

IAT 814 - VISUALIZATION AND VISUAL ANALYTICS

A HISTO-GEOGRAPHICAL DASHBOARD OF STOCK TRENDS



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1. Motivation & Introduction

In today's time, almost all stock market graphs indicate trends of a stock over time, however none tie them up with major historical timelines that have caused major fluctuations in the value of the stock. This is the challenge we are trying to address, and we aim to support the stockholders (retail investors) and shareholders, understand the impact various events have on the value of the stock to make decision making easier. This project uses a timeline of major global historical events and ties them up with dashboards that house multiple visualizations that shed light on several metrics associated with stock markets.

In the project, we have maintained multiple dashboards to analyze how stock markets are affected by geo-political events. We have taken different types of metrics for the end-user to better understand the data better and conclude his research on the topic. The metrics include change % over the event, steepest drop in stock, steepest drop from start of the event and we have also pre-processed days the stock declined and recovery period.

The dashboards will help us interactively to understand the changes in stock value that happened during these major events. We can traverse between Global and regional to understand the difference at a Global or country level.

Stock Market Dashboard URL

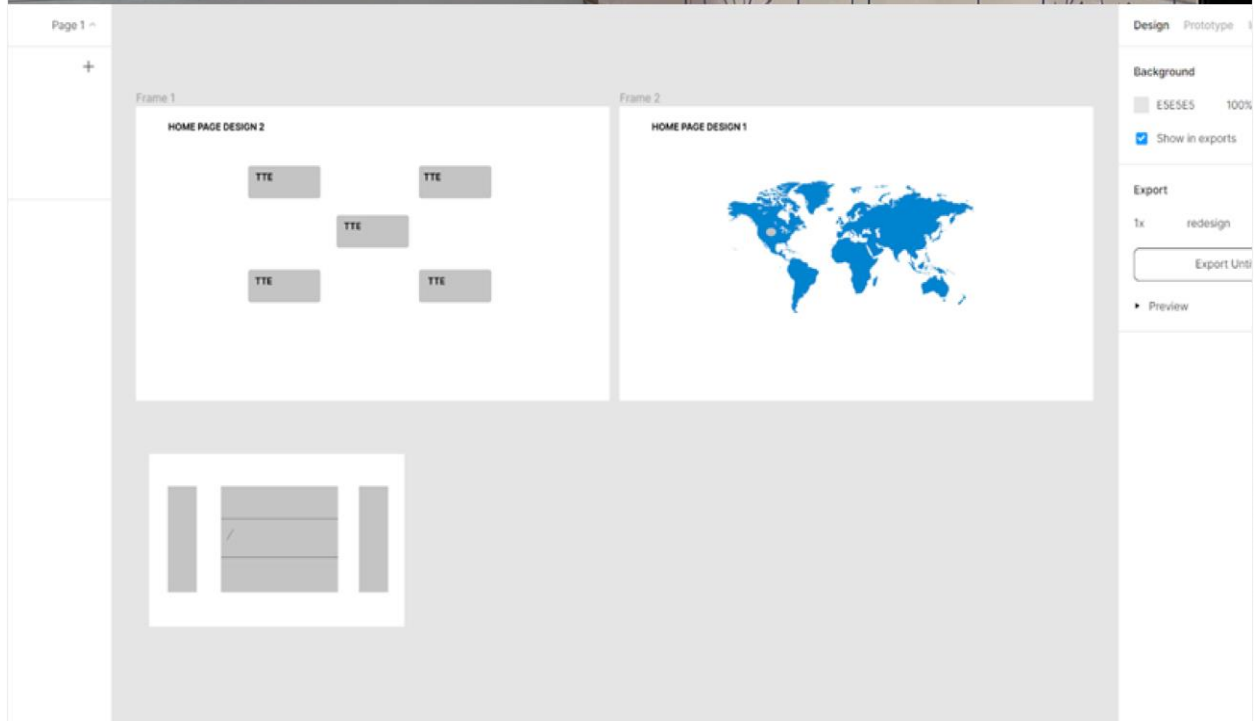
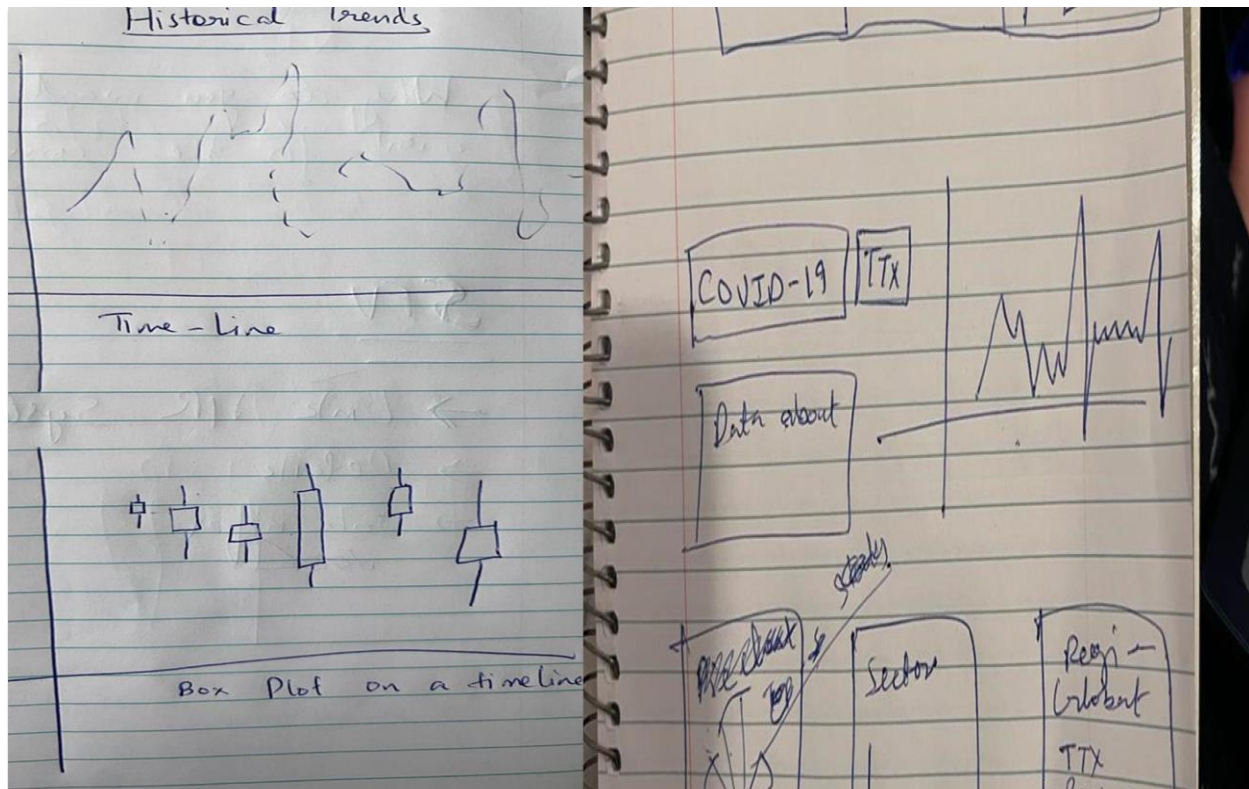
<http://137.184.232.99:4000/>

Goal and Target Audience

The main goal of the project is to establish a tie up between historical events and their impacts on the stock market fluctuations. This in turn will be crucial to new investors/stakeholders helping them make informed financial decisions in the face of an unexpected global economic event. The target stakeholders include:

- **Pre-Investors** - IPO based investors can investigate historical data of Exchanges and understand how a new stock has performed.
- **Active Investors** - Type of investors who keep actively investing into stocks can understand the trends with the help of our interactive graphs.
- **Passive Investors** - Type of investors who act like retail investors or personal investors can also gain insight into data trends of stocks.

Prototyping and Sketches



2. About Dataset

Questions we intend to answer

Representing the facts in appropriate visuals by obeying the rule of expressiveness and effectiveness along with proper channels and marks can-do wonders that text cannot do.

The end goal of our project was to answer the various questions related to the impact of global events on the stock market. The questions are as follows,

- What is the impact of the major events on the stock trends, both at a global and regional scale?
- How does an event originating from a certain part of the world have an impact on not only its local stock exchange, but also other national stock exchanges?
- What are various sectors that have been impacted during a stock value fluctuation?
- How long has it taken for stock values to dip to their lowest point and how quickly have they recovered during these events?

