Foreign Direct Investment Analysis

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Importing Libraries

In [ ]:
```
import pandas as pd
import seaborn as sns
import numpy as np
import matplotlib.pyplot as plt
```

In [ ]:
```
from statsmodels.tsa.arima.model import ARIMA
from datetime import datetime
```

Connecting Drive

In [ ]:
```
from google.colab import drive
drive.mount('/content/drive')
```

```
Mounted at /content/drive
```

In [ ]:
```
DS=pd.read_csv('/content/drive/MyDrive/UM_Projects_data/FDI data.csv')
```

In [ ]:
```
DS.head()
```

Out[ ]:

	Sector	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10
0	METALLURGICAL INDUSTRIES	22.69	14.14	36.61	8.11	200.38	149.13	169.94	1175.75	959.94	419.88
1	MINING	1.32	6.52	10.06	23.48	9.92	7.40	6.62	444.36	34.16	174.40
2	POWER	89.42	757.44	59.11	27.09	43.37	72.69	157.15	988.68	907.66	1271.79
3	NON-CONVENTIONAL ENERGY	0.00	0.00	1.70	4.14	1.27	1.35	2.44	58.82	125.88	622.52
4	COAL PRODUCTION	0.00	0.00	0.00	0.04	0.00	9.14	1.30	14.08	0.22	0.00

Data Cleaning and Preparation

In [ ]:
```
Nullcheck=DS.isnull().sum()
Nullcheck
```

Out[ ]:
```
Sector     0
2000-01    0
2001-02    0
2002-03    0
2003-04    0
2004-05    0
2005-06    0
2006-07    0
2007-08    0
2008-09    0
2009-10    0
2010-11    0
2011-12    0
2012-13    0
2013-14    0
2014-15    0
2015-16    0
2016-17    0
dtype: int64
```

In [ ]:
```
DS.describe()
```

Out[ ]:

	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008
count	63.000000	63.000000	63.000000	63.000000	63.000000	63.000000	63.000000	63.000000	63.000
mean	37.757302	63.931587	42.925714	34.727778	51.090317	87.932540	198.281905	390.085714	498.348
std	112.227860	157.878737	86.606439	67.653735	101.934873	206.436967	686.783115	1026.249935	1134.649
min	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000
25%	0.000000	0.000000	0.200000	0.215000	0.715000	1.230000	4.160000	9.950000	11.950
50%	4.030000	5.070000	11.010000	6.370000	9.090000	22.620000	25.820000	58.820000	84.880
75%	23.510000	44.830000	36.555000	38.660000	43.205000	63.855000	108.325000	279.270000	383.320
max	832.070000	873.230000	419.960000	368.320000	527.900000	1359.970000	4713.780000	6986.170000	6183.490

In [ ]:
```
row_rename_dict = {
    'SERVICES SECTOR (Fin.,Banking,Insurance,Non Fin/Business,Outsourcing,R&D,Courier,Tech. Testi
    'CONSTRUCTION DEVELOPMENT: Townships, housing, built-up infrastructure and construction-devel
    'TEA AND COFFEE (PROCESSING & WAREHOUSING COFFEE & RUBBER)':'TEA AND COFFEE',
    'PRINTING OF BOOKS (INCLUDING LITHO PRINTING INDUSTRY)': 'BOOK PRINTING',
    'PAPER AND PULP (INCLUDING PAPER PRODUCTS)': 'PAPER AND PULP',
    'INFORMATION & BROADCASTING (INCLUDING PRINT MEDIA)' : 'INFORMATION AND BROADCASTING',
    'PRIME MOVER (OTHER THAN ELECTRICAL GENERATORS)' : 'PRIME MOVER',
    'MATHEMATICAL,SURVEYING AND DRAWING INSTRUMENTS':'MATHEMATICAL SURVEY INSTRUMENTS'
}

DS['Sector'] = DS['Sector'].replace(row_rename_dict)
```

