EXPLORATORY DATA ANALYSIS

Name: Rudrani Ghosh

In [375]:

```
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import warnings
warnings.filterwarnings('ignore')

data = pd.read_csv("/Users/rudranighosh/Downloads/Healthcare Providers.csv")
data.head()
```

Out[375]:

	index	National Provider Identifier	Last Name/Organization Name of the Provider	First Name of the Provider	Middle Initial of the Provider	Credentials of the Provider	Gender of the Provider	Entity Type of the Provider	Street Address 1 of the Provider	Street Address 2 of the Provider	...	HCPCS Code
0	8774979	1891106191	UPADHYAYULA	SATYASREE	NaN	M.D.	F	I	1402 S GRAND BLVD	FDT 14TH FLOOR	...	99223
1	3354385	1346202256	JONES	WENDY	P	M.D.	F	I	2950 VILLAGE DR	NaN	...	G0202
2	3001884	1306820956	DUROCHER	RICHARD	W	DPM	M	I	20 WASHINGTON AVE	STE 212	...	99348
3	7594822	1770523540	FULLARD	JASPER	NaN	MD	M	I	5746 N BROADWAY ST	NaN	...	81002
4	746159	1073627758	PERROTTI	ANTHONY	E	DO	M	I	875 MILITARY TRL	SUITE 200	...	96372

5 rows × 27 columns

In [376]:

```
# Descriptive statistics
data.describe()
```

Out[376]:

	index	National Provider Identifier	Zip Code of the Provider
count	1.000000e+05	1.000000e+05	1.000000e+05
mean	4.907646e+06	1.498227e+09	4.163820e+08
std	2.839633e+06	2.874125e+08	3.082566e+08
min	2.090000e+02	1.003001e+09	6.010000e+02
25%	2.458791e+06	1.245669e+09	1.426300e+08
50%	4.901266e+06	1.497847e+09	3.633025e+08
75%	7.349450e+06	1.740374e+09	6.819881e+08
max	9.847440e+06	1.993000e+09	9.990166e+08

In [377]:

```
# information about the dataset
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 100000 entries, 0 to 99999
Data columns (total 27 columns):
 #   Column                                                    Non-Null Count   Dtype  
---  ------                                                    --------------   -----  
 0   index                                                     100000 non-null  int64  
 1   National Provider Identifier                              100000 non-null  int64  
 2   Last Name/Organization Name of the Provider               100000 non-null  object 
 3   First Name of the Provider                                95745 non-null   object 
 4   Middle Initial of the Provider                            70669 non-null   object 
 5   Credentials of the Provider                               92791 non-null   object 
 6   Gender of the Provider                                    95746 non-null   object 
 7   Entity Type of the Provider                               100000 non-null  object 
 8   Street Address 1 of the Provider                          100000 non-null  object 
 9   Street Address 2 of the Provider                          40637 non-null   object 
 10  City of the Provider                                      100000 non-null  object 
 11  Zip Code of the Provider                                  100000 non-null  float64
 12  State Code of the Provider                                100000 non-null  object 
 13  Country Code of the Provider                              100000 non-null  object 
 14  Provider Type                                             100000 non-null  object 
 15  Medicare Participation Indicator                          100000 non-null  object 
 16  Place of Service                                          100000 non-null  object 
 17  HCPCS Code                                                100000 non-null  object 
 18  HCPCS Description                                         100000 non-null  object 
 19  HCPCS Drug Indicator                                      100000 non-null  object 
 20  Number of Services                                        100000 non-null  object 
 21  Number of Medicare Beneficiaries                          100000 non-null  object 
 22  Number of Distinct Medicare Beneficiary/Per Day Services  100000 non-null  object 
 23  Average Medicare Allowed Amount                           100000 non-null  object 
 24  Average Submitted Charge Amount                           100000 non-null  object 
 25  Average Medicare Payment Amount                           100000 non-null  object 
 26  Average Medicare Standardized Amount                      100000 non-null  object 
dtypes: float64(1), int64(2), object(24)
memory usage: 20.6+ MB
```

Converting Object to Numeric Type

In [378]:

```
numeric_columns = [
    'Number of Services',
    'Number of Medicare Beneficiaries',
    'Number of Distinct Medicare Beneficiary/Per Day Services',
    'Average Medicare Allowed Amount',
    'Average Submitted Charge Amount',
    'Average Medicare Payment Amount',
    'Average Medicare Standardized Amount'
]

for column in numeric_columns:
    data[column] = pd.to_numeric(data[column], errors='coerce')


data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 100000 entries, 0 to 99999
Data columns (total 27 columns):
 #   Column                                                    Non-Null Count   Dtype
---  ------                                                    --------------   -----
 0   index                                                     100000 non-null  int64
 1   National Provider Identifier                              100000 non-null  int64
 2   Last Name/Organization Name of the Provider               100000 non-null  object
 3   First Name of the Provider                                95745 non-null   object
 4   Middle Initial of the Provider                            70669 non-null   object
 5   Credentials of the Provider                               92791 non-null   object
 6   Gender of the Provider                                    95746 non-null   object
 7   Entity Type of the Provider                               100000 non-null  object
 8   Street Address 1 of the Provider                          100000 non-null  object
 9   Street Address 2 of the Provider                          40637 non-null   object
 10  City of the Provider                                      100000 non-null  object
 11  Zip Code of the Provider                                  100000 non-null  float64
 12  State Code of the Provider                                100000 non-null  object
 13  Country Code of the Provider                              100000 non-null  object
 14  Provider Type                                             100000 non-null  object
 15  Medicare Participation Indicator                          100000 non-null  object
 16  Place of Service                                          100000 non-null  object
 17  HCPCS Code                                                100000 non-null  object
 18  HCPCS Description                                         100000 non-null  object
 19  HCPCS Drug Indicator                                      100000 non-null  object
 20  Number of Services                                        97347 non-null   float64
 21  Number of Medicare Beneficiaries                          99595 non-null   float64
 22  Number of Distinct Medicare Beneficiary/Per Day Services  98500 non-null   float64
 23  Average Medicare Allowed Amount                           99255 non-null   float64
 24  Average Submitted Charge Amount                           93277 non-null   float64
 25  Average Medicare Payment Amount                           99534 non-null   float64
 26  Average Medicare Standardized Amount                      99530 non-null   float64
dtypes: float64(8), int64(2), object(17)
memory usage: 20.6+ MB
```

Looking for Missing Values and imputing them with Mean

In [379]:

```python
# missing values
print(data.isnull().sum())
```

```
index                                                           0
National Provider Identifier                                    0
Last Name/Organization Name of the Provider                     0
First Name of the Provider                                   4255
Middle Initial of the Provider                              29331
Credentials of the Provider                                  7209
Gender of the Provider                                       4254
Entity Type of the Provider                                     0
Street Address 1 of the Provider                                0
Street Address 2 of the Provider                            59363
City of the Provider                                            0
Zip Code of the Provider                                        0
State Code of the Provider                                      0
Country Code of the Provider                                    0
Provider Type                                                   0
Medicare Participation Indicator                                0
Place of Service                                                0
HCPCS Code                                                      0
HCPCS Description                                               0
HCPCS Drug Indicator                                            0
Number of Services                                           2653
Number of Medicare Beneficiaries                              405
Number of Distinct Medicare Beneficiary/Per Day Services     1500
Average Medicare Allowed Amount                               745
Average Submitted Charge Amount                              6723
Average Medicare Payment Amount                               466
Average Medicare Standardized Amount                          470
dtype: int64
```

In [380]:

```python
# Imputation of missing values with mean
data[numeric_columns] = data[numeric_columns].fillna(data[numeric_columns].mean())

print(data.isnull().sum())
```

```
index                                                           0
National Provider Identifier                                    0
Last Name/Organization Name of the Provider                     0
First Name of the Provider                                   4255
Middle Initial of the Provider                              29331
Credentials of the Provider                                  7209
Gender of the Provider                                       4254
Entity Type of the Provider                                     0
Street Address 1 of the Provider                                0
Street Address 2 of the Provider                            59363
City of the Provider                                            0
Zip Code of the Provider                                        0
State Code of the Provider                                      0
Country Code of the Provider                                    0
Provider Type                                                   0
Medicare Participation Indicator                                0
Place of Service                                                0
HCPCS Code                                                      0
HCPCS Description                                               0
HCPCS Drug Indicator                                            0
Number of Services                                              0
Number of Medicare Beneficiaries                                0
Number of Distinct Medicare Beneficiary/Per Day Services        0
Average Medicare Allowed Amount                                 0
Average Submitted Charge Amount                                 0
Average Medicare Payment Amount                                 0
Average Medicare Standardized Amount                            0
dtype: int64
```

Looking for Duplicate Values

In [381]:

```python
# Check for duplicates
print(data.duplicated().sum())
```

```
0
```

Data Preprocessing

In [382]:

```python
# Merging the name columns into a single column
data['Full Name'] = data['First Name of the Provider'].fillna('') + ' ' + \
                    data['Middle Initial of the Provider'].fillna('') + ' ' + \
                    data['Last Name/Organization Name of the Provider'].fillna('')
data['Full Name'] = data['Full Name'].str.strip()

data = data.drop(columns=['Last Name/Organization Name of the Provider',
                          'First Name of the Provider',
                          'Middle Initial of the Provider'])

data.head()
```

Out[382]:

	index	National Provider Identifier	Credentials of the Provider	Gender of the Provider	Entity Type of the Provider	Street Address 1 of the Provider	Street Address 2 of the Provider	City of the Provider	Zip Code of the Provider	State Code of the Provider	...	HCPCS Description
0	8774979	1891106191	M.D.	F	I	1402 S GRAND BLVD	FDT 14TH FLOOR	SAINT LOUIS	631041004.0	MO	...	Initial hospita inpatient care typically 70 ..
1	3354385	1346202256	M.D.	F	I	2950 VILLAGE DR	NaN	FAYETTEVILLE	283043815.0	NC	...	Screening mammography bilateral (2- view study..
2	3001884	1306820956	DPM	M	I	20 WASHINGTON AVE	STE 212	NORTH HAVEN	64732343.0	CT	...	Establishec patient home visit, typically 25 m..
3	7594822	1770523540	MD	M	I	5746 N BROADWAY ST	NaN	KANSAS CITY	641183998.0	MO	...	Urinalysis manual tes
4	746159	1073627758	DO	M	I	875 MILITARY TRL	SUITE 200	JUPITER	334585700.0	FL	...	Injection beneath the skin or intc muscle for ..

5 rows × 25 columns

In [383]:

```python
# Merging the address columns
data['Full Address'] = data['Street Address 1 of the Provider'].fillna('') + ' ' + \
                       data['Street Address 2 of the Provider'].fillna('')
data['Full Address'] = data['Full Address'].str.strip()

data = data.drop(columns=['Street Address 1 of the Provider',
                          'Street Address 2 of the Provider'])

data.head()
```

Out[383]:

	index	National Provider Identifier	Credentials of the Provider	Gender of the Provider	Entity Type of the Provider	City of the Provider	Zip Code of the Provider	State Code of the Provider	Country Code of the Provider	Provider Type	...	HCPCS Drug Indicator	Numb Servic
0	8774979	1891106191	M.D.	F	I	SAINT LOUIS	631041004.0	MO	US	Internal Medicine	...	N	27
1	3354385	1346202256	M.D.	F	I	FAYETTEVILLE	283043815.0	NC	US	Obstetrics & Gynecology	...	N	175
2	3001884	1306820956	DPM	M	I	NORTH HAVEN	64732343.0	CT	US	Podiatry	...	N	32
3	7594822	1770523540	MD	M	I	KANSAS CITY	641183998.0	MO	US	Internal Medicine	...	N	20
4	746159	1073627758	DO	M	I	JUPITER	334585700.0	FL	US	Internal Medicine	...	N	33

5 rows × 24 columns

In [384]:
```python
# Standardize credentials
data['Credentials of the Provider'] = data['Credentials of the Provider'].str.replace(r'\.', '', rege

data.head()
```

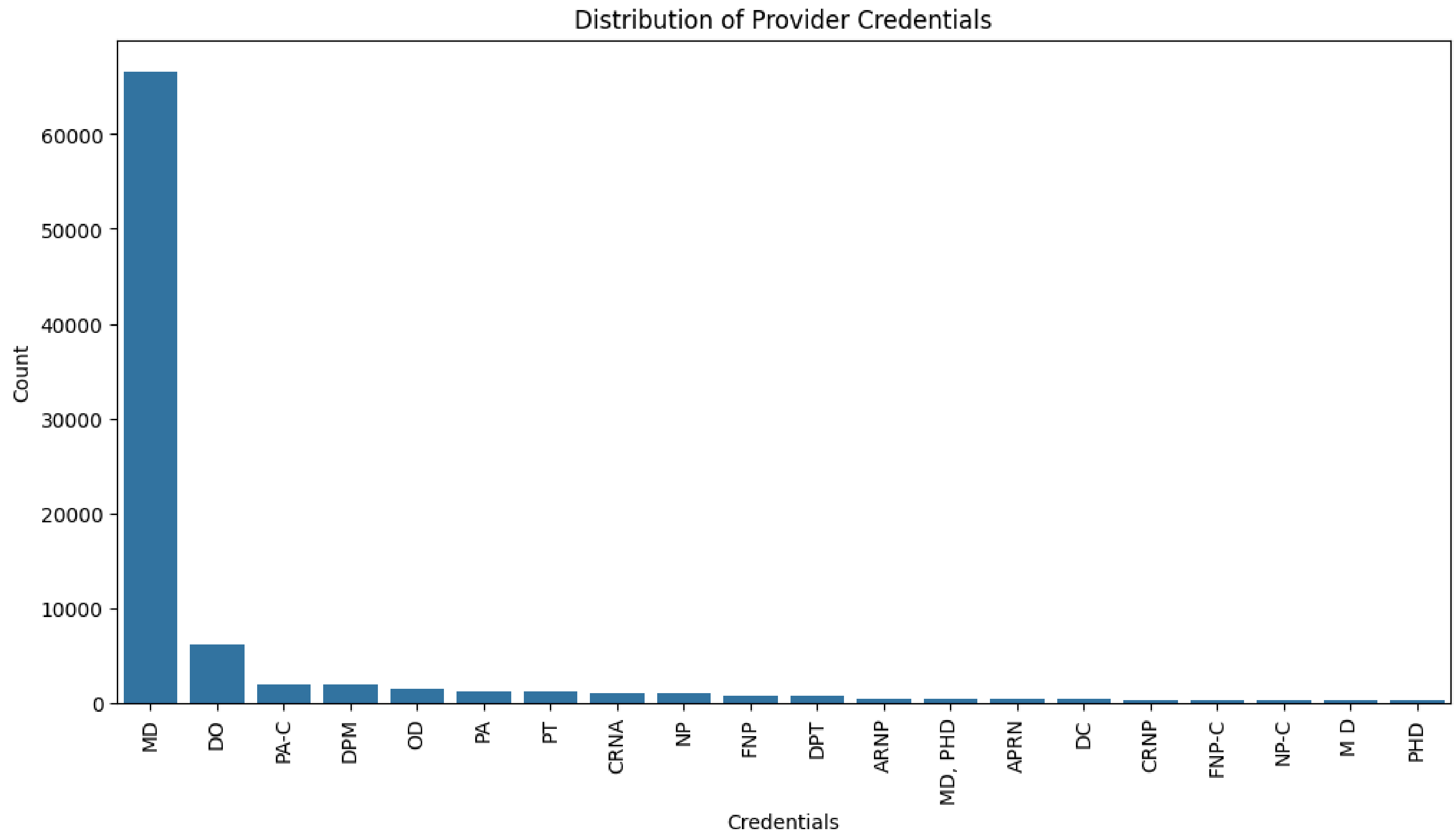
Out[384]:

	index	National Provider Identifier	Credentials of the Provider	Gender of the Provider	Entity Type of the Provider	City of the Provider	Zip Code of the Provider	State Code of the Provider	Country Code of the Provider	Provider Type	...	HCPCS Drug Indicator	Numb Servic
0	8774979	1891106191	MD	F	I	SAINT LOUIS	631041004.0	MO	US	Internal Medicine	...	N	27
1	3354385	1346202256	MD	F	I	FAYETTEVILLE	283043815.0	NC	US	Obstetrics & Gynecology	...	N	175
2	3001884	1306820956	DPM	M	I	NORTH HAVEN	64732343.0	CT	US	Podiatry	...	N	32
3	7594822	1770523540	MD	M	I	KANSAS CITY	641183998.0	MO	US	Internal Medicine	...	N	20
4	746159	1073627758	DO	M	I	JUPITER	334585700.0	FL	US	Internal Medicine	...	N	33

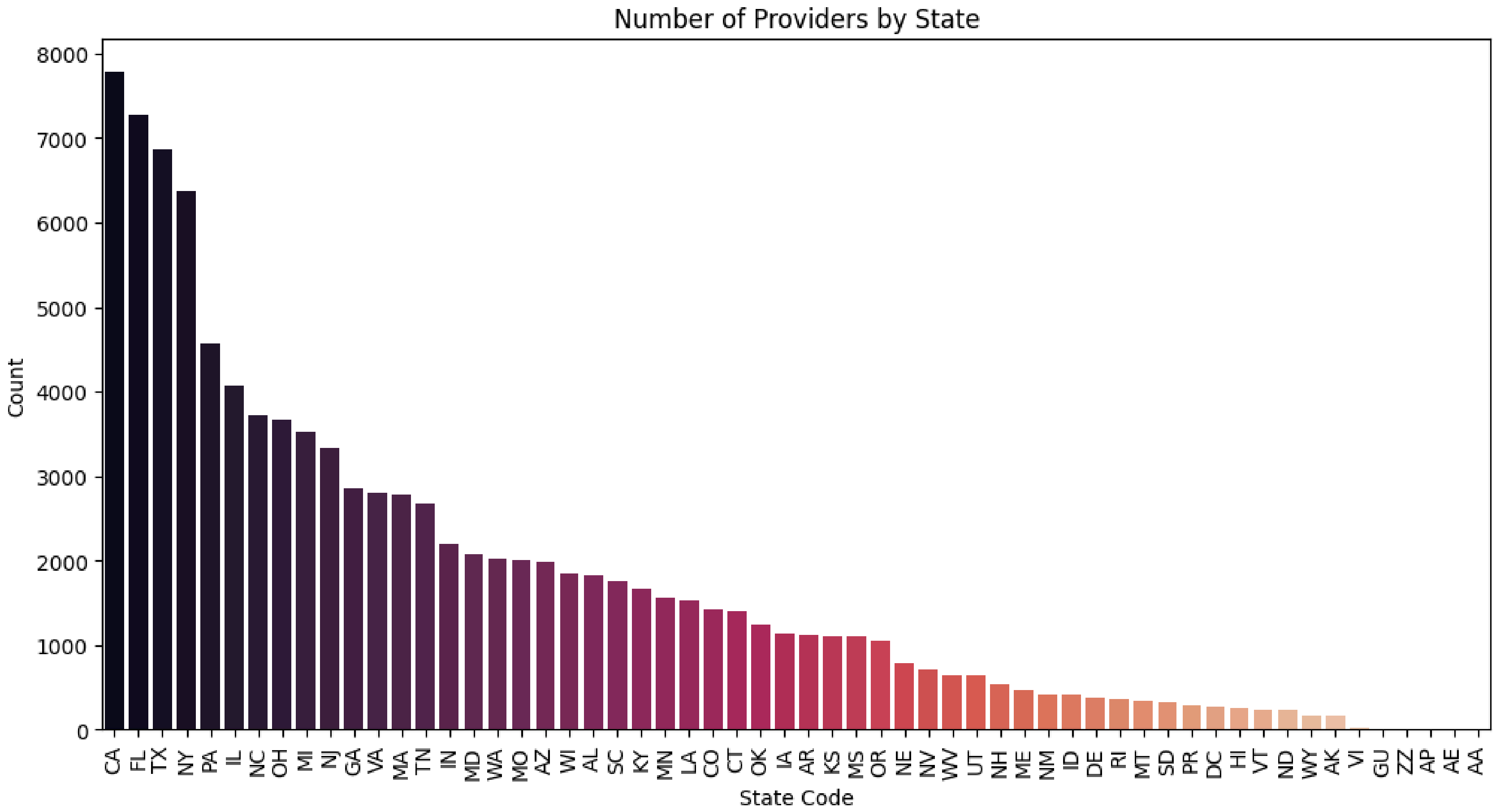
5 rows × 24 columns

GRAPHS:

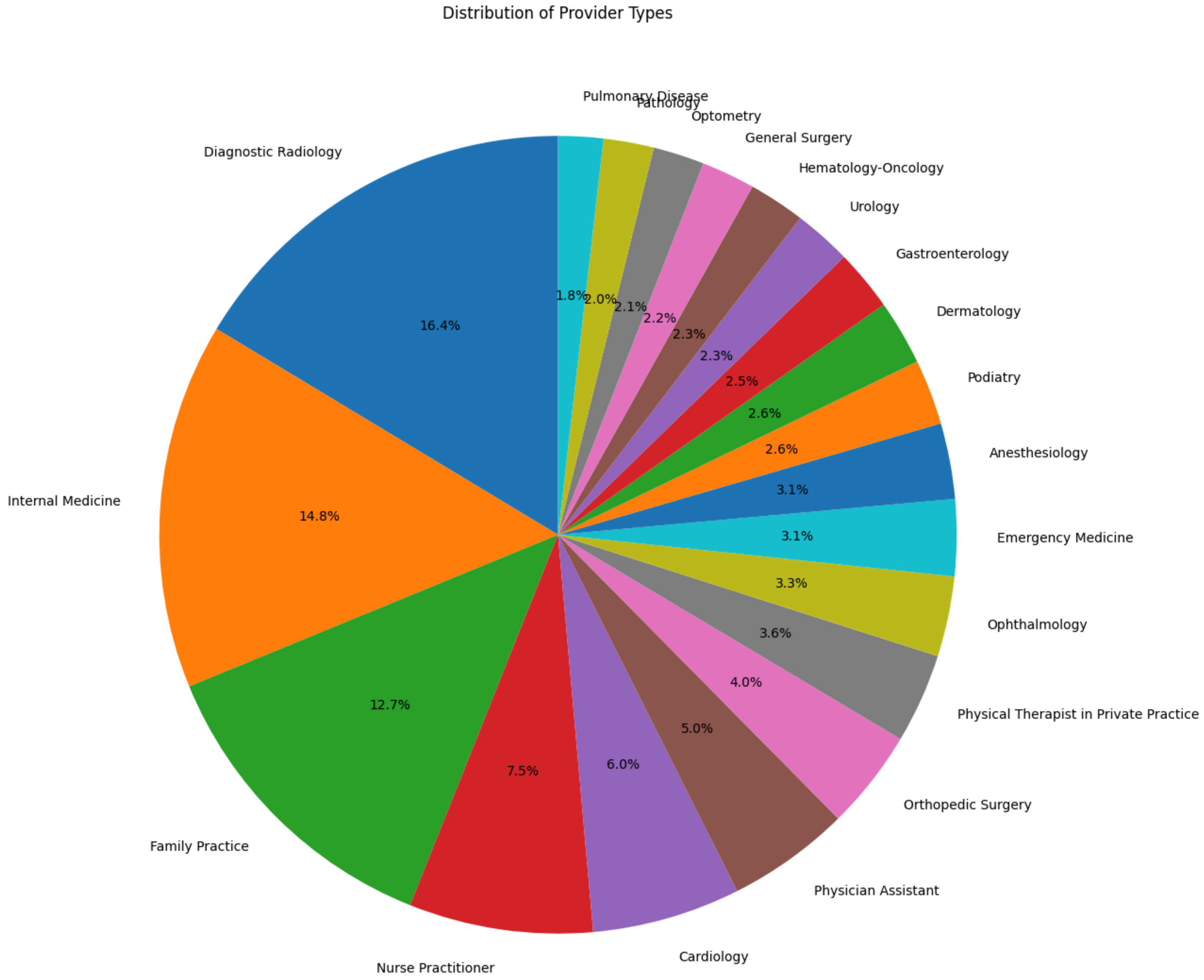
In [385]:
```python
# Plot bar plot for Credentials of the Provider
credentials_counts = data['Credentials of the Provider'].value_counts().head(20)

plt.figure(figsize=(12, 6))
sns.barplot(x=credentials_counts.index, y=credentials_counts.values)
plt.title('Distribution of Provider Credentials')
plt.xlabel('Credentials')
plt.ylabel('Count')
plt.xticks(rotation=90)
plt.show()
```



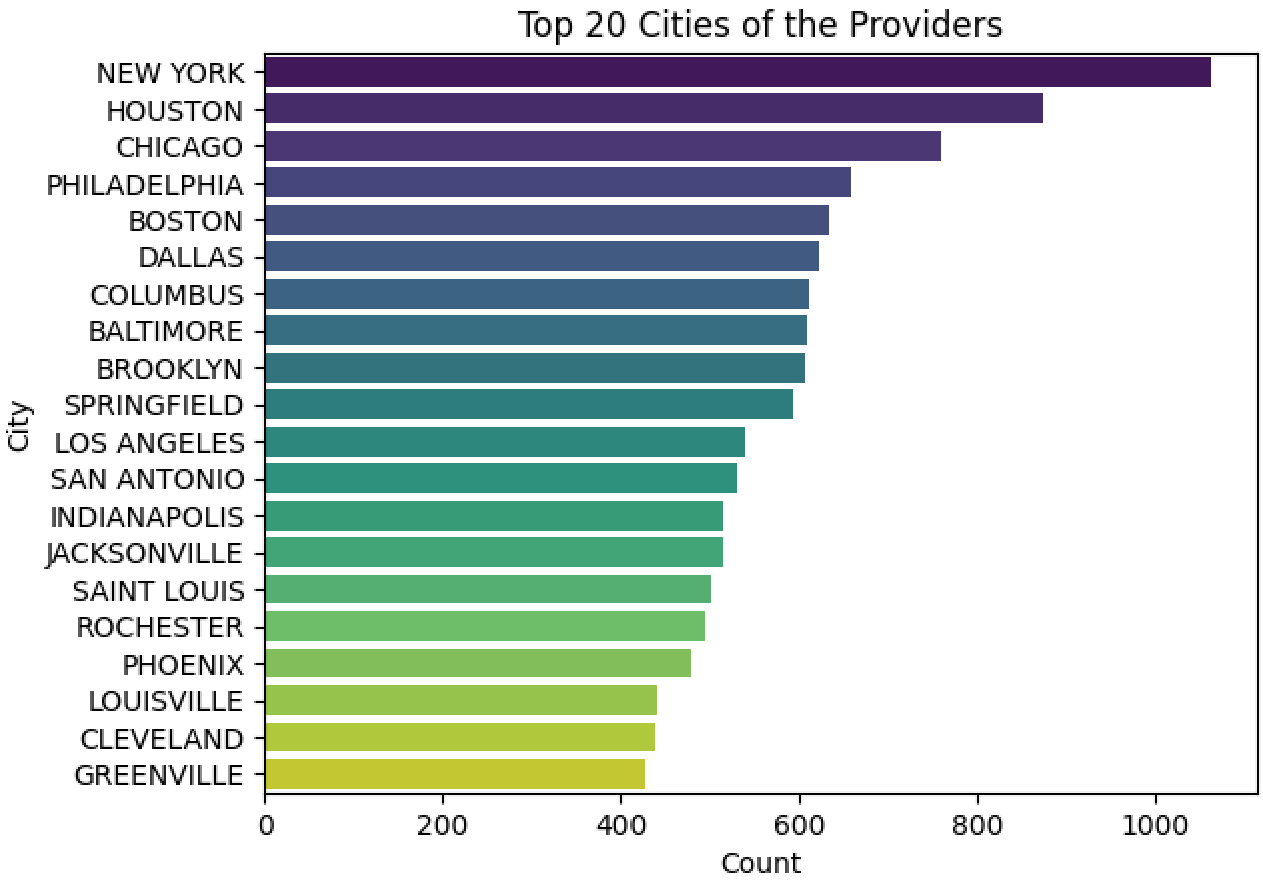
In [386]:
```
state_counts = data['State Code of the Provider'].value_counts()

# bar graph for State Code of the Provider
plt.figure(figsize=(12, 6))
sns.barplot(x=state_counts.index, y=state_counts.values, palette='rocket')
plt.title('Number of Providers by State')
plt.xlabel('State Code')
plt.ylabel('Count')
plt.xticks(rotation=90)
plt.show()
```



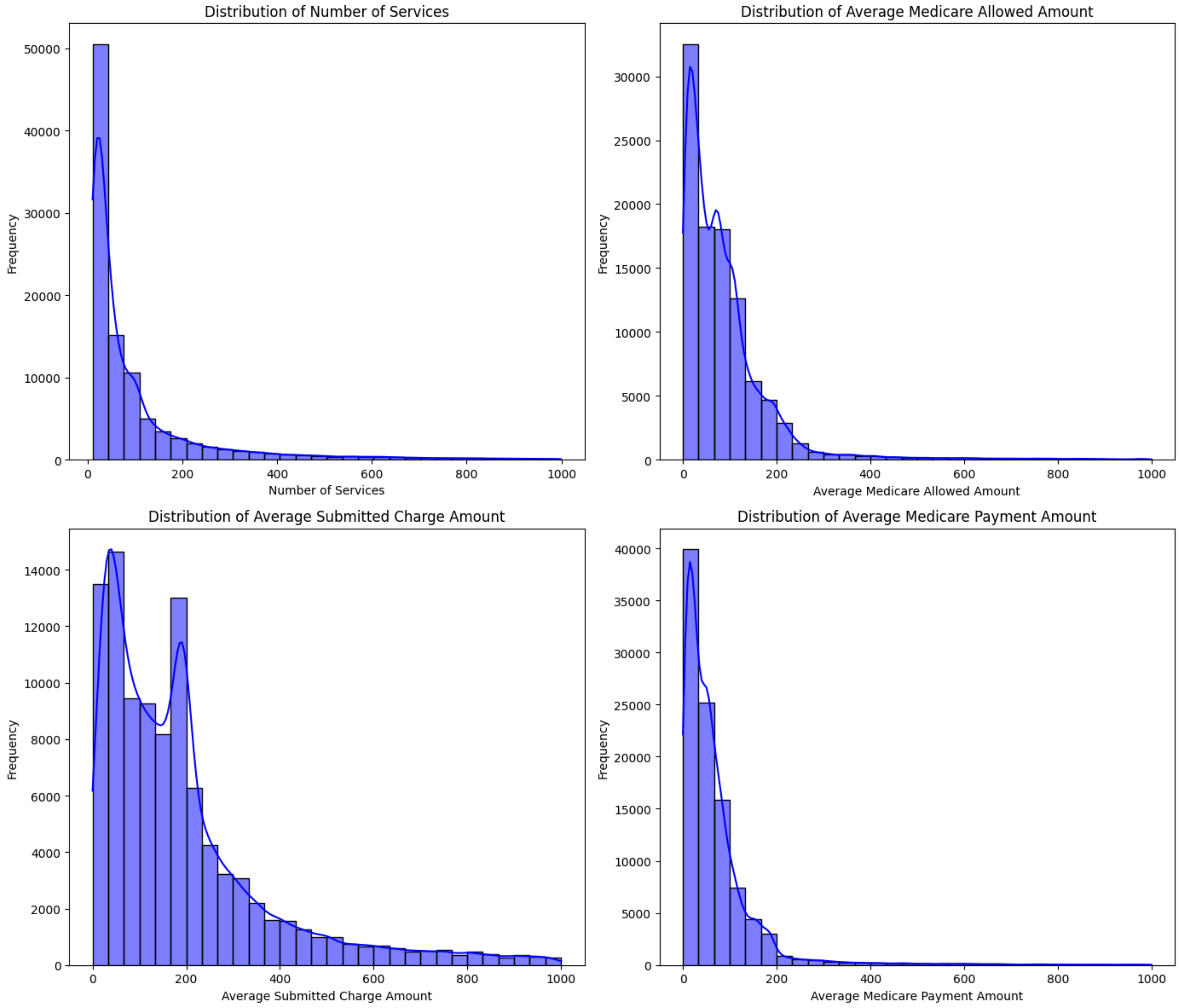
```
In [387]: provider_type_counts = data['Provider Type'].value_counts().head(20)

          # pie chart for Provider Types
          plt.figure(figsize=(12, 14))
          plt.pie(provider_type_counts, labels=provider_type_counts.index, autopct='%1.1f%%', startangle=90)
          plt.title('Distribution of Provider Types')
          plt.axis('equal')
          plt.show()
```



```
In [388]: # occurrences of each city
          city_counts = data['City of the Provider'].value_counts().head(20)

          # Plot of top 20 cities
          sns.barplot(x=city_counts.values, y=city_counts.index, palette='viridis')
          plt.title('Top 20 Cities of the Providers')
          plt.xlabel('Count')
          plt.ylabel('City')
          plt.show()
```

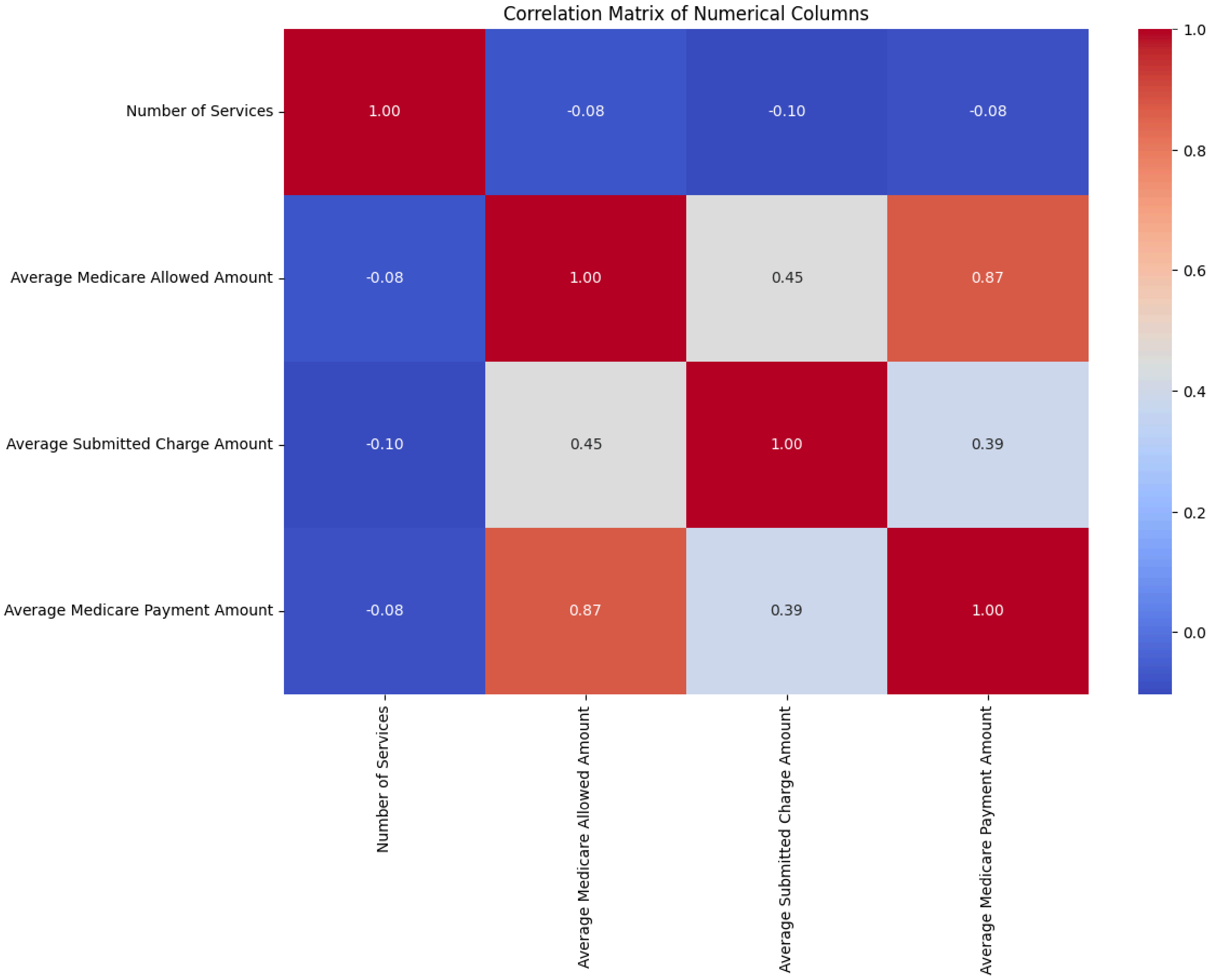


```
In [389]: numeric_columns = [
              'Number of Services',
              'Average Medicare Allowed Amount',
              'Average Submitted Charge Amount',
              'Average Medicare Payment Amount'
          ]

          for column in numeric_columns:
              data[column] = pd.to_numeric(data[column], errors='coerce')

          plt.figure(figsize=(14, 12))

          for i, column in enumerate(numeric_columns, 1):
              plt.subplot(2, 2, i)
              sns.histplot(data[column].dropna(), bins=30, kde=True, color='blue')
              plt.title(f'Distribution of {column}')
              plt.xlabel(column)
              plt.ylabel('Frequency')

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

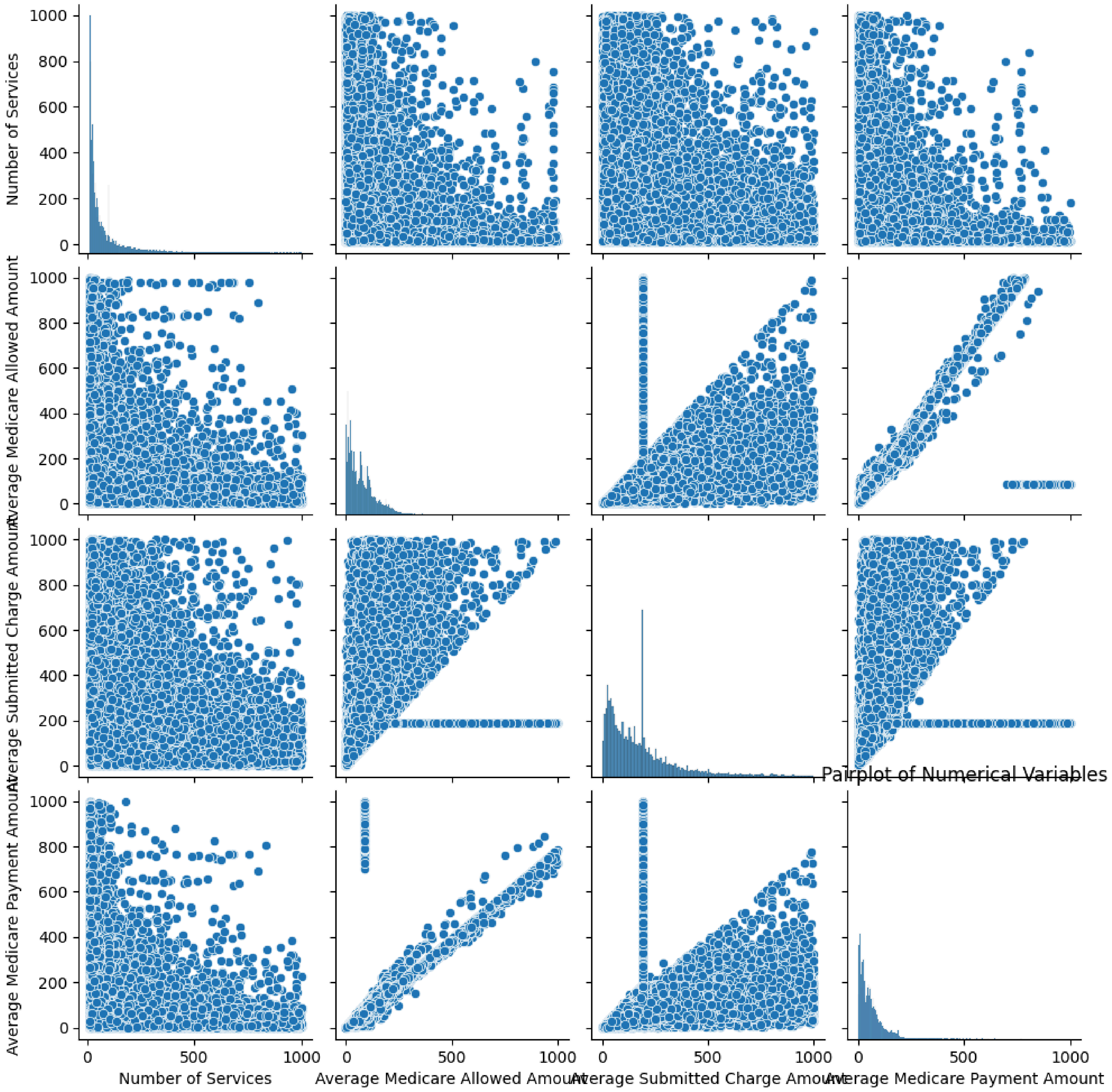


In [390]:

```
corr_matrix = data[numeric_columns].corr()

#correlation heatmap
plt.figure(figsize=(12, 8))
sns.heatmap(corr_matrix, annot=True, cmap='coolwarm', fmt='.2f')
plt.title('Correlation Matrix of Numerical Columns')
plt.show()
```



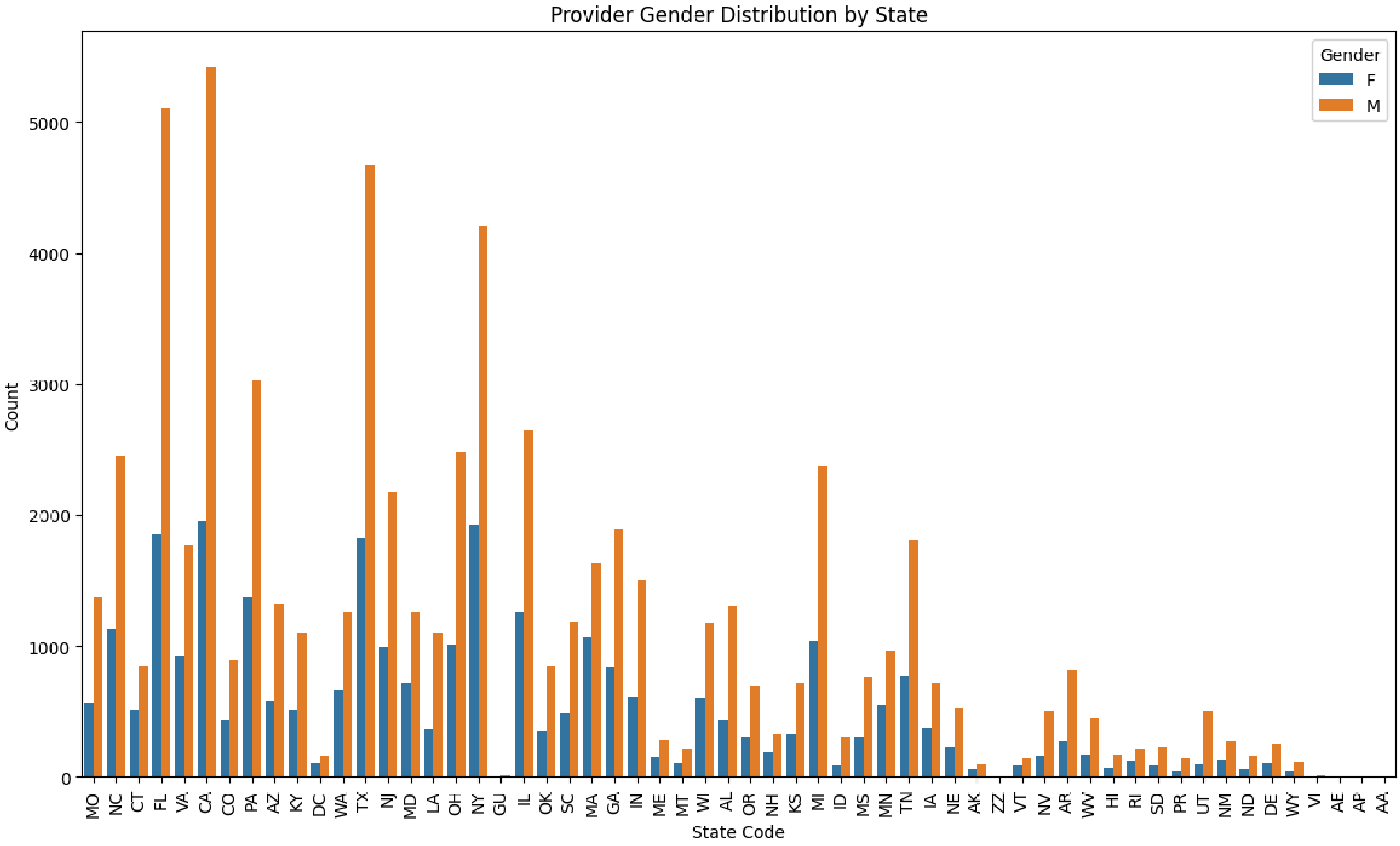
In [391]:
```
sns.pairplot(data[numeric_columns])
plt.title('Pairplot of Numerical Variables')
plt.show()
```



Bivariate Analysis

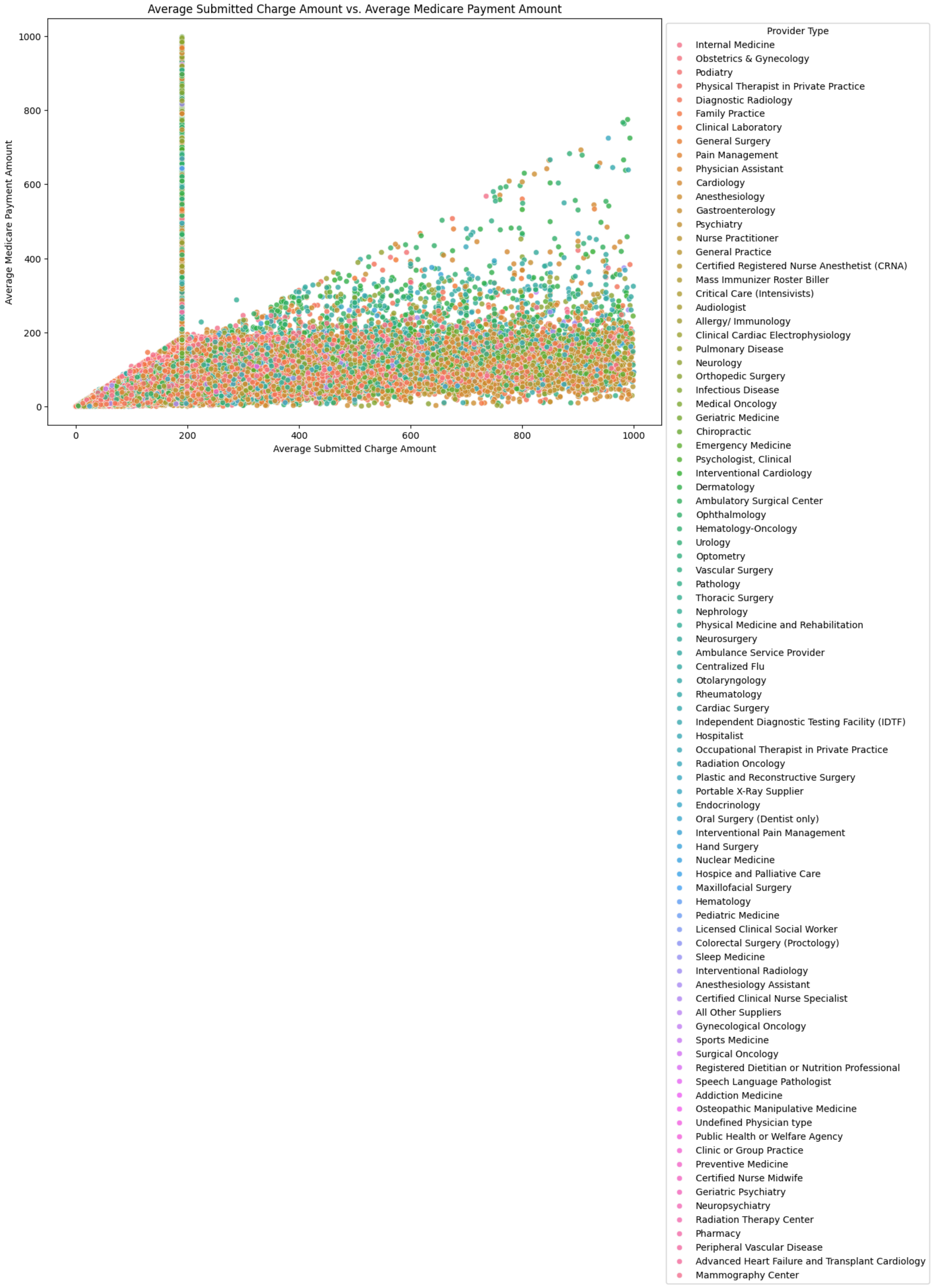
In [392]:

```
#Countplot of Provider Gender Distribution by State

plt.figure(figsize=(14, 8))
sns.countplot(x='State Code of the Provider', hue='Gender of the Provider', data=data)
plt.title('Provider Gender Distribution by State')
plt.xlabel('State Code')
plt.ylabel('Count')
plt.xticks(rotation=90)
plt.legend(title='Gender')
plt.show()
```



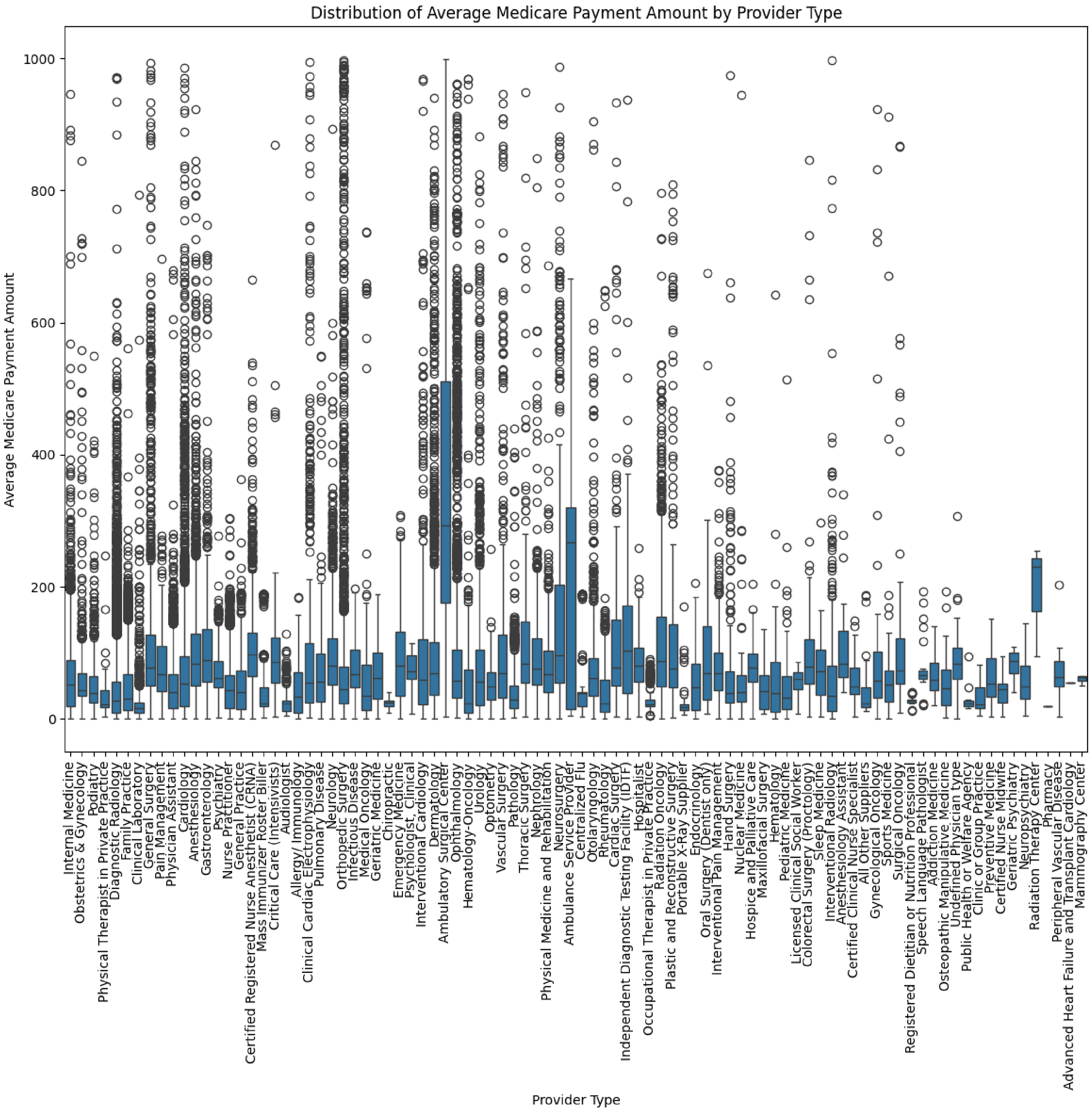
In [393]:

```
#Scatter Plot of Average Submitted Charge vs. Average Payment

plt.figure(figsize=(12, 8))
sns.scatterplot(x='Average Submitted Charge Amount', y='Average Medicare Payment Amount', data=data,
plt.title('Average Submitted Charge Amount vs. Average Medicare Payment Amount')
plt.xlabel('Average Submitted Charge Amount')
plt.ylabel('Average Medicare Payment Amount')
plt.legend(title='Provider Type', loc='upper left', bbox_to_anchor=(1, 1))
plt.show()
```



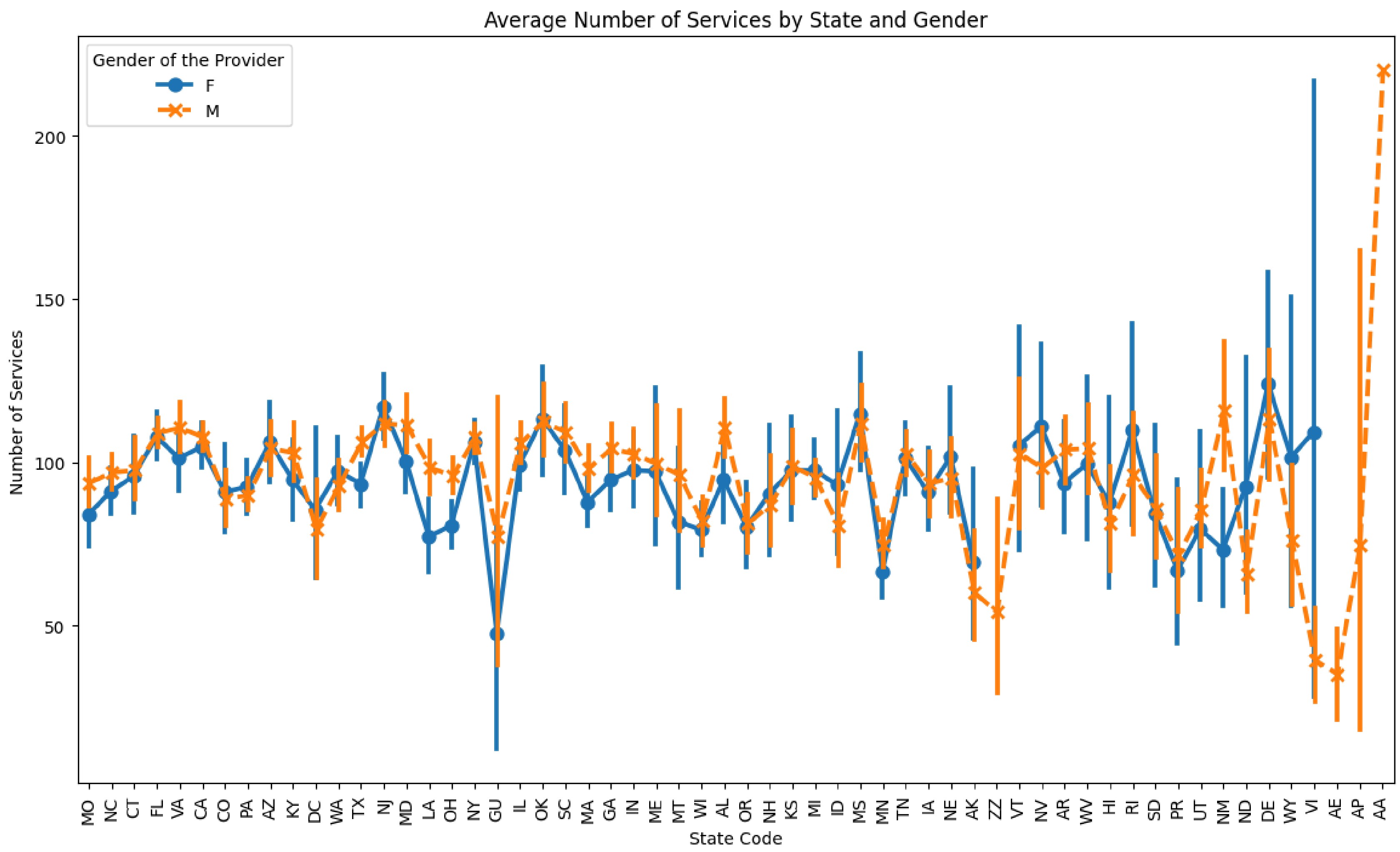
In [394]:

```
#Boxplot of Average Medicare Payment Amount by Provider Type

plt.figure(figsize=(14, 10))
sns.boxplot(x='Provider Type', y='Average Medicare Payment Amount', data=data)
plt.title('Distribution of Average Medicare Payment Amount by Provider Type')
plt.xlabel('Provider Type')
plt.ylabel('Average Medicare Payment Amount')
plt.xticks(rotation=90)
plt.show()
```



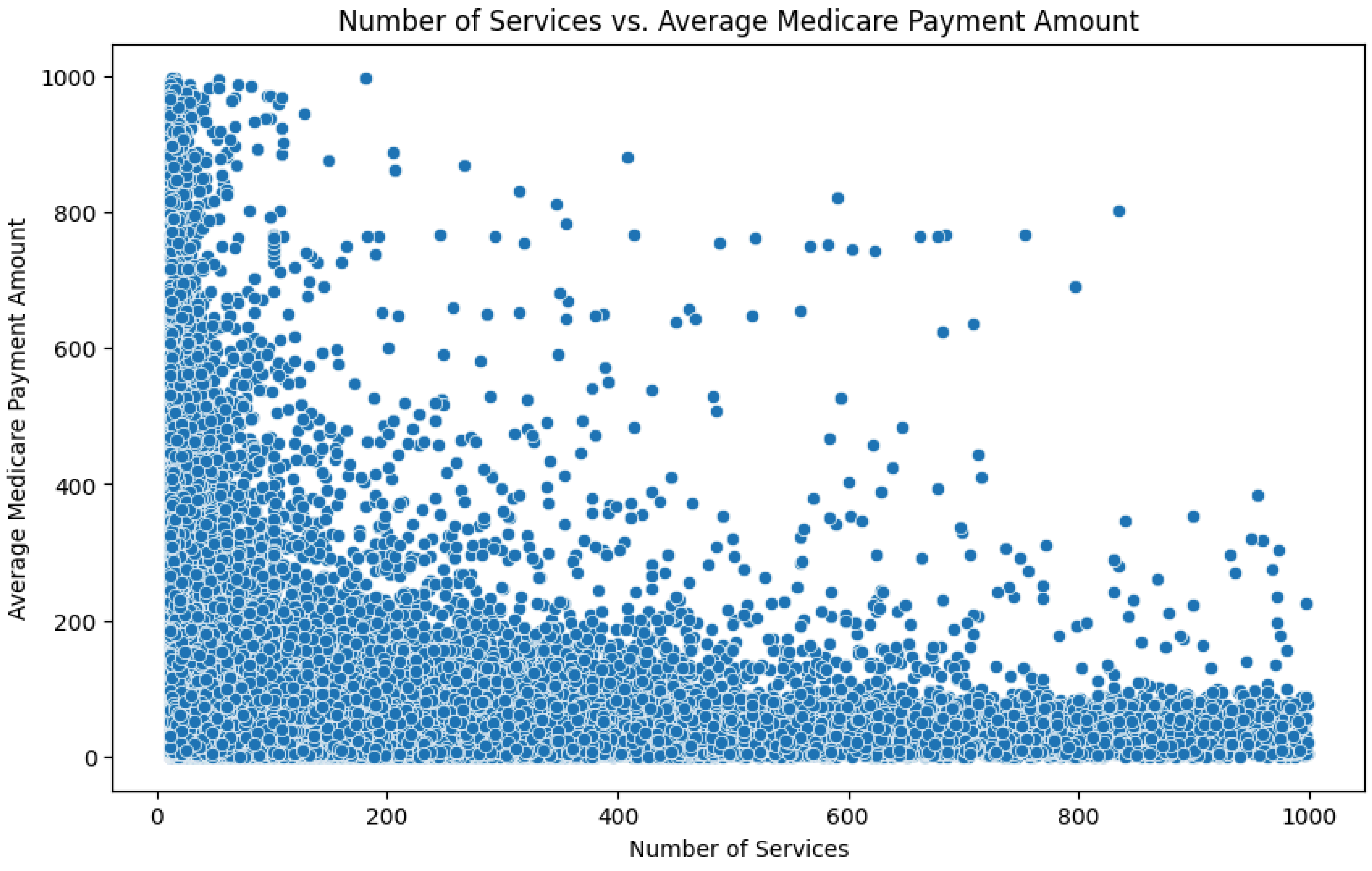
In [395]:

```
# point plot to show the relationship between average Number of Services by State Code of the Provide

plt.figure(figsize=(14, 8))
sns.pointplot(x='State Code of the Provider', y='Number of Services', hue='Gender of the Provider', d
plt.title('Average Number of Services by State and Gender')
plt.xlabel('State Code')
plt.ylabel('Number of Services')
plt.xticks(rotation=90)
plt.show()
```

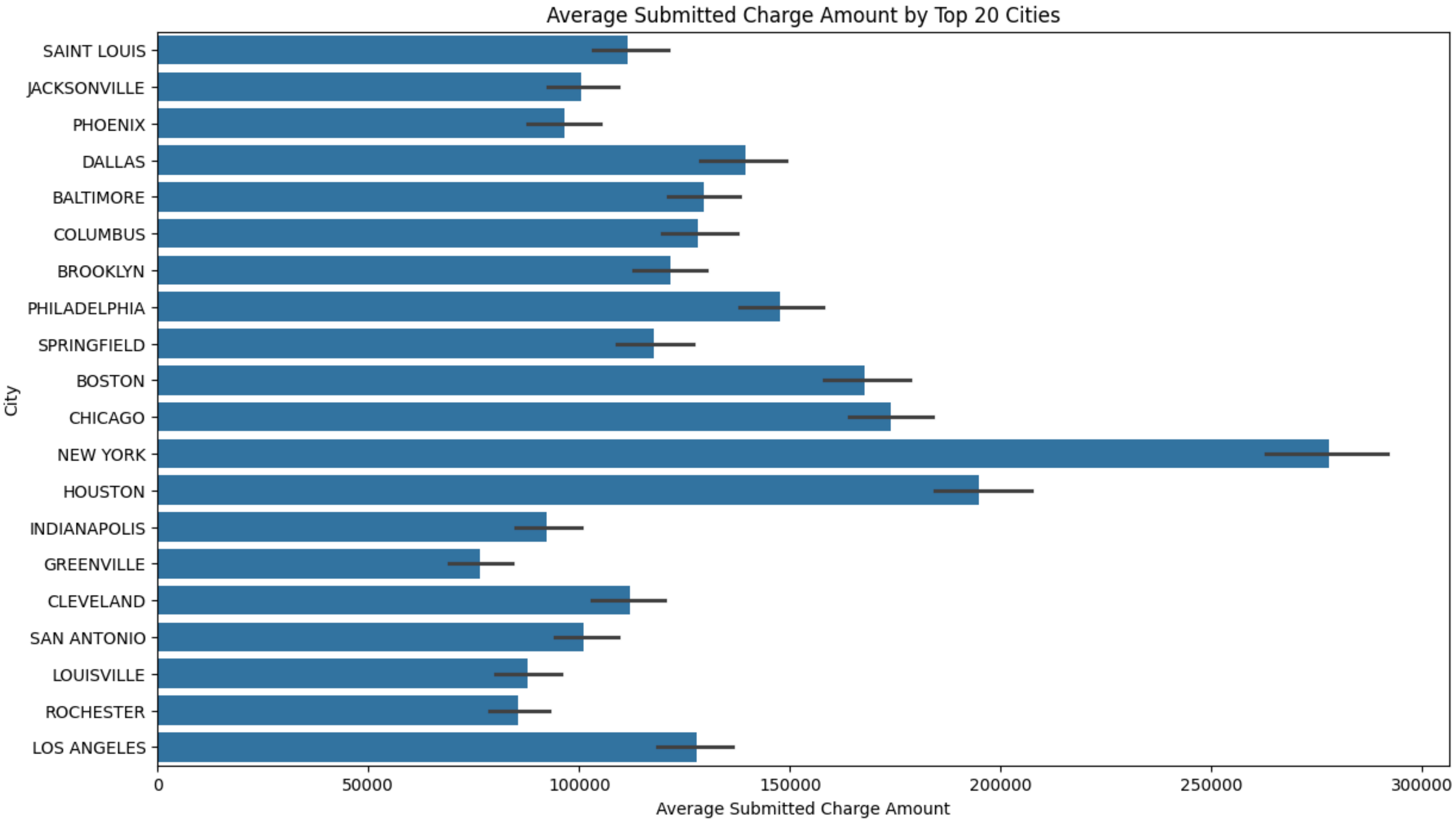


In [396]:

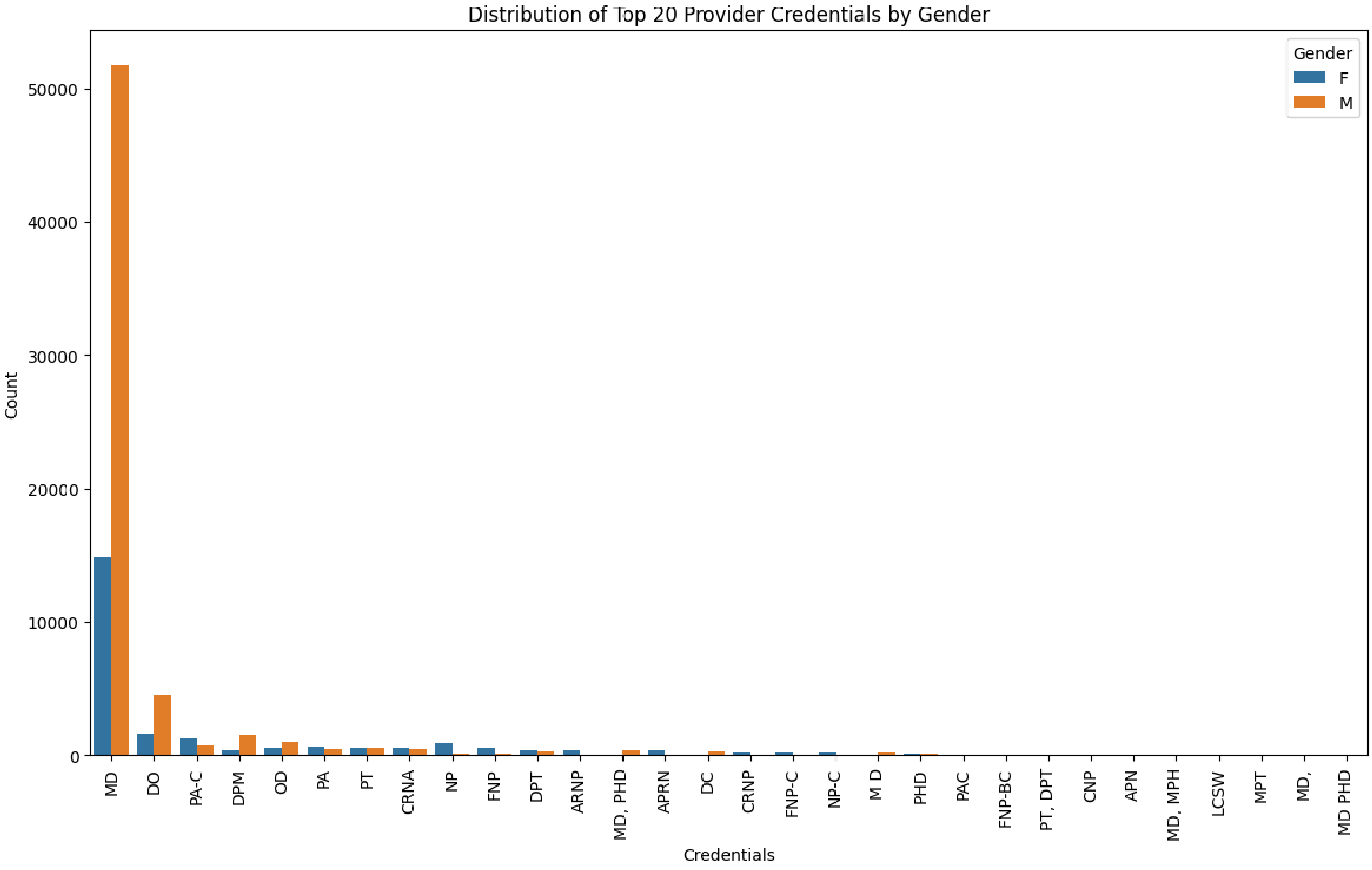
```
#Correlation between Number of Services and Payment Amounts

plt.figure(figsize=(10, 6))
sns.scatterplot(x='Number of Services', y='Average Medicare Payment Amount', data=data)
plt.title('Number of Services vs. Average Medicare Payment Amount')
plt.xlabel('Number of Services')
plt.ylabel('Average Medicare Payment Amount')
plt.show()
```



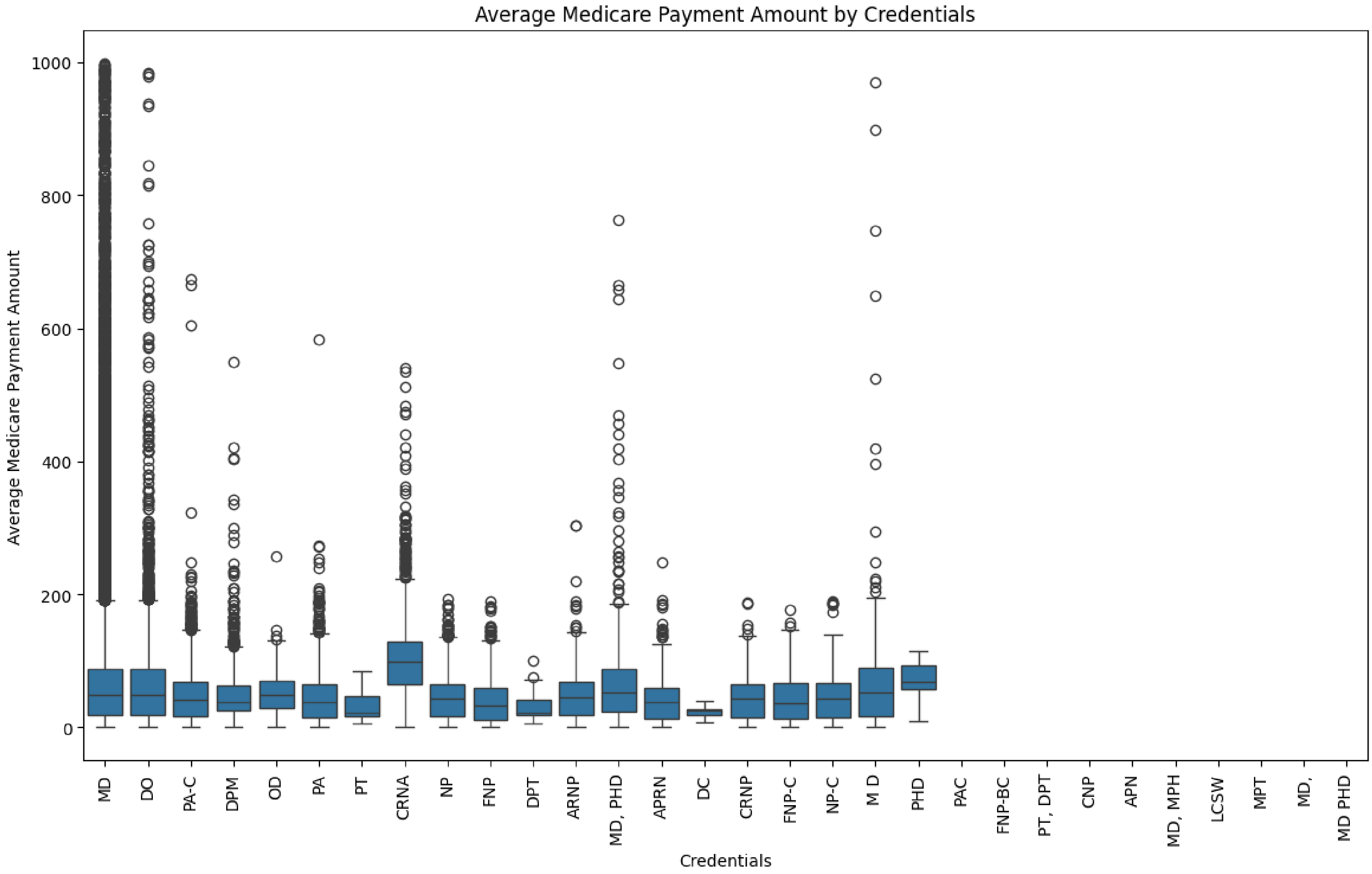
```
In [397]: #Bargraph of Average Submitted Charge Amount by City:

          top_20_cities = data['City of the Provider'].value_counts().head(20).index
          filtered_city_data = data[data['City of the Provider'].isin(top_20_cities)]

          plt.figure(figsize=(14, 8))
          sns.barplot(x='Average Submitted Charge Amount', y='City of the Provider', data=filtered_city_data, e
          plt.title('Average Submitted Charge Amount by Top 20 Cities')
          plt.xlabel('Average Submitted Charge Amount')
          plt.ylabel('City')
          plt.show()
```



```
In [398]: #Bargraph of Distribution of Top 20 Provider Credentials by Gender
          data['Credentials of the Provider'] = data['Credentials of the Provider'].str.strip()
          data['Gender of the Provider'] = data['Gender of the Provider'].str.strip()
          top_20_credentials = data['Credentials of the Provider'].value_counts().head(20).index

          # Filtered data to include only rows with the top 20 credentials
          filtered_data = data[data['Credentials of the Provider'].isin(top_20_credentials)]

          plt.figure(figsize=(14, 8))
          sns.countplot(data=filtered_data, x='Credentials of the Provider', hue='Gender of the Provider', orde
          plt.title('Distribution of Top 20 Provider Credentials by Gender')
          plt.xlabel('Credentials')
          plt.ylabel('Count')
          plt.xticks(rotation=90)
          plt.legend(title='Gender')
          plt.show()
```



In [399]:
```
#Average Medicare Payment Amount by Credentials

plt.figure(figsize=(14, 8))
sns.boxplot(x='Credentials of the Provider', y='Average Medicare Payment Amount', data=filtered_data,
plt.title('Average Medicare Payment Amount by Credentials')
plt.xlabel('Credentials')
plt.ylabel('Average Medicare Payment Amount')
plt.xticks(rotation=90)
plt.show()
```



In [ ]: