EXPORTS PRODUCTS FROM INDIA TO ASIAN COUNTRIES

CSV file:

EXPORTS TO ASIAN COUNTRIES

Source url:

https://indiadataportal.com/p/export-trade-statistics/r/mci-tradestat_export_lfy-cn-mn-asi

Number of rows and columns:

* Rows: 5348874 * Columns :15

Introduction:

```
The "Exports to Asian Countries" dataset provides a
comprehensive view of trade exports from an unspecified country
(presumably India given the source) to various Asian countries.
This dataset covers the periodical data of Source exports in
terms of value in both USD and INR and also in terms of
quantity. Each record provides the date, target Director
country, type of product (both in terms of HS code and the
commodity name), the value of the commodity, and the General
quantity of the commodity being exported.
```

Aim of your project:

- The products exported.
- The year which has highest export.
- Finding in which countries has highest product exported.
- Top 10 Countries by Export Value

Libraries

In [195…

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
import matplotlib.cm as cm
```

1. Data Loading and Initial Overview

- ## Loading the dataset:

In [196…
```
df = pd.read_csv(r'C:\Users\iamfiroz\Desktop\WORK BOOK\MODULE 5\PROJECT\ASIAN
```

- ## Number of rows and columns

In [197…
```
print(f"Dataset shape: {df.shape}")
```

```
Dataset shape: (5348874, 15)
```

- ## Data types of each column

In [198…
```
print("Data types:")
print(df.dtypes)
```

```
Data types:
id                   int64
date                object
country_name        object
alpha_3_code        object
country_code         int64
region              object
region_code          int64
sub_region          object
sub_region_code      int64
hs_code              int64
commodity           object
unit                object
value_qt           float64
value_rs           float64
value_dl           float64
dtype: object
```

- ## Initial observations (e.g., head(), info(), describe())

Head

In [199…
```
print("First 5 rows:")
print(df.head())
```

```
First 5 rows:
   id        date country_name alpha_3_code  country_code region  region_code
\
0   0  2015-01-01  Afghanistan          AFG             4   Asia          142
1   1  2015-01-01  Afghanistan          AFG             4   Asia          142
2   2  2015-01-01  Afghanistan          AFG             4   Asia          142
3   3  2015-01-01  Afghanistan          AFG             4   Asia          142
4   4  2015-01-01  Afghanistan          AFG             4   Asia          142

      sub_region  sub_region_code  hs_code  \
0  Southern Asia               34  2023000
1  Southern Asia               34  3061719
2  Southern Asia               34  4021010
3  Southern Asia               34  4021090
4  Southern Asia               34  4022920

                                          commodity unit  value_qt  value_rs
\
0          Boneless Meat Of Bovine Animals , Frozen  Kgs    337.00    347.09
1                                     Other Scampi  Kgs      0.64      2.92
2                                     Skimmed Milk  Kgs     32.00     71.66
3  Other Mlk And Crm In Pwdr,Granl Or Solid Frm O...  Kgs     25.00     56.83
4                                   Milk For Babies  Kgs      7.96     23.38

   value_dl
0      0.56
1      0.00
2      0.12
3      0.09
4      0.04
```

Info

In [200…

```
print("Dataset info:")
df.info()
```

```
Dataset info:
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 5348874 entries, 0 to 5348873
Data columns (total 15 columns):
 #   Column           Dtype
---  ------           -----
 0   id               int64
 1   date             object
 2   country_name     object
 3   alpha_3_code     object
 4   country_code     int64
 5   region           object
 6   region_code      int64
 7   sub_region       object
 8   sub_region_code  int64
 9   hs_code          int64
 10  commodity        object
 11  unit             object
 12  value_qt         float64
 13  value_rs         float64
 14  value_dl         float64
dtypes: float64(3), int64(5), object(7)
memory usage: 612.1+ MB
```

Describe

In [201…

```
print("Descriptive statistics:")
print(df.describe())
```

```
Descriptive statistics:
                 id  country_code  region_code  sub_region_code       hs_code
\
count  5.348874e+06  5.348874e+06    5348874.0     5.348874e+06  5.348874e+06
mean   2.674436e+06  4.464536e+02        142.0     7.214627e+01  5.571467e+07
std    1.544087e+06  2.475116e+02          0.0     5.309008e+01  2.637186e+07
min    0.000000e+00  4.000000e+00        142.0     3.000000e+01  1.012100e+06
25%    1.337218e+06  1.580000e+02        142.0     3.400000e+01  3.204134e+07
50%    2.674436e+06  4.580000e+02        142.0     3.500000e+01  5.903201e+07
75%    4.011655e+06  6.820000e+02        142.0     1.450000e+02  8.415839e+07
max    5.348873e+06  8.870000e+02        142.0     1.450000e+02  1.000000e+08

           value_qt      value_rs      value_dl
count  5.303585e+06  5.348850e+06  5.065986e+06
mean   4.867739e+04  1.352006e+02  2.504703e-01
std    3.783406e+06  3.106449e+03  4.937564e+00
min    0.000000e+00  0.000000e+00  0.000000e+00
25%    1.400000e-01  2.900000e-01  0.000000e+00
50%    2.470000e+00  3.220000e+00  1.000000e-02
75%    4.084000e+01  2.412000e+01  6.000000e-02
max    2.046347e+09  9.778869e+05  1.517490e+03
```

2. Data Pre-processing

Perform all necessary cleaning steps such as:

- Handling missing values:

In [202…
```
print("Missing values per column:")
print(df.isnull().sum())
```

```
Missing values per column:
id                      0
date                    0
country_name            0
alpha_3_code            0
country_code            0
region                  0
region_code             0
sub_region              0
sub_region_code         0
hs_code                 0
commodity               0
unit                 5838
value_qt            45289
value_rs               24
value_dl           282888
dtype: int64
```

- Removing Columns

In [203…
```
df = df.drop(columns=['id', 'alpha_3_code', 'country_code', 'region_code', 'su
```

- Removing duplicates

In [204…
```
# Find duplicate rows
duplicate_rows = df[df.duplicated()]
print("Duplicate rows:")
print(duplicate_rows)
```

```
Duplicate rows:
                date country_name region          sub_region commodity unit  \
335       2015-01-01  Afghanistan   Asia       Southern Asia    Others  Nos
5904      2015-01-01        China   Asia        Eastern Asia    Others  Kgs
16507     2015-01-01     Malaysia   Asia  South-eastern Asia    Others  Kgs
17477     2015-01-01     Malaysia   Asia  South-eastern Asia    Others  Nos
17625     2015-01-01     Malaysia   Asia  South-eastern Asia    Others  Nos
...              ...          ...    ...                 ...       ...  ...
5347304   2025-07-01     Viet Nam   Asia  South-eastern Asia     Other  Kgs
5347956   2025-07-01     Viet Nam   Asia  South-eastern Asia    Others  Nos
5348218   2025-07-01     Viet Nam   Asia  South-eastern Asia    Others  Nos
5348295   2025-07-01     Viet Nam   Asia  South-eastern Asia    Others  Nos
5348308   2025-07-01     Viet Nam   Asia  South-eastern Asia    Others  Nos

          value_qt  value_rs  value_dl
335           0.01      0.25       0.0
5904          0.00      0.01       NaN
16507         0.01      0.05       NaN
17477         0.00      0.04       NaN
17625         0.00      0.31       0.0
...            ...       ...       ...
5347304       1.00      0.00       0.0
5347956       2.00      0.00       0.0
5348218       1.00      0.01       0.0
5348295       1.00      0.01       0.0
5348308       1.00      0.00       0.0

[4664 rows x 9 columns]
```

- ## Counting duplicates

In [205…
```python
# Count of duplicate rows
duplicate_count = len(duplicate_rows)
print(f"Number of duplicate rows: {duplicate_count}")
```

```
Number of duplicate rows: 4664
```

- ## Remove duplicate rows

In [206…
```python
df = df.drop_duplicates()
```

- ## Filtering products

In [207…
```python
# Get unique values in the commodity column
unique_products = df['commodity'].unique()
```

In [208…
```python
# Display the unique products
print("Unique products in commodity column:")
print(unique_products)
```

```
Unique products in commodity column:
['Boneless Meat Of Bovine Animals , Frozen' 'Other Scampi' 'Skimmed Milk'
 ... 'Acid Green 38(Alizarine Cyanine Green 3G)'
 'Goods Specified In Supplementary Note 4 To This Chapter'
 'Goods Specified In Supplementary Note 10 To This Chapter']
```

- ## Counting types of products

In [209…
```
# how many unique products there are
print(f"Number of unique products: {len(unique_products)}")
```

```
Number of unique products: 11030
```

- ## Correcting data types

In [210…
```
df['date'] = pd.to_datetime(df['date'])
```

- ## Creating derived columns

In [211…
```
df['year'] = df['date'].dt.year
print(df['year'])
```

```
0          2015
1          2015
2          2015
3          2015
4          2015
           ...
5348869    2025
5348870    2025
5348871    2025
5348872    2025
5348873    2025
Name: year, Length: 5344210, dtype: int32
```

In [212…
```
# extracting month from date
df['month'] = df['date'].dt.month
```

In [213…
```
# Create a dictionary mapping month numbers to month names
month_names = {
    1: 'January',
    2: 'February',
    3: 'March',
    4: 'April',
    5: 'May',
    6: 'June',
    7: 'July',
    8: 'August',
    9: 'September',
    10: 'October',
```

```
    11: 'November',
    12: 'December'
}
```

In [214…
```
df['month'] = df['month'].map(month_names)
print(df['month'])
```

```
0          January
1          January
2          January
3          January
4          January
            ...
5348869       July
5348870       July
5348871       July
5348872       July
5348873       July
Name: month, Length: 5344210, dtype: object
```

- ## Finding Unique products using cvc

In [215…
```
unique_commodities = df['commodity'].unique()

unique_df = pd.DataFrame({'unique_commodities': unique_commodities})

# Write the unique commodities to a new CSV file
unique_df.to_csv('unique_commodities2.csv', index=False)

print(f"Successfully wrote {len(unique_commodities)} unique commodities to 'ur
```

```
Successfully wrote 11030 unique commodities to 'unique_commodities2.csv'
```

- ## Removing words

In [216…
```
df['commodity'] = df['commodity'].str.replace('Otr ', '')
```

In [217…
```
df['commodity'] = df['commodity'].str.replace('Othr ', '')
```

In [218…
```
df['commodity'] = df['commodity'].str.replace('Othrs ', '')
```

In [219…
```
df['commodity'] = df['commodity'].str.replace('Others, ', '')
```

In [220…
```
df['commodity'] = df['commodity'].str.replace('Other ', '')
```

In [221…
```
df['commodity'] = df['commodity'].str.replace('(', '')
```

In [222…
```
df['commodity'] = df['commodity'].str.replace(')', '')
```

In [223…
```
df['commodity'] = df['commodity'].str.replace('-', '')
```

In [224…
```
df['commodity'] = df['commodity'].str.replace('* Other', '')
```

In [225…
```
df['commodity'] = df['commodity'].str.replace('*0Ther ', '')
```

In [226…
```
df['commodity'] = df['commodity'].str.replace('"', '')
```

In [227…
```
df['commodity'] = df['commodity'].str.replace('*', '')
```

In [228…
```
df['commodity'] = df['commodity'].str.replace('0Ther ', '')
```

In [229…
```
df['commodity'] = df['commodity'].str.replace('0Thers', '')
```

In [230…
```
df['commodity'] = df['commodity'].str.replace('0Thr ', '')
```

In [231…
```
df['commodity'] = df['commodity'].str.replace('Others ', '')
```

In [232…
```
df['commodity'] = df['commodity'].str.replace('Others', '')
```

In [233…
```
df['commodity'] = df['commodity'].str.replace('Othr', '')
```

In [234…
```
df['commodity'] = df['commodity'].str.replace('Others', '')
```

In [235…
```
df['commodity'] = df['commodity'].str.replace('Other/', '')
```

In [236…
```
df['commodity'] = df['commodity'].str.replace('Other, ', '')
```

In [237…
```
df['commodity'] = df['commodity'].str.replace('Other,', '')
```

In [238…
```
df['commodity'] = df['commodity'].str.replace('Other', '')
```

In [239…
```
df['commodity'] = df['commodity'].str.replace('Of ', '')
```

- Filling missing values:

In [240…
```
df['value_qt'] = df['value_qt'].fillna(df['value_qt'].median())
df['value_rs'] = df['value_rs'].fillna(df['value_rs'].median())
df['value_dl'] = df['value_dl'].fillna(df['value_dl'].median())
most_common_unit = df['unit'].mode()[0]
df['unit'] = df['unit'].fillna(most_common_unit)
mode_commodity = df['commodity'].mode()[0]
df['commodity'] = df['commodity'].fillna(mode_commodity)
df = df[df['commodity'] != '']
```

In [241…
```
print("Missing values after filling:")
print(df.isnull().sum())
```

```
Missing values after filling:
date            0
country_name    0
region          0
sub_region      0
commodity       0
unit            0
value_qt        0
value_rs        0
value_dl        0
year            0
month           0
dtype: int64
```

- Filtering

In [242…
```
unique_countries = df['country_name'].unique()
print(f"Country:{unique_countries}")
```

```
Country:['Afghanistan' 'Armenia' 'Azerbaijan' 'Bahrain' 'Bangladesh' 'Bhutan'
 'Brunei Darussalam' 'Cambodia' 'China' 'Cyprus'
 "Democratic People's Republic of Korea" 'Georgia' 'Hong Kong' 'Indonesia'
 'Iraq' 'Islamic Republic of Iran' 'Israel' 'Japan' 'Jordan' 'Kazakhstan'
 'Kuwait' 'Kyrgyzstan' "Lao People's Democratic Republic" 'Lebanon'
 'Macao' 'Malaysia' 'Maldives' 'Mongolia' 'Myanmar' 'Nepal' 'Oman'
 'Pakistan' 'Philippines' 'Qatar' 'Republic of Korea' 'Saudi Arabia'
 'Singapore' 'Sri Lanka' 'Syrian Arab Republic'
 'Taiwan, Province of China' 'Tajikistan' 'Thailand' 'Timor-Leste'
 'Turkmenistan' 'Turkiye' 'United Arab Emirates' 'Uzbekistan' 'Viet Nam'
 'Yemen' 'State of Palestine' 'Türkiye']
```

In [243…
```
num_countries = df['country_name'].nunique()
print(f"Number of unique country names: {num_countries}")
```

```
Number of unique country names: 51
```

In [244…
```
unique_sub_region = df['sub_region'].unique()
print(f"Sub_region:{unique_sub_region}")
```

```
Sub_region:['Southern Asia' 'Western Asia' 'South-eastern Asia' 'Eastern Asia'
 'Central Asia']
```

In [245…
```
num_countries = df['sub_region'].nunique()
print(f"Number of unique Sub_region: {num_countries}")
```

```
Number of unique Sub_region: 5
```

In [246…
```
unique_products_O = df[df['commodity'].str.startswith('O')]['commodity'].uniqu
print(unique_products_O)
```

['Oxytetracycline' 'Omeprazole And Lansoprazole' 'Othe Parts Fr Use'
 'Objective Lenses' 'Ophthalmic Surgical Instrmnt And Appliances'
 'Oil Seed Crushng/Grndng Mchnry Including For Extrctn/Prpn Anml/Vgtbl Fatsandoils'
 'Onions Fresh Or Chilled' 'Organic SurfaceActive ProdToilet'
 'Organic SurfaceActive Product Nes'
 'Orngc SrfceActv Agnts W/N For Rtl Sl' 'Odhani,Cotton,N.E.S.'
 'Optical Media Hdg 852349'
 'Optical Fibre Cables Thn Lead Alloy Sheathd Cables'
 'Orthopeaedic Or Fracture Appliances' 'Onions Dried'
 'Oranges Fresh Or Dried' 'Oleoresins'
 'Oil Cake Soyabean,Solvent Extracted Defatted Variety'
 'OilCake And OilCake Meal Mustard Seeds Expeller Variety' 'Oxygen'
 'Oleum' 'Oxides,Hydroxides And Peroxide Strontium Or Barium'
 'OrthoChloroBenzaldehyde' 'Oleic Linoleic Acids And Their Salts Andestrs'
 'Oxalic Acid' 'Ortho Toluidine'
 'OMPPhnylenediamine Diaminotoluene And Their Drvtvs Salts Thereof'
 'OrganoSulphur Compnds'
 'Othe Cmpnds Cntng In Structure A Quinolineor Isoquinoline Ring System W/N Hydrgntd,Not Further Fused'
 'Oestrogens And Progestogens' 'Oxyclozanide' 'Oleoresines Spices N.E.S.,'
 'Odoriferous Prpns Usd For Deodorizing Room Excl Agarbatti'
 'Organic Composite Solvents And Thinners Nes'
 'Office Supplies Excl Pins Clips Writing Instruments Make'
 'Office Or School Supplies Nes' 'Ornamental Tapes Cotton'
 'Outer Grmnts For Mens And Boys' 'Outer Soles And Heels Rbber/Plstcs'
 'Oters' 'Oil/PrtlFltrs Fr Intrnl Cmbstn Engns'
 'Overhead Travelling Cranes On Fxd Support'
 'Oil Seed Crushng/Grndng Mchnry Including Purifyng Tanks'
 'Ovns;Cookers,Cooking Plates Boiling Rings,Grillers And Roasters'
 'Optcl Fibrs,Optical Fibre Bundles And Cables' 'Optical Elements'
 'Oxygen Therapy Apparatus' 'Orignl Engrvngs,Prnts And Lithogrphs'
 'Orignl Sclptrs And Statuary In Stone' 'Orang Juic Frozn'
 'Ordinary Portland Cement, Dry'
 'OilCake And OilCake Meal Soya Bean Expeller Variety'
 'Oil Cake/Solid Resdus' 'Ofloxacin' 'OXylene'
 'Octylphnl Nonylphnl And Thr Isomers,Salts' 'OPhenyl Phenols'
 'Ortho Chloro Paranitroaniline' 'Oil Extended Styrene Butadiene Rubber'
 'Ovrcoat,Capes,Cloaks,Anoraks Etc Cotton' 'Oil Pump'
 'Optcl Instrments And Appliances' 'Oil Pressure Lamps'
 'Octopus Than Live Frsh/Chlld And Frozen' 'Oil Lamps,NonMetal'
 'Oleoresins Flowers'
 'OilCake And OilCake Meal Decorticated Expeller Variety Cotton Seeds'
 'Oil Seeds And Oleginous Fruits W/N Broken'
 'OilCake AndoilCake Meal Seeds Solvnt Extrctd Defatd Varty'
 'Objective Lenses For Cameral,Projectors Or Photographic Enlargers Or Reducers'
 'Oleoresins Soices'
 'Obtained By Blending With Creosote Oil Or Coal Tar Distillates'
 'ODiaminotoluene' 'Oil Well Chemical' 'Ots/Mr Type'
 'Othe Parts Fr Commncn Jammng Eqptmnts' 'Optical Filters'
 'Oleores Ins Seeds'
 'Oth Armtc Hydcrbn Mxtrs Which 65 Prcnt Or More By Vl Incldng Losses Distls At 250 Dgr.C. By Iso 3405 Astm D 86 Method'

'Oxides Boron' 'Oleic Acid' 'O Phenylenediamine'
'Orgnc Drvts Hydrazine/Hydrxylmine'
'Original Sclptrs And Statuary In Metal'
'Ovrcoat,CarCoats,Capes Etc Cotton' 'Ornamental Fish'
'Osse In Trtd With Acid '
'OilCake And OilCake Meal Decrticed,Solvnt Extracted Defatd Varity Cotton Seeds'
'OilCake Neem Seed Expeller Variety'
'OilCake And OilCake Meal Seasamum Seeds Slvnt Extrctd Dfatd Varty'
'OilCake And OilCake Meal Castor Seeds Solvnt Extrctd Defatd Varty'
'OilCake And OilCake Meal Neem Seed Solvnt Extrctd Defatd Varty'
'Oil And Oil Prodcts Distilation High Temp. Coal Tar, Etc.'
'Overcoats,Rncots Etc Andsmlr Artcls Cotn'
'Overcoats,Raincoats,Carcoats,Capes,Cloaks And Similar Articles Man Made Fibres'
'Outr Grmnts,Mens And Boys The Fbrcs Imprgntd,Coatd,Covrd/Lamntd Wth Prprtn Celulos Dervtvs And Artfcl Pl'
'Orignl Sclptrs And Statuary In Matrls' 'Offset Printing Machinery'
'Ovrcoats,CarCoats,Capes Etc Fbrs' 'Out Board Engines'
'Oral Rehydration Salts' 'Oxygen,Medicinal Grape'
'Oxirane Ethylene Oxide'
'Opacifying Prpns Fr XRay Exams; Diagnosticreagnts Dsgnd To Be Admnstrd To Patient Be Administered To The Pat'
'Oil Than Edble GradeExcldg Crude Oil From Olives'
'Ordinary Portland Cement, Coloured'
'Oxyphen Butazone, Phenyl Butazone And Formulations Thereof'
'Olives Provisionally Preserved' 'Orange Prepared Or Preserved'
'OilCake And OilCake Meal Sunflower Seed Expeller Variety'
'OilCake And OilCake Meal Seasamum Seeds Expeller Variety'
'OilCake And OilCak Meal Oil Seeds And Olegns Fruts Nes Expllr Varty'
'OilCake And OilCake Meal Mustard Seeds Solvent ExtractedDefatted Variety'
'Outer Garments,Mens And Boys Rubberised Textile Fabrics'
'Ornmnt Plted With Prcs Metal'
'Offset Printing MachinerySheet Fed, Office TypeSheet Size Nt Excdng 22X36 Cm'
'Overcoats,Raincoats,Carcoats,Capes,Cloaks And Smlr Artcls Wool/Fine Animal Hair'
'Outer Garments,Mens And Boys Textile Fabrics,wise Impregnated Or Coated'
'Office Supplies Excl Pins Clips Writing Instruments Polyurethane Foam'
'Ox Gallstone'
'Overcoats,Raincoats,Carcoats,Capes Cloaks And Similar Artcls Textile Fibres'
'Outr Grmnts Womens And Girls The Fbrcs Imprgntd,Coatd,Covrd/Laminated Wth Preprtnof Celulos Dervts/Artf'
'Oleoresins Roots'
'OilCake And OilCake Meal Groundnut Slvnt Extracted VarityDefatted'
'OilCake And Residue Palm Nut/Kernel'
'Oil Cake And Meal Castor Seeds Expeller Variety'
'Ovrcoat Etc Synthetic Fibres' 'Oleoresins Fruits'
'Outer Grmnts For Womens And Girls' 'Odhani,Cotton,White Bleached'
'Oil Lamps,Metal' 'Offset Printing MachineryReel Fed'
'Oxides And Hydroxides Vanadium'
'O Dichlorobenzene Orthodichlorobenzene' 'Ortho Nitrotoluene' 'Orchids'
'Olive Oil And Its Fractns Excldng VrgnEdible Grde'
'Olive Oil And Its Fractns Excld Vrgn'
'OilCake And OilCake Meal Sunflower Seed Slvnt ExtrctdDfatd Variety'

'OctopusOctopus Spp Live Frsh/Chld' 'Oleoresins Leaves'
'Onion Seeds Used For Sowing' 'Oilbanum Or Frankincense'
'Organo Arsenic Compounds' 'Ovrcoat,CarCoats,Cloaks Capes Etc Silk'
'Opthalmoscope' 'Othe Parts Fr Amtr Radio Commncn Eqptmnt'
'Olive Oil Virgin' 'Octoic Acid Caprylic Acid'
'Orang Juic Not Frozn Value Not Exceeding 20' 'Oak Wood Veneer'
'OilCake And OilCake Meal Undecorticated Solvnt Extrctd Deftd Varty Cotn Seed
s'
'Oats' 'Odhani,Cotton,Grey' 'Oter Sulphides NonMetals Nes'
'Ovrcoats,CarCoats,Capes Etc Silk'
'OilCake And OilCake Meal Linseed Solvent Extracted Defatted Variety'
'Opthalmic Laser'
'Outr Grmnts,Womens And Girls Textile Fabrics,wise Impregnated'
'Oriented Strand Board/Wafer Board Unworked/Sanded'
'Opthalmic Rough Blanks' 'Octopus'
'OilCake And OilCake Meal Mowra Seeds Expeller Variety' 'Orange Squash'
'Ortho Nitro Anisole' 'Optical Calcile Crystal'
'OilCake And OilCake Meal GroundNut Expeller Variety'
'Ovrcoat Etc Wool/Fine Anml Hair' 'Olives' 'Ovrcot Etc Artificial Fibres'
'On Extended Natural Rubber' 'Olives Prpd/Prsvd, Nt Frzn'
'Oil Bound Distemper' 'Out Board Motors' 'Ortho Nitrochlorobenzene'
'Oilcake And OilCake Meal Linseed Expeller Variety'
'Orthochloro Benzoic Acid'
'Optcl Instrs And Applns Fr Insp Semi Cn Wafers/DevicsIncl Ic Fr Insp Photoms
k/Reticls Usd In Mfg Semi CnIncl Ic'
'OneHanded SecatursIncld Poultry Shears'
'Oil Excld Crude Oil Edble Gradenot Chmcly Modfd Fr Olives'
'Ores And Cncrts Rare Esrthmtls'
'OilCake And OilCake Meal Niger Seeds Solvent ExtractedDefatted Variety'
'OilCake And OilCake Meal Expeller Variety Coconut Or Copra'
'Oth Monitors Capable Directly Connecting To And Designed For Use With An Auto
matic Data Processing Machine Heading 8471'
'Octopus Frozen'
'Oth Yarn Polypropylene Single,With A Twist Exceeding 50 Turns/Per Metre'
'Operated By Light Or Photon Beam Processes'
'OilCake And OilCake Meal Solvent ExtractedDefatted Variety Coconut/ Copra'
'OilCake And Meal Sa;LDeOiled Expeller Variety'
'OilCake And OilCake Meal Mango Kernel Expeller Variety'
'Outer Garments,Womens And Girls Rubberised Textile Fabrics'
'Oysters Frozen'
'OilCake And OilCake Meal Undecorticated Expeller Variety Cotton Seeds'
'Obtained From Wood Than Bamboo'
'Ortho Tertiary Butyl Cyclohexyl Acetate' 'Okra/Lady Finger Bhindi'
'Oak Wood In Rough' 'Open Cell For Television Set'
'OilCake And OilCake Meal Sal Deoiled Solvnt Extrctd Defatd Vatty'
'Overcoats,Raincoats,Carcoats,Capes,Cloaks And Smlr Artcls'
'Overcoats,Raincoats,Carcoats,Capes,Cloaks And Similar Articles'
'Overcoat,Raincoat, Carcoats,Capes,Cloaks And Smlr Artcls'
'Open Woven Fabrics A Width Not Exceeding 30 Cm'
'Open Woven Fabrics A Width Exceeding 30 Cm'
'Overcoats,Raincoats,Carcoats,Capes Cloaks And Smlr Artcls'
'Overcoats,Rain Coats, Car Coats, Capes, Cloaks And Smlr Artcls'
'Organic LightEmitting Diodes Oled : For The Goods SubHeading 8517 13 Or 8517
14'

