SaleDataAnalysis

February 6, 2025

[61]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler
from sklearn.ensemble import RandomForestRegressor, GradientBoostingRegressor
from xgboost import XGBRegressor
from sklearn.linear_model import LinearRegression
from sklearn.metrics import mean_absolute_error, mean_squared_error, r2_score
from statsmodels.tsa.arima.model import ARIMA
```

[62]:
```
# Load dataset
df = pd.read_csv("Sales_Transactions_Dataset_Weekly.csv")
```

[63]:
```
# Display basic info
display(df.head())
print(df.info())
print("Columns in dataset:", df.columns)
```

	Product_Code	W0	W1	W2	W3	W4	W5	W6	W7	W8	…	Normalized 42	\
0	P1	11	12	10	8	13	12	14	21	6	…	0.06	
1	P2	7	6	3	2	7	1	6	3	3	…	0.20	
2	P3	7	11	8	9	10	8	7	13	12	…	0.27	
3	P4	12	8	13	5	9	6	9	13	13	…	0.41	
4	P5	8	5	13	11	6	7	9	14	9	…	0.27	

	Normalized 43	Normalized 44	Normalized 45	Normalized 46	Normalized 47	\
0	0.22	0.28	0.39	0.50	0.00	
1	0.40	0.50	0.10	0.10	0.40	
2	1.00	0.18	0.18	0.36	0.45	
3	0.47	0.06	0.12	0.24	0.35	
