity Trading Volume is also negatively correlated with repo gcf market with a even stronger negative relationship. It is positively related to the structured finance trading volume.

Explanation: The negative relationship between Equity Trading Volume and repo gcf follows the same logic as previous explanations in question 2. As market volatility increased due to the COVID, both equity and structured finance trading volumes rose as investors reacted to changing market conditions, adjusted their risk exposures, and sought liquidity, driving the correlation between the two markets.

---

4. Fixed Trading Volume

Observation: Fixed Trading Volume is positively and strongly correlated with Corporate Bond Trading Volume and Treasury trading volume.

Explanation: Since Treasury bond and Corporate Bond are all belongs to fixed income bond, they will respond similarly to economic conditions.

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5. Structured Finance Trading

Observation: Structured Finance Trading Volume is strongly positively related to Equity Trading Volume. The reason was explained above. Structure Finance Trading Volume is negatively correlated to repo gcf Trading Volume.

Explanation: Structured finance trading volume is negatively correlated with repo GCF trading volume during COVID-19 because, during the pandemic, investors sought liquidity and safety. As uncertainty spiked, they turned to the repo market to access short-term funds quickly, increasing repo GCF activity. At the same time, structured finance products, which are more complex and riskier, became less attractive, leading to a drop in their trading volume as investors avoided these less liquid and higher-risk instruments in favor of safer, more liquid assets.

---

6. Agency Trading Volume

Observation: Agency Trading Volume does not have significant correlation with any other markets.

Explanation: During COVID-19, investors' focus was on managing liquidity and adjusting portfolios in more volatile markets like Treasuries, corporate bonds, and repos. Agency securities were less impacted by the extreme market fluctuations, leading to relatively stable trading volumes that didn't move in sync with the more reactive markets, resulting in low correlation.

---

7. Corporate Bond Trading Volume

Observation: Corporate Bond Trading Volume is strongly positively correlated to Fixed Income Trading Volume and Treasury Trading Volume.

Explanation: Reasons were explained above.

Download annual data for issuance statistics for

1. **US Marketable Treasury Issuance, Outstanding, and Interest Rates**
2. **US MBS Issuance and Outstanding**
3. **US ABS Issuance and Outstanding**
4. **US Fixed Income Issuance and Outstanding**
5. **US ABCP and CP Outstanding**
6. **US Municipal Issuance**
7. **US Corporate Bond Issuance**

We have done this for you

US Marketable Treasury Issuance, Outstanding, and Interest Rates

---

```
(21, 5)
```

```
(32, 5)
```

```
(31, 7)
```

```
(32, 7)
```

```
(31, 4)
```

US MBS Issuance and Outstanding

```
(25, 4)
(31, 4)
(19, 4)
```

US ABS Issuance and Outstanding

```
(36, 8)
(32, 8)
(36, 8)
```

US Fixed Income Issuance and Outstanding

```
(25, 6)
(31, 6)
(41, 6)
```

US ABCP and CP Outstanding

```
(18, 6)
```

```
(163, 6)
```

US Municipal Issuance

```
(25, 9)
```

```
(32, 9)
```

US Corporate Bond Issuance

```
(19, 8)
```

```
(32, 9)
```

Compute the descriptive statistics (N, mean, p25, p50, p75, standard deviation etc.,) of the trading activity for each market

```
--------------------------------------------------

This is the Statistics of us_treasury_issuance
            Bills       Notes       Bonds        Total
count   21.000000   21.000000   21.000000    21.000000
mean   201.288457  508.826571  120.078668   830.193696
25%    -37.017000  233.794000   -5.926000   234.341000
50%     59.738000  350.898000  144.575018   684.221000
75%    137.968000  743.171000  190.993000  1104.877000
std    583.452813  467.025212  123.081254   936.425711
--------------------------------------------------

This is the Statistics of us_treasury_outstanding
             Bills        Notes        Bonds         TIPS        FRN  \
count    31.000000    31.000000    31.000000    24.000000    7.00000
mean   1314.098161  4280.254387   974.562742   659.923208  356.18100
25%     735.410500  1825.733000   535.114500   168.857250  331.54850
50%     963.867000  2360.793000   602.731000   549.092500  343.05200
75%    1700.749500  7604.424500  1324.157000  1100.146500  412.31250
std     869.972367  3235.984386   671.852081   511.297154  105.29994

              Total
count     31.000000
mean    7160.251548
25%     3235.622000
50%     4169.959000
75%    11450.263000
std     5281.677561
--------------------------------------------------

This is the Statistics of us_treasury_yield
       3-Month Bills  10-Year Notes     Spread
count      31.000000      31.000000  31.000000
mean        2.628227       4.376834   1.748607
25%         0.285397       2.567997   1.030000
50%         2.105760       4.290000   1.630000
75%         4.685000       5.950000   2.786667
std         2.224621       2.016971   1.043864
--------------------------------------------------

This is the Statistics of us_mortgage_issuance
```

```
            Agency  Non-Agency        Total
count    25.000000   25.000000    25.000000
mean   1597.897040  385.381703  1983.278743
25%    1265.161643  138.191966  1439.641644
50%    1601.417196  223.926444  2012.587623
75%    1982.014695  339.462022  2428.668839
std     709.953959  418.388674   805.237158
------------------------------------------------

This is the Statistics of us_mortgage_outstanding
            Agency   Non-Agency        Total
count    19.000000    19.000000    19.000000
mean   6650.016316  1996.000276  8646.016592
25%    5446.118550  1382.493250  8566.260250
50%    6947.737700  1702.974700  9023.211929
75%    7502.661885  2489.892500  9369.223700
std    1599.348925   751.147368  1504.557756
------------------------------------------------

This is the Statistics of us_abs_issuance
               Auto        CDO/CLO  Credit Cards     Equipment         Other  \
count     36.000000      32.000000     34.000000     36.000000     36.000000
mean   59838.386472   95240.487591  37289.136059  11213.072492  26664.997715
25%    25189.825000    6360.849500  20317.100000   3691.865250   6156.707606
50%    65270.400000   55746.700000  38494.055000  11920.100000  24414.425045
75%    89644.813250  120878.784750  51469.943750  17215.900000  39365.766682
std    36964.631888  120359.910713  21820.687749   8476.192760  21862.239494

       Student Loans          Total
count      31.000000      36.000000
mean    20212.236484  234997.166677
25%     10187.145000   64412.705023
50%     15802.000000  205753.987075
75%     24008.859000  326708.683141
std     18065.563741  194421.095217
------------------------------------------------

This is the Statistics of us_abs_outstanding
       Automobile     CDO/CLO  Credit Card  Equipment       Other  \
count   36.000000   36.000000    36.000000  36.000000   36.000000
mean   118.993462  381.905217   157.313646  33.371754   76.861821
25%     42.364425    1.979625    74.043750  10.241875    6.568325
```

```
50%    133.713100  278.233050   130.789600  38.467500   69.220650
75%    187.734350  703.641450   247.105450  49.865600  113.963925
std     74.036973  365.781725   103.026820  23.366615   68.718778

       Student Loans        Total
count      36.000000    36.000000
mean      104.355850   872.801749
25%         2.775475   155.417250
50%        73.855350   950.071600
75%       201.308450  1408.297750
std        96.953843   657.538066
--------------------------------------------------

This is the Statistics of us_fixed_income_issuance
          Treasury  Corporate Debt   Municipal  Mortgage-Related        Total
count    25.000000       25.000000   25.000000         25.000000    25.000000
mean   1504.490165     1081.726516  354.502004       1974.865166  6050.576651
25%     652.722222      757.501300  295.124200       1439.641644  4710.221766
50%    1029.445376     1045.938100  380.290900       2012.587623  6432.285651
75%    2215.244415     1423.039800  409.625500       2428.318839  7341.480696
std     996.168177      451.740057   83.520602        803.558496  2209.280897
--------------------------------------------------

This is the Statistics of us_fixed_income_outstanding
          Treasury  Corporate Debt    Municipal  Mortgage-Related  \
count    41.000000       41.000000    41.000000         41.000000
mean   5734.178902     4093.055000  2210.233537       4934.288806
25%    2195.800000     1363.512000  1178.619000       1340.118200
50%    3340.500000     3440.712000  1480.713000       4119.309900
75%    8853.023000     6738.086000  3842.512000       8894.813341
std    5237.995103     3063.355503  1334.425265       3774.094115

             Total
count     41.000000
mean   20090.398956
25%     7176.631300
50%    16162.204000
75%    33920.737851
std    14535.563325
--------------------------------------------------

This is the Statistics of us_abcp_outstanding
```

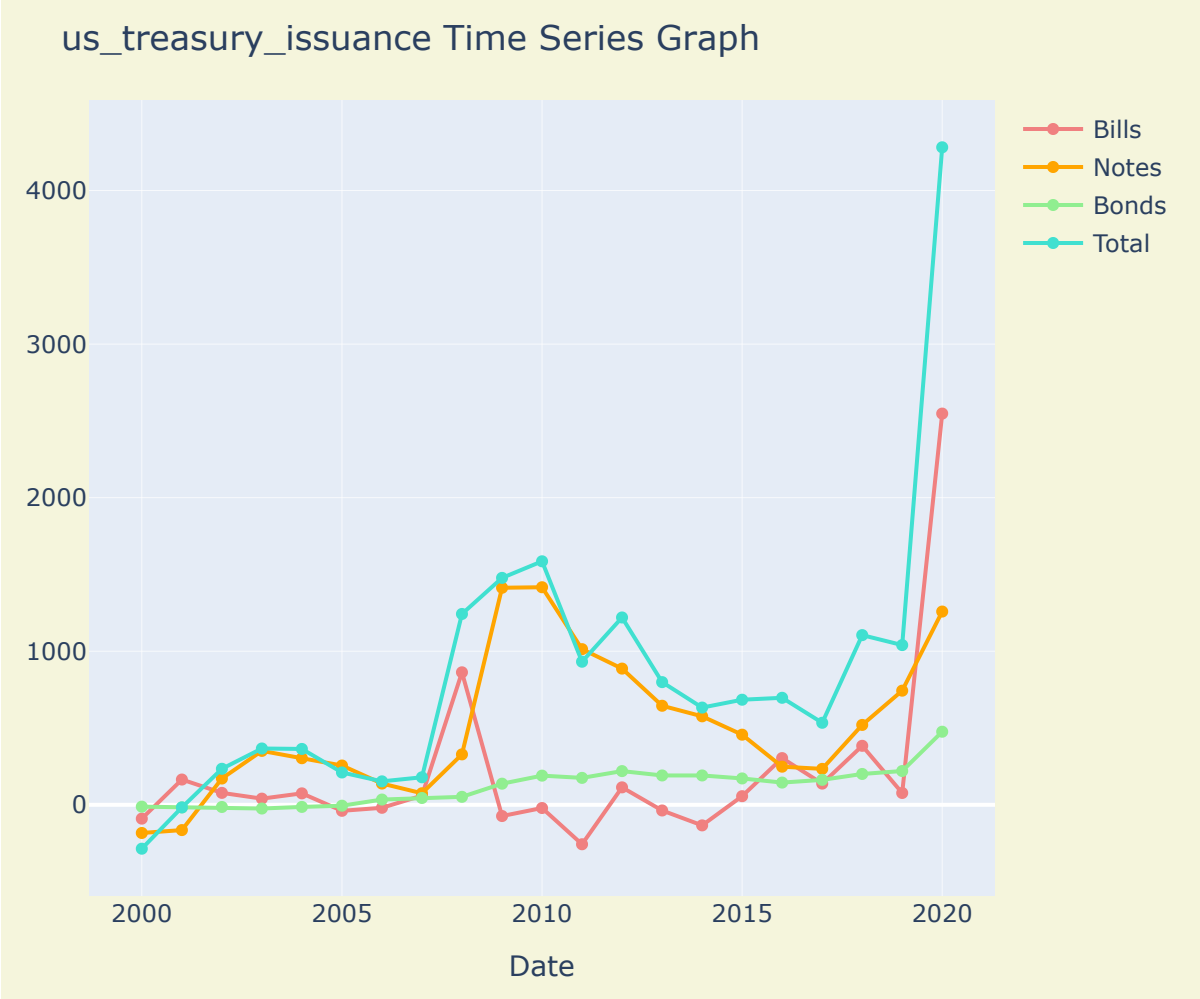
```
       Non-Financial   Financial        ABCP      Other        Total
count      18.000000   18.000000   18.000000  18.000000    18.000000
mean      171.354635  551.181218  492.245469   0.265643  1215.046965
25%       124.069131  475.465527  252.066687   0.000000   955.743048
50%       161.789592  520.752804  366.466200   0.000000  1051.350395
75%       223.761805  588.153703  703.771930   0.000000  1388.849507
std        55.390994  102.375382  278.458181   0.865136   334.604447
--------------------------------------------------
```

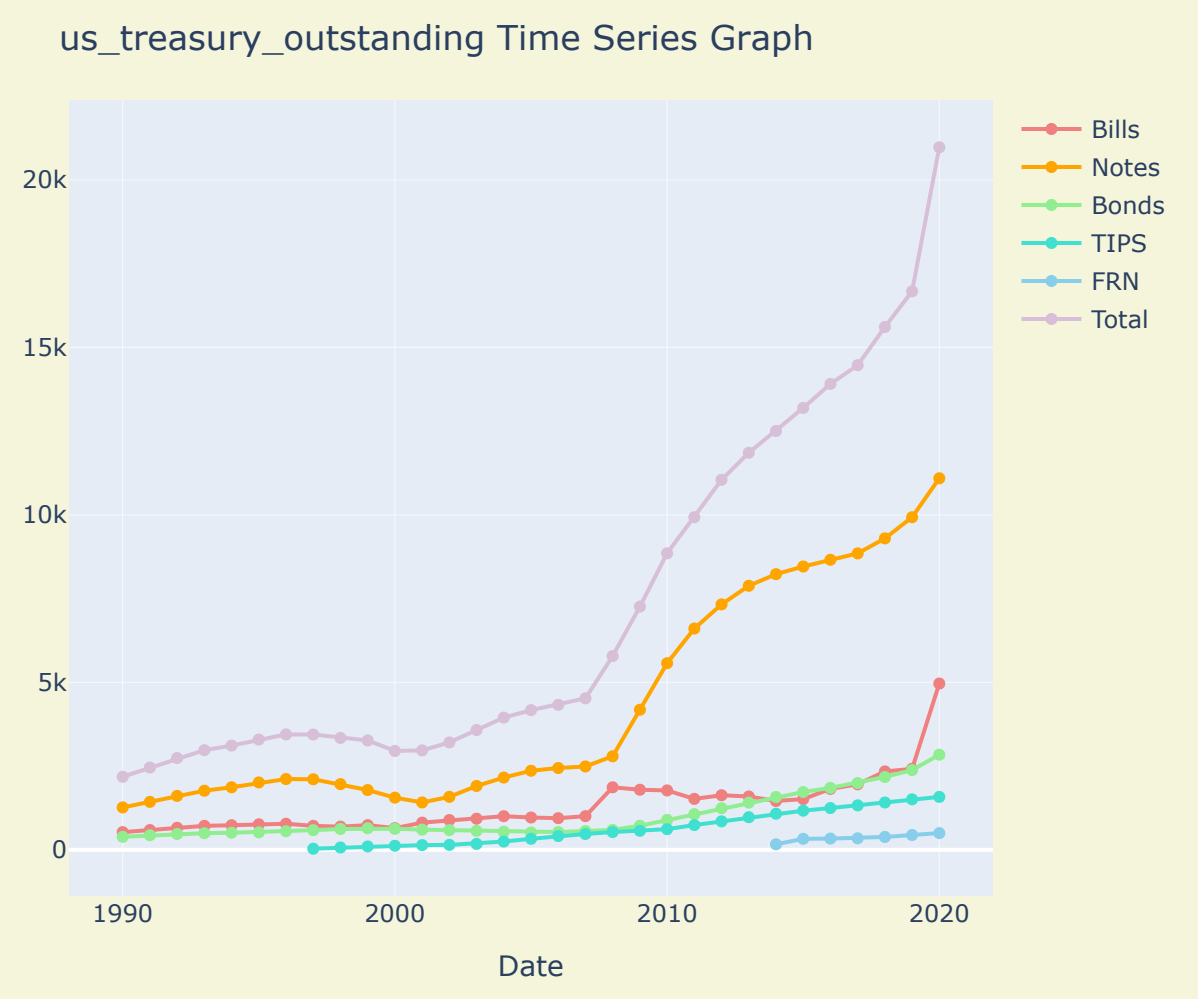
```
This is the Statistics of us_municipal_issuance
                GO     Revenue  Competitive  Negotiated  Private Placement  \
count   25.000000   25.000000    25.000000   25.000000          25.000000
mean   126.349548  228.152476    70.845996  271.074408          12.581620
25%    106.011900  192.782700    59.556800  225.668800           3.640900
50%    131.460400  240.787300    71.456600  290.101100           6.467700
75%    147.525700  272.010600    75.917500  325.157200          22.674900
std     35.949882   51.146247    15.878508   68.299743          11.523641

       New Capital   Refunding       Total
count    25.000000   25.000000   25.000000
mean    202.764292  151.737112  354.502004
25%     154.584500  120.490100  295.124200
50%     203.175300  148.953500  380.290900
75%     256.755000  188.269300  409.625500
std      51.404981   61.555815   83.520602
--------------------------------------------------
```

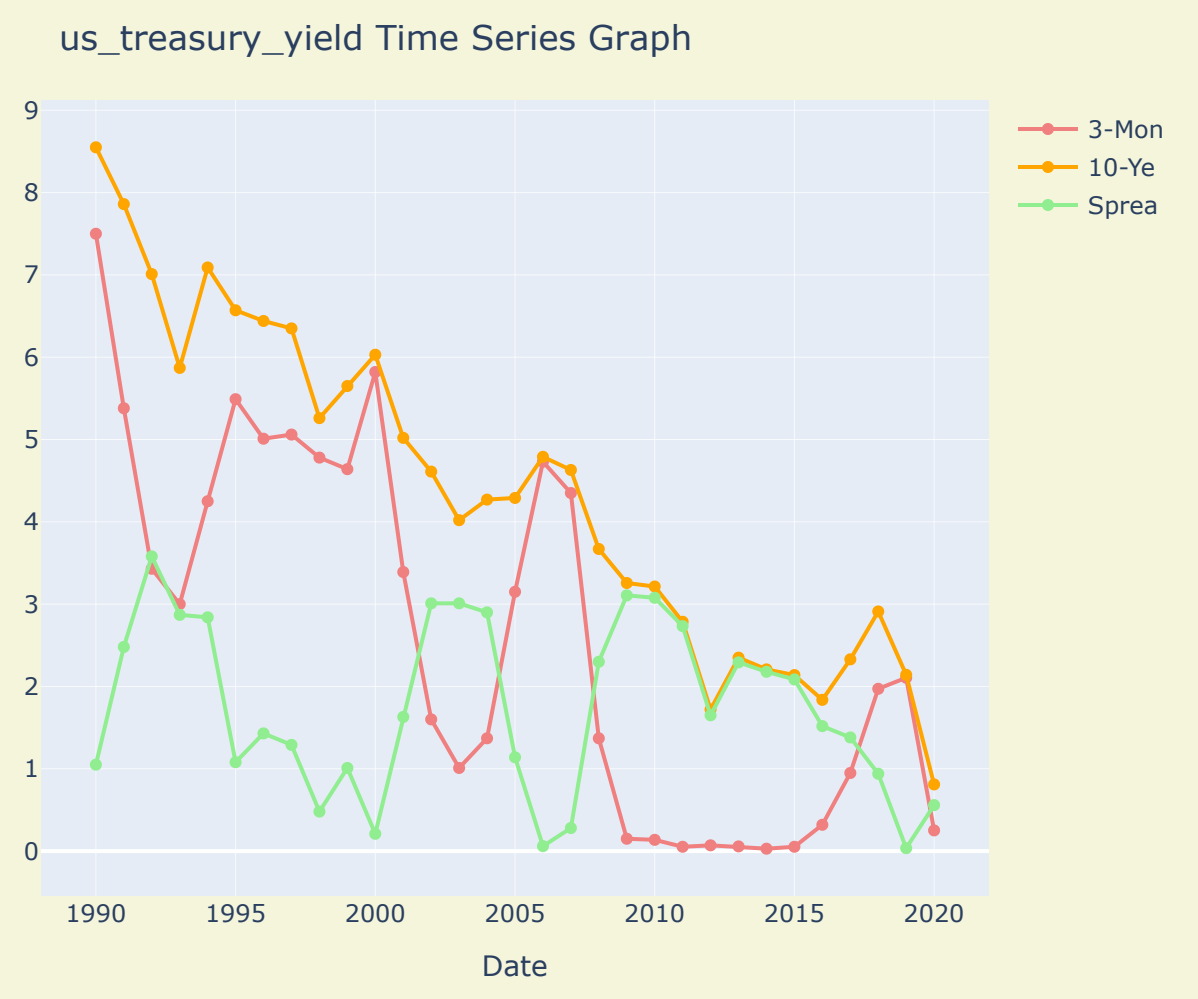
```
This is the Statistics of us_corporate_bond_issuance
       Investment Grade  High Yield    Callable  Non-Callable  Fixed Rate  \
count         19.000000   19.000000   19.000000     19.000000   19.000000
mean         716.329405  146.998021  442.386616    420.940847  670.108058
25%          560.163450   79.089450  261.741000    346.591850  448.355650
50%          670.790100  128.247400  411.168100    387.641800  540.652200
75%          858.447050  185.328950  599.727200    482.290300  893.054000
std          237.193299   98.208799  259.883264     99.407003  330.859035

       Floating Rate        Total
count      19.000000    19.000000
mean      193.219405   905.620911
25%       112.134500   648.883550
50%       151.551600   855.418600
```

```
75%       223.951550  1106.869000
std       133.290786   324.170923
```

Plot the time-series data for SIFMA for the time period that each series is available (you can plot one graph for each market, with multiple series)




