

A Time-series Comparison and Drilldown Visualization of Economies Worldwide

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Abstract – *A Time-series Comparison Visualization of economic indicators*

Existing visualizations portray economic comparisons using bar charts, geographic maps and scatterplots, but these are static - ideal for knowing what happened in a particular time, but does not tell of patterns of a country's economic history, and how it performs compared to another in the same frame of time. It is difficult to know what changed, by what magnitude, from one time period to another, and which sectors were affected or were the cause.

We built a visualization combining an animated glyph chart and static stacked area chart. The glyph chart represents six economic indicators of one country or region, and the stacked area chart shows how the different sectors contributed to the GDP. Users can see how the indicators evolve over time as they play the animation, thereby deriving insights such as economic patterns. Additionally, users can select up to 3 selections to compare between them.

Our initial goal was to provide users better tools to understand and interpret economies around the world, and we want to make it easy to see general patterns of economics, helping people uncover their own insights, start conversations about trends, and help them make clearer decisions whether as a job seeker, migrant, businessman, investor or just having a coffee chat on economics. We hope that with this visualization, users have greater capacity to do that.

Keywords – *Economics, Indicators, Time-Series, Comparison, Visual Analytics, Decision-making*

I. INTRODUCTION

Economics plays a big part in our lives, but its interpretation is often fuzzy or disjoint without an overarching perspective on how it is doing. People care about the economy because it affects people's life in the way that they work, live and spend money every day, but key information such as Gross Domestic Product (GDP) or Unemployment Rates for every country is not easily compared to its values in the past. If so, how will people know how good or bad changes are at present if they cannot estimate the magnitude of changes in the past?

In this case, visualizations are meant to help people cut through the clutter to look at what matters. However, existing charts are largely static, and do not assist users in making specific comparisons in terms of country, region and time. Geographic maps plot changes of indicators over time, but they do not facilitate comparison of the amount of change compared to its past [1]. Additionally, cross-analysis may need multiple displays, complicating the already dense amount of indicators to consider [2]. As such, our project aims to address these limitations by combining charts that we thought could best represent economic information, to simplify the comparisons made between the economic indicators by dimensions of time, country and sector.

II. MOTIVATION AND OBJECTIVES

Our research and development efforts were motivated by the lack of tools comparing a set of economic indicators of countries. Most importantly, we wanted to allow any user the ability to **know how it performs compared to another in the same frame of time, to know what changed, by what magnitude, from one time period to another, and which sectors were affected** or perhaps were the cause.

In doing so, we can make it easy for people to see the general patterns of economics. We felt that this would be especially useful for job seekers, migrants, businessmen, investors or even budding economists wanting to understand the issues and have conversations about them, and to make clearer decisions.

III. DATA TRANSFORMATION

i. Source of Data

The purpose of the tool is to compare different indicators in time and location. The first important step was to know which indicators to compare. These indicators needed to be relevant of a growth or decline stage of the economy. As such, we narrowed down 6 of them: GDP growth, Inflation, Unemployment (Labor Market), Deposit Interest Rates, Lending Interest Rates and Central Government Debt. Additionally, sector contribution to GDP was obtained to help users see patterns between economic indicators and sector performance. The data was obtained from the World Bank database.

ii. Preparation of Data

Numerical transformation, expecting of a dates format change, was not needed since all the indicators were in percentage. But a format conversion from CSV to JSON was necessary to implement our data in the D3.js library and comparing them by countries and over time.

Excel was used as the file format, and together with JMP, to clean and compile all the different indicators sheets selecting the years 2007-2015. An online tool has been used to be able to convert the CSV format to JSON one.

IV. USER INTERFACE DESIGN

The design focuses on simple steps to allow the user to gain different insights and views. Users need only select a country or region, and press play. Thereafter, they can pause and make comparisons by making another selection, helping the user explore and repeat the process.

To ensure that this process was as close to seamless as possible, elements on the user interface were cautiously chosen. We took certain best practices into account and produce a simple and interactive experience that anyone could use.

i. Elements

Interface elements act in a certain way which users are more familiar with. For example, input controls like buttons and dropdown list are used following how the user interaction similar to websites. Drop-down forms with real-time search allows quick exploration and selection of a country and region.

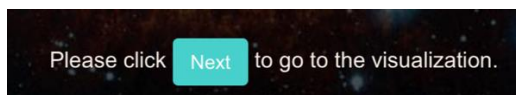


Figure 4.1 Next Button



Figure 4.2 Animated Slider

ii. Best Practices

A. Simplicity:

The interface of the tool avoids unnecessary elements to distract users and keep messages on labels clear to understand. No chart junk is shown, only the bare minimum to provide context and comparisons.

B. Meaningful page layout

Timeline slider is shown on the top of page. Upon selection, the graphs will be shown side-by-side in a single page

The scrollbar is disabled, and charts resized as more selections are chosen to maintain the layout and comparison ability over time in one page.

C. Color

Color for each element are mostly in the same palettes. Consistent element design makes user more comfortable with this tool and facilitate efficiency to get the work done. For example, the legend of the selections appear immediately next to the charts, and server as positional representation of the charts to its right.

V. THE APPLICATION

i. Select and Search Function

Users can compare economic indicators by searching or selecting from the dropdown list on our application of up to 3 selections at a time.

The visualization will be generated below upon selection. When multiple selection boxes are filled, the application will plot the additional selections, allowing the user to compare between countries on the same graph, and re-sizing the stacked area charts to fit on a single page.

For example, comparing how one country fares against their closest competitors by choosing or searching this country. Selecting another country, other countries can be analyzed in a similar way, to see if they are heading towards a similar trend in terms of indicator values changing, and whether their sectors follow the same pattern.

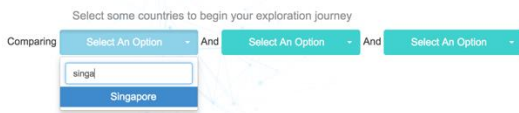


Figure 5.1 Select and Search Field

ii. *Data Visualization*

These are our charts used in the overall visualization.

A. *Glyph Chart*

6 dimensions representing the economic indicators are positioned to the left, with colored circles representing its values appearing along its axis, and colored area which connects these circles in a 'radar' or 'glyph'. Changes to these values over time make them move to different positions, and allow users to derive insights of the economic indicators and how they perform over time.

The areas are in specific colors to represent the country, which can be seen from the legend. Red circles denote negative values, while gray ones denote empty or NaN values. These records were still kept as the resulting display is the same.

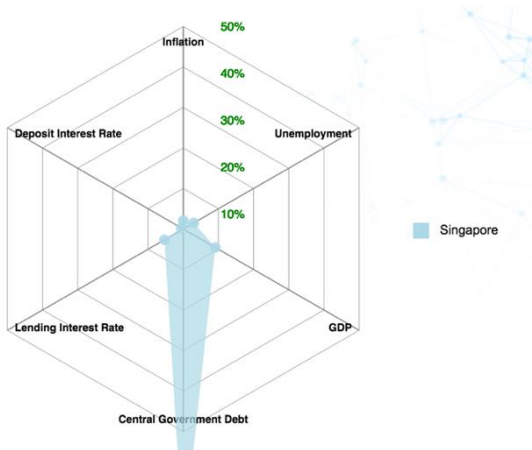


Figure 5.2.1 Glyph Chart

B. *Stacked Area Chart*

This stacked area chart plots the overarching sectors contributing to GDP of a country. The x axis represents the year, and y axis for cumulative percentage of GDP. Note that some countries or regions do not have a sector contributing to their GDP.

The legend appears next to its corresponding stacked area chart, representing your selection. Each color on the stacked area chart is representing a sector, either Agriculture, Industry or Services.

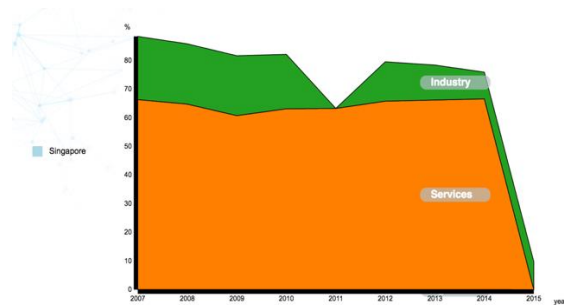


Figure 5.2.2 Stacked Area Chart

iii. *Time-series function*

Time-series function provides a play button and a timeline to animate the visualization. Changes will be made on the animated radar chart. Each year represents a 'snapshot' of the economic profile of the countries or regions, allowing you to see the changes over time.

By doing so, users can see the evolution of these economic indicators over time and compare them to how the industries fared, revealing some insights on how well or bad the performance is, and in which sector.



Figure 5.3.1 Initial Timeline

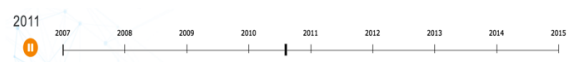


Figure 5.3.2 Animated Timeline

iv. Hover function

Hovering over both charts, details of the indicators on a tooltip will be shown beside the cursor. Other than overall picture of the economy profile, users could obtain the exact values as well.

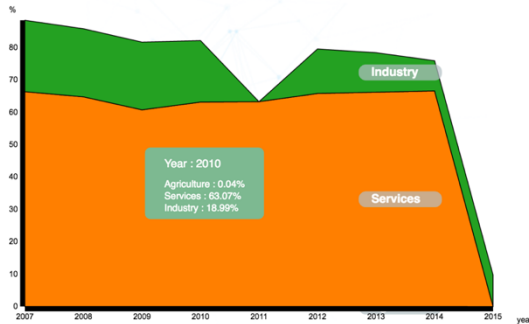


Figure 5.41 Hover over Stacked Area Chart

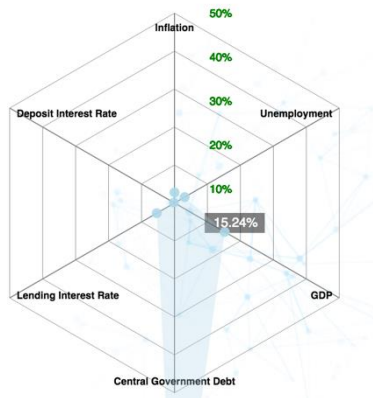


Figure 5.4.2 Hover over Glyph Chart

VI. ANALYSIS

Our application generate visualization based on World Bank database and provide visual cues for users to look into. A set of data can be obtained and interpreted from graphs. When the user select one country and enter single view mode, 6 economic indicators will be shown on the radar chart and how three sectors made contribution to the overall GDP will be shown on the stacked area chart. Hovering over either chart, the exact value will give accurate information to users. Playing the button, how the indicators change along the time will be animated on the radar chart. Same to the comparison mode, other than all the information users can get from single view mode, comparison among countries will be visualized on the radar chart and stacked area chart.

Apart from the basic usage of this visualization, interpretation and exploration is subject to the user's needs. For example, a job seeker may want a relatively stable economy for the country to migrate to. When pressing 'play' he or she is looking for almost no changes to the economic indicators, except for Savings Interest Rates, and a low unemployment rate, which works to his or her advantage in the long run. A businessman would look at Lending Interest Rates, and possibly high GDP, indicating there are opportunities for growth and a low competitive advantage. Additionally, users new to economics can spot unusual patterns, and are prompted to learn more about them and the differences of the indicators with other countries.

Regardless of the different ways of use, our visualization allows different users to derive their own insights in a simpler manner compared to existing means, and hopefully initiate more detailed conversations or know which indicators to start thinking from before making their decisions.

The purpose of the functions discussed earlier were to help user spot trends quickly based on visual cues. Now that users have assistance in zooming in to a particular pattern, trend or insight, these tooltips assist the user in obtaining the exact information which they can note down when comparing with more countries around the world. Thus, this speeds up their decision making ability as they have the raw data and knowledge of the underlying behavior of the countries he or she have compared from before.

VII. FUTURE WORK

i. Detailed sector breakdown

An improvement of our application would be to detail the industries instead of displaying the generic sectors of Industrial, Agricultural and Services. We would like to integrate specific sectors to allow more accurate analysis, and allow the users to derive more insights. For a job seeker, it would be good to know that manufacturing is doing well but which precise industry such as glass or technology would lend more interesting insights and decision making capabilities to a job seeker or economist.

ii. *Time-series bar for the stacked area chart*

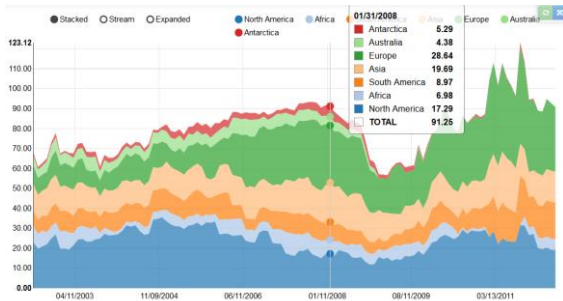


Figure 7.2 Time-series bar

Currently, hovering over the stacked area chart will show you a small box which is a tooltip containing values of sector contributions to GDP at that specific year. For the future work, we can present a bar along the axis to cut the specific year and to show each value respectively to allow more intuitive understanding. Additionally, this can be linked with the glyph chart when playing the animation.

iii. *Inner circle for negative values*

In our radar chart, we currently mark negative change in red. Further work could include an additional inner circle to denote negative change up to -10%. Additionally, coloring the area and circles in red can be more intuitive to denote negative values to users by making use of color and position change in the animation to know something drastic has happened if one year was positive, showing the colored areas expanding outwards, and another year had turned negative, with the areas collapsing inwards.

iv. *Grouping economic indicators*

The six economic indicators used now may be difficult to follow all at once. We propose future work to study the correlation of one indicator to another, perhaps forming boom or bust stages of an economic cycle, after each has reached a certain threshold. This would make the chart more intuitive to interpret.

VIII. LIMITATIONS

i. *Comparison limits*

There is a need to consider the amount of cross-analysis users can take at a time. For these reasons, we decided to keep it at 3. However, this may pose as a limitation as there could be faster and more space-friendly techniques to visualize the comparisons between user selections.

ii. *Data availability*

Even for the indicators we have selected, the data are sometimes not filled for some countries, appearing as blanks, or even as zeroes, which affects the data integrity and thus visualization. Additionally, regional data for each industry could not be obtained. According to World Bank, surveys are infrequent in developing countries, and industrial production for example, are not captured in formal sectors. There are some unreported, illegal or small-scale activities which are not accounted for. Thus, the figures provided by World Bank should be taken as an estimate and not as exact figures when making a comparison.

iii. *Monthly and quarterly indicator snapshots*

Having monthly and quarterly periods can allow much more insight on how a country or region is doing. Our sources may not be able to consistently update their data on time, thus affecting this visualization from being used frequently, thereby limiting its analysis to an annual one.

IX. CONCLUSION

Our tool allows users to compare and interpret economic information in one place. Regarding what the market offers, we think that our visualization is a new approach to interpreting economic information and helps people be more informed. It enables them to see the past trends in the economy regarding time and location, and simplifies a part of their analysis and decision-making process. In overall, we hope that to improve this tool based on our limitations and future work, to allow greater data exploration and helping users to draw even clearer relationships between the dimensions.

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<http://worldbank.org>

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