Relationship between Six Nations and World Cup Performances

In [587]:

```
#Install relevent programs
%pip install beautifulsoup4 requests selenium bs4
%pip install --upgrade selenium webdriver-manager
```

```
Requirement already satisfied: beautifulsoup4 in c:\users\gre01\anaconda3\lib\site-packag
es (4.10.0)
Requirement already satisfied: requests in c:\users\gre01\anaconda3\lib\site-packages (2.
26.0)
Requirement already satisfied: selenium in c:\users\gre01\anaconda3\lib\site-packages (4.
20.0)
Requirement already satisfied: bs4 in c:\users\gre01\anaconda3\lib\site-packages (0.0.2)
Requirement already satisfied: soupsieve>1.2 in c:\users\gre01\anaconda3\lib\site-package
s (from beautifulsoup4) (2.2.1)
Requirement already satisfied: idna<4,>=2.5 in c:\users\gre01\anaconda3\lib\site-packages
(from requests) (3.2)
Requirement already satisfied: charset-normalizer~=2.0.0 in c:\users\gre01\anaconda3\lib\
site-packages (from requests) (2.0.4)
Requirement already satisfied: certifi>=2017.4.17 in c:\users\gre01\anaconda3\lib\site-pa
ckages (from requests) (2021.10.8)
Requirement already satisfied: urllib3<1.27,>=1.21.1 in c:\users\gre01\anaconda3\lib\site
-packages (from requests) (1.26.7)
Requirement already satisfied: typing_extensions>=4.9.0 in c:\users\gre01\anaconda3\lib\s
ite-packages (from selenium) (4.11.0)
Requirement already satisfied: trio~=0.17 in c:\users\gre01\anaconda3\lib\site-packages (
from selenium) (0.25.0)
Requirement already satisfied: trio-websocket~=0.9 in c:\users\gre01\anaconda3\lib\site-p
ackages (from selenium) (0.11.1)
Requirement already satisfied: cffi>=1.14 in c:\users\gre01\anaconda3\lib\site-packages (
from trio~=0.17->selenium) (1.14.6)
Requirement already satisfied: outcome in c:\users\gre01\anaconda3\lib\site-packages (fro
m trio~=0.17->selenium) (1.3.0.post0)
Requirement already satisfied: sortedcontainers in c:\users\gre01\anaconda3\lib\site-pack
ages (from trio~=0.17->selenium) (2.4.0)
Requirement already satisfied: exceptiongroup in c:\users\gre01\anaconda3\lib\site-packag
es (from trio~=0.17->selenium) (1.2.1)
Requirement already satisfied: sniffio>=1.3.0 in c:\users\gre01\anaconda3\lib\site-packag
es (from trio~=0.17->selenium) (1.3.1)
Requirement already satisfied: attrs>=23.2.0 in c:\users\gre01\anaconda3\lib\site-package
s (from trio~=0.17->selenium) (23.2.0)
Requirement already satisfied: pycparser in c:\users\gre01\anaconda3\lib\site-packages (f
rom cffi>=1.14->trio~=0.17->selenium) (2.20)
Requirement already satisfied: wsproto>=0.14 in c:\users\gre01\anaconda3\lib\site-package
s (from trio-websocket~=0.9->selenium) (1.2.0)
Requirement already satisfied: PySocks!=1.5.7,<2.0,>=1.5.6 in c:\users\gre01\anaconda3\li
b\site-packages (from urllib3<1.27,>=1.21.1->requests) (1.7.1)
Requirement already satisfied: h11<1,>=0.9.0 in c:\users\gre01\anaconda3\lib\site-package
s (from wsproto>=0.14->trio-websocket~=0.9->selenium) (0.14.0)
Note: you may need to restart the kernel to use updated packages.
Requirement already satisfied: selenium in c:\users\gre01\anaconda3\lib\site-packages (4.
20.0)
Requirement already satisfied: webdriver-manager in c:\users\gre01\anaconda3\lib\site-pac
kages (4.0.1)
Requirement already satisfied: trio-websocket~=0.9 in c:\users\gre01\anaconda3\lib\site-p
ackages (from selenium) (0.11.1)
Requirement already satisfied: urllib3[socks]<3,>=1.26 in c:\users\gre01\anaconda3\lib\si
te-packages (from selenium) (1.26.7)
Requirement already satisfied: certifi>=2021.10.8 in c:\users\gre01\anaconda3\lib\site-pa
ckages (from selenium) (2021.10.8)
Requirement already satisfied: trio~=0.17 in c:\users\gre01\anaconda3\lib\site-packages (
from selenium) (0.25.0)
Requirement already satisfied: typing_extensions>=4.9.0 in c:\users\gre01\anaconda3\lib\s
ite-packages (from selenium) (4.11.0)
```

```
Requirement already satisfied: requests in c:\users\gre01\anaconda3\lib\site-packages (fr
om webdriver-manager) (2.26.0)
Requirement already satisfied: packaging in c:\users\gre01\anaconda3\lib\site-packages (f
rom webdriver-manager) (21.0)
Requirement already satisfied: python-dotenv in c:\users\gre01\anaconda3\lib\site-package
s (from webdriver-manager) (1.0.1)
Requirement already satisfied: sniffio>=1.3.0 in c:\users\gre01\anaconda3\lib\site-packag
es (from trio~=0.17->selenium) (1.3.1)
Requirement already satisfied: outcome in c:\users\gre01\anaconda3\lib\site-packages (fro
m trio~=0.17->selenium) (1.3.0.post0)
Requirement already satisfied: attrs>=23.2.0 in c:\users\gre01\anaconda3\lib\site-package
s (from trio~=0.17->selenium) (23.2.0)
Requirement already satisfied: cffi>=1.14 in c:\users\gre01\anaconda3\lib\site-packages (
from trio~=0.17->selenium) (1.14.6)
Requirement already satisfied: sortedcontainers in c:\users\gre01\anaconda3\lib\site-pack
ages (from trio~=0.17->selenium) (2.4.0)
Requirement already satisfied: exceptiongroup in c:\users\gre01\anaconda3\lib\site-packag
es (from trio~=0.17->selenium) (1.2.1)
Requirement already satisfied: idna in c:\users\gre01\anaconda3\lib\site-packages (from t
rio~=0.17->selenium) (3.2)
Requirement already satisfied: pycparser in c:\users\gre01\anaconda3\lib\site-packages (f
rom cffi>=1.14->trio~=0.17->selenium) (2.20)
Requirement already satisfied: wsproto>=0.14 in c:\users\gre01\anaconda3\lib\site-package
s (from trio-websocket~=0.9->selenium) (1.2.0)
Requirement already satisfied: PySocks!=1.5.7,<2.0,>=1.5.6 in c:\users\gre01\anaconda3\li
b\site-packages (from urllib3[socks]<3,>=1.26->selenium) (1.7.1)
Requirement already satisfied: h11<1,>=0.9.0 in c:\users\gre01\anaconda3\lib\site-package
s (from wsproto>=0.14->trio-websocket~=0.9->selenium) (0.14.0)
Requirement already satisfied: pyparsing>=2.0.2 in c:\users\gre01\anaconda3\lib\site-pack
ages (from packaging->webdriver-manager) (3.0.4)
Requirement already satisfied: charset-normalizer~=2.0.0 in c:\users\gre01\anaconda3\lib\
site-packages (from requests->webdriver-manager) (2.0.4)
Note: you may need to restart the kernel to use updated packages.
```

In [708]:

```
%pip install plotly graphviz pearsonr statsmodels
```

```
Requirement already satisfied: plotly in c:\users\gre01\anaconda3\lib\site-packages (5.22
.0)
Requirement already satisfied: graphviz in c:\users\gre01\anaconda3\lib\site-packages (0.
20.3)
Requirement already satisfied: pearsonr in c:\users\gre01\anaconda3\lib\site-packages (0.
1.0)
Requirement already satisfied: statsmodels in c:\users\gre01\anaconda3\lib\site-packages
(0.12.2)
Requirement already satisfied: packaging in c:\users\gre01\anaconda3\lib\site-packages (f
rom plotly) (21.0)
Requirement already satisfied: tenacity>=6.2.0 in c:\users\gre01\anaconda3\lib\site-packa
ges (from plotly) (8.2.3)
Requirement already satisfied: numpy>=1.15 in c:\users\gre01\anaconda3\lib\site-packages
(from statsmodels) (1.20.3)
Requirement already satisfied: scipy>=1.1 in c:\users\gre01\anaconda3\lib\site-packages (
from statsmodels) (1.7.1)
Requirement already satisfied: pandas>=0.21 in c:\users\gre01\anaconda3\lib\site-packages
(from statsmodels) (1.3.4)
Requirement already satisfied: patsy>=0.5 in c:\users\gre01\anaconda3\lib\site-packages (
from statsmodels) (0.5.2)
Requirement already satisfied: python-dateutil>=2.7.3 in c:\users\gre01\anaconda3\lib\sit
e-packages (from pandas>=0.21->statsmodels) (2.8.2)
Requirement already satisfied: pytz>=2017.3 in c:\users\gre01\anaconda3\lib\site-packages
(from pandas>=0.21->statsmodels) (2021.3)
Requirement already satisfied: six in c:\users\gre01\anaconda3\lib\site-packages (from pa
tsy>=0.5->statsmodels) (1.16.0)
Requirement already satisfied: pyparsing>=2.0.2 in c:\users\gre01\anaconda3\lib\site-pack
ages (from packaging->plotly) (3.0.4)
Note: you may need to restart the kernel to use updated packages.
```

World Cup Top 3 Data Collection

In [591]:

```
import requests
from bs4 import BeautifulSoup
import pandas as pd
```

In [593]:

```
def parse_html_from_url(url):
    #Fetch and parse HTML from a specified URL
    response = requests.get(url)
    response.raise_for_status()
    soup = BeautifulSoup(response.text, 'html.parser')
    return soup
```

In [595]:

```
def extract_data_by_section(soup, section_id):
    #Extract data from a section specified by its ID
    section = soup.find('span', {'id': section_id})
    if section:
        table = section.find_next('table', {'class': 'wikitable'})
        if table:
            return extract_table_data(table)
        else:
            print(f"No table found for {section_id}")
    else:
        print(f"No section found for {section_id}")
    return pd.DataFrame()
```

In [597]:

```
def extract_table_data(table):
    #Extract rows from the specified table
    rows = table.find_all('tr')
    data = []
    for row in rows:
        cols = row.find_all('td')
        if cols:
            year_text = cols[0].text.strip()
            try:
                year = int(year_text)  # Convert year to integer
            except ValueError:
                print(f"Skipping row, invalid year: {year_text}")
                continue
            if year > 2024:
                print(f"Skipping future tournament year: {year}")
                continue  # Skip future years
            try:
                champion = cols[2].text.strip()
                runner_up = cols[4].text.strip()
                third = cols[5].text.strip()
                data.append((year_text, champion, runner_up, third))
            except IndexError as e:
                print(f"Error processing row: {row}, error: {e}")
    return pd.DataFrame(data, columns=['Year', 'Champion', 'Runner-up', 'Third'])
```

