Analyzing Global Economic Growth and Development Trends Using the Penn World Table (PWT)

A Focused Visualization of the Top 10 GDP Countries and Critical Economic Years in Global Economic History

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1. Dataset Description: The Penn World Table (PWT)

The Penn World Table (PWT) is one of the largest and most often used global macroeconomic data sets which includes various keys and factors for evaluation of economic development and growth for different countries during the specified time periods. It includes a vast dataset of economical indicators of countries and different decades. Being very comprehensive and given with high degrees of disaggregation, the PWT constitutes a superb equipment for assessing trends of economic development in the world and for comparing the economy of different countries.

As mentioned earlier, there are some reasons that make the PWT rich in information and includes several key variables. Real GDP per capita, which informs about the total and inflation-adjusted national production, allows examining a country's size and its growth rate in foreign currency terms over time and as compared with countries in the sample.The measures of labor productivity, which express the level of GDP per units of labor, provide information about the efficiency of using labor in one or another economy. Awareness of price in terms of referred indices is essential for the computation of the purchasing power or the cost of basic amenities in different countries. Additional information on capital formation or funds invested in physical capital which include machinery and buildings gives information on extent to which a country is concerned with the expansion of its capacity to produce goods. The PWT also holds the statistical capacity pie which reflects on the quality and inventory of the statistics on the economy for a particular country. It is here that an X-ray into the input data available for analysis and decision making offers a perspective. However, the integration of these variables in PWT makes cross-country analysis possible and useful forcapture of the global economic systems.

2. Variables Probed and Scale of Measure Employed in Developing the Visualizations

The following will seek to discuss each visualization with respect to the variables used and their respective measurement levels.

Real GDP Over Time

This visualization, presented as a line chart showcases the trend of real GDP for numerous countries across an extended period.

Real GDP: Measured on a ratio scale, real GDP represents the inflation-adjusted value of all goods and services produced within a country. This scale allows for meaningful comparisons of economic output over time, as it accounts for changes in price levels.

Year: Represented on an interval scale, the year variable depicts the specific time points at which real GDP is measured. The interval scale allows for the calculation of differences between years.

Country: This variable, measured on a nominal scale, categorizes the data by country, enabling comparisons of real GDP trends across different nations.

This will help in analysing how the actual GDP for each country has changed overtime. Growth, stagnation, or contraction periods can be diagnosed. The economic performances of various countries can be contrasted. Notable economic events, including recessions, recoveries, or booms, and their impacts on the course of trends in GDP, are highlighted.

Labour Productivity

This visualization, displayed as a bar chart, highlights labour productivity levels for various countries across selected years.

Labor Productivity: Measured on a ratio scale, labor productivity quantifies the economic output generated per unit of labor input. The ratio scale enables comparisons of productivity levels between countries and across different time periods.

Year: Similar to its use in the "Real GDP Over Time" visualization, the year variable here is also measured on an interval scale, allowing for temporal comparisons.

Country: As in the previous visualization, the country variable utilizes a nominal scale to differentiate data based on national categories.

This visualization allows a user to identify countries that had the highest and lowest productivity in selected years, show patterns in changes in productivity growth or decline by time and check if labor inputs relate to the differences between countries concerning economic output through comparison of the relative productivity.

Growth Contributors:

The treemap visualization has involved various variables, with different measurement scales aimed at providing further insights about the data distribution and comparisons in relation to categories. The following provides the focus on the analysis of each variable together with the corresponding measurement scales in the visualization:

1. Country: This is a variable that depicts the different regions or countries being covered in the analysis-for example, Russia, India, China. This is a qualitative variable measured on a nominal scale since there is no inherent order or ranking among the countries involved in this analysis either. Data is organised and grouped visually in the treemap using this variable.

2. Statistical Capacity Indicator (Statcap): This is a variable that indicates the statistical capacity of each country as measured by a composite index. The score on Statcap is a quantitative variable and measured on an interval scale because it has meaningful differences between scores without a true zero point. Color intensity in the treemap corresponds to the values of Statcap, where deeper shades go for higher scores.

3. Year: The three-year values in the chart-2008, 2010 and 2019-are a categorical variable measured on a continuous ordinal scale. Because the variable is discrete, there is an inherent order in this sequence of years that allows for time comparisons. Still, these aren't continuous measures and don't lend themselves to arithmetic averages.

4. Dimensions: The dimension of each block in this treemap likely represents some other measurement characteristic that might be appended to Statcap, maybe the population size or regional relevance. In case they are depicted, then this is a quantitative characteristic measured on a ratio scale, since it has a true zero point and these can be measured on a ratio scale. The treemap combines the variables in a layered, hierarchical manner to depict the relationships and differences between the countries, their statistical capacities, and changes over time. Altogether, it is with the pertinent application of nominal, ordinal, interval, and ratio scales that point to a profound and intuitive understanding of the data. Size, color, and grouping all correlate with applicable scales to effectively communicate patterns and trends in statistical capacity across countries.

Price Levels Between Countries

This is a bar chart and is meant to illustrate relative price levels across different economies.

Price Level Indices (Pl I, Pl K, Pl N): These are measures on a ratio scale which represent the relative cost of goods and services in different countries with respect to a base country.

Country: This country variable uses a nominal scale to categorize and differentiate data according to national classification.

Statistical Capacity Indicator for the World

This visualization represents the Statistical Capacity Indicator for different countries using a choropleth map.

Statistical Capacity: It comes in the measure ratio scale. It therefore reflects the quality and availability of economic data for a country and implies higher values for having stronger statistical capacity.

Country: This graph employs a nominal scale that reflects the geographical location of countries on the map.

The scales of measurement applied here are critical elements in the description and interpretation of the data. Compared to all other types, ratio scales provide the highest level of comparison. For instance, a ratio scale offers meaningful ratios and even a calculation of differences. It renders difference measurement. A nominal scale groups data into qualitative categories that do not contain any inherent order or ranks.

3. Process of making visualizations- Top 10 countries basis GDP (filtered by critical economic years in the history)

The file format may vary in case of importing PWT data since Tableau supports many database connections, text files (.csv,.txt), and Excel files (.xls,.xlsx). Most import procedures start with choosing the type of the data source and indicating the file location or a connection to the file.

After the identification of the Penn World data file, Tableau previewed the data so that it could be reviewed ahead of full import into the workspace.

The transformation and cleaning may significantly affect the kind of quality and structure of delivered data. For example, the format standardization implies the single date format combining and the elimination of the country name inconsistencies. Some of the possible changes included the calculation of the new variables, for instance, the total growth contribution, capital attractiveness index, and labor productivity that shall be derived by dividing the real GDP and the number of people employed.

I processed the data further to begin working with Tableau. From the top ten countries by GDP data sheet, I created a new table and filtered for only those years: 1950, 1970, 1990, 2000, 2008, 2010, and 2019. This preparation put me working from a dataset that was reduced and focused on the main objectives of the analysis.

Green was the colour hue dominating this process' colours.

Some of the data types, which may be easily represented using different visualization styles in Tableau, are real GDP, labor productivity, pricing levels, and statistical capacity. Each method of

visualization provides different types of insights, and when they occur on the same dashboard, they provide a complete picture of the data.

Real GDP Over Time

A line chart can be used in order to analyze changes within the economy over a span of time, beginning with a time series analysis of Real GDP. Beginning by dragging the "Year" dimension to the Columns shelf and the "Real GDP" measure to the Rows shelf, this chart will be created. Adding this means that by bringing the "Country" dimension into the Color mark, it gives a color-coded account of each nation's GDP and facilitates an easy visual comparison of economic performance.

Labour Productivity

This is a handy way to display labor productivity by nation and year. The formatting, which puts "Country" on the Rows shelf and "Year" on the Columns shelf, makes it easy to do both side-by-side comparisons of nations and time-series analyses of what happens over the course of time. The Size and Color markings were assigned the "Labor Productivity" measure, which has produced bars that vary by size and color to reflect differences in production.

This makes comparison of productivity across nations and years visually intuitive.

Price Levels

A group bar chart is good for comparative purposes on the price level among nations. Tableau generates grouped bars that will allow for comparison of the price levels by side by moving "Country" to the Rows shelf and each measure, including "Pl I," "Pl K," and "Pl N," to the Columns shelf. The clustering feature of Tableau will also allow clustering of countries with similar price points, thus providing an overview of how different countries rank in terms of this metric.

Statistical Capacity Map

The Statistical Capacity Indicator is the most illustrative at the world level in a map format. Where one has dragged the "Country" dimension over to the Detail mark within the Marks card, Tableau has generated a map where every country takes an entity form. By dragging the "Statistical Capacity" measure over to the Color mark, it also generates a color gradient reflecting the level of statistical capacity that prevails over countries; darker for the former while lighter for the latter. Once the different visualizations were created, they could be assembled to make up a dashboard. Positioning, resizing, and aligning each visualization on the canvas was easy using a drag-and-drop interface in Tableau.

The addition of more dynamic features to the dashboard, such as filters, would also increase interactivity. Filters allow the user to focus on particular subsets of data by filtering by year or by country and establishing a range for particular metrics like labor productivity or statistical capacity. Tableau has individual filters that apply to individual sheets and global filters that affect all representations of the dashboard. Interactive aspects include controls, tooltips, and highlights which further improved user engagement. Tooltips give more information about specific data while hover information of data points can be shown with related information in other visualizations. The user can change the values interactively using parameters and control sliders along with seeing how the representation changes. It may result in a more intuitive and interesting data exploration.

A Tableau dashboard may be both educational and entertaining by carefully integrating various visualizations and interactive elements, where users can easily examine data from several angles and come to insightful knowledge.

4. Visualization analysis:

1. Country-wise Real GDP over Time

A fascinating story about the development of economies worldwide between 1951 and 2021 surfaced in the real GDP over time visualization. China patently has been on an incredible, exponential tract since 1990. It is consistent with China's economic reforms and its opening to international markets. Economic maturity in industrialised economies is represented by the flip side of the picture with the graph of industrialized countries such as the US and Japan steadily going up but with growth rates dropping. The picture also shows India's slow rise with the help of cumbersome reforms and gargantuan, underemployed labor forces. That is, the claim underscores the seriousness of demographic issues in setting trends for the GDP, especially for densely populated countries like China and India.

In fact, it's interesting to note that the graph shows signs of both economic stability and volatility. The global financial crisis in 2008, for instance, led to an underlying transitory decline in most nations but recovery probabilities differed.

Japan and the Russian Federation, at times, have proposed stationary levels, probably because of structural or geopolitical factors. Conclusion This graph is such a fine representation of how economic growth patterns differ by the rather complex association of population dynamics, resources, and policy.

The key takeaways: Economic growth differs significantly from one country to another, but developed economies are steadily increasing while developing economies, such as China, rapidly grow.

2. Labor Productivity by Country and Year

The labor productivity visualization provides an easy correlation between the economic efficiency of the different nations. Due to the developed technological infrastructure, the well-skilled labor force, and hence the streamlined production processes, productivity levels amongst the advanced nations such as the United States, Germany, and Japan reach a remarkably high number.

The United States is undoubtedly one of the most advanced countries because of its stead development over the years. On the other hand, low-value-added sectors with structural inefficiencies are pointed out by developing countries like India with relatively lower productivity levels.

In this regard, China's path is all the more remarkable since it is becoming a middle-income economy from a low-income economy based on technological adoption and manufactured efficiency.

Paralleling China's transformation into a global hub for business and innovation is the country's remarkable rise in productivity over the last few decades. As in many developed economies, productivity sometimes leveled off or declined in the short term. This was symptomatic of periodic

recessions and even more severe events such as the 2008 financial crisis. This graphic goes on to show that the best investments in education, technology, and policy reform both matter equally to high workforce productivity standing alongside economic standing. Productivity growth positions all nations well to raise their living standards and contend internationally.

Key Takeaway: As developing countries like China quickly overtake developed economies, labor productivity growth is essential for economic competitiveness.

3. Contributors to Growth (Capital, Labour and TFP)

The growth contributors chart identifies the fundamental forces behind economic performance by classifying contributions into capital, labor, and total factor productivity. TFP measures efficiency and innovation, registering its highest rates in developed economies like the US, Germany, and Japan-this is a phenomenal validation for the shift toward knowledge-based economies. In contrast, developing nations such as China and India relied more on extensive growth models characterized by high input reliance on labor and capital.

Contributions of TFP have revealed that economies are entirely capable of generating value added beyond the normative input. This aspect is highly significant in developed economies since growth is now driven by the proper and technologically advanced procedure. Capitalism, besides labor, has become an indicator of increased productivity in promising countries. That becomes highly interesting: it reveals that a balanced contribution from the three criteria identifies that the country has a high chance of steady development.

Hence, it acts as a diagnostic instrument in determining economic maturity. Further sustainable patterns of growth are reflected by countries with stronger TFP contributions; those that mainly rely on labor and capital may lead to diminishing benefits in the long run.

The key takeaways: Long-term economic stability and prosperity is greatly propelled by moving toward productivity-based growth.

4. Price level by country: comparison

The gap and heterogeneity of the economy are also represented by comparing prices by country: Pl I, Pl K, Pl N. If countries are plotted according to the different pricing levels, they would show clusters with fundamentally different cost structures. High price levels characterize Cluster 1, which consists of developed economies with strong purchasing power. In classes two and three - the emerging and low-income countries - cheap prices are caused by currencies often being weak and overall living costs low.

This clustering brings out the dynamics of the world economy. High prices in industrialized countries are indicative of well-developed infrastructures, better incomes, and hence more disposable income. Low prices in developing nations mean that it is cost effective to produce or live there; therefore, such nations can attract international investment.

Key takeaways:What is brought about through this intra-cluster inequality is the complexity of global economics-the fact that even countries with comparable pricing levels will have different economic potential and standards of living.

This will enable the public and private sectors to better understand the distribution trends of price levels, thus helping the planners identify economic opportunities and problems related to this global pricing trend to guide strategic investment decisions. The price level variances depict the changes in purchasing power and living standards and are, therefore, expressions of global economic inequality.

5. Statistical Capacity Indicator of Developing Countries: China, India, and Russia)

The Statistical Capacity Indicator (Statcap) for China, India, and Russia in 2008, 2010, and 2019 is shown on the statistical map; deeper shades correspond to higher Statcap values. The visualization shows that countries are capable of collecting, analyzing, and disseminating highly high-quality data. Conforming to its efforts toward strengthening statistical capacities for economic growth and the growing need for reliable information, India's pattern is improving over time. However, the pattern has made lots of progress with improvements in data governance and the possibly very much needed updating of statistical methods as the biggest drivers. Scores for China during the period considered are much more stable but strong, that its system is well-developed and capable of meeting the demands of this gigantic and very intricate economy. On the other hand, Russia's statistical capacity has been sound rather than year-by-year based on its overall scores over time. Comparing these countries has thus highlighted the disparities in statistical evolution. India, from a meager start, shows that its upward curve portrays substantial space for growth. Statistics infrastructure is mature in China, and thus can be seen by the consistency of scores there. In contrast to India's dynamic improvement, Russia's performance remains stable, indicating stability but only a recent and restricted growth.

Key takeaways: These differences portray the different strategies and goals for development each of these nations has set for their statistical systems. The improvement in India's statistical capability is the greatest over time and therefore shows improvement in its attempts at modernizing its data system. A comparison of both emerging countries can be garnered from the fact that Russia has stability but only made slight recent improvements with respect to its statistical capabilities, whereas China has steadily produced high marks, showing maturity in the statistical system.