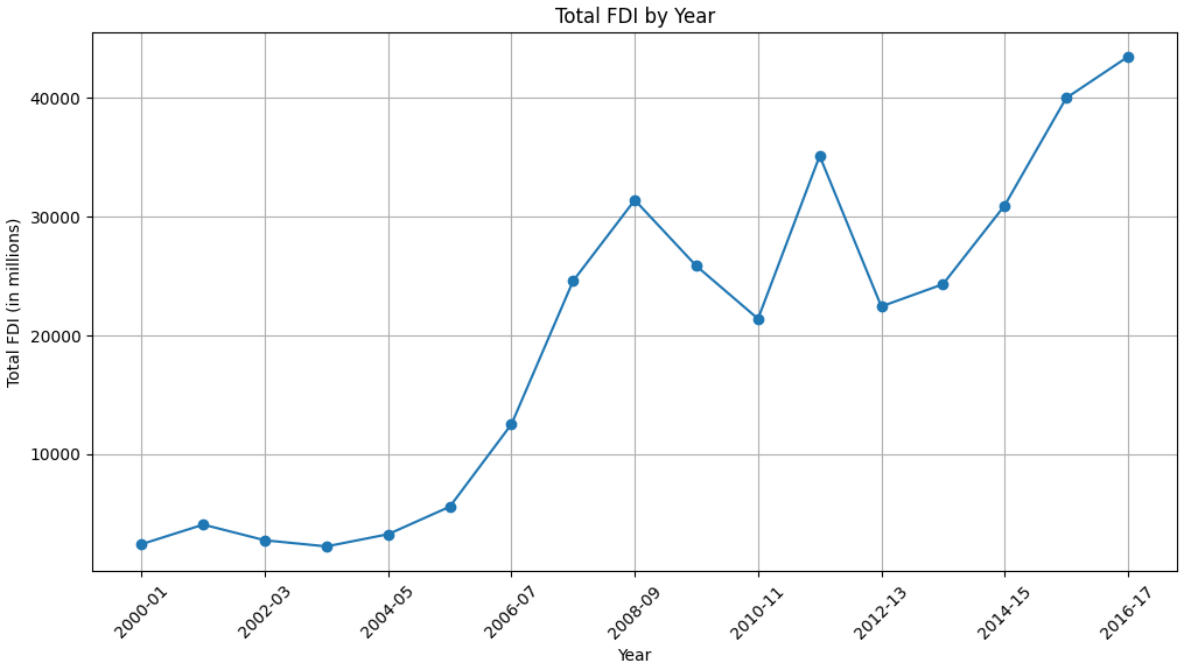
In [ ]:
```
DS.columns
```

Out[ ]:
```
Index(['Sector', '2000-01', '2001-02', '2002-03', '2003-04', '2004-05',
       '2005-06', '2006-07', '2007-08', '2008-09', '2009-10', '2010-11',
       '2011-12', '2012-13', '2013-14', '2014-15', '2015-16', '2016-17'],
      dtype='object')
```

EDA

In [ ]:
```
#Total FDI for each year
TFDI_Y = DS.drop(columns='Sector').sum()

# Plotting the total FDI over the years
plt.figure(figsize=(12, 6))
TFDI_Y.plot(kind='line', marker='o')
plt.title('Total FDI by Year')
plt.xlabel('Year')
plt.ylabel('Total FDI (in millions)')
plt.grid(True)
plt.xticks(rotation=45)
plt.show()
```