4	0.53	0.27	0.60	0.20	0.20	

	Normalized 48	Normalized 49	Normalized 50	Normalized 51
0	0.22	0.17	0.11	0.39
1	0.50	0.10	0.60	0.00
2	1.00	0.45	0.45	0.36

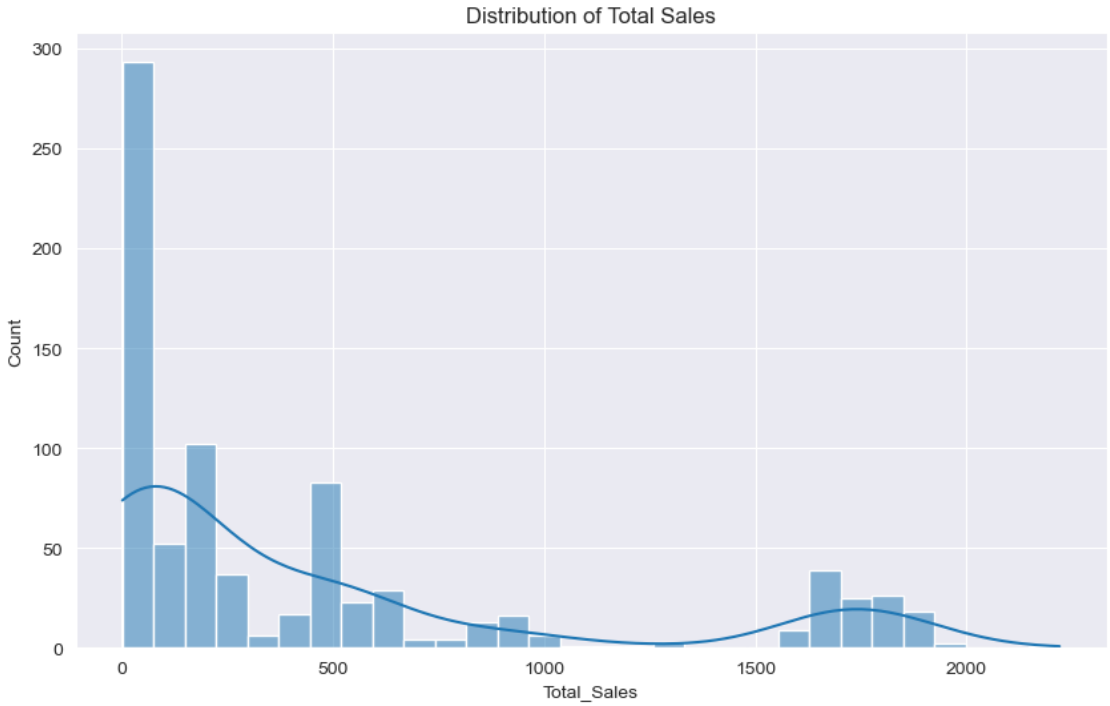
```
3           0.71           0.35           0.29           0.35
4           0.13           0.53           0.33           0.40

[5 rows x 107 columns]
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 811 entries, 0 to 810
Columns: 107 entries, Product_Code to Normalized 51
dtypes: float64(52), int64(54), object(1)
memory usage: 678.1+ KB
None
Columns in dataset: Index(['Product_Code', 'W0', 'W1', 'W2', 'W3', 'W4', 'W5',
'W6', 'W7', 'W8',
       …
       'Normalized 42', 'Normalized 43', 'Normalized 44', 'Normalized 45',
       'Normalized 46', 'Normalized 47', 'Normalized 48', 'Normalized 49',
       'Normalized 50', 'Normalized 51'],
      dtype='object', length=107)
```

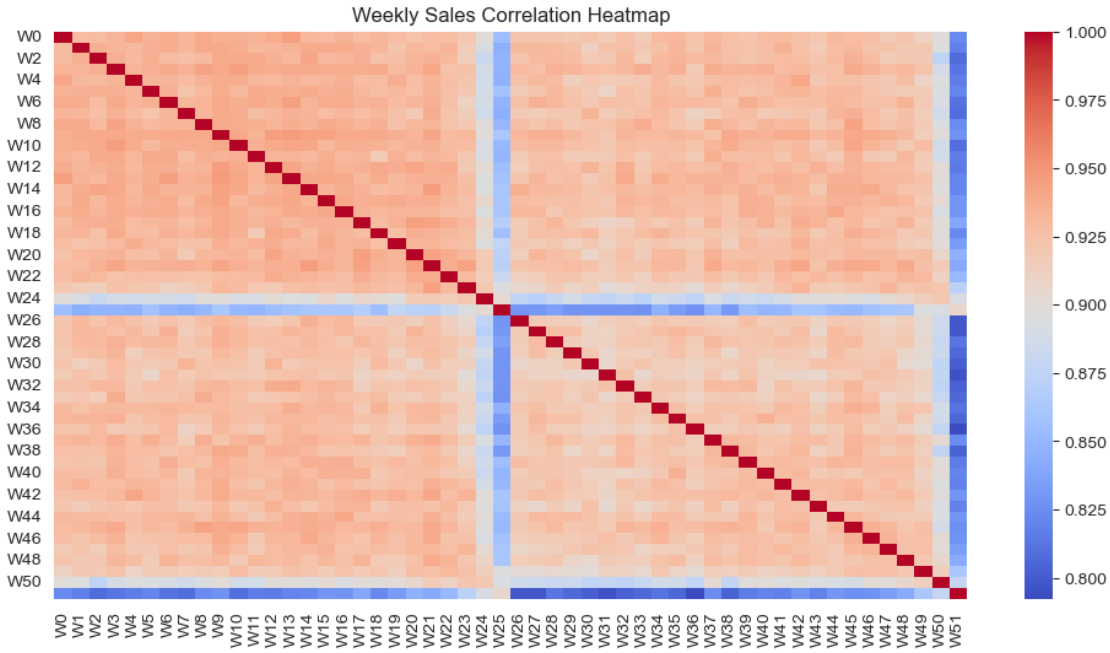
[64]:
```python
# Extract weekly sales columns
weekly_columns = [col for col in df.columns if col.startswith("W")]
normalized_columns = [col for col in df.columns if col.startswith("Normalised")]
```

[65]:
```python
# Aggregate sales over the 52 weeks
df["Total_Sales"] = df[weekly_columns].sum(axis=1)
df["Average_Sales"] = df[weekly_columns].mean(axis=1)
```

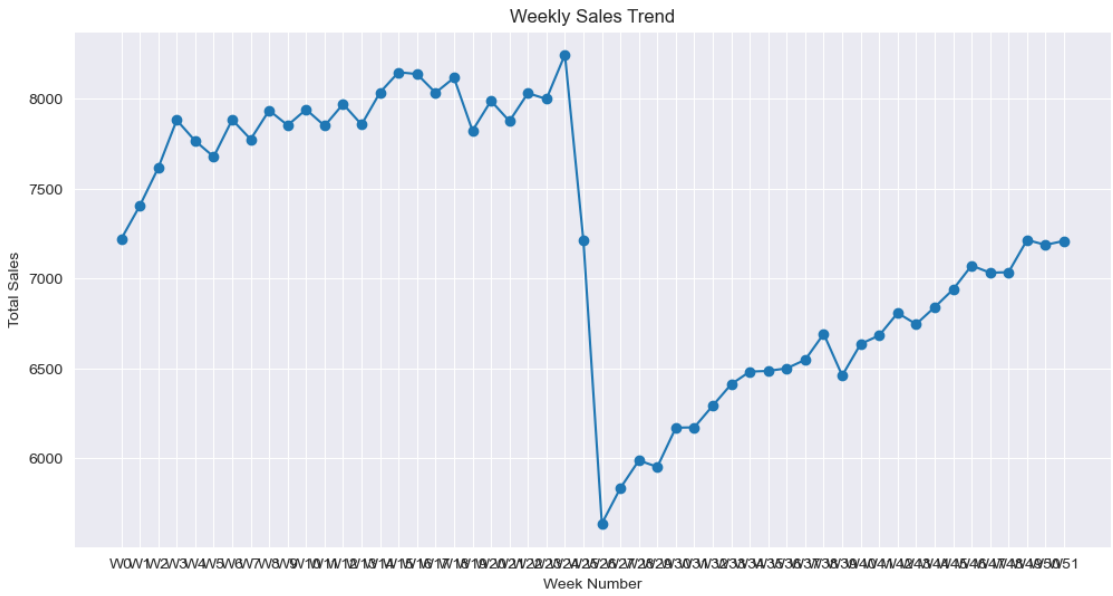
[66]:
```python
# Exploratory Data Analysis
plt.figure(figsize=(10, 6))
sns.histplot(df["Total_Sales"], bins=30, kde=True)
plt.title("Distribution of Total Sales")
plt.show()
```



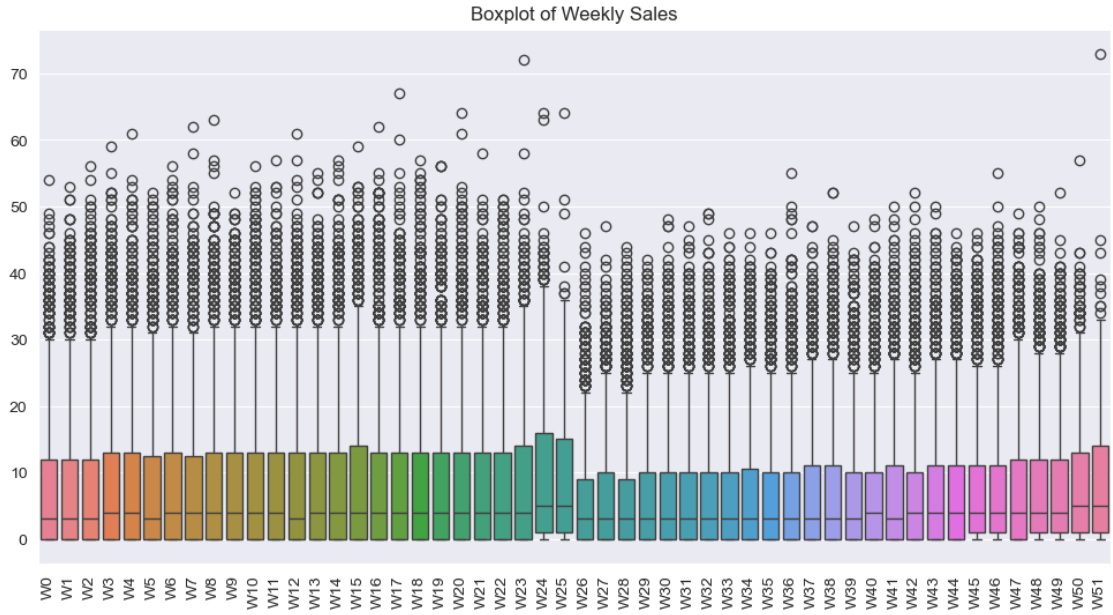
[67]:
```
plt.figure(figsize=(12, 6))
sns.heatmap(df[weekly_columns].corr(), cmap="coolwarm")
plt.title("Weekly Sales Correlation Heatmap")
plt.show()
```



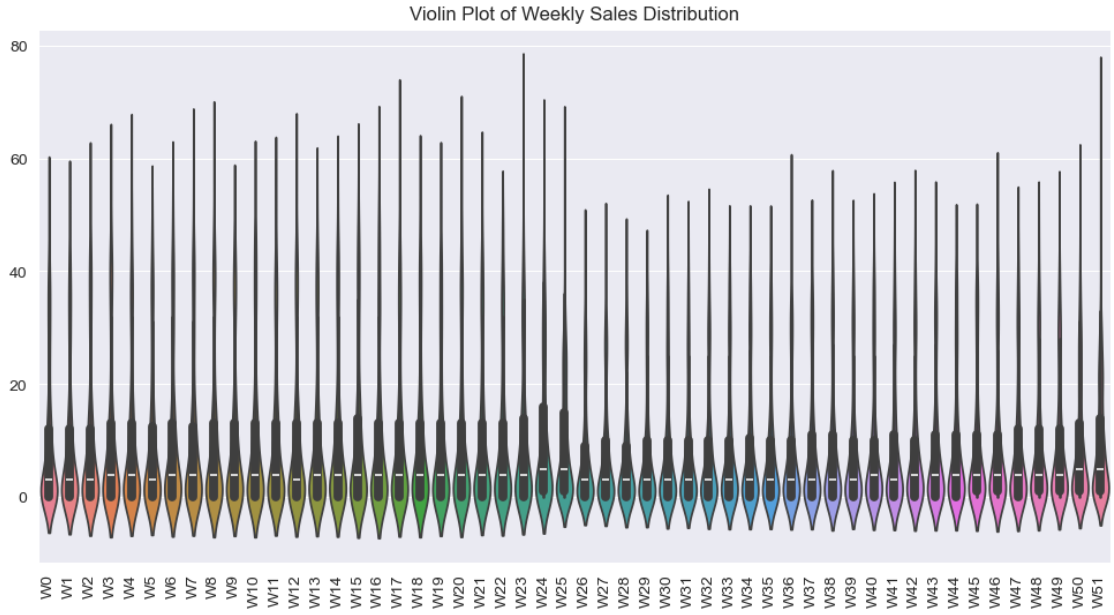
[68]:
```
# Time Series Analysis
weekly_sales_trend = df[weekly_columns].sum()
plt.figure(figsize=(12, 6))
plt.plot(weekly_sales_trend, marker='o')
plt.title("Weekly Sales Trend")
plt.xlabel("Week Number")
plt.ylabel("Total Sales")
plt.show()
```



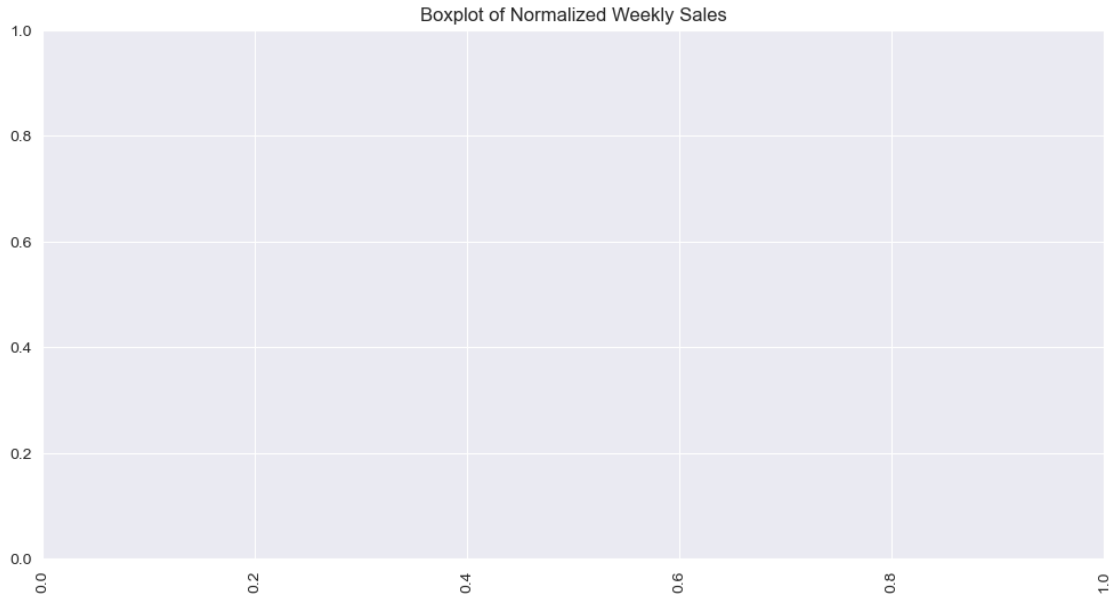
[69]:
```
plt.figure(figsize=(12, 6))
sns.boxplot(data=df[weekly_columns])
plt.title("Boxplot of Weekly Sales")
plt.xticks(rotation=90)
plt.show()
```



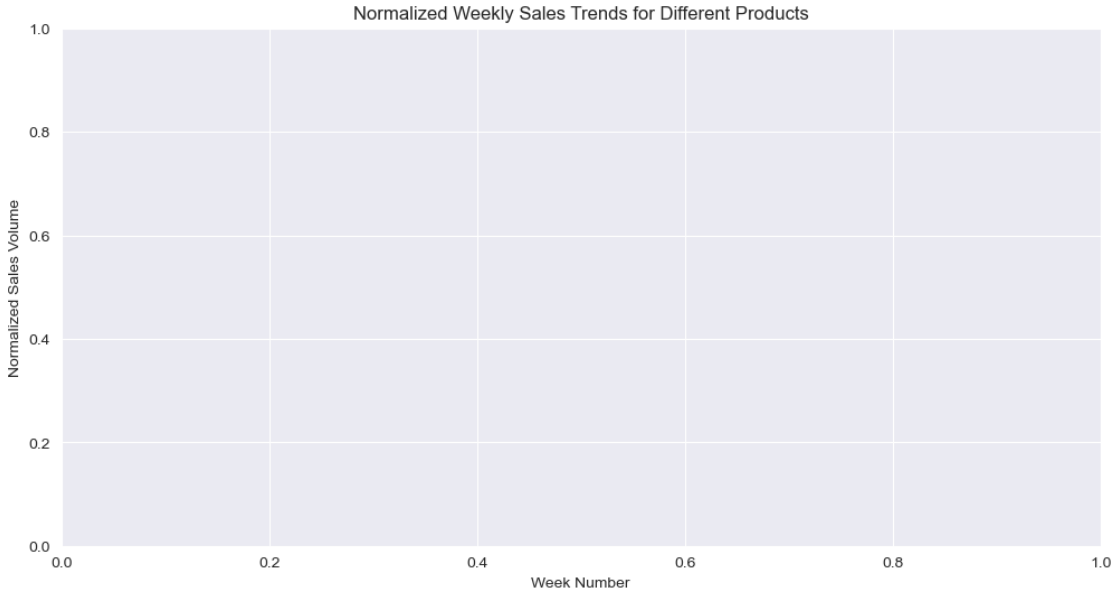
[70]:
```
plt.figure(figsize=(12, 6))
sns.violinplot(data=df[weekly_columns])
plt.title("Violin Plot of Weekly Sales Distribution")
plt.xticks(rotation=90)
plt.show()
```



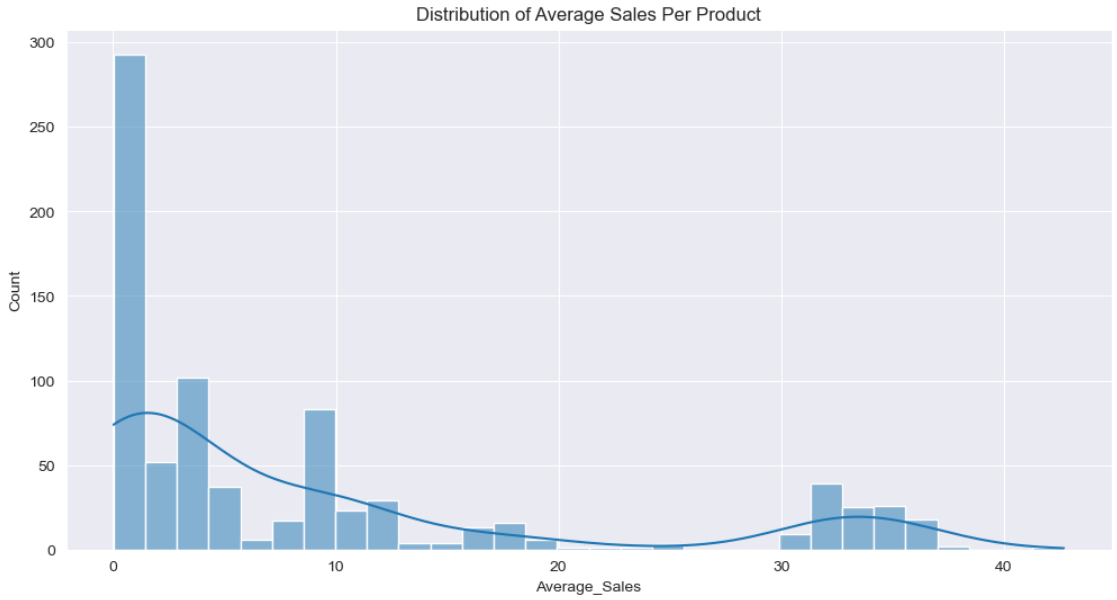
[71]:
```
plt.figure(figsize=(12, 6))
sns.boxplot(data=df[normalized_columns])
plt.title("Boxplot of Normalized Weekly Sales")
plt.xticks(rotation=90)
plt.show()
```



[72]:
```
plt.figure(figsize=(12, 6))
sns.lineplot(data=df[normalized_columns].T)
plt.title("Normalized Weekly Sales Trends for Different Products")
plt.xlabel("Week Number")
plt.ylabel("Normalized Sales Volume")
plt.show()
```



[73]:
```
plt.figure(figsize=(12, 6))
sns.histplot(df["Average_Sales"], bins=30, kde=True)
plt.title("Distribution of Average Sales Per Product")
plt.show()
```



[74]:
```
# Define target and features
target = "Total_Sales"
```

```
features = weekly_columns + normalized_columns
X = df[features]
y = df[target]
```

[75]:
```
# Split data into training and test sets
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2,␣
 ↪random_state=42)
```

[76]:
```
# Train models
models = {
    "Linear Regression": LinearRegression(),
    "Random Forest": RandomForestRegressor(n_estimators=100, random_state=42),
    "Gradient Boosting": GradientBoostingRegressor(n_estimators=100,␣
 ↪random_state=42),
    "XGBoost": XGBRegressor(n_estimators=100, random_state=42)
}
```

[77]:
```
# Evaluate models
for name, model in models.items():
    model.fit(X_train, y_train)
    y_pred = model.predict(X_test)
    print(f"{name} Results:")
    print("MAE:", mean_absolute_error(y_test, y_pred))
    print("RMSE:", np.sqrt(mean_squared_error(y_test, y_pred)))
    print("R^2 Score:", r2_score(y_test, y_pred))
    print("---" * 10)
```

```
Linear Regression Results:
MAE: 1.7407479684018435e-13
RMSE: 2.5233825788697046e-13
R^2 Score: 1.0
------------------------------
Random Forest Results:
MAE: 21.099263803680984
RMSE: 32.82629852491179
R^2 Score: 0.9966191999298025
------------------------------
Gradient Boosting Results:
MAE: 23.9422554780873
RMSE: 41.806133747686886
R^2 Score: 0.9945165274895462
------------------------------
XGBoost Results:
MAE: 31.743770514894848
RMSE: 66.9311968865947
R^2 Score: 0.9859449355343864
------------------------------
```

[78]:
```
# Time Series Forecasting (ARIMA)
ts_data = weekly_sales_trend.values
model_arima = ARIMA(ts_data, order=(5,1,0))
model_fit = model_arima.fit()
forecast = model_fit.forecast(steps=10)
```

[79]:
```
plt.figure(figsize=(12, 6))
plt.plot(range(len(ts_data)), ts_data, label="Actual Sales")
plt.plot(range(len(ts_data), len(ts_data) + 10), forecast, label="Forecast",␣
↪linestyle='dashed')
plt.legend()
plt.title("Sales Forecast Using ARIMA")
plt.show()
```