us_treasury_outstanding Time Series Graph
Bills
Notes
Bonds
TIPS
FRN
Total
20k
15k
10k
5k
0
1990
2000
2010
2020
Date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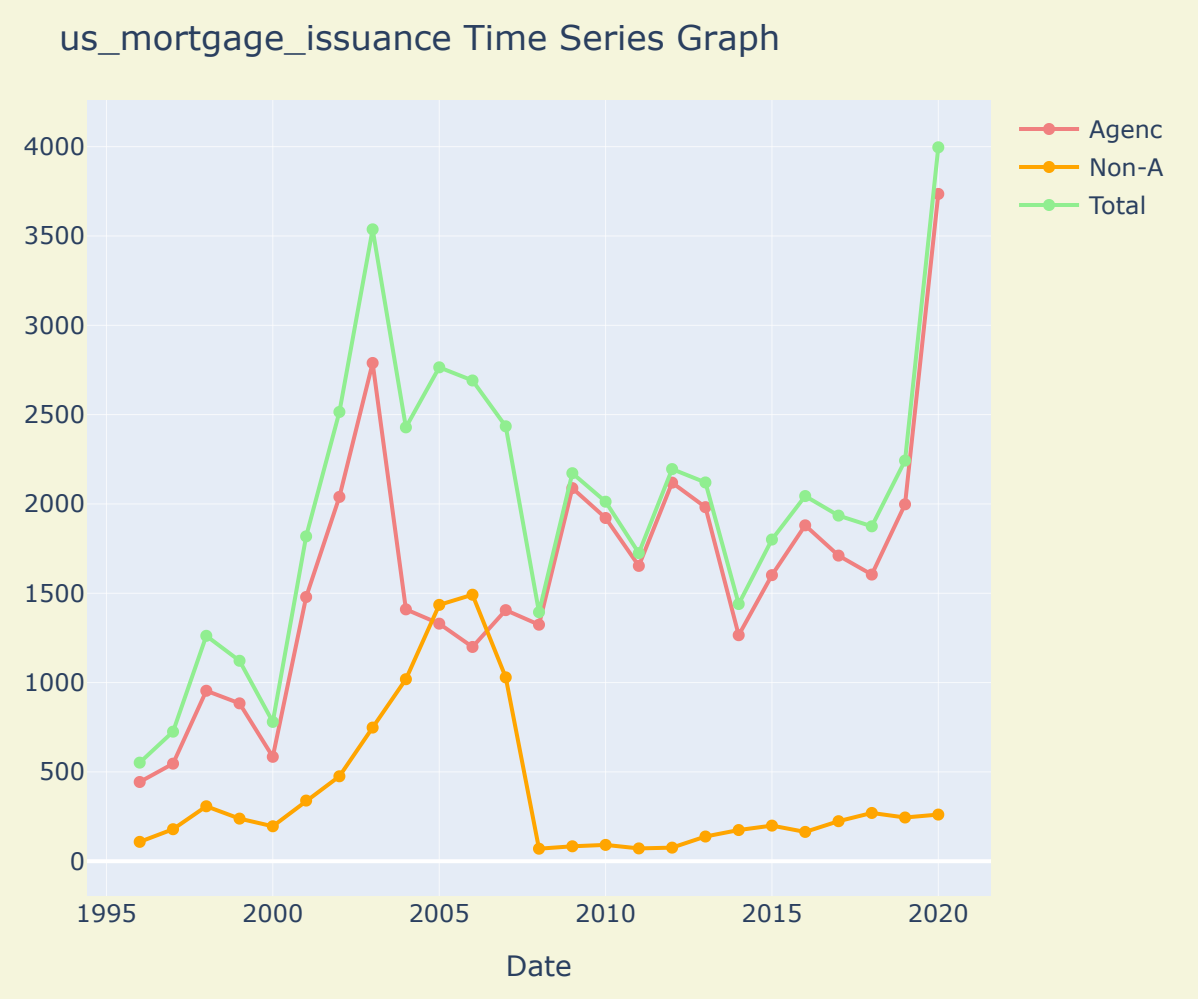
us_mortgage_issuance Time Series Graph
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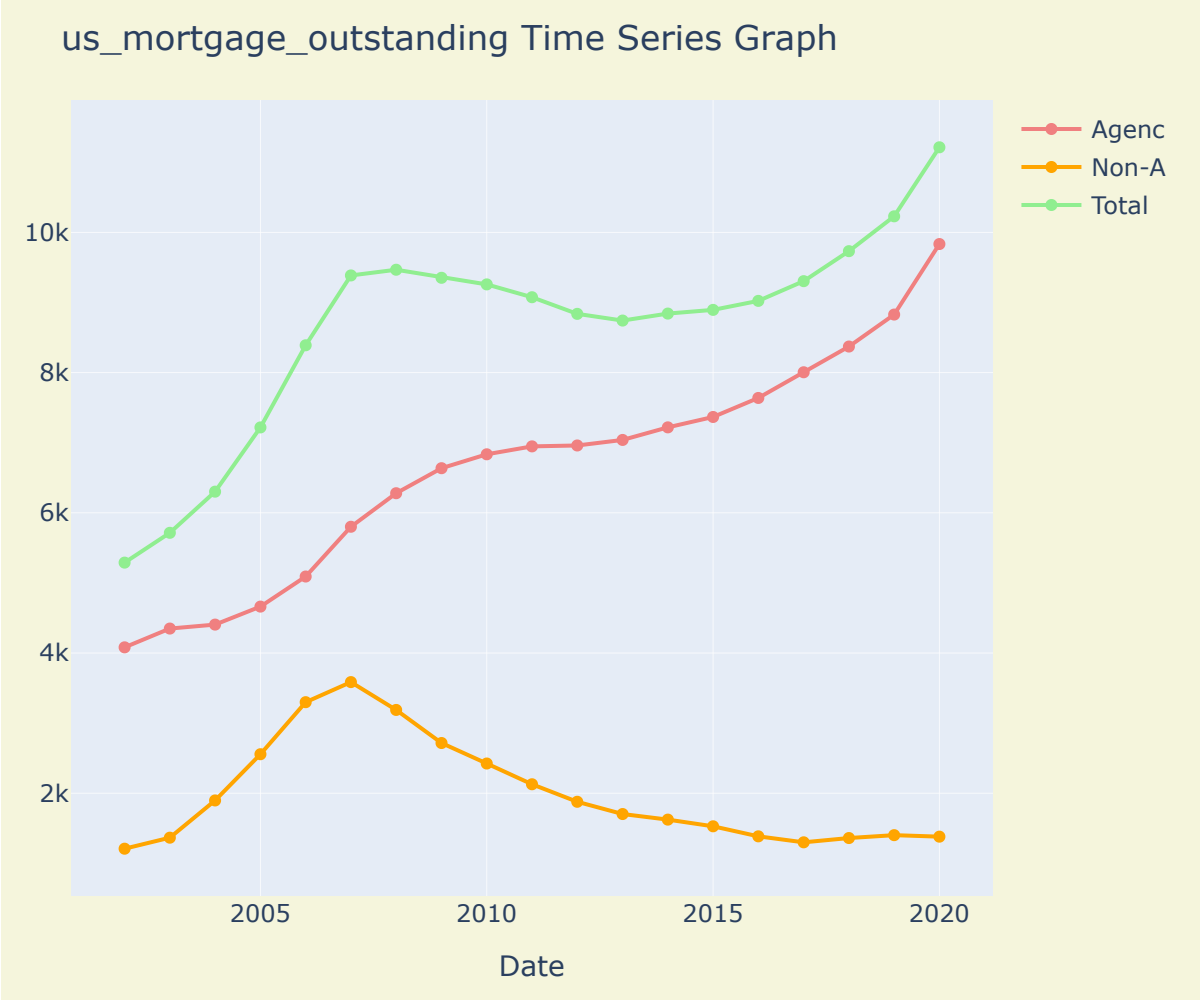
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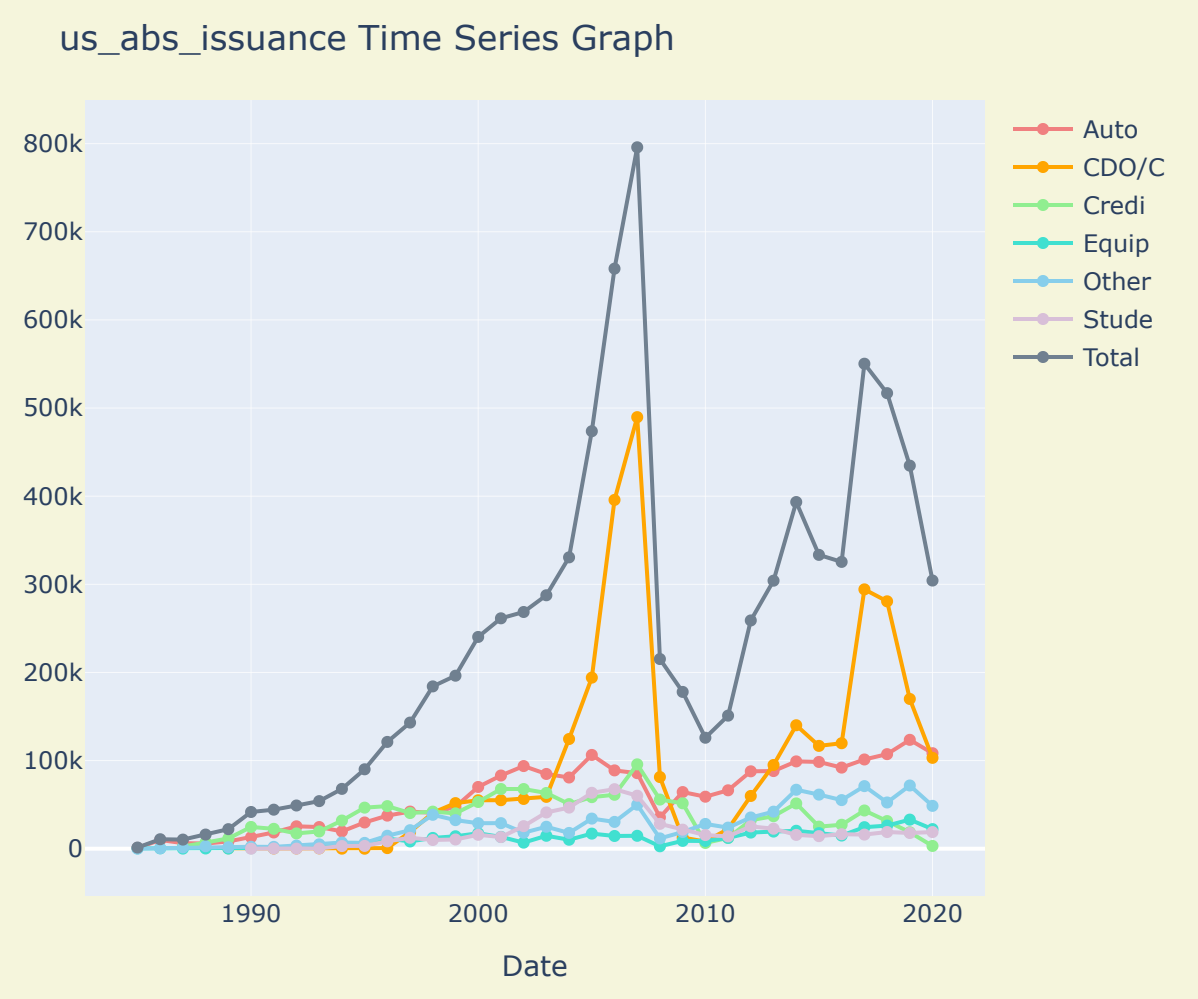
us_abs_issuance Time Series Graph
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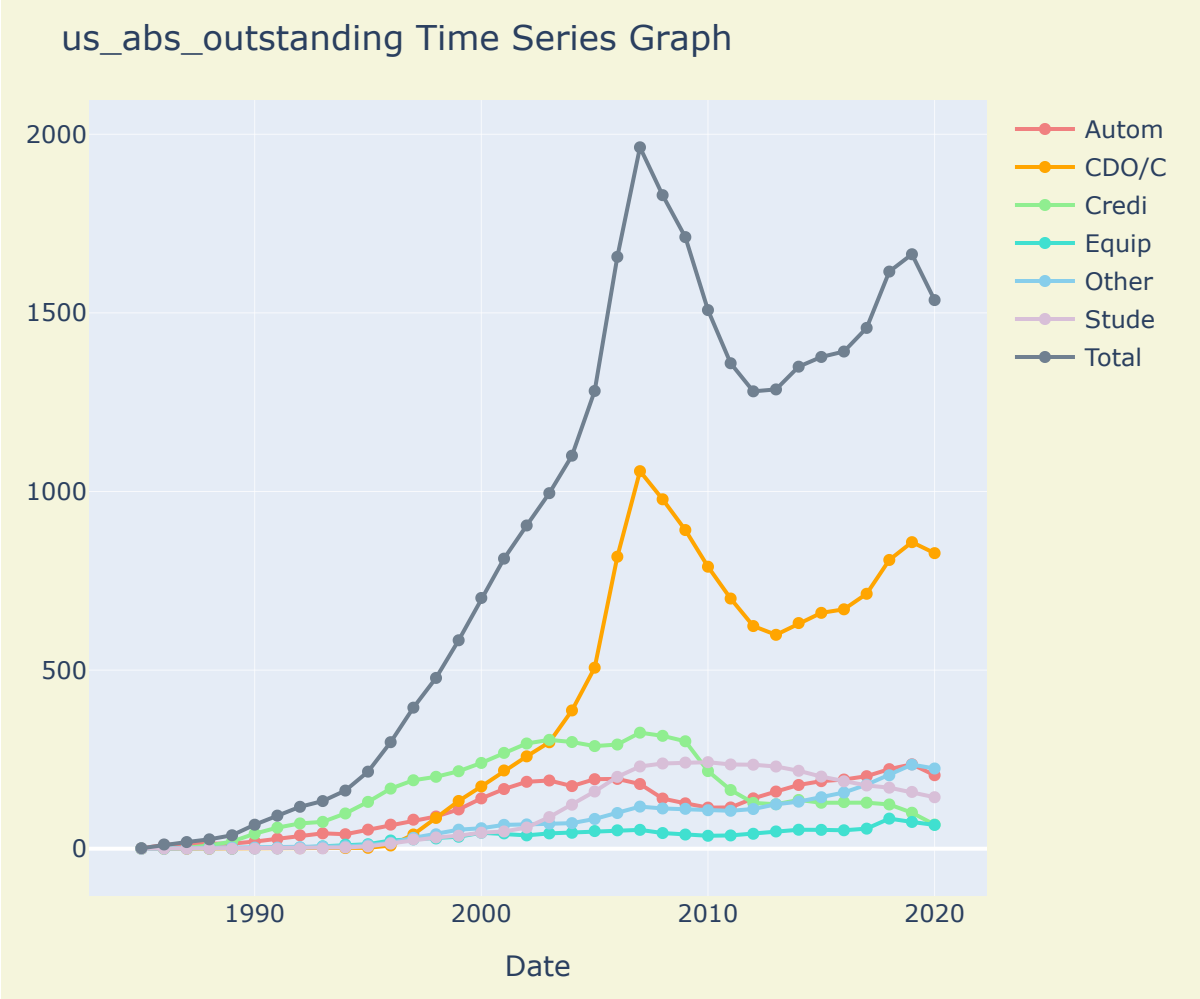
us_abs_outstanding Time Series Graph
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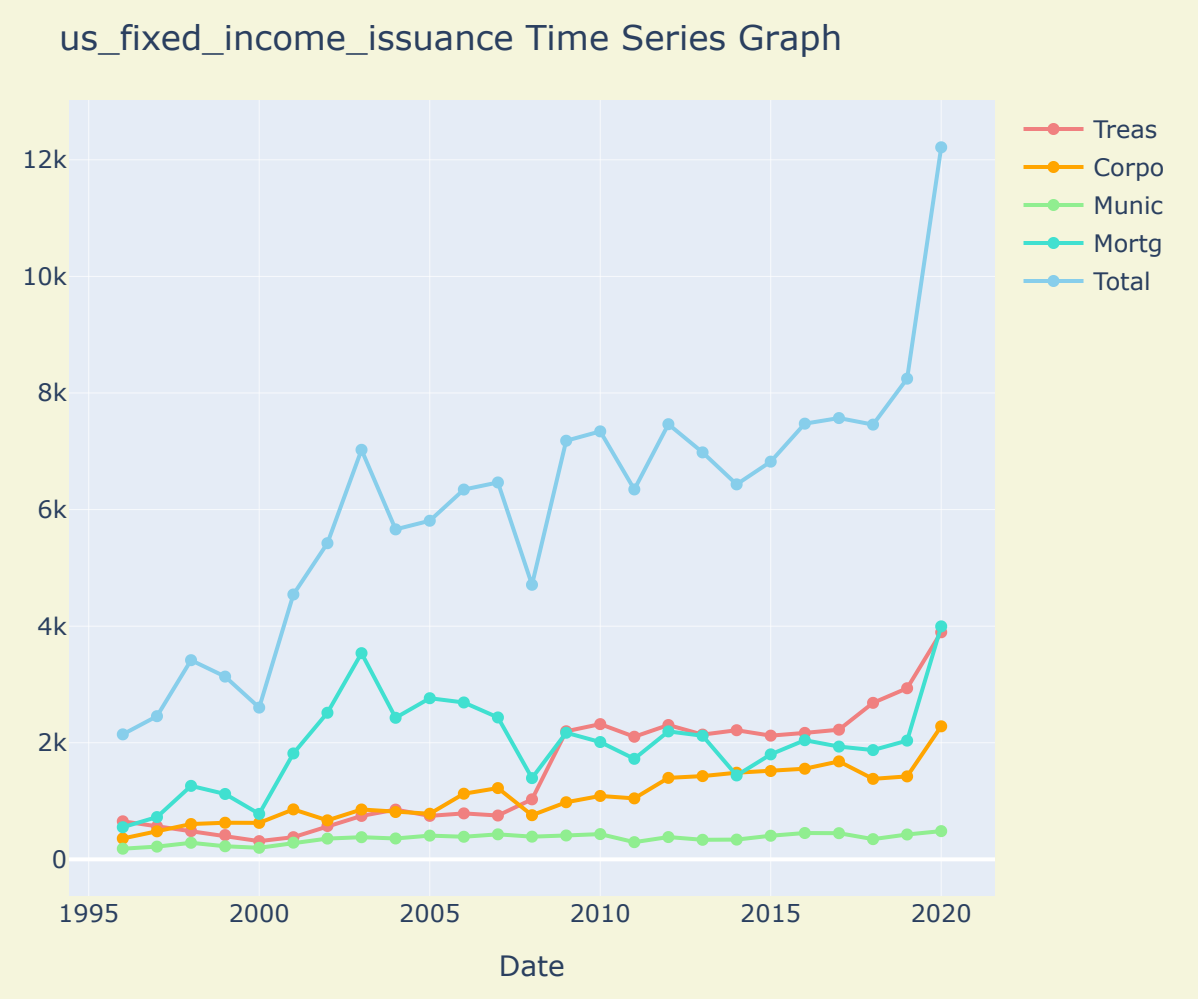
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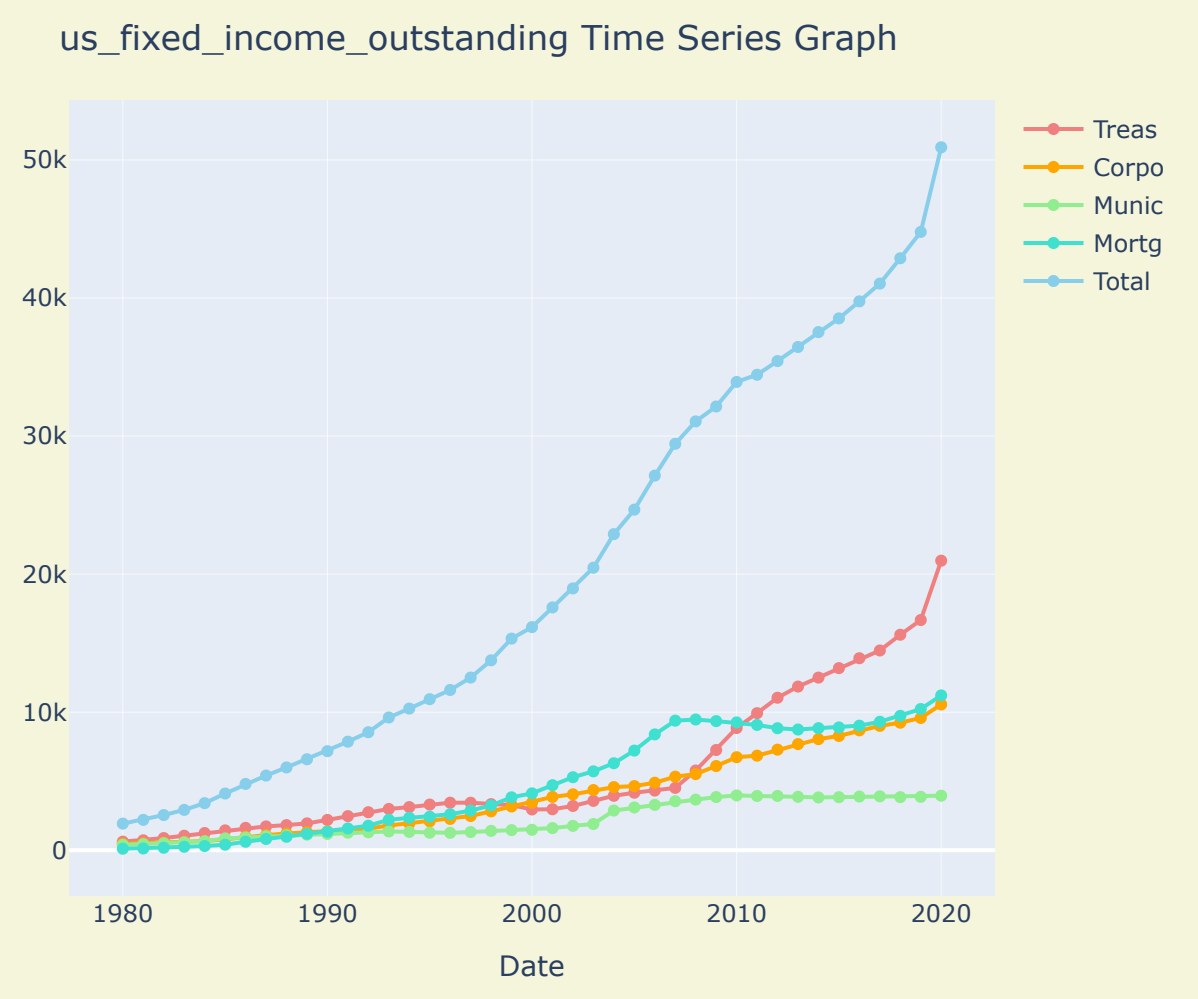
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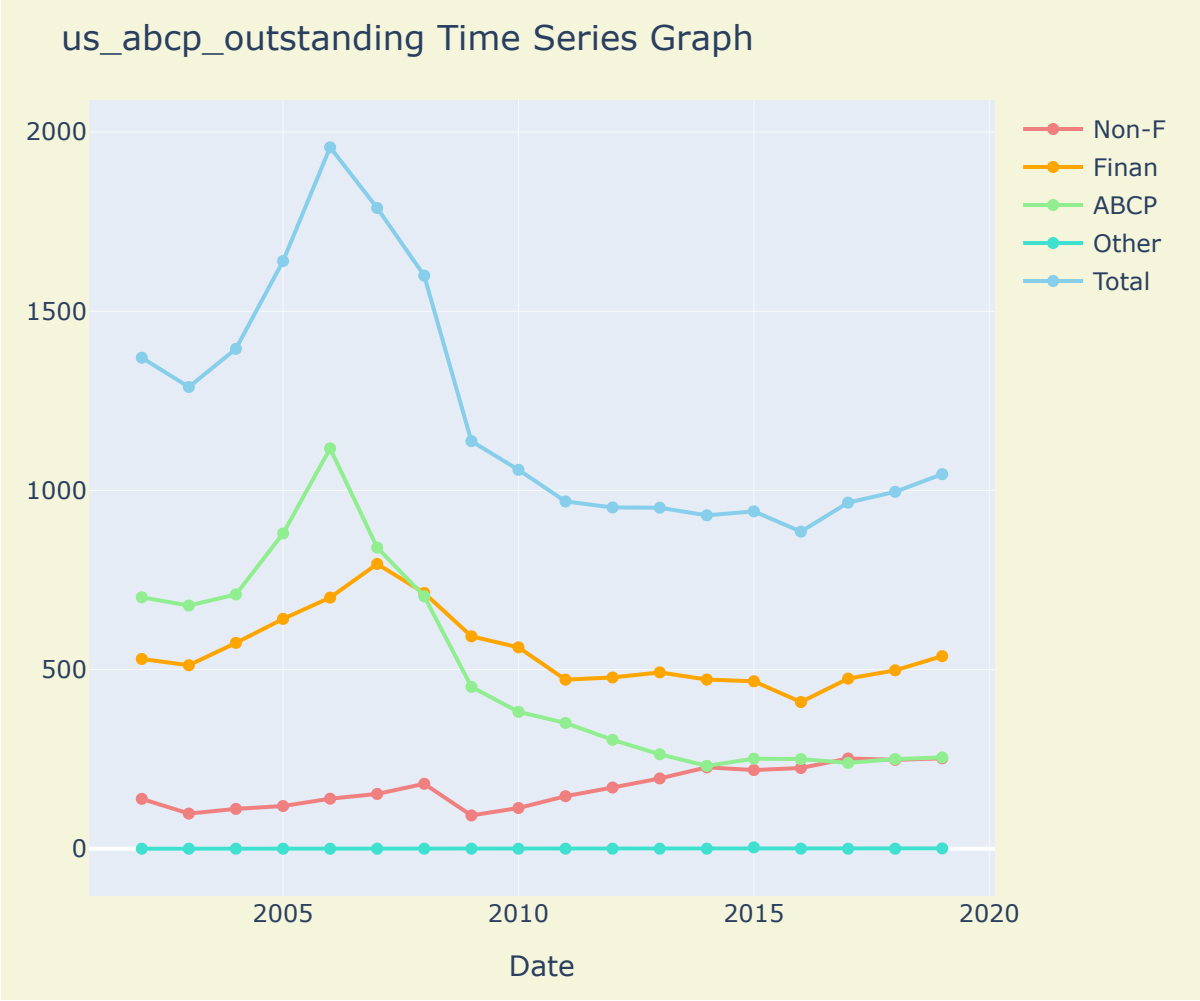
us_abcp_outstanding Time Series Graph
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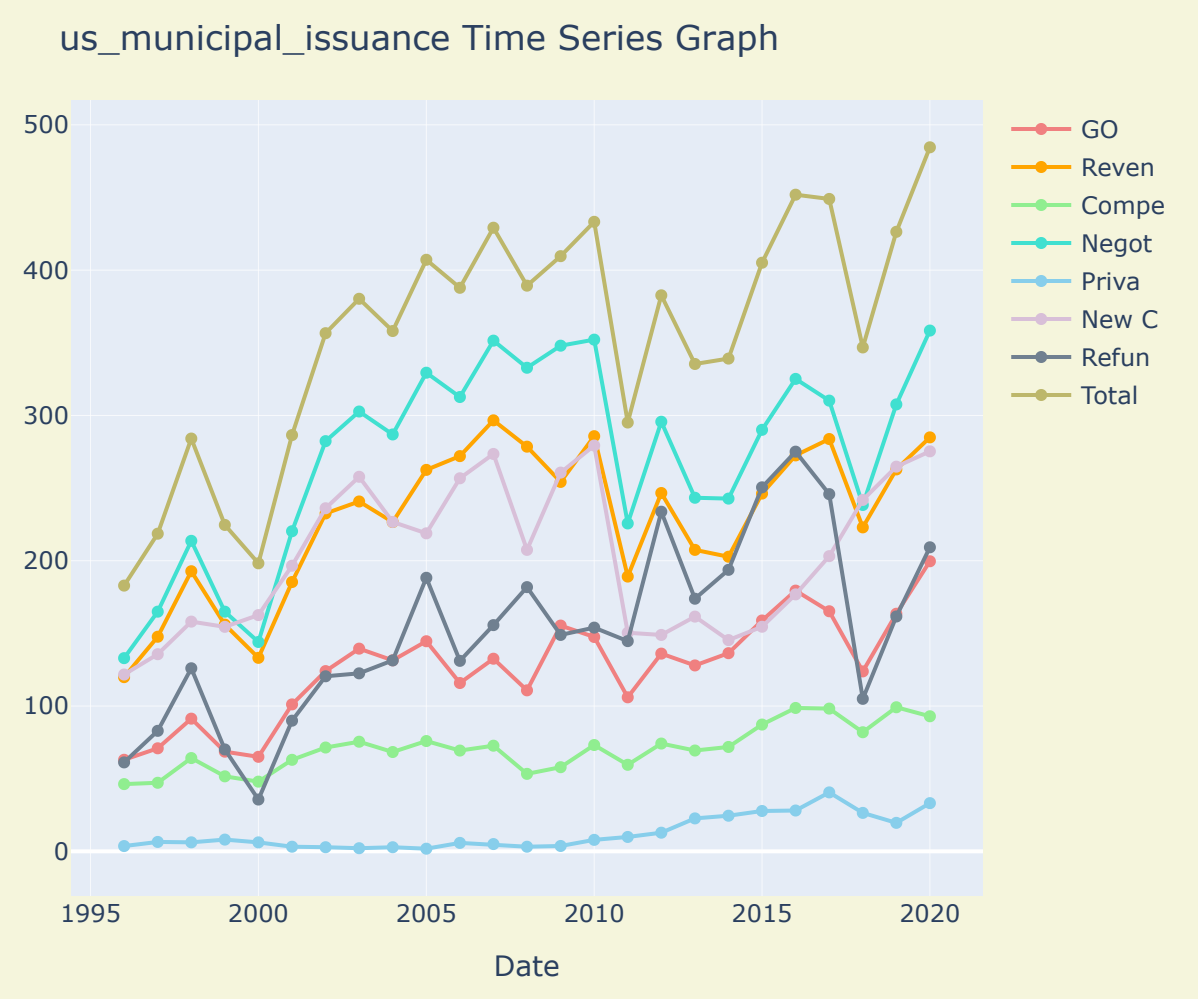
us_municipal_issuance Time Series Graph
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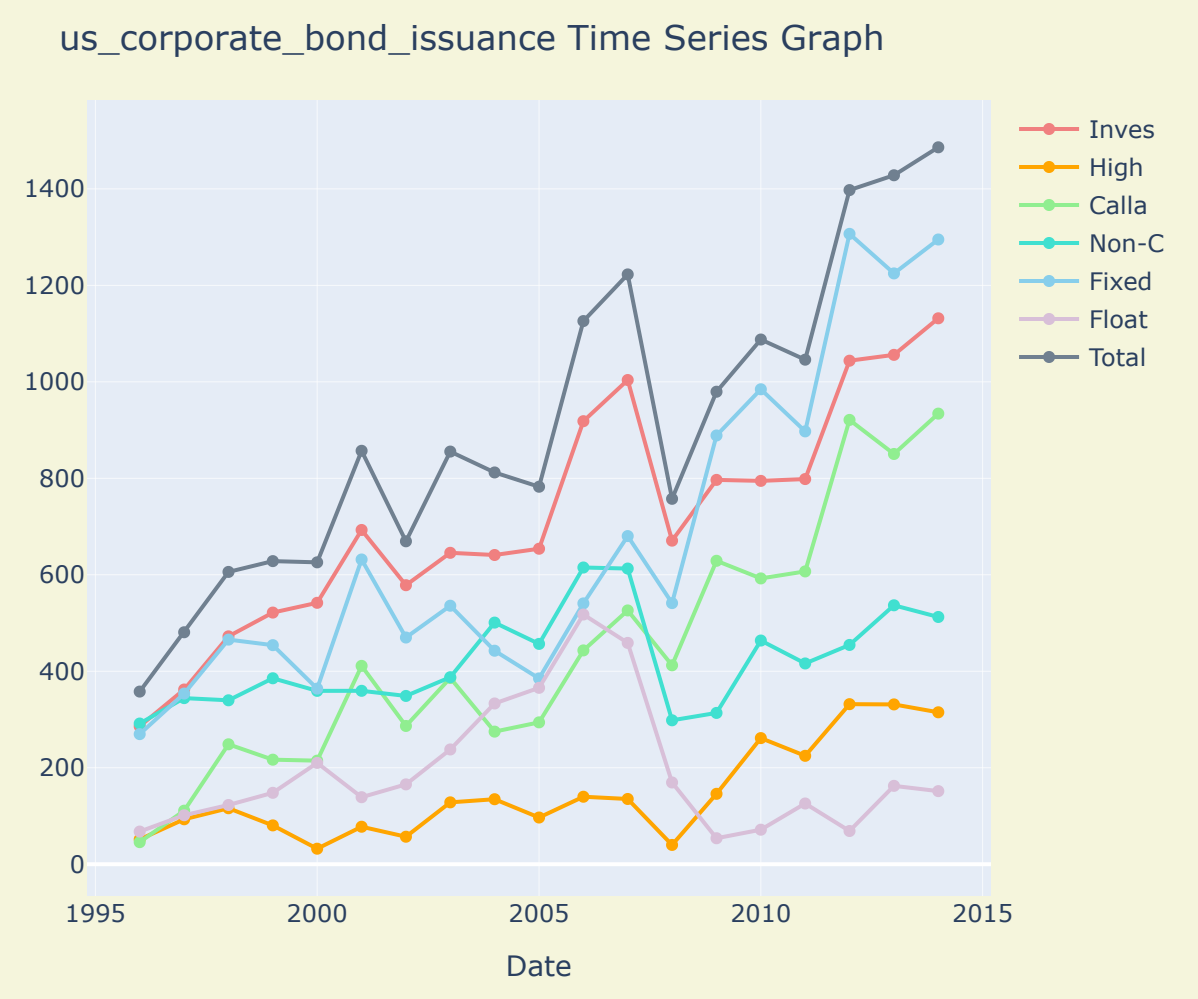

Do you see any patterns in the time-series? Is there any seasonality?

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1. Treasury Issuance

Observation: There is a significant spike around 2020 with all types of securities increasing sharply. Before 2020, there are small peaks around 2008 to 2010. There is no obvious seasonality observed.

Explanation: The increse in 2020 is result from government's response to the COVID-19 to borrow a lot of money to pay for relief and stimulate the market. The earlier increses around 2008 to 2010 were also due to government needing more funds during global financial crisis. This shows that Treasury issuance goes up mainly during economic crises when government need more money.

---

2. Treasury Outstanding

Observation: Treasury Outstanding shows a steady increase over time with a sharp rise around 2020. The total amount of Outstanding Treasury securities increased significantly during this period. No obivious seasonal pattern.

Explanation: The steady increase in Treasury outstanding reflects the government's ongoing borrowing to fund its operations and various programs. The sharp rise in 2020 is also due to the COVID-19, following the same reason as Treasury Issuance increase.

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3. Treasury Yield

Observation: Treasury Yield shows a fluctuated decrease over time with a relatively sharp decrease around 2020. 3-month yield decrease drastically around 2008 and remains low till about 2017.

Explanation: The decerase in the treasury rate often occur during economic recessions, such as economic crisis in 2008 and COVID-19 in 2020. This pattern shows that Treasury yields are significantly influenced by economic events.

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4. Mortgage Issuance

Observation: Mortgage Issuance is quite fluctuated between 1995 to 2020. There is a sharp rise in 2003 followed by a large decrease. There is a another even sharper rise in 2020.

Explanation: The peak around 2003 and the following decline reflect the housing boom and subsequent crash during the 2008 financial crisis. The sharp increase in mortgage issuance starting in 2020 is likely due to the low interest rates and government policies aimed at supporting the housing market during the COVID-19 pandemic.

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5. Mortgage Outstanding

Observation: Total Mortgage has a generally steady increase with a small spike in 2007, which mainly because of the Non Agency Mortgages' sudden increase and decline, while angency mortgages have a more steady growth.

Explanation: The steady growth in agency mortgages reflects the government's support for housing. The peak and subsequent decline in non-agency mortgages correspond to the housing boom and bust leading to the 2008 financial crisis.

---

6. ABS Issuance

Observation: There are two siginificant spike in ABS Issuance: one at around 2007 and another at around 2018. These spikes are mainly driven by CDO/CLO issuance, which sharply declined after the 2008 financial crisis. Overall issuance decreased significantly after 2008, with some recovery in recent years.

Explanation: The peak around 2007-2008 reflects the housing bubble and the widespread issuance of CDOs/CLOs, which played a major role in the financial crisis. The sharpe decrease afterward indicates the collapse of these markets and following regulations. The smaller peak around 2008 shows a recoery in ABS issuance.

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7. ABS Outstanding

Observation: The ABS Outstanding shows a peak around 2008, followed by a decline and then a partial recovery starting at around 2014. The pattern of total Outstanding mainly follows the shape of CDO/CLO outstanding.

Explanation: The sharp increase until 2008 reflects the rapid growth of the ABS market, particularly driven by CDOs/CLOs during the housing boom. The decline after 2008 corresponds to the financial crisis. The partial recovery in recent years indicates a rebound in the ABS market but at more moderate levels.

---

8. Fixed Income Issuance

Observation: There is a sharp rise in issuance in around 2020 due to increasae in treasury issuance, corporate issuance and mortgage issuance. In the remaining time, there is a slight increasing trends with fluctuations.

Explanation: The sharpe rise in finxed income issuance around 2020 reflects government's response to the COVID-19, where large amounts of debt were issued to fund relief efforts and economic stimulus.

Plot the data along with each of the macro-economic indicators that you selected? Are there any patterns that you can observe? Give a brief explanation for your findings

Convert Monthly macro-economic indicators into Annual macro-economic indicators

- **Inflation Rate (Computed by CPI):** Change to annual rate by using the difference of cpi at last month and first month for each year and divide it with the cip at the first month for that year.
- **Unemployment Rate:** Calculate the average of unemployment rate in each year to get annual unemployment rate
- **Interest Rate (Federal Fund Rate):** Given Federal Fund Rate does not have any compounding effect, the annual rate will generated using the average of federal fund rate for a whole year.

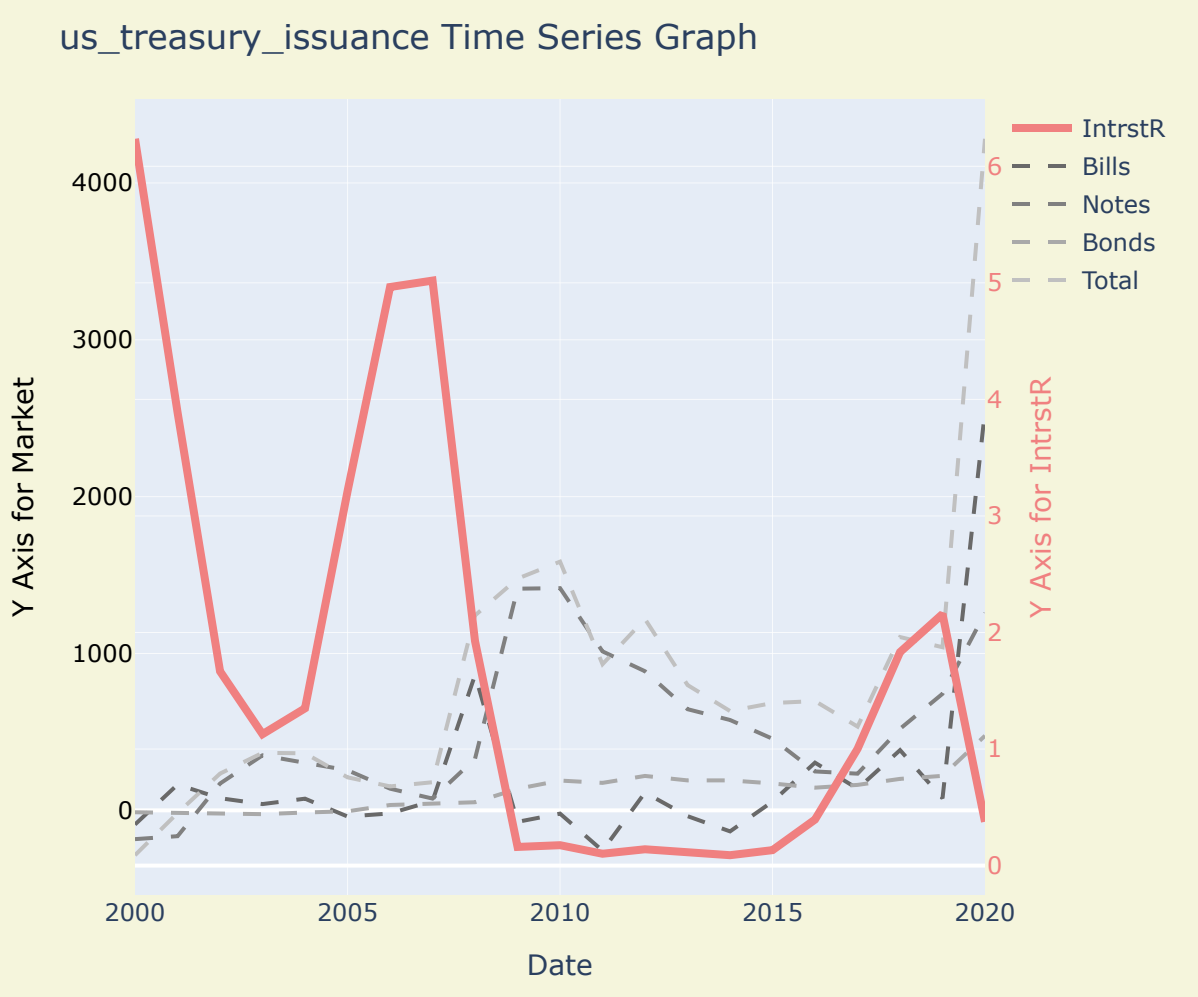
Obtain annual Interest Rate

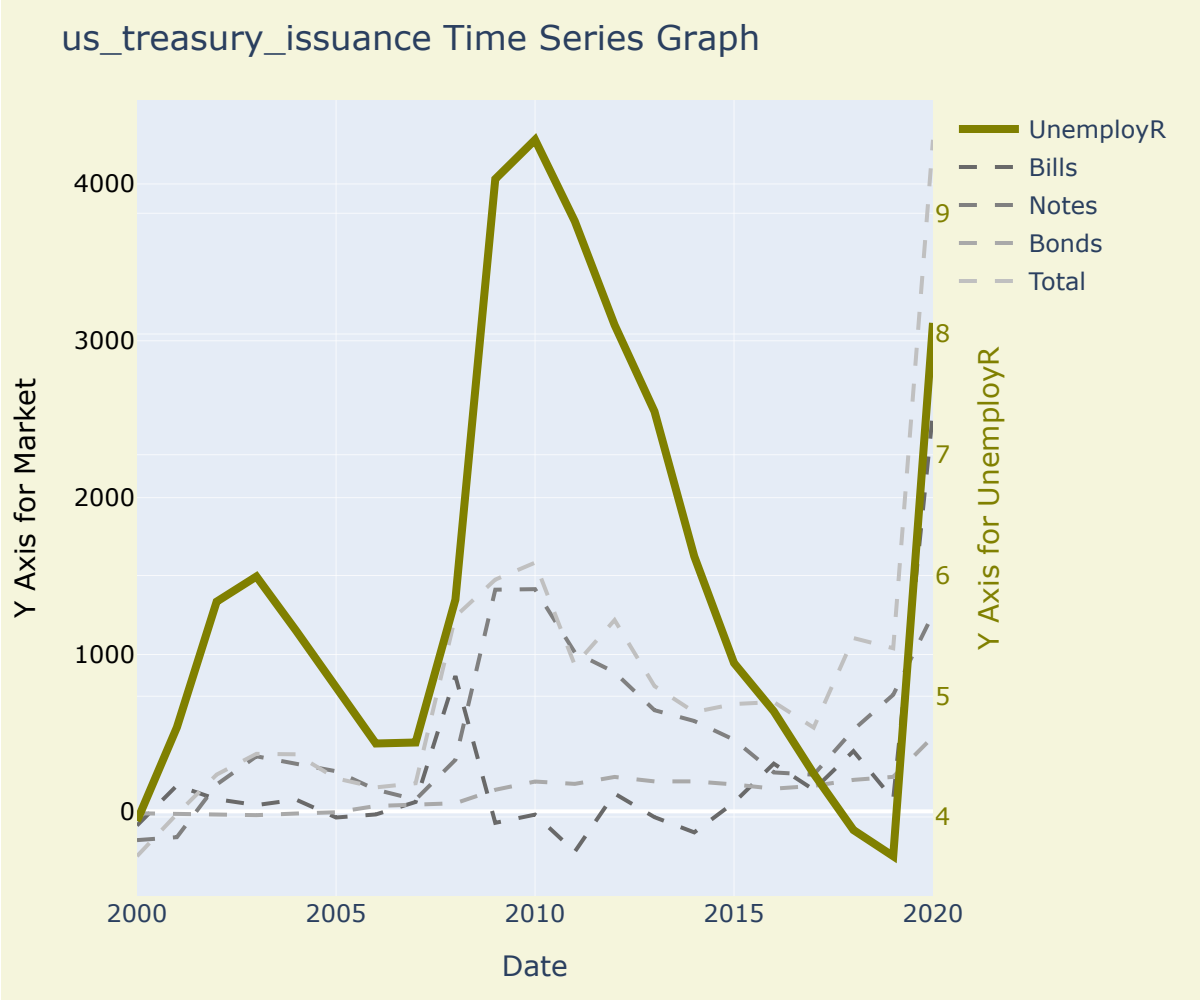
Obtain annual Unemployment Rate

Obtain annual Inflation

	Year	IntrstR	UnemployR	InflaR
0	1980-01-01	13.355833	7.175000	12.353706
1	1981-01-01	16.378333	7.616667	8.912037
2	1982-01-01	12.258333	9.708333	3.825717
3	1983-01-01	9.086667	9.600000	3.787103
4	1984-01-01	10.225000	7.508333	4.043393

Ploting data along macro-economic indicator

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Y Axis for UnemployR
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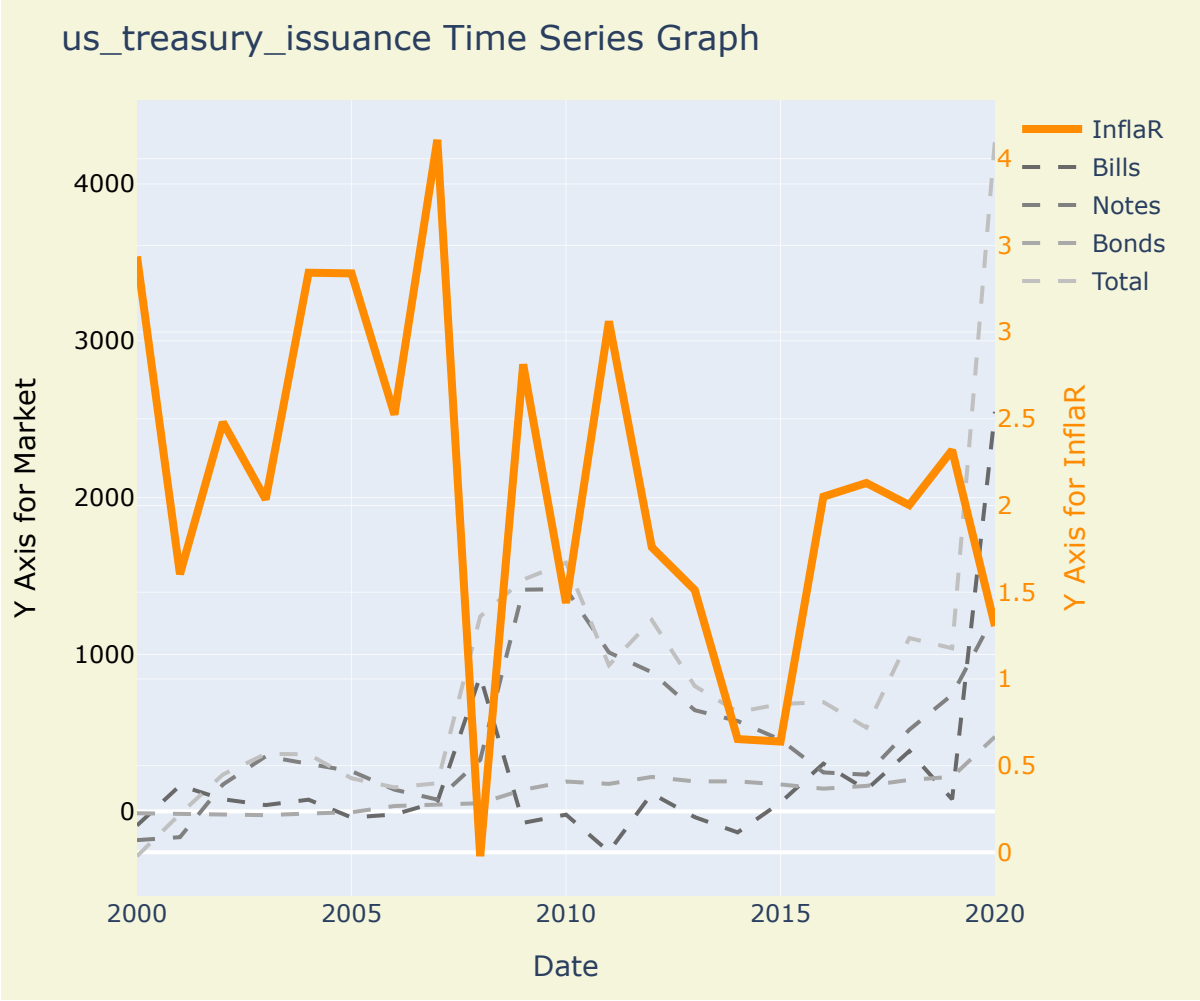
us_treasury_issuance Time Series Graph
InflaR
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Bonds
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Y Axis for Market
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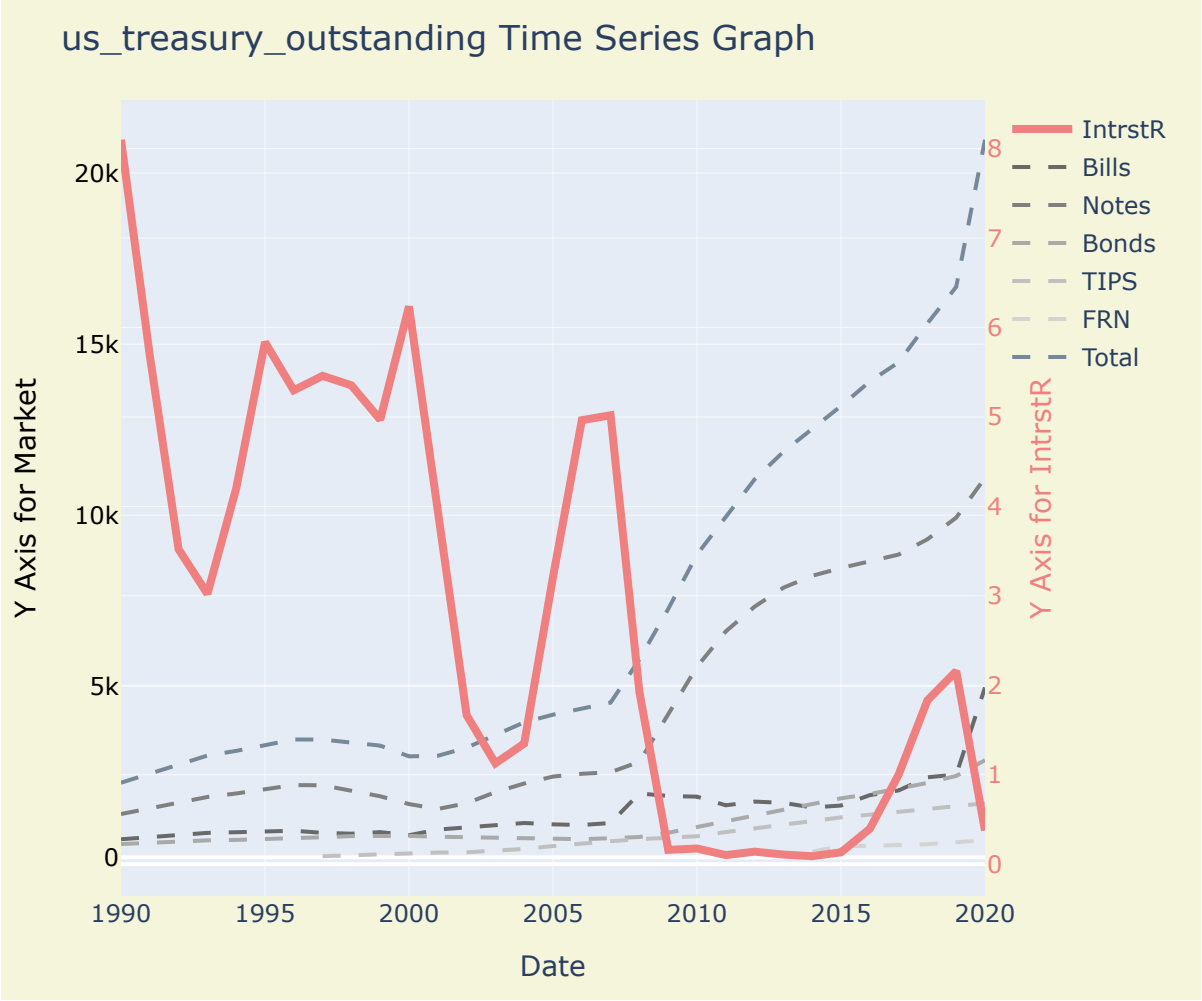
us_treasury_outstanding Time Series Graph
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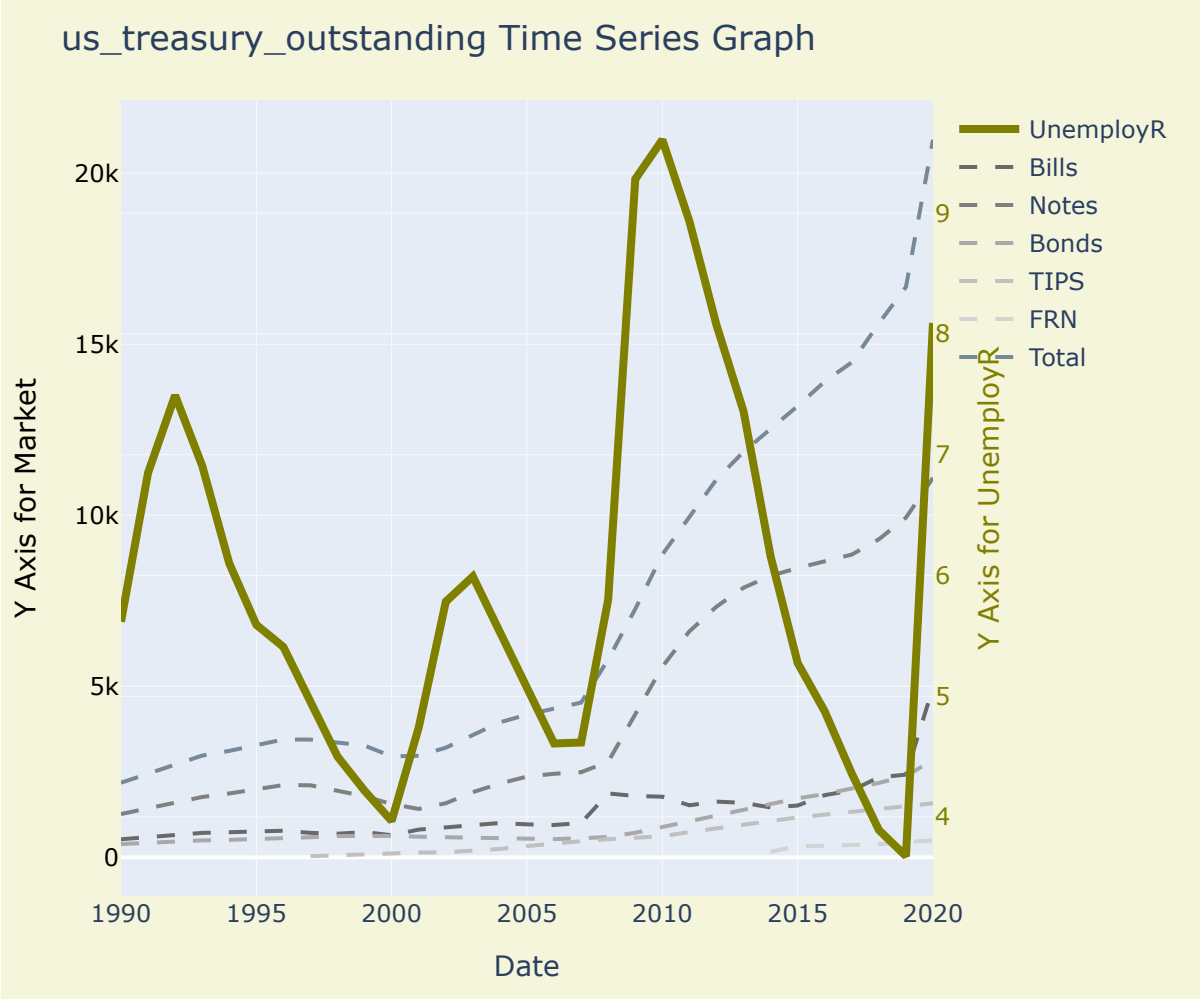
us_treasury_outstanding Time Series Graph
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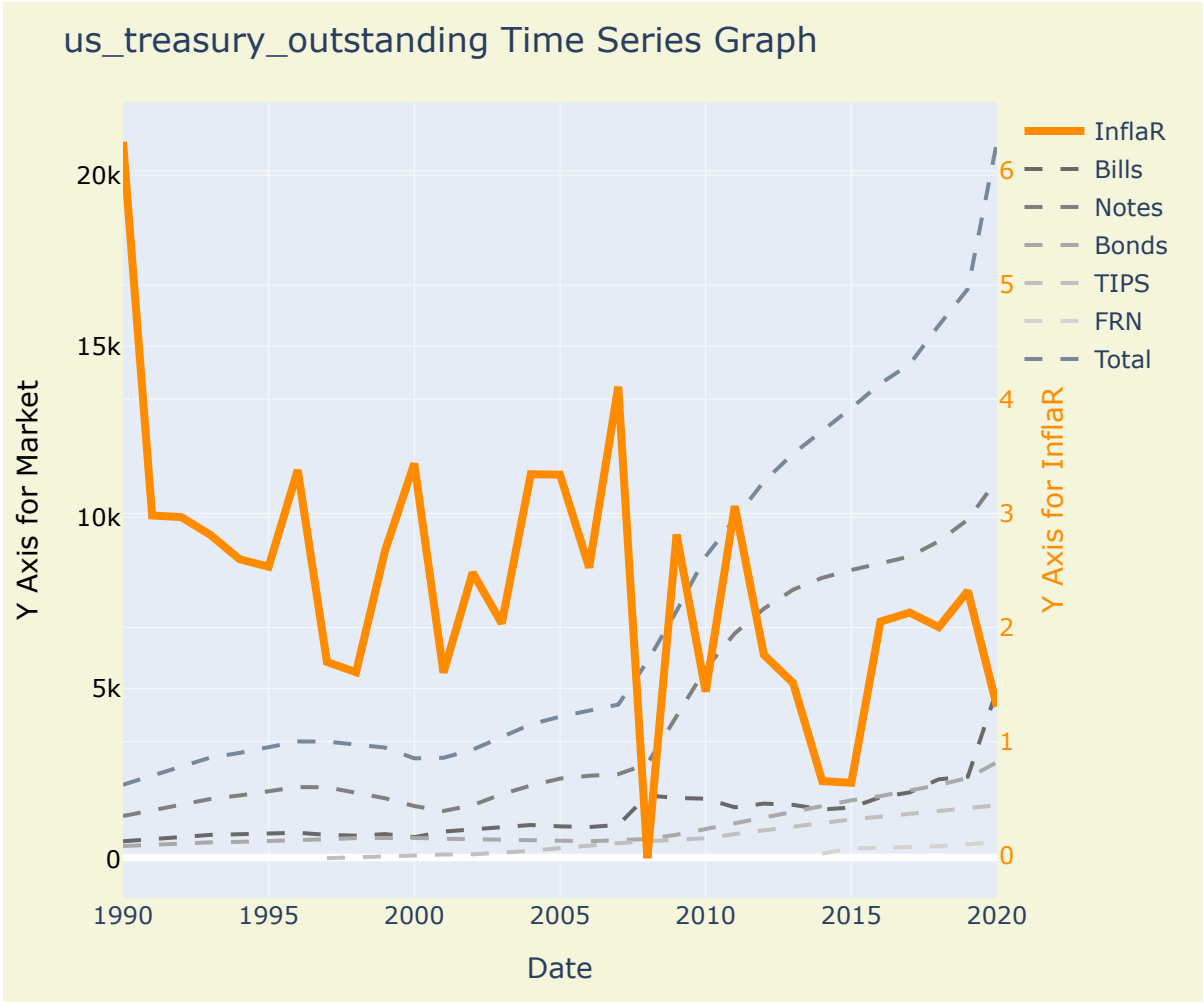
us_treasury_outstanding Time Series Graph
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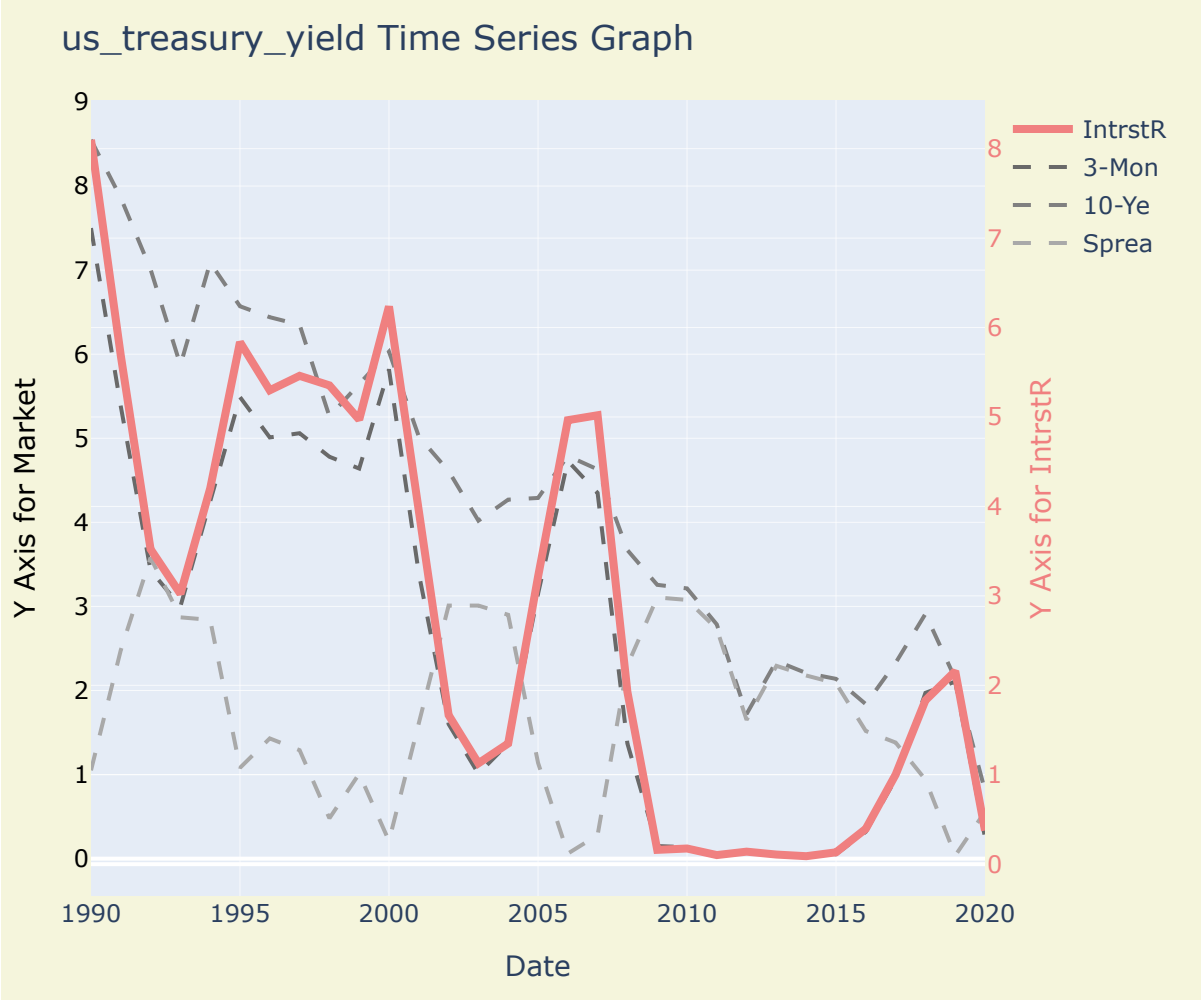
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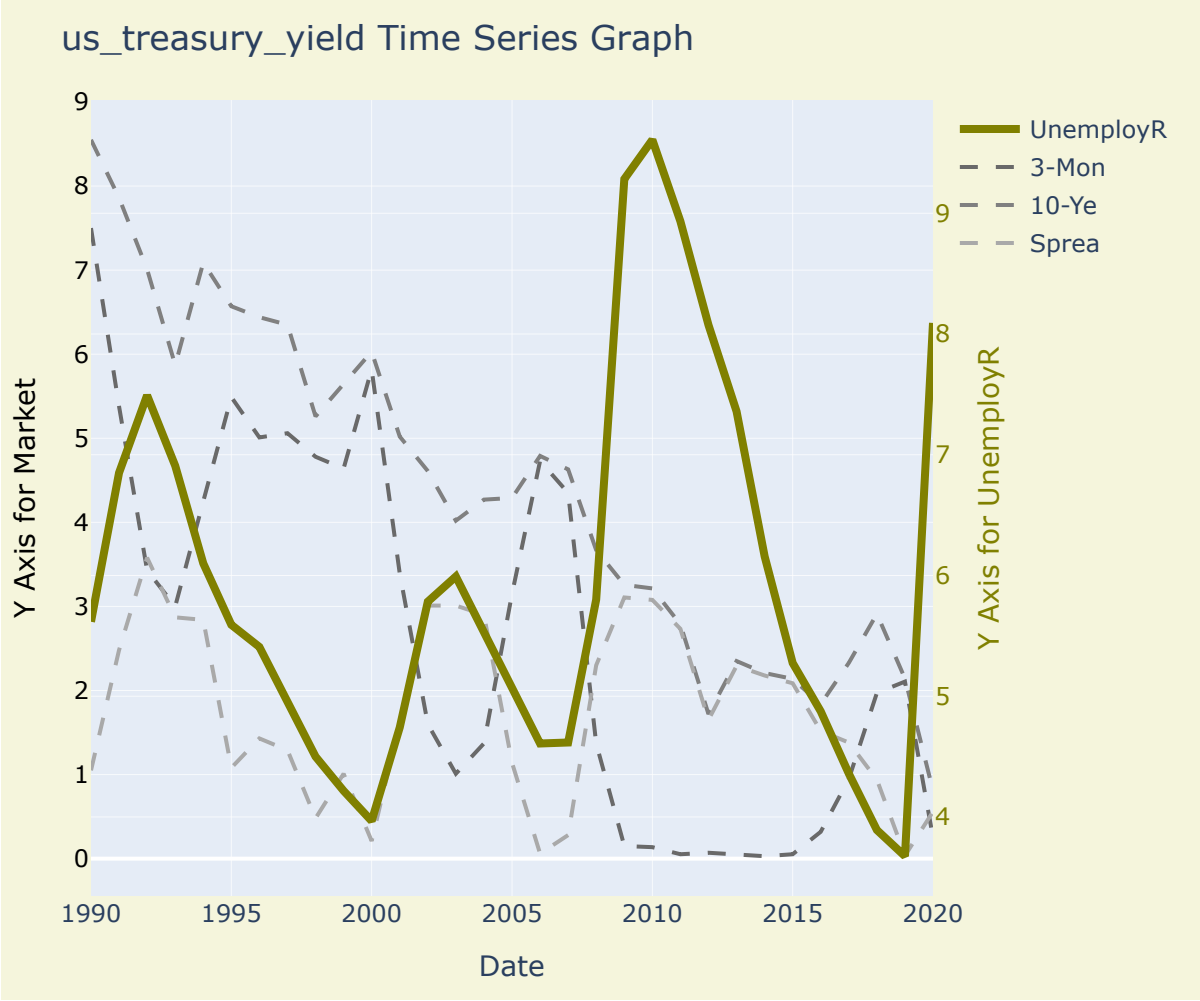
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Y Axis for Market
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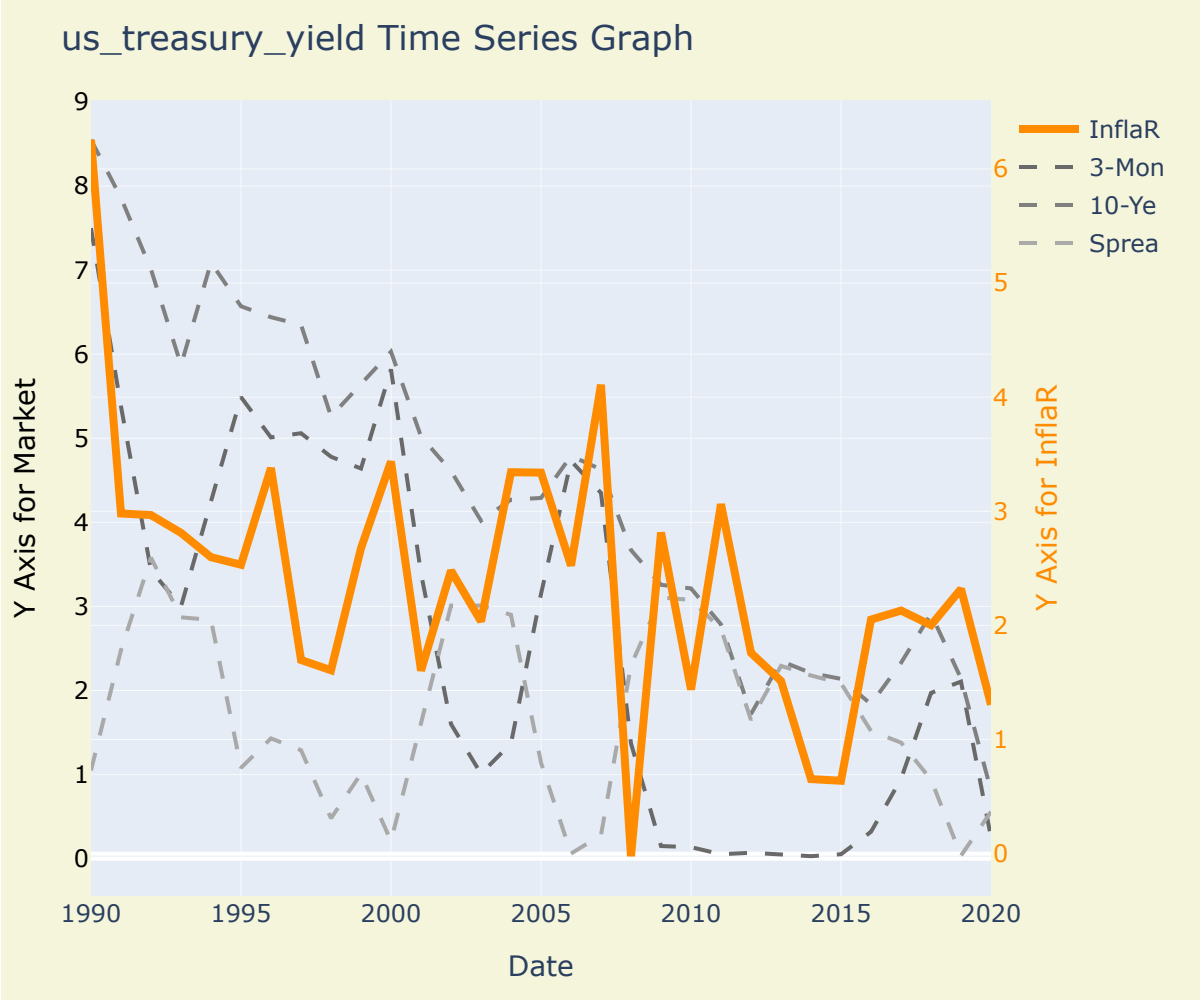
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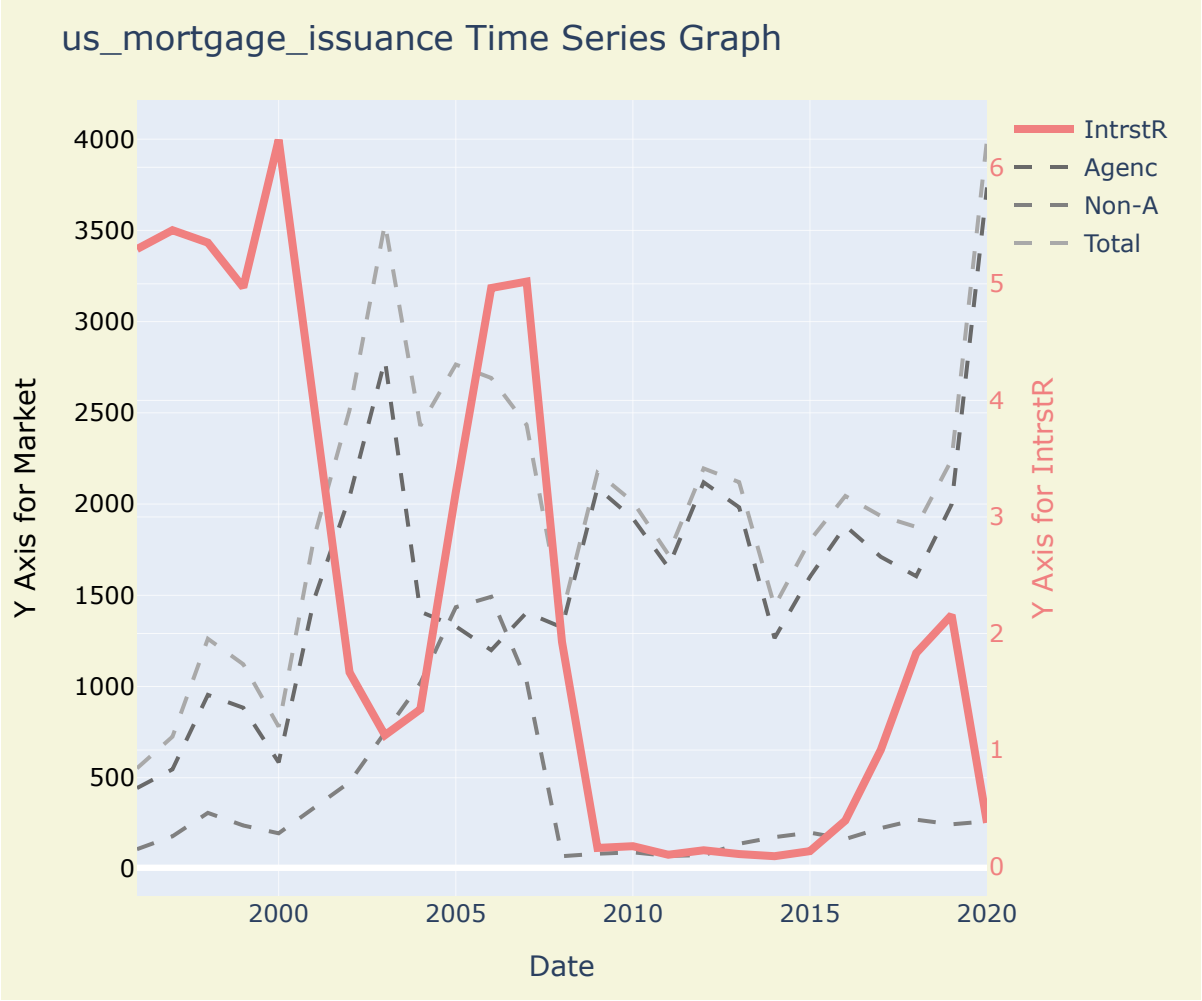
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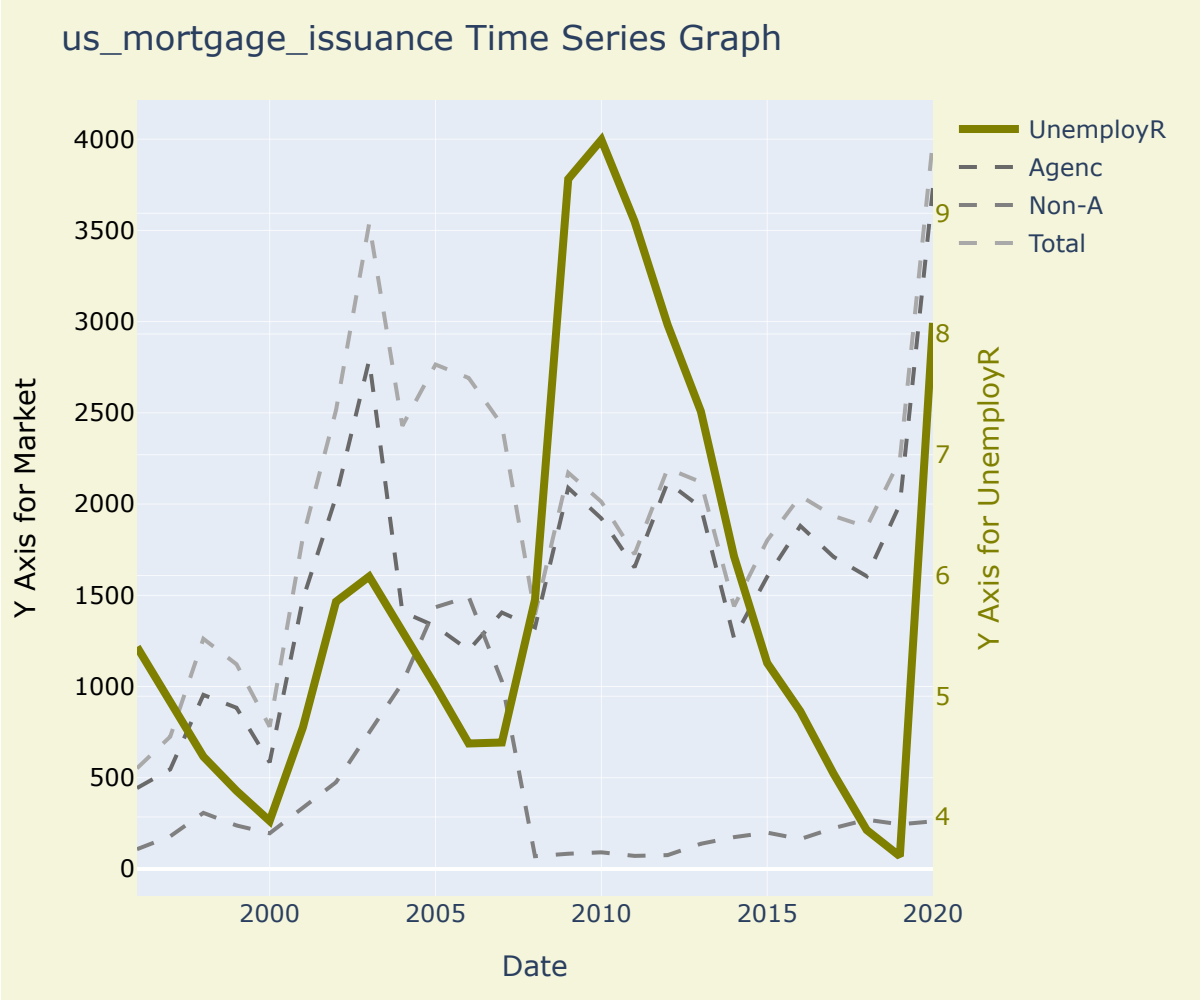
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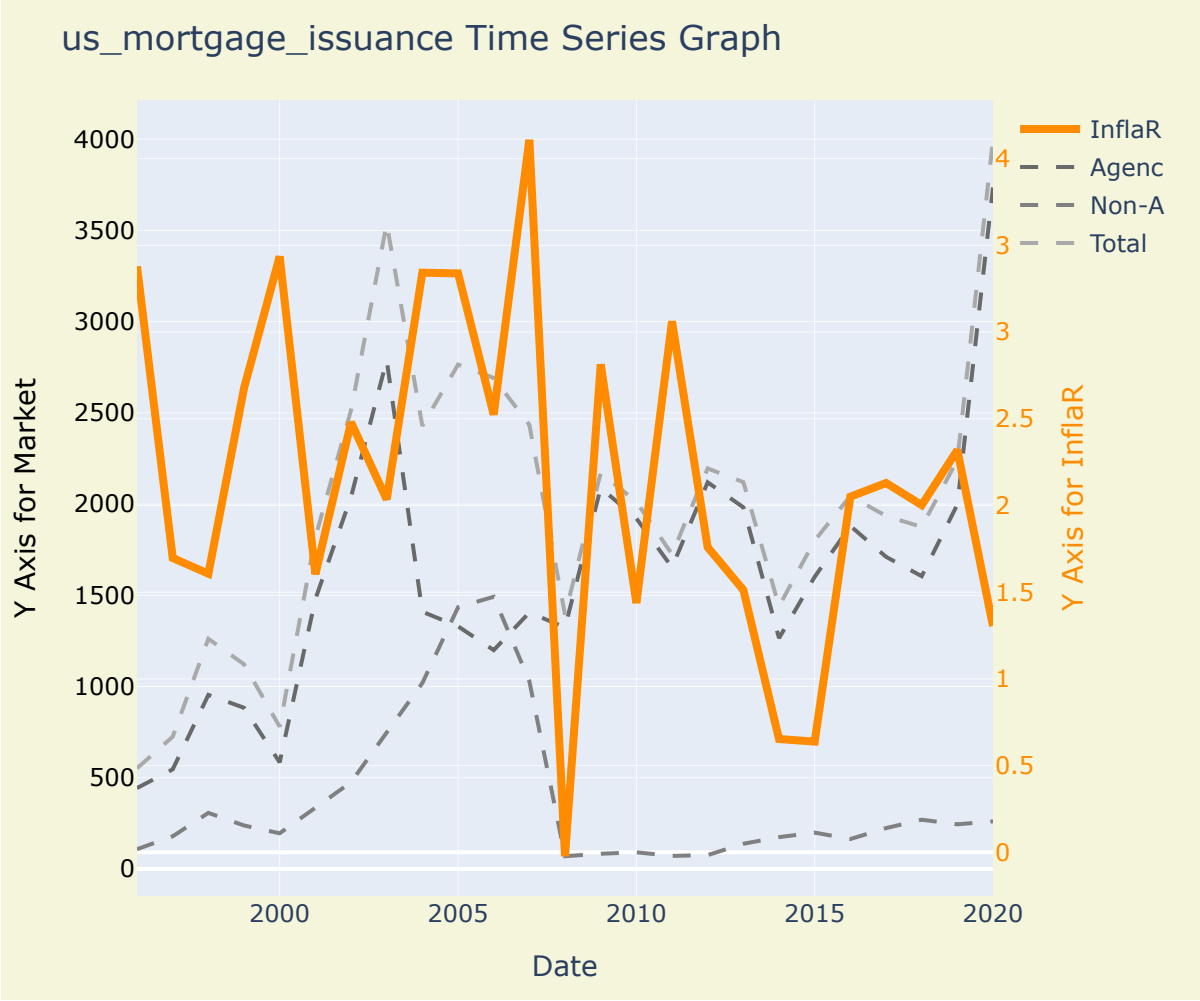
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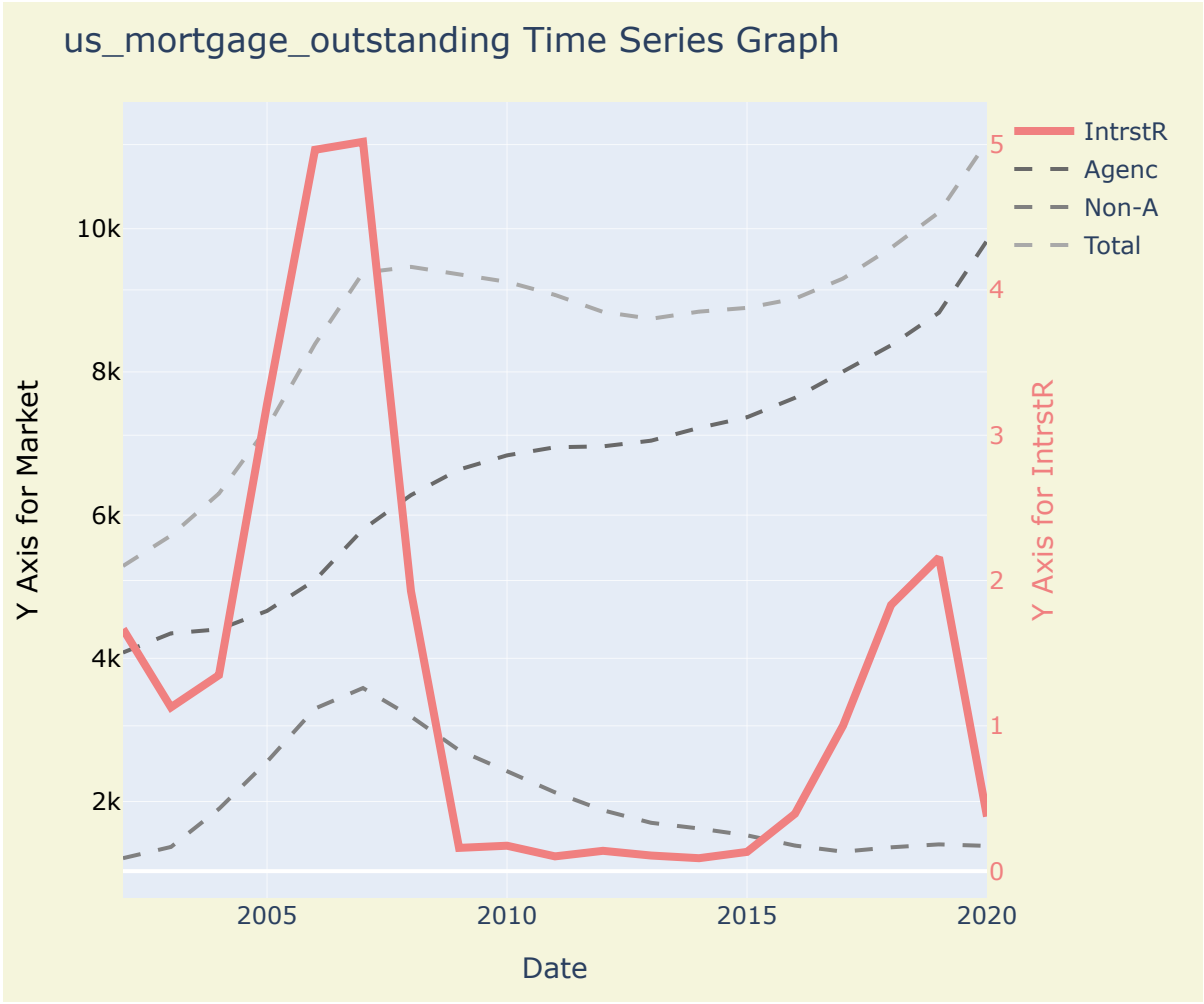
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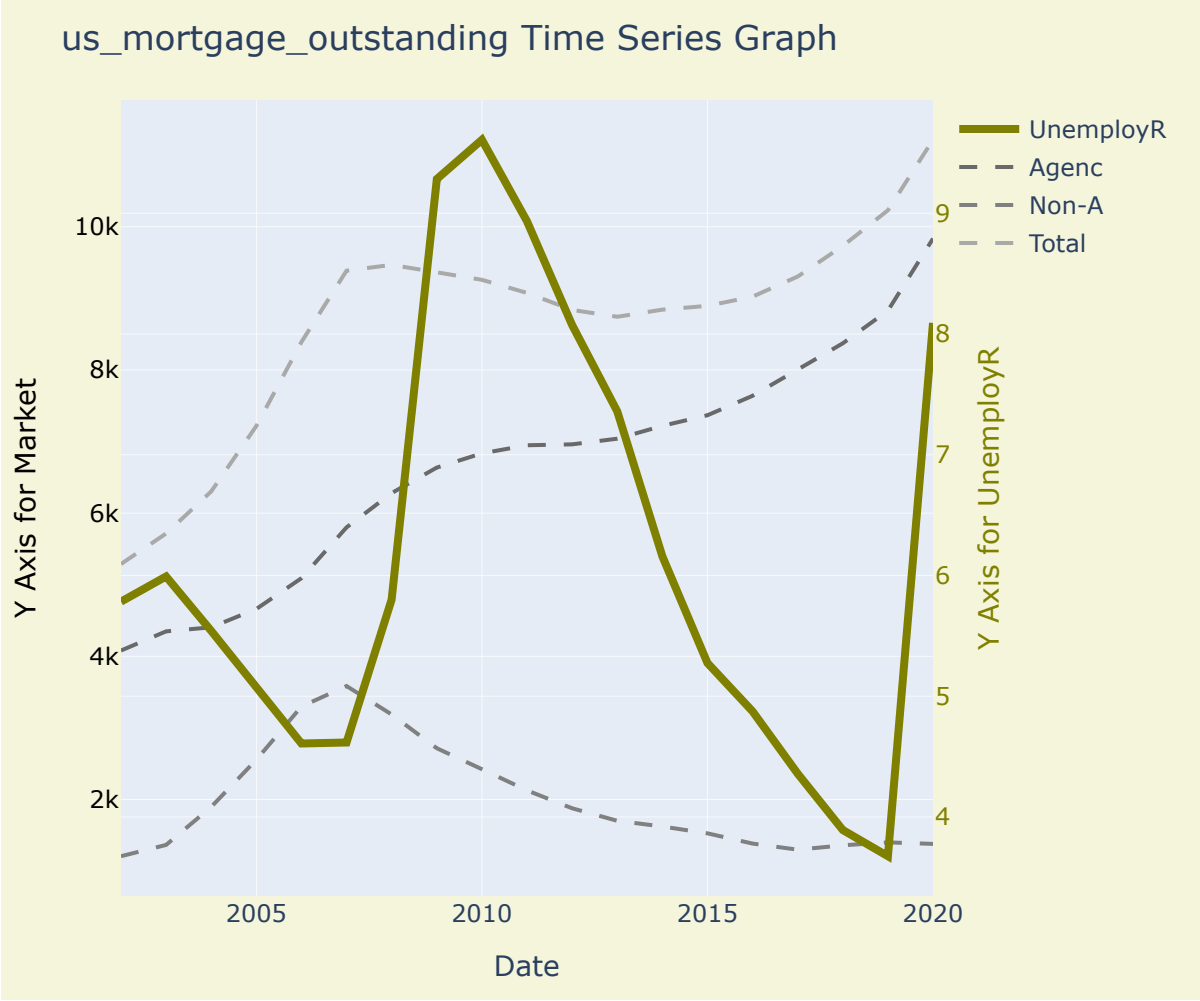
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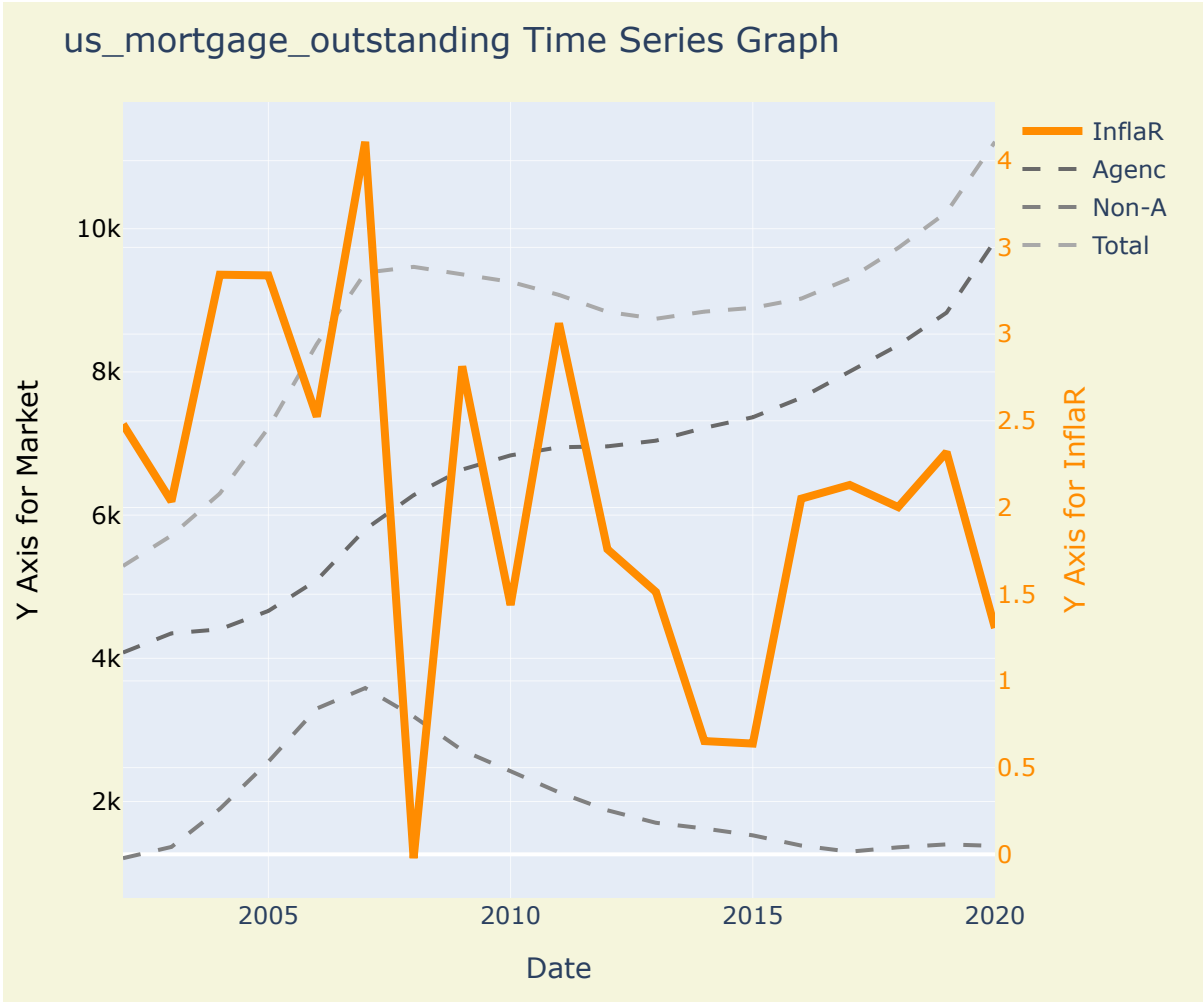
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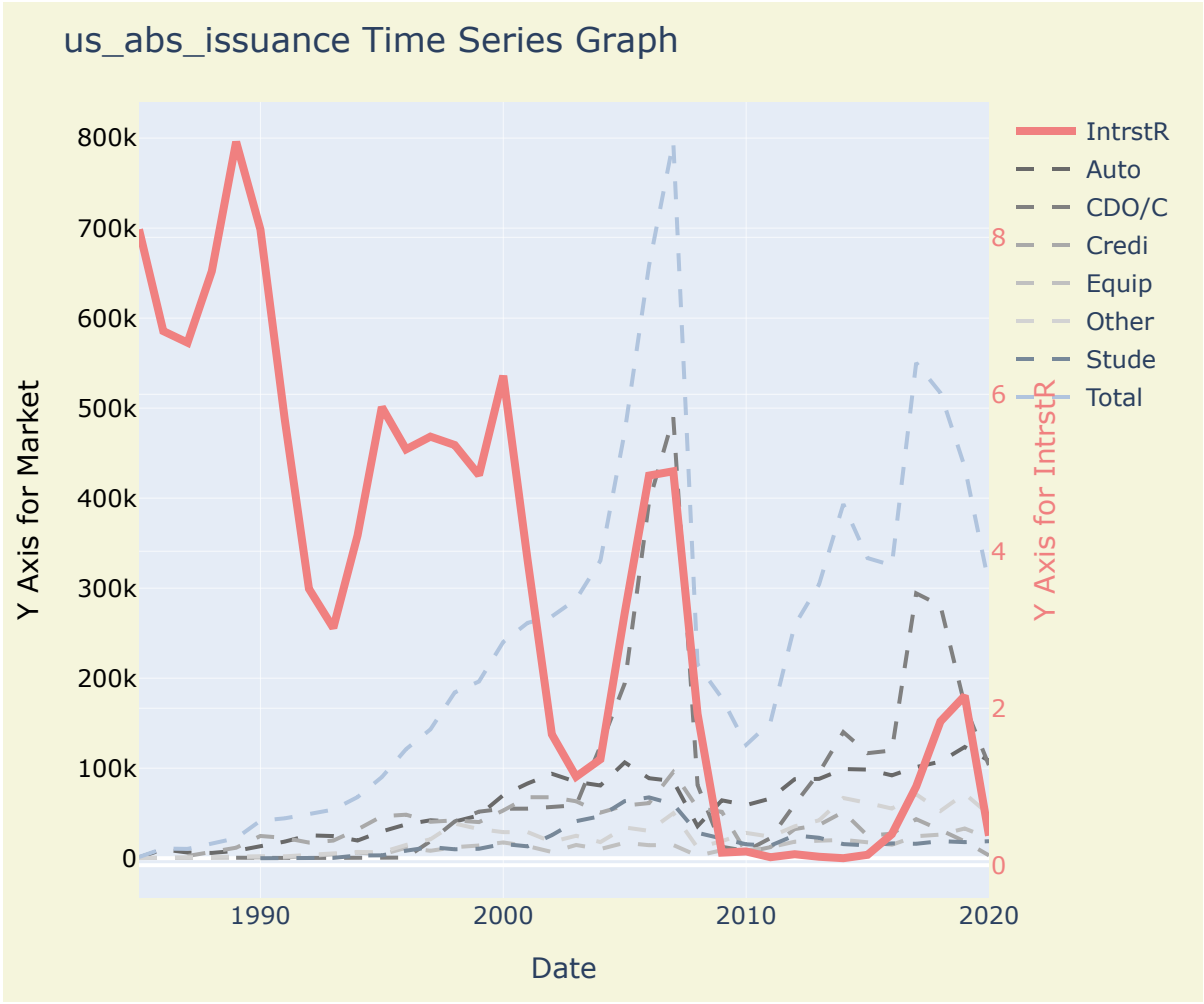
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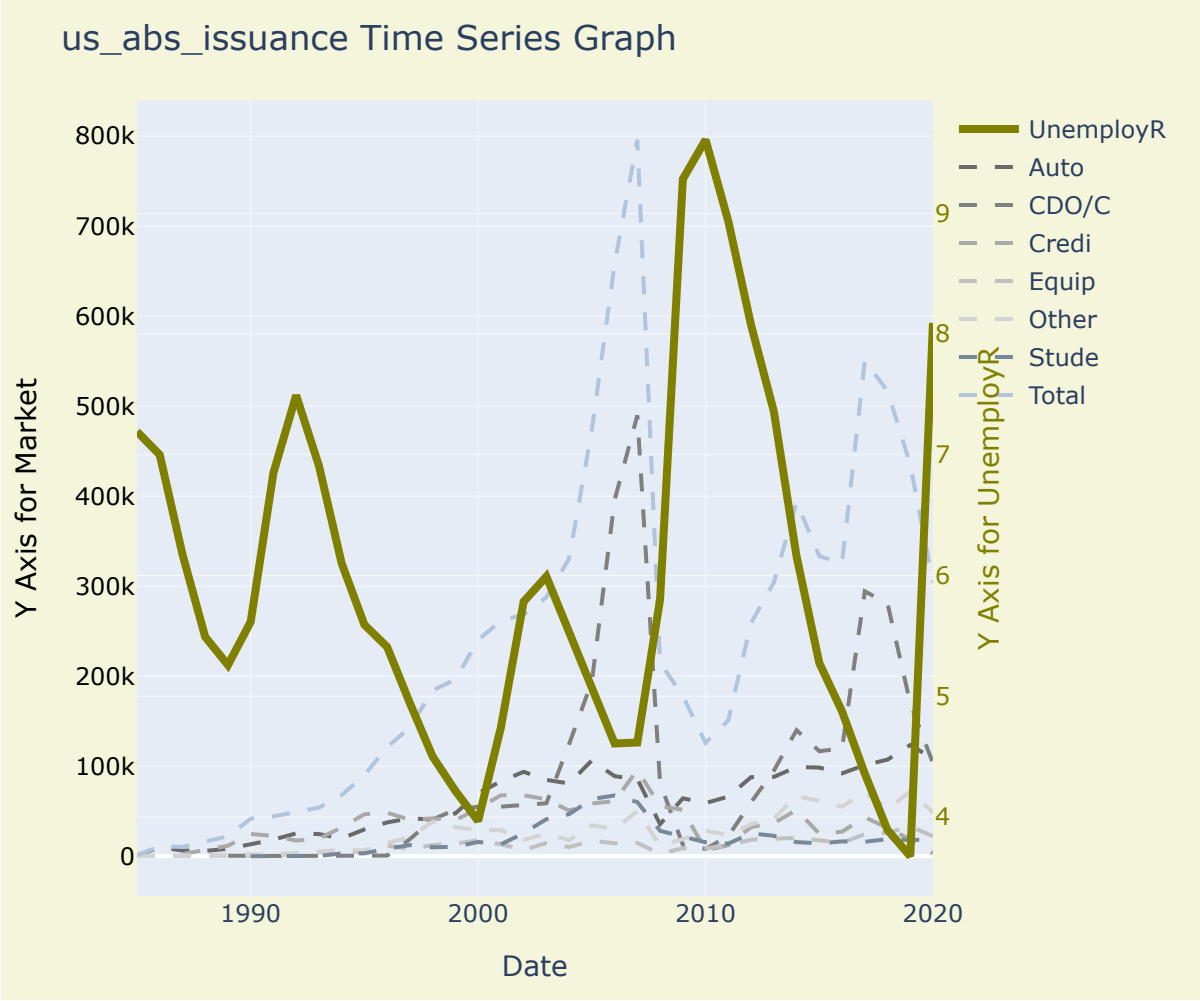
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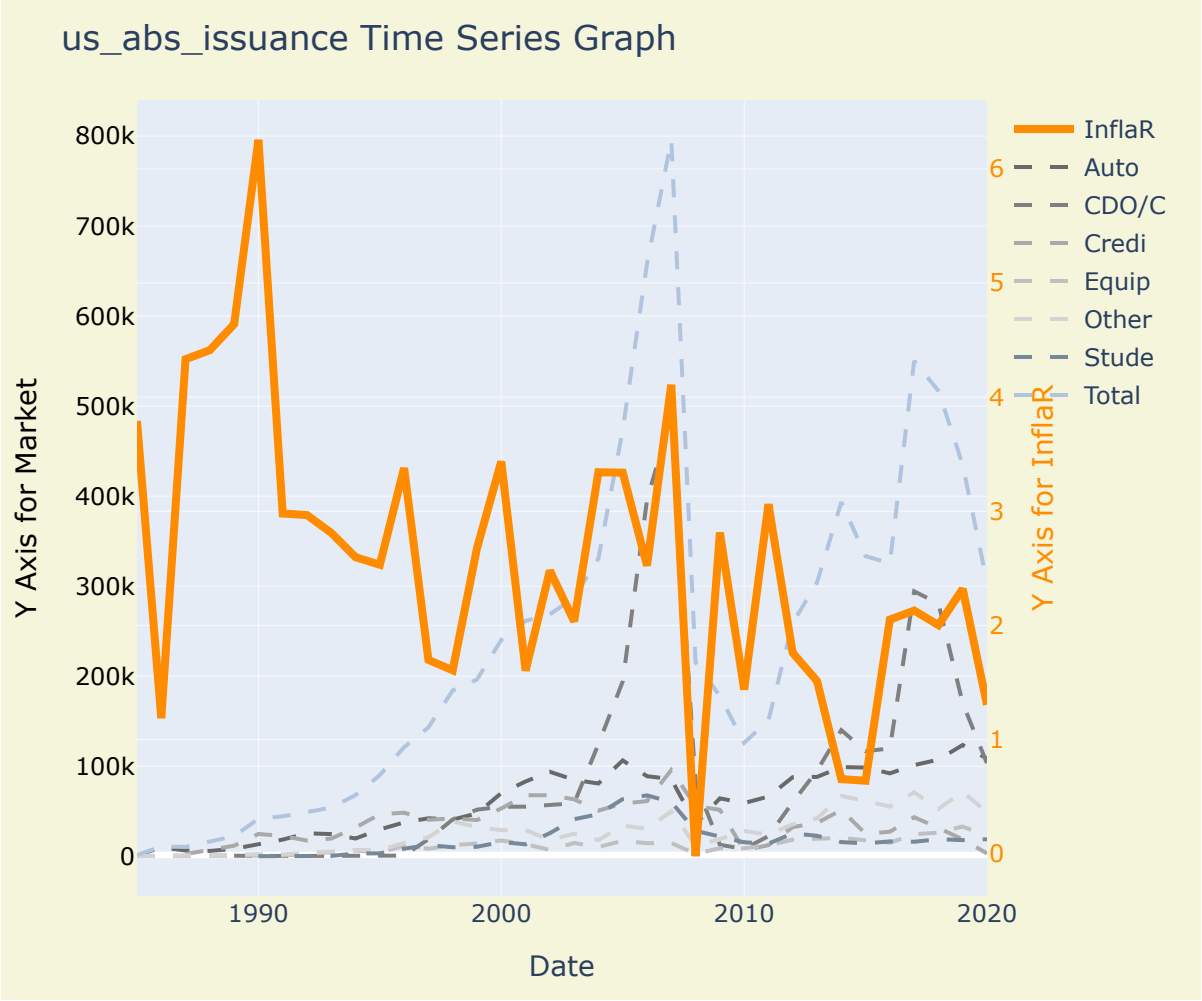
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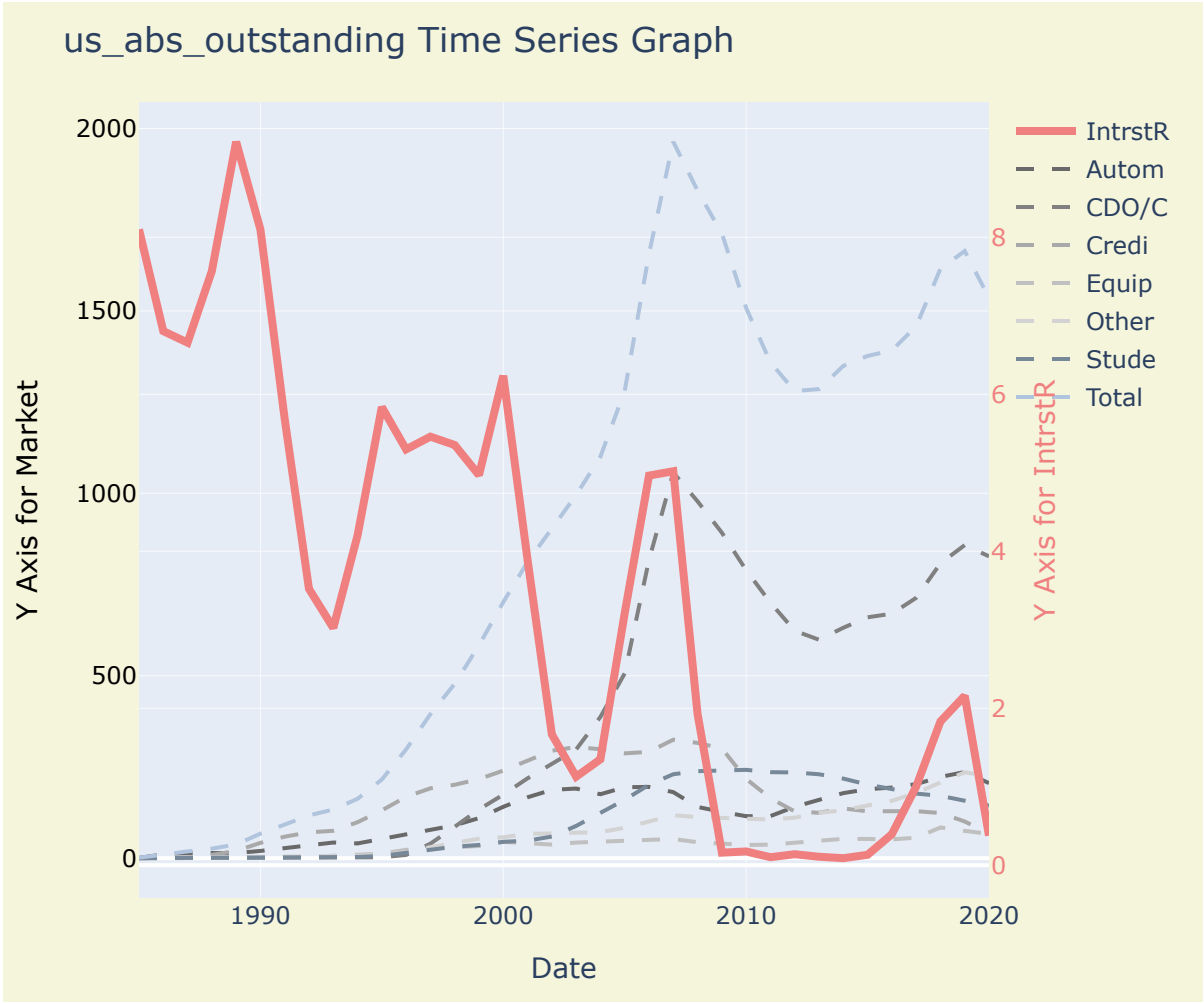
us_abs_outstanding Time Series Graph
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Y Axis for IntrstR
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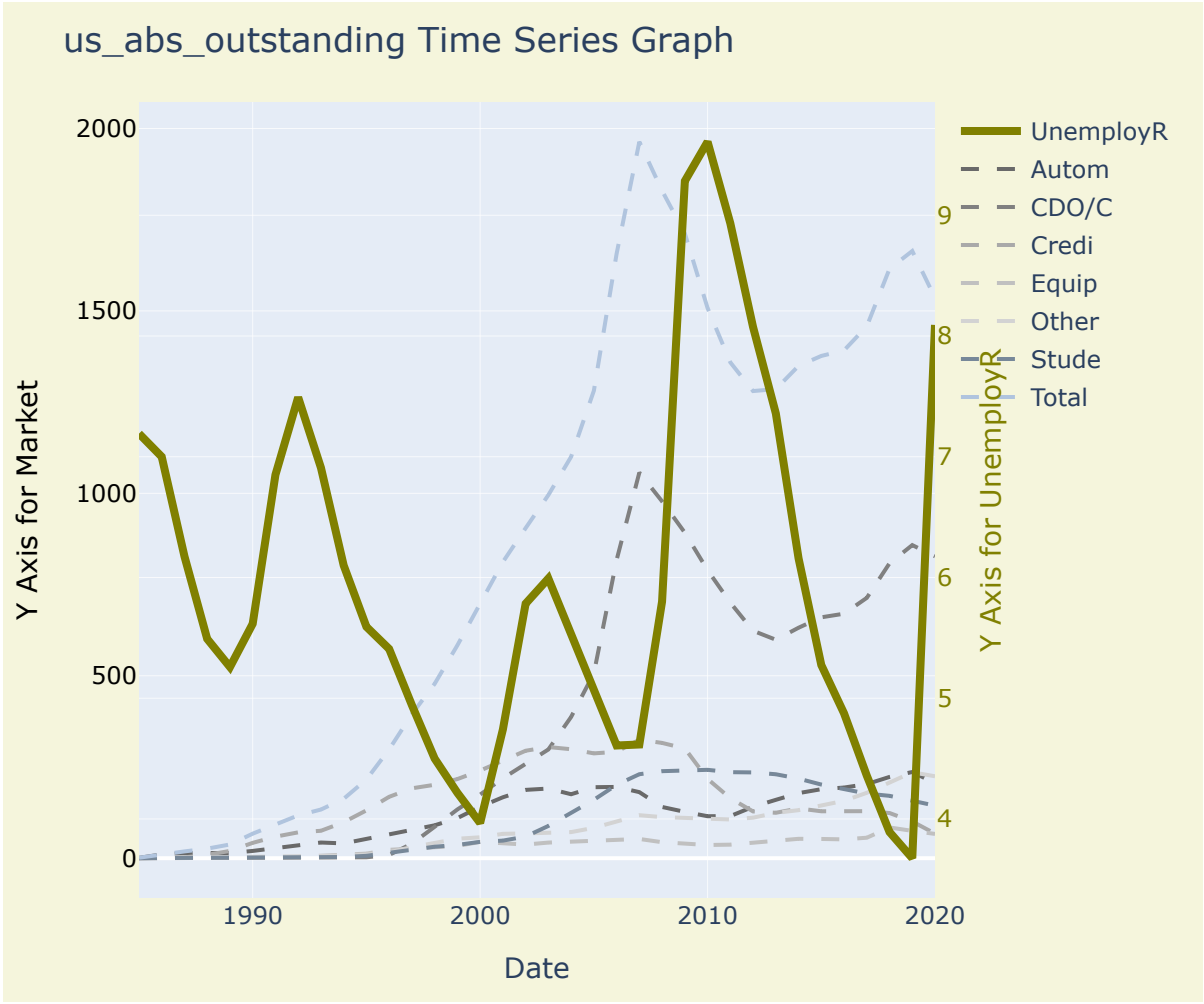
us_abs_outstanding Time Series Graph
Y Axis for Market
Y Axis for UnemployR
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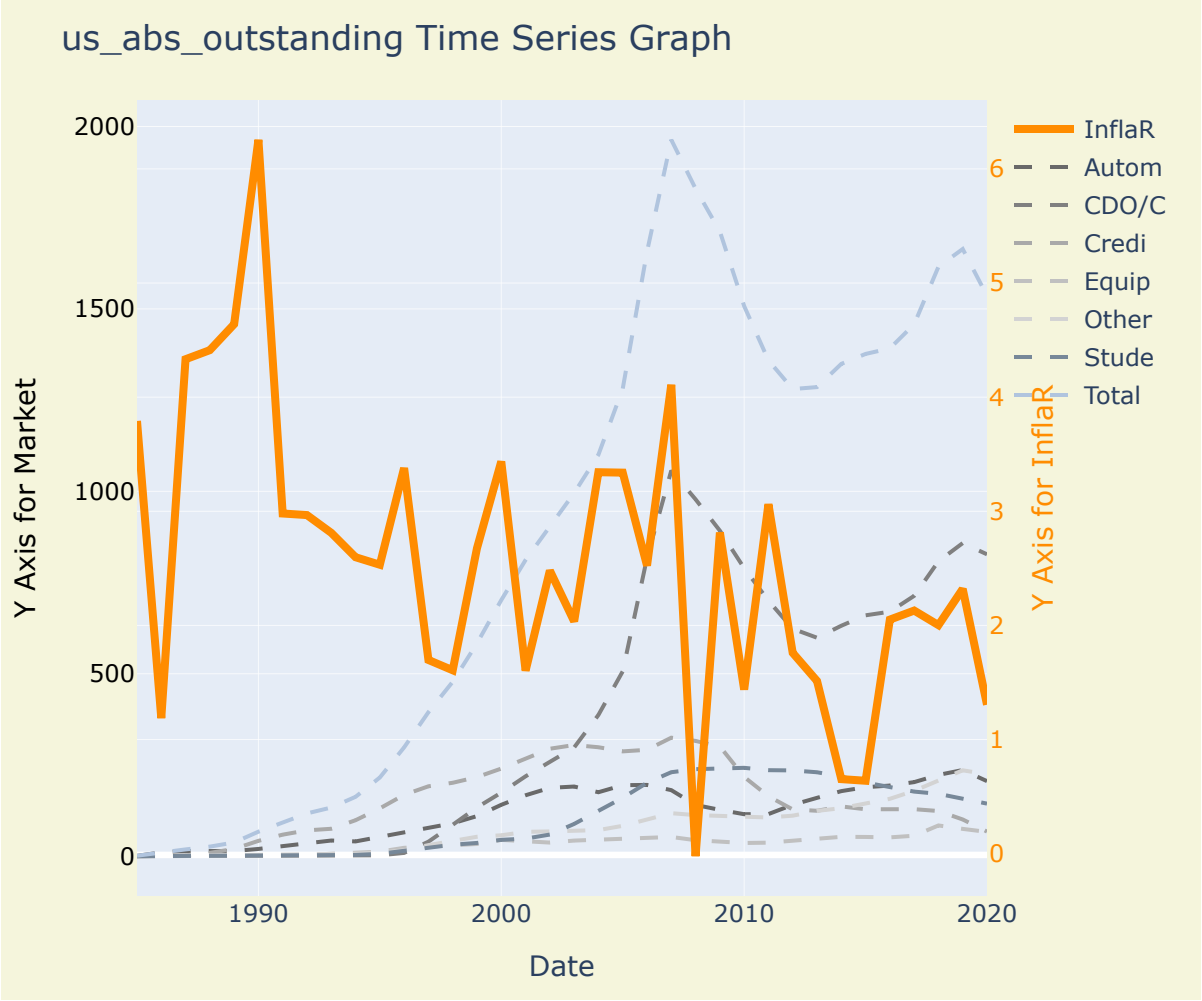
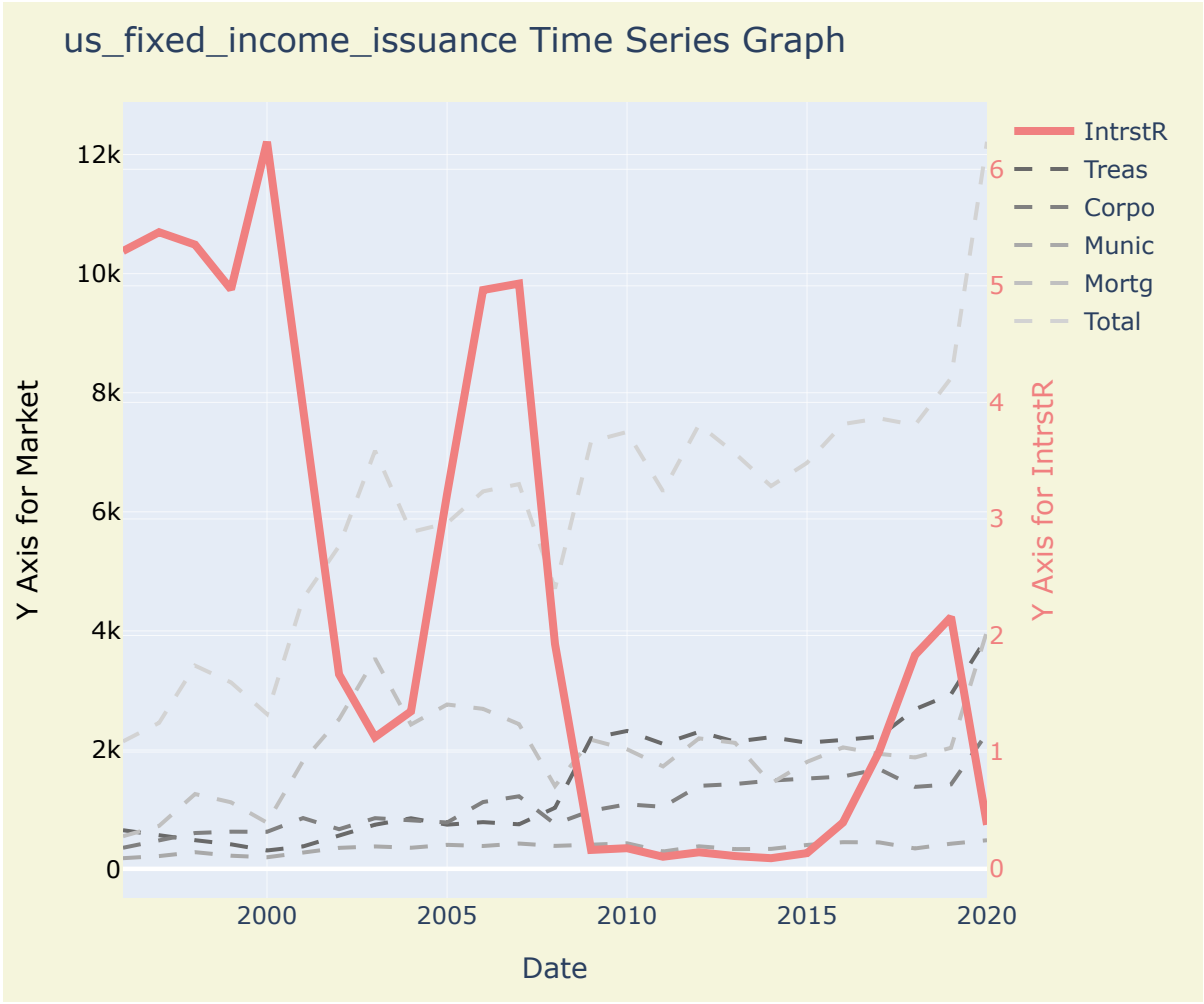
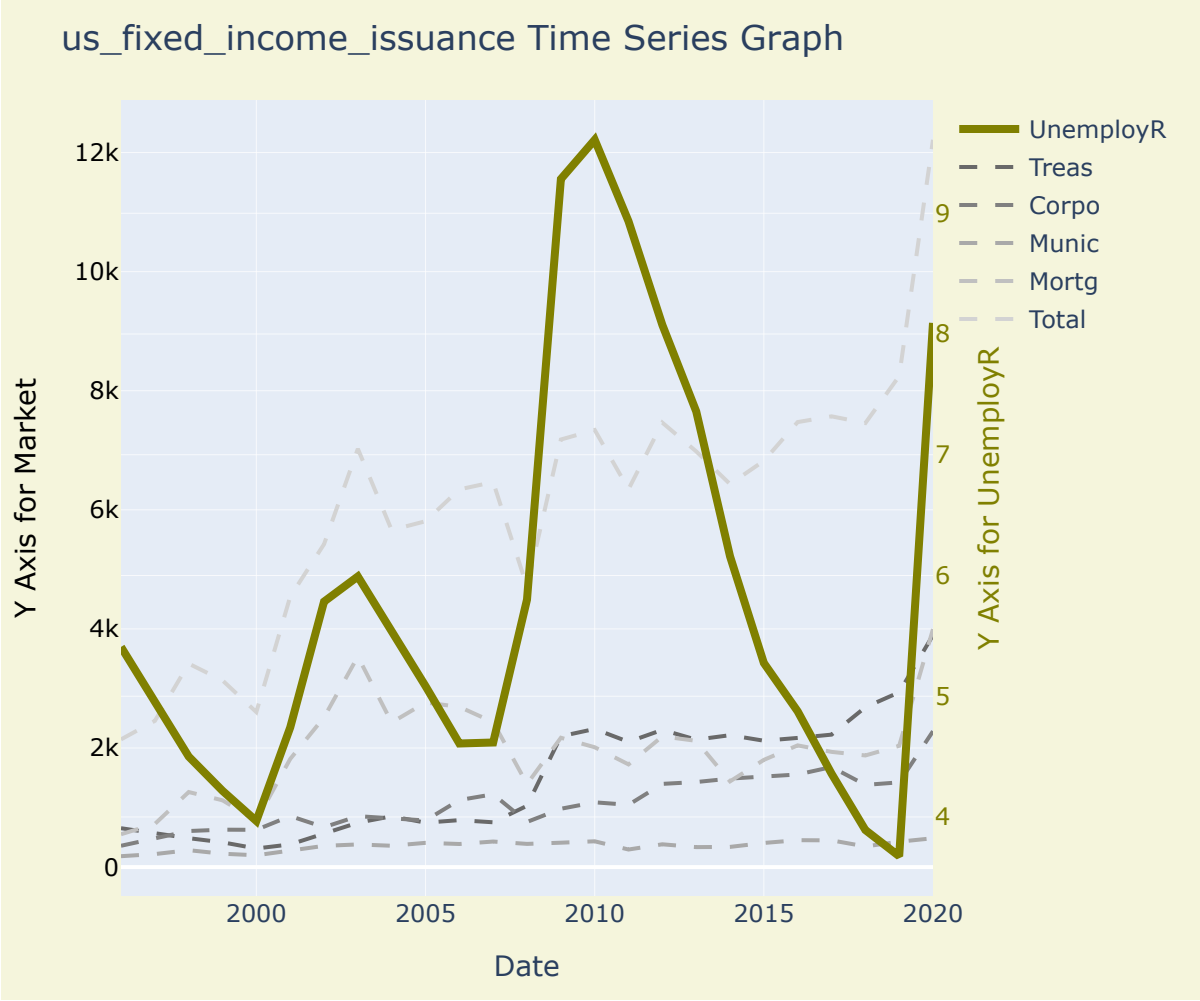
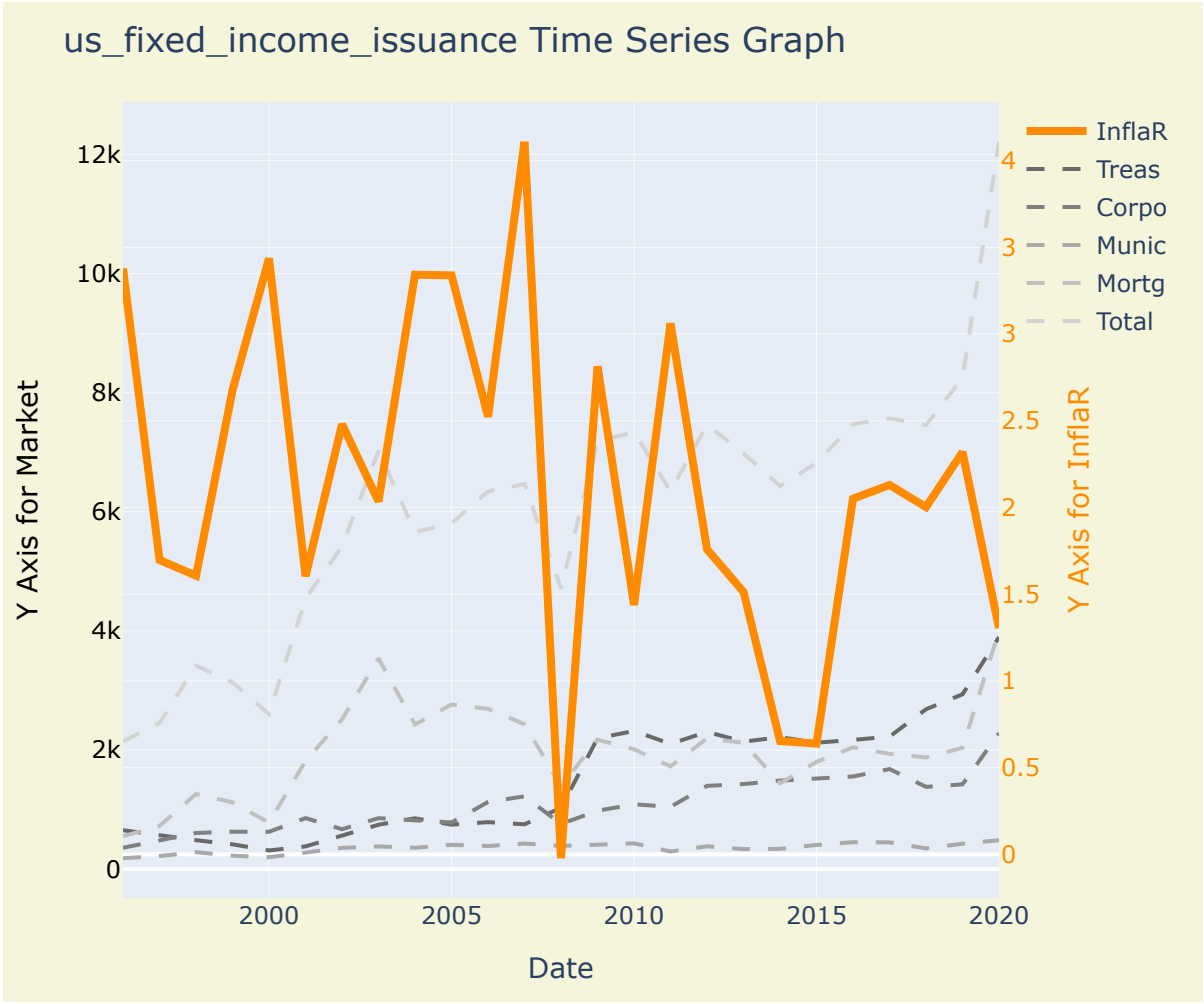
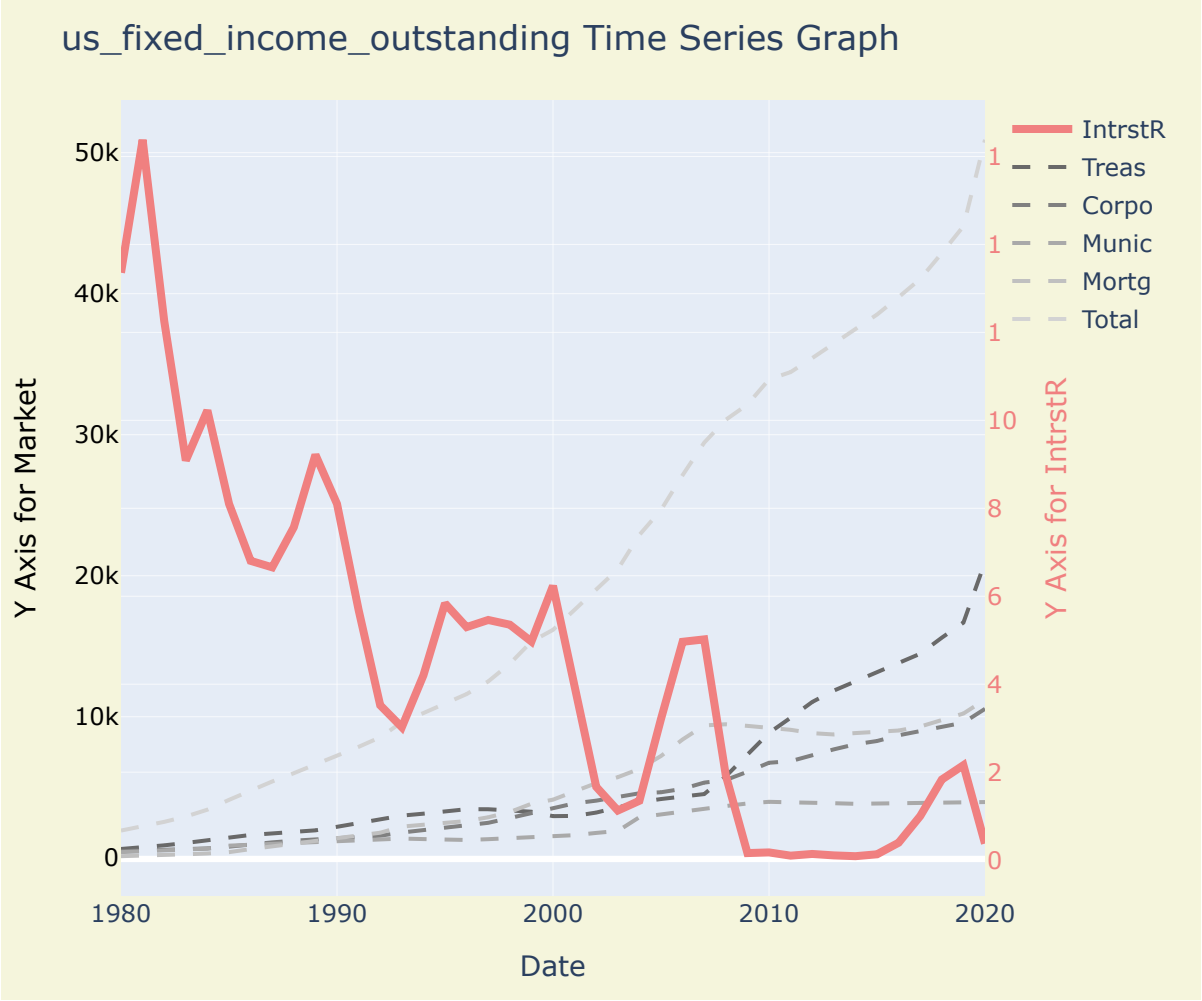
Stude
Total

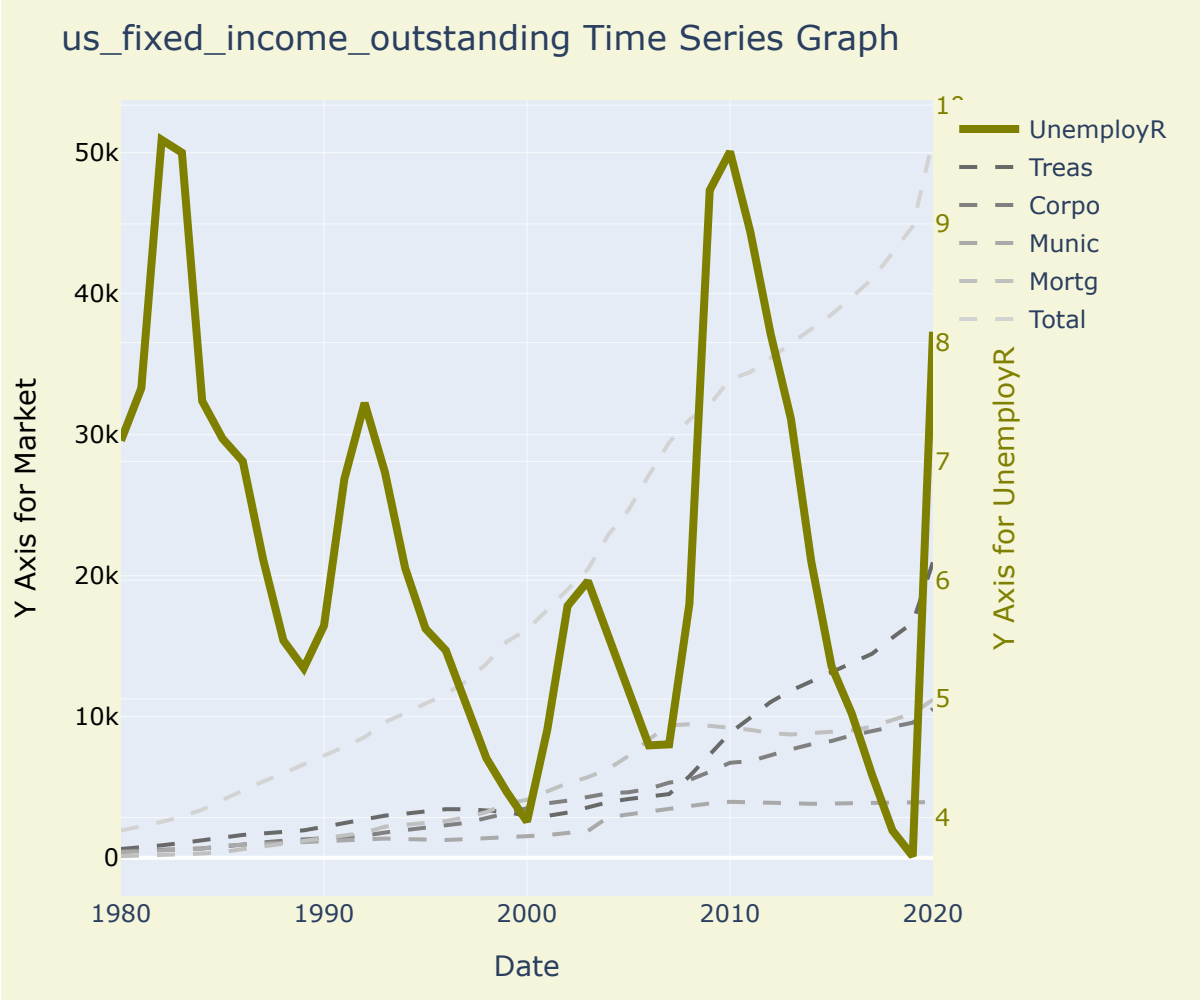

us_abs_outstanding Time Series Graph
Y Axis for Market
Y Axis for InflaR
Date
InflaR
Autom
CDO/C
Credi
Equip
Other
Stude
Total
2000
1500
1000
500
0
6
5
4
3
2
1
0
1990
2000
2010
2020

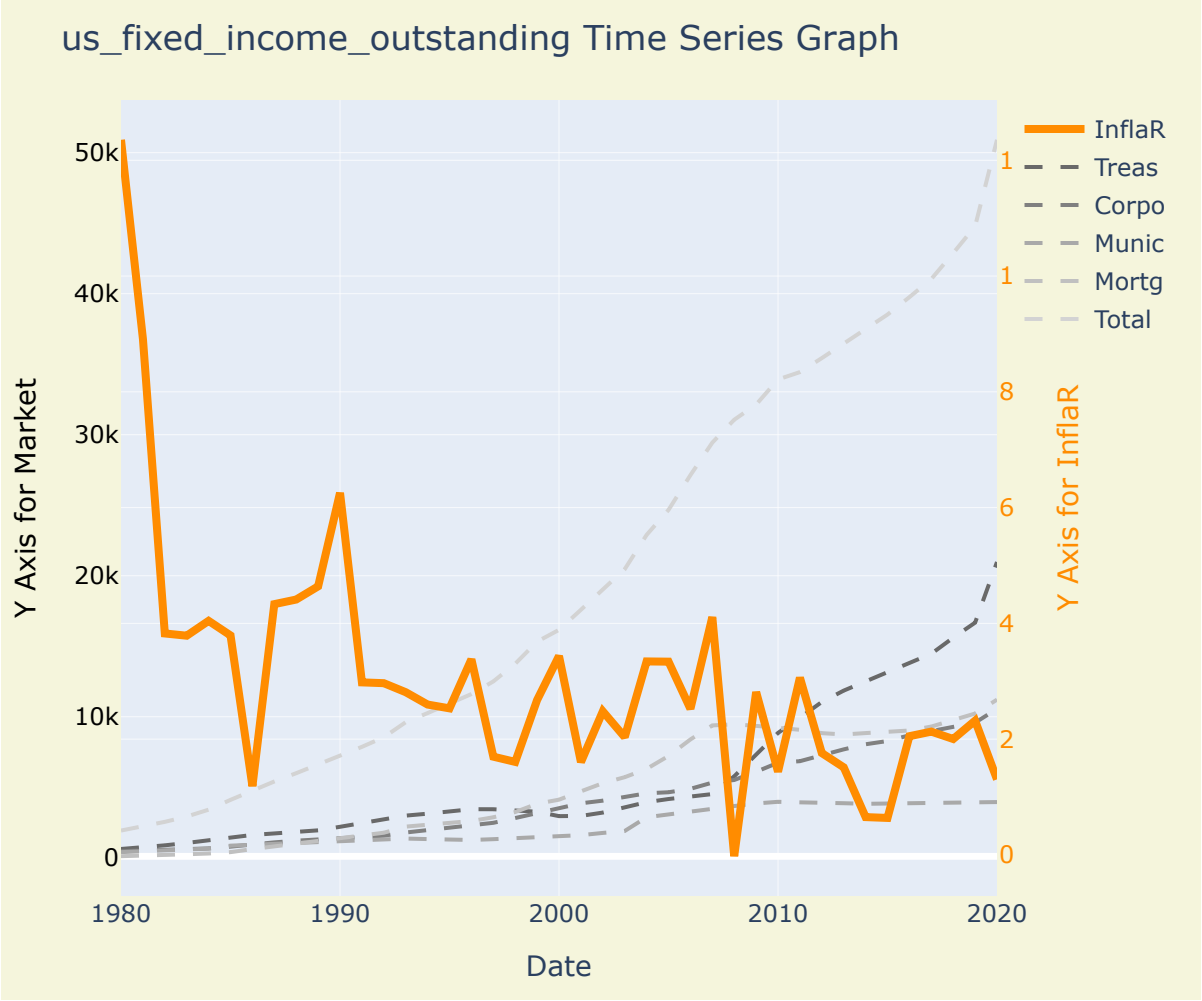

us_fixed_income_issuance Time Series Graph
Y Axis for Market
Y Axis for IntrstR
Date
IntrstR
Treas
Corpo
Munic
Mortg
Total
12k
10k
8k
6k
4k
2k
0
6
5
4
3
2
1
0
2000
2005
2010
2015
2020

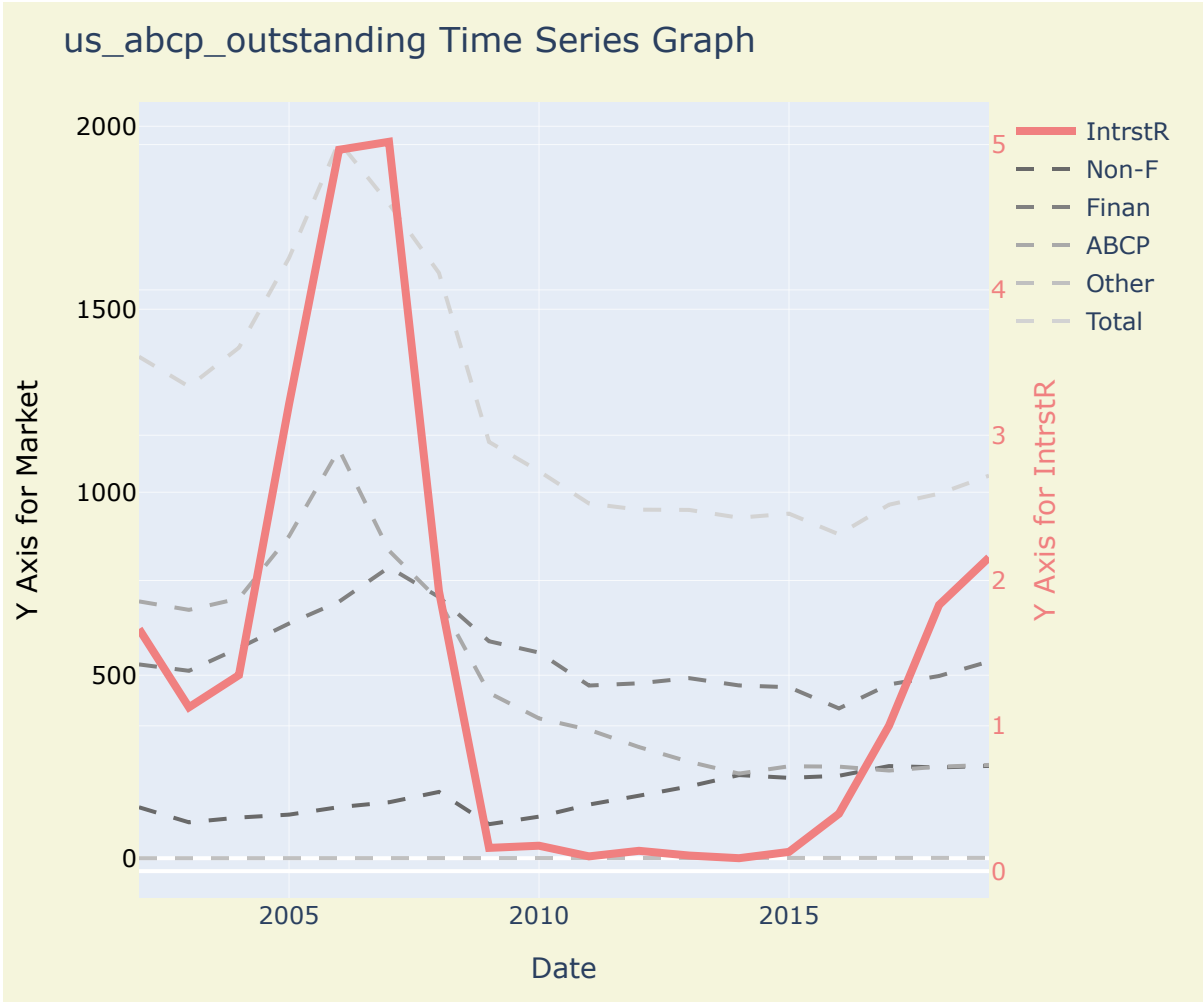

us_fixed_income_issuance Time Series Graph
Y Axis for Market
12k
10k
8k
6k
4k
2k
0
2000
2005
2010
2015
2020
Date
Y Axis for UnemployR
9
8
7
6
5
4
UnemployR
Treas
Corpo
Munic
Mortg
Total

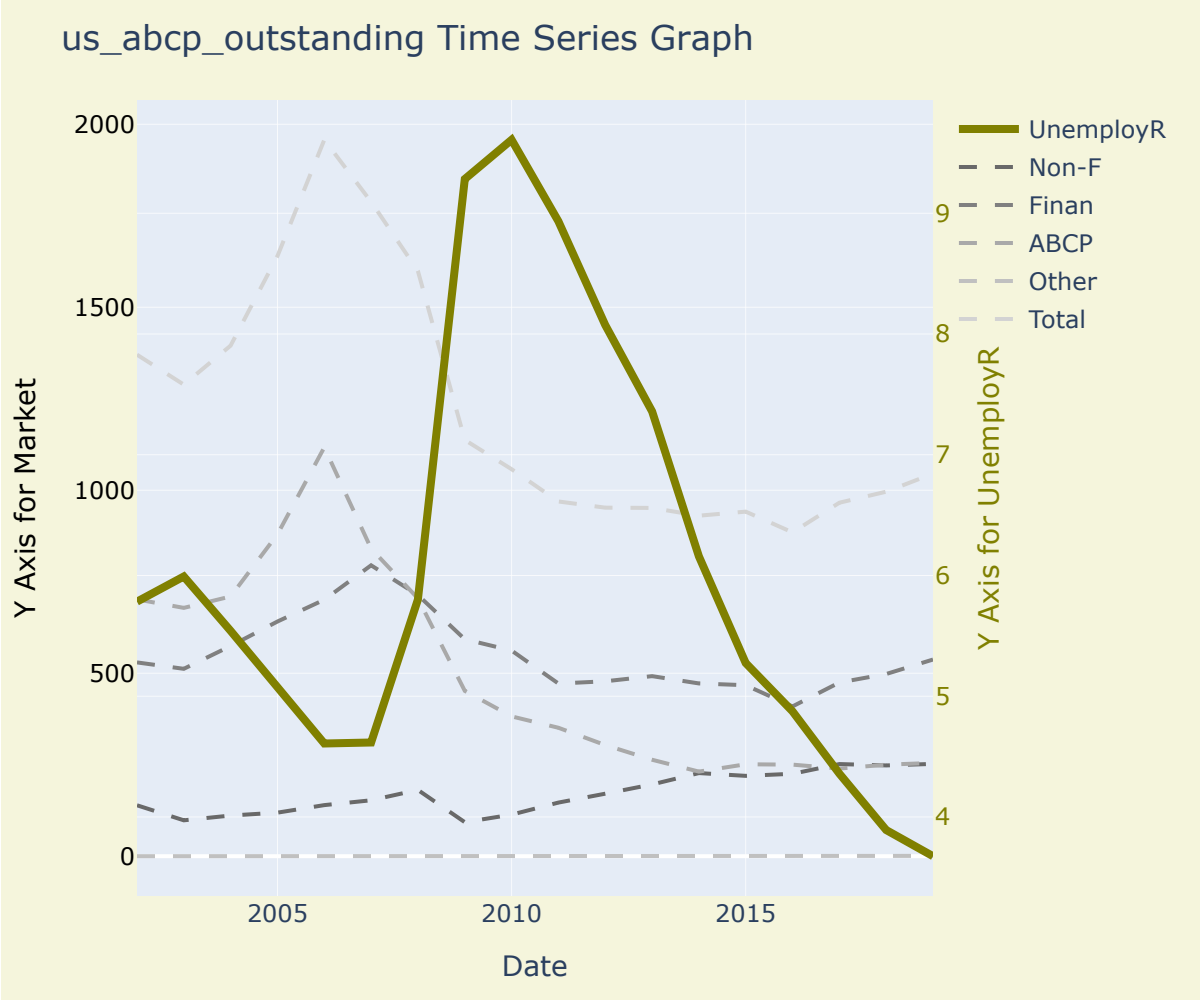

us_fixed_income_issuance Time Series Graph
Y Axis for Market
12k
10k
8k
6k
4k
2k
0
2000
2005
2010
2015
2020
Date
Y Axis for InflaR
4
3
3
2.5
2
1.5
1
0.5
0
InflaR
Treas
Corpo
Munic
Mortg
Total

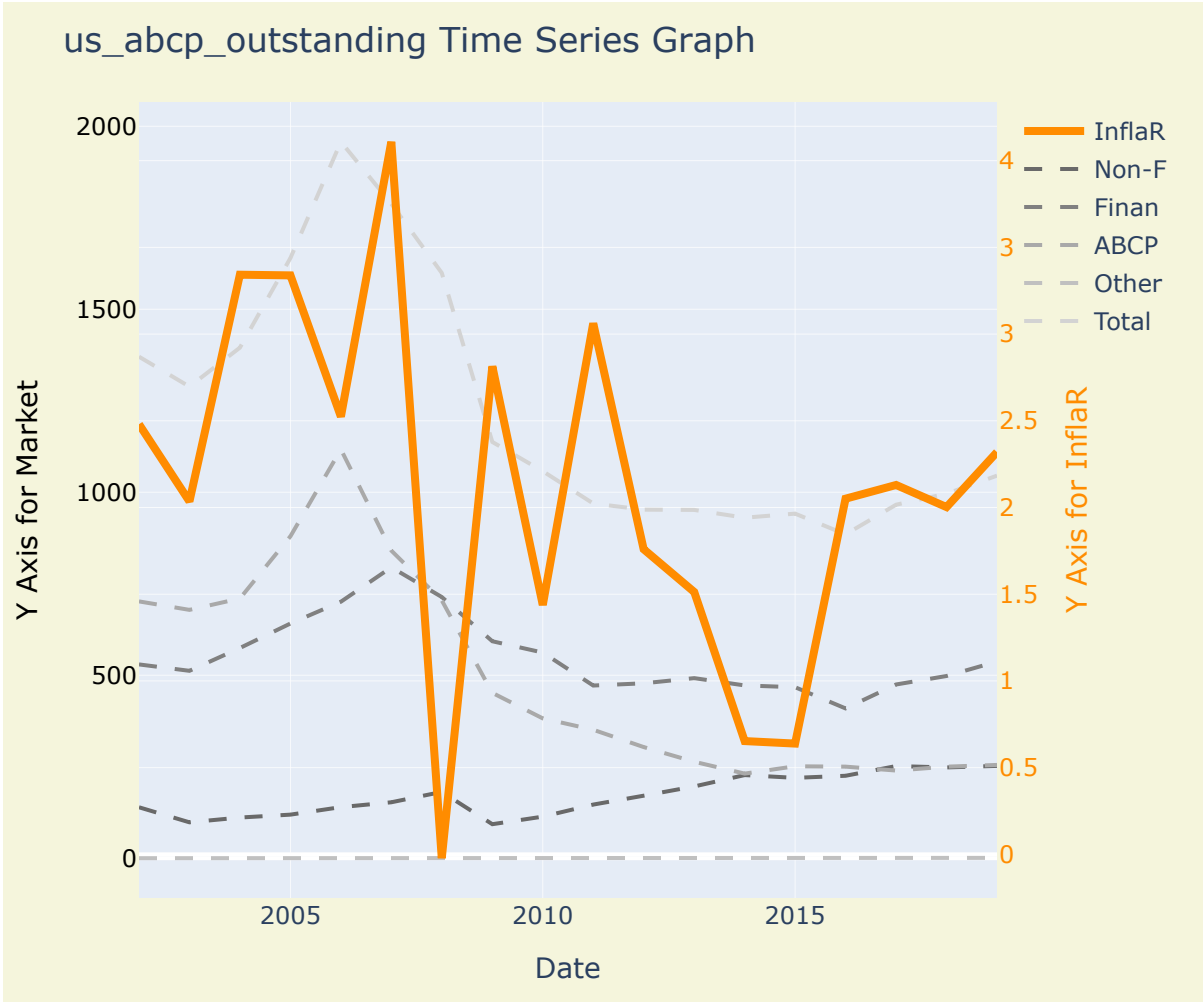

us_fixed_income_outstanding Time Series Graph
Y Axis for Market
50k
40k
30k
20k
10k
0
1980
1990
2000
2010
2020
Date
Y Axis for IntrstR
1
1
1
10
8
6
4
2
0
IntrstR
Treas
Corpo
Munic
Mortg
Total

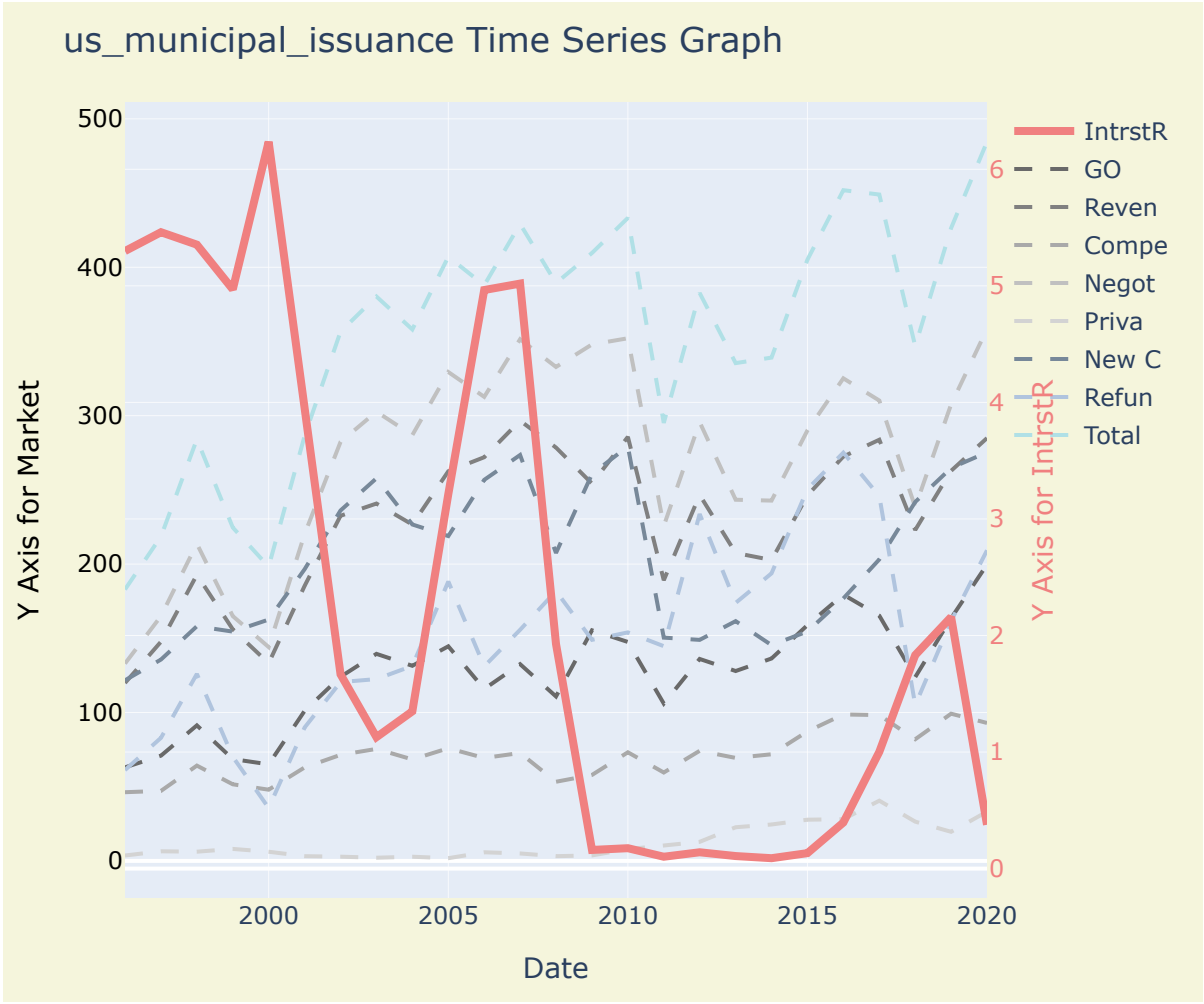

us_fixed_income_outstanding Time Series Graph
Y Axis for Market
50k
40k
30k
20k
10k
0
1980
1990
2000
2010
2020
Date
Y Axis for UnemployR
9
8
7
6
5
4
UnemployR
Treas
Corpo
Munic
Mortg
Total

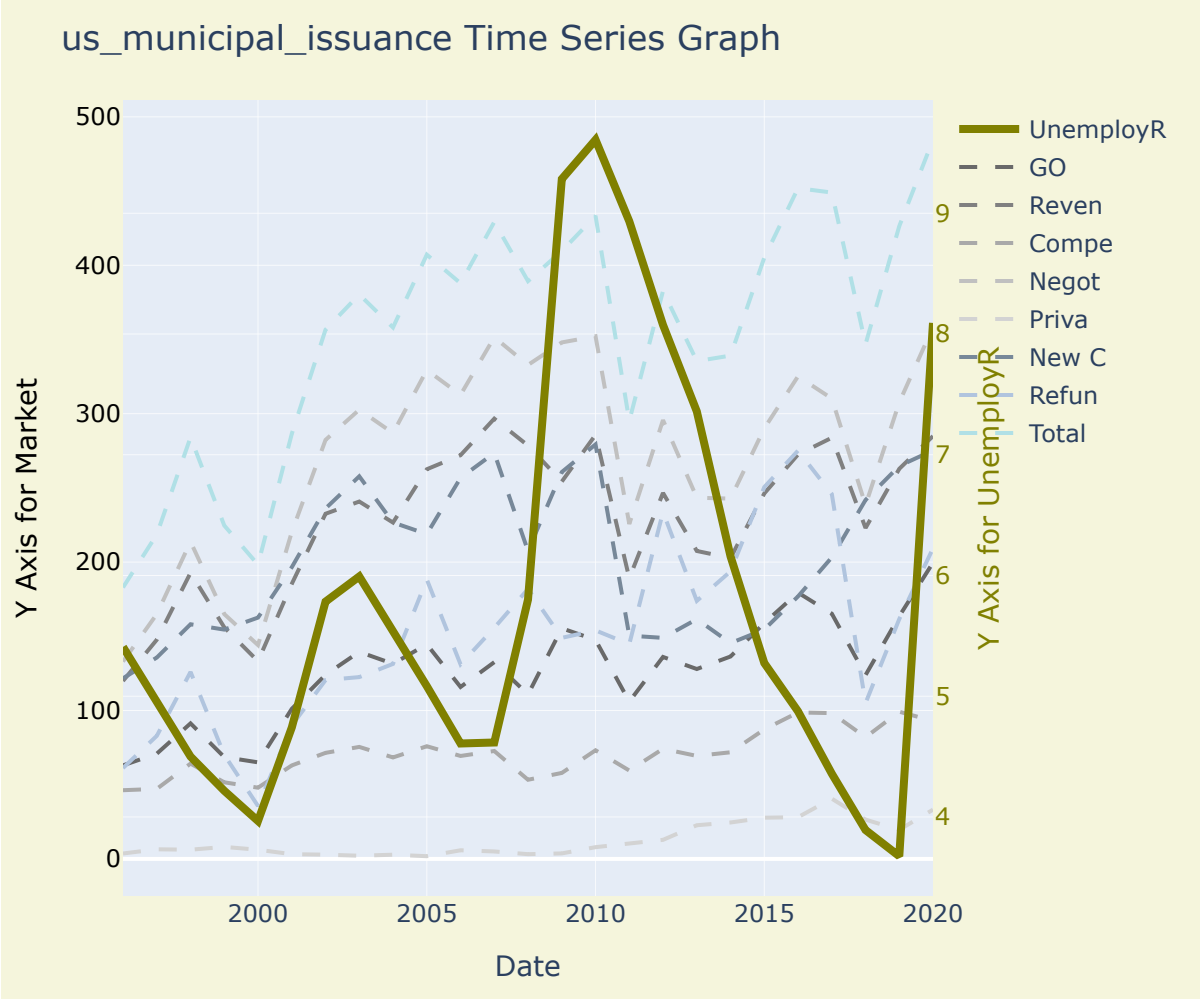

us_fixed_income_outstanding Time Series Graph
Y Axis for Market
50k
40k
30k
20k
10k
0
1980
1990
2000
2010
2020
Date
Y Axis for InflaR
1
1
8
6
4
2
0
InflaR
Treas
Corpo
Munic
Mortg
Total

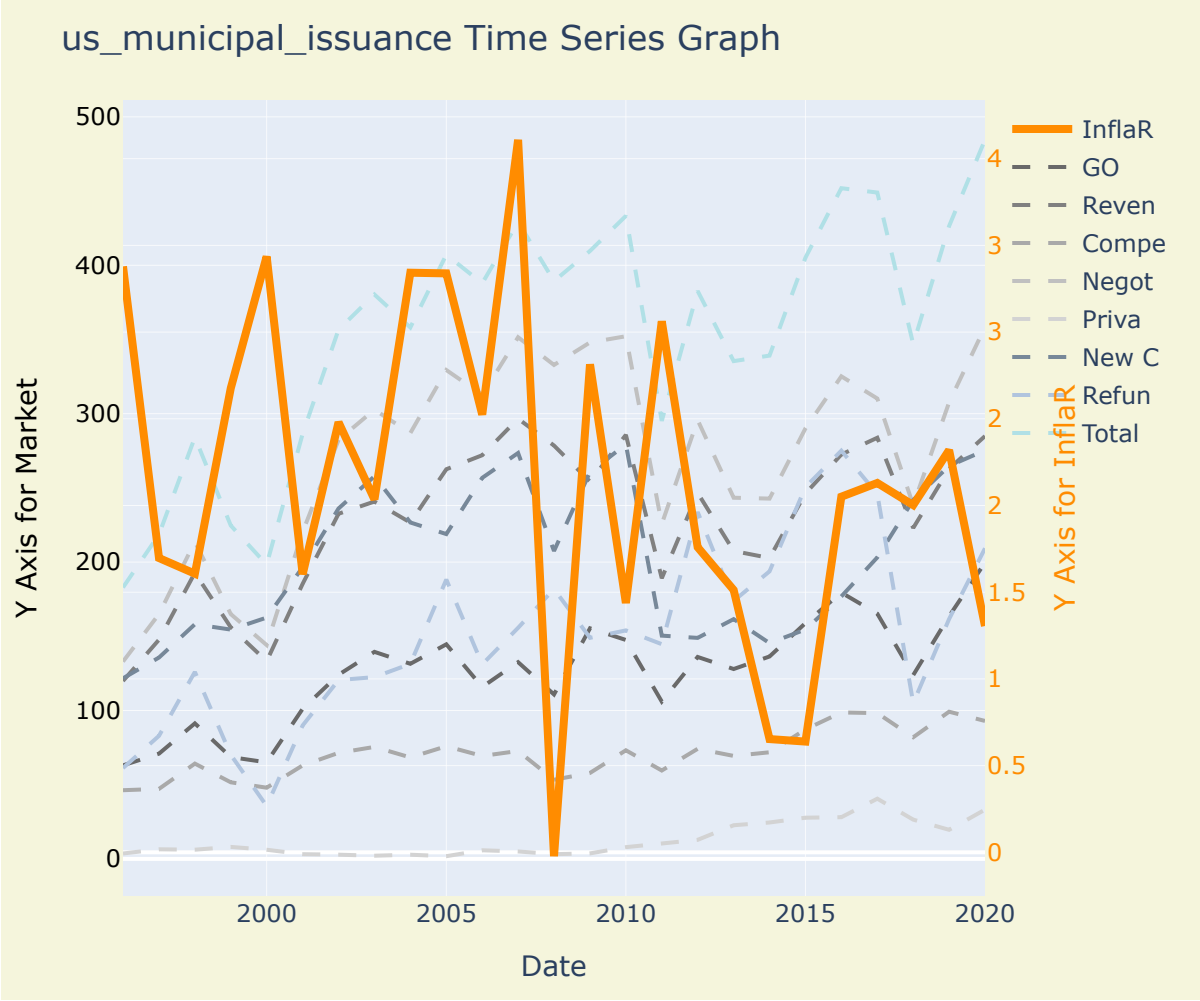

us_abcp_outstanding Time Series Graph
Y Axis for Market
Y Axis for IntrstR
Date
IntrstR
Non-F
Finan
ABCP
Other
Total
2000
1500
1000
500
0
5
4
3
2
1
0
2005
2010
2015

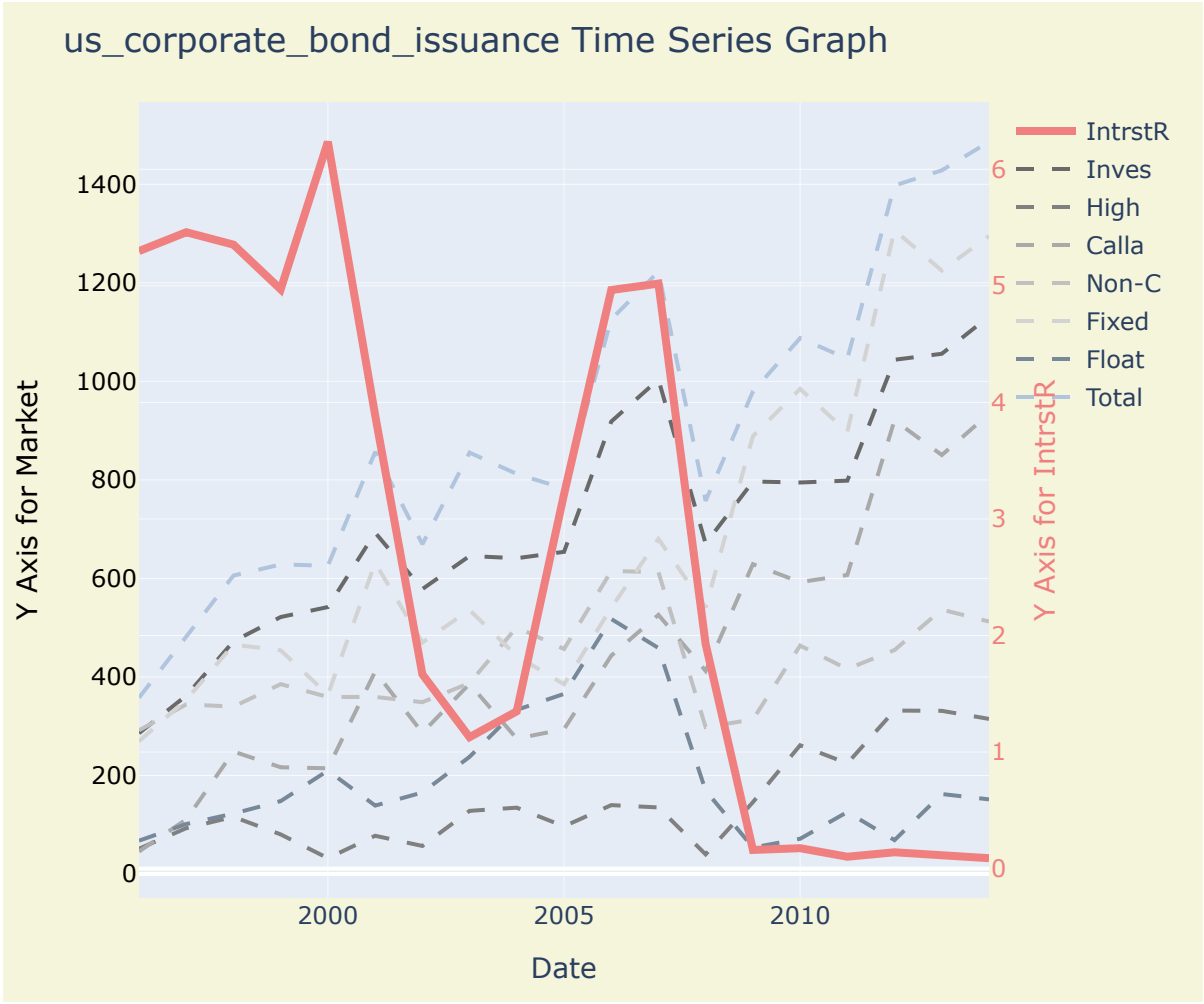

us_abcp_outstanding Time Series Graph
Y Axis for Market
2000
1500
1000
500
0
2005
2010
2015
Date
Y Axis for UnemployR
9
8
7
6
5
4
UnemployR
Non-F
Finan
ABCP
Other
Total

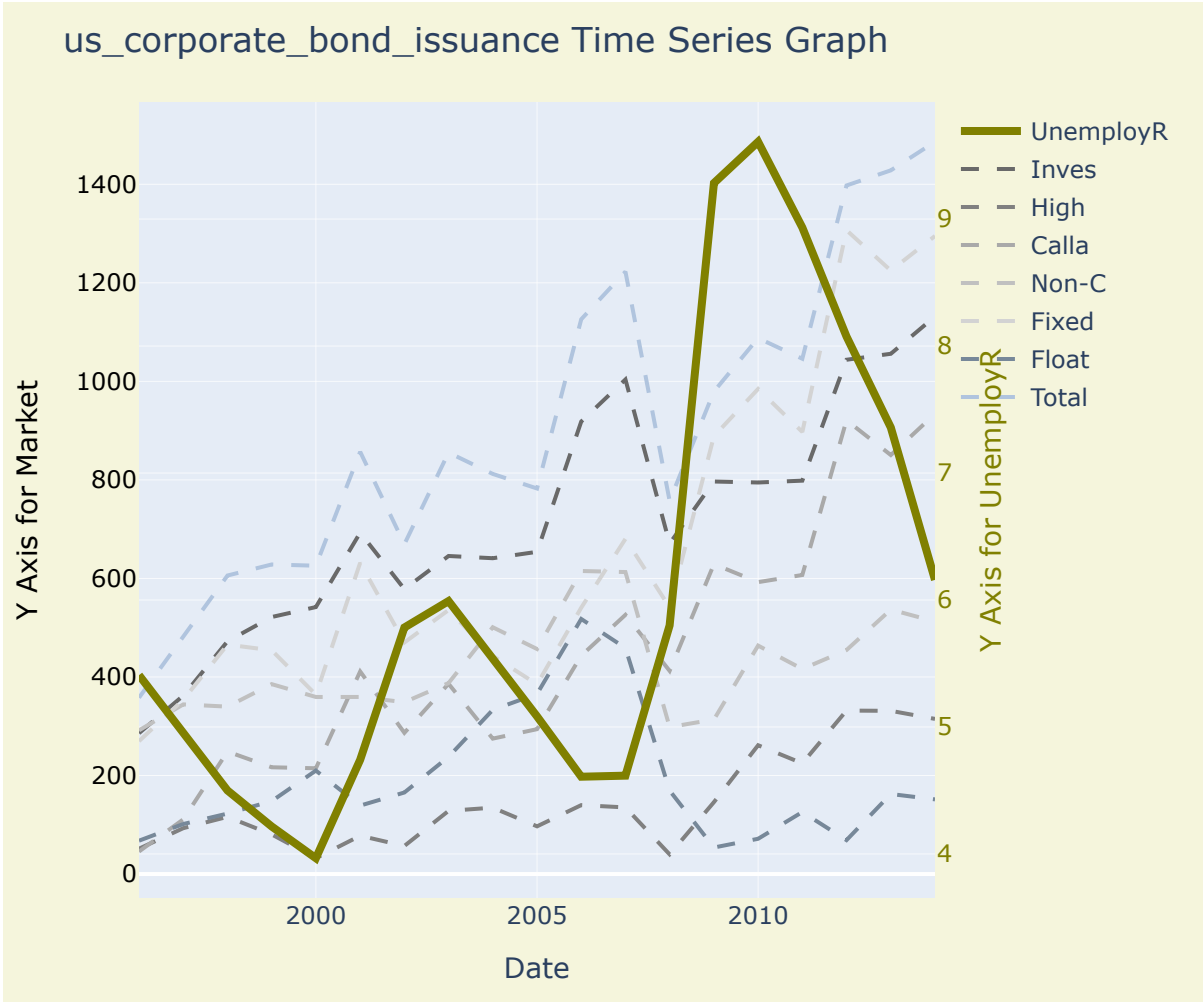

us_abcp_outstanding Time Series Graph
Y Axis for Market
Y Axis for InflaR
Date
InflaR
Non-F
Finan
ABCP
Other
Total
2000
1500
1000
500
0
4
3
3
2.5
2
1.5
1
0.5
0
2005
2010
2015

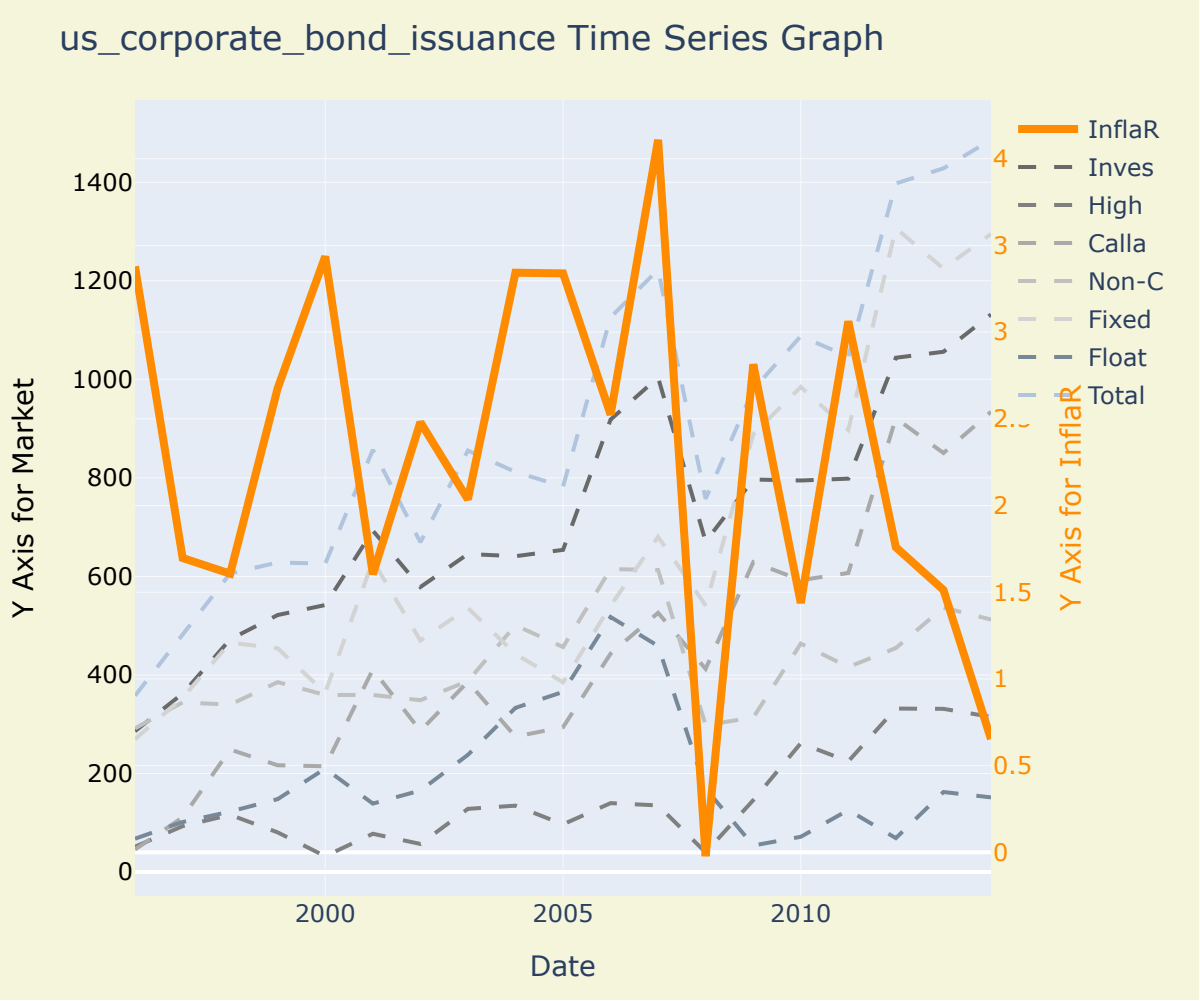

us_municipal_issuance Time Series Graph
Y Axis for Market
Y Axis for IntrstR
Date
IntrstR
GO
Reven
Compe
Negot
Priva
New C
Refun
Total
500
400
300
200
100
0
6
5
4
3
2
1
0
2000
2005
2010
2015
2020


us_municipal_issuance Time Series Graph
Y Axis for Market
Y Axis for UnemployR
Date
UnemployR
GO
Reven
Compe
Negot
Priva
New C
Refun
Total
500
400
300
200
100
0
9
8
7
6
5
4
2000
2005
2010
2015
2020


us_municipal_issuance Time Series Graph
Y Axis for Market
Y Axis for InflaR
Date
InflaR
GO
Reven
Compe
Negot
Priva
New C
Refun
Total
500
400
300
200
100
0
4
3
3
2
2
1.5
1
0.5
0
2000
2005
2010
2015
2020


us_corporate_bond_issuance Time Series Graph
Y Axis for Market
Y Axis for IntrstR
Date
IntrstR
Inves
High
Calla
Non-C
Fixed
Float
Total
0
200
400
600
800
1000
1200
1400
0
1
2
3
4
5
6
2000
2005
2010


us_corporate_bond_issuance Time Series Graph
Y Axis for Market
Y Axis for UnemployR
Date
UnemployR
Inves
High
Calla
Non-C
Fixed
Float
Total
0
200
400
600
800
1000
1200
1400
4
5
6
7
8
9
2000
2005
2010



Relationship Between Macroeconomic Indicators and Financial Markets (2012-2021)

1. Unemployment Rate and Financial Markets

Treasury Issuance: Treasury issuance follows a similar pattern as unemployment rate, where they all have a peak at around 2003, 2010, and 2020. This indicates that increase in treasury issuance is governments strategy to deal with financial crisis, and increase in

unemployment rate is also a result from financial crisis.

Treasury Outstanding: The unemployment rate's correlation between treasury Issuance is not obvious. However, the slight increase in Treasury outstanding in around 2010 coincides with the peak of unemployment rate.

Treasury Yield: Treasury Yield follows its own decreasing pattern, does not correlate alot with unemployment.

Mortgage Issuance: Mortgage Issuance doesn't seem to have a strong relationship with Unemployment rate

Mortgage Outstanding: Mortgage Outstanding and Unemployment rate do not have a strong correlation

ABS Issuance & Outstanding: The peak in unemployment rate happens at relatively same period as the peal in ABS Outstanding & Issuance. These might all due to the housing boom and the following financial crisis where lots of people lose their jobs.

Fixed Income Issuance & Outstanding: The unemployment rate correlation between fixed income outstanding and fixed income issuance is not obvious. However, the small rise in Fixed income outstanding in around 2010 (financial crisis) coincide with a large peak in unemployment rate, and the drastic increase in outstanding around 2020 (COVID) also coincide with a drastic increase in unemployment rate. This means that increase in unemployment rate and increase in fixed income outstanding are all due to financial crisis.

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2. Inflation Rate and Financial Markets

Treasury Issuance: There is no obvious relationshipb between Inflation rate and Treasury Issuance.

Treasury Outstanding: There is no obvious relationshipb between Inflation rate and Treasury Outstanding.

Treasury Yield: Treasury Yield and Inflation all follows a slight decreasing pattern, since lower inflation leads to lower interest rates, which directly influence Treasury yields. Moreover, during financial crisis, both inflation and tresury tields are likely to fall as a result of increased demand for safe assets.

Mortgage Issuance: There is no obvious relationshipb between Inflation rate and Mortgage Issuance .

Mortgage Outstanding: The peak of inflation coincides with a peak for mortgage outstanding at around 2008, which was closely linked to the housing bubble and the rapid expansion in mortgage lending. The following collapse of the bubble and the financial crisis brought both mortgage outstanding and inflation back down.

ABS Issuance & Outstanding: There is no obvious relationshipb between Inflation rate and ABS Issuance & Outstanding.This indicates that inflation cannot be controlled by government and its fluctuations are not strongly associated with any events, which is hard to predict.

Fixed Income Issuance & Outstanding: There is no obvious relationship between Inflation rate and fixed income issuance & outstanding. This indicates that inflation cannot be controlled by government and its fluctuations are not strongly associated with any events, which is hard to predict.

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3. Interest Rate and Financial Markets

Treasury Issuance: Treasury Issuance seems to be negatively correlated with interest rate because lower interest rates reduce the cost of borrowing, prompting the government to issue more debt. This relationship is particularly obvious during financial crisis, when central banks lower rates to stimulate the economy, and governments increase spending, leading to higher Treasury issuance.

Treasury Outstanding: There is no obvious relationshipb between Interest rate and Treasury Outstanding.

Treasury Yield: Treasury Yield and Interest rate all follows a slight decreasing pattern because they are influenced by the same economic factors and monetary policies. When the central bank cuts interest rates to stimulate the economy, Treasury yields tend to decrease as well, reflecting lower borrowing costs and investors' expectations for slower economic growth.

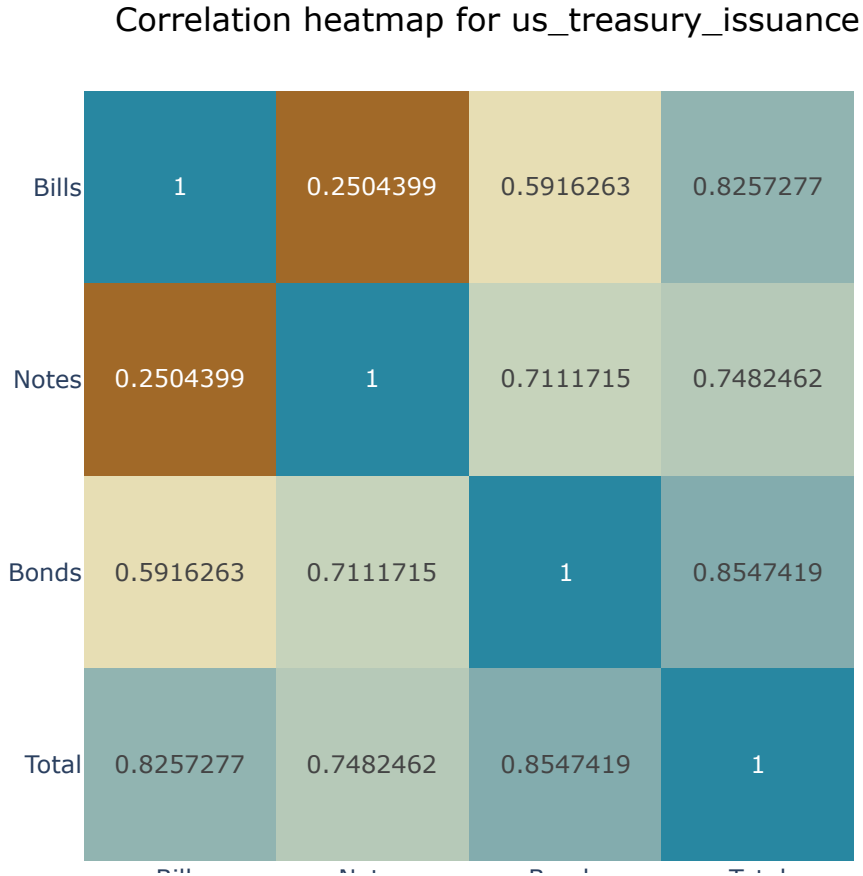
Mortgage Issuance: There is no obvious relationshipb between Interest rate and Mortgage Issuance .

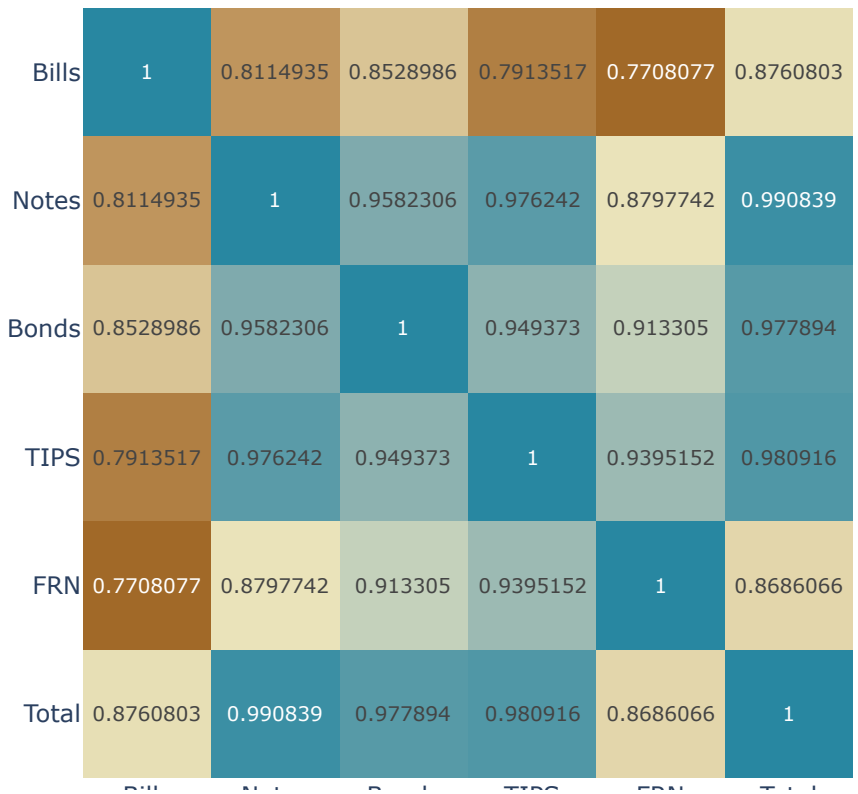
Mortgage Outstanding: The peak of interest rate coincides with a peak for mortgage outstanding at around 2008, which was closely linked to the housing bubble and the rapid expansion in mortgage lending. The following collapse of the bubble and the financial crisis brought both mortgage outstanding and interest rate back down, which means people will try to find safer bonds to invest which draw down the interest rate.

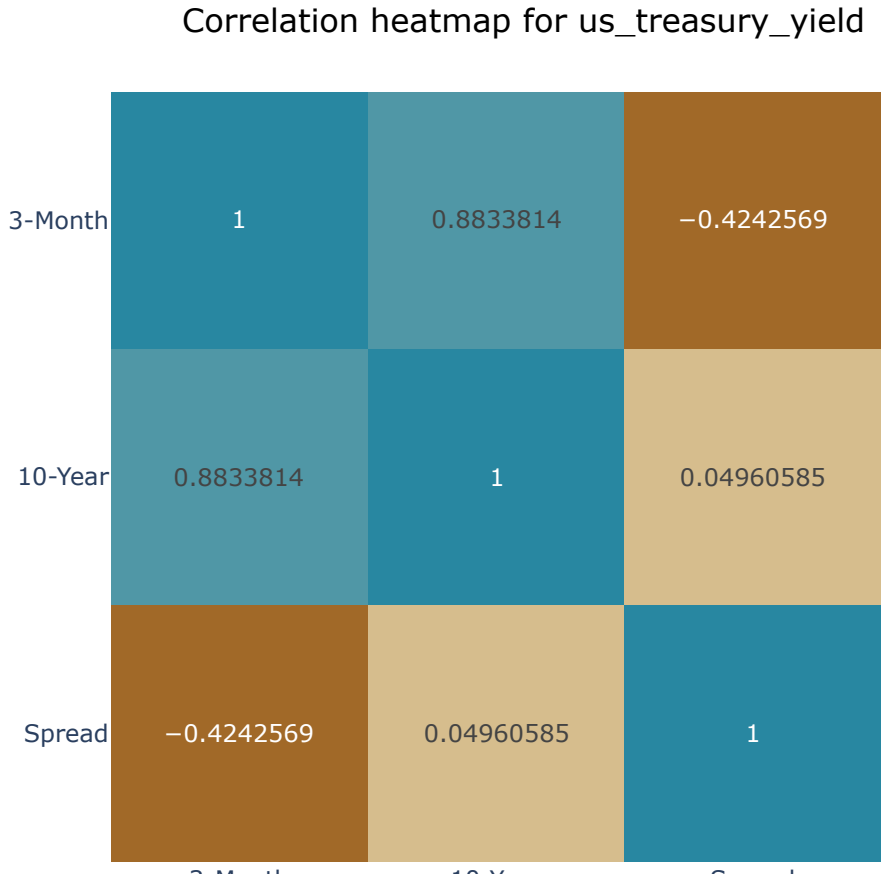
ABS Issuance & Outstanding: There is no obvious relationshipb between Interest rate and ABS Issuance & Outstanding.

Fixed Income Issuance & Outstanding: There is no obvious relationship between Interest rate and fixed income issuance & outstanding.

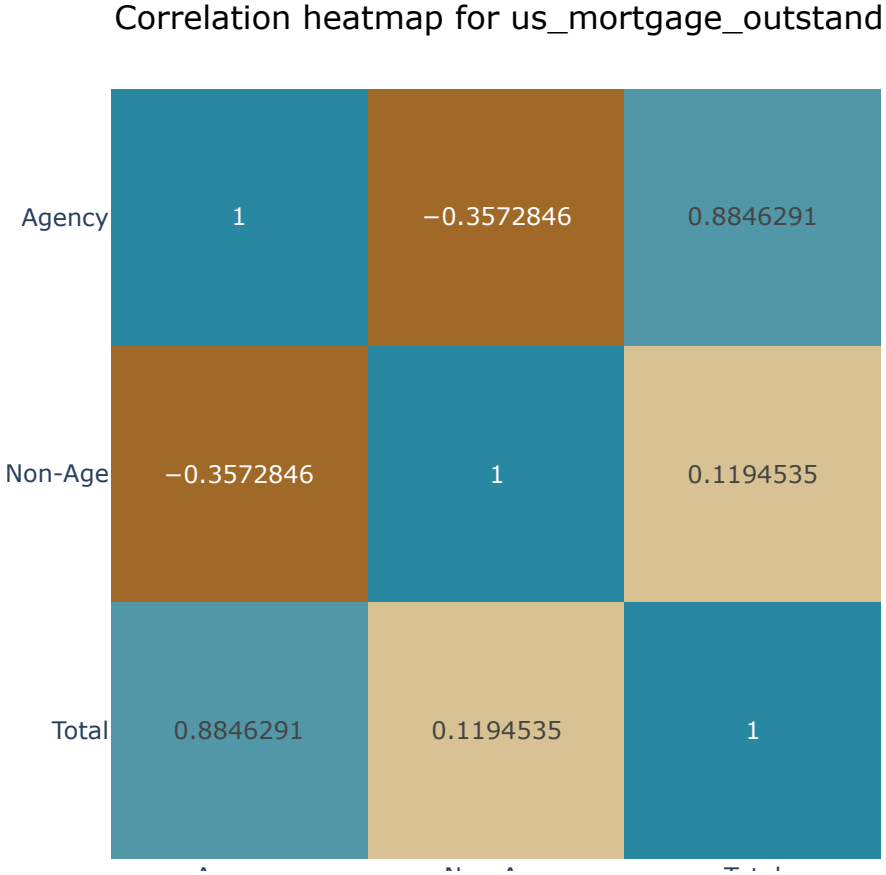
What is the correlation across various securities in that particular market (say across various treasury based on tenor)?

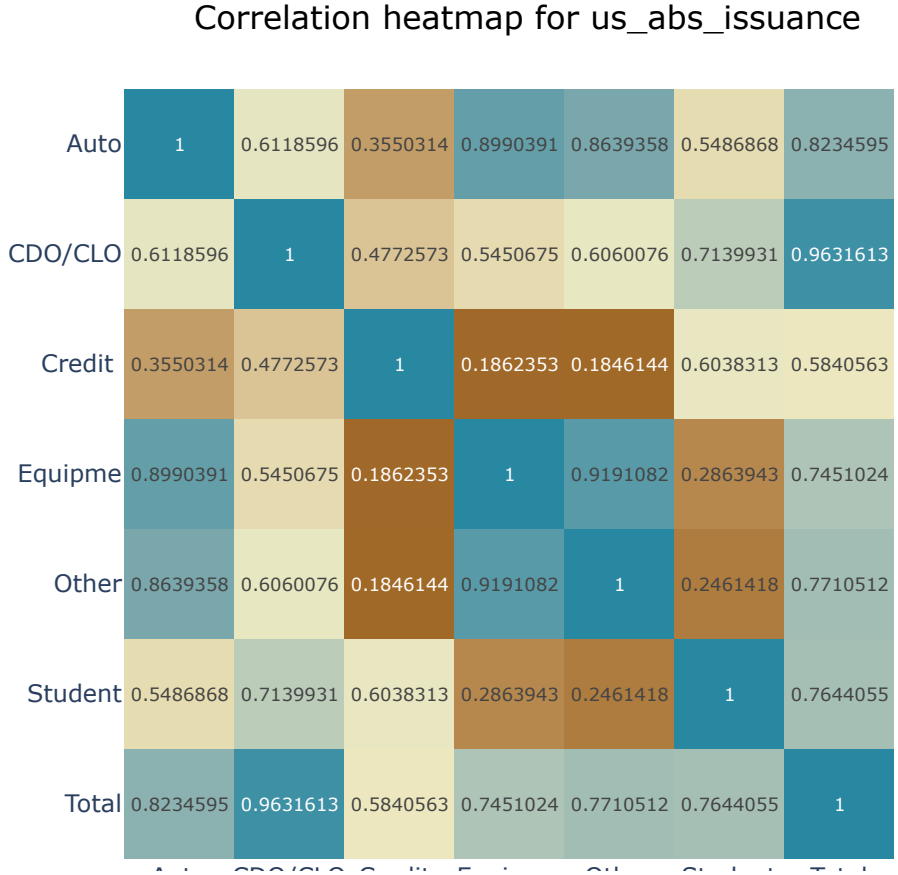

Correlation heatmap for us_treasury_issuance
Bills
Notes
Bonds
Total
1
0.2504399
0.5916263
0.8257277
0.2504399
1
0.7111715
0.7482462
0.5916263
0.7111715
1
0.8547419
0.8257277
0.7482462
0.8547419
1

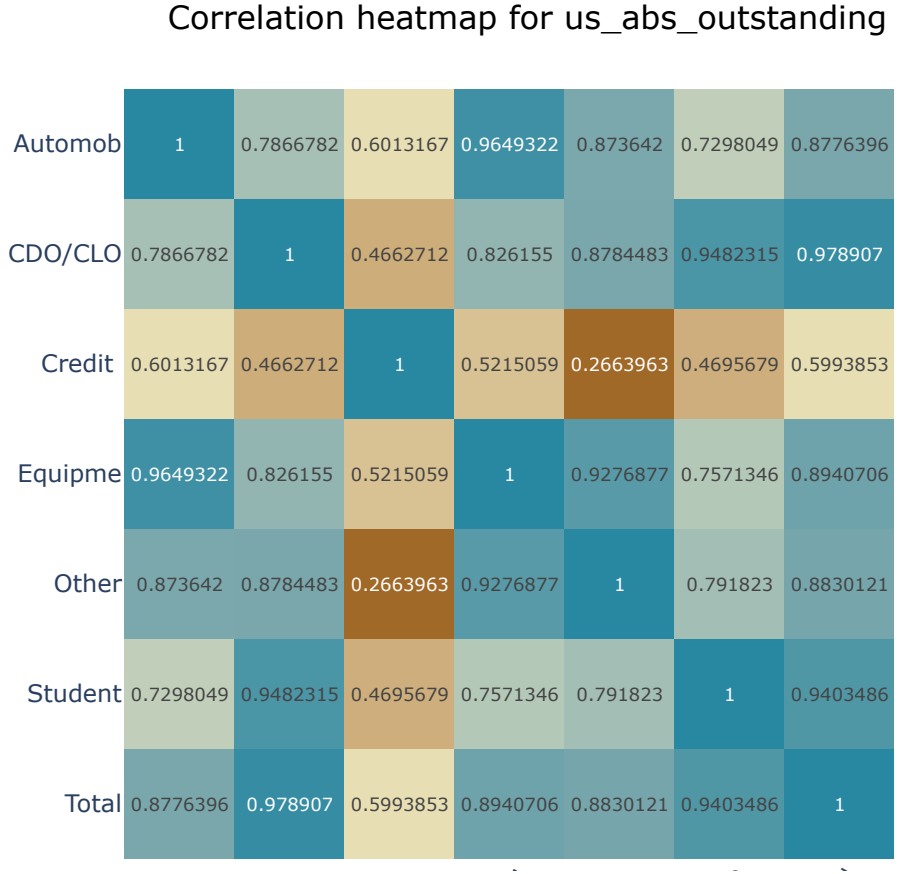

Correlation heatmap for us_treasury_outstanding
Bills
Notes
Bonds
TIPS
FRN
Total
1 0.8114935 0.8528986 0.7913517 0.7708077 0.8760803
0.8114935 1 0.9582306 0.976242 0.8797742 0.990839
0.8528986 0.9582306 1 0.949373 0.913305 0.977894
0.7913517 0.976242 0.949373 1 0.9395152 0.980916
0.7708077 0.8797742 0.913305 0.9395152 1 0.8686066
0.8760803 0.990839 0.977894 0.980916 0.8686066 1

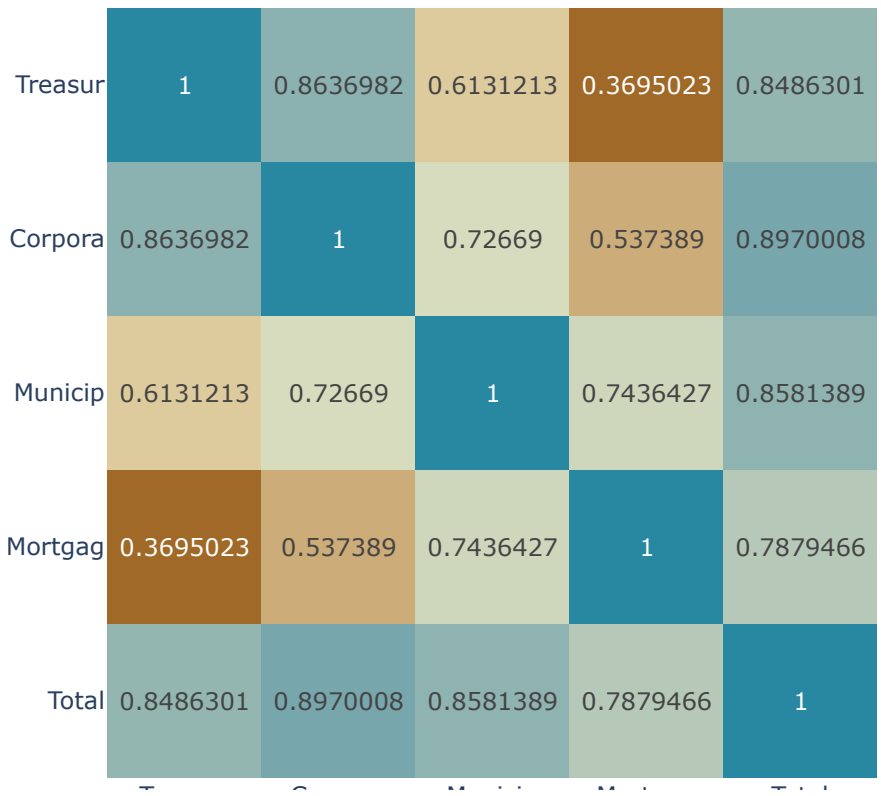

Correlation heatmap for us_treasury_yield
3-Month
10-Year
Spread
1
0.8833814
−0.4242569
0.8833814
1
0.04960585
−0.4242569
0.04960585
1

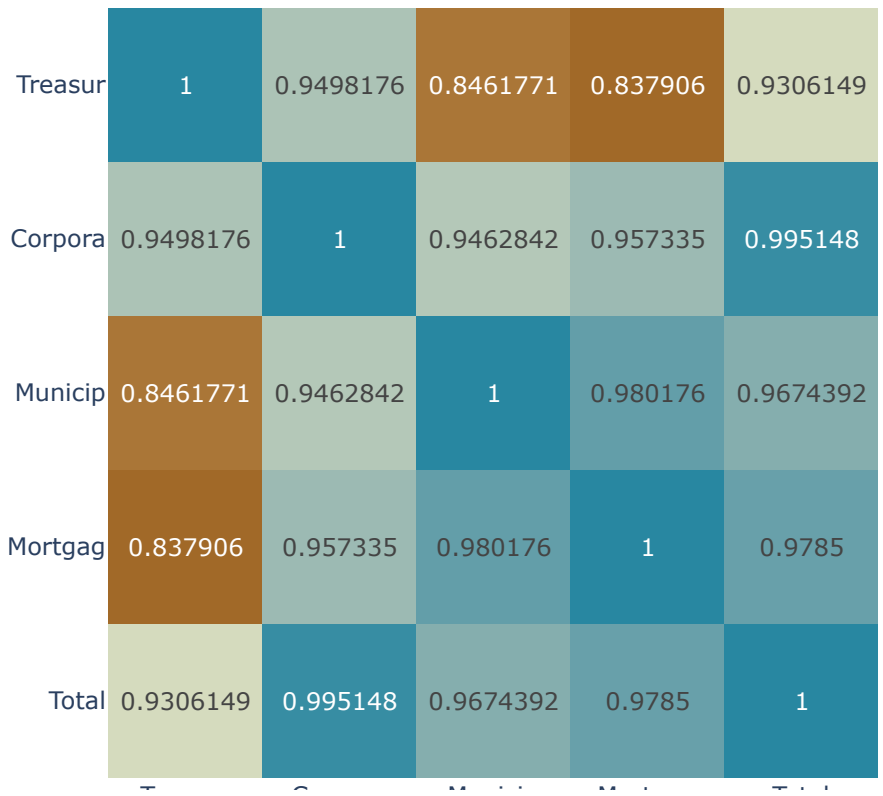

Correlation heatmap for us_mortgage_issuance
Agency
Non-Age
Total
1
−0.05163811
0.8548403
−0.05163811
1
0.4740566
0.8548403
0.4740566
1


Correlation heatmap for us_mortgage_outstanding
Agency
Non-Age
Total
1
−0.3572846
0.8846291
−0.3572846
1
0.1194535
0.8846291
0.1194535
1


Correlation heatmap for us_abs_issuance
Auto
CDO/CLO
Credit
Equipme
Other
Student
Total
1 0.6118596 0.3550314 0.8990391 0.8639358 0.5486868 0.8234595
0.6118596 1 0.4772573 0.5450675 0.6060076 0.7139931 0.9631613
0.3550314 0.4772573 1 0.1862353 0.1846144 0.6038313 0.5840563
0.8990391 0.5450675 0.1862353 1 0.9191082 0.2863943 0.7451024
0.8639358 0.6060076 0.1846144 0.9191082 1 0.2461418 0.7710512
0.5486868 0.7139931 0.6038313 0.2863943 0.2461418 1 0.7644055
0.8234595 0.9631613 0.5840563 0.7451024 0.7710512 0.7644055 1


Correlation heatmap for us_abs_outstanding
Automob
CDO/CLO
Credit
Equipme
Other
Student
Total
1 0.7866782 0.6013167 0.9649322 0.873642 0.7298049 0.8776396
0.7866782 1 0.4662712 0.826155 0.8784483 0.9482315 0.978907
0.6013167 0.4662712 1 0.5215059 0.2663963 0.4695679 0.5993853
0.9649322 0.826155 0.5215059 1 0.9276877 0.7571346 0.8940706
0.873642 0.8784483 0.2663963 0.9276877 1 0.791823 0.8830121
0.7298049 0.9482315 0.4695679 0.7571346 0.791823 1 0.9403486
0.8776396 0.978907 0.5993853 0.8940706 0.8830121 0.9403486 1


Correlation heatmap for us_fixed_income_issuance
Treasur
Corpora
Municip
Mortgag
Total
1
0.8636982
0.6131213
0.3695023
0.8486301
0.8636982
1
0.72669
0.537389
0.8970008
0.6131213
0.72669
1
0.7436427
0.8581389
0.3695023
0.537389
0.7436427
1
0.7879466
0.8486301
0.8970008
0.8581389
0.7879466
1


Correlation heatmap for us_fixed_income_outstanding
Treasur
Corpora
Municip
Mortgag
Total
1
0.9498176
0.8461771
0.837906
0.9306149
0.9498176
1
0.9462842
0.957335
0.995148
0.8461771
0.9462842
1
0.980176
0.9674392
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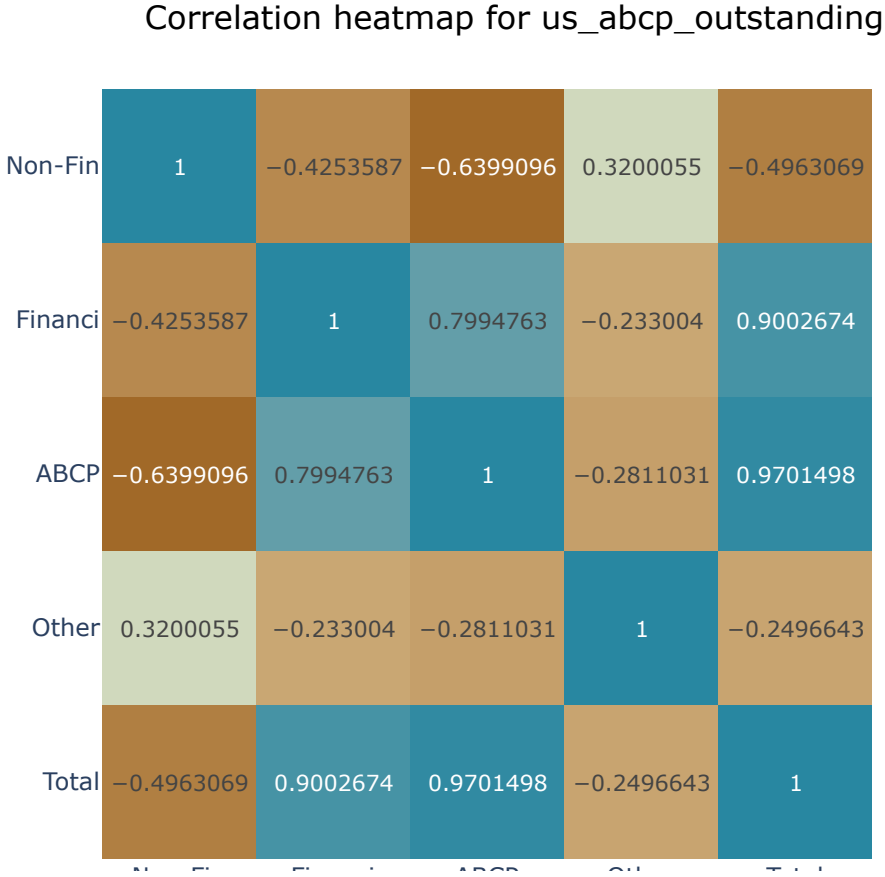
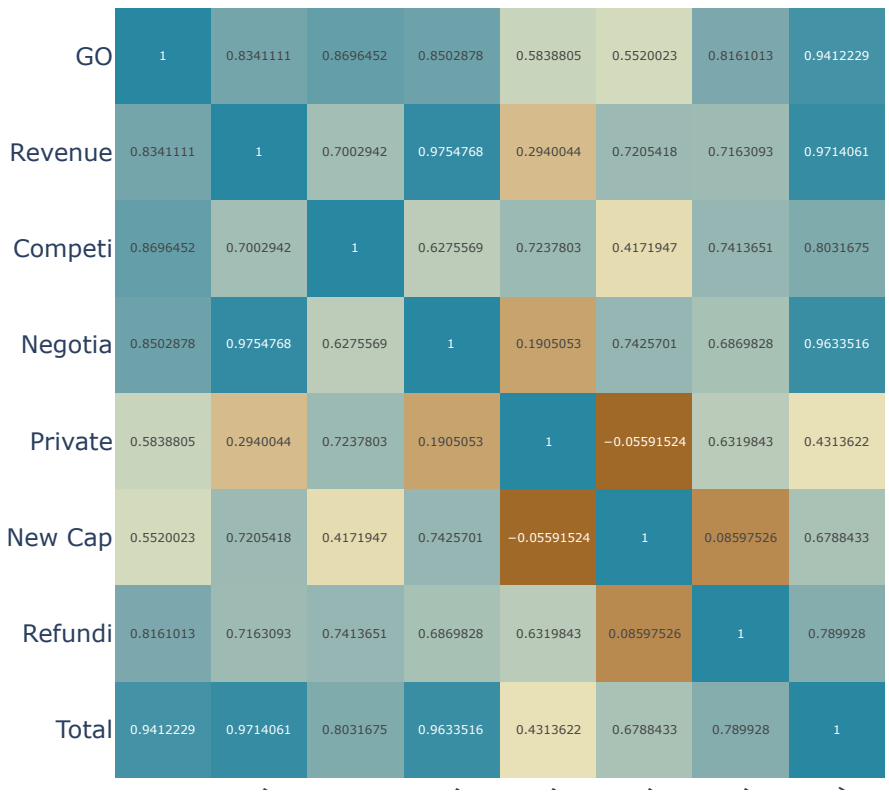
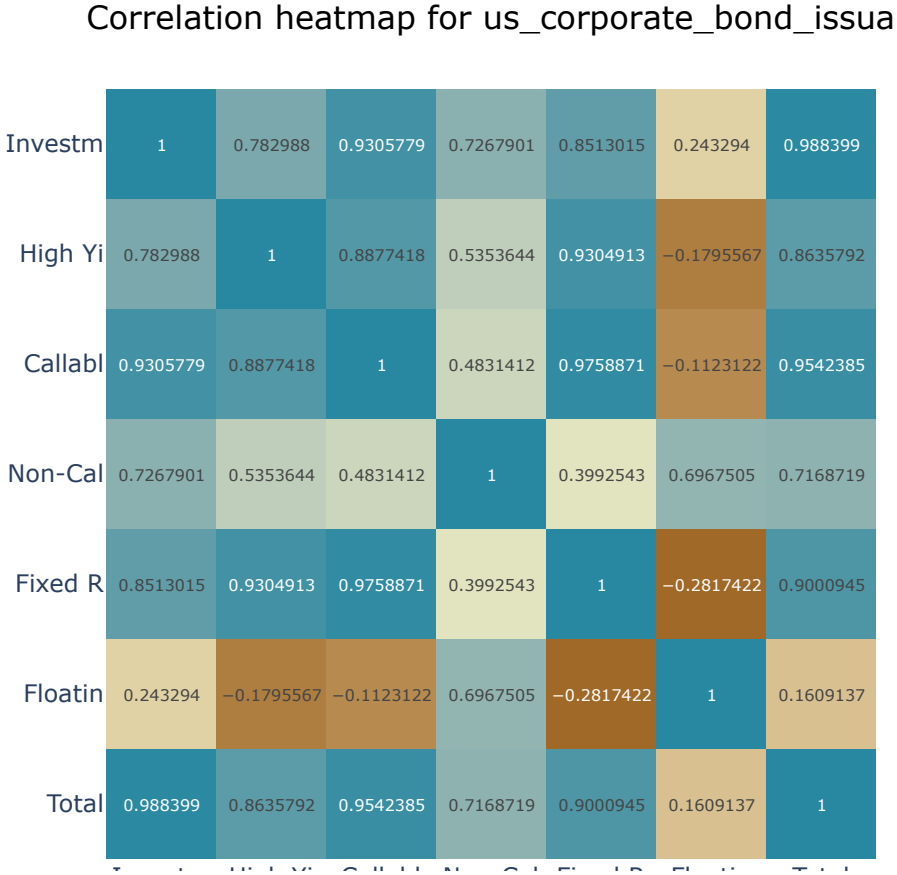
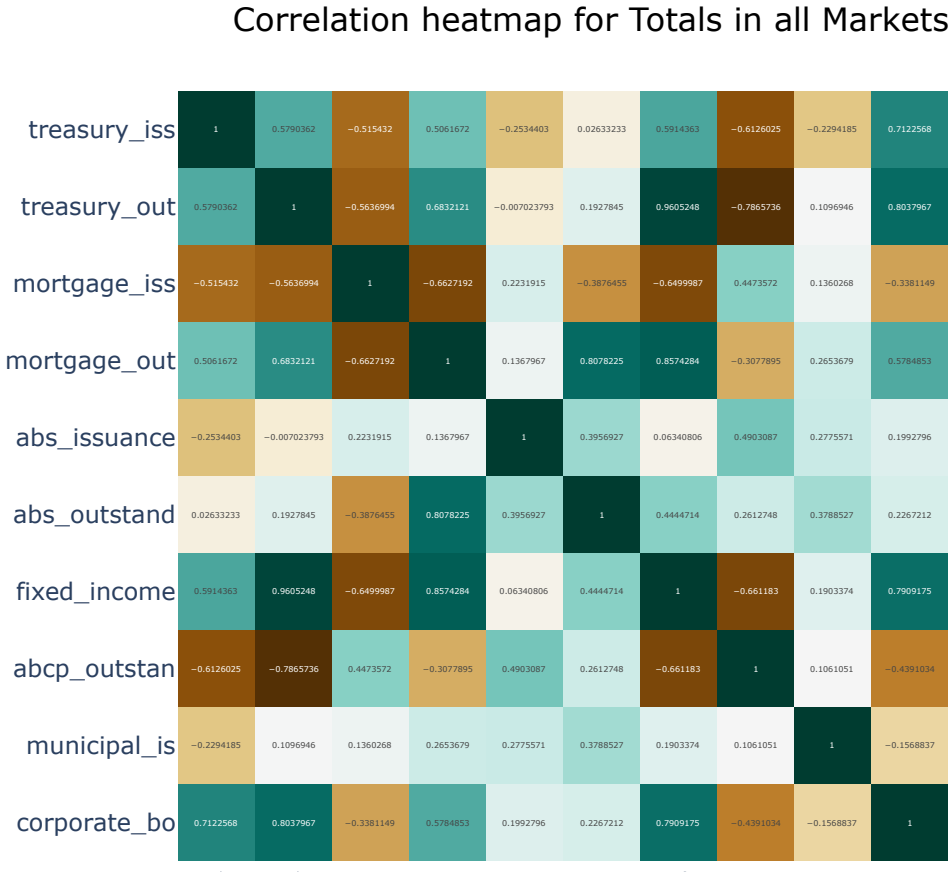
0.9674392
0.9785
1


Correlation heatmap for us_abcp_outstanding
Non-Fin
Financi
ABCP
Other
Total
1
−0.4253587
−0.6399096
0.3200055
−0.4963069
−0.4253587
1
0.7994763
−0.233004
0.9002674
−0.6399096
0.7994763
1
−0.2811031
0.9701498
0.3200055
−0.233004
−0.2811031
1
−0.2496643
−0.4963069
0.9002674
0.9701498
−0.2496643
1


Correlation heatmap for us_municipal_issuance
GO
Revenue
Competi
Negotia
Private
New Cap
Refundi
Total
1 0.8341111 0.8696452 0.8502878 0.5838805 0.5520023 0.8161013 0.9412229
0.8341111 1 0.7002942 0.9754768 0.2940044 0.7205418 0.7163093 0.9714061
0.8696452 0.7002942 1 0.6275569 0.7237803 0.4171947 0.7413651 0.8031675
0.8502878 0.9754768 0.6275569 1 0.1905053 0.7425701 0.6869828 0.9633516
0.5838805 0.2940044 0.7237803 0.1905053 1 −0.05591524 0.6319843 0.4313622
0.5520023 0.7205418 0.4171947 0.7425701 −0.05591524 1 0.08597526 0.6788433
0.8161013 0.7163093 0.7413651 0.6869828 0.6319843 0.08597526 1 0.789928
0.9412229 0.9714061 0.8031675 0.9633516 0.4313622 0.6788433 0.789928 1



What is the correlation in the trading activity across various security markets (consider the aggregate trading volume in each security market for the cross-market correlations)? Discuss your observations



Observations and Analysis on Various Financial Metrics

1. Treasury Issuance Correlations

Observations: Treasury issuance is strongly and positively correlated to corporate bond issuance, and is negatively associated with mortgage issuance and abcp outstanding.

Potential Explanation: Treasury issuance is closely linked to corporate bond issuance because both increase when companies and the government need to borrow more money, especially during times of financial crisis. Treasury issuance is negatively linked to mortgage issuance and ABCP is because that when the government borrows more by issuing Treasuries, it often happens during economic downturns, when there is less demand for mortgages and short-term commercial paper like ABCP.

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2. Treasury Outstanding Correlations

Observations: Treasury Outstanding is strongly and positively correlated to fixed income outstanding and also is negatively associated with abcp outstanding.

Potential Explanation: Treasury Outstanding is strongly and positively correlated with fixed income outstanding because both involve large amounts of government and corporate debt. Treasury Outstanding is negatively associated with ABCP outstanding because when investors prefer the safety of Treasuries, especially during economic uncertainty, they might move away from riskier short-term investments like ABCP, causing a decrease in ABCP outstanding.

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3. Mortgage Issuance Correlations

Observations: Mortgage Issuance is negatively associated with Mortgage Outstanding and Fixed Income Issuance.

Potential Explanation: When interest rates are low, more people take out new mortgages, leading to higher issuance. However, the total mortgage outstanding might decrease as older mortgages are paid off or prepaid off. At the same time, if more funds are going into new mortgages, less money might be invested in other fixed income products, causing their issuance to drop.

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4. Mortgage Outstanding Correlations

Observations: Mortgage Outstanding is positively associated with fixed income issuance and abs outstanding. However, it is negatively correlated with Mortgage issuance.

Potential Explanation: More mortgages lead to growth in fixed income market and abs markets, so that their issuance or outstanding will increase.

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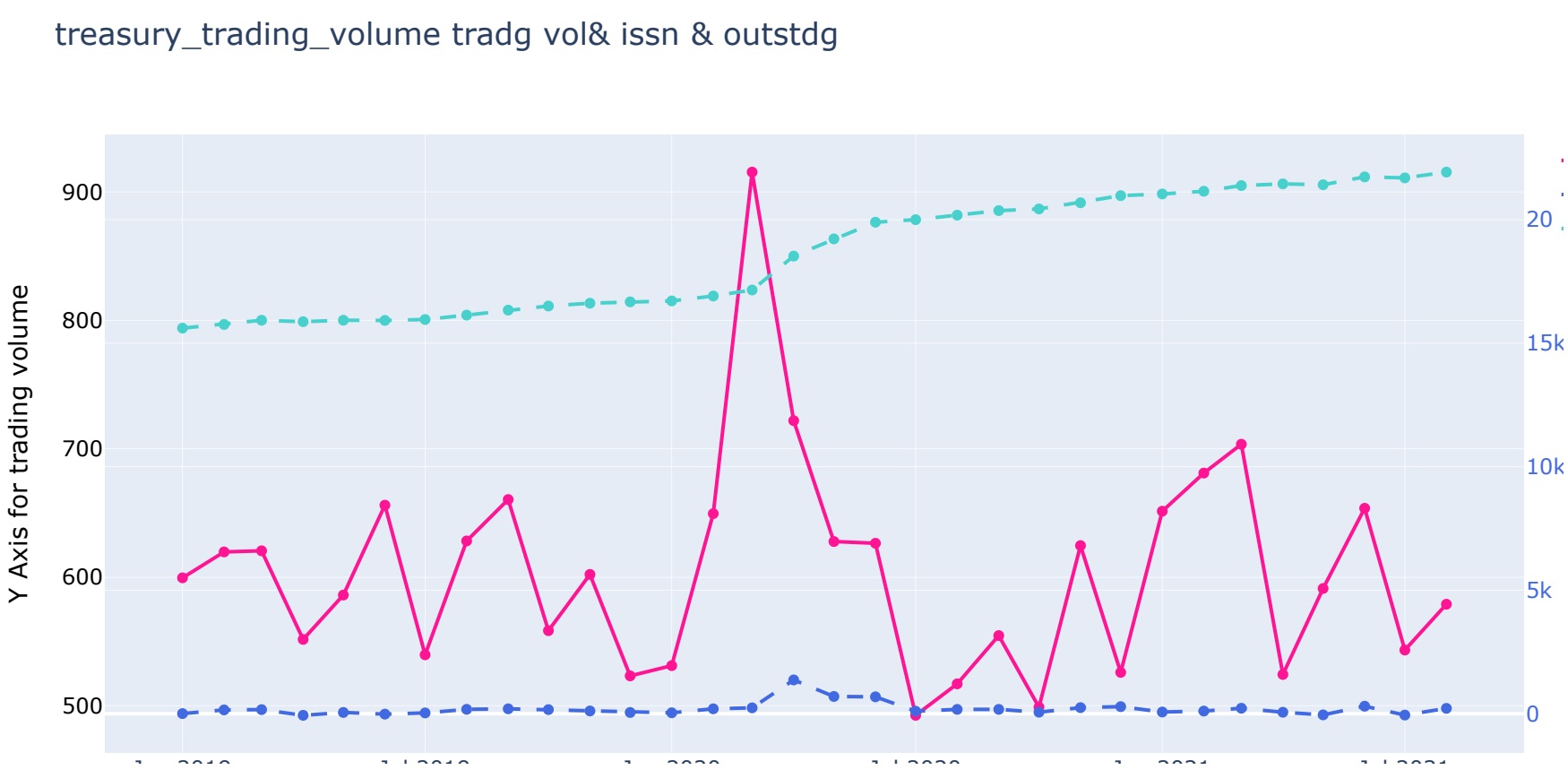
5. ABS Issuance Correlations

Observations: ABS issuance does not have a strong correlation with any other financial metrics.

Potential Explanation: Since ABS is influenced by specific factors rather than broad economic indicators, it is more independent and less tied to general financial trends.

Plot the issuance and outstanding for each market against the trading volume in that market. Discuss your observations briefly

- I will use the monthly data of issuance or/and outstanding to compare with trading volume, since trading volume is a monly variable in part I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Y Axis for trading volume
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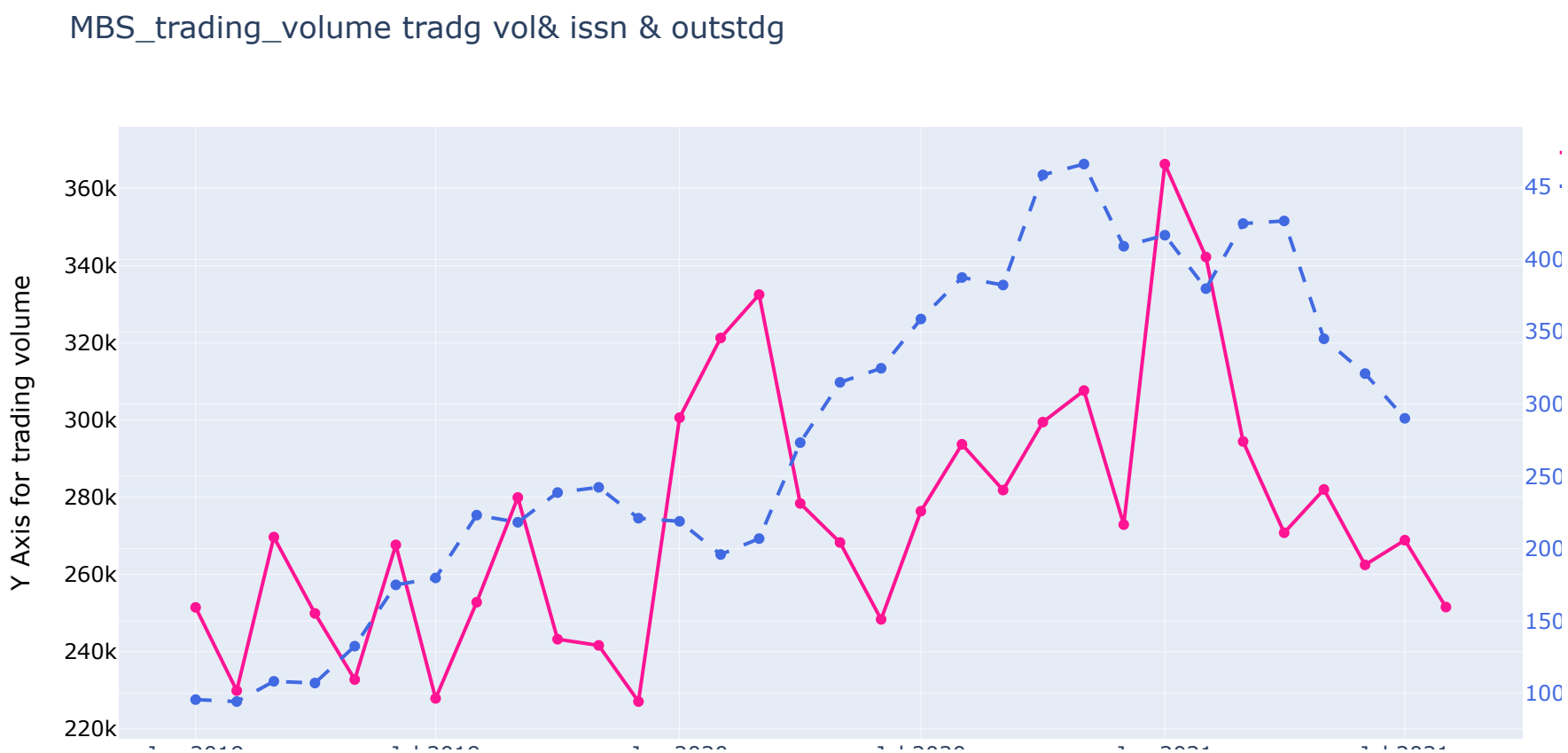
800
700
600
500
20
15k
10k
5k
0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Y Axis for trading volume
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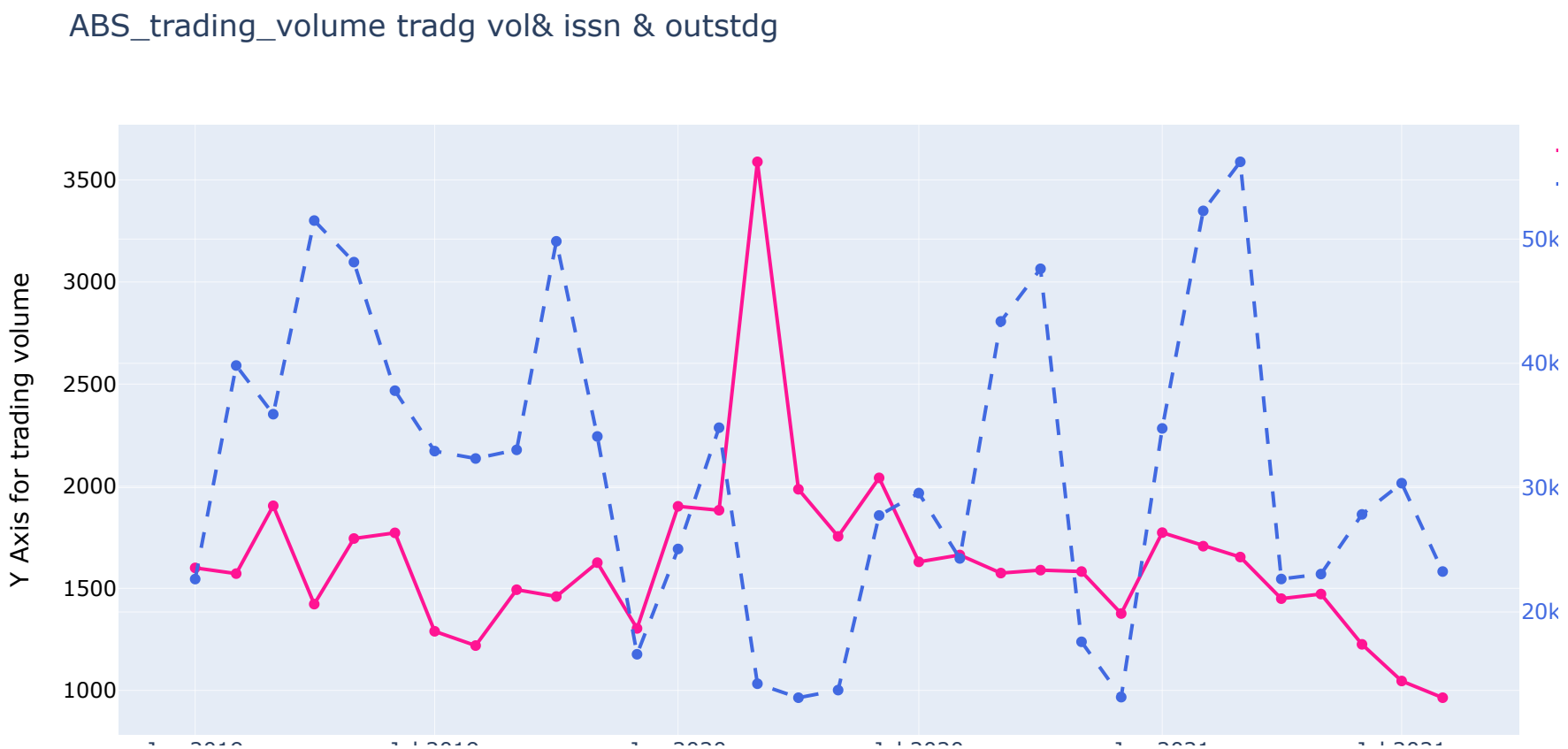
320k
300k
280k
260k
240k
220k
45
400
350
300
250
200
150
100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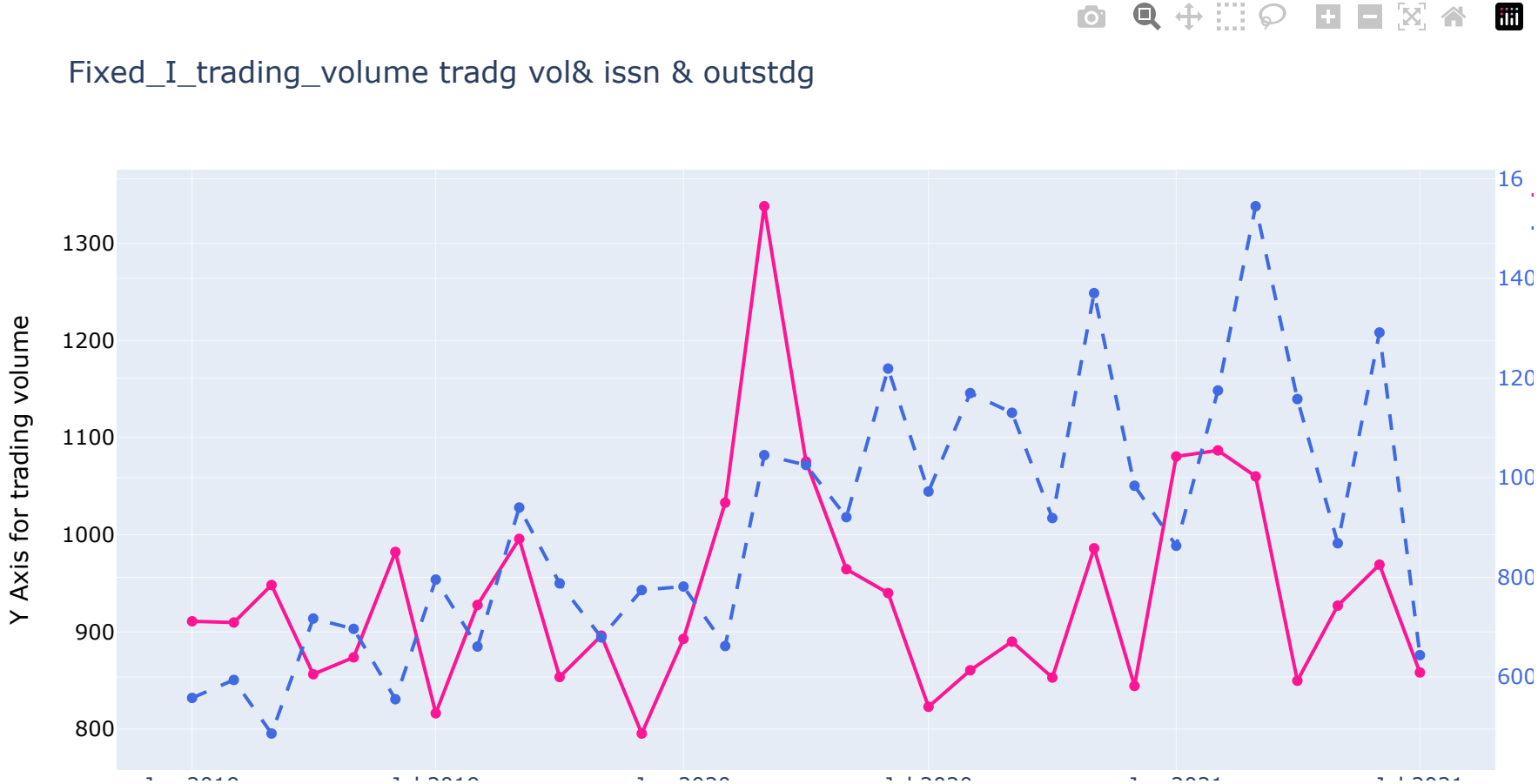
2500
2000
1500
1000
50k
40k
30k
20k


Fixed_I_trading_volume tradg vol& issn & outstdg
Y Axis for trading volume
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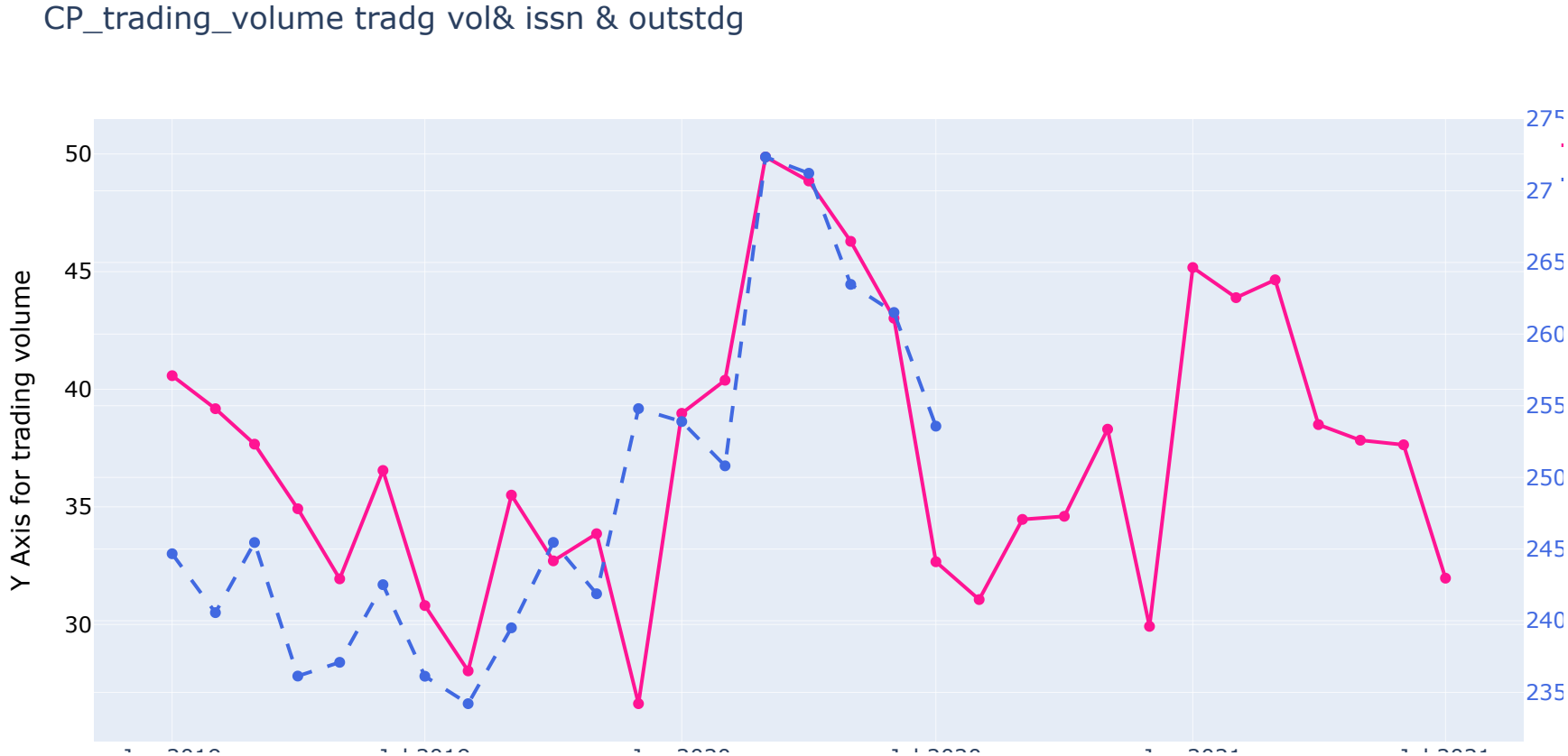
1200
1100
1000
900
800
16
140
120
100
800
600


CP_trading_volume tradg vol& issn & outstdg
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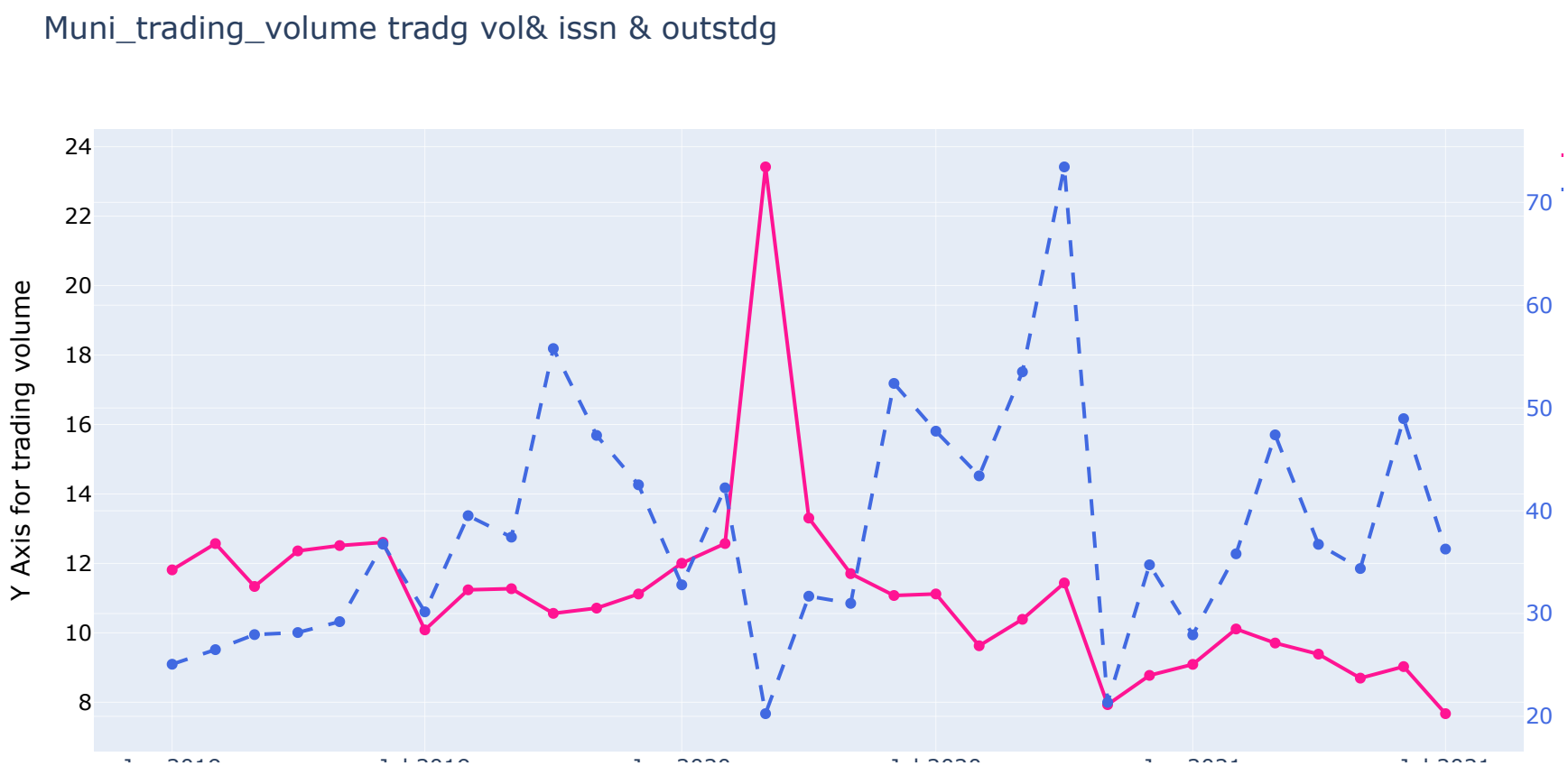
255
250
245
240
235


Muni_trading_volume tradg vol& issn & outstdg
Y Axis for trading volume
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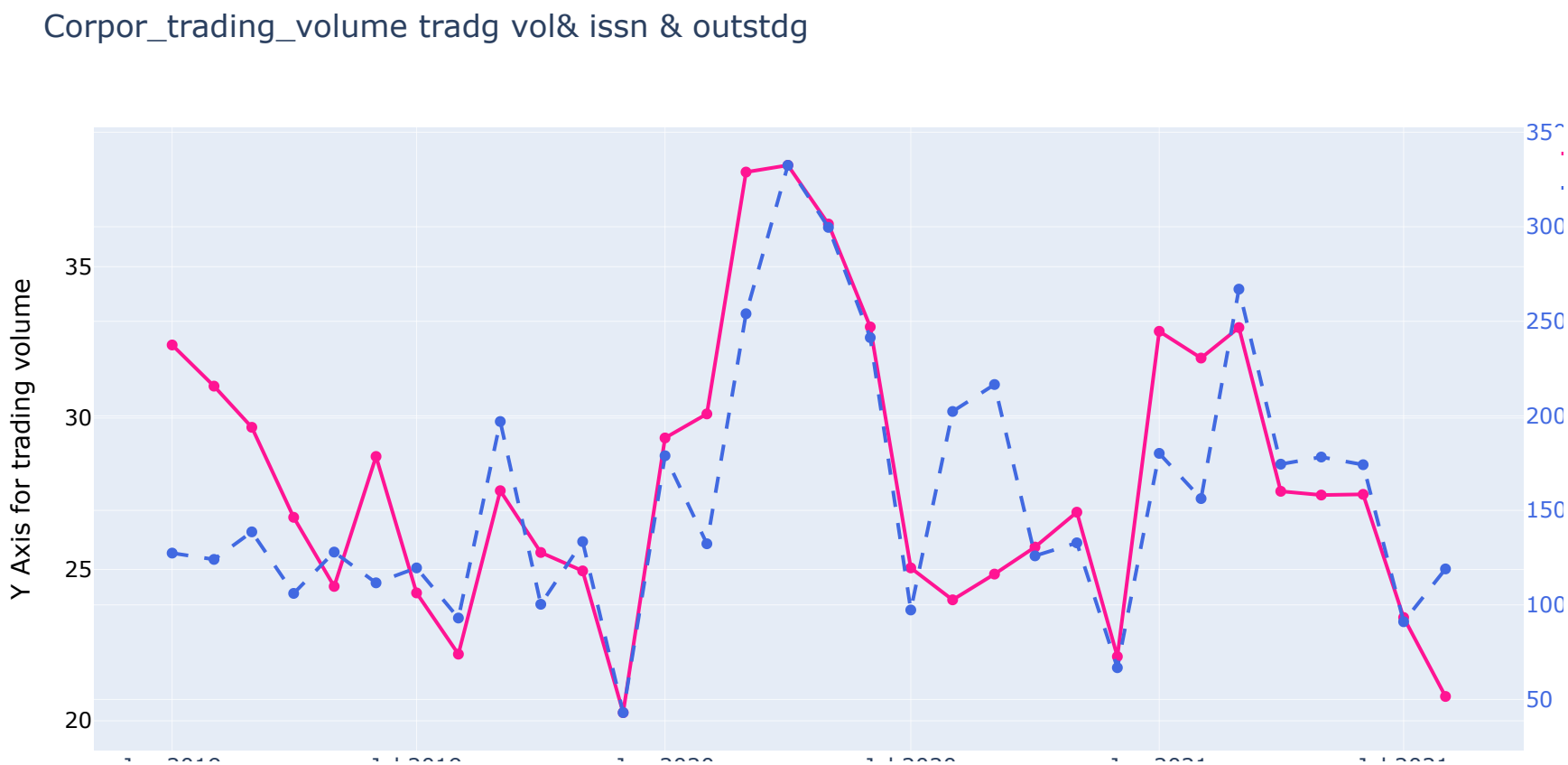
20
18
16
14
12
10
8
70
60
50
40
30
20



Observations

US Marketable Treasury trading Volume, Issuance, and Outstanding:

- The Outstanding distributive far above Issuance while the trading volume mainly fluctuating between outstanding and issuance. There is no obvious relationship between these three variables

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US MBS Issuance and trading volume:

- There is no obvious similar pattern between trading volume and issuance. Howeverm both issuance and trading volume have a slight increasing trend.

US ABS Issuance and trading volume:

- The issuance and trading volume seems to have a reverse correlation since the peak of trading volume coincides with the minimum of issuance and during the period with low trading volume, the issuance is still high. However, both issuance and trading volume fluctuating drastically.

US Fixed Income Issuance and trading volume:

- Issuance has a slight increasing pattern, while it has no obvious correlation between trading volume.

US ABCP and CP Outstanding:

- Trading volume and Outstanding are highly correlated, following almost the same pattern. However, more data is needed to justify such claim.

US Municipal Issuance:

- Issuance and trading volume have a slight reverse relationship, but there is no other obvious pattern.

US Corporate Bond Issuance:

- Trading volume and Issuance are highly correlated, following highly similar pattern over 2019 to 2021, indicating that the trading volume might mainly decided by the amount of issuance.