```
 'OrganoSilicon Compounds'
 'Organic LightEmitting Diodes Oled : For The Goods SubHeading 8471 30 Or 8471
41'
 'Organic LightEmitting Diodes Oled : For The Goods SubHeading 8528 72 Or 8528
73'
 'OEthyl SPhenyl Ethylphosphonothiolothionate Fonofos' 'Open Fabrics'
 'Organic Chemicals' 'Oth Txtl Yrn, Fbric Mdup Artcl']
```

- Aggregate

In [247…

```
# group by country and see all commodities for each country
country_commodities = df.groupby('country_name')['commodity'].unique()
print(country_commodities)
```

country_name	
Afghanistan	[Boneless Meat Bovine Animals , Froze n, Scampi...
Armenia	[Boneless Meat Bovine Animals , Froze n, Mango ...
Azerbaijan	[Boneless Meat Bovine Animals , Froze n, Edible...
Bahrain	[Boneless Meat Bovn Anmls, Frsh Or Chl d, Bonel...
Bangladesh	[Salmonide Fresh Or Chilled Excl Headi ng 03029...
Bhutan	[Meat/Edbl Ofal Fowls The Spcs Gals Do mesticus...
Brunei Darussalam	[Boneless Meat Bovine Animals , Froze n, Seer F...
Cambodia	[Grapes Fresh, Groats And Meal Maize C orn, Sta...
China	[Freshwater Ornamental Fish, Live Eels Anguill...
Cyprus	[Crabs Frozen, Scampi, Shrimps And Pra wns, Cut...
Democratic People's Republic of Korea	[Tunas Frozen Excl Heading 030391 To 0 30399, C...
Georgia	[Onions Dried, Chickpeas Garbanzos Dri ed And S...
Hong Kong	[Boneless Meat Bovine Animals , Froze n, Freshw...
Indonesia	[Edible Offal Bovine Animals,Frozen, T unas Fro...
Iraq	[Boneless Meat Bovine Animals , Froze n, Natura...
Islamic Republic of Iran	[Boneless Meat Bovine Animals , Froze n, Yellow...
Israel	[Freshwater Ornamental Fish, Fish Incl Nile Pe...
Japan	[Freshwater Ornamental Fish, Ornamenta l Fish, ...
Jordan	[Boneless Meat Bovn Anmls, Frsh Or Chl d, Bonel...
Kazakhstan	[Black Tea In Packt>25 Gm But<=1 Kg, T ea Black...
Kuwait	[Boneless Meat Bovn Anmls, Frsh Or Chl d, Bonel...
Kyrgyzstan	[Boneless Meat Bovine Animals , Froze n, Tea Bl...
Lao People's Democratic Republic	[Boneless Meat Bovine Animals , Froze n, Sinews...
Lebanon	[Boneless Meat Bovine Animals , Froze n, Edible...
Macao	[Mixed Vegetables, ,Dried, Bananas, Fr esh, Med...
Malaysia	[Boneless Meat Bovine Animals , Froze n, Edible...
Maldives	[Live Goats, Boneless Meat Bovine Anim

```
als , Fr...
Mongolia                                [Boneless Meat Bovine Animals , Froze
n, Cucumb...
Myanmar                                 [Human Hair,Unworked; Whethr Or Not Wa
shd Or S...
Nepal                                   [PureBred Breeding Asses, Asses, Live
Swine, P...
Oman                                    [Boneless Meat Bovn Anmls, Frsh Or Chl
d, Bonel...
Pakistan                                [Boneless Meat Bovine Animals , Froze
n, Edbl O...
Philippines                             [Boneless Meat Bovine Animals , Froze
n, Cheese...
Qatar                                   [Boneless Meat Bovn Anmls, Frsh Or Chl
d, Bonel...
Republic of Korea                       [Boneless Meat Bovine Animals , Froze
n, Salmon...
Saudi Arabia                            [Boneless Meat Bovn Anmls, Frsh Or Chl
d, Bonel...
Singapore                               [Live Animals, Freshwater Ornamental F
ish, Orn...
Sri Lanka                               [Salmonide Fresh Or Chilled Excl Headi
ng 03029...
State of Palestine                      [Sweet Biscuits, Penicillins And Thr D
rvtvs Wt...
Syrian Arab Republic                    [Boneless Meat Bovine Animals , Froze
n, Coconu...
Taiwan, Province of China               [Ornamental Fish, Salmonide Fresh Or C
hilled E...
Tajikistan                              [Boneless Meat Bovine Animals , Froze
n, Edible...
Thailand                                [Boneless Meat Bovine Animals , Froze
n, Edible...
Timor-Leste                             [Frsh Or Chld Fillets Seer, Medicament
s Contai...
Turkiye                                 [Scampi, Whole Squids Oth Thn Live, Fr
esh Or C...
Turkmenistan                            [Boneless Meat Bovine Animals , Froze
n, Instan...
Türkiye                                 [Skipjack Tuna StripeBellied Bonito, K
atsuwonu...
United Arab Emirates                    [Boneless Meat Bovn Anmls, Frsh Or Chl
d, Bonel...
Uzbekistan                              [Seeds Cummin Excl. Black; Neither Cru
shed Nor...
Viet Nam                                [Boneless Meat Bovine Animals , Froze
n, Edbl O...
Yemen                                   [Boneless Meat Bovine Animals , Froze
n, Roses,...
Name: commodity, dtype: object
```

In [248…

```python
# Aggregate by country_name
region_aggregation = df.groupby('country_name').agg({
    'value_rs': 'sum',
```

```
    'value_dl': 'mean'
})
print(region_aggregation)
```

country_name	value_rs	value_dl
Afghanistan	3.227301e+06	0.124722
Armenia	1.831065e+05	0.068946
Azerbaijan	2.029124e+05	0.050190
Bahrain	2.644864e+06	0.046978
Bangladesh	4.012428e+07	0.280076
Bhutan	2.773694e+06	0.031755
Brunei Darussalam	2.283622e+05	0.025046
Cambodia	7.235184e+05	0.049482
China	6.803718e+07	0.630957
Cyprus	5.920736e+05	0.054902
Democratic People's Republic of Korea	1.588005e+05	0.045220
Georgia	4.577955e+05	0.048608
Hong Kong	5.821104e+07	0.858880
Indonesia	2.062661e+07	0.238639
Iraq	6.494214e+06	0.250479
Islamic Republic of Iran	1.200060e+07	0.327561
Israel	1.566272e+07	0.250476
Japan	1.983668e+07	0.207683
Jordan	2.951863e+06	0.090007
Kazakhstan	7.510938e+05	0.070763
Kuwait	5.889009e+06	0.082220
Kyrgyzstan	1.443926e+05	0.020721
Lao People's Democratic Republic	1.370481e+05	0.045000
Lebanon	1.041962e+06	0.044699
Macao	2.739333e+04	0.029266
Malaysia	2.668817e+07	0.232311
Maldives	1.188684e+06	0.020613
Mongolia	7.852393e+04	0.023418
Myanmar	4.512041e+06	0.115705
Nepal	2.926336e+07	0.134760
Oman	8.135947e+06	0.100759
Pakistan	6.341199e+06	0.166788
Philippines	7.191022e+06	0.112169
Qatar	5.949402e+06	0.071619
Republic of Korea	2.007130e+07	0.262607
Saudi Arabia	2.791148e+07	0.269399
Singapore	3.995544e+07	0.346343
Sri Lanka	1.945703e+07	0.127766
State of Palestine	4.300140e+03	0.026564
Syrian Arab Republic	6.325919e+05	0.074201
Taiwan, Province of China	8.231797e+06	0.142817
Tajikistan	1.405019e+05	0.044227
Thailand	1.750271e+07	0.173325
Timor-Leste	4.591564e+04	0.058323
Turkiye	2.352932e+07	0.293461
Turkmenistan	2.893225e+05	0.084024
Türkiye	1.078438e+04	0.185604
United Arab Emirates	1.139797e+08	0.570502
Uzbekistan	8.434936e+05	0.072319
Viet Nam	2.838842e+07	0.346514
Yemen	3.000417e+06	0.117716

- Checking data handling

In [249…
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Index: 4860754 entries, 0 to 5348873
Data columns (total 11 columns):
 #   Column        Dtype         
---  ------        -----         
 0   date          datetime64[ns]
 1   country_name  object        
 2   region        object        
 3   sub_region    object        
 4   commodity     object        
 5   unit          object        
 6   value_qt      float64       
 7   value_rs      float64       
 8   value_dl      float64       
 9   year          int32         
 10  month         object        
dtypes: datetime64[ns](1), float64(3), int32(1), object(6)
memory usage: 426.5+ MB
```

3. Exploratory Data Analysis (EDA)

- Univariate Analysis:

In [250…
```
# 1. Univariate Analysis
# Statistical summary of numerical columns
numerical_summary = df.describe()
print("Statistical Summary of Numerical Columns:")
print(numerical_summary)
```

```
Statistical Summary of Numerical Columns:
                                date      value_qt      value_rs  \
count                          4860754  4.860754e+06  4.860754e+06
mean   2019-10-10 01:31:25.264548864  5.072107e+04  1.350555e+02
min              2015-01-01 00:00:00  0.000000e+00  0.000000e+00
25%              2017-05-01 00:00:00  1.500000e-01  2.900000e-01
50%              2019-06-01 00:00:00  2.480000e+00  3.270000e+00
75%              2021-07-01 00:00:00  4.000000e+01  2.451000e+01
max              2025-07-01 00:00:00  2.046347e+09  9.778869e+05
std                              NaN  3.935808e+06  3.127115e+03

           value_dl          year
count  4.860754e+06  4.860754e+06
mean   2.380684e-01  2.019314e+03
min    0.000000e+00  2.015000e+03
25%    0.000000e+00  2.017000e+03
50%    1.000000e-02  2.019000e+03
75%    5.000000e-02  2.021000e+03
max    1.517490e+03  2.025000e+03
std    4.847558e+00  3.032933e+00
```

In [251…

```python
# Frequency distribution of categorical columns
print("\nFrequency Distribution of Country:")
print(df['country_name'].value_counts())
```

Frequency Distribution of Country:

country_name	
Nepal	376561
United Arab Emirates	369942
Sri Lanka	264218
Bangladesh	255348
Singapore	210221
Malaysia	204019
Saudi Arabia	201642
China	182413
Thailand	178733
Bhutan	175235
Japan	174323
Oman	156963
Indonesia	150091
Qatar	148475
Viet Nam	138409
Republic of Korea	137572
Turkiye	133776
Kuwait	132687
Philippines	117325
Maldives	115466
Hong Kong	107250
Israel	100706
Bahrain	99875
Taiwan, Province of China	97920
Myanmar	63832
Pakistan	59556
Islamic Republic of Iran	58568
Jordan	58495
Iraq	54609
Yemen	45342
Lebanon	43620
Afghanistan	40393
Cambodia	26466
Uzbekistan	26235
Georgia	20655
Kazakhstan	19661
Cyprus	17539
Brunei Darussalam	16643
Syrian Arab Republic	13462
Kyrgyzstan	12941
Azerbaijan	8139
Türkiye	6774
Armenia	6544
Mongolia	6380
Tajikistan	5912
Turkmenistan	5848
Democratic People's Republic of Korea	5368
Lao People's Democratic Republic	4874
Timor-Leste	2111
Macao	1390
State of Palestine	227

Name: count, dtype: int64

In [252…
```
print("\nFrequency Distribution of Region:")
print(df['region'].value_counts())
```

```
Frequency Distribution of Region:
region
Asia    4860754
Name: count, dtype: int64
```

- ## Multivariate Analysis:

In [253…
```
# Correlation analysis
correlation = df.select_dtypes(include=[np.number]).corr()
print("\nCorrelation Matrix:")
print(correlation)
```

```
Correlation Matrix:
          value_qt  value_rs  value_dl      year
value_qt  1.000000  0.001104  0.106557  0.021763
value_rs  0.001104  1.000000  0.940786 -0.014774
value_dl  0.106557  0.940786  1.000000 -0.000243
year      0.021763 -0.014774 -0.000243  1.000000
```

- ## Correlation Analysis

In [254…
```
# Correlation analysis between numerical columns
correlation_matrix = df[['value_qt', 'value_rs', 'value_dl']].corr()
print("\nCorrelation Matrix:")
print(correlation_matrix)
```

```
Correlation Matrix:
          value_qt  value_rs  value_dl
value_qt  1.000000  0.001104  0.106557
value_rs  0.001104  1.000000  0.940786
value_dl  0.106557  0.940786  1.000000
```

- ## Groupby

In [255…
```
# Advanced groupby - Average value by region and sub-region
region_subregion_avg = df.groupby(['region', 'sub_region'])['value_rs'].mean()
print("\nAverage Value by Region and Sub-region:")
print(region_subregion_avg.head(10))
```

```
Average Value by Region and Sub-region:
  region          sub_region    value_rs
0   Asia        Central Asia   30.720915
1   Asia        Eastern Asia  245.086720
2   Asia  South-eastern Asia  131.208879
3   Asia       Southern Asia   85.016221
4   Asia        Western Asia  135.398728
```

In [256…
```
# Group by country and calculate mean values
country_analysis = df.groupby('country_name').agg({
```

```
    'value_qt': 'mean',
    'value_rs': 'mean',
    'value_dl': 'mean'
}).reset_index()

print("Country Analysis:")
print(country_analysis.head())
```

```
Country Analysis:
  country_name       value_qt    value_rs  value_dl
0  Afghanistan    8532.018500   79.897536  0.124722
1      Armenia    4829.534245   27.980814  0.068946
2   Azerbaijan    4540.471721   24.930878  0.050190
3      Bahrain    8478.075829   26.481738  0.046978
4   Bangladesh  144353.720714  157.135657  0.280076
```

- Pivot Table

In [257…

```
# Create a pivot table to analyze commodity values by region
pivot_region_commodity = pd.pivot_table(
    df,
    values='value_dl',
    index='sub_region',
    columns='commodity',
    aggfunc='sum'
)
print("\nPivot Table - Region by Commodity:")
print(pivot_region_commodity.head())
```

Pivot Table - Region by Commodity:

commodity	Brominated Or Iodinated Derivatives Acyclic Hydrocarbons
sub_region	
Central Asia	NaN
Eastern Asia	1.23
South-eastern Asia	2.42
Southern Asia	0.00
Western Asia	0.01

commodity	LightEmitting Diode Led Lamps	,	,Dried
sub_region			
Central Asia	0.00	0.01	0.01
Eastern Asia	1.87	1.10	1.36
South-eastern Asia	0.60	0.68	5.38
Southern Asia	9.81	11.47	3.22
Western Asia	1.63	1.75	3.25

commodity	,Excldng Live Sheep And Lamb For Brdng Purpose
sub_region	
Central Asia	NaN
Eastern Asia	NaN
South-eastern Asia	NaN
Southern Asia	NaN
Western Asia	93.96

commodity	,Nt Incl. In The SubHdng Abve,Contng 30% Or More By Mas 1,1,1,2Hfc134A Bt Nt Cont Unsat Fluorinate Drvt Hfo
sub_region	
Central Asia	NaN
Eastern Asia	NaN
South-eastern Asia	0.09
Southern Asia	0.00
Western Asia	1.43

commodity	,With Both Outer Plies Coniferous Wood,Laminated Veneered L umber Lvl
sub_region	
Central Asia	NaN
Eastern Asia	NaN
South-eastern Asia	NaN
Southern Asia	0.0
Western Asia	NaN

commodity	.	0Acetylsalicylic Acid Its Salts And Estrs
sub_region		
Central Asia	NaN	0.12
Eastern Asia	NaN	NaN
South-eastern Asia	NaN	0.41
Southern Asia	NaN	0.06
Western Asia	0.0	0.55

commodity	0Ptical Whitening Agents	...
sub_region		...

```
Central Asia                          0.35  ...
Eastern Asia                         45.10  ...
South-eastern Asia                  105.82  ...
Southern Asia                        52.04  ...
Western Asia                         66.38  ...

commodity           Zirconium And Artcls Zirconium  Zirconium Dioxides  \
sub_region
Central Asia                                   NaN                 NaN
Eastern Asia                                  0.18                0.20
South-eastern Asia                            0.01                0.04
Southern Asia                                 0.05                0.29
Western Asia                                  0.02                0.03

commodity           Zirconium Ores And Concentrates  \
sub_region
Central Asia                                    NaN
Eastern Asia                                   5.96
South-eastern Asia                             0.03
Southern Asia                                  0.28
Western Asia                                   0.38

commodity           [Tropical Wood:Doors And Their Frames And Thresholds:]  \
sub_region
Central Asia                                                          NaN
Eastern Asia                                                         0.11
South-eastern Asia                                                   0.18
Southern Asia                                                        0.91
Western Asia                                                         0.60

commodity           nE.G.Milk Cream      s  sIncl BeeKeepng Machinery  \
sub_region
Central Asia                   NaN   0.02                         NaN
Eastern Asia                  0.04  12.55                        0.08
South-eastern Asia            0.11  12.09                        0.26
Southern Asia                52.19   9.62                        4.19
Western Asia                  0.82   0.98                        1.54

commodity           unflwr Andsafflwr Oil Excld Edible/ NonEdble Grade  \
sub_region
Central Asia                                                         0.00
Eastern Asia                                                         0.03
South-eastern Asia                                                   0.38
Southern Asia                                                        0.78
Western Asia                                                         0.26

commodity           ushrooms And Truffles Provisnly Presrvd  \
sub_region
Central Asia                                           NaN
Eastern Asia                                          0.01
South-eastern Asia                                    0.02
Southern Asia                                         0.58
Western Asia                                          0.09
```

```
commodity           wise Wrkd Rubies Sapphires And Emerals
sub_region
Central Asia                                          0.00
Eastern Asia                                        782.64
South-eastern Asia                                  103.10
Southern Asia                                         1.26
Western Asia                                         52.93

[5 rows x 10881 columns]
```

- ## Time series Analysis

In [258…]
```
# Time series analysis - Monthly trend by year
if 'date' in df.columns:
    df['year_month'] = df['date'].dt.to_period('M')
    monthly_trend = df.groupby('year_month')['value_rs'].mean()
    print(monthly_trend)
```

```
year_month
2015-01    180.534511
2015-02    161.114568
2015-03    164.299913
2015-04    158.298688
2015-05    146.438019
              ...
2025-03      2.072486
2025-04      2.020094
2025-05      1.950872
2025-06      1.824786
2025-07      1.892182
Freq: M, Name: value_rs, Length: 100, dtype: float64
```

- ## Generate statistical summaries to support findings

In [259…]
```
summary_stats = df.describe(include='all')
print(summary_stats)
```

```
                                date country_name   region    sub_region  \
count                          4860754      4860754  4860754       4860754
unique                             NaN           51        1             5
top                                NaN        Nepal     Asia  Western Asia
freq                               NaN       376561  4860754       1619472
mean    2019-10-10 01:31:25.264548864          NaN      NaN           NaN
min               2015-01-01 00:00:00          NaN      NaN           NaN
25%               2017-05-01 00:00:00          NaN      NaN           NaN
50%               2019-06-01 00:00:00          NaN      NaN           NaN
75%               2021-07-01 00:00:00          NaN      NaN           NaN
max               2025-07-01 00:00:00          NaN      NaN           NaN
std                                NaN          NaN      NaN           NaN

       commodity     unit      value_qt      value_rs      value_dl  \
count    4860754  4860754  4.860754e+06  4.860754e+06  4.860754e+06
unique     10881       19           NaN           NaN           NaN
top         Grey      Kgs           NaN           NaN           NaN
freq       13803  3342906           NaN           NaN           NaN
mean         NaN      NaN  5.072107e+04  1.350555e+02  2.380684e-01
min          NaN      NaN  0.000000e+00  0.000000e+00  0.000000e+00
25%          NaN      NaN  1.500000e-01  2.900000e-01  0.000000e+00
50%          NaN      NaN  2.480000e+00  3.270000e+00  1.000000e-02
75%          NaN      NaN  4.000000e+01  2.451000e+01  5.000000e-02
max          NaN      NaN  2.046347e+09  9.778869e+05  1.517490e+03
std          NaN      NaN  3.935808e+06  3.127115e+03  4.847558e+00

                year    month year_month
count   4.860754e+06  4860754    4860754
unique           NaN       12        100
top              NaN     July    2025-03
freq             NaN   442303      59320
mean    2.019314e+03      NaN        NaN
min     2.015000e+03      NaN        NaN
25%     2.017000e+03      NaN        NaN
50%     2.019000e+03      NaN        NaN
75%     2.021000e+03      NaN        NaN
max     2.025000e+03      NaN        NaN
std     3.032933e+00      NaN        NaN
```

In [260…

```
# You can also get specific statistics for numerical columns
numerical_summary = df[['value_qt', 'value_rs', 'value_dl']].describe()
print("\nNumerical columns summary:")
print(numerical_summary)
```

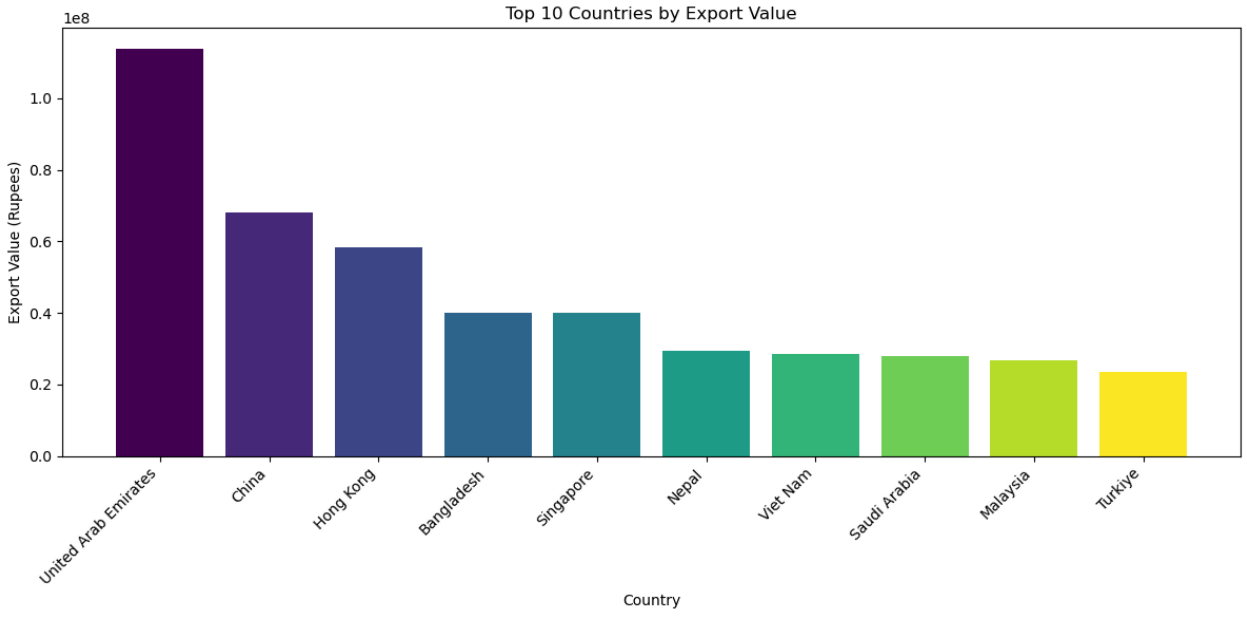
```
Numerical columns summary:
           value_qt      value_rs      value_dl
count  4.860754e+06  4.860754e+06  4.860754e+06
mean   5.072107e+04  1.350555e+02  2.380684e-01
std    3.935808e+06  3.127115e+03  4.847558e+00
min    0.000000e+00  0.000000e+00  0.000000e+00
25%    1.500000e-01  2.900000e-01  0.000000e+00
50%    2.480000e+00  3.270000e+00  1.000000e-02
75%    4.000000e+01  2.451000e+01  5.000000e-02
max    2.046347e+09  9.778869e+05  1.517490e+03
```

In [261…
```
# For categorical columns, you might want to see value counts
print("\nCountry distribution:")
print(df['country_name'].value_counts().head())
```

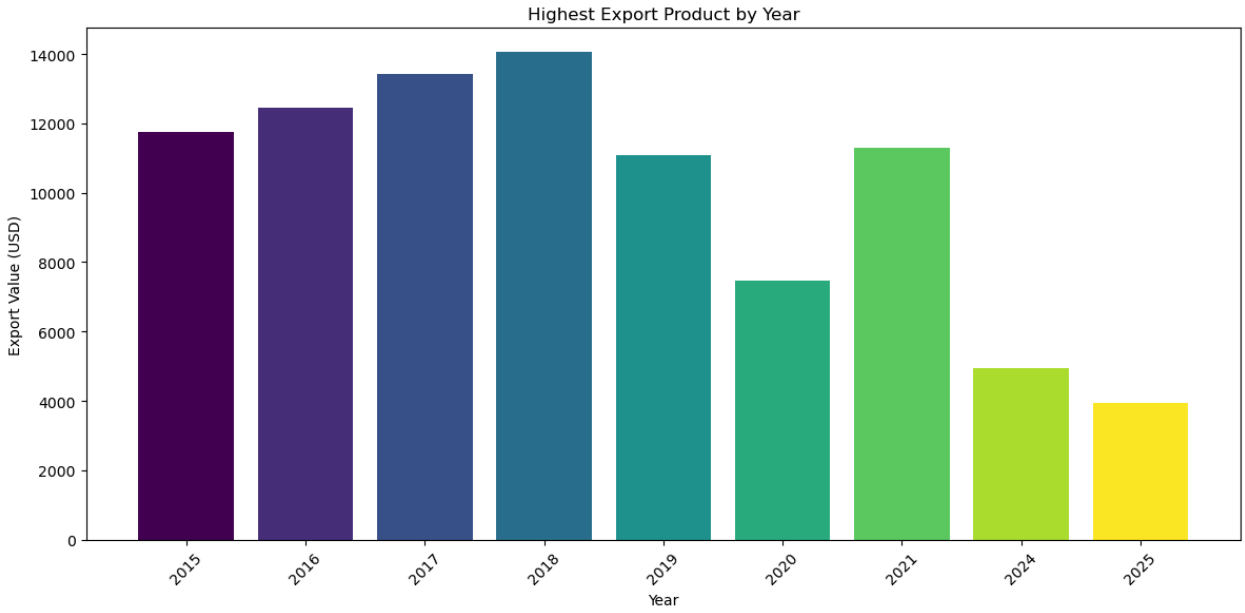
```
Country distribution:
country_name
Nepal                  376561
United Arab Emirates   369942
Sri Lanka              264218
Bangladesh             255348
Singapore              210221
Name: count, dtype: int64
```

4. Visualizations

In [262…
```
export_by_country = df.groupby('country_name')['value_rs'].sum().reset_index()

export_by_country = export_by_country.sort_values('value_rs', ascending=False)

top_countries = export_by_country.head(10)

plt.figure(figsize=(12, 6))

colors = plt.cm.viridis(np.linspace(0, 1, len(top_countries)))

plt.bar(top_countries['country_name'], top_countries['value_rs'], color=colors
plt.title('Top 10 Countries by Export Value')
plt.xlabel('Country')
plt.ylabel('Export Value (Rupees)')
plt.xticks(rotation=45, ha='right')
plt.tight_layout()
plt.show()
```

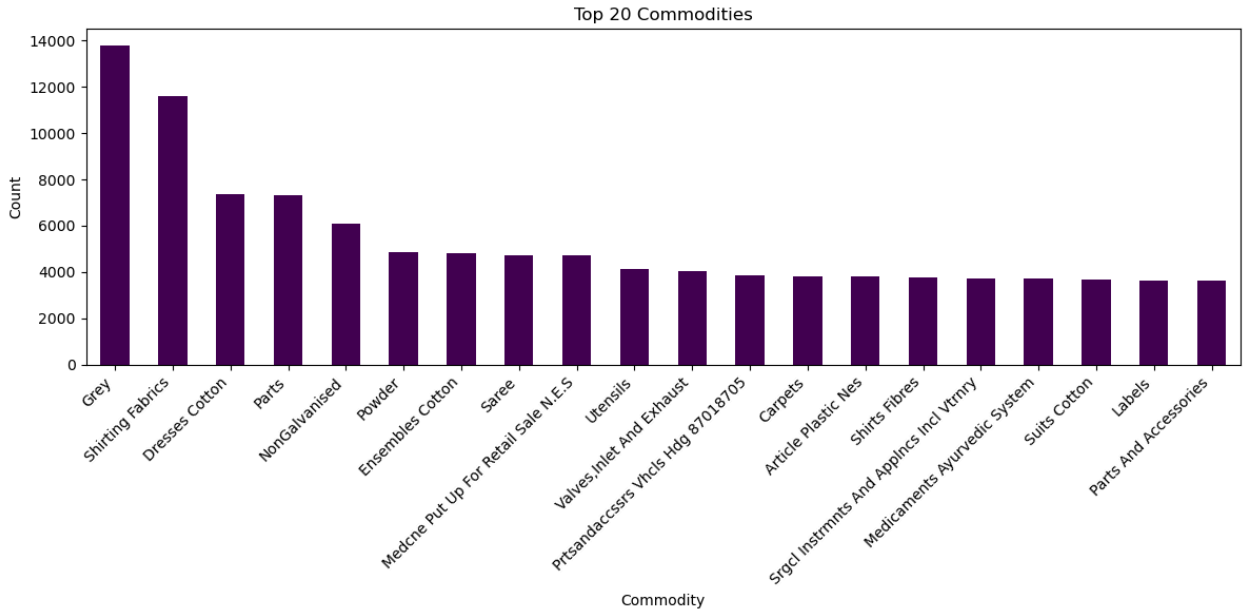


In [263…
```
yearly_exports = df.groupby(['year', 'commodity'])['value_dl'].sum().reset_inc

highest_exports = yearly_exports.loc[yearly_exports.groupby('year')['value_dl'

plt.figure(figsize=(12, 6))

colors = plt.cm.viridis(np.linspace(0, 1, len(highest_exports)))
bars = plt.bar(highest_exports['year'].astype(str), highest_exports['value_dl'

plt.xlabel('Year')
plt.ylabel('Export Value (USD)')
plt.title('Highest Export Product by Year')
plt.xticks(rotation=45)
plt.tight_layout()
plt.show()
```



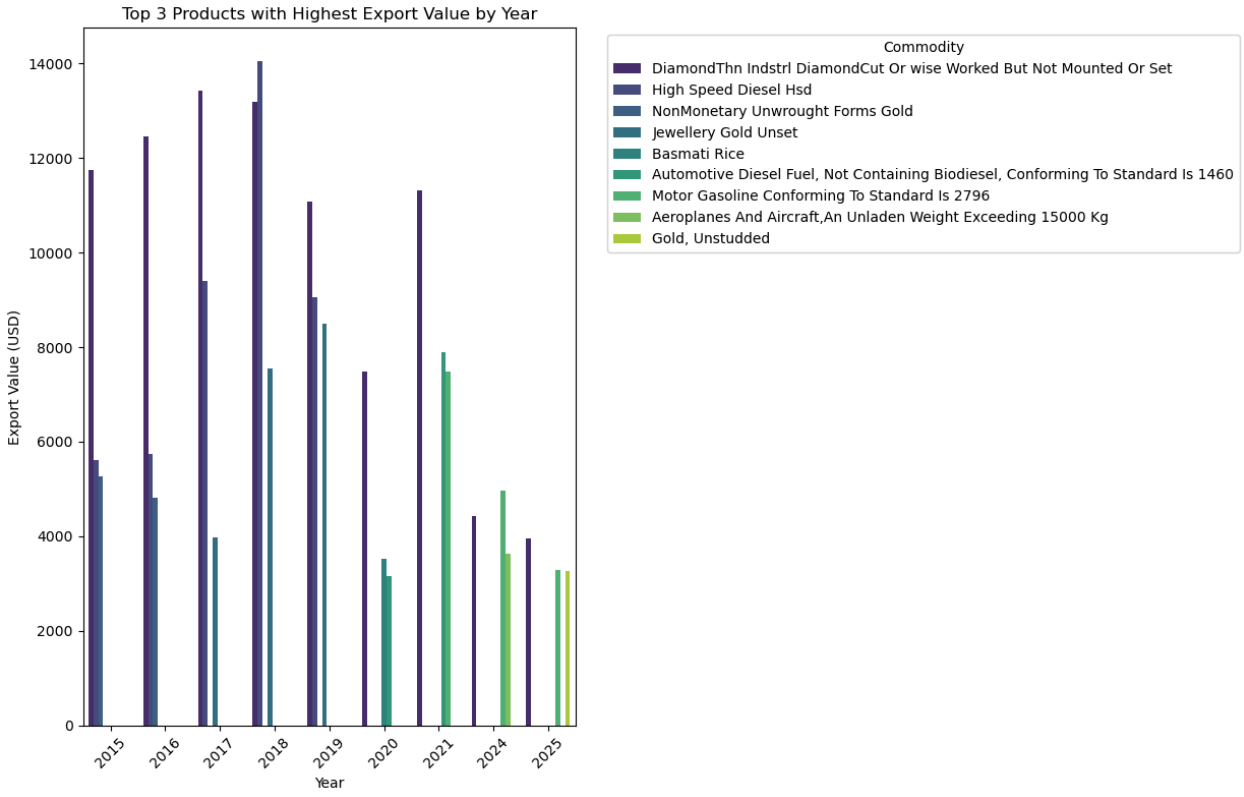
- Bar plot of commodity counts

In [264…
```
commodity_counts = df['commodity'].value_counts().head(20)

# Create a bar plot
plt.figure(figsize=(12, 6))
commodity_counts.plot(kind='bar', colormap='viridis')
plt.title('Top 20 Commodities')
plt.xlabel('Commodity')
plt.ylabel('Count')
plt.xticks(rotation=45, ha='right')
plt.tight_layout()
plt.show()
```



In [265…

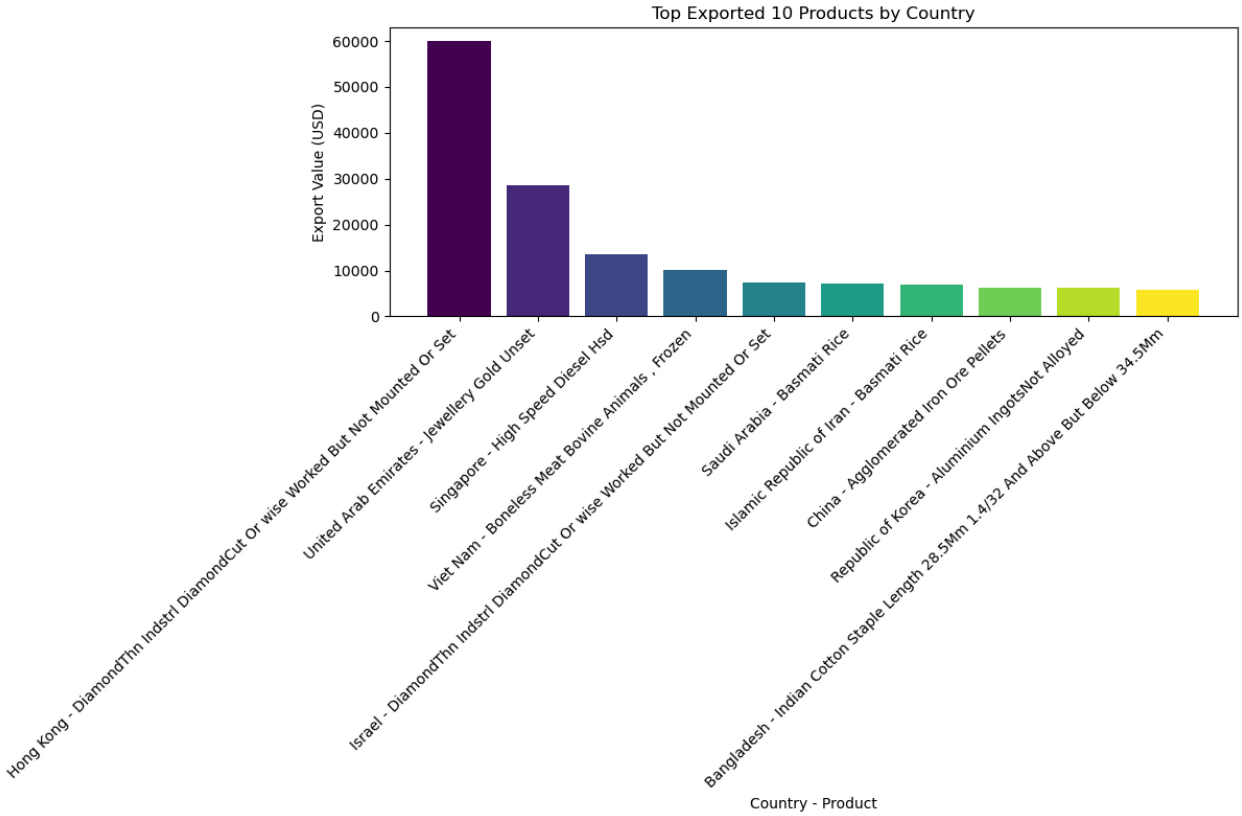
```
top_exports = df.groupby(['year', 'commodity'])['value_dl'].sum().reset_index(

# For each year, find the top 3 products by export value
top_3_by_year = top_exports.sort_values(['year', 'value_dl'], ascending=[True,

plt.figure(figsize=(15, 8))
chart = sns.barplot(x='year', y='value_dl', hue='commodity', data=top_3_by_yea
plt.title('Top 3 Products with Highest Export Value by Year')
plt.xlabel('Year')
plt.ylabel('Export Value (USD)')
plt.xticks(rotation=45)
plt.legend(title='Commodity', bbox_to_anchor=(1.05, 1), loc='upper left')
plt.tight_layout(rect=[0, 0, 0.85, 1])  # Adjust the right margin to make room
plt.show()
```



- Bar chart of the top 10 exports

In [266…

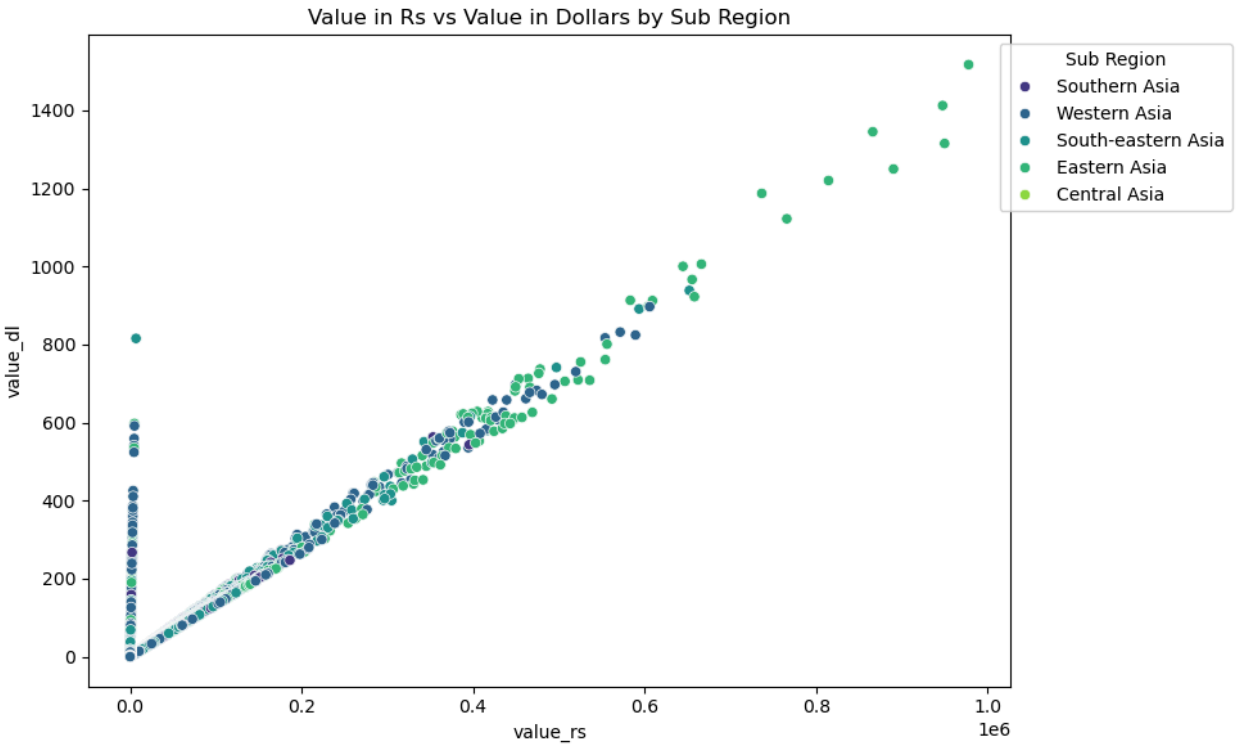
```
export_summary = df.groupby(['country_name', 'commodity'])['value_dl'].sum().r

top_exports = export_summary.loc[export_summary.groupby('country_name')['value

top_exports_sorted = top_exports.sort_values('value_dl', ascending=False)

plt.figure(figsize=(12, 8))
top_10 = top_exports_sorted.head(10)

colors = cm.viridis(np.linspace(0, 1, len(top_10)))

plt.bar(top_10['country_name'] + ' - ' + top_10['commodity'], top_10['value_dl
plt.xticks(rotation=45, ha='right')
plt.title('Top Exported 10 Products by Country')
plt.xlabel('Country - Product')
plt.ylabel('Export Value (USD)')
plt.tight_layout()
plt.show()
```



- ## Scatterplot

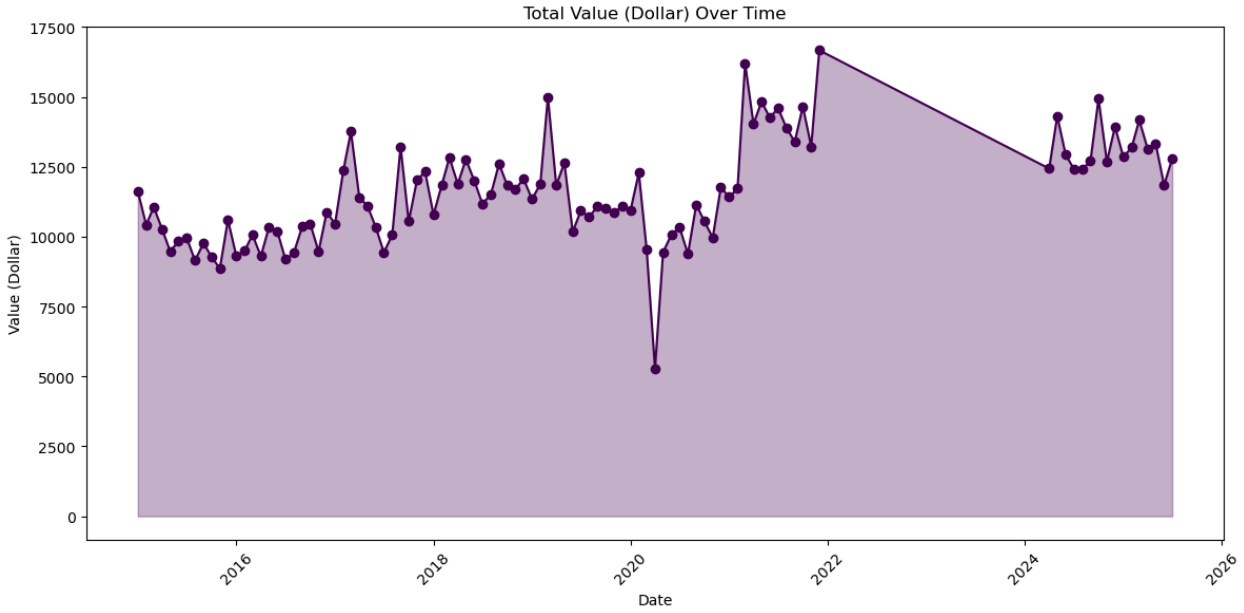
In [267…

```
# Create the scatterplot with a specified legend location
plt.figure(figsize=(10, 6))
sns.scatterplot(x='value_rs', y='value_dl', hue='sub_region', data=df,palette=
plt.title('Value in Rs vs Value in Dollars by Sub Region')
plt.legend(loc='upper right', bbox_to_anchor=(1.25, 1), title='Sub Region')
plt.tight_layout()
plt.show()
```



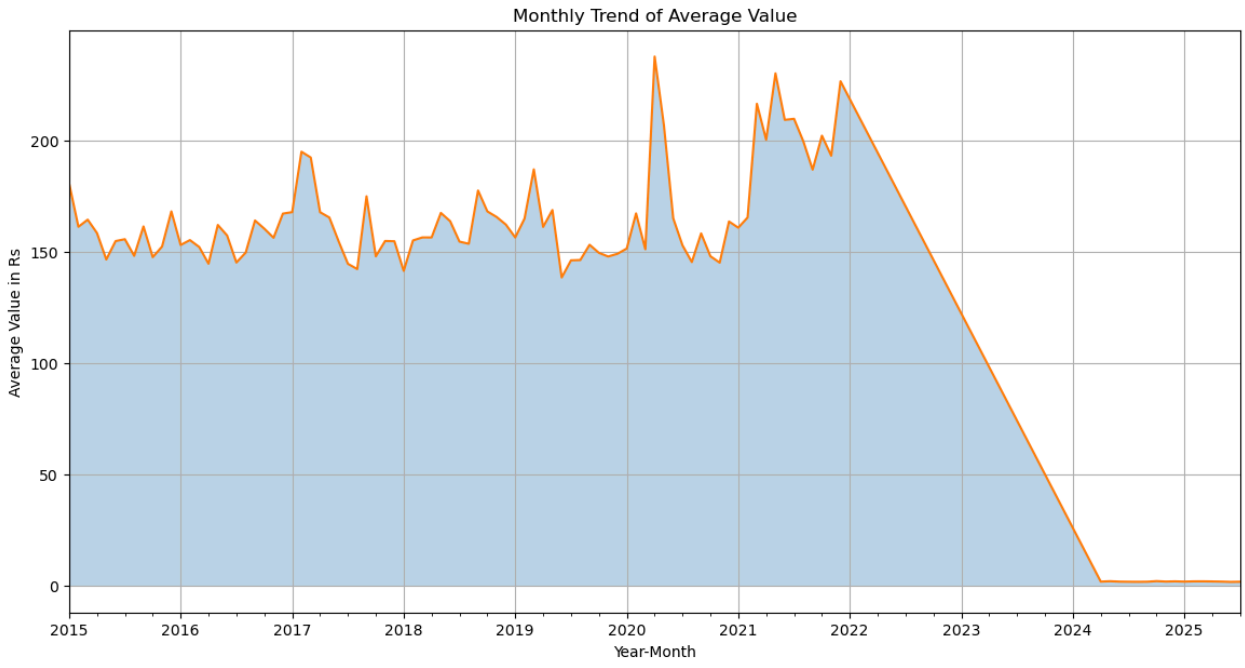
In [268…

```
# Line chart of value_dl over time
plt.figure(figsize=(12, 6))
df_time = df.groupby('date')['value_dl'].sum().reset_index()

# Plot with viridis colormap for fill
plt.plot(df_time['date'], df_time['value_dl'], marker='o', color='#440154')
plt.fill_between(df_time['date'], df_time['value_dl'], alpha=0.3, color='#4401

plt.title('Total Value (Dollar) Over Time')
plt.xlabel('Date')
plt.ylabel('Value (Dollar)')
plt.xticks(rotation=45)
plt.tight_layout()
plt.show()
```



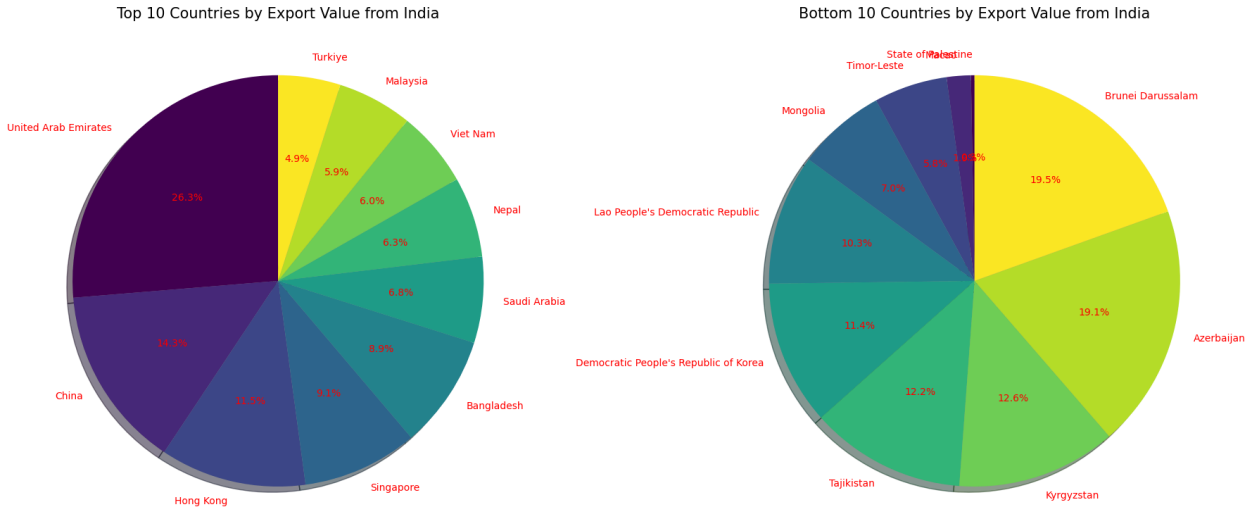
In [269…

```
# Time series analysis - Monthly trend by year
if 'date' in df.columns:
    df['year_month'] = df['date'].dt.to_period('M')
    monthly_trend = df.groupby('year_month')['value_rs'].mean()

    plt.figure(figsize=(14, 7))

    monthly_trend.plot(color=['#ff7f0e'])
    plt.title('Monthly Trend of Average Value')
    plt.xlabel('Year-Month')
    plt.ylabel('Average Value in Rs')
    plt.grid(True)
    plt.fill_between(monthly_trend.index.astype(str), monthly_trend.values, al
    plt.show()
```



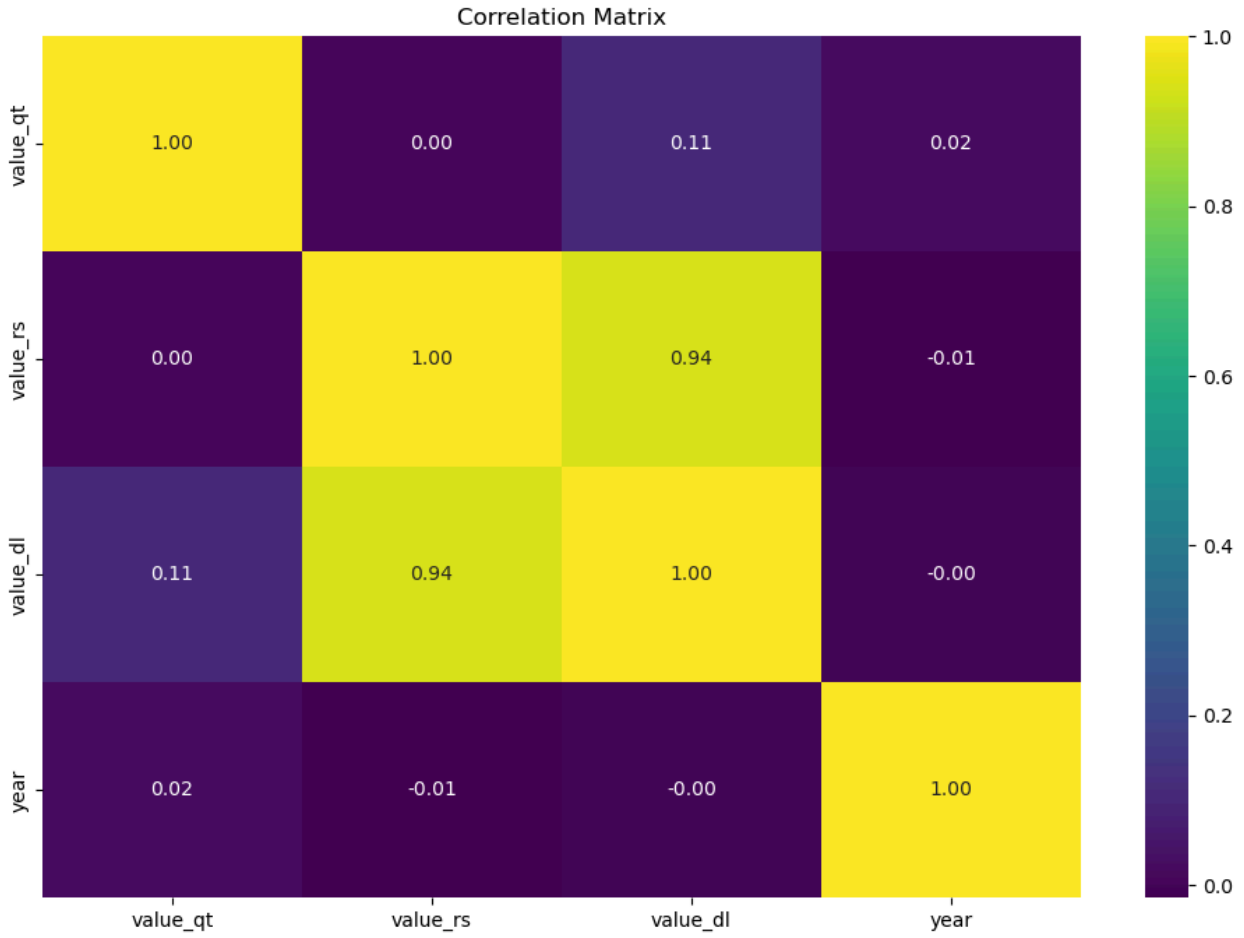
In [270…

```
fig, (ax1, ax2) = plt.subplots(1, 2, figsize=(18, 8))

top_countries = df.groupby('country_name')['value_dl'].sum().nlargest(10)

ax1.pie(top_countries, labels=top_countries.index, autopct='%1.1f%%',
        shadow=True, startangle=90,
        colors=plt.cm.viridis(np.linspace(0, 1, len(top_countries))),
        textprops={'color': 'Red'})
ax1.set_title('Top 10 Countries by Export Value from India', fontsize=15)

bottom_countries = df.groupby('country_name')['value_dl'].sum().nsmallest(10)

ax2.pie(bottom_countries, labels=bottom_countries.index, autopct='%1.1f%%',
        shadow=True, startangle=90,
        colors=plt.cm.viridis(np.linspace(0, 1, len(bottom_countries))),
        textprops={'color': 'Red'})
ax2.set_title('Bottom 10 Countries by Export Value from India', fontsize=15)

plt.tight_layout()
plt.show()
```



In [271…

```
# Visualize correlation matrix
plt.figure(figsize=(12, 8))
sns.heatmap(correlation, annot=True, cmap='viridis', fmt='.2f')
plt.title('Correlation Matrix')
plt.show()
```



In [272…

```
country_commodity_exports = df.groupby(['country_name', 'commodity'])['value_d

top_commodities_by_country = country_commodity_exports.loc[
    country_commodity_exports.groupby('country_name')['value_dl'].idxmax()
]

top_commodities_by_country = top_commodities_by_country.sort_values('value_dl'

top_10_countries = top_commodities_by_country['country_name'].head(10).tolist(
country_top5_commodities = df[df['country_name'].isin(top_10_countries)]
country_top5_commodities = country_top5_commodities.groupby(['country_name', '

top5_per_country = []
for country in top_10_countries:
    country_data = country_top5_commodities[country_top5_commodities['country_
    top5_per_country.append(country_data.nlargest(5, 'value_dl'))

top5_per_country = pd.concat(top5_per_country)

heatmap_data = top5_per_country.pivot_table(index='country_name', columns='com

plt.figure(figsize=(16, 10))
sns.heatmap(heatmap_data, annot=True, fmt='.1e', cmap='YlGnBu')
plt.title('Top 5 Commodities Exported to Top 10 Countries')
plt.tight_layout()
```

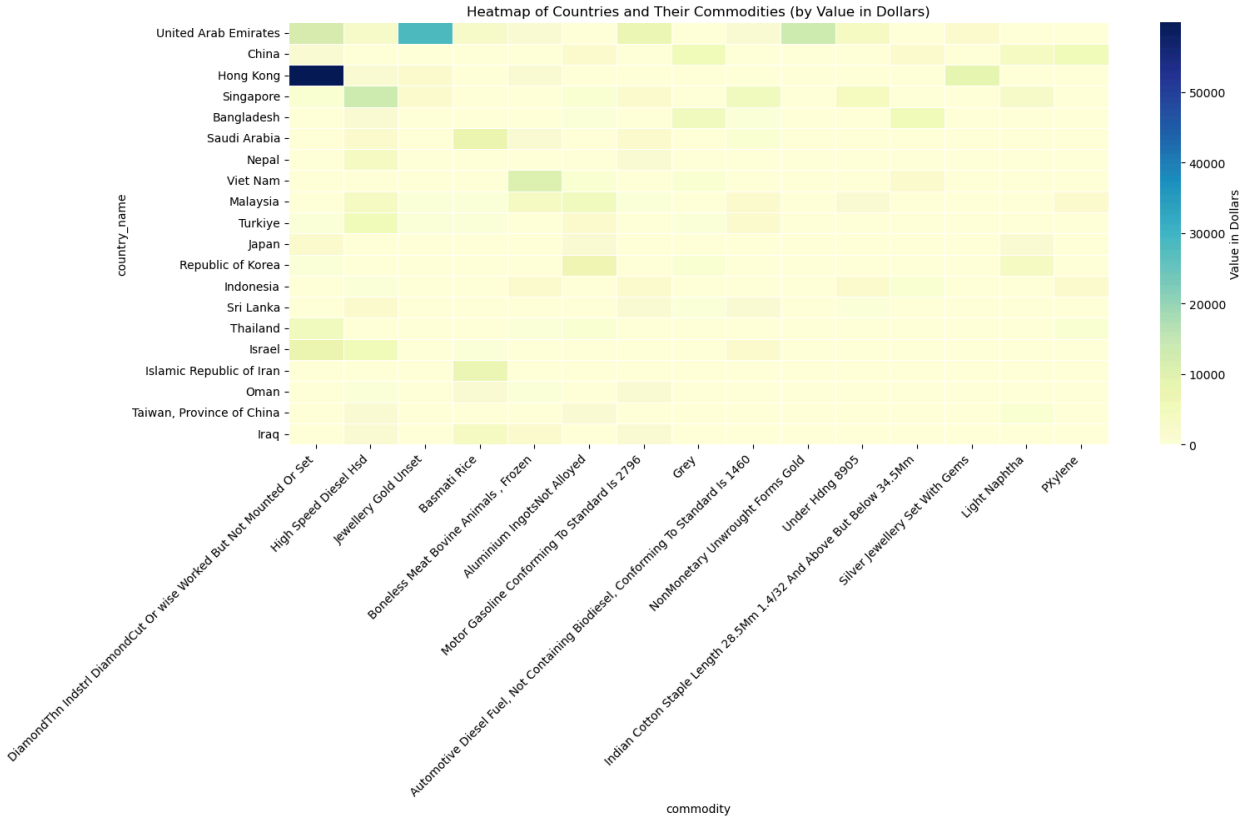
```
plt.show()
```

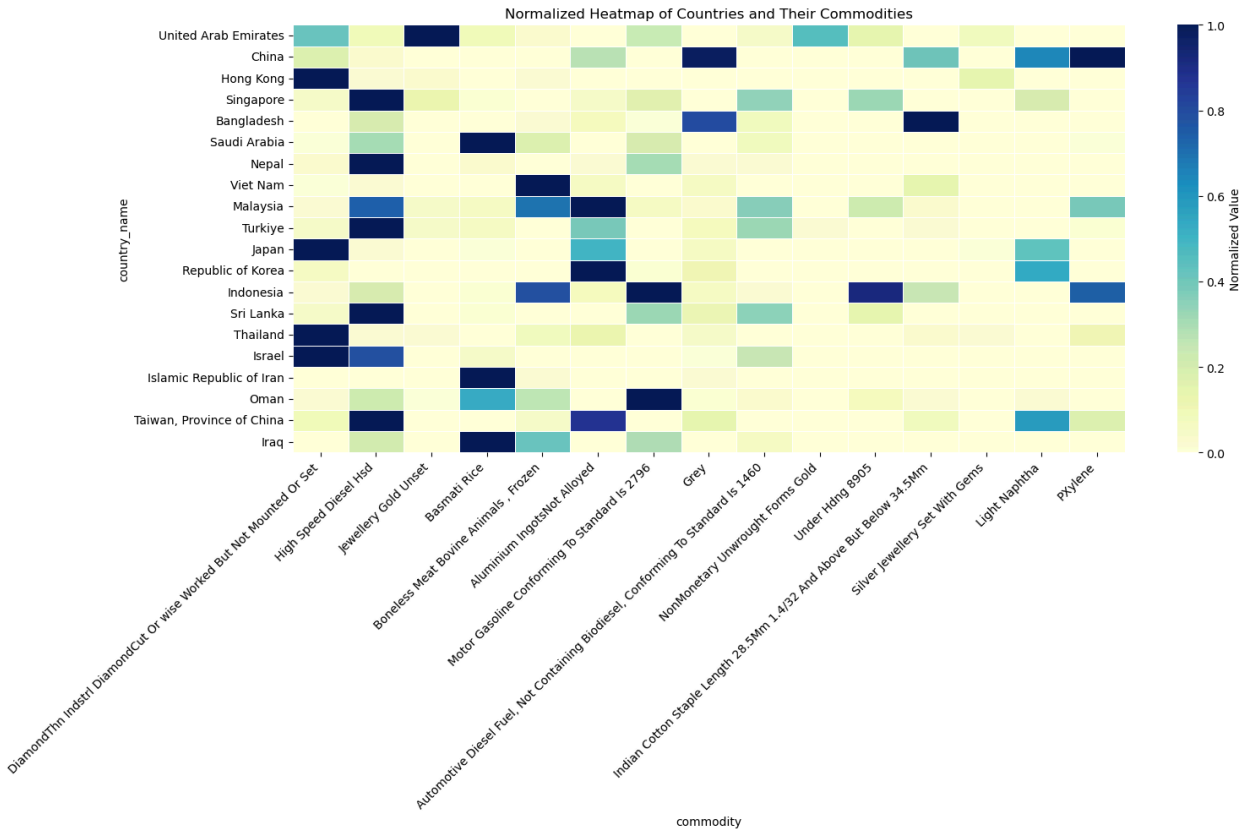
In [273…
```
bottom_10_countries = df.groupby('country_name')['value_dl'].sum().sort_values
print(bottom_10_countries)
```

```
country_name
State of Palestine                          6.03
Macao                                      40.68
Timor-Leste                               123.12
Mongolia                                  149.41
Lao People's Democratic Republic          219.33
Democratic People's Republic of Korea     242.74
Tajikistan                                261.47
Kyrgyzstan                                268.15
Azerbaijan                                408.50
Brunei Darussalam                         416.84
Name: value_dl, dtype: float64
```

In [274…
```
heatmap_data = df.pivot_table(
    index='country_name',
    columns='commodity',
    values='value_dl',
    aggfunc='sum'
)

heatmap_data = heatmap_data.fillna(0)

top_countries = df.groupby('country_name')['value_dl'].sum().nlargest(20).inde
```

```python
top_commodities = df.groupby('commodity')['value_dl'].sum().nlargest(15).index

# Filter the heatmap data
heatmap_data = heatmap_data.loc[top_countries, top_commodities]

# Create the heatmap
plt.figure(figsize=(16, 10))
sns.heatmap(
    heatmap_data,
    cmap='YlGnBu',
    annot=False,
    fmt='.0f',
    linewidths=0.5,
    cbar_kws={'label': 'Value in Dollars'}
)

plt.title('Heatmap of Countries and Their Commodities (by Value in Dollars)')
plt.xticks(rotation=45, ha='right')
plt.tight_layout()
plt.show()


plt.figure(figsize=(16, 10))
sns.heatmap(
    heatmap_data.apply(lambda x: (x - x.min()) / (x.max() - x.min()), axis=1),
    cmap='YlGnBu',
    annot=False,
    fmt='.2f',
    linewidths=0.5,
    cbar_kws={'label': 'Normalized Value'}
)

plt.title('Normalized Heatmap of Countries and Their Commodities')
plt.xticks(rotation=45, ha='right')
plt.tight_layout()
plt.show()
```





In [275…

```
unique_commodities = df['commodity'].value_counts().head(10)
print(unique_commodities)
```

```
commodity
Grey                                  13803
Shirting Fabrics                      11584
Dresses Cotton                         7366
Parts                                  7332
NonGalvanised                          6072
Powder                                 4859
Ensembles Cotton                       4811
Saree                                  4715
Medcne Put Up For Retail Sale N.E.S    4712
Utensils                               4152
Name: count, dtype: int64
```

5. Insight Generation and Report

- ## Key Insight :
    - Top expoterd from India to other 10 countries.
    - Highest Exported products from India
    - Finding which year has highest export.

- ## Interpretation of results

- ### Which country has highest income produced:

  |Sl.No|Country Name| |---|----------| |1|United Arab Emirates| |2|China| |3|Hong Kong| |4|Bangladesh| |5|Singapore| |6|Nepal| |7|Viet Nam| |8|Saudi Arabia| |9|Malasia| |10|Turkiey|

- ### Top exported product by Year:

  |Sl.No|Year| |-----|-----| |1|2018| |2|2017| |3|2016| |4|2015| |5|2021| |6|2019| |7|2020| |8|2024| |9|2025|

- ### Top exported from India to other 10 countries:

  |Sl.No|Country Name|Export Percentage| |---|----------|----------| |1.| United Arab Emirates|26.3%| |2.|China|14.3%| |3.|Hong Kong|11.5%| |4.|Singapore|9.1%| |5.|Bangladesh|8.9%| |6.|Saudi Arabia|6.8%| |7.|Nepal|6.3%| |8.|Malaysia|6.0%| |9.|VietNam|5.9%| |10.|Turkiye|4.9%|

- ## During each year highest exported product during each year:

  |Year|Product 1|Product 2|Product 3| |-----|-----|----|------| |2015|Diamond |High Speed Diesel|Non-monetary Unwrought forms of Gold| |2016|Diamond|High Speed Diesel|Non-monetary Unwrought forms of Gold| |2017|Diamond|High Speed Diesel|Jwellery Gold Unset| |2018|Diamond|High Speed Diesel|Jwellery Gold Unset| |2019|Diamond|High Speed Diesel|Jwellery Gold Unset| |2020|Diamond|Basmathi Rice|Automotive Diesel fuel not contains Biodiesel,confirming to standard is 1460| |2021|Diamond|Automotive Diesel fuel not contains Biodiesel,confirming to standard is 1460|Motor Gasoline confirming to Standard is 2796| |2024|Diamond|Motor Gasoline confirming to Standard is 2796|Aeroplane & aircraft,An unladden weight exceeding 15000Kg| |2025| Diamond|Motor Gasoline confirming to Standard is 2796|Gold Unstudded|

- ## Top 20 commodity exported from India:

  |Sl.No|Commodity| |-----|-----| |1.|Grey| |2.|Shirting Fabric| |3.|Dresses Cotton| |4.|Parts| |5.|Non-Galvanised| |6.|Powder| |7.|Ensembles Cotton| |8.|Sarees| |9.|Medicine put up for retail sales| |10.|Utensils| |11.|Values,Inlets & Exhaust| |12.|Parts & acessories of vehicle| |13.|Carpets| |14.|Article Plastic Nes| |15.|Shirt Fiber| |16.|Instruments & Applinces| |17.|Medicine Ayurvedic System| |18.|Suits Cotton| |19.|Labels| |20.|Parts and acessories|

- ## Find top 10 exported products by country:

Sl.No	Country Name	Commodity
1	Hong Kong	Diamond
2	United Arab Emirates	Jwellery Gold Unset
3	Singapore	High Speed Diesel
4	Vietnam	Boneless meat Bovine animals,Frozen
5	Israel	Diamond
6	Saudi Arabia	Basmathi Rice
7	Islamic Republic of Iran	Basmathi Rice

Sl.No	Country Name	Commodity
8	China	Agglomerated Iorn Ore pellets
9	Repubic of Korea	Aluminium Ingot not alloyed
10	Bangladesh	Indian cotton staple length 28.5Mm 1.4/32 & above but bellow 34.5Mm.

Recomentations

- Highest income produced is from United Arab Emirates,lowest income produced State of Palastien.
- Top exporting year is 2018 and lowest year is 2025.

📈 Strategic Recommendations for Improving India's Exports Based on the provided data tables, India's export performance is heavily reliant on a few key products and markets. To enhance export growth, the strategy should focus on **value chain upgrading, market diversification, and improving product data granularity**.

1. Value Chain Upgrading for Core Products💎

The data shows a consistent reliance on Diamonds and Refined Petroleum Products (High Speed Diesel, Motor Gasoline). The recommendation is to push exports higher up the value chain for these dominant sectors.

Current Export (Product 1/2/3)	Target Upgrade (Product/Action)	Target Market
Diamond (Hong Kong, Israel)	Increase **finished, branded jewellery exports** (e.g., Jwellery Gold Unset, Gold Unstudded).	**UAE, Singapore**, and new high-income markets (e.g., EU, US).
High Speed Diesel, Motor Gasoline (Singapore)	Export higher-value **specialty chemicals** and **lubricants** that use petroleum byproducts.	**Vietnam** (growing economy), **Turkiye**, and new industrial markets.
Agglomerated Iron Ore Pellets (China)	Shift to exporting **finished steel products** and **high-value iron/steel articles** (Capitalize on the "Non-Galvanised" commodity).	**China** (to capture domestic demand),**Malaysia**.

Action: Implement Production-Linked Incentive (PLI) schemes specifically for value-added jewellery manufacturing and advanced chemical refining to make the shift financially attractive.

---

2. Market and Product Diversification 🌏

India's exports are concentrated, with the UAE, China, and Hong Kong accounting for over 50% of the top 10 market share. Diversification is key to mitigating risks from trade shocks (like new tariffs or geopolitical issues).
• **Boost Agricultural Exports:** Capitalize on the established market for **Basmathi Rice** in **Saudi Arabia** and **Iran**. Invest in **cold chain infrastructure** and **branding** to increase high-value perishables like frozen **Boneless meat Bovine animals** to **Vietnam** and new markets in Southeast Asia.

o **Rationale:** This strengthens India's role as a major food supplier, providing resilience against global industrial demand fluctuations.

• **Target Manufacturing in Key Markets:** Leverage the high export potential commodities that appear low on the country-specific lists (e.g., **Medicine put up for retail sales, Parts & acessories of vehicle**).

o **China**: Aggressively market high-quality **Pharmaceuticals** (a top-20 commodity) and **Parts & accessories of vehicle** to China's large consumer and industrial base.

o **Turkiye**: Use this nation as a gateway to Europe, focusing on textiles **(Shirting Fabric, Dresses Cotton, Suits Cotton)** and auto components (**Parts, Values,Inlets & Exhaust**).

Action: Focus on concluding **Free Trade Agreements (FTAs)** with other high-growth economies to reduce tariff barriers for these non-traditional export products.

3. Improve Product Data and Cluster Development 🏭

The "Top 20 commodity exported" list is too vague (e.g., Grey, Parts, Powder). This lack of detail makes targeted policy intervention difficult.

• **Data Granularity**: Mandate the use of the **HS-6 digit classification** for the top 20 commodities to identify the **specific, high-demand products** within generic categories (e.g., distinguishing between different types of 'Parts & acessories of vehicle' or 'Medicine').

• **Cluster Development**: Invest in **Mega Common Facility Centres (CFCs)** in key export clusters (e.g., textile hubs for cotton products to Bangladesh, engineering hubs for 'Parts' to Korea/Malaysia). This centralizes infrastructure, lowers production costs, and standardizes quality for MSMEs.

Action: Establish a dedicated, high-level **Export Acceleration Task Force** to monitor the progress of non-traditional exports and address real-time logistical or regulatory hurdles faced by exporters.

In [ ]: