TIME SERIES ANALYSIS OF INDIA'S EXPORT FROM 2014 TO 2023.

A PROJECT REPORT

SUBMITTED FOR THE PARTIAL FULFILMENT OF

BACHELOR'S (HONS) IN STATISTICS

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UNDER THE SUPERVISION OF:

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CERTIFICATE

The project report titled TIME SERIES ANALYSIS OF INDIA'S EXPORT FROM 2014 TO 2023 submitted by DISHA KANOJIA (ROLL NO. -22229STA004) for the partial fulfilment of the BSc.(hons.) in STATISTICS for the session 2024-2025, has been originally completed by her under my supervision. I recommend this project for evaluation.

SBasu 21/4/25

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ABSTRACT

This project presents a comprehensive time series analysis of India's export data from 2014 to 2023, aiming to uncover underlying trends, seasonal patterns. The study utilizes publicly available trade statistics sourced from government and international databases to examine the export performance of India over a decade. The analysis reveals key insights into the cyclical nature of exports, the impact of global events such as the COVID-19 pandemic, and shifts in trade dynamics. Through visualizations, decomposition techniques, and model evaluations, the project provides a data-driven understanding of India's export trends and offers valuable foresight for policymakers, economists, and businesses engaged in international trade.

CONTENT

INTRODUCTION

1.1 Background

India, as one of the world's fastest-growing economies, has witnessed significant changes in its export patterns over the last decade. Understanding these patterns provides valuable insights into economic growth, trade partnerships, and the impact of domestic and global events.

1.2 Importance of Export Analysis

Exports play a critical role in a country's economic development by contributing to GDP, creating employment, and strengthening foreign exchange reserves. Analysing export trends helps policymakers, economists, and businesses make informed decisions.

1.3 Objective of the Project

The main objective of this project is to perform a time series analysis on India's export data from 2014 to 2023. This includes:

Identifying trends, seasonal variations, and patterns

Evaluating the impact of key national and international events

1.4 Scope of the Study

This study focuses on total exports from India on a [monthly/yearly] basis over a 10-year period. The scope may include analysis by sector or country, depending on data availability.

1.5 Methodology Overview

The project involves:

Data collection and preprocessing

Exploratory Data Analysis (EDA)

Curve fitting

Time series decomposition

1.6 Structure of the Report

This report is structured as follows:

Section 2: Data Collection and Preprocessing

Section 3: Exploratory Data Analysis

Section 4: Curve fitting and moving average

Section 5: evaluating secular trends

Section 6: Conclusion and Insights

LITERATURE REVIEW

1. Overview of Time Series Analysis in Export Studies

Time series analysis has been widely used in economic research, particularly for understanding trends, cycles, and forecasting in export data. Techniques such as exponential smoothing, and decomposition models are commonly employed to study trade dynamics.

2. Studies Focused on India's Export Trends

India's export behaviour has been analysed extensively, especially in the context of globalization and policy reforms. Research by the Reserve Bank of India (2021) highlighted how international commodity prices and trade agreements impact India's export growth.

3. Use of Forecasting Techniques and Evaluation Metrics

Various forecasting models can be used to predict export performance, including ARIMA, Holt-Winters, and linear regression-based curve fitting. Researchers often evaluate their models using performance metrics such as Mean Square Error (MSE), Mean Absolute Percentage Error (MAPE), and R-squared values.

4. Seasonal Index and Its Role in Export Analysis

Seasonal indexing has been particularly useful in understanding periodic fluctuations in trade data. It allows researchers to isolate and examine the seasonal effect, making the forecasting models more accurate and actionable.

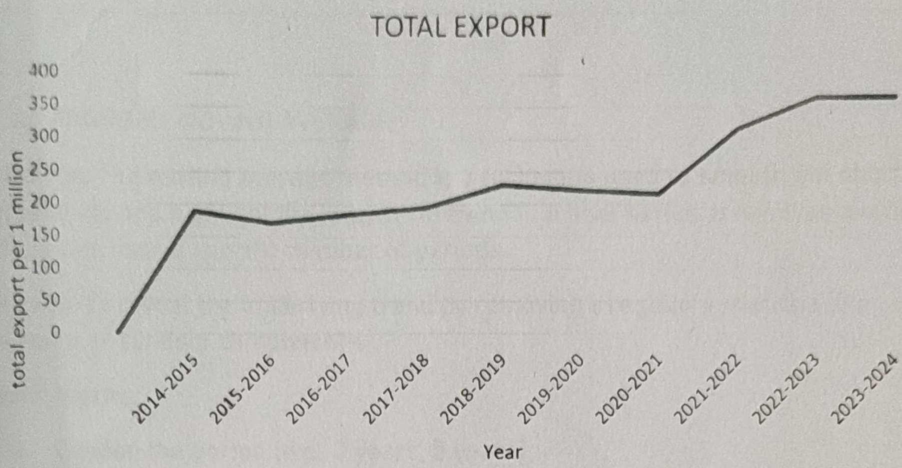
5. Emerging Approaches in Export Forecasting

While traditional models remain popular, hybrid approaches combining statistical and machine learning methods are gaining traction. Zhang et al. (2016) demonstrated the advantages of integrating neural networks with time series models, leading to more precise forecasts in complex trade environments.

This shift towards advanced analytics reflects a broader trend in economic forecasting, suggesting future opportunities for enhancing India's export prediction models.

YEAR	TOTAL EXPORT in Rs. Per million
2014-2015	189.6348418
2015-2016	171.6384404
2016-2017	184.9433553
2017-2018	195.6514528
2018-2019	230.7726194
2019-2020	221.9854181
2020-2021	215.9043221
2021-2022	314.7021493
2022-2023	362.1549876
2023-2024	361.8952271
	2449.282814

TABLE-1 ALL INDIA TOTAL EXPORT FROM 2014 TO 2023 IN RUPEES PER IN MILLION



GRAPH-1: WE PLOTTED TOTAL EXPORT IN RUPEES PER MILLION AT Y-AXIS AND YEAR AT X AXIS

CALCULATION OF SECULAR TREND:

Definition: A secular trend is the long-term movement or direction in a time series data that persists over an extended period—often years or decades. It reflects the underlying pattern in data, ignoring short-term fluctuations such as seasonal effects or cyclical movements.

Examples:

- The long-term increase in global temperatures (climate change).
- Population growth over decades.
- Rise in stock market indices over a 20-year period.

Key Characteristics:

- Long-term in nature.
- Smooth and continuous direction (upward or downward).
- Can be linear or nonlinear.
- Helps in long-range forecasting and policy planning.

Methods to Identify Secular Trends:

- Fitting a straight-line trend (linear regression).
- Fitting a curved line (polynomial regression).

- Moving Average Method (explained below).

A) TREND BY MOVING AVERAGE:

Definition: The moving average method is a technique used to smooth out short-term fluctuations and highlight the long-term trend in a time series. It involves averaging data points over a specific number of periods.

Purpose: To reveal the underlying trend by removing irregular variations like seasonal or random components.

How It Works:

1. Choose the period (e.g., 3 years, 5 years).
2. Take the average of successive groups of data points.
3. Plot these averages to visualize the trend

3 AND 5 YEAR MOVING AVERAGE:

			3 AND 5 YEAR MOOVING AVERAGE
YEAR	TOTAL EXPORT	3-YEAR MOVING AVERAGE	5-YEAR MOOVING AVERAGE
	(INRs.) per million		
2014-15	189.6348418		
2015-16	171.6384404	182.0722125	
2016-17	184.9433553	184.0777495	194.5281419
2017-18	195.6514528	203.7891425	200.9982572
2018-19	230.7726194	216.1364968	209.8514336
2019-20	221.9854181	222.8874532	235.8031923
2020-21	215.9043221	250.8639632	269.1038993
2021-22	314.7021493	297.587153	295.3284208
2022-23	362.1549876	346.250788	
2023-24	361.8952271		
	2449.282814	1903.664959	1405.613345

Method of CURVE FITTING BY PRINCIPLE OF LEAST SQUARES:

The least square method is the process of finding the best fitting curve or line of best fit for a set of data points by reducing the sum of the squares of the offsets (residual part) of the points from the curve. During the process of finding the relation between two variables, the trend of outcomes are estimated quantitatively. The principle of least square is the most popular and widely used method of fitting mathematical functions to a given set of data. The method yields very correct results if sufficiently good appraisal of the form of the function to the fitted is obtained either by a theoretical understanding of the mechanism of the variable change.

The various types of curves that may be used to describe the given data in practice are:

(yt is the value of the variable corresponding to time t)

I. A straight line

II. Second degree parabola

III. Kth degree polynomial

IV. Exponential curve

V. Second degree curve fitted to logarithms

VI. Growth Curves

FITTING OF A TWO DEGREE POLYNOMIAL:

A second-degree curve fitting, or polynomial regression, involves finding the best-fit quadratic equation (y = ax^2 + bx + c) for a set of data points. The process uses least squares to minimize the error between the data points and the predicted values from the curve. This involves finding the coefficients a, b, and c that best represent the data.

Steps for Second-Degree Curve Fitting:

Define the model: The second-degree polynomial equation is $y = ax^2 + bx + c$.

Collect data: Gather the data points (x, y) that you want to fit to the curve.

Calculate Sums: Compute the following sums:

$\sum y$ (sum of y values)

$\sum x$ (sum of x values)

$\sum x^2$ (sum of x squared values)

$\sum xy$ (sum of x times y values)

$\sum x^3$ (sum of x cubed values)

$\sum x^4$ (sum of x to the power of 4 values)

Form normal equations: Set up a system of equations to solve for the coefficients a, b, and c. The normal equations are:

$\sum y = na + b\sum x + c\sum x^2$

$\sum xy = a\sum x^2 + b\sum x^3 + c\sum x^2$

$\sum x^2 y = a\sum x^3 + b\sum x^4 + c\sum x^2$

Solve the system: Solve the normal equations to find the values of a, b, and c. Various methods can be used, including:

Elimination: Solve for two unknowns at a time and then substitute to find the third.

Matrix methods: Represent the system of equations in matrix form and solve for the coefficients.

Write the equation: Substitute the calculated values of a, b, and c into the general equation $y = ax^2 + bx + c$ to obtain the fitted curve equation.

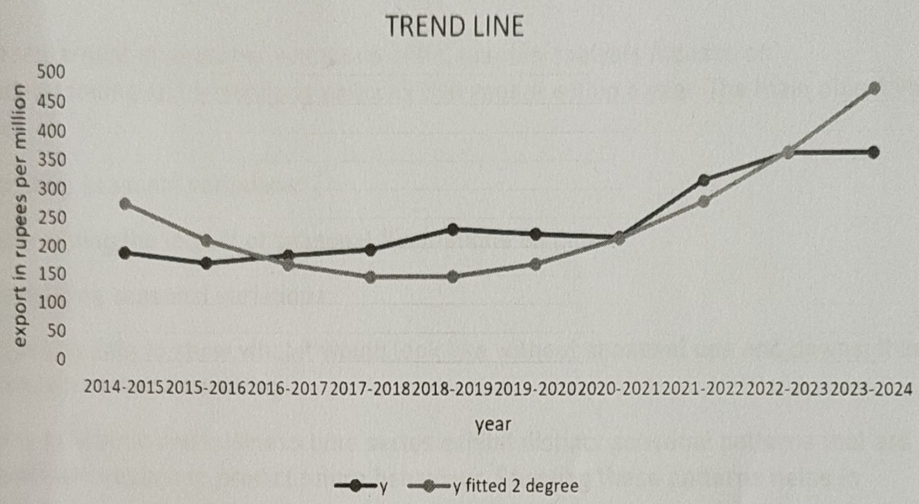
Evaluate the fit: Assess the goodness of fit using metrics like the coefficient of determination (R^2) or residual analysis.

TABLE-3

year	y	y fitted 2 degree
2014-2015	189.6348418	275.9216
2015-2016	171.6384404	211.8072
2016-2017	184.9433553	169.1528
2017-2018	195.6514528	147.9584
2018-2019	230.7726194	148.224
2019-2020	221.9854181	169.9496
2020-2021	215.9043221	213.1352
2021-2022	314.7021493	277.7808
2022-2023	362.1549876	363.8864
2023-2024	361.8952271	471.452
	2449.282814	2449.268

Table-3 is the computational of trend line and after calculating we find the last column where trend values are given.

Now we plot the graph to see the trend line by taking export in rupees per million on y axis and year on x -axis.



<u>GRAPH showing fitted polynomial by red and the trend by blue</u>

The fitted equation comes out to be:

$$Y=2.6825x^2+10.8628x+156.4043$$

y

MEASUREMENT OF SEASONAL VARIATIONS:

Measurement of seasonal variations in time series analysis focuses on understanding and quantifying patterns that repeat within a year. The main objectives are:

Isolating seasonal variations:

Determining the impact of seasonal fluctuations on data.

Eliminating seasonal variations:

Adjusting data to show what it would look like without seasonal ups and downs; this is known as deseasonlising.

Many economic and business time series exhibit distinct seasonal patterns that are significant enough to predict future behaviour. Studying these patterns helps in understanding the effects of seasonal changes and in analysing other types of variations, such as cyclic variations.

To isolate the seasonal variations, i.e., to determine the effect of seasonal swings on the value of the given phenomenon, and

To eliminate them, i.e., to determine the value of the phenomenon if there were no seasonal ups and downs in the series. This is known as de-seasonalising the given data and is necessary for the study of cyclic variations

There are 3 methods :

1.) Method of simple average
2.) Ratio to moving average
3.) Ratio to trend

Ratio to trend method:

The Ratio-to-Trend method measures seasonal variation by comparing the actual data points to a trend line, revealing the proportion of the data attributed to seasonal effects. It's a relatively simple method, suitable when cyclical variations are absent, but it may not fully capture complex data patterns.

Here's a more detailed explanation:

1. Data Conversion:

The method often starts by converting quarterly or monthly data into yearly data by averaging the corresponding periods within each year.

2. Trend Calculation:

A trend line is fitted to the yearly data using the least squares method, which can be a straight line or a curve.

3. Ratio Calculation:

For each original data point, a ratio is calculated by dividing the actual value by its corresponding trend value.

4. Seasonal Index Calculation:

The ratios for each period (e.g., quarter or month) are then averaged to obtain a seasonal index for that period.

5. Interpretation:

These seasonal indices indicate how much a particular period's actual value deviates from the expected trend value, thus highlighting the seasonal pattern.

MONTHS	2014	2015	2016	2017	2018	2019	2020
JAN	166.9321502	151.7913	142.5683	152.2026944	161.6973755	186.8014	184.3697
FEB	157.76913	136.3799	142.2464	165.8556316	167.5836394	191.3453	198.3289
MAR	185.1228306	150.0828	153.5588	193.0289061	190.6192509	227.3182	159.7846
APR	157.1225354	138.9181	138.6785	158.5520881	170.3226786	180.7715	77.55741
MAY	166.03474	143.7362	149.918	154.2782923	195.4925947	208.251	145.6192
JUN	154.728538	142.5609	152.465	148.3004254	184.1130086	173.7908	166.85
JUL	154.9072492	148.1499	145.7885	143.6891703	176.9145971	180.5093	178.3523
AUG	163.2203306	140.4434	144.57	149.3988938	193.3971205	184.9212	170.4706
SEP	175.7030296	144.8204	151.9555	184.0889394	201.2349508	185.6423	202.5085
OCT	158.8229508	139.5892	155.9267	148.9626381	196.4064279	186.3581	183.0606
NOV	163.427932	129.3311	135.6995	170.5410082	187.3351396	184.1423	175.3068
DEC	164.1270715	150.4616	163.3444	178.8027621	197.0447533	192.9845	200.2945

YEAR	2021	2022	2023
Jan	201..3307	262.28	293.195
Feb	201.0499	278.6664	305.764605
Mar	256.6427	339.85	345.265032
Apr	229.0063	302.3722	283.943289
May	236.6472	301.5732	287.81808
Jun	239.013	330.0957	282.266247
Jul	264.6664	305.1591	283.341025
Aug	247.6336	294.4946	316.942052
Sep	248.7518	283.946	285.749671
Oct	267.6553	260.2095	278.285033
Nov	236.862	285.4131	281.096443
Dec	295.9893	314.0613	319.715497

Table shows the monthly export value in rupees per million from 2014

YEAR	QUARTER	X	T	y	(y+T)100
2014	I	39	358.3285	509.8241108	86815.26108
	II	37	-229.343	477.8858134	24854.28134
	III	35	-216.943	493.8306094	27688.76094
	IV	33	-204.543	486.3779543	28183.49543
2015	I	31	-192.143	438.2539974	24611.09974
	II	29	-179.743	425.2151524	24547.21524
	III	27	-167.343	433.4137863	26607.07863
	IV	25	-154.943	419.3818329	26443.88329
2016	I	23	-142.543	438.3735899	29583.05899
	II	21	-130.143	441.0615309	31091.85309
	III	19	-117.743	442.3141089	32457.11089
	IV	17	-105.343	454.9706384	34962.76384
2017	I	15	-92.943	511.0872321	41814.42321
	II	13	-80.543	461.1308058	38058.78058
	III	11	-68.143	477.1770035	40903.40035
	IV	9	-55.743	498.3064084	44256.34084
2018	I	7	-43.343	519.9002658	47655.72658
	II	5	-30.943	549.9282819	51898.52819
	III	3	-18.543	571.5466684	55300.36684
	IV	1	-6.143	580.7863208	57464.33208
2019	I	-1	6.257	605.4648772	61172.18772
	II	-3	18.657	562.8133494	58147.03494
	III	-5	31.057	551.0727969	58212.97969
	IV	-7	43.457	563.4847897	60694.17897
2020	I	-9	55.857	542.4831994	59834.01994
	II	-11	68.257	390.0265848	45828.35848
	III	-13	80.657	551.3314857	63198.84857
	IV	-15	93.057	558.6619	65171.89
2021	I	-17	105.457	659.0232326	76448.02326
	II	-19	117.857	704.666467	82252.3467
	III	-21	130.257	761.0517635	89130.87635
	IV	-23	142.657	800.5066506	94316.36506
2022	I	-25	155.057	880.7965649	103585.3565

	II	27	167.457	934.0411166	110149.8117
	III	29	179.857	883.5997749	106345.6775
	IV	31	192.257	859.6838389	105194.0839
2023	I	33	204.657	944.2250982	114888.2098
	II	35	217.057	854.027617	107108.4617
	III	37	229.457	886.0327486	111548.9749
	IV	39	241.857	879.0969721	112095.3972

Table shows the quarterly data of exp;ort value in rupees from 2014 to 2023

The trend line for quarterly data is

Y=600.07-6.2x+0.057x^2

PROCEDURE TO CALCULATE SEASONAL INDEX:

If the data contain a trend to an appreciable extent, an appropriate trend equation is first found to determine the trend for various quarters or months. Usually, the monthly or quarterly trend values are obtained from the quarterly (or monthly) average trend equation. The trend is then eliminated by expressing the original y values as percentages of the corresponding trend values. This method is based upon the assumption that cyclical variations are either not marked or completely absent.

Symbolically, it can be written as:

(y/T) * 100 = (TSI/T) * 100 = SI * 100

From this, the irregular component can be eliminated by using the Simple Average Method.

	I	II	III	IV
2014	509.82	477.88	493.83	486.37
2015	438.25	425.21	433.41	419.38
2016	438.37	441.06	442.31	454.97
2017	511.08	461.13	477.17	498.3
2018	519.9	549.92	571.54	580.78
2019	605.46	562.81	551.07	563.48
2020	542.48	390.02	551.33	558.66
2021	659.02	704.66	761.05	800.5
2022	880.79	934.04	883.59	859.68
2023	944.22	854.02	886.03	879.09
sum	5105.17	5800.75	6051.33	6101.21
Average	510.517	580.075	605.133	610.121
S.I.	22.14	25.156	26.243	26.4597

<u>Table for calculation of seasonal index when the adjusted trend ratio are arranged by quarters and seasonal index are calculated by method of simple avereges.</u>

LIMITATION:

Research is never ending process, every research is having some limitation. Here for calculating the secular trend, I am using least square method so drawback of this method:

This method is quite tedious and time consuming as compared and rather difficult for a non-mathematical to understand.

Moving average method is also used which cannot accurately predict future price movements, only smooth out past trends. In volatile markets, Moving Averages can produce misleading signals, leading to potential losses.

The main drawbacks of the least squares method for time series analysis include its sensitivity to outliers, the assumption of negligible errors in independent variables, and its inability to handle complex trend patterns or growth curves. It also requires all calculations to be redone if new observations are added.

A primary drawback of seasonal variations is their impact on accurate forecasting and planning, particularly when seasonal patterns are complex or change over time. This can lead to inefficiencies in areas like production, inventory management, and resource allocation.

Here's a more detailed breakdown:

Forecasting Accuracy:

Seasonal variations can introduce noise and complexity into time series data, making it difficult to accurately predict future trends. If seasonal patterns are not properly accounted for, forecasts can be inaccurate, leading to wasted resources or missed opportunities.

Inventory Management:

In retail, seasonal demand fluctuations can lead to either overstocking (waste and lost profits) or understocking (lost sales and customer dissatisfaction). Accurately predicting seasonal demand is crucial for effective inventory management and minimizing these risks.

Production Planning:

Similarly, seasonal variations in demand can impact production planning, leading to potential bottlenecks or excess capacity. Understanding and accounting for these variations is essential for optimizing production schedules and minimizing costs.

Resource Allocation:

Seasonal fluctuations can also affect resource allocation, such as staffing and energy consumption. Inaccurate predictions of seasonal demand can lead to understaffing or overstaffing, and inefficient use of energy resources.

RESULT

As we can see the India's export from 2014 onwards, Indian exports in Rupees experienced a combination of growth and decline, influenced by factors like global trade trends, the rupee's exchange rate, and domestic economic conditions and COVID. While there were periods of growth, particularly in the early years, there have also been instances of decline, especially in recent times.

CONCLUSION:

By analysing the trend of Indian exports through methods like trend equation fitting and seasonal variation analysis, a more complete understanding of the factors driving exports is achieved. This includes identifying the impact of global economic conditions, government policies, and seasonal factors. Further research would involve specific data analysis and statistical modeling to draw more precise conclusions.

With this we conclude Indian exports in Rupees experienced a combination of growth and decline, influenced by factors like global trade trends, the rupee's exchange rate, and domestic economic conditions and COVID.

REFERENCE:

1) TIME SERIES ANALYSIS from IGNOU
2) Ministry of Commerce and Industry

GOI https://www.commerce.gov.in