Global Innovation Index (GII)
Day 3 EDA

June 21, 2025

[1]:
```
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
```

[45]:
```
df = pd.read_csv(r'../data/GII_2011_2024_long_format.tsv', sep='\t')
print(df.head())
print(df.info())
df_clean = df[(df['Rank'] != -1) & (df['Score'] != -1)].copy()
print(f"Number of countries: {df_clean['Country'].nunique()}, number of records␣
 ↪after cleaning: {len(df_clean)}")
```

```
  Country  Year  Rank  Score
0     AGO  2011    -1  -1.00
1     AGO  2012   135  22.20
2     AGO  2013   135  23.46
3     AGO  2014   135  23.82
4     AGO  2015   120  26.20
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 2086 entries, 0 to 2085
Data columns (total 4 columns):
 #   Column   Non-Null Count  Dtype
---  ------   --------------  -----
 0   Country  2086 non-null   object
 1   Year     2086 non-null   int64
 2   Rank     2086 non-null   int64
 3   Score    2086 non-null   float64
dtypes: float64(1), int64(2), object(1)
memory usage: 65.3+ KB
None
Number of countries: 149, number of records after cleaning: 1862
```

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```
# ... (code to load and clean the data)
df_cleaned = df.dropna(subset=['Rank', 'Score']).copy()
```

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```
# ===  Add logical classification (Region, Performance Category) ===
region_mapping = {
    'IRL': 'Europe', 'GBR': 'Europe', 'DEU': 'Europe', 'FRA': 'Europe',
    'USA': 'North America', 'CAN': 'North America', 'MEX': 'North America',
    'CHN': 'Asia', 'JPN': 'Asia', 'KOR': 'Asia', 'SGP': 'Asia',
    'BRA': 'South America', 'ARG': 'South America', 'CHL': 'South America',
    'EGY': 'Africa', 'ZAF': 'Africa', 'KEN': 'Africa', 'NGA': 'Africa'
}
df_clean['Region'] = df_clean['Country'].map(region_mapping).fillna('Other')

df_clean['Performance_Category'] = pd.cut(
    df_clean['Score'], bins=[0, 25, 50, 75, 100], labels=['Low', 'Medium',␣
 ↪'Good', 'Excellent']
)
```

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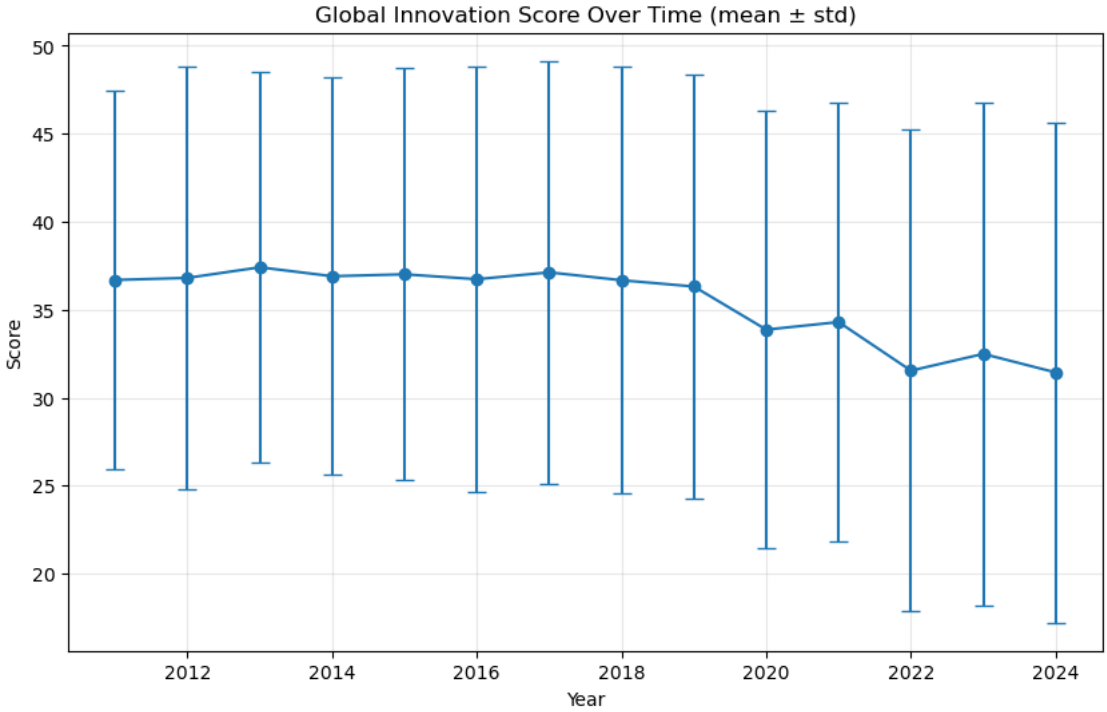
# === Global trend analysis ===
plt.figure(figsize=(10, 6))
yearly_avg = df_clean.groupby('Year')['Score'].agg(['mean', 'std'])
plt.errorbar(yearly_avg.index, yearly_avg['mean'], yerr=yearly_avg['std'],␣
 ↪marker='o', capsize=5)
plt.title('Global Innovation Score Over Time (mean ± std)')
plt.xlabel('Year')
plt.ylabel('Score')
plt.grid(alpha=0.3)
plt.show()
```


Global Innovation Score Over Time (mean ± std)
Score
Year
50
45
40
35
30
25
20
2012
2014
2016
2018
2020
2022
2024

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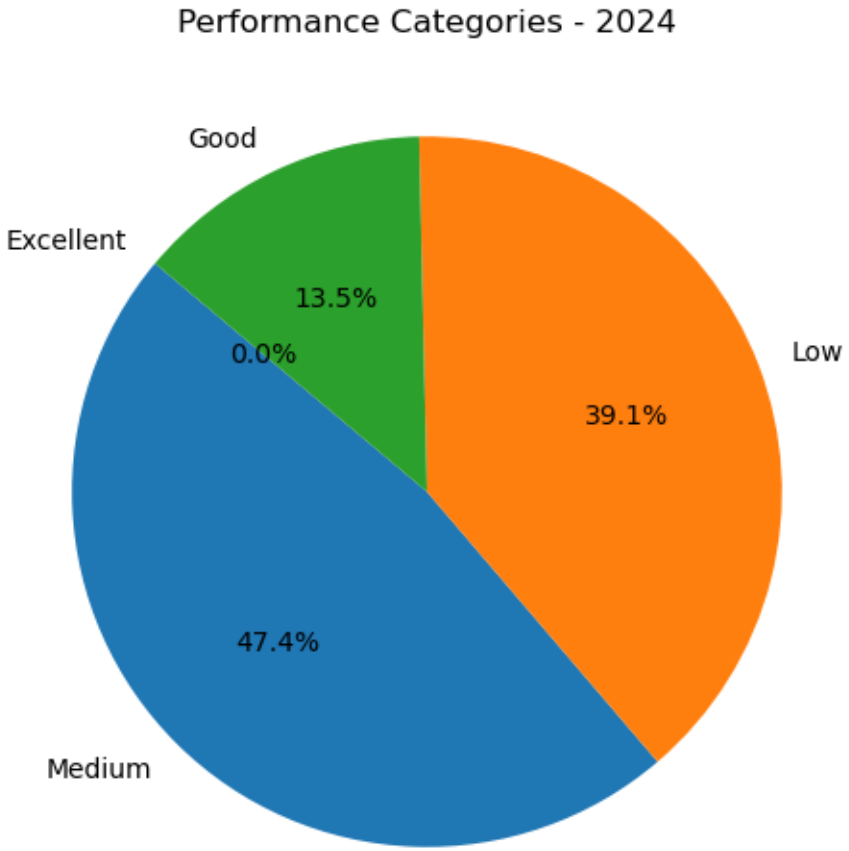
```
# === Distribution of performance categories in 2024 ===
plt.figure(figsize=(6, 6))
cat_2024 = df_clean[df_clean['Year'] == 2024]['Performance_Category'].
 ↪value_counts()
plt.pie(cat_2024.values, labels=cat_2024.index, autopct='%1.1f%%',␣
 ↪startangle=140)
plt.title('Performance Categories - 2024')
plt.show()
```



[69]:
```
# === 10 Top and bottom countries 2024 ===
top_2024 = df_clean[df_clean['Year'] == 2024].nsmallest(10, 'Rank')
bottom_2024 = df_clean[df_clean['Year'] == 2024].nlargest(10, 'Rank')

print(" Top 10 Countries 2024:\n", top_2024[['Country', 'Rank', 'Score']])
print("\n Bottom 10 Countries 2024:\n", bottom_2024[['Country', 'Rank',␣
 ↪'Score']])
```

```
 Top 10 Countries 2024:
      Country  Rank  Score
363       CHE     1   67.5
1791      SWE     2   64.5
1987      USA     3   62.4
377       CHL     4   32.6
1721      SGP     4   61.2
685       GBR     5   61.0
1063      KOR     6   60.9
629       FIN     7   59.4
1455      NLD     8   58.8
503       DEU     9   58.1

 Bottom 10 Countries 2024:
      Country  Rank  Score
13        AGO   133   10.2
1413      NER   132   11.2
1259      MLI   131   11.8
615       ETH   130   12.3
167       BFA   129   12.8
1329      MOZ   128   13.1
125       BDI   127   13.2
1343      MRT   126   13.2
1287      MMR   125   13.8
1441      NIC   124   14.0
```

[71]:
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# === Volatility analysis ===
volatility = df_clean.groupby('Country').agg({
    'Score': ['std', 'mean'], 'Rank': ['std', 'mean'], 'Year': 'count'})

volatility.columns = ['Score_Std', 'Score_Mean', 'Rank_Std', 'Rank_Mean',␣
 ↪'Years_Count']
volatility = volatility[volatility['Years_Count'] >= 5]
volatility = volatility.sort_values('Score_Std', ascending=False)

print("\n Most volatile countries (Score):\n", volatility.head())
```

```
 Most volatile countries (Score):
         Score_Std  Score_Mean   Rank_Std   Rank_Mean  Years_Count
Country
AGO       6.484687   18.135000   5.221863  131.125000            8
MOZ       5.976184   22.446923  13.022170  113.923077           13
MLI       5.623512   21.949286   8.562954  117.357143           14
UGA       5.483335   23.867143  10.875924  108.142857           14
GTM       5.450769   24.943571  10.807252  102.214286           14
```

[83]:
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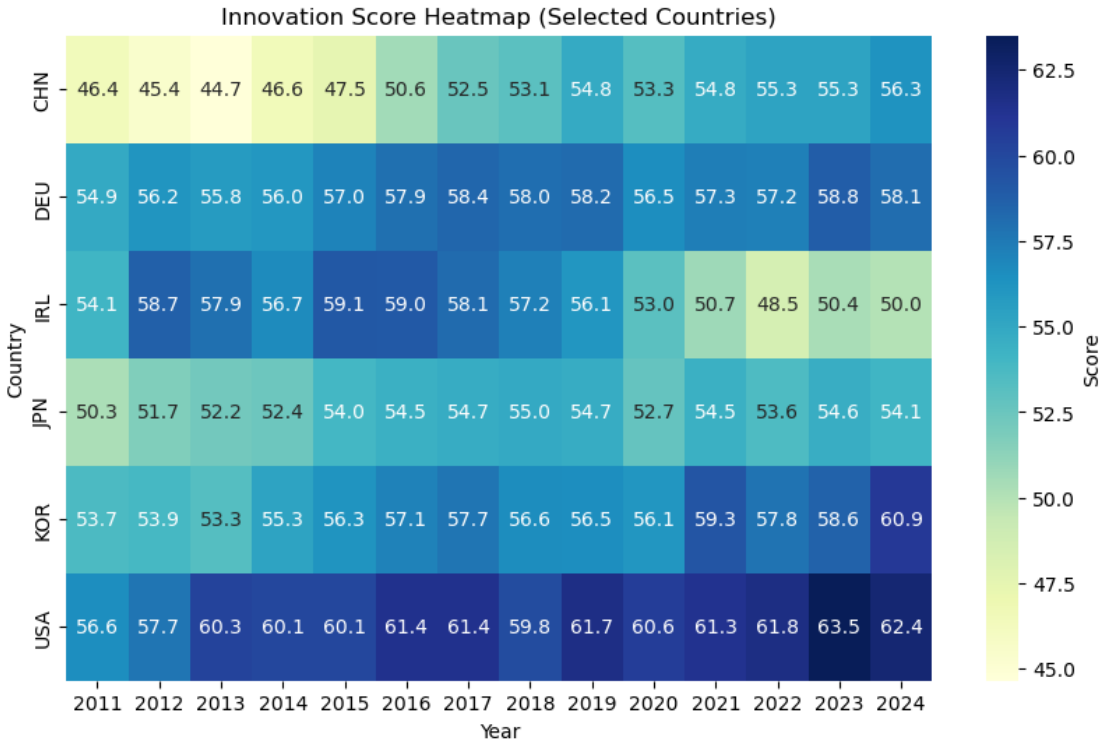
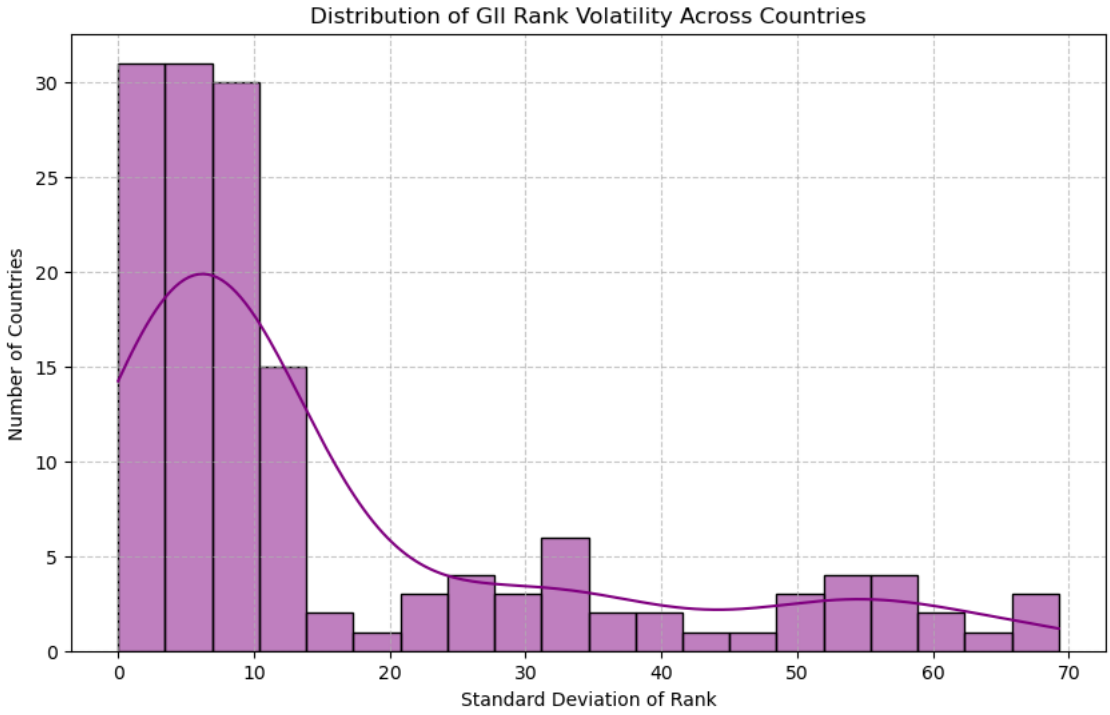
# === Heatmap of selected countries ===
pivot = df_clean[df_clean['Country'].isin(['USA', 'CHN', 'DEU', 'IRL', 'JPN',␣
 ↪'KOR'])].pivot(
    index='Country', columns='Year', values='Score'
)
plt.figure(figsize=(10, 6))
sns.heatmap(pivot, annot=True, fmt='.1f', cmap='YlGnBu', cbar_kws={'label':␣
 ↪'Score'})
plt.title('Innovation Score Heatmap (Selected Countries)')
plt.show()
```

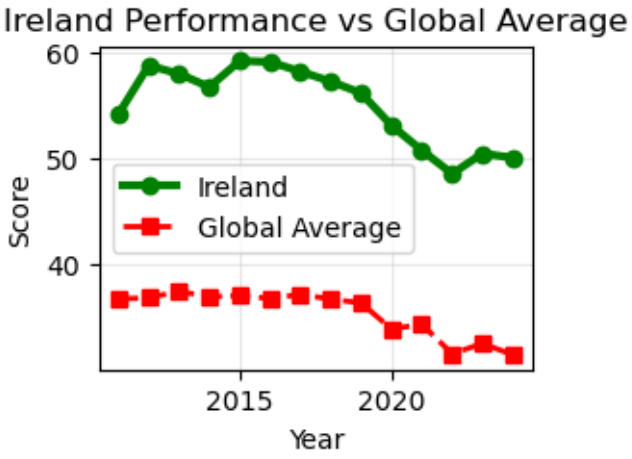


[37]:
```
# Visualize distribution of rank volatility
plt.figure(figsize=(10, 6))
sns.histplot(rank_stability, bins=20, kde=True, color='purple')
plt.title('Distribution of GII Rank Volatility Across Countries')
plt.xlabel('Standard Deviation of Rank')
plt.ylabel('Number of Countries')
plt.grid(True, linestyle='--', alpha=0.7)
plt.show()
```



[55]:
```
#  Ireland vs Global Average comparison
plt.subplot(2, 2, 4)
ireland_data = df_clean[df_clean['Country'] == 'IRL']
global_avg = df_clean.groupby('Year')['Score'].mean()

plt.plot(ireland_data['Year'], ireland_data['Score'],
         marker='o', linewidth=3, label='Ireland', color='green')
plt.plot(global_avg.index, global_avg.values,
         marker='s', linewidth=2, label='Global Average',
         color='red', linestyle='--')
plt.title('Ireland Performance vs Global Average')
plt.xlabel('Year')
plt.ylabel('Score')
plt.legend()
plt.grid(True, alpha=0.3)
```



[33]:
```
# Distribution of Scores for a recent year (e.g., 2024)
year_to_examine = 2024
df_year = df_cleaned[df_cleaned['Year'] == year_to_examine]['Score'].dropna()

if not df_year.empty:
    plt.figure(figsize=(10, 6))
    sns.histplot(df_year, kde=True, bins=15, color='orange')
    plt.title(f'Distribution of GII Scores in {year_to_examine}')
    plt.xlabel('GII Score')
    plt.ylabel('Number of Countries')
    plt.grid(axis='y', linestyle='--', alpha=0.7)
    plt.show()
else:
    print(f"No valid score data for year {year_to_examine}.")
```