In [599]:

```
#URL of the Wikipedia page for the Rugby World Cup
url = 'https://en.wikipedia.org/wiki/Rugby_World_Cup'
soup = parse_html_from_url(url)
section_id = 'Tournaments'
World_Cup_Data = extract_data_by_section(soup, section_id)

print("World Cup Data:")
print(World_Cup_Data)
```

```
Skipping future tournament year: 2027
Skipping future tournament year: 2031
World Cup Data:
   Year      Champion    Runner-up         Third
```

0	1987	New Zealand	France	Wales
1	1991	Australia	England	New Zealand
2	1995	South Africa	New Zealand	France
3	1999	Australia	France	South Africa
4	2003	England	Australia	New Zealand
5	2007	South Africa	England	Argentina
6	2011	New Zealand	France	Australia
7	2015	New Zealand	Australia	South Africa
8	2019	South Africa	England	New Zealand
9	2023	South Africa	New Zealand	England

In [601]:

```
World_Cup_Data.to_csv('World_Cup_Data.csv', index=False)
```

World Cup Quarterfinalists Data Collection

In [603]:

```
import time
```

In [605]:

```
#Function to extract top teams from each pool
def extract_top_teams(pool_df):
    top_teams = []
    #Determine the number of rows per pool
    if int(url.split('/')[-1][:4]) <= 1999:
        rows_per_pool = 7
    else:
        rows_per_pool = 8
    #Iterate through each pool
    for pool_start_index in range(0, len(pool_df), rows_per_pool):
        #Get the top two teams from each pool based on points
        top_teams.extend(pool_df.iloc[pool_start_index+2:pool_start_index+4, 0].tolist()
)
    return top_teams


world_cup_quarterfinalists = pd.DataFrame(columns=['Year', 'Country'])
```

In [607]:

```
#Iterate through each year
for year in range(1987, 2024, 4):
    try:
        #Construct the URL (page layouts change in the year 2011)
        if year <= 2011:
            url = f'https://www.globalrugbyresults.com/{year}rugbyworldcup.html'
            table_index = 3
        else:
            url = f'https://www.globalrugbyresults.com/{year}RugbyWorldCup.html'
            table_index = 2

        time.sleep(2)

        Rugby_World_Cup_Quarters_df = pd.read_html(url)

        #Extract the relevant DataFrame containing pool stage results
        pool_stage_df = Rugby_World_Cup_Quarters_df[table_index]

        #Extract top teams from each pool
        top_teams = extract_top_teams(pool_stage_df)

        #Add the year to the list of years
        year_list = [year] * len(top_teams)

        year_df = pd.DataFrame({'Year': year_list, 'Country': top_teams})
```

```
        #Append the current year's data to world_cup_quarterfinalists
        world_cup_quarterfinalists = world_cup_quarterfinalists.append(year_df, ignore_i
ndex=True)
    except Exception as e:
        print(f"Error processing data for year {year}: {e}")
```

In [609]:

```
print(world_cup_quarterfinalists)
```

```
    Year       Country
0   1987     Australia
1   1987       England
2   1987         Wales
3   1987       Ireland
4   1987   New Zealand
..   ...           ...
77  2023  South Africa
78  2023         Wales
79  2023          Fiji
80  2023       England
81  2023     Argentina

[82 rows x 2 columns]
```

In [611]:

```
world_cup_quarterfinalists.to_csv('world_cup_quarterfinalists.csv', index=False)
```

Six Nations Data Collection

In [613]:

```
from selenium import webdriver
from selenium.webdriver.common.by import By
from selenium.webdriver.chrome.service import Service
from selenium.webdriver.support.ui import WebDriverWait
from selenium.webdriver.support import expected_conditions as EC
from webdriver_manager.chrome import ChromeDriverManager
```

In [615]:

```
def fetch_page(url):
    options = webdriver.ChromeOptions()
    options.add_argument('--headless')
    driver = webdriver.Chrome(service=Service(ChromeDriverManager().install()), options=
options)
    driver.get(url)
    return driver
```

In [617]:

```
def scrape_season_data(driver):
    try:
        standings = []
        #Wait for the Javascript driven dynamic content to load
        WebDriverWait(driver, 3).until(EC.presence_of_element_located((By.CSS_SELECTOR,
".ui-table__row")))
        rows = driver.find_elements(By.CSS_SELECTOR, ".ui-table__row")
        #Debug
        #print(f"Found {len(rows)} rows")
        for row in rows:
            rank = row.find_element(By.CSS_SELECTOR, ".table__cell--rank .tableCellRank"
).text.strip()
            team_name = row.find_element(By.CSS_SELECTOR, ".tableCellParticipant__name")
.text.strip()
            total_points = row.find_element(By.CSS_SELECTOR, ".table__cell--points").tex
t.strip()
            total_playing_points = row.find_element(By.CSS_SELECTOR, ".table__cell--tota
```

```
lPoints").text.strip()
            standings.append({'Rank': rank, 'Team': team_name, 'Points': total_points, '
Scored Points': total_playing_points})
            #Debug
            #print(f"Scraped data - Rank: {rank}, Team: {team_name}, Points: {total_point
s}")
        return standings
    except Exception as e:
        print(f"Error scraping data: {e}")
        return None
```

In [619]:

```
def compile_data(url):
    main_driver = fetch_page(url)
    #Filter only the links of interest
    links = main_driver.find_elements(By.CSS_SELECTOR, 'a[href*="/six-nations-20"]:not([
href*="standings"])')
    #Debug so I dont have to go through all 24 years each time
    #year_urls = [link.get_attribute('href') for link in links if '2024' in link.text or
'2023' in link.text]
    year_urls = [link.get_attribute('href') for link in links]

    results = []
    for year_url in year_urls:
        print(f"Processing {year_url}")
        driver_year = fetch_page(year_url)
        standings_link = driver_year.find_element(By.CSS_SELECTOR, 'a[href*="standings"]
')
        standings_url = standings_link.get_attribute('href')

        driver_standings = fetch_page(standings_url)
        teams = scrape_season_data(driver_standings)
        if teams:
            #Extract year from the URL
            year = standings_url.split('/')[-2].split('-')[-1] if 'standings' in standin
gs_url.split('/')[-1] else standings_url.split('/')[-3].split('-')[-1]
            for team in teams:
                results.append([year] + list(team.values()))
        driver_standings.quit()
        driver_year.quit()

    main_driver.quit()
    return pd.DataFrame(results, columns=['Year', 'Rank', 'Team', 'Points', 'Scored Poin
ts'])
```

In [621]:

```
main_url = 'https://www.livesport.com/en/rugby-union/europe/six-nations/archive/'
six_nations_data = compile_data(main_url)
print(six_nations_data)
```

```
Processing https://www.livesport.com/en/rugby-union/europe/six-nations-2024/
Processing https://www.livesport.com/en/rugby-union/europe/six-nations-2023/
Processing https://www.livesport.com/en/rugby-union/europe/six-nations-2022/
Processing https://www.livesport.com/en/rugby-union/europe/six-nations-2021/
Processing https://www.livesport.com/en/rugby-union/europe/six-nations-2020/
Processing https://www.livesport.com/en/rugby-union/europe/six-nations-2019/
Processing https://www.livesport.com/en/rugby-union/europe/six-nations-2018/
Processing https://www.livesport.com/en/rugby-union/europe/six-nations-2017/
Processing https://www.livesport.com/en/rugby-union/europe/six-nations-2016/
Processing https://www.livesport.com/en/rugby-union/europe/six-nations-2015/
Processing https://www.livesport.com/en/rugby-union/europe/six-nations-2014/
Processing https://www.livesport.com/en/rugby-union/europe/six-nations-2013/
Processing https://www.livesport.com/en/rugby-union/europe/six-nations-2012/
Processing https://www.livesport.com/en/rugby-union/europe/six-nations-2011/
Processing https://www.livesport.com/en/rugby-union/europe/six-nations-2010/
Processing https://www.livesport.com/en/rugby-union/europe/six-nations-2009/
Processing https://www.livesport.com/en/rugby-union/europe/six-nations-2008/
Processing https://www.livesport.com/en/rugby-union/europe/six-nations-2007/
Processing https://www.livesport.com/en/rugby-union/europe/six-nations-2006/
Processing https://www.livesport.com/en/rugby-union/europe/six-nations-2005/
```

```
Processing https://www.livesport.com/en/rugby-union/europe/six-nations-2004/
Processing https://www.livesport.com/en/rugby-union/europe/six-nations-2003/
Processing https://www.livesport.com/en/rugby-union/europe/six-nations-2002/
Processing https://www.livesport.com/en/rugby-union/europe/six-nations-2001/
Processing https://www.livesport.com/en/rugby-union/europe/six-nations-2000/
     Year Rank      Team Points Scored Points
0    2024   1.   Ireland     20        144:60
1    2024   2.    France     15       128:122
2    2024   3.   England     14       118:123
3    2024   4.  Scotland     12       115:115
4    2024   5.     Italy     11        92:126
..    ...  ...       ...    ...           ...
145  2000   2.    France      6        140:92
146  2000   3.   Ireland      6       168:133
147  2000   4.     Wales      6       111:135
148  2000   5.  Scotland      2        95:145
149  2000   6.     Italy      2       106:228

[150 rows x 5 columns]
```

In [623]:

```
print(six_nations_data.columns)
```

```
Index(['Year', 'Rank', 'Team', 'Points', 'Scored Points'], dtype='object')
```

In [625]:

```
#Expand 'Scored Points' column into two new columns
six_nations_data[['Points Scored', 'Points Conceded']] = six_nations_data['Scored Points
'].str.split(':', expand=True)

six_nations_data['Points Scored'] = pd.to_numeric(six_nations_data['Points Scored'])
six_nations_data['Points Conceded'] = pd.to_numeric(six_nations_data['Points Conceded'])

six_nations_data['Points Difference'] = six_nations_data['Points Scored'] - six_nations_
data['Points Conceded']

#Remove 'Scored Points' column
six_nations_data = six_nations_data.drop(columns=['Scored Points'])

print(six_nations_data.head())
```

```
   Year Rank      Team Points  Points Scored  Points Conceded  \
0  2024   1.   Ireland     20            144               60
1  2024   2.    France     15            128              122
2  2024   3.   England     14            118              123
3  2024   4.  Scotland     12            115              115
4  2024   5.     Italy     11             92              126

   Points Difference
0                 84
1                  6
2                 -5
3                  0
4                -34
```

In [627]:

```
six_nations_data.to_csv('Six_Nations_data.csv', index=False)
```

Investment Analysis

In [629]:

```
import matplotlib.pyplot as plt
import seaborn as sns
```

In [631]:

```
investment_data_path = '6_nations_teams_investments.csv'
investment_data = pd.read_csv(investment_data_path)

print(investment_data)
```

```
    Year      Team  Expenditure (£/€)  Expenditure (£)
0   2023   England         99400000.0     9.940000e+07
1   2023    France        142944183.0     1.223639e+08
2   2023   Ireland         93118736.0     7.971203e+07
3   2023     Italy         37496556.9     3.209802e+07
4   2023  Scotland         75382000.0     7.538200e+07
5   2023     Wales         79500000.0     7.950000e+07
6   2022   England         77400000.0     7.740000e+07
7   2022    France        125699609.0     1.076021e+08
8   2022   Ireland        109686828.0     9.389475e+07
9   2022     Italy         36037805.5     3.084929e+07
10  2022  Scotland         61051000.0     6.105100e+07
11  2022     Wales         70100000.0     7.010000e+07
12  2021   England         57400000.0     5.740000e+07
13  2021    France         88150169.0     7.545881e+07
14  2021   Ireland         94093057.0     8.054608e+07
15  2021     Italy         32314997.0     2.766247e+07
16  2021  Scotland         48811000.0     4.881100e+07
17  2021     Wales         43800000.0     4.380000e+07
```