Dataset

The visualizations needed for this project rely solely on stock data of various organizations on different stock exchanges. All this data compiled is then preprocessed to churn out newer datasets that will be of use to building meaningful visualizations.

- **Primary Data Source: Yahoo Finance**
Yahoo Finance contains comprehensive information not only about the stock information of organizations from different stock exchanges, but also has detailed information about the organizations, which help in enhancing the quality of the data in hand. It also comes with a rich API which has been harnessed to scrape data for this project.

The following is a set of datasets (some of which have been Scraped from the API, while some have been Churned out of preprocessing pipelines):

1. **Company meta-data** that contains information about the organization, its stock-name, the stock-market it is listed on and other information that provides an overall idea of the organization (Scraped and Churned). The metadata for all organizations is in a single CSV file.
 - **Dimensions**
 - Stock_id
 - Company_name
 - Sector
 - LongBusinessSummary
 - Country
 - Industry
 - Currency
 - Exchange
 - **Measures**
 - 52 Week Change
 - fiftyTwoWeekHigh
 - Volume

Source

https://github.com/ayushraina928/stock-market-viz-d3/blob/main/company_meta_final.csv

2. **Company Stock data** that contains detailed information of the stock value of every organization in their respective currency, over a period of time. Each company's stock data has been stored in separate CSV files. (Scraped and churned)
 - Dimensions
 - Date of the recorded stock's value
 - Measures
 - Open - Opening value of the stock for the day
 - High - Highest value of the stock for the day
 - Low - Lowest value of the stock for the day
 - Close - Closing value of the stock for the day
 - Volume - Volume of stock shares over the period of time
 - Stock Splits - The value of the stock is split to make into 2.

Source

https://github.com/ayushraina928/stock-market-viz-d3/tree/main/company_stock_data

3. **Company Stock Data** in USD that contains detailed information of the stock value of every organization in USD, over a period of time. Each company's stock data has been converted to USD and stored in separate CSV files. (Churned)

- **Dimensions**

- Date of the recorded stock's value
- Year of the recorded stock's value

- **Measures**

- Open - Opening value of the stock for the day
- High - Highest value of the stock for the day
- Low - Lowest value of the stock for the day
- Close - Closing value of the stock for the day
- Volume - Volume of stock shares over the period of time
- Stock Splits - The value of the stock is split to make into 2.
- USD_value - The converted USD value for that year
- OpenUSD - The opening value converted to USD
- HighUSD - The high value converted to USD
- LowUSD - The low value converted to USD
- CloseUSD - The closing value converted to USD

Source

https://github.com/ayushraina928/stock-market-viz-d3/tree/main/company_stock_data_usd

4. **Non-Sector Data** - This category of datasets is a much more granular group of datasets that has been distributed across the various major historical events. Within each event directory the files are further split into multiple categories - Global level and the Country level of each stock exchange (NYSE, TTX, etc). The files contain summed up/aggregated stock information - precisely, only the Opening Value, of all organizations grouped on the basis of only Date either at a global level or at a country level. All these CSV files share the same schema. (Churned)

- **Dimensions**

- Date - The date upon which the aggregated Opening Value was grouped up.

- **Measures**

- Open - A number which is the aggregation(summation) of opening values of all organizations (either at global/country level) grouped on a certain date.
- ChangePercentage - The percentage change in the aggregated Opening value since the previous day.

5. Each of the above-mentioned CSV files come with an **additional metrics CSV file** that contains useful computed metrics data for that particular event and as before they exist at both a country and global level (Churned). Their dimensions and metrics are as follows:

- **Dimensions**

- StartDate - The start date of the event.
- HighestDate - The date the HighestValue (explained later) was reached.
- LowestDate - the date the LowestValue (explained later) was reached.
- RecoveryDate - The date the recovery (explained later) was achieved.
- LowestOverallDate - The day the LowestOverall (explained later) was achieved.

- **Measures**

- StartValue - A number which indicates the starting value of the aggregated Opening values at the very beginning of the historical event.
- HighestValue - A number which indicates the Highest possible figure that the aggregated Opening Value reached before the maximum dip in value occurred.
- LowestValue - A number which indicates the Lowest possible figure that the aggregated Opening Value reached after the maximum dip in value occurred.
- DropDiff - A number which indicates the difference in the HighestValue and LowestValue, which gives us the greatest dip in aggregated stock value over the entire duration of the event.
- DropPercentage - The DropDiff expressed as a percentage.
- DropDays - The number of days during which the highest drop occurred.
- RecoveryValue - A number which is the highest aggregated opening value that was achieved after the highest dip.
- RecoveryDays - The number of days it took the aggregated opening value to recover after the highest dip.
- RecoveryDiff - A number which indicates the difference between the recovered value and the LowestValue
- RecoveryPercentage - The RecoveryDiff expressed as a percentage.
- LowestOverallValue - A number which indicates the lowest possible value of the aggregated Opening Value throughout the duration of the event.
- LowestOverallDiff - A number which indicates the difference between the StartValue and the LowestOverallValue
- LowestOverallPercentage - The LowestOverallDiff expressed as a percentage.

5.1 The non-sector directory also contains a third set of files that contain volume information recorded for the duration of a historical event. The CSV files are only at the Country Level and contain aggregated (summed up) values of the Volume data of all companies at only the Country level (Churned).

- **Dimensions**
 - Date - The date for which the volume data was aggregated for a certain country
- **Measures**
 - Volume - A number which indicates the aggregated Volume value

Source(s)

For this dataset, there are multiple csv files as mentioned previously. There are multiple urls, of which only certain ones have been listed. All the urls to the other CSV files follow one of the following patterns:

./History/EVENT-NAME/noSector/nosector_EVENT-NAME_all.csv
./History/EVENT-NAME/noSector/nosector_EVENT-NAME_all_metrics.csv
./History/EVENT-NAME/noSector/nosector_EVENT-NAME_COUNTRY.csv
./History/EVENT-NAME/noSector/nosector_EVENT-NAME_all_metrics.csv
./History/EVENT-NAME/noSector/nosector_EVENT-NAME_COUNTRY_metrics.csv.
./History/EVENT-NAME/noSector/nosector_volume_EVENT-NAME_COUNTRY.csv.

Some of our data sources are as follows:

<https://github.com/ayushraina928/stock-market-viz-d3/tree/main/History/chinese-crash>

https://github.com/ayushraina928/stock-market-viz-d3/blob/main/History/chinese-crash/noSector/nosector_chinese-crash_all.csv

https://github.com/ayushraina928/stock-market-viz-d3/blob/main/History/chinese-crash/noSector/nosector_chinese-crash_canada.csv

https://github.com/ayushraina928/stock-market-viz-d3/blob/main/History/chinese-crash/noSector/nosector_chinese-crash_canada_metrics.csv

https://github.com/ayushraina928/stock-market-viz-d3/blob/main/History/chinese-crash/noSector/nosector_volume_chinese-crash_canada.csv

6. **Sector Data** - Like the previous category of datasets this is also a granular group of datasets that has been distributed across the various major historical events, but with specific focus on different sectors. Within each event directory the files are further split into multiple categories - Global level and the Country level of each stock exchange (NYSE, TTX, etc). The files contain summed up/aggregated stock information - precisely, only the Opening Value, of all organizations grouped on the basis of both the Date and the Sector either at a global level or at a country level. All these CSV files share the same schema. (Churned)

- **Dimensions**

- Date - The date upon which the aggregated Opening Value was grouped up.
- Sector - The sector upon which the aggregated Opening Value was grouped up.

- **Measures**

- Open - A number which indicates the aggregation(summation) of opening values of all organizations (either at global/country level) grouped on a certain date and sector.

Each of the above-mentioned CSV files come with an additional metrics CSV file that contains useful computed metrics data for that particular event and grouped by Sector. As before they exist at both a global and country level (Churned). Their dimensions and metrics are as follows:

- **Dimensions**

- Sector - The sector for which the metrics have been found
- HighestDate - The date the HighestValue(explained later) was reached.
- LowestDate - the date the LowestValue(explained later) was reached.
- RecoveryDate - The date the recovery(explained later) was achieved.

- **Measures**

- HighestValue - A number which indicates the Highest possible figure that the aggregated Opening Value reached before the maximum dip in value occurred.
- LowestValue - A number which indicates the Lowest possible figure that the aggregated Opening Value reached after the maximum dip in value occurred.
- DropDiff - A number which indicates the difference in the HighestValue and LowestValue, which gives us the greatest dip in aggregated stock value over the entire duration of the event.
- DropPercentage - The DropDiff expressed as a percentage.
- DropDays - The number of days during which the highest drop occurred.
- RecoveryValue - A number which indicates the highest aggregated opening value that was achieved after the highest dip.

- RecoveryDays - The number of days it took the aggregated opening value to recover after the highest dip.
- RecoveryDiff - A number which indicates the difference between the recovered value and the LowestValue
- RecoveryPercentage - The RecoveryDiff expressed as a percentage.

Source(s)

For this group of datasets, there are multiple csv files as mentioned previously. There are multiple urls, of which only certain ones have been listed. All the urls to the other CSV files follow one of the following patterns:

```
./History/EVENT-NAME/Sector/sector_EVENT-NAME_all.csv
./History/EVENT-NAME/Sector/sector_EVENT-NAME_all_metrics_.csv
./History/EVENT-NAME/noSector/sector_EVENT-NAME_COUNTRY.csv
./History/EVENT-NAME/noSector/nosector_EVENT-NAME_COUNTRY_metrics_.csv
./History/EVENT-NAME/noSector/nosector_volume_EVENT-NAME_COUNTRY.csv.
```

Some of our data sources are as follows:

<https://github.com/ayushraina928/stock-market-viz-d3/tree/main/History/chinese-crash/Sector>

https://github.com/ayushraina928/stock-market-viz-d3/blob/main/History/chinese-crash/Sector/sector_chinese-crash_all.csv

https://github.com/ayushraina928/stock-market-viz-d3/blob/main/History/chinese-crash/Sector/sector_chinese-crash_all_metrics_.csv

https://github.com/ayushraina928/stock-market-viz-d3/blob/main/History/chinese-crash/Sector/sector_chinese-crash_canada.csv

https://github.com/ayushraina928/stock-market-viz-d3/blob/main/History/chinese-crash/Sector/sector_chinese-crash_canada_metrics_.csv

Below are sample screenshots of some of the datasets in use:

main

[stock-market-viz-d3](#) / [company_stock_data_usd](#) / [0005.HK.csv](#)

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SiddharthaHaldar

Company Stock data in USD made

Latest commit 35c08eb 3 days ago

History

1 contributor

5573 lines (5573 sloc)

995 KB

[Raw](#)
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We can't make this file beautiful and searchable because it's too large.

```

1 Date,Open,High,Low,Close,Volume,Dividends,Stock Splits,year,USD_value,OpenUSD,HighUSD,LowUSD,CloseUSD
2 2000-01-03,56.17156521860758,56.97304974661933,54.92917352252536,55.184658005053711,3908164,0.0,0,2000,7.791167,6.279726543996244,6.312518105005236,6.050185616933299,6.08297717
3 2000-01-04,54.16271209716797,54.418196588192345,53.65174311511922,54.16271209716797,6895378,0.0,0,2000,7.791167,6.951809927468885,6.984601483730531,6.886226814945594,6.9518099
4 2000-01-05,51.60786331708159,52.11883226081507,50.84140990148136,51.35237884521485,14657098,0.0,0,2000,7.791167,6.623893868156284,6.689476975761791,6.525519206748021,6.5911023
5 2000-01-06,51.60787145870248,52.11884048304607,49.18076859307043,49.563995361328125,10632084,0.0,0,2000,7.791167,6.6238949131372885,6.689478031089062,6.312375102865904,6.36156
6 2000-01-07,50.33044095747488,51.60786331708159,49.8194720140144,51.35237884521485,8368286,0.0,0,2000,7.791167,6.459936099142514,6.623893868156284,6.394352991537007,6.591102314
7 2000-01-10,52.62979225158691,52.62979225158691,50.84140125274658,51.09688568115234,6201139,0.0,0,2000,7.791167,6.755058934250403,6.755058934250403,6.525518096678788,6.55830964
8 2000-01-11,51.096904521085776,51.096904521085776,49.81948190805864,50.07496643066406,8366294,0.0,0,2000,7.791167,6.558312063017746,6.558312063017746,6.394354261442303,6.427145
9 2000-01-12,48.92525219607663,49.563963060255176,48.92525219607663,49.18073654174805,7369722,0.0,0,2000,7.791167,6.279579451457866,6.361558295471677,6.279579451457866,6.3123709
10 2000-01-13,49.56398199650256,49.691729437009,48.79753378934639,49.43624496459961,5281865,0.0,0,2000,7.791167,6.361561393774547,6.37795170562627,6.2631867330460755,6.3451656
11 2000-01-14,49.94721390480219,50.20269837490349,49.05301825944768,49.43624496459961,5930363,0.0,0,2000,7.791167,6.4107487241387835,6.443540277714942,6.295978286622233,6.3451656
12 2000-01-17,50.33045174791405,50.33045174791405,49.05302911471826,49.30851364135742,4628898,0.0,0,2000,7.791167,6.459937484065487,6.459937484065487,6.2959796799013885,6.3287712
13 2000-01-18,49.30850112438202,49.30850112438202,48.54204773902893,49.053816662597656,3157976,0.0,0,2000,7.791167,6.328769634174447,6.328769634174447,6.238394976648419,6.2959788
14 2000-01-19,48.28656592894997,49.05301844210791,47.52011161579203,47.64785385131836,13908521,0.0,0,2000,7.791167,6.197603648971967,6.295978310066761,6.099228987877173,6.1156247
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17 2000-01-24,47.52011054939083,47.7755950146287,46.88139938601265,47.39236831665039,11414778,0.0,0,2000,7.791167,6.09922885093674,6.132020403956005,6.017249968587845,6.08283307
18 2000-01-25,46.7536484312616,47.00913284891877,45.85945296946152,46.24267959594727,13997737,0.0,0,2000,7.791167,6.000853072622061,6.0336446194669895,5.886082658664809,5.9352699
19 2000-01-26,46.4981580760381,47.00912684610445,46.24267369100493,46.62590026855469,7499739,0.0,0,2000,7.791167,5.968060763687661,6.033643849002909,5.935269221030038,5.984456535
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21 2000-01-28,45.2083740021799,48.79752180758756,48.28655299284842,48.4142951965332,11642131,0.0,0,2000,7.791167,6.238393649657104,6.263185195181615,6.197602104132593,6.21399787

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main

[stock-market-viz-d3](#) / [History](#) / [chinese-crash](#) / [noSector](#) / [nosector_chinese-crash_all.csv](#)

[Go to file](#)

main stock-market-viz-d3 / History / chinese-crash / Sector / sector_chinese-crash_all_metrics_csv Go to file ...

SiddharthaHaldar Sector Metrics added Latest commit 5b587df 2 days ago History

1 contributor

10 lines (10 sloc) 2.04 KB Raw Blame

Search this file...

	sector	highestValue	highestDate	lowestValue	lowestDate	dropDiff	dropPercentage	dropDays	recoveryValue	recoveryDate
1	Technology	328.4573248248859	2015-06-23 00:00:00	23.15913520700224	2016-01-01 00:00:00	305.2981896178837	-92.94911897021954	192.0	300.21646714852665	2016-01-05 00:00:00
2	Industrials	333.18498771799625	2015-12-30 00:00:00	9.810170593377686	2016-02-15 00:00:00	323.3748171246186	-97.05563847261904	47.0	320.30913350854354	2016-03-01 00:00:00
3	Energy	2586.766600124524	2015-06-01 00:00:00	7.178258282434151	2016-01-01 00:00:00	2579.58834184209	-99.72250073578002	214.0	2013.26998837468	2016-03-01 00:00:00
4	Consumer Defensive	10256.355268344296	2015-10-30 00:00:00	11.682259825650757	2016-01-01 00:00:00	10244.673008518645	-99.8860973560295	63.0	9380.21393862478	2016-02-26 00:00:00
5	Healthcare	7069.253639454413	2015-12-03 00:00:00	24.49482299033206	2015-12-28 00:00:00	7044.758816464081	-99.65350199271924	25.0	7116.079762744555	2015-12-30 00:00:00
6	Financial Services	1333.145316830202	2015-06-01 00:00:00	4.875090538854846	2015-12-25 00:00:00	1328.2702262913472	-99.63431664370646	207.0	1208.4024840199618	2015-12-30 00:00:00
7	Communication Services	102.66798835889604	2015-08-11 00:00:00	4.504470869060352	2016-01-01 00:00:00	98.16351748983568	-95.61258485623182	143.0	99.4844004490764	2016-01-04 00:00:00
8	Basic Materials	3173.670814639935	2015-06-03 00:00:00	48.123983709671776	2015-12-28 00:00:00	3125.5468309302632	-98.48364917093232	208.0	2259.052559800216	2015-12-29 00:00:00
9	Consumer Cyclical	488.7340966374881	2015-07-31 00:00:00	278.5038508169328	2016-02-22 00:00:00	210.2302458205553	-43.01526070453209	206.0	286.2787884386432	2016-02-23 00:00:00

Implementation

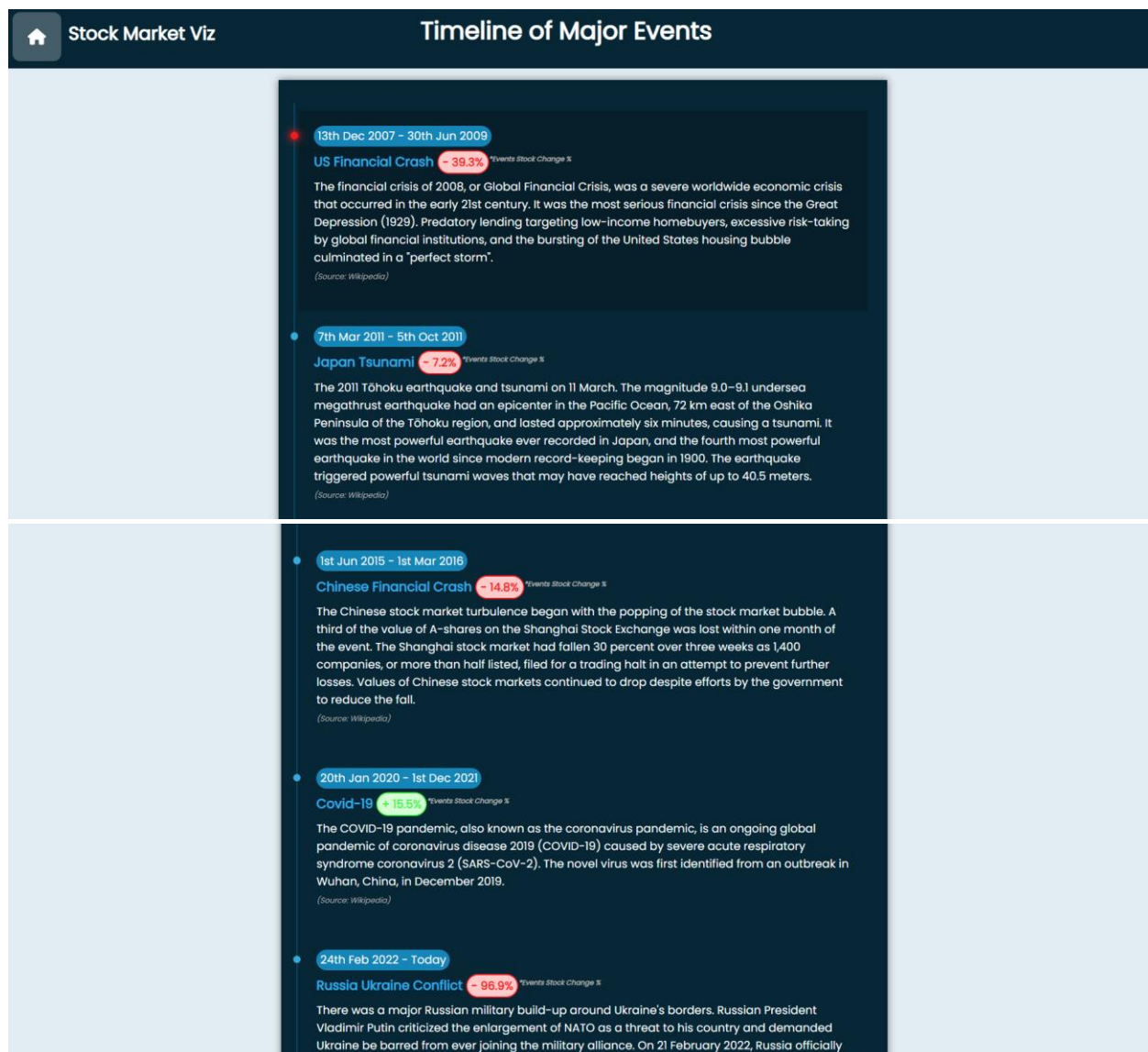
The scraped data contained only organization metadata and daily stock information. These scraped datasets had to be thoroughly preprocessed to churn out newer aggregated datasets that could then be used to make information rich dashboards. The visualizations have been developed using Tableau. Initially, multiple sheets were created with each one representing a particular metric. Later on, these sheets were combined together based on the correlation between the data and the historical events and represented as multiple dashboards.

Interactions were implemented as part of these dashboards. Finally, the dashboards were published in Tableau Public. A responsive and interactive web UI has been built using HTML, CSS and JavaScript backed by a python server. This web UI contains the home page of the timeline of events, which is connected to various dashboards. The public Tableau links were embedded within the HTML pages which rendered the dashboards within the dashboards.

3. Visual Analysis

The impact of various global historical events on the stock market was showcased using multiple dashboards. For the sake of explanation only the dashboard(s) of a single event will be done in detail. The dashboards of all other events follow the same design principles and contain the same set of metrics and level of interactivity.

1st Visual Dashboard - Timeline of events



The first page shows a vertical timeline of various major global events and their summaries. Each event comprises a few components:

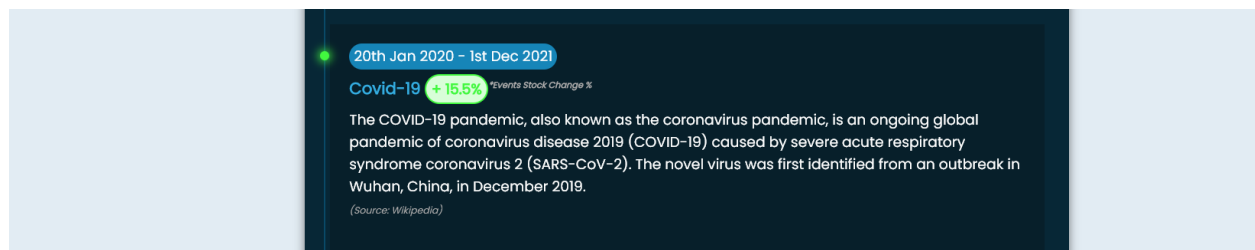
- **Date Range:** This shows the date range of how long the event lasted.
- **Event Header and Summary:** This shows the title of the event and a brief description of what the event encompassed and its impact on the world.
- **Events Stock Change %:** This has been shown using a percentage figure enclosed in a bubble that indicates the percentage change in the global aggregated opening value of stocks between the start and the end of the event.

Design Choices

- The event's stock exchange values have been color coded (red/green) that help indicate whether the opening values have incremented/decremented.
- On hover the bubbles get highlighted in different colors - they are color coded as red/green thus conveying a rise/fall in the opening value of the stock.
- A vertical timeline has been implemented in place of a horizontal one as a vertical timeline provides the convenience of viewing all events in a chronological fashion and scrolling vertically is more convenient than scrolling horizontally.

Interactions

There are two main interactions involved in this timeline page. The first interactivity involved is the hover feature that highlights the bubble with a color based on whether the value of the opening value has dropped or risen over the entire duration of the event. The second kind of interactivity is when the events are clicked, it directs the user to the dashboard of that event.

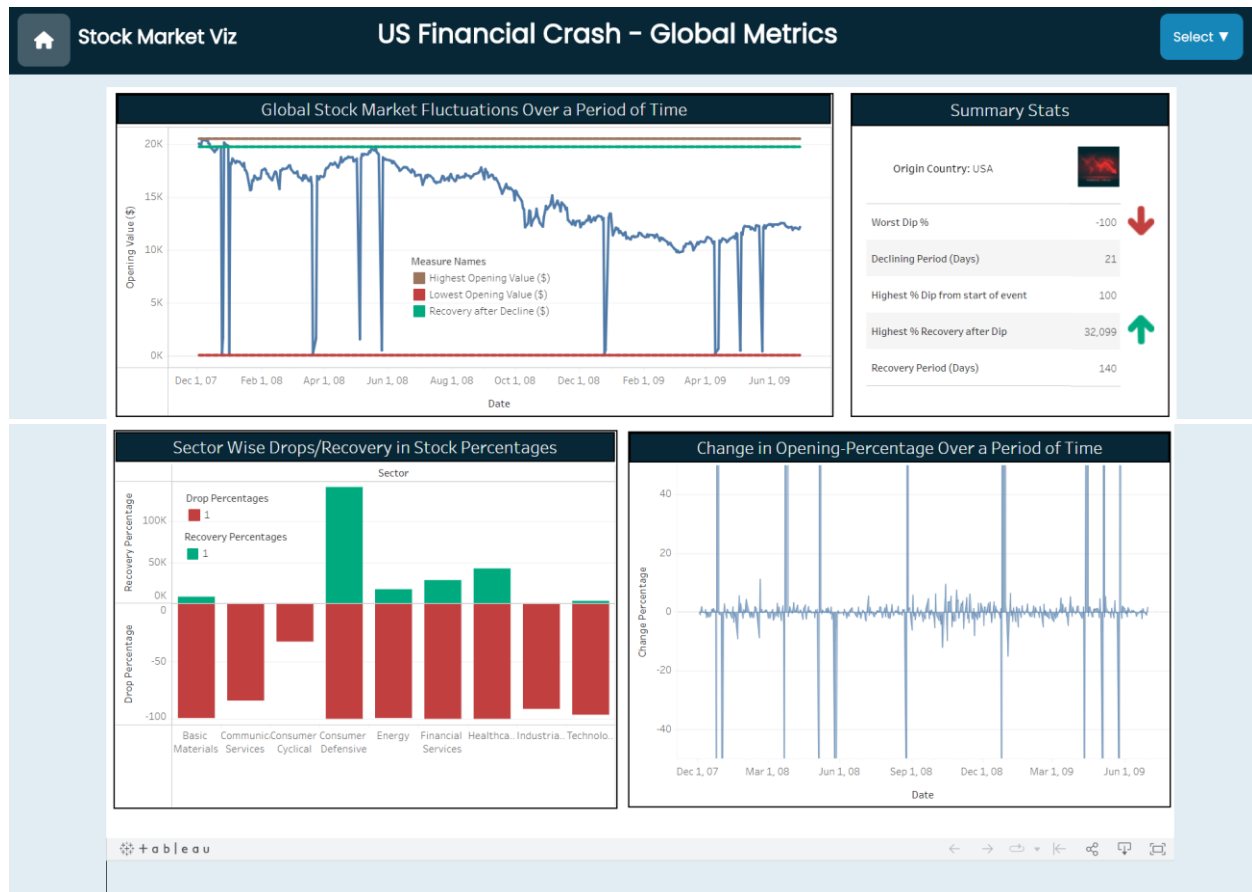


Visual Encodings

We have used different types of marks and channels to increase the effectiveness and expressiveness of the dashboards. Using color as a channel to depict increase/decrease. Timeline is provided as label. The timeline uses spatial line channel to express the dashboards.

Use of all these channels is effective as they are lower in rank to understand which means it is easy to understand these dashboards.

2nd Visual Dashboard - Global Metrics of the US Financial Crash



The dashboard focuses on how the stock trends in the market were affected and how different sectors were faced with positive or negative changes in their opening stock values. There are 4 independent panes showing different metrics. These metrics will now be explained:

- **Global Stock Market Fluctuations Over a Period of Time:** This graph represents the fluctuation of the Opening Value trends of all organizations globally. The x-axis represents the date timeline while the y-axis represents the aggregated Opening Stock Value in USD. There are also three lines that can be seen. The brown line is the Stock Value at its highest point before facing the most aggressive dip during the entirety of the event. The red line indicates the lowest point the value reaches when it is at its most aggressive dive. Finally, the green line indicates the highest stock value after the most severe dip.
- **Summary Stats:** This is not a graph. This is a table that shows a summary of what the first graph was trying to convey. This helps the user get a quicker idea of the metrics being highlighted in the first graph. The first value is the Worst Dip % which represents the worst dip (i.e., the drop in between the green and the red lines of the first graph) as

a percentage followed by the Declining Period, which tells how long this dip lasted. The next value is the highest dip from the start percentage. This metric helps users know the percentage difference between the values at the start of the event and when it has been at its lowest throughout the event. This metric is not similar to the first metric discussed before. The first metric has its visual representation using the lines in the previous graph and is easily discernible from this one. The final metric pertains to the highest recovery percentage and the time it took to recover (i.e., the duration in between the red and green line in the first graph).

- **Sector Wise Drops/Recovery in Stock Percentages:** This graph shifts the focus to different sectors and their aggregated drop (represented in red) and recovery percentages (represented in green). The drop percentage refers to the maximum drop in opening value the sector had faced during the event and the recovery percentage refers to the maximum rise in value the sector had seen after the highest drop in value. The y-axis represents the percentage change, while the x-axis represents the different sectors.
- **Change in Opening-Percentage Over a Period of Time:** This graph is related to the first graph; in that it shows the percentage change in the value of the aggregated Opening values from the day before. The x-axis represents the different dates while the y-axis represents the percentage change.

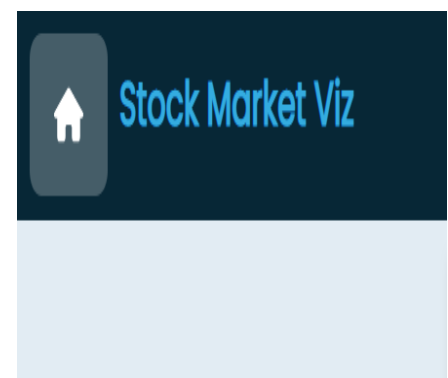
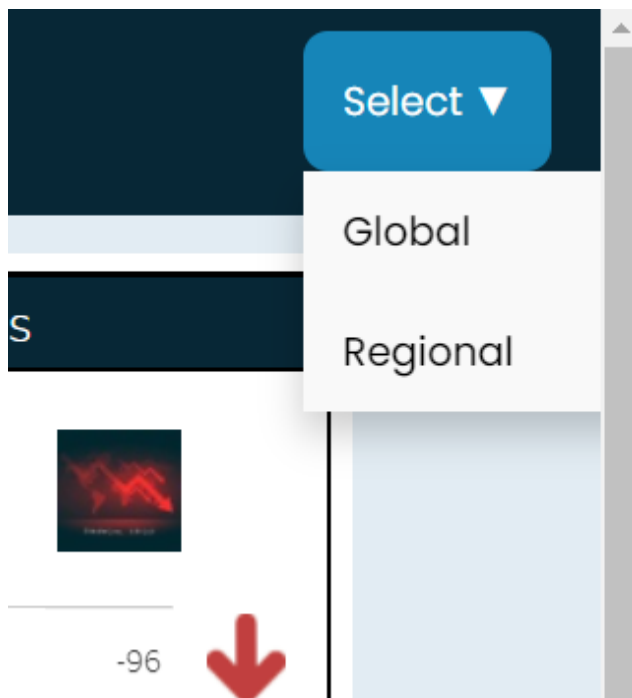
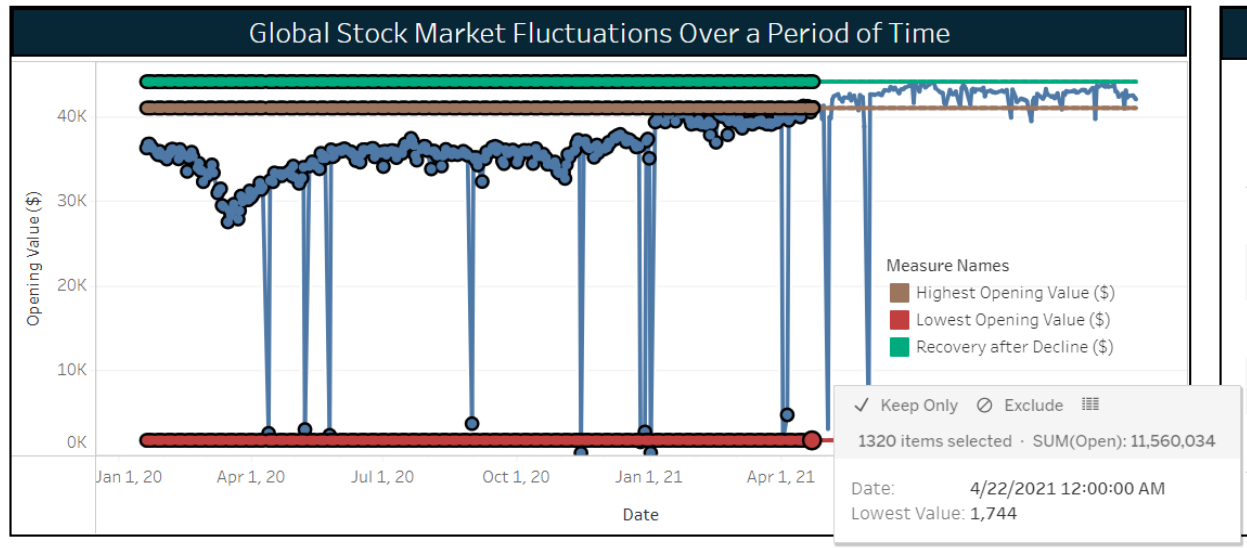
Design Choices

- The line chart is suitable for showing trends and this fits the purpose of showing fluctuations in the stock value.
- The highest, lowest and recovered values are discernible using different color-coded lines.
- The drop and rise in percentage values of the different sectors have been shown using bar charts and have also been color coded, thereby helping convey the data in a lucid fashion.
- The dashboard has been designed with all relevant data and information to provide a comprehensive understanding of how the stock values behave in the face of a global event.
- Brushing on the line charts and each bar chart makes it easy to concentrate on a specific set of points and range of dates.

Interactions

The first level of interactivity that has been introduced in the sheets - Keep Only / Exclude, helps users direct focus on certain sections of the graph. The second level of interactivity is a context switch drop down that helps switch from the Global Context to Regional/Country level context. The third kind of interactivity helps the user to switch back to the original timeline page, by clicking on the home button.

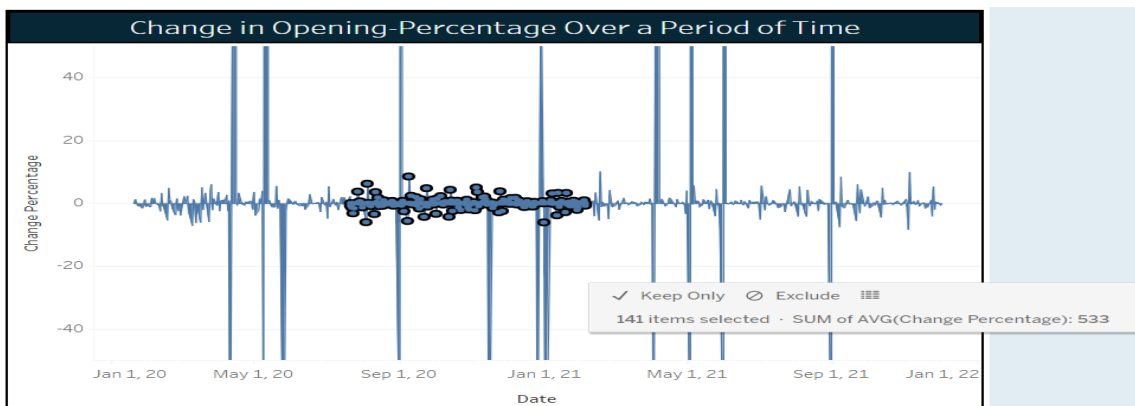
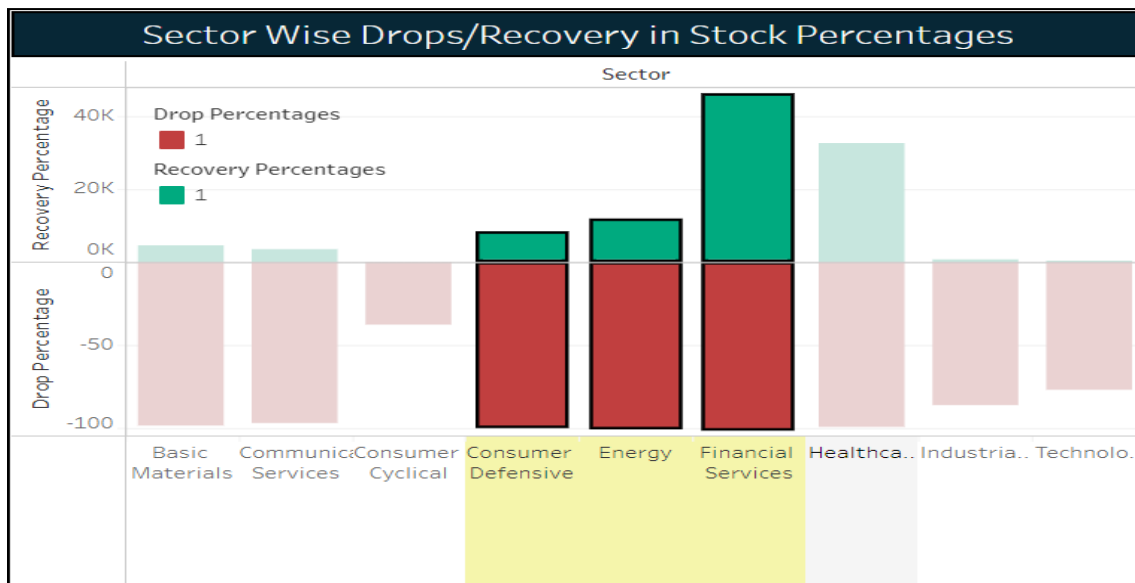
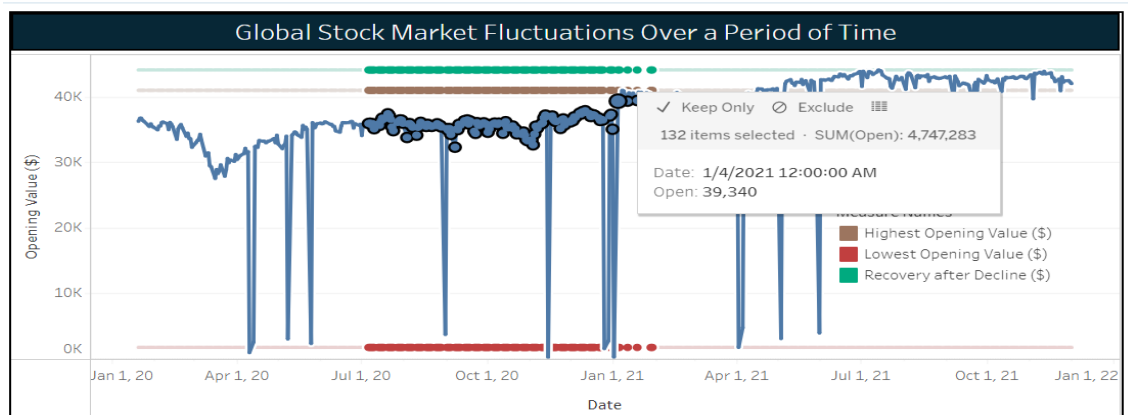
Some Examples to understand the interactivity



Brushing and Tooltips

Brushing in the dashboard is possible by dragging and selecting the specific areas of interest for all the sheets of the dashboard. Tool tips and details are given to provide information at the specific point when hovered.

Some Examples to understand the brushing and tooltips



Takeaway

Through this visualization, we answered a couple of questions pertaining to how the aggregated stock values changed over time and how the different sectors have been affected. For the US Financial Crisis in particular we can see that the overall data in the line chart helps us understand the trends, sector bar plot helps us visualize which sector fared better in the event. Area line charts help to give users a perspective of how strong the actual change for the stock value was at the opening time.

This interactivity can also be found in all the other Global charts for different sets of events.

Visual Encodings

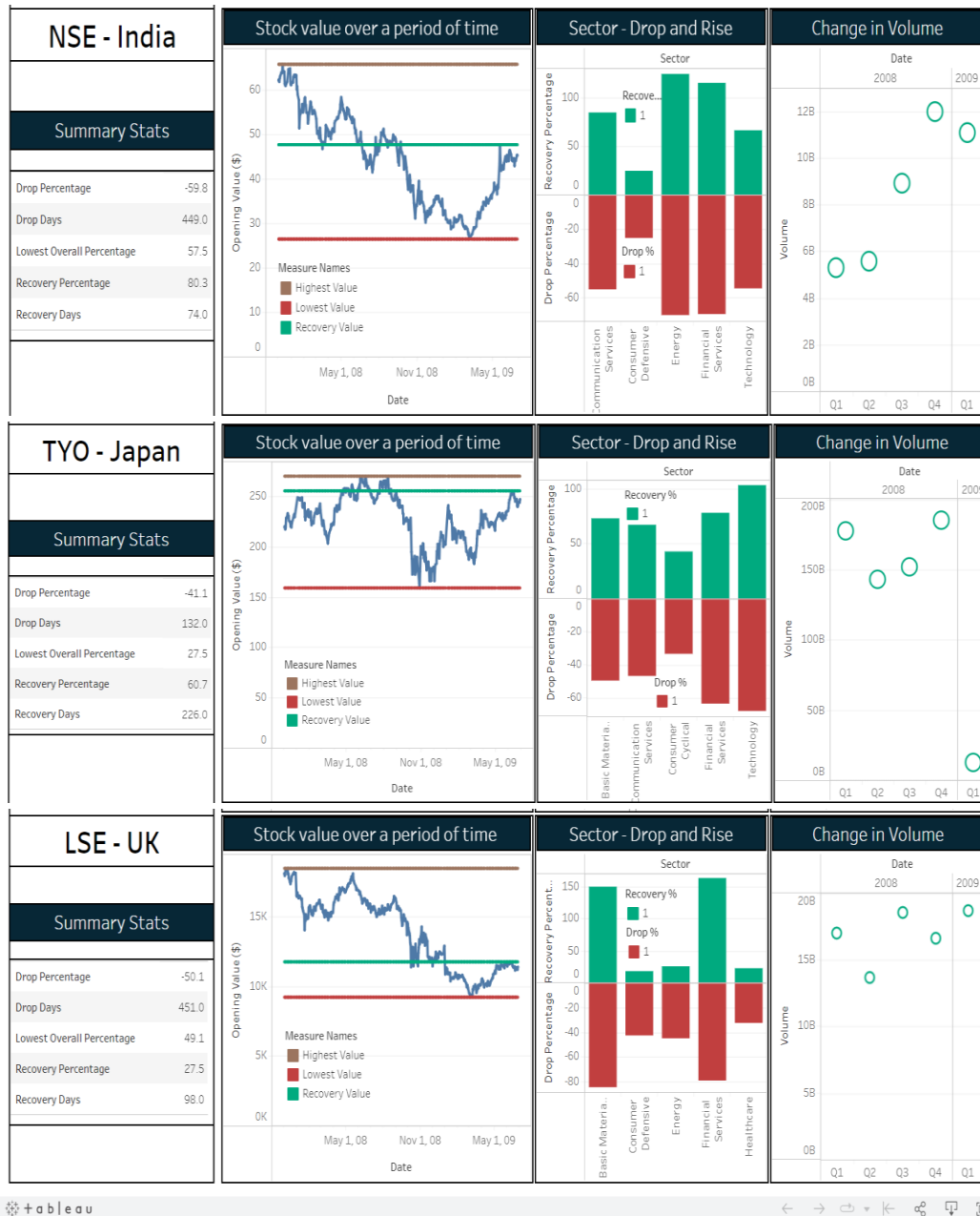
We have used different types of marks and channels to increase the effectiveness and expressiveness of the dashboards.

- **Categorical Channels:** Using color as a channel to depict Line charts different sets of lines and Bar graphs different scale. These are used to increase the effectiveness as the user will have a much better time at understanding the data.
- **Spatial Channels:** Line, Area-1D and Area-2D are used as spatial channels to increase the effectiveness of the dashboard.
- **Linear Information** – We have also provided information as summary stats which helps the user understand the data.

Use of all these multiple encoding channels is effective as they are lower in rank to understand which means it is easy to understand these dashboards.

3rd Visual Dashboard - Regional Metrics of the US Financial Crash





This dashboard now changes focus from the global context to the regional level and shows how the different national stock exchanges were affected by the event. The event in focus is the US Financial Crash of 2007 - 09. The regional dashboards of all other events follow the same design principles and level of interactivity.

- Summary Stats:** This table gives a summarized information of the metrics of a particular exchange. The metrics shown are similar to the summary stats table in the Global Dashboard.

- **Stock Value over a period of time:** This graph represents the fluctuation of the Opening Value trends of all organizations within a particular stock exchange. The x-axis represents the date timeline while the y-axis represents the aggregated Opening Stock Value in USD. There are also three lines that can be seen. The brown line is the Stock Value at its highest point before facing the most aggressive dip during the entirety of the event. The red line indicates the lowest point the value reaches when it is at its most aggressive dive. Finally, the green line indicates the highest stock value after the most severe dip.
- **Sector - Drop and Rise:** This graph shifts the focus to different sectors that the organizations of a particular stock exchange belong to and their aggregated drop (represented in red) and recovery percentages (represented in green). The drop percentage refers to the maximum drop in opening value the sector had faced during the event and the recovery percentage refers to the maximum rise in value the sector had seen after the highest drop in value. The y-axis represents the percentage change, while the x-axis represents the different sectors.
- **Change in Volume:** This graph helps understand the change in volume of stock shares for a particular stock exchange. The y-axis represents the volume value. The upper x-axis shows a year-based timeline, while the lower x-axis shows a much-detailed timeline - the quartile ranges.

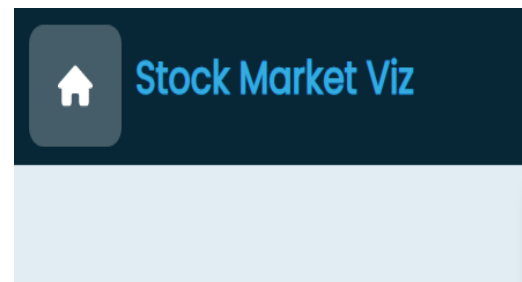
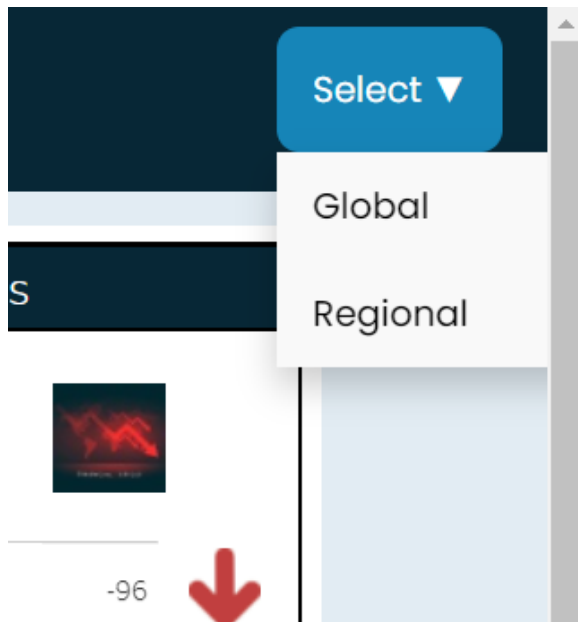
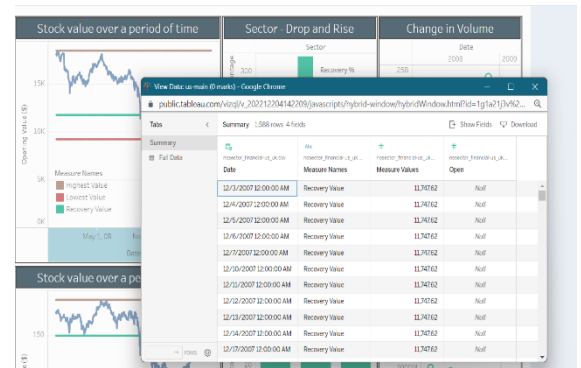
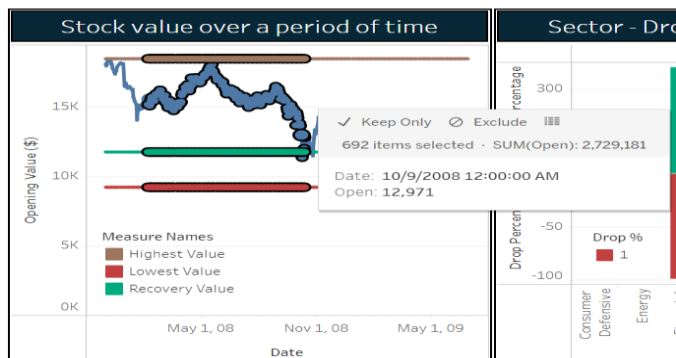
Design Choices

- The line chart is suitable for showing trends and this fits the purpose of showing fluctuations in the stock value.
- The highest, lowest and recovered values are discernible using different color-coded lines.
- The drop and rise in percentage values of the different sectors have been shown using bar charts and have also been color coded, thereby helping convey the data in a lucid fashion.
- The use of two x-axes (the upper and the lower one) in the volume scatter plot is useful as it helps users get a clearer idea of how the volume has fluctuated over the years and the different quarters of the year.
- Brushing on the line charts and each bar chart makes it easy to concentrate on a specific set of points and range of dates.

Interactions

The first level of interactivity that has been introduced in the sheets - Keep Only / Exclude, helps users direct focus on certain sections of the graph. The second level of interactivity is a context switch drop down that helps switch from the Regional/Country level context to the Global Context. The third kind of interactivity helps the user to switch back to the original timeline page, by clicking on the home button. The final kind of interactivity helps users view the dataset from the dashboard itself.

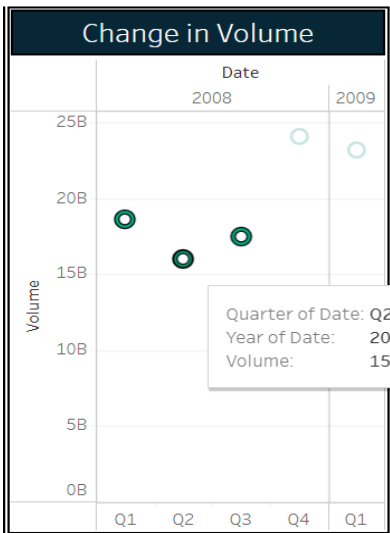
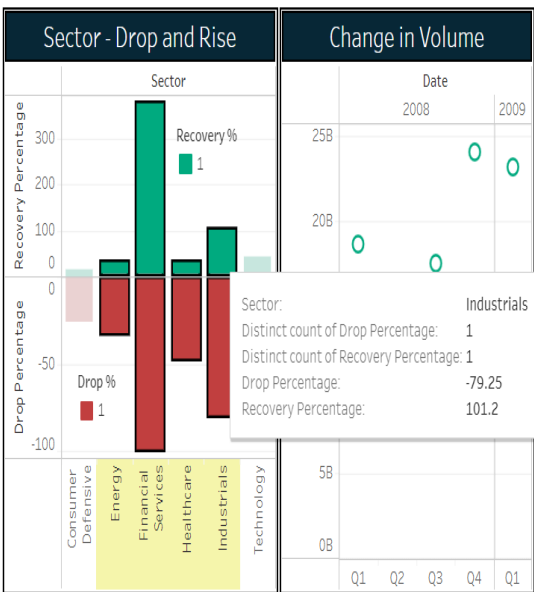
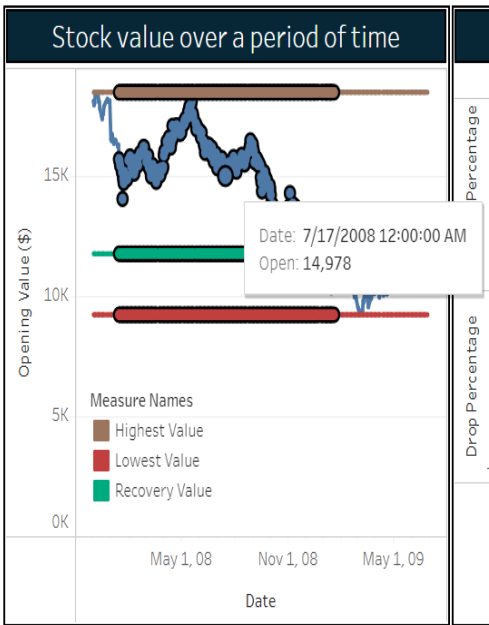
Some Examples to understand the interactivity



Brushing and Linking

Brushing in the dashboard is possible by dragging and selecting the specific areas of interest for all the sheets of the dashboard. Tool tips and details are given to provide information at the specific point when hovered.

Some Examples to understand the brushing and tooltips



Takeaway

Through this above dashboard, we answered a couple of questions pertaining to how the aggregated stock values of various stock exchanges were affected by a particular event and how that event had an impact on the volume data of stock shares of that exchange.

This interactivity can also be found in all the other regional charts for different sets of events.

Visual Encodings

We have used different types of marks and channels to increase the effectiveness and expressiveness of the dashboards.

- **Categorical Channels:** Using color as a channel to depict Line charts different sets of lines and Bar graphs different scale. These are used to increase the effectiveness as the user will have a much better time at understanding the data.
- **Spatial Channels:** Line, Area-1D and Points are used as spatial channels to increase the effectiveness of the dashboard.
- **Linear Information:** We have also provided information as summary stats which helps the user understand the data.

Use of all these multiple encoding channels is effective as they are lower in rank to understand which means it is easy to understand these dashboards.

4. Conclusion

The dashboards are designed to help from a novice entering stock market to veteran, to understand the nuances of geo-political data and their impact on stock market. Three dashboards namely Timeline, Global and Regional are used to traverse between multiple encoding of channels and marks which follow the design principles for proper Data Visualizations. This has increased the effectiveness and expressiveness of the dashboards.

Evaluation

As the project revolves around the impact of the geopolitical events on the stock market trends the evaluation would involve working with various financial stakeholders and thereby gathering information on how their decision would be impacted by this dashboard.

Feasibility Pilot

For our feasibility plot we needed individuals who were involved actively with the stock market and how their decisions would be guided by the dashboard. Niranjan who is an active trader helped us with his valuable feedback. To enable this pilot, we designed a scenario and let the users walk through our prototype. We encouraged them to 'Think Aloud' which helped us gauge their feedback with their interaction.

The user was able to understand and articulate the problem that we are trying to solve. The visualization system was expressive, effective for the user to understand intuitively without any 'hand-holding'. The user was able to relate to the problem, and was able to find their goal. Feedback from Niranjan:

"The idea behind the project is definitely interesting. Generally, most stock trends that I have observed have a singular view of how the economy/market or points moved over time. This is certainly a new perspective where I can compare the individual stock market of a region over that of the entire world and also compare the trends and how they are affected by different world events. Although new to stock investing, I have observed signs of world events influencing trends and I think such a view will help me make good decisions and make money faster (which is the goal honestly).

Evaluation: I would qualify as a seasoned investor and I believe the sketches were very clear in their objective. It can answer the questions that a new investor would have like observing the effects of various world events on the market. The bar charts will help us identify how different sectors perform under the influence of various events. The visualizations would definitely help even experienced investors make better decisions by observing their local markets and how they compared to the global economy and market."

Future Works

- We would like to introduce a live update to our dashboard metrics by scraping daily data and plugging them directly into our dashboards.
- We would like to incorporate more filter capabilities to enable more control over the data being visualized and links between the visualizations, such that a filter/change applied to one graph can be reflected in all other graphs that are linked.
- We would like to address stock split by introducing a categorical channel that will enable users to ignore a point if it is identified as a stock split.

Project Demo Video

<https://www.youtube.com/watch?v=O-Xnq1-OL1s>

Stock Market Dashboard URL

<http://137.184.232.99:4000/>

Acknowledgement

We would like to give thanks to our instructors Dr. Lyn Bartram and Parastoo Piray for their constant support, guidance throughout the course which helped us understand the nuances of visual analytics and complete our Visual Analytic Project.

References

1. "A Nested Model for Visualization Design and Validation" by Tamara Munzner. IEEE TVCG (Proc. InfoVis 2009) 15(6):921-928, 2009
2. Sarikaya, Alper, Michael Correll, Lyn Bartram, Melanie Tory, and Danyel Fisher. "What do we talk about when we talk about dashboards?" *IEEE transactions on visualization and computer graphics* 25, no. 1 (2018): 682-692
3. Ji Soo Yi, Youn ah Kang, John T. Stasko, and Julie A. Jackos. Toward a Deeper Understanding of the Role of Interaction in Information Visualization. Proceedings of IEEE Information Visualization, 2007
4. Lam, Heidi, et al. "Empirical studies in information visualization: Seven scenarios." *IEEE transactions on visualization and computer graphics* 18.9
5. Wikipedia Sources for Content on Events (https://en.wikipedia.org/wiki/Main_Page)
6. Yahoo API for Research on stock exchanges ([Yahoo API](#))