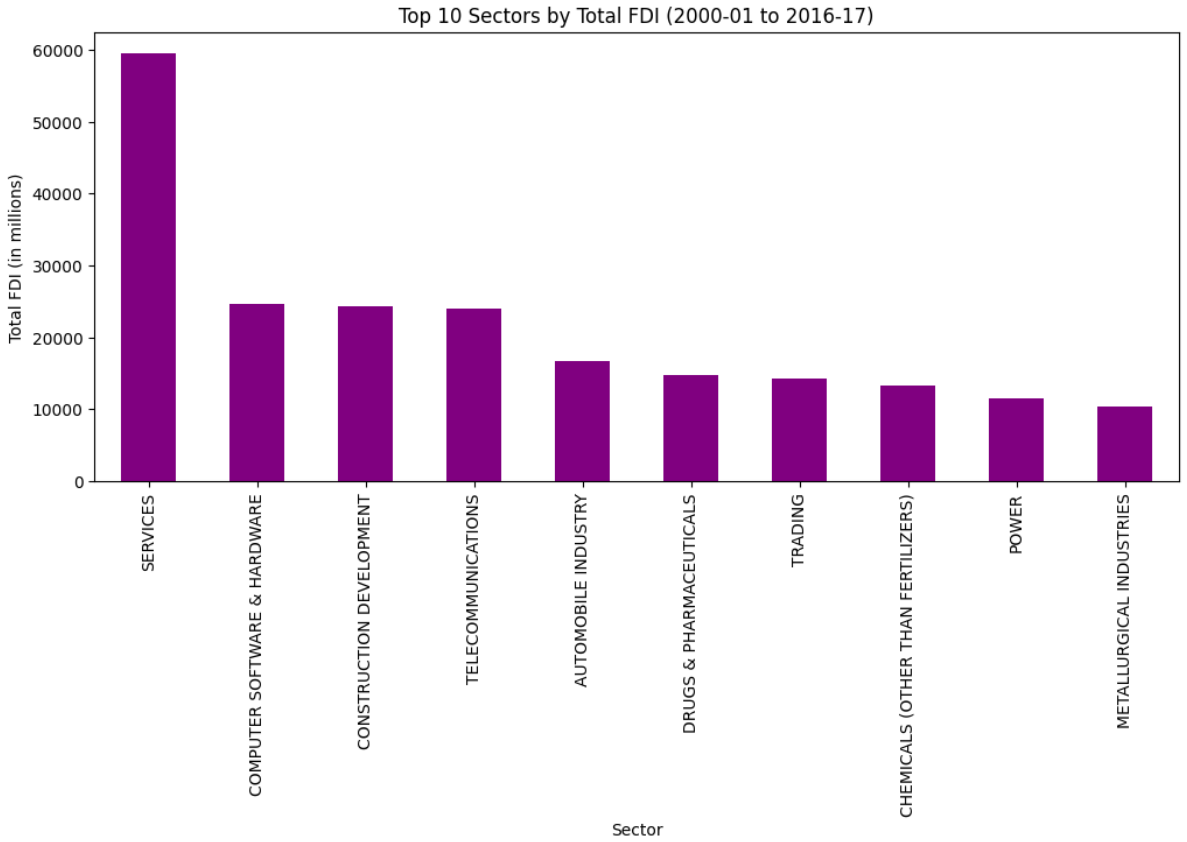


In [ ]:
```
# Printing the total FDI values for each year
print("Total FDI for each year:")
print(TFDI_Y)
```

```
Total FDI for each year:
2000-01     2378.71
2001-02     4027.69
2002-03     2704.32
2003-04     2187.85
2004-05     3218.69
2005-06     5539.75
2006-07    12491.76
2007-08    24575.40
2008-09    31395.96
2009-10    25834.38
2010-11    21383.07
2011-12    35120.78
2012-13    22423.59
2013-14    24299.32
2014-15    30930.47
2015-16    40000.99
2016-17    43478.26
dtype: float64
```

In [ ]:
```
# Calculating total FDI by sector over the entire period
TFID_S = DS.set_index('Sector').sum(axis=1).sort_values(ascending=False)

# Plotting the top 10 sectors by total FDI
top_10_sectors = TFID_S.head(10)
plt.figure(figsize=(12, 5))
top_10_sectors.plot(kind='bar', color='purple')
plt.title('Top 10 Sectors by Total FDI (2000-01 to 2016-17)')
plt.xlabel('Sector')
plt.ylabel('Total FDI (in millions)')
plt.xticks(rotation=90)
plt.show()
```

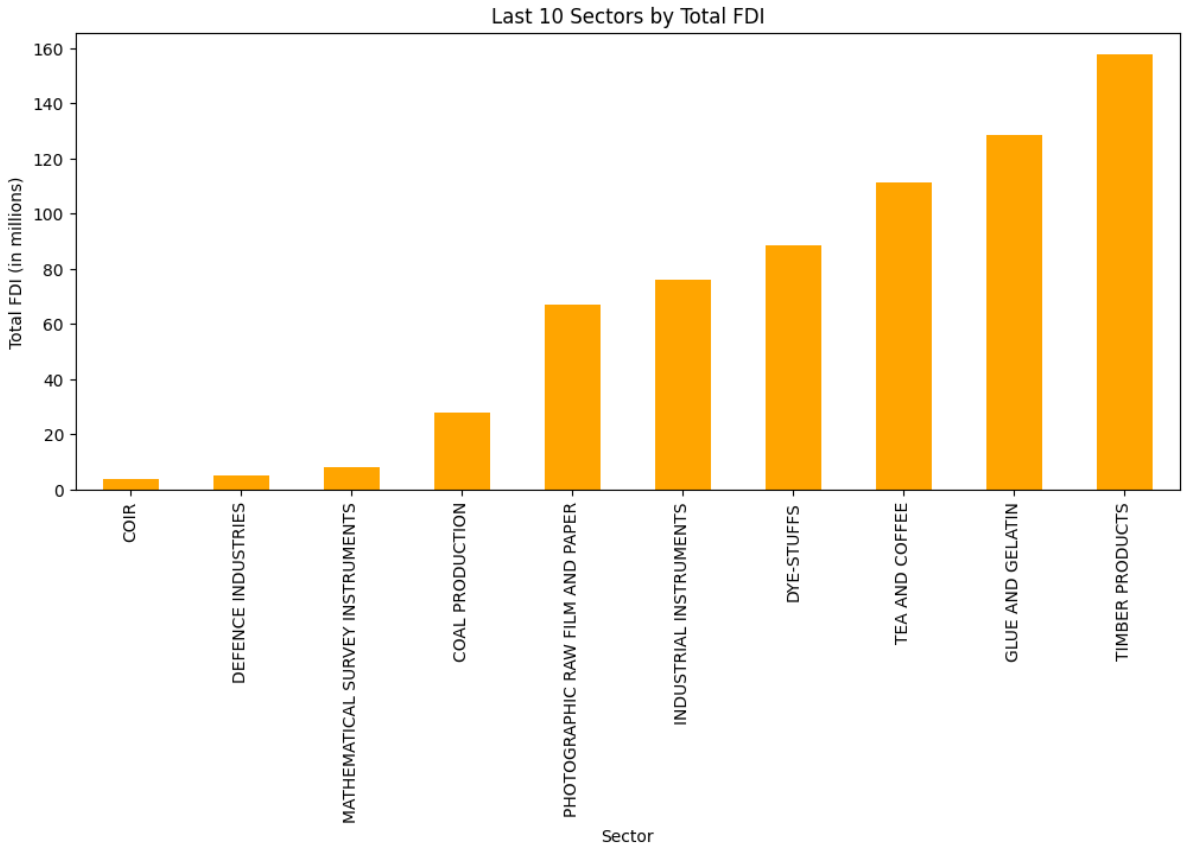


In [ ]:
```
print(top_10_sectors)
```

```
Sector
SERVICES                                59476.49
COMPUTER SOFTWARE & HARDWARE            24669.49
CONSTRUCTION DEVELOPMENT                24293.09
TELECOMMUNICATIONS                      23946.01
AUTOMOBILE INDUSTRY                     16673.92
DRUGS & PHARMACEUTICALS                 14706.90
TRADING                                 14210.88
CHEMICALS (OTHER THAN FERTILIZERS)      13293.09
POWER                                   11589.13
METALLURGICAL INDUSTRIES                10330.54
dtype: float64
```

In [ ]:
```
# Calculating total FDI by sector over the entire period
TFID_SA = DS.set_index('Sector').sum(axis=1).sort_values(ascending=True)

# Plotting the last 10 sectors by total FDI
last_10_sectors = TFID_SA.head(10)
plt.figure(figsize=(12, 5))
last_10_sectors.plot(kind='bar', color='orange')
plt.title('Last 10 Sectors by Total FDI')
plt.xlabel('Sector')
plt.ylabel('Total FDI (in millions)')
plt.xticks(rotation=90)
plt.show()
```



In [ ]:
```
print(last_10_sectors)
```

```
Sector
COIR                                4.06
DEFENCE INDUSTRIES                  5.12
MATHEMATICAL SURVEY INSTRUMENTS     7.98
COAL PRODUCTION                    27.74
PHOTOGRAPHIC RAW FILM AND PAPER    67.28
INDUSTRIAL INSTRUMENTS             76.12
DYE-STUFFS                         88.40
TEA AND COFFEE                    111.22
GLUE AND GELATIN                  128.39
TIMBER PRODUCTS                   157.68
dtype: float64
```

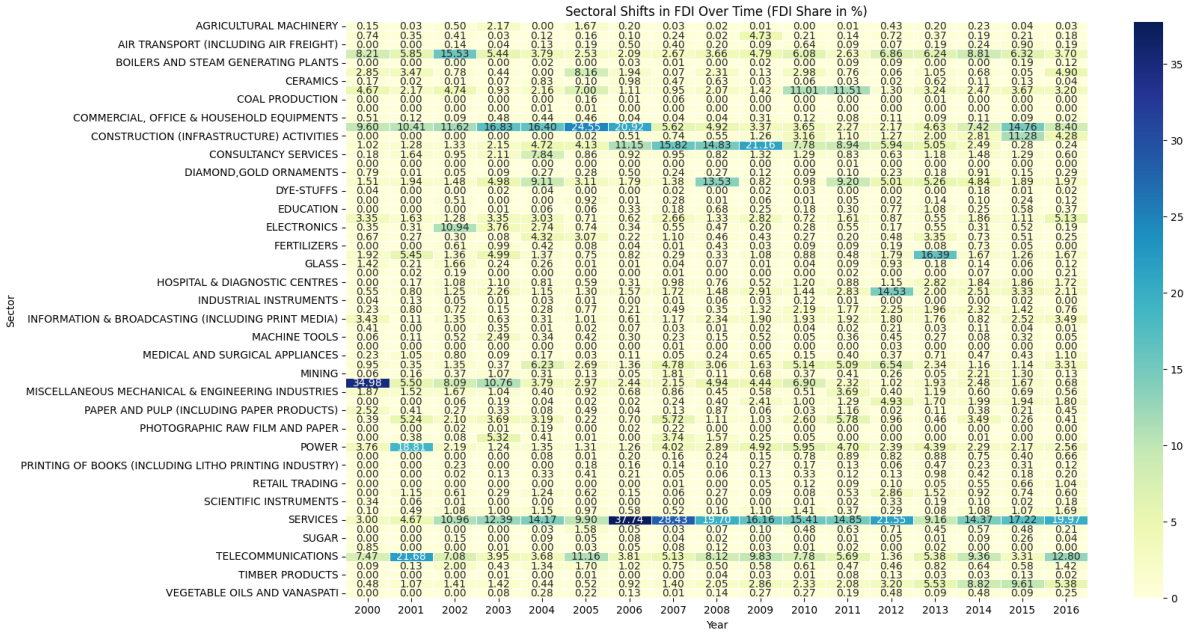
In [ ]:
```
#Sectoral Shifts
fdi_l = pd.melt(DS, id_vars='Sector', var_name='Year', value_name='FDI')
fdi_l['Year'] = fdi_l['Year'].str.split('-').str[0].astype(int)

# Calculating total FDI per year
total_fdi_per_year = fdi_l.groupby('Year')['FDI'].sum().reset_index(name='Total_FDI')
fdi_ln = fdi_l.merge(total_fdi_per_year, on='Year')

# Calculating FDI share per sector per year
fdi_ln['FDI_Share'] = fdi_ln['FDI'] / fdi_ln['Total_FDI'] * 100

fdi_pivot = fdi_ln.pivot(index='Sector', columns='Year', values='FDI_Share')

# Plotting heatmap to visualize sectoral shifts
plt.figure(figsize=(16, 10))
sns.heatmap(fdi_pivot, cmap='YlGnBu', annot=True, fmt='.2f', linewidths=.5)
plt.title('Sectoral Shifts in FDI Over Time (FDI Share in %)')
plt.xlabel('Year')
plt.ylabel('Sector')
plt.show()
```



In [ ]:
```
# Calculating change in FDI share between start and end year for each sector
fdi_shift = fdi_pivot.loc[:, [fdi_pivot.columns.min(), fdi_pivot.columns.max()]].dropna()
fdi_shift['Change'] = fdi_shift.iloc[:, 1] - fdi_shift.iloc[:, 0]
fdi_shift = fdi_shift.sort_values(by='Change', ascending=False)

# Displaying sectors with significant shifts
print("Sectors with significant increases in FDI share:")
print(fdi_shift.head())

print("\nSectors with significant decreases in FDI share:")
print(fdi_shift.tail())
```

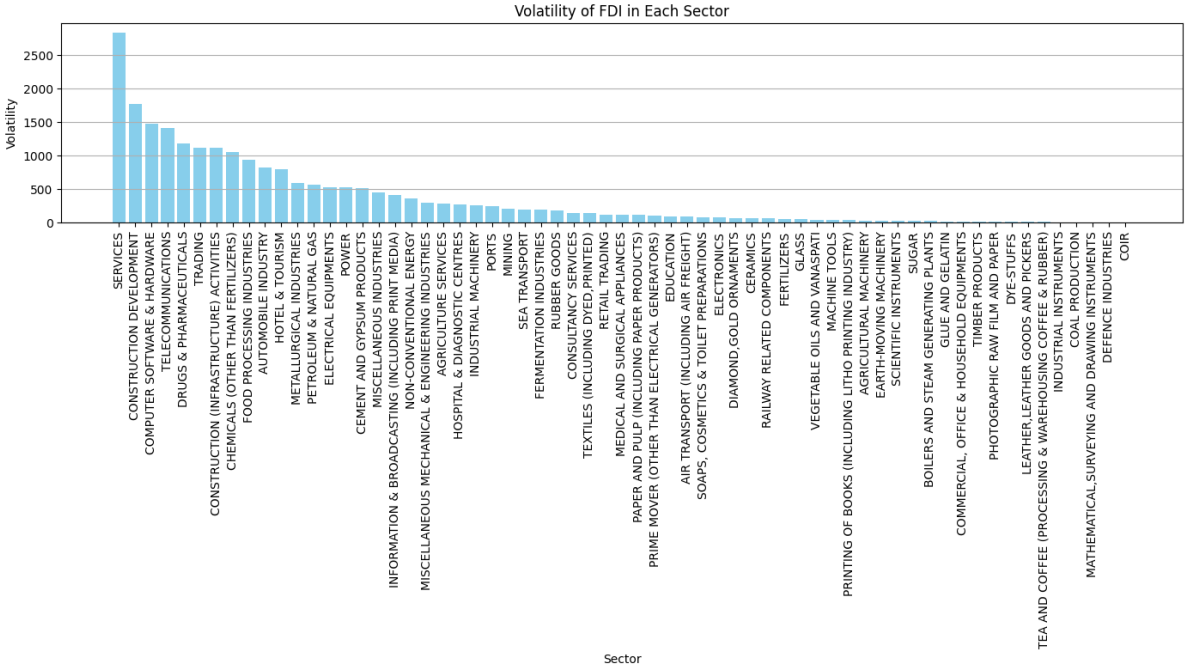
```
Sectors with significant increases in FDI share:
Year                                          2000        2016      Change
Sector
SERVICES                                  3.000786   19.973361   16.972575
TELECOMMUNICATIONS                        7.470015   12.796487    5.326472
TRADING                                   0.483035    5.378320    4.895285
CONSTRUCTION (INFRASTRUCTURE) ACTIVITIES  0.000000    4.279679    4.279679
METALLURGICAL INDUSTRIES                  0.953878    3.312414    2.358536

Sectors with significant decreases in FDI share:
Year                                                2000      2016  \
Sector
MISCELLANEOUS MECHANICAL & ENGINEERING INDUSTRIES   1.870762  0.564052
CHEMICALS (OTHER THAN FERTILIZERS)                  4.672280  3.203440
PAPER AND PULP (INCLUDING PAPER PRODUCTS)           2.524057  0.454503
AUTOMOBILE INDUSTRY                                 8.211594  3.701436
MISCELLANEOUS INDUSTRIES                           34.979884  0.681720

Year                                                Change
Sector
MISCELLANEOUS MECHANICAL & ENGINEERING INDUSTRIES  -1.306710
CHEMICALS (OTHER THAN FERTILIZERS)                 -1.468840
PAPER AND PULP (INCLUDING PAPER PRODUCTS)          -2.069554
AUTOMOBILE INDUSTRY                                -4.510158
MISCELLANEOUS INDUSTRIES                          -34.298164
```

In [ ]:
```
yrs = DS.columns[1:]
# Calculating the standard deviation for each sector
DS['Volatility'] = DS[yrs].std(axis=1)
# Sorting by volatility
fdi_data_sorted = DS.sort_values(by='Volatility', ascending=False)

# Plotting
plt.figure(figsize=(14, 8))
plt.bar(fdi_data_sorted['Sector'], fdi_data_sorted['Volatility'], color='skyblue')
plt.xlabel('Sector')
plt.ylabel('Volatility')
plt.title('Volatility of FDI in Each Sector')
plt.xticks(rotation=90)
plt.grid(axis='y')
plt.tight_layout()
plt.show()
```



In [ ]:
```
print(fdi_data_sorted[['Sector', 'Volatility']])
```

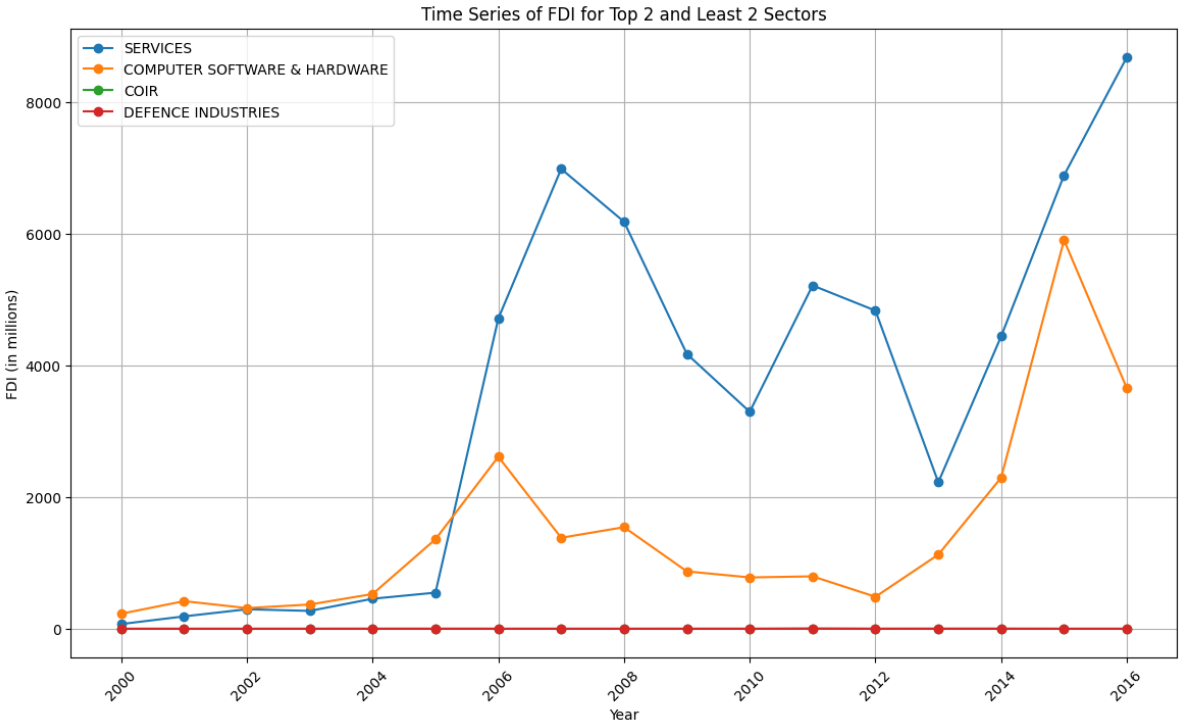
```
                                      Sector   Volatility
49                                  SERVICES  2831.889810
61                     CONSTRUCTION DEVELOPMENT  1776.831403
9                   COMPUTER SOFTWARE & HARDWARE  1476.671248
11                          TELECOMMUNICATIONS  1412.295111
32                       DRUGS & PHARMACEUTICALS  1188.423119
..                                          ...          ...
25                       INDUSTRIAL INSTRUMENTS     6.980444
4                                COAL PRODUCTION     3.929237
27  MATHEMATICAL,SURVEYING AND DRAWING INSTRUMENTS     1.637282
47                       DEFENCE INDUSTRIES     0.891382
59                                       COIR     0.365699

[63 rows x 2 columns]
```

In [ ]:
```
TFDIS = DS.set_index('Sector').sum(axis=1)
#The top 2 and least 2 sectors
top_2 = TFDIS.nlargest(2).index
least_2 = TFDIS.nsmallest(2).index
# Combining top 2 and least 2 sectors
selected_sectors = list(top_2) + list(least_2)
# Extracting data for the selected sectors
selected_data = DS[DS['Sector'].isin(selected_sectors)].set_index('Sector').T
selected_data.index = selected_data.index.str.split('-').str[0].astype(int)

# Plotting the time series
plt.figure(figsize=(14, 8))
for sector in selected_sectors:
    plt.plot(selected_data.index, selected_data[sector], marker='o', label=sector)

# Plotting
plt.title('Time Series of FDI for Top 2 and Least 2 Sectors')
plt.xlabel('Year')
plt.ylabel('FDI (in millions)')
plt.xticks(rotation=45)
plt.legend()
plt.grid(True)
plt.show()
```

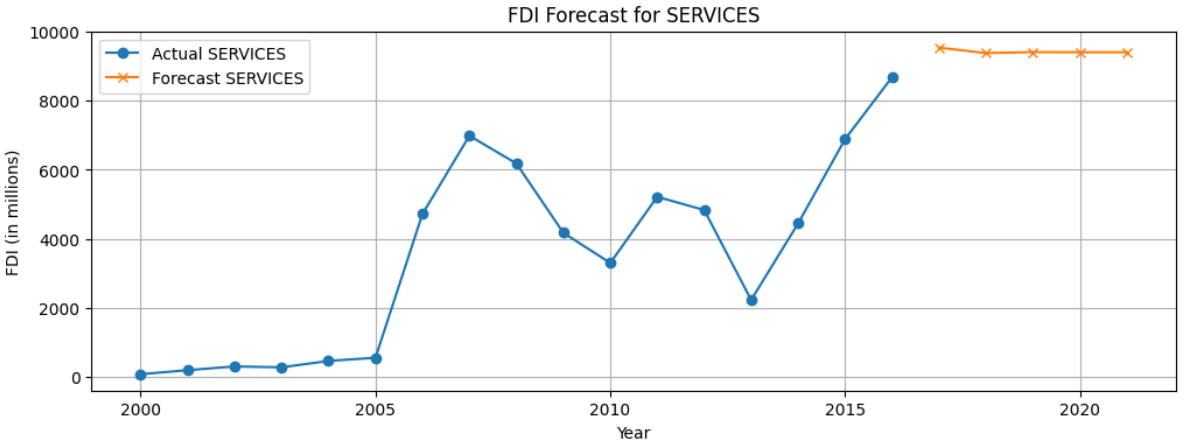


In [ ]:
```
sel_data = DS[DS['Sector'].isin(top_2)].set_index('Sector').T
sel_data.index = sel_data.index.str.split('-').str[0].astype(int)

def forecast_arima(time_series, forecast_periods=5, sector_name=''):
    model = ARIMA(time_series, order=(1, 1, 1))
    model_fit = model.fit()
    # Forecast future values
    forecast = model_fit.forecast(steps=forecast_periods)
    forecast_years = [time_series.index[-1] + i for i in range(1, forecast_periods + 1)]

    # Plotting actual and forecasted values
    plt.figure(figsize=(12, 4))
    plt.plot(time_series.index, time_series, label=f'Actual {sector_name}', marker='o')
    plt.plot(forecast_years, forecast, label=f'Forecast {sector_name}', marker='x')
    plt.title(f'FDI Forecast for {sector_name}')
    plt.xlabel('Year')
    plt.ylabel('FDI (in millions)')
    plt.legend()
    plt.grid(True)
    plt.show()
    return forecast
# Forecast for each top sector
for sector in top_2:
    time_series = selected_data[sector].dropna()
    print(f'Forecasting for sector: {sector}')
    forecast_arima(time_series, forecast_periods=5, sector_name=sector)
```

```
Forecasting for sector: SERVICES
/usr/local/lib/python3.10/dist-packages/statsmodels/tsa/base/tsa_model.py:473: ValueWarning: An u
nsupported index was provided and will be ignored when e.g. forecasting.
  self._init_dates(dates, freq)
/usr/local/lib/python3.10/dist-packages/statsmodels/tsa/base/tsa_model.py:473: ValueWarning: An u
nsupported index was provided and will be ignored when e.g. forecasting.
  self._init_dates(dates, freq)
/usr/local/lib/python3.10/dist-packages/statsmodels/tsa/base/tsa_model.py:473: ValueWarning: An u
nsupported index was provided and will be ignored when e.g. forecasting.
  self._init_dates(dates, freq)
/usr/local/lib/python3.10/dist-packages/statsmodels/tsa/base/tsa_model.py:836: ValueWarning: No s
upported index is available. Prediction results will be given with an integer index beginning at
`start`.
  return get_prediction_index(
/usr/local/lib/python3.10/dist-packages/statsmodels/tsa/base/tsa_model.py:836: FutureWarning: No
supported index is available. In the next version, calling this method in a model without a suppo
rted index will result in an exception.
  return get_prediction_index(
```




```
Forecasting for sector: COMPUTER SOFTWARE & HARDWARE
```

```
/usr/local/lib/python3.10/dist-packages/statsmodels/tsa/base/tsa_model.py:473: ValueWarning: An u
nsupported index was provided and will be ignored when e.g. forecasting.
  self._init_dates(dates, freq)
/usr/local/lib/python3.10/dist-packages/statsmodels/tsa/base/tsa_model.py:473: ValueWarning: An u
nsupported index was provided and will be ignored when e.g. forecasting.
  self._init_dates(dates, freq)
/usr/local/lib/python3.10/dist-packages/statsmodels/tsa/base/tsa_model.py:473: ValueWarning: An u
nsupported index was provided and will be ignored when e.g. forecasting.
  self._init_dates(dates, freq)
/usr/local/lib/python3.10/dist-packages/statsmodels/tsa/statespace/sarimax.py:966: UserWarning: N
on-stationary starting autoregressive parameters found. Using zeros as starting parameters.
  warn('Non-stationary starting autoregressive parameters'
/usr/local/lib/python3.10/dist-packages/statsmodels/tsa/base/tsa_model.py:836: ValueWarning: No s
upported index is available. Prediction results will be given with an integer index beginning at
`start`.
  return get_prediction_index(
/usr/local/lib/python3.10/dist-packages/statsmodels/tsa/base/tsa_model.py:836: FutureWarning: No
supported index is available. In the next version, calling this method in a model without a suppo
rted index will result in an exception.
  return get_prediction_index(
```