In [633]:

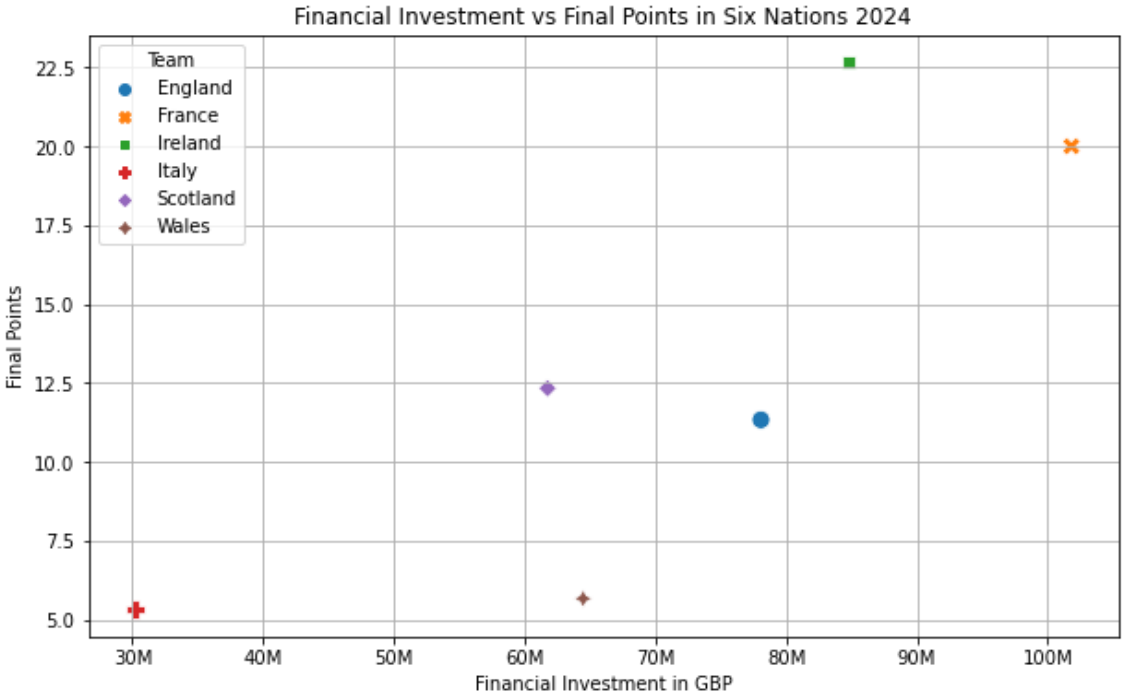
```
#Cleaning data
six_nations_data['Year'] = six_nations_data['Year'].astype(str).str.strip()
investment_data['Year'] = investment_data['Year'].astype(str).str.strip()
six_nations_data['Points'] = pd.to_numeric(six_nations_data['Points'], errors='coerce')

#Filter Six Nations data for the years 2022 to 2024
six_nations_filtered = six_nations_data[six_nations_data['Year'].isin(['2024', '2023', '
2022'])]

average_scores = six_nations_filtered.groupby('Team')['Points'].mean().reset_index()
average_investment = investment_data.groupby('Team')['Expenditure (£)'].mean().reset_ind
ex()

#Merge the averaged scores and investments
merged_investment_data = pd.merge(average_scores, average_investment, on='Team', how='in
ner')
print(merged_investment_data)
```

```
       Team     Points  Expenditure (£)
0   England  11.333333     7.806667e+07
1    France  20.000000     1.018083e+08
2   Ireland  22.666667     8.471762e+07
3     Italy   5.333333     3.020326e+07
4  Scotland  12.333333     6.174800e+07
5     Wales   5.666667     6.446667e+07
```

In [635]:

```
import matplotlib.ticker as ticker

#Plotting the relationship between Investment and Ranking
plt.figure(figsize=(10, 6))
ax = sns.scatterplot(data=merged_investment_data, x='Expenditure (£)', y='Points', hue='
Team', s=100, style='Team')

plt.title('Financial Investment vs Final Points in Six Nations 2024')
plt.xlabel('Financial Investment in GBP')
plt.ylabel('Final Points')
plt.grid(True)

#Format the x-axis
ax.xaxis.set_major_formatter(ticker.FuncFormatter(lambda x, pos: '{:,.0f}M'.format(x/1e6
)))
```

```
plt.show()
```



In [637]:

```
print(investment_data)
```

	Year	Team	Expenditure (£/€)	Expenditure (£)
0	2023	England	99400000.0	9.940000e+07
1	2023	France	142944183.0	1.223639e+08
2	2023	Ireland	93118736.0	7.971203e+07
3	2023	Italy	37496556.9	3.209802e+07
4	2023	Scotland	75382000.0	7.538200e+07
5	2023	Wales	79500000.0	7.950000e+07
6	2022	England	77400000.0	7.740000e+07
7	2022	France	125699609.0	1.076021e+08
8	2022	Ireland	109686828.0	9.389475e+07
9	2022	Italy	36037805.5	3.084929e+07
10	2022	Scotland	61051000.0	6.105100e+07
11	2022	Wales	70100000.0	7.010000e+07
12	2021	England	57400000.0	5.740000e+07
13	2021	France	88150169.0	7.545881e+07
14	2021	Ireland	94093057.0	8.054608e+07
15	2021	Italy	32314997.0	2.766247e+07
16	2021	Scotland	48811000.0	4.881100e+07
17	2021	Wales	43800000.0	4.380000e+07

In [639]:

```
print(merged_data_1)
```

	Year	Rank	Team	Points	Expenditure (£/€)	Expenditure (£)	\
0	2023	1.	Ireland	27	93118736.0	7.971203e+07	
1	2023	2.	France	20	142944183.0	1.223639e+08	
2	2023	3.	Scotland	15	75382000.0	7.538200e+07	
3	2023	4.	England	10	99400000.0	9.940000e+07	
4	2023	5.	Wales	6	79500000.0	7.950000e+07	
5	2023	6.	Italy	1	37496556.9	3.209802e+07	
6	2022	1.	France	25	125699609.0	1.076021e+08	
7	2022	2.	Ireland	21	109686828.0	9.389475e+07	
8	2022	3.	England	10	77400000.0	7.740000e+07	
9	2022	4.	Scotland	10	61051000.0	6.105100e+07	
10	2022	5.	Wales	7	70100000.0	7.010000e+07	
11	2022	6.	Italy	4	36037805.5	3.084929e+07	
12	2021	1.	Wales	20	43800000.0	4.380000e+07	
13	2021	2.	France	16	88150169.0	7.545881e+07	
14	2021	3.	Ireland	15	94093057.0	8.054608e+07	
15	2021	4.	Scotland	15	48811000.0	4.881100e+07	
16	2021	5.	England	10	57400000.0	5.740000e+07	

```
17  2021    6.      Italy       0          32314997.0     2.766247e+07

    Expenditure per Point (£)
0                2.952298e+06
1                6.118195e+06
2                5.025467e+06
3                9.940000e+06
4                1.325000e+07
5                3.209802e+07
6                4.304084e+06
7                4.471178e+06
8                7.740000e+06
9                6.105100e+06
10               1.001429e+07
11               7.712322e+06
12               2.190000e+06
13               4.716176e+06
14               5.369738e+06
15               3.254067e+06
16               5.740000e+06
17               0.000000e+00
```

In [640]:

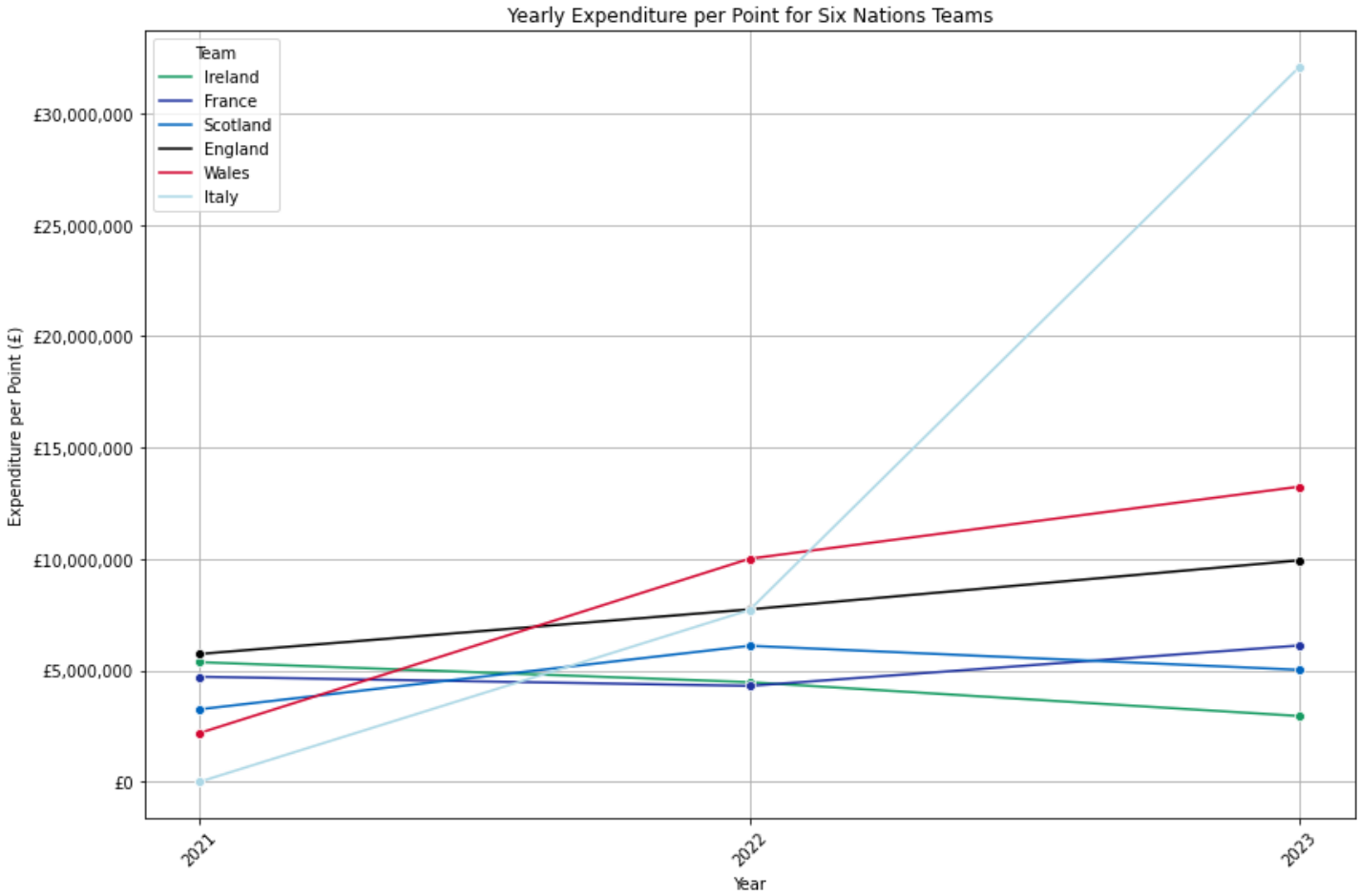
```
#Clean data
merged_data_1['Points'] = merged_data_1['Points'].astype(int)
merged_data_1['Year'] = merged_data_1['Year'].astype(int)

#Calculate 'Expenditure per Point (£)'
merged_data_1['Expenditure per Point (£)'] = merged_data_1['Expenditure (£)'] / merged_da
ta_1['Points']

#Handling infinite values
merged_data_1['Expenditure per Point (£)'].replace([np.inf, -np.inf], np.nan, inplace=Tr
ue)
merged_data_1['Expenditure per Point (£)'].fillna(0, inplace=True)  # Assuming you want
to set 0 where calculation was not possible

print("\nFinal Data with Expenditure per Point:\n")
print(merged_data_1[['Year', 'Team', 'Points', 'Expenditure (£)', 'Expenditure per Point
(£)']])
```

```
Final Data with Expenditure per Point:

    Year      Team  Points  Expenditure (£)  Expenditure per Point (£)
0   2023   Ireland      27     7.971203e+07               2.952298e+06
1   2023    France      20     1.223639e+08               6.118195e+06
2   2023  Scotland      15     7.538200e+07               5.025467e+06
3   2023   England      10     9.940000e+07               9.940000e+06
4   2023     Wales       6     7.950000e+07               1.325000e+07
5   2023     Italy       1     3.209802e+07               3.209802e+07
6   2022    France      25     1.076021e+08               4.304084e+06
7   2022   Ireland      21     9.389475e+07               4.471178e+06
8   2022   England      10     7.740000e+07               7.740000e+06
9   2022  Scotland      10     6.105100e+07               6.105100e+06
10  2022     Wales       7     7.010000e+07               1.001429e+07
11  2022     Italy       4     3.084929e+07               7.712322e+06
12  2021     Wales      20     4.380000e+07               2.190000e+06
13  2021    France      16     7.545881e+07               4.716176e+06
14  2021   Ireland      15     8.054608e+07               5.369738e+06
15  2021  Scotland      15     4.881100e+07               3.254067e+06
16  2021   England      10     5.740000e+07               5.740000e+06
17  2021     Italy       0     2.766247e+07               0.000000e+00
```

In [641]:

```
#Define custom palette
team_colors = {
    'Ireland': '#169b62',
    'France': '#2033a0',
    'England': '#000000',
```

```
    'Scotland': '#0065bf',
    'Italy': '#ADD8E6',
    'Wales': '#d30731'
}

plt.figure(figsize=(12, 8))
ax = sns.lineplot(data=merged_data_1, x='Year', y='Expenditure per Point (£)', hue='Team
', marker='o', palette=team_colors)

plt.title('Yearly Expenditure per Point for Six Nations Teams')
plt.xlabel('Year')
plt.ylabel('Expenditure per Point (£)')
plt.grid(True)

ax.set_xticks(merged_data_1['Year'].unique())
ax.set_xticklabels(merged_data_1['Year'].unique(), rotation=45)

#Format the y-axis to display currency
formatter = ticker.FuncFormatter(lambda x, pos: f'£{x:,.0f}')
ax.yaxis.set_major_formatter(formatter)

plt.legend(title='Team')
plt.tight_layout()
plt.show()
```



In [702]:

```
import plotly.graph_objects as go

#Calculate the averages for teams over time
average_data = merged_data_1.groupby('Team').agg({
    'Expenditure (£)': 'mean',
    'Points': 'mean'
}).reset_index()

average_data['Expenditure per Point (£)'] = average_data['Expenditure (£)'] / average_da
ta['Points']

#Sort the data from highest to lowest Expenditure per Point
average_data = average_data.sort_values(by='Expenditure per Point (£)', ascending=False)
```

```
#Define team colors for consistency
team_colors = {
    'Ireland': '#169b62',
    'France': '#2033a0',
    'England': '#FFFFFF',
    'Scotland': '#0065bf',
    'Italy': '#ADD8E6',
    'Wales': '#d30731'
}

#Define border colors
border_colors = {
    'Ireland': '#169b62',
    'France': '#2033a0',
    'England': 'red',
    'Scotland': '#0065bf',
    'Italy': '#ADD8E6',
    'Wales': 'darkgreen'
}

#Create the Plotly figure
fig = go.Figure()

#Add bars for Expenditure
fig.add_trace(go.Bar(
    x=average_data['Team'],
    y=average_data['Expenditure (£)'],
    name='Average Expenditure (£)',
    #Apply colours
    marker_color=[team_colors[team] for team in average_data['Team']],
    marker_line_color=[border_colors[team] for team in average_data['Team']],
    marker_line_width=5,
    #Add hover pop-up box with key info
    hoverinfo="text",
    hovertemplate=(
        "Team: %{x}<br>" +
        "Average Expenditure: £%{y:,.0f}<br>" +
        "Expenditure per Point: £%{customdata:.2f}<extra></extra>"
    ),
    customdata=average_data['Expenditure per Point (£)'],
    showlegend=False
))

#Add a line for Points with secondary Y-axis
fig.add_trace(go.Scatter(
    x=average_data['Team'],
    y=average_data['Points'],
    name='Points',
    mode='lines+markers',
    line=dict(color='gold', width=3),
    yaxis='y2'
))

#layout of both y-axis
fig.update_layout(
    title='Financial Investment vs Final Points in Six Nations 2022-2024',
    xaxis_title='Countries',
    yaxis=dict(
        title='Average Investment (£)',
        titlefont=dict(color='blue'),
        tickfont=dict(color='blue'),
        tickprefix="£",
        ticksuffix="M",
        position=0
    ),
    yaxis2=dict(
        title='Average Points',
        titlefont=dict(color='gold'),
        tickfont=dict(color='gold'),
        overlaying='y',
        side='right',
```

```
        position=1
    ),
    plot_bgcolor='white',
    legend=dict(x=0.70, y=0.99, bordercolor='black', borderwidth=1)
)

#Remove grid lines for clarity
fig.update_xaxes(showgrid=False, linewidth=1, linecolor='black')
fig.update_yaxes(showgrid=False, linewidth=1, linecolor='black')


#Add a subnote
fig.add_annotation(
    x=0.5,
    y=-0.2,
    xref="paper",
    yref="paper",
    text="Data ordered from highest to lowest Expenditure per Point",
    showarrow=False,
    font=dict(
        family="Arial, sans-serif",
        size=12,
        color="black"
    ),
    align="center"
)


fig.show()
```

World Cup Quarter Finalists (Top 8) Analysis

In [644]:

```
#Filter the data to include only Six Nations teams
six_nations_teams = ['England', 'Scotland', 'Wales', 'Ireland', 'France', 'Italy']  # As
suming Italy is included in the Six Nations
six_nations_data_teams = world_cup_quarterfinalists[world_cup_quarterfinalists['Country']
```

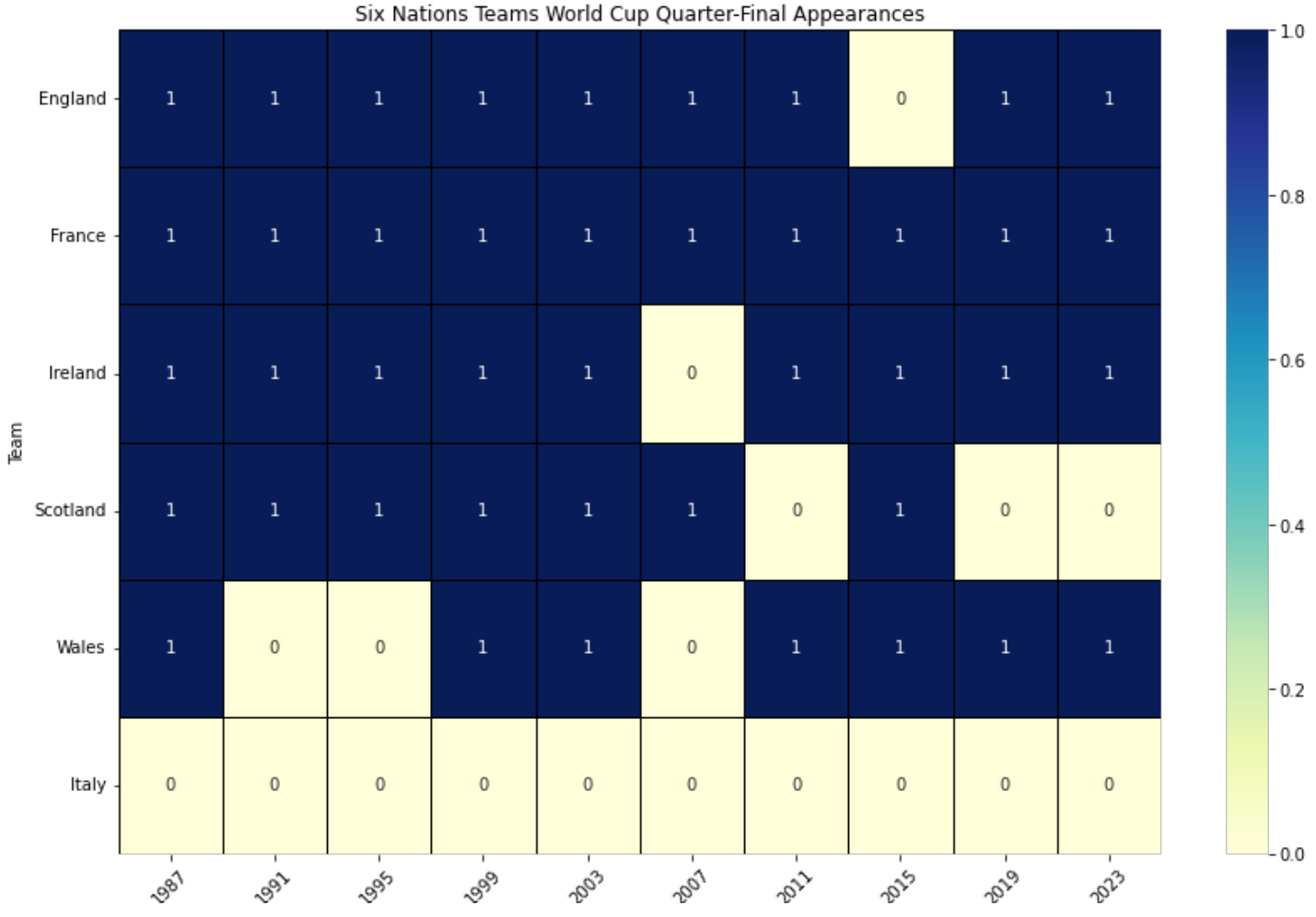
```
.isin(six_nations_teams)]

#Pivot the dataFrame to get the count of appearances for each team in each year
heatmap_data_quarters = six_nations_data_teams.pivot_table(index='Country', columns='Yea
r', aggfunc='size', fill_value=0)

#Not all Six Nations teams will have made the quarter finals ever, so append them in for
consistency
for team in six_nations_teams:
    if team not in heatmap_data_quarters.index:
        heatmap_data_quarters.loc[team] = [0] * len(heatmap_data_quarters.columns)

print(heatmap_data_quarters)
```

```
Year       1987  1991  1995  1999  2003  2007  2011  2015  2019  2023
Country
England       1     1     1     1     1     1     1     0     1     1
France        1     1     1     1     1     1     1     1     1     1
Ireland       1     1     1     1     1     0     1     1     1     1
Scotland      1     1     1     1     1     1     0     1     0     0
Wales         1     0     0     1     1     0     1     1     1     1
Italy         0     0     0     0     0     0     0     0     0     0
```

Visualisation of Quarterfinals Apperences of Six Nations Teams

In [645]:

```
#Create the heatmap
plt.figure(figsize=(12, 8))
sns.heatmap(heatmap_data_quarters, cmap='YlGnBu', annot=True, fmt='d', linewidths=0.5, li
necolor='black')
plt.title('Six Nations Teams World Cup Quarter-Final Appearances')
plt.xlabel('Year')
plt.ylabel('Team')
plt.xticks(rotation=45)
plt.yticks(rotation=0)
plt.tight_layout()
plt.show()
```



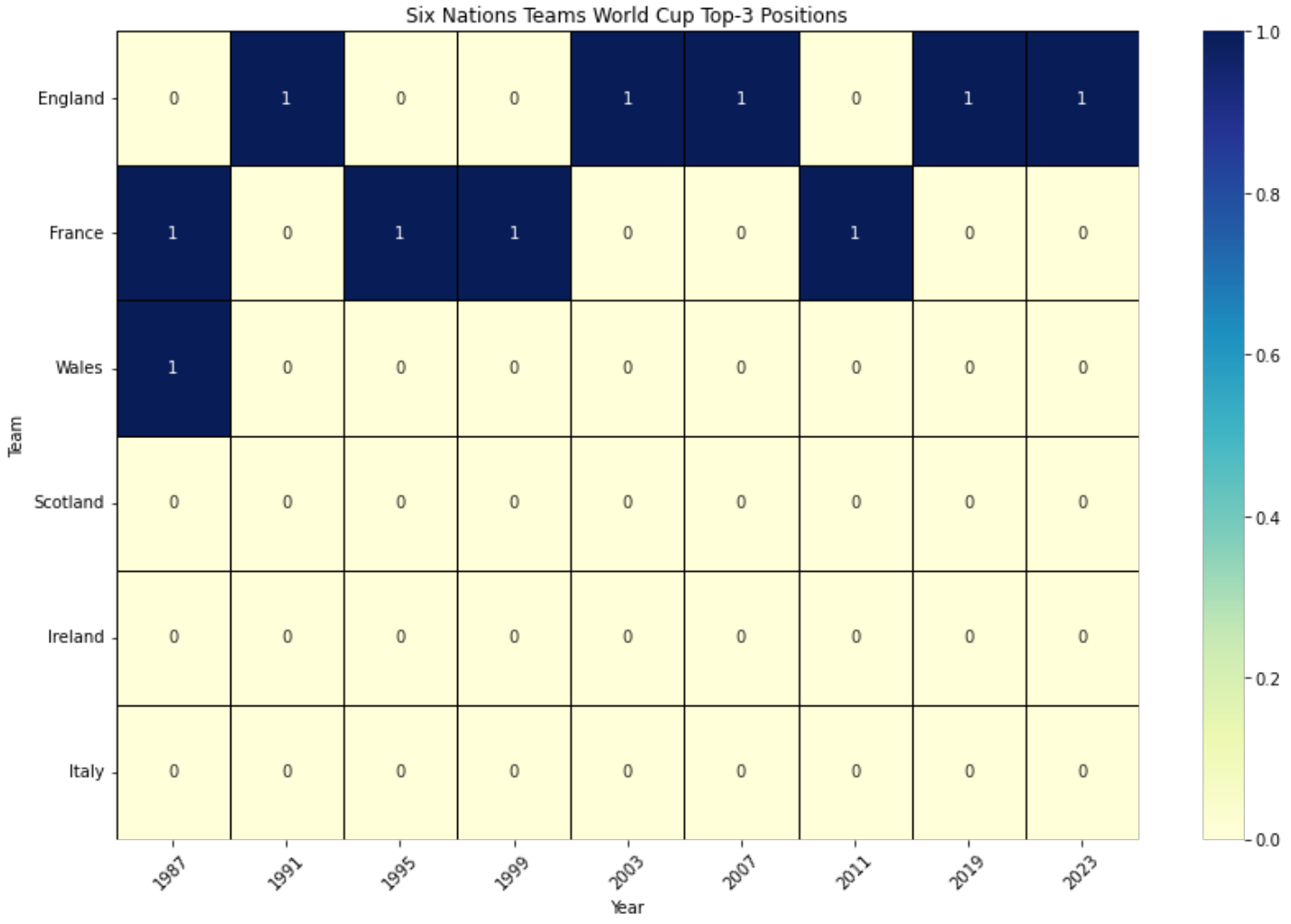
Year

In [646]:

```
#Reshape the dataFrame
long_format = pd.melt(world_cup_data, id_vars='Year', value_vars=['Champion', 'Runner-up
', 'Third'], var_name='Placement', value_name='Country')
filtered_data = long_format[long_format['Country'].isin(six_nations_teams)]

#Pivot table
heatmap_data_top3 = filtered_data.pivot_table(index='Country', columns='Year', aggfunc='
size', fill_value=0)

#Same as above not all teams from the Six Nations will have reached a Top 3 position in t
he World Cup
for team in six_nations_teams:
    if team not in heatmap_data_top3.index:
        heatmap_data_top3.loc[team] = [0] * len(heatmap_data_top3.columns)  # Add a row
of zeros

#Ensure the team order in the heatmap matches quarter finalists
heatmap_data = heatmap_data_top3.loc[six_nations_teams]
```

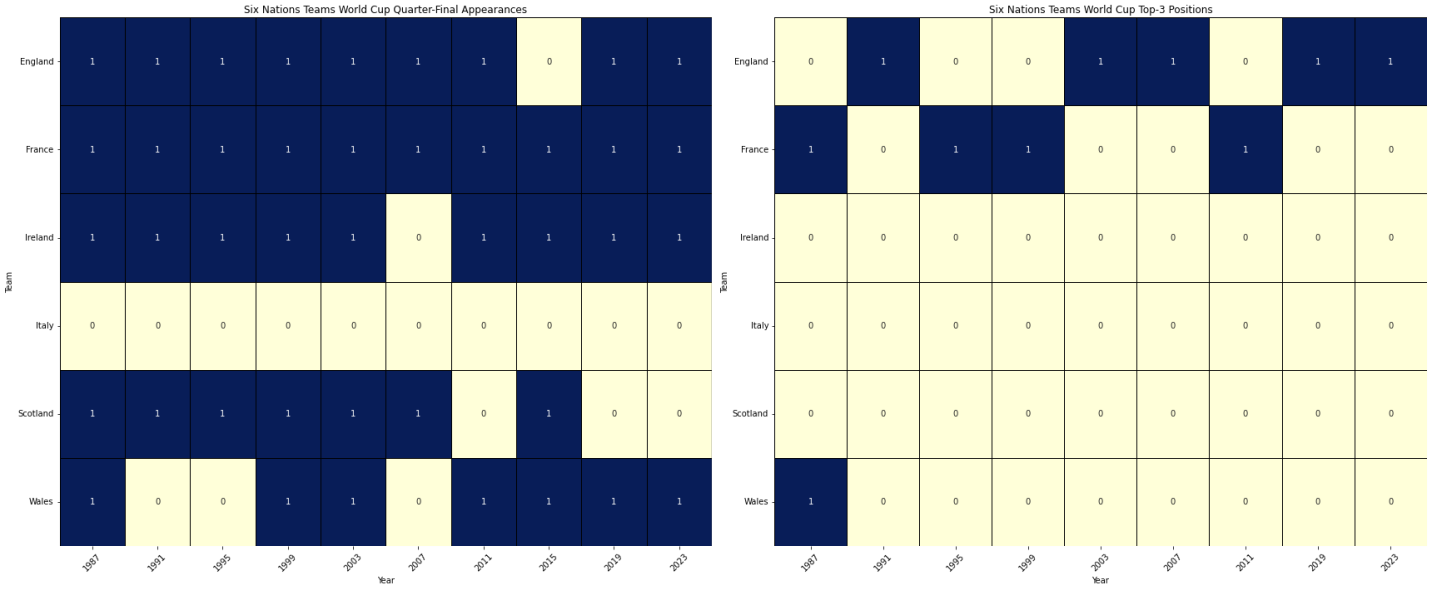
In [647]:

```
#Create the heatmap
plt.figure(figsize=(12, 8))
sns.heatmap(heatmap_data_top3, cmap='YlGnBu', annot=True, fmt='d', linewidths=0.5, lineco
lor='black')
plt.title('Six Nations Teams World Cup Top-3 Positions')
plt.xlabel('Year')
plt.ylabel('Team')
plt.xticks(rotation=45)
plt.yticks(rotation=0)
plt.tight_layout()
plt.show()
```



In [648]:

```
#Sort the indices of the DataFrame
heatmap_data_quarters = heatmap_data_quarters.sort_index()
heatmap_data_top3 = heatmap_data_top3.sort_index()

#Combine plots into one frame
fig, axes = plt.subplots(nrows=1, ncols=2, figsize=(24, 10))  # Adjust figsize as needed

#World Cup Quarter-Final Appearances
sns.heatmap(heatmap_data_quarters, cmap='YlGnBu', annot=True, fmt='d', linewidths=0.5, li
necolor='black', ax=axes[0], cbar=False)
axes[0].set_title('Six Nations Teams World Cup Quarter-Final Appearances')
axes[0].set_xlabel('Year')
axes[0].set_ylabel('Team')
axes[0].set_xticklabels(axes[0].get_xticklabels(), rotation=45)
axes[0].set_yticklabels(axes[0].get_yticklabels(), rotation=0)

#World Cup Top-3 Appearances
sns.heatmap(heatmap_data_top3, cmap='YlGnBu', annot=True, fmt='d', linewidths=0.5, lineco
lor='black', ax=axes[1], cbar=False)
axes[1].set_title('Six Nations Teams World Cup Top-3 Positions')
axes[1].set_xlabel('Year')
axes[1].set_ylabel('Team')
axes[1].set_xticklabels(axes[1].get_xticklabels(), rotation=45)
axes[1].set_yticklabels(axes[1].get_yticklabels(), rotation=0)

plt.tight_layout()
plt.show()

print (heatmap_data_top3)
```



Year	1987	1991	1995	1999	2003	2007	2011	2019	2023
Country									
England	0	1	0	0	1	1	0	1	1
France	1	0	1	1	0	0	1	0	0
Ireland	0	0	0	0	0	0	0	0	0
Italy	0	0	0	0	0	0	0	0	0
Scotland	0	0	0	0	0	0	0	0	0
Wales	1	0	0	0	0	0	0	0	0

Correlation between Six Nations performance and reaching World Cup Quarterfinals

In [649]:

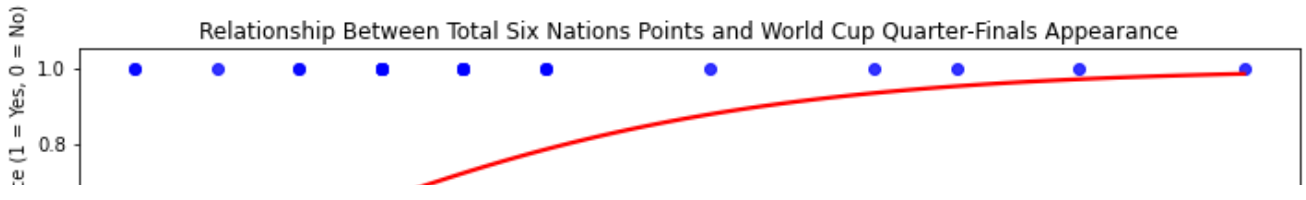
```
#Reshape and Clean Data
heatmap_data_long = heatmap_data_quarters.reset_index().melt(id_vars='Country', var_name
='Year', value_name='QuarterFinalist')
heatmap_data_long['Year'] = heatmap_data_long['Year'].astype(int)
```

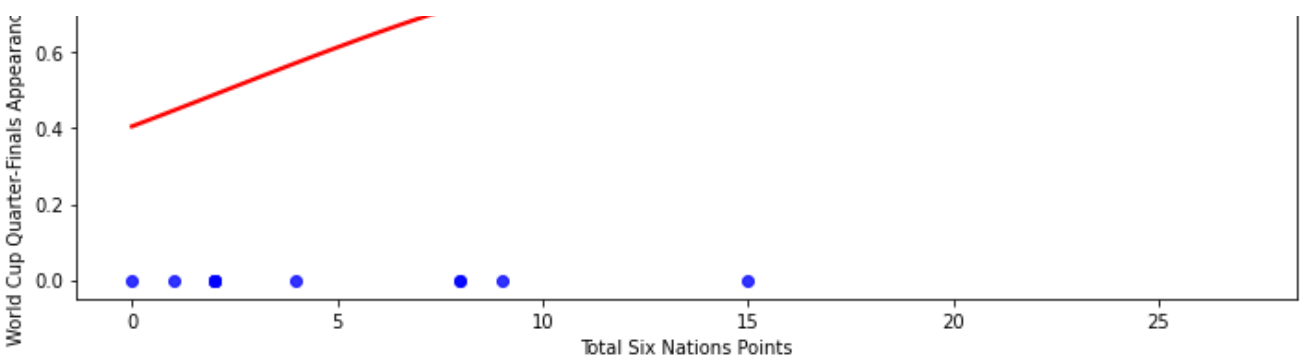
```
#Rename columns for clarity and consistency
heatmap_data_long.rename(columns={'Country': 'Team'}, inplace=True)

#Clean six_nations_data
six_nations_data['Year'] = six_nations_data['Year'].astype(int)
six_nations_data['Points'] = pd.to_numeric(six_nations_data['Points'])
six_nations_data['Points Scored'] = pd.to_numeric(six_nations_data['Points Scored'])
six_nations_data['Points Conceded'] = pd.to_numeric(six_nations_data['Points Conceded'])

merged_data = pd.merge(six_nations_data, heatmap_data_long, on=['Year', 'Team'])

#Calculate the correlations
correlation_points = merged_data['Points'].corr(merged_data['QuarterFinalist'])
correlation_points_scored = merged_data['Points Scored'].corr(merged_data['QuarterFinalis
t'])
correlation_points_conceded = merged_data['Points Conceded'].corr(merged_data['QuarterFi
nalist'])

print(f"The correlation between Six Nations total points and reaching the World Cup quart
er-finals is: {correlation_points:.3f}")
print(f"The correlation between Six Nations points scored and reaching the World Cup quar
ter-finals is: {correlation_points_scored:.3f}")
print(f"The correlation between Six Nations points conceded and reaching the World Cup qu
arter-finals is: {correlation_points_conceded:.3f}")
```

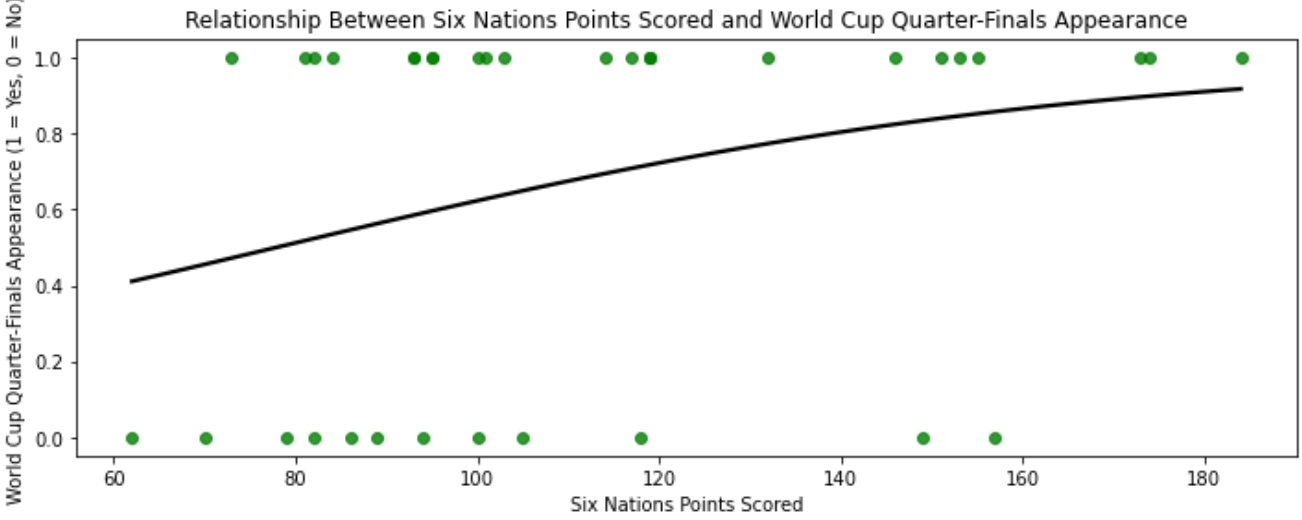
```
The correlation between Six Nations total points and reaching the World Cup quarter-final
s is: 0.334
The correlation between Six Nations points scored and reaching the World Cup quarter-fina
ls is: 0.291
The correlation between Six Nations points conceded and reaching the World Cup quarter-fi
nals is: -0.427
```

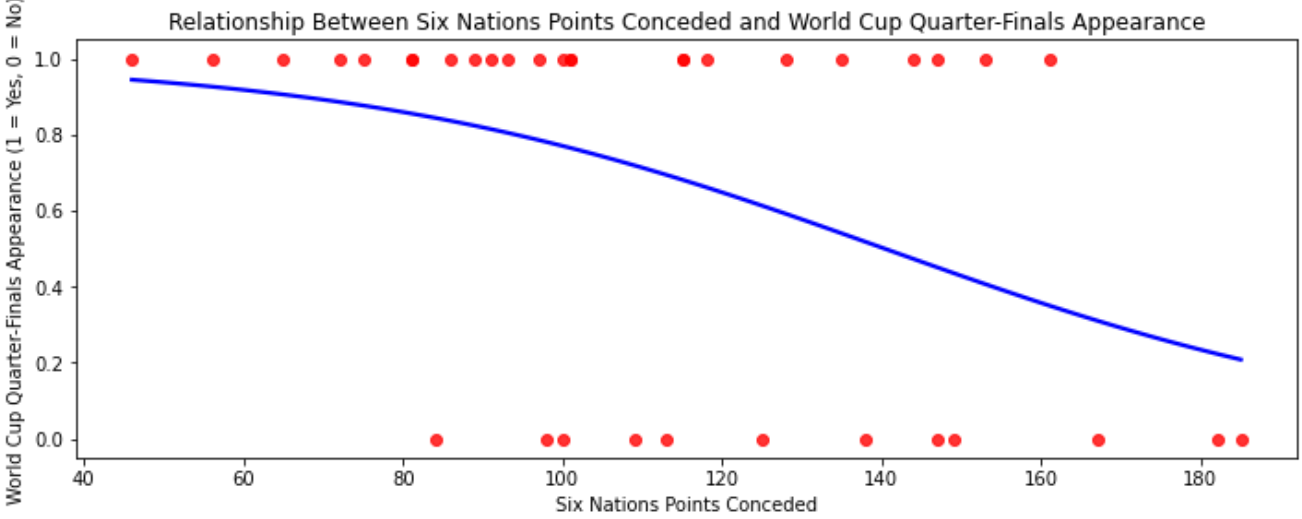
In [650]:

```
plt.figure(figsize=(10, 12))

#Subplot 1: Total Points
plt.subplot(3, 1, 1)  # 3 rows, 1 column, 1st subplot
sns.regplot(x='Points', y='QuarterFinalist', data=merged_data, logistic=True, ci=None, s
catter_kws={'color': 'blue'}, line_kws={'color': 'red'})
plt.title('Relationship Between Total Six Nations Points and World Cup Quarter-Finals App
earance')
plt.xlabel('Total Six Nations Points')
plt.ylabel('World Cup Quarter-Finals Appearance (1 = Yes, 0 = No)')

#Subplot 2: Points Scored
plt.subplot(3, 1, 2)  # 3 rows, 1 column, 2nd subplot
sns.regplot(x='Points Scored', y='QuarterFinalist', data=merged_data, logistic=True, ci=
None, scatter_kws={'color': 'green'}, line_kws={'color': 'black'})
plt.title('Relationship Between Six Nations Points Scored and World Cup Quarter-Finals Ap
pearance')
plt.xlabel('Six Nations Points Scored')
plt.ylabel('World Cup Quarter-Finals Appearance (1 = Yes, 0 = No)')

#Subplot 3: Points Conceded
plt.subplot(3, 1, 3)  # 3 rows, 1 column, 3rd subplot
sns.regplot(x='Points Conceded', y='QuarterFinalist', data=merged_data, logistic=True, c
i=None, scatter_kws={'color': 'red'}, line_kws={'color': 'blue'})
plt.title('Relationship Between Six Nations Points Conceded and World Cup Quarter-Finals
Appearance')
plt.xlabel('Six Nations Points Conceded')
plt.ylabel('World Cup Quarter-Finals Appearance (1 = Yes, 0 = No)')

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









In [651]:

```
import statsmodels.api as sm

#Add a constant to the independent variable
merged_data['intercept'] = 1.0

#Total Points Model
logit_model_points = sm.Logit(merged_data['QuarterFinalist'], merged_data[['intercept',
'Points']])
result_points = logit_model_points.fit()
print("Model Summary for Total Points:")
print(result_points.summary())

#Points Scored Model
logit_model_points_scored = sm.Logit(merged_data['QuarterFinalist'], merged_data[['inter
cept', 'Points Scored']])
result_points_scored = logit_model_points_scored.fit()
print("\nModel Summary for Points Scored:")
print(result_points_scored.summary())

#Points Conceded Model
logit_model_points_conceded = sm.Logit(merged_data['QuarterFinalist'], merged_data[['int
ercept', 'Points Conceded']])
result_points_conceded = logit_model_points_conceded.fit()
```

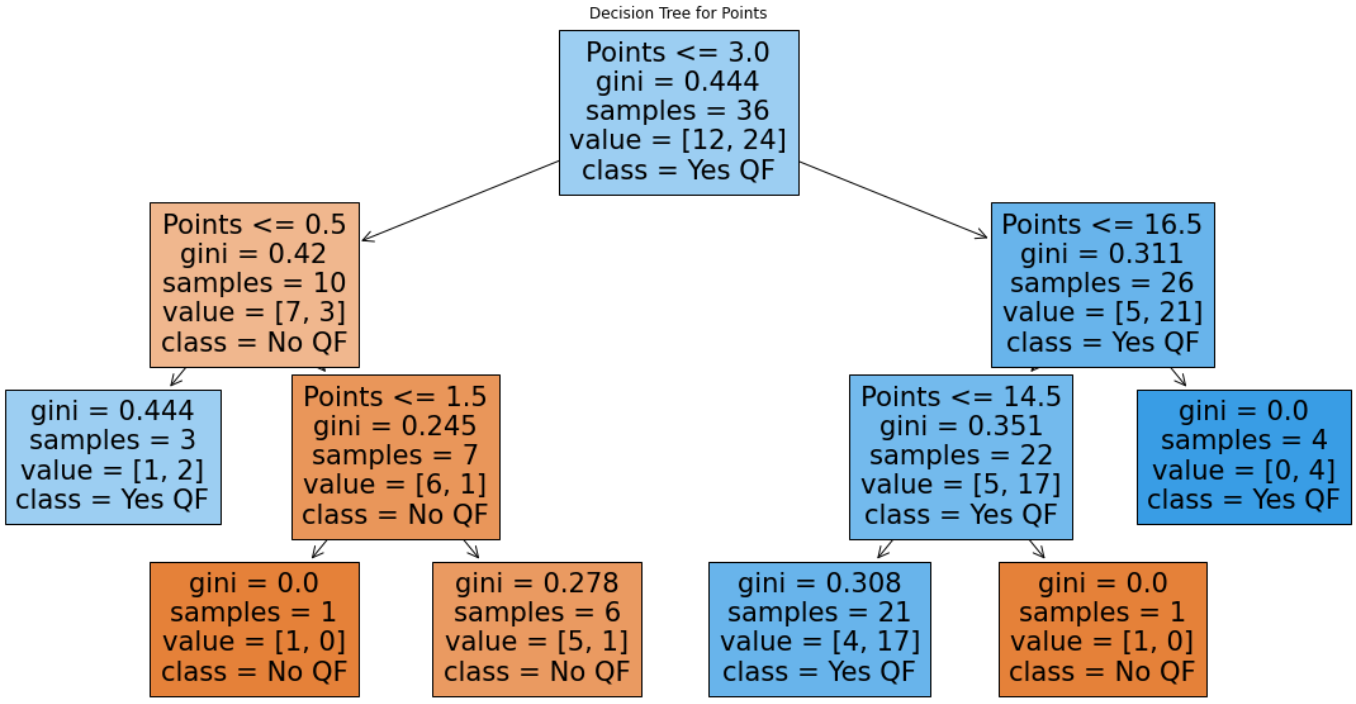
```
print("\nModel Summary for Points Conceded:")
print(result_points_conceded.summary())
```

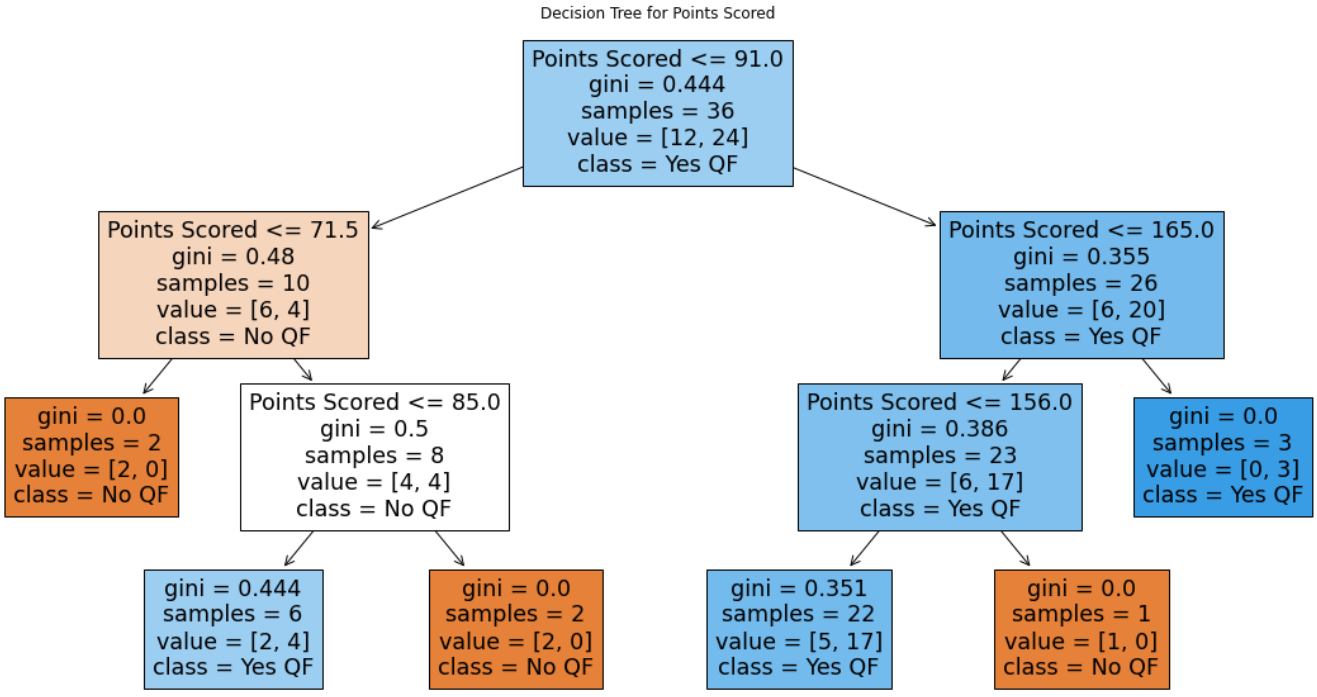
```
Optimization terminated successfully.
         Current function value: 0.566361
         Iterations 6
Model Summary for Total Points:
                           Logit Regression Results
==============================================================================
Dep. Variable:        QuarterFinalist   No. Observations:                   36
Model:                          Logit   Df Residuals:                       34
Method:                           MLE   Df Model:                            1
Date:                Mon, 06 May 2024   Pseudo R-squ.:                  0.1102
Time:                        15:26:56   Log-Likelihood:                -20.389
converged:                       True   LL-Null:                       -22.915
Covariance Type:            nonrobust   LLR p-value:                   0.02461
==============================================================================
                 coef    std err          z      P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
intercept     -0.3878      0.626     -0.619      0.536      -1.615       0.840
Points         0.1688      0.091      1.846      0.065      -0.010       0.348
==============================================================================
Optimization terminated successfully.
         Current function value: 0.590113
         Iterations 6

Model Summary for Points Scored:
                           Logit Regression Results
==============================================================================
Dep. Variable:        QuarterFinalist   No. Observations:                   36
Model:                          Logit   Df Residuals:                       34
Method:                           MLE   Df Model:                            1
Date:                Mon, 06 May 2024   Pseudo R-squ.:                 0.07290
Time:                        15:26:57   Log-Likelihood:                -21.244
converged:                       True   LL-Null:                       -22.915
Covariance Type:            nonrobust   LLR p-value:                   0.06758
==============================================================================
                    coef    std err          z      P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
intercept        -1.7650      1.465     -1.205      0.228      -4.636       1.106
Points Scored     0.0227      0.014      1.668      0.095      -0.004       0.049
==============================================================================
Optimization terminated successfully.
         Current function value: 0.540494
         Iterations 6

Model Summary for Points Conceded:
                           Logit Regression Results
==============================================================================
Dep. Variable:        QuarterFinalist   No. Observations:                   36
Model:                          Logit   Df Residuals:                       34
Method:                           MLE   Df Model:                            1
Date:                Mon, 06 May 2024   Pseudo R-squ.:                  0.1509
Time:                        15:26:57   Log-Likelihood:                -19.458
converged:                       True   LL-Null:                       -22.915
Covariance Type:            nonrobust   LLR p-value:                  0.008555
==============================================================================
                    coef    std err          z      P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
intercept          4.2012      1.579      2.660      0.008       1.106       7.297
Points Conceded   -0.0299      0.013     -2.360      0.018      -0.055      -0.005
==============================================================================
```

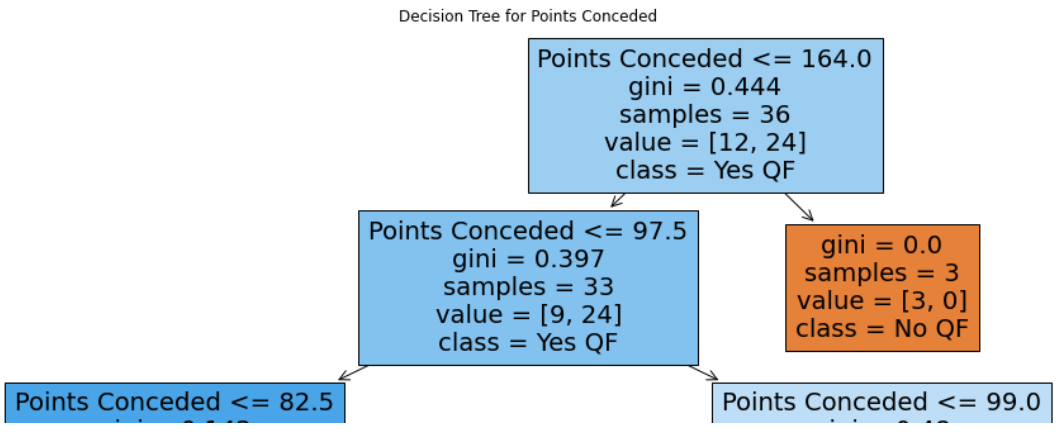
In [652]:

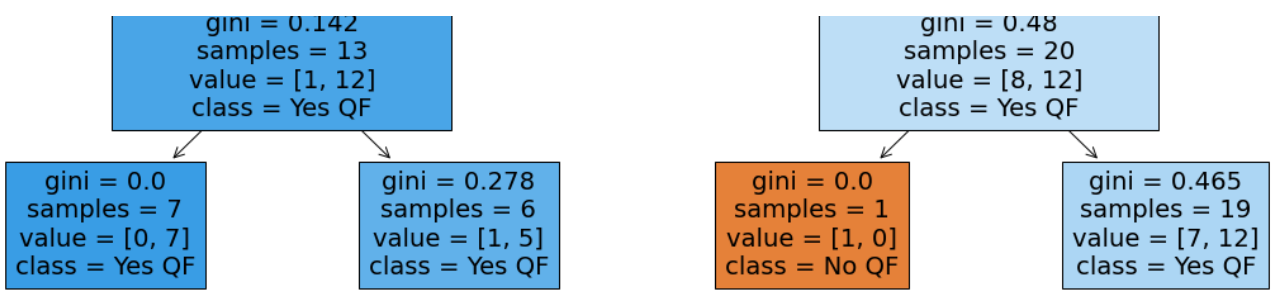
```
from sklearn.tree import DecisionTreeClassifier, plot_tree

features = ['Points', 'Points Scored', 'Points Conceded']
feature_names = [['Points'], ['Points Scored'], ['Points Conceded']]
class_names = ['No QF', 'Yes QF']

#Iterate through each feature and build a separate model
```

```
for feature, name in zip(features, feature_names):
    tree_model = DecisionTreeClassifier(max_depth=3)
    tree_model.fit(merged_data[name], merged_data['QuarterFinalist'])

    #Plot the decision tree
    plt.figure(figsize=(20,10))
    plot_tree(tree_model, filled=True, feature_names=name, class_names=class_names)
    plt.title(f"Decision Tree for {name[0]}")
    plt.show()
```



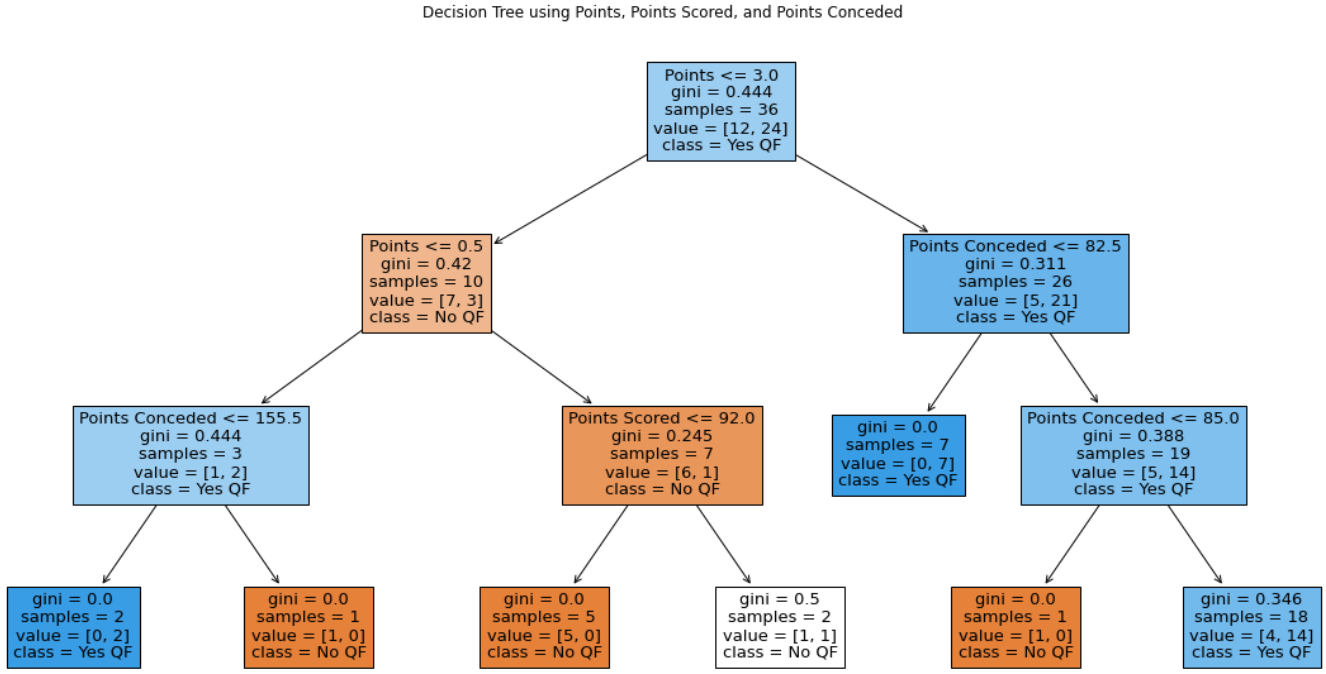






In [653]:

```
#Create and fit the model using all features
combined_tree_model = DecisionTreeClassifier(max_depth=3)
combined_tree_model.fit(merged_data[features], merged_data['QuarterFinalist'])

#Plot the decision tree for the combined model
plt.figure(figsize=(20,10))
plot_tree(combined_tree_model, filled=True, feature_names=features, class_names=class_nam
es)
plt.title("Decision Tree using Points, Points Scored, and Points Conceded")
plt.show()
```



Average performances in Six Nations to reach World Cup Quarterfinals and Top 3

In [684]:

```
#Average Total Points
#Reshape world_cup_data to have a single 'Country' column for teams in top 3
top3_teams = world_cup_data.melt(id_vars='Year', value_vars=['Champion', 'Runner-up', 'Th
ird'], var_name='Position', value_name='Team')

#Clean data
six_nations_data['Team'] = six_nations_data['Team'].str.strip()
top3_teams['Team'] = top3_teams['Team'].str.strip()
world_cup_quarterfinalists['Country'] = world_cup_quarterfinalists['Country'].str.strip()


#Make merged dataframes
top3_merge = pd.merge(six_nations_data, top3_teams, on=['Year', 'Team'])
quarterfinals_merge = pd.merge(six_nations_data, world_cup_quarterfinalists, left_on=['Y
ear', 'Team'], right_on=['Year', 'Country'])

#Calculate averages
average_points_top3 = top3_merge['Points'].mean()
```

```
average_points_quarterfinals = quarterfinals_merge['Points'].mean()
print(f"Average Six Nations points for top 3 positions in the World Cup: {average_points_
top3}")
print(f"Average Six Nations points for World Cup quarterfinals qualification: {average_po
ints_quarterfinals}")
```

```
Average Six Nations points for top 3 positions in the World Cup: 10.0
Average Six Nations points for World Cup quarterfinals qualification: 9.083333333333334
```

In [688]:

```
#Average Points Scored
#Calculate averages
average_points_scored_top3 = top3_merge['Points Scored'].mean()
average_points_scored_quarterfinals = quarterfinals_merge['Points Scored'].mean()

print(f"Average Six Nations points for top 3 positions in the World Cup: {average_points_
scored_top3}")
print(f"Average Six Nations points for World Cup quarterfinals qualification: {average_po
ints_scored_quarterfinals}")
```

```
Average Six Nations points for top 3 positions in the World Cup: 138.6
Average Six Nations points for World Cup quarterfinals qualification: 119.0
```

Correlation between Six Nations Winner and reaching World Cup Top 3

In [689]:

```
#Find the winners from each six nations
six_nations_data['Rank'] = six_nations_data['Rank'].str.strip()  # Clean any whitespace
six_nations_winners = six_nations_data[six_nations_data['Rank'] == '1.']
print(six_nations_winners)
```

```
     Year Rank     Team  Points  Points Scored  Points Conceded  \
0    2024   1.  Ireland      20            144               60
6    2023   1.  Ireland      27            151               72
12   2022   1.   France      25            141               73
18   2021   1.    Wales      20            164              103
24   2020   1.  England      18            121               77
30   2019   1.    Wales      23            114               65
36   2018   1.  Ireland      23            160               82
42   2017   1.  England      19            146               81
48   2016   1.  England      10            132               70
54   2015   1.  Ireland       8            119               56
60   2014   1.  Ireland       8            132               49
66   2013   1.    Wales       8            122               66
72   2012   1.    Wales      10            109               58
78   2011   1.  England       8            132               81
84   2010   1.   France      10            135               69
90   2009   1.  Ireland      10            121               73
96   2008   1.    Wales      10            148               66
102  2007   1.   France       8            155               86
108  2006   1.   France       8            148               85
114  2005   1.    Wales      10            151               77
120  2004   1.   France      10            144               60
126  2003   1.  England      10            173               46
132  2002   1.   France      10            156               75
138  2001   1.  England       8            229               80
144  2000   1.  England       8            183               70

     Points Difference
0                   84
6                   79
12                  68
18                  61
24                  44
30                  49
36                  78
42                  65
48                  62
54                  63
```

```
60                  83
66                  56
72                  51
78                  51
84                  66
90                  48
96                  82
102                 69
108                 63
114                 74
120                 84
126                127
132                 81
138                149
144                113
```

In [692]:

```
#Merge Six Nations winners with World Cup top 3 data
winners_top3_merge = pd.merge(six_nations_winners, top3_teams, left_on=['Year', 'Team'],
right_on=['Year', 'Team'])

#Create a binary column indicating if the Six Nations winner was in the top 3 of the Worl
d Cup
winners_top3_merge['Top_3_Finish'] = 1

print(winners_top3_merge)
```

```
   Year Rank     Team  Points  Points Scored  Points Conceded  \
0  2003   1.  England      10            173               46

   Points Difference  Top_3_Finish  Position
0                127             1  Champion
```

In [707]:

```
#Correlation Calculations
#Ensure 'six_nations_winners' is independent
six_nations_winners = six_nations_data[six_nations_data['Rank'].str.strip() == '1.'].cop
y()

#To remove the copy of a slice error
six_nations_winners.loc[:, 'Top_3_Finish'] = six_nations_winners.apply(
    lambda row: 1 if (row['Year'], row['Team']) in list(zip(winners_top3_merge['Year'],
winners_top3_merge['Team'])) else 0,
    axis=1
)

#Correlation calc
from scipy.stats import pearsonr
correlation, p_value = pearsonr(six_nations_winners['Points'], six_nations_winners['Top_3
_Finish'])
print("Correlation coefficient:", correlation)
print("P-value:", p_value)
```

```
Correlation coefficient: -0.10305766184139871
P-value: 0.6239809121574545
```

In [710]:

```
import statsmodels.api as sm

six_nations_winners['Non_Top_3_Finish'] = six_nations_winners['Top_3_Finish'].apply(lambd
a x: 1 if x == 0 else 0)

#Add an intercept term
six_nations_winners['intercept'] = 1

#Logistic regression model
logit_model = sm.Logit(six_nations_winners['Non_Top_3_Finish'], six_nations_winners[['int
ercept', 'Points']])
```

```
result = logit_model.fit()

print(result.summary())
```

```
Optimization terminated successfully.
         Current function value: 0.161135
         Iterations 9
                           Logit Regression Results
==============================================================================
Dep. Variable:       Non_Top_3_Finish   No. Observations:                   25
Model:                          Logit   Df Residuals:                       23
Method:                           MLE   Df Model:                            1
Date:                Mon, 06 May 2024   Pseudo R-squ.:                0.04054
Time:                        21:15:59   Log-Likelihood:                -4.0284
converged:                       True   LL-Null:                       -4.1986
Covariance Type:            nonrobust   LLR p-value:                    0.5596
==============================================================================
                 coef    std err          z      P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
intercept      1.6967      2.986      0.568      0.570      -4.155       7.548
Points         0.1305      0.279      0.468      0.640      -0.416       0.677
==============================================================================
```

In [ ]: