



Estimation of GDP growth –

Non-conventional approaches

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Why non-conventional approaches needed?

Gross Domestic Product (GDP) of a nation measures

- how big is the economy
- how well the economy is performing

GDP is generally estimated by National Statistical Agency of a country based on

- System of National Accounts (SNA) , 2008 adopted by UNSC

Why non-conventional approaches needed...

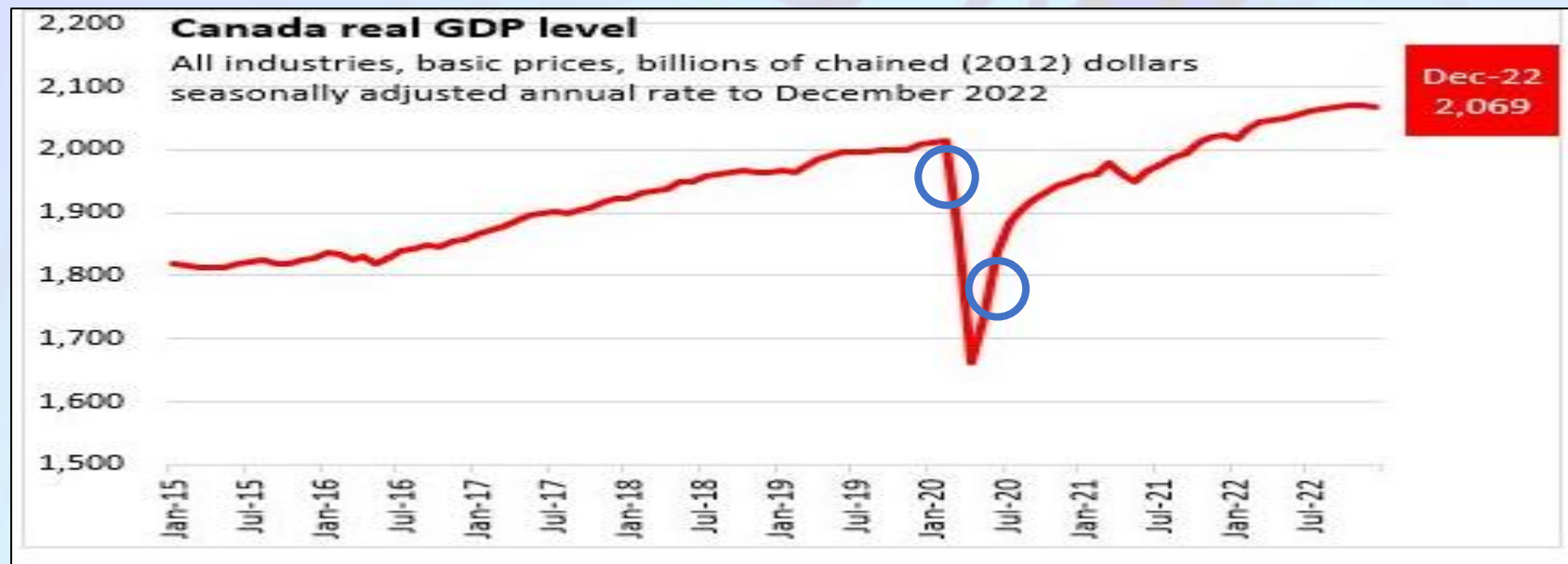
- Frequency of conventional GDP releases – Annual & Quarterly
- Are the data sources of Annual and Quarterly same?

No, Because-

- (i) Annual series involves data collection from large number of sources which is time-consuming.
- (ii) Most/ many of the sources can provide data only at the end of financial year.
- (iii) Some of the indicators are available quarterly and can be directly consumed.
- (iv) Extrapolation of indicators surveyed in benchmark years are performed for quarterly estimates.

Why non-conventional approaches needed...

There is constant demand for monthly/ weekly trackers of GDP . Why?



For early detection of upward or downward trend in the economy

Why non-conventional approaches needed...

- In unusual situations (pandemic/ war/ natural disaster) conventional sources of data fails.
- Covid out-break has popularised the use of Google trend data as a reliable source of indicators
 - to provide independent estimate of economic indicators like GDP/ inflation
 - augment traditional data sources to provide estimates of economic indicators

Why non-conventional approaches needed...

- Policy makers observe high-frequency indicators for getting early signals.
- To draw inference about the economy from monthly (high-frequency) indicators, formal procedure for grossing up is needed.

-Different non-conventional approaches are used for summarising information contained in high-frequency indicators and provide estimate for GDP/ macroeconomic growth.

Non-conventional approaches

- Parametric model approach
 - based on high-frequency indicators, parametric model is fitted to estimate monthly GDP growth
- Non-parametric Machine learning approach
 - based on alternative data sources (e.g.:- Google Trends) to estimate quarterly/ monthly GDP growth



Nowcasting

On the last day of quarter/ month

Challenges of non-conventional approaches

- Choice of indicators is considered to be the most challenging issue in non-conventional approaches. It depends on-
 - availability of data on or before completion of time-frame (month/week etc.)
 - usability (minimum processing needed)
 - Structure of economy (% share of formal economy)
 - Cultural aspects

There is no 'magic number' which defines the ideal number of indicators.

Choice of indicators

Depends on the following characteristics:-

- Should have production relationship or price relationship with the target variable (GDP growth)
- Most of these indicators are by-products of administrative process.
- Limited number of indicators may be collected through survey
- Similarities with trend pattern needs to be evaluated qualitatively.
- Multiple indicators may be available for same item

Choice of indicators....

Needs periodic review as

- contribution of the sector related to the indicator might change over time.
- agency might stop producing the data related to the indicator in the form it is being consumed in the model.
- new type of indicators might have become important due to change in consumption pattern/ payment structure etc.

- Reviewing suitability of indicators is a continuous task.
- Frequency of review depends on the availability of resources as well as structure of the economy.

Suggestion for selection of indicators

- Production & Turnover
 - Production index for industry, by major division (mining, manufacturing, electricity, water, etc.)
 - Construction index
 - Trade index
 - Number of building permits granted
 - Number of personal car/ commercial vehicle registration
 - Production of commodity (arrival in market may be used as proxy)
 - Agricultural goods
 - Minerals

Suggestion for selection of indicators....

- Price index
 - Consumer Price Index
 - Producer Price Index
 - Import Price index
 - Export Price Index

Suggestion for selection of indicators....

- Labour market
 - unemployment rate
 - wage rate
- External sector
 - import/ export of goods and services
 - official reserve assets
- Economic sentiment (survey based)
 - consumer confidence
 - composite business cycle indicators

Suggestion for selection of indicators....

- General Government

- revenue

- expenditure

- Financial Market

- interest rate

- exchange rate

- stock market indicators

- spread between lending & borrowing rates

Suggestion for selection of indicators....

- **Transport**

- air cargo movement
- airport footfall
- railway freight movement
- railway passenger movement

- **Financial Sector**

- Central bank reserve money
- Central bank net foreign assets
- Central bank domestic lending
- Central bank reserve money

Suggestion for selection of indicators....

- Payment structure related
 - number of online transactions
 - number of ATMs
 - number of UPI payments

List is only indicativedepends entirely on structure of economy

What is Google Trend data?

- Google Trends provides unfiltered sample of actual search requests made to Google
 - annonymised
 - categorized (determining the category of search)
 - aggregated
- A random sample of search results are shown based on given **time-period** and **geographical location**.
- Search results are **normalized**.

Reference to Original Study

- *Tracking Activity in Real Time With Google Trends* by Nicolas Woloszko of Economics Department of OECD in November, 2020.
- Developed tracker for *weekly growth* movement of GDP of 46 OECD and G-20 nations.
- Used 46 keywords of Google search

Search Topics & Categories

Topics

- finite number of topics and subtopics (around 470) under Google Search
- GT provides sample from all searches related to specific topic
- for GT analysis 23 Topic keyword used

Example:- House moving, Recruitment, Investment, Lawyer, Job, Unemployment, Office space, Job search etc.

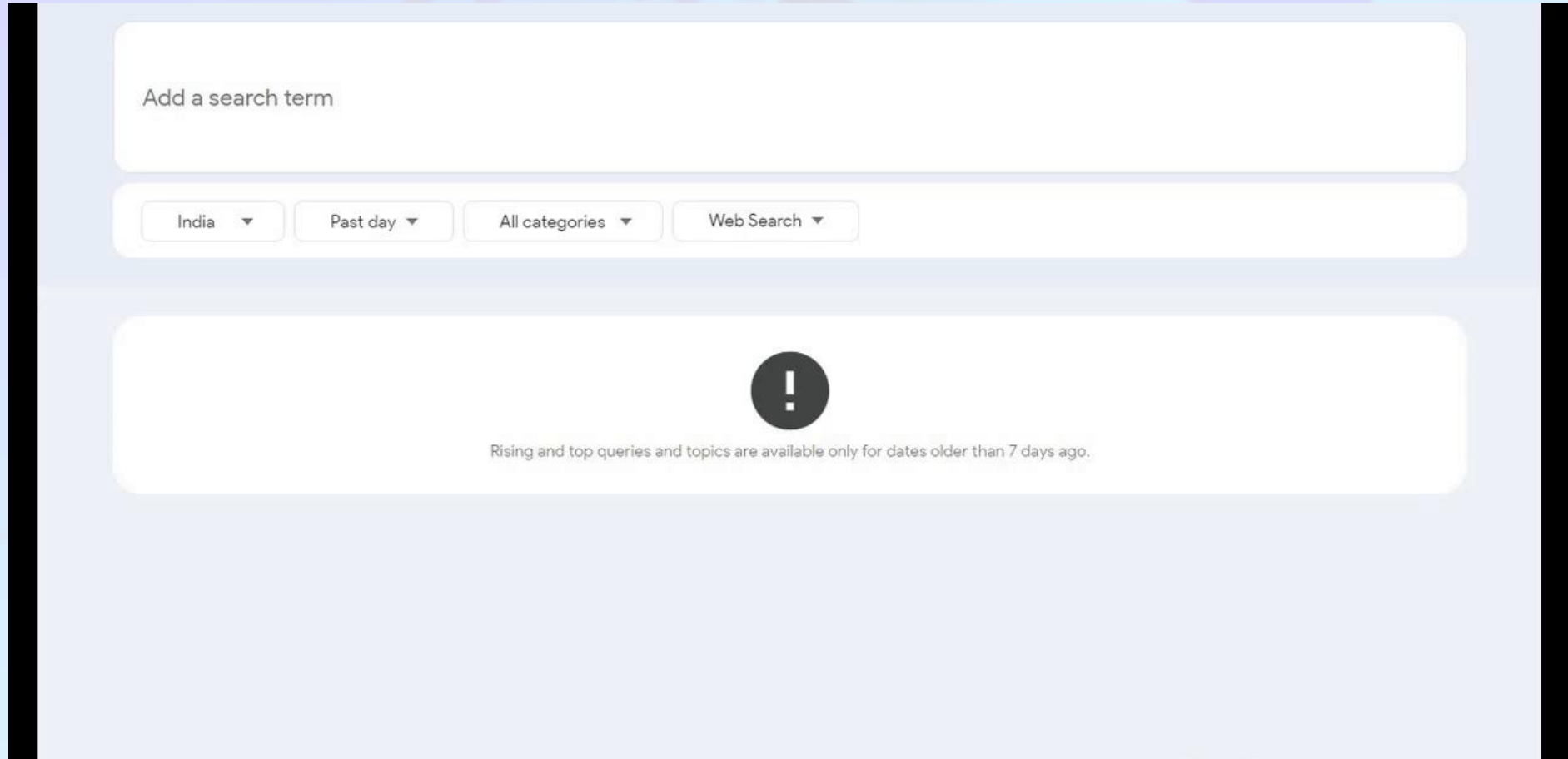
Search Topics & Categories.....

Categories

- category provides broader search option
- GT provides sample from all searches falling under specific category
- for GT analysis 88 Category keywords used

Example:- Autos & Vehicles, luxury goods, pharmacy, jobs, food production etc.

A small video to show Google Trend



Pre-processing of Google Trend Data

- **Trend**

- data has an overall upward trend which can be removed using any suitable method

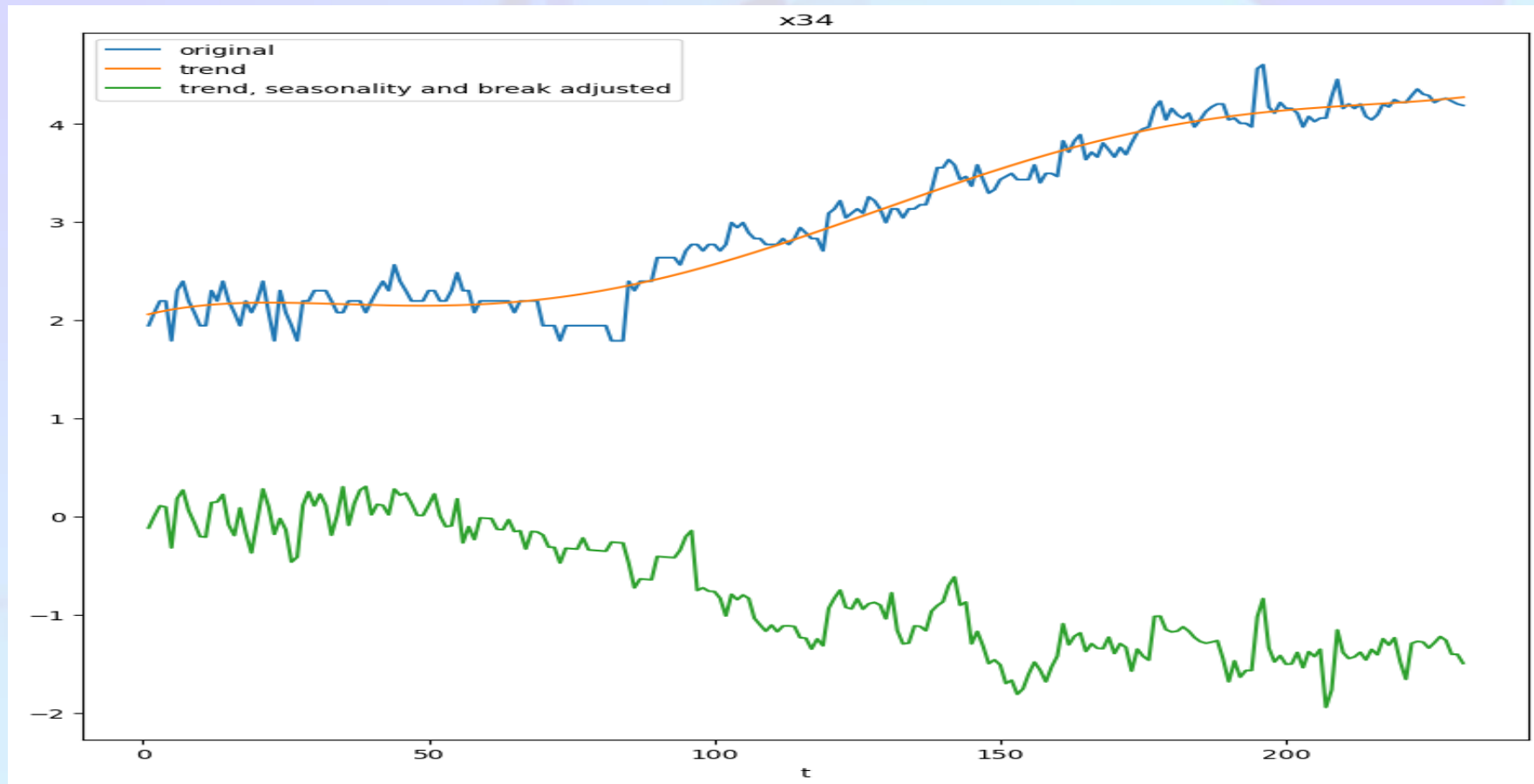
- **Seasonality**

- Most variables exhibit strong seasonal patterns. Consequently, variables are transformed using the log difference with the same month of the past year.

- **Breaks (2011 & 2016)**

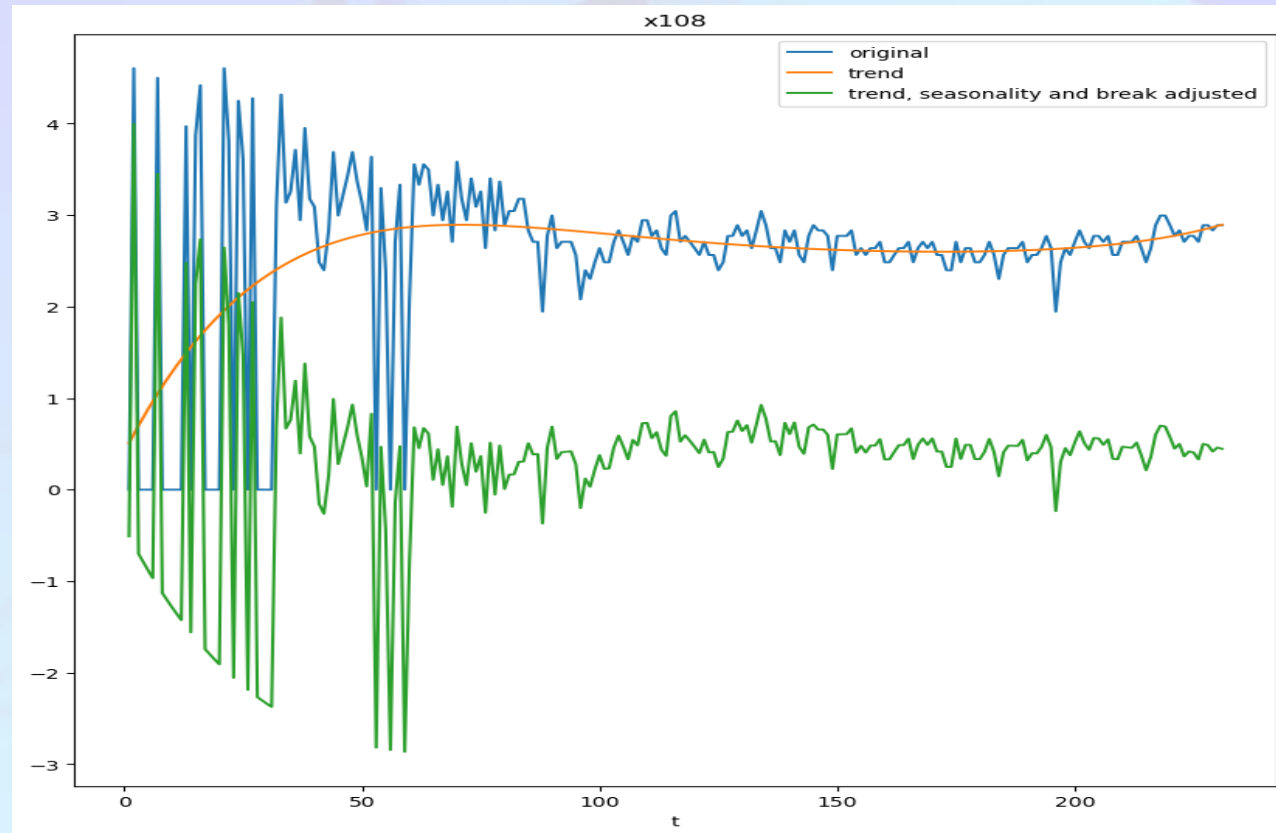
- difference between January 2011 (2016) and January 2010 (2015) is subtracted from observations after January 2011(2016)

Pre-processing of Google Trend Data....



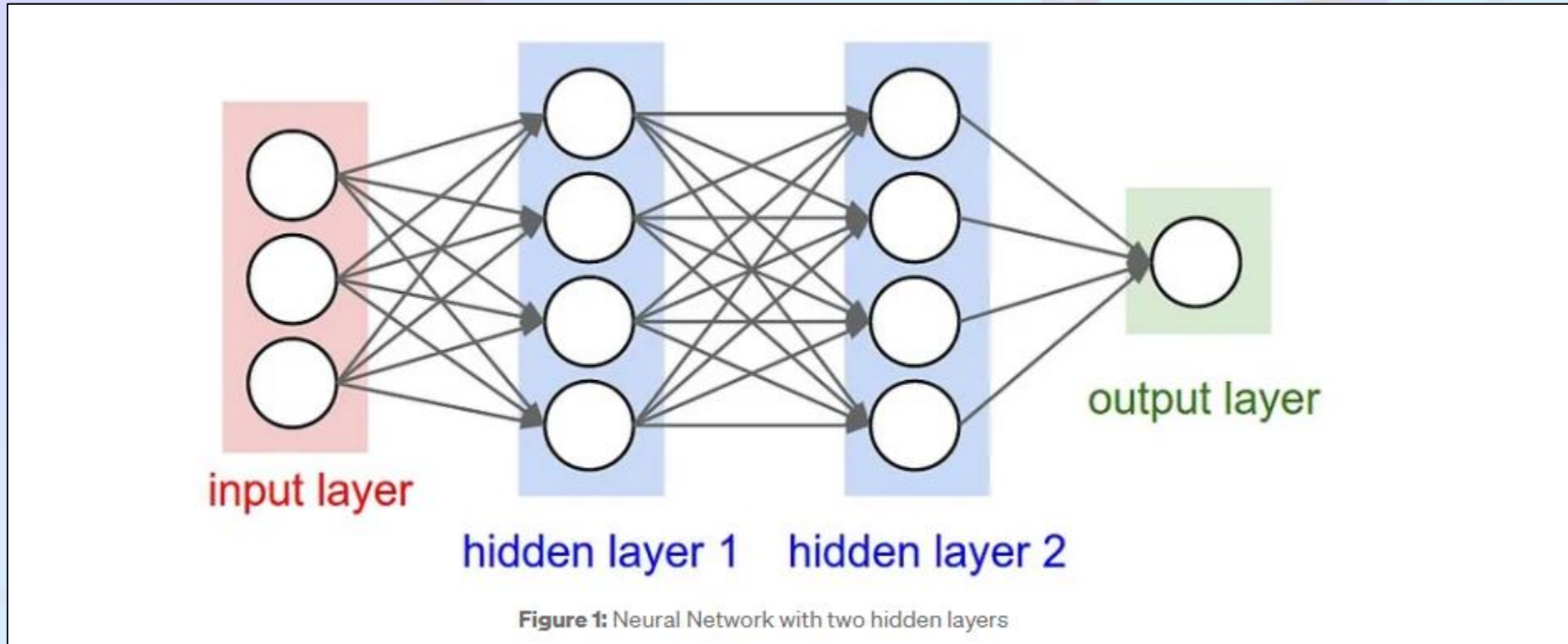
Keyword: grocery & food retailers (category)

Pre-processing of Google Trend Data....



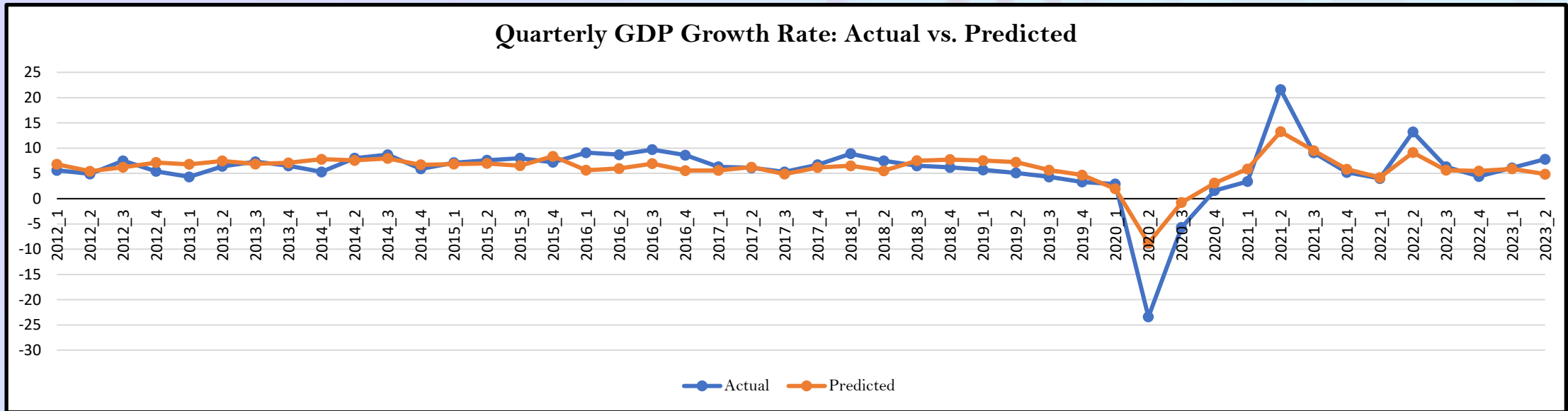
Keyword: financial crisis (topic)

Model Fitting



- Uses standard architecture with two hidden layers of 300 and 10 neurons
- Adam solver and “relu” activation functions

Results



- Growth rate derived from the model and actual growth rate are reasonably close.
- Major departure noticed during first and second quarter of 2020 where growth rate was highly negative.
- R^2 value of the model is found to be 0.4305

Dynamic Factor Model

- Parametric model based approach
- Suitable for economies where several high frequency indicators exist

- can be augmented with large number of indicators
- unlike regression model, it is not affected by 'curse of dimensionality'
- mixed-frequency indicators can be used

Dynamic Factor Model.....

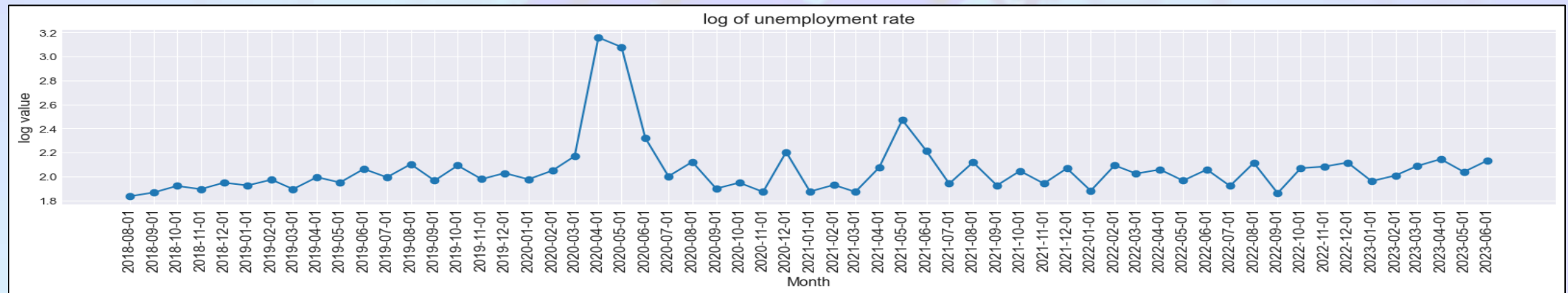
- aimed at measuring the growth trend of GDP/ any other macro-economic indicator
- not aimed at matching the precision of NSO responsible for GDP compilation
- suitable for nowcasting or forecasting for near future (few months or 1-2 quarters)

Typical HFIs used for DFM

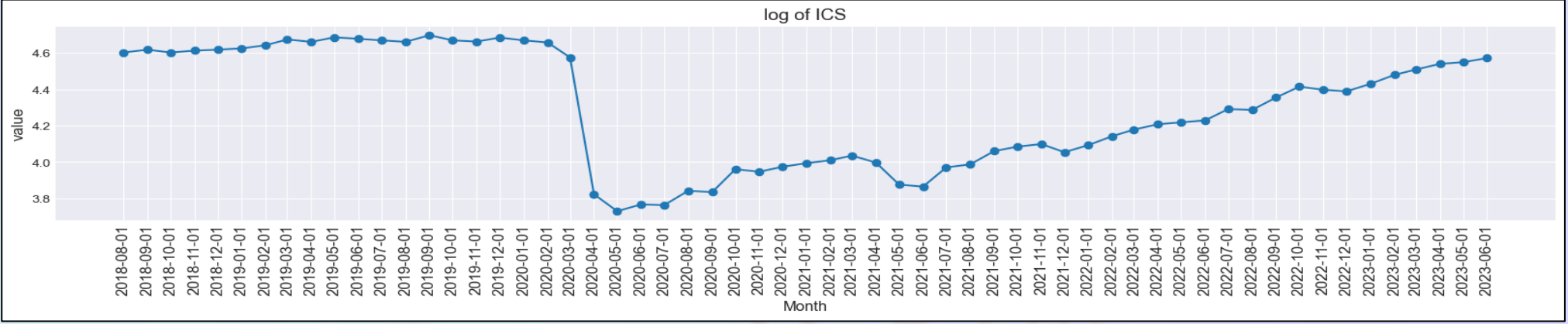
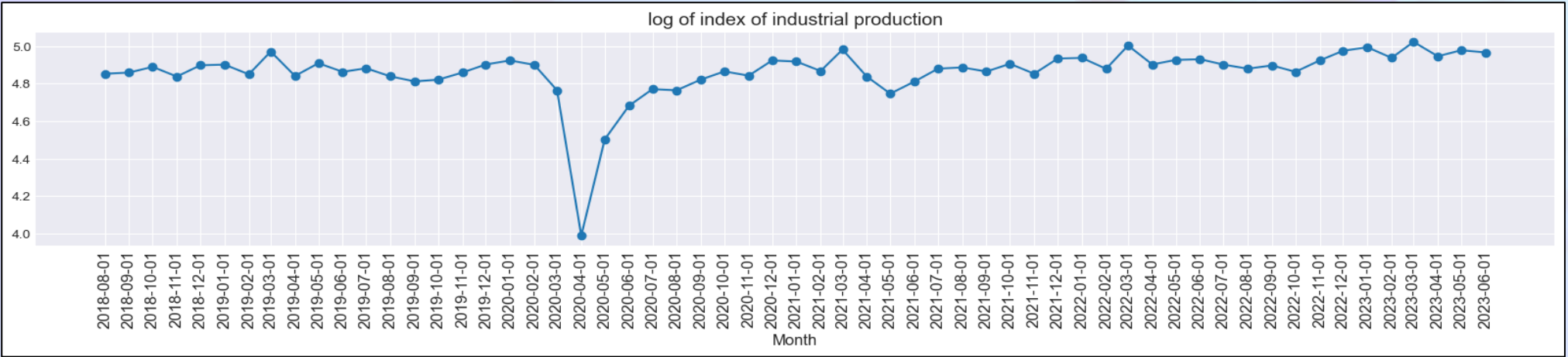
Traffic movement
Aircraft Movement (in '000)
Air Passengers (in million)
Railway freight (in million tonnes).....
Consumption Related
Index of Consumer Sentiments (ICS)
Index of Current Economic Conditions (ICC)
Index of Consumer Expectations (ICE).....
Employment related
unemployment rate
Production Related
Index of Industrial Production
Stock Market related
NIFTY500
Import/ Export related
Net import of petroleum

Pre-processing

- Log-transformation of indicators is suggested
- Lagged value of indicators may be taken if the original data is not stationery
- Each indicator value is standardised



Pre-processing.....



Model Fitting

- Using DFM, the information contained in large number of indicators is transformed into one or few factors.
- Factor(s) are orthogonal in nature.
- Monthly factors are quarterised (if the target variable is quarterly)
- Factor(s) is regressed on the target variable (*GDP/macroeconomic variable of interest*) to estimate the model.

Model Fitting....

Step 1:-

A general dynamic factor model is written as:

$$x_{it} = \Lambda f_t + u_{it} \quad \text{where } i=1,2,\dots,n$$

$$f_t = A_1 f_{t-1} + A_2 f_{t-2} + \eta_t \quad \text{where } \eta_t \sim N(0, I)$$

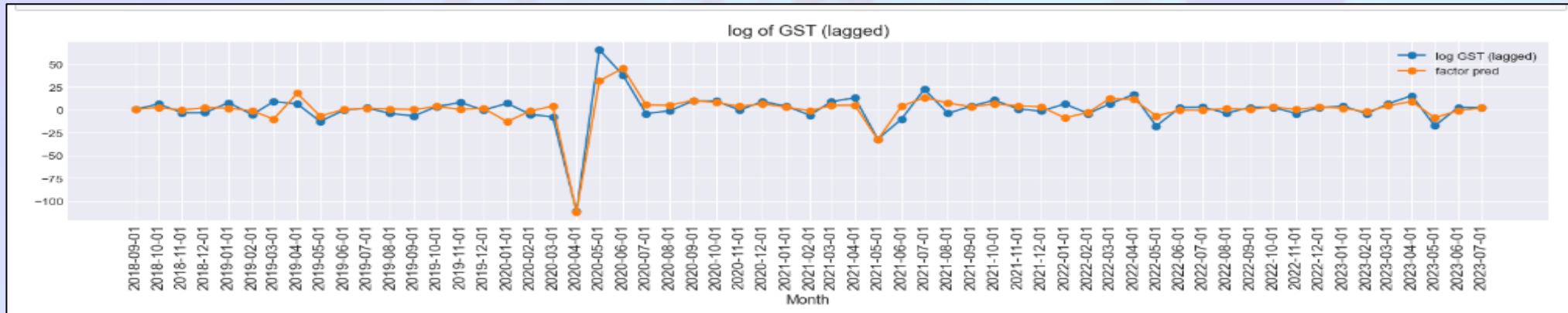
$$u_{it} = C_1 u_{it-1} + \varepsilon_{it} \quad \text{where } \varepsilon_{it} \sim N(0, \sigma_i^2)$$

't' represents the time dimension

Step 2:-

$$y_{it} = \beta_0 + \beta_1 f_t + \mu_t \quad \text{where } \mu_t \sim N(0, \sigma^2)$$

Results



Target Variable:- one-month lagged value of indirect tax collection

Factor construction:- 10 HFI from traffic frequency, import, exchange rate, unemployment, consumer confidence, industrial production etc.

Conclusion

An economic nowcast is

- **Current**
 - **Model based & replicable**
 - **Continuously updated**
 - **Time granular**
- ➔ Provides a summary which approximates macro growth rate

Conclusion...

- **Target variable** : GDP, inflation, tax collection (forecast), industrial production etc.
- **X-variable**: can be a mix of traditional macro data as well as alternative data sources.
- **Other model suggestions**: Computationally intensive non-linear techniques or machine learning models



Thank You