In [30]:
```
import pandas as pd
import numpy as np
from sklearn.model_selection import train_test_split, learning_curve
from sklearn.linear_model import LinearRegression
from sklearn.preprocessing import PolynomialFeatures, StandardScaler
from sklearn.pipeline import Pipeline
from sklearn.metrics import mean_squared_error, r2_score
import matplotlib.pyplot as plt
import seaborn as sns
```

In [2]:
```
df = pd.read_csv('car data.csv')
df
```

Out[2]:

	Car_Name	Year	Selling_Price	Present_Price	Driven_kms	Fuel_Type	Selling_type	Tra
0	ritz	2014	3.35	5.59	27000	Petrol	Dealer	
1	sx4	2013	4.75	9.54	43000	Diesel	Dealer	
2	ciaz	2017	7.25	9.85	6900	Petrol	Dealer	
3	wagon r	2011	2.85	4.15	5200	Petrol	Dealer	
4	swift	2014	4.60	6.87	42450	Diesel	Dealer	
...	...	...	...	...	...	...	...	
296	city	2016	9.50	11.60	33988	Diesel	Dealer	
297	brio	2015	4.00	5.90	60000	Petrol	Dealer	
298	city	2009	3.35	11.00	87934	Petrol	Dealer	
299	city	2017	11.50	12.50	9000	Diesel	Dealer	
300	brio	2016	5.30	5.90	5464	Petrol	Dealer	

301 rows × 9 columns

In [3]:
```
print(df.head())
```

```
  Car_Name  Year  Selling_Price  Present_Price  Driven_kms Fuel_Type  \
0     ritz  2014           3.35           5.59       27000    Petrol
1      sx4  2013           4.75           9.54       43000    Diesel
2     ciaz  2017           7.25           9.85        6900    Petrol
3  wagon r  2011           2.85           4.15        5200    Petrol
4    swift  2014           4.60           6.87       42450    Diesel

  Selling_type Transmission  Owner
0       Dealer       Manual      0
1       Dealer       Manual      0
2       Dealer       Manual      0
3       Dealer       Manual      0
4       Dealer       Manual      0
```

In [4]:
```
features = ['Year', 'Present_Price', 'Driven_kms', 'Fuel_Type', 'Selling_ty
X = df[features]
y = df['Selling_Price']
```

In [5]:
```
X = pd.get_dummies(X, columns=['Fuel_Type', 'Selling_type', 'Transmission']
X
```

Out[5]:

	Year	Present_Price	Driven_kms	Owner	Fuel_Type_Diesel	Fuel_Type_Petrol	Selling_ty
0	2014	5.59	27000	0	0	1	
1	2013	9.54	43000	0	1	0	
2	2017	9.85	6900	0	0	1	
3	2011	4.15	5200	0	0	1	
4	2014	6.87	42450	0	1	0	
...	...	...	...	...	...	...	
296	2016	11.60	33988	0	1	0	
297	2015	5.90	60000	0	0	1	
298	2009	11.00	87934	0	0	1	
299	2017	12.50	9000	0	1	0	
300	2016	5.90	5464	0	0	1	

301 rows × 8 columns

In [6]:
```
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, ra
X_train, X_test, y_train, y_test
```

Out[6]: (

	Year	Present_Price	Driven_kms	Owner	Fuel_Type_Diesel	Fuel_Type_Petrol	Selling_type_Individual	Transmission_Manual
184	2008	0.750	26000	1	0	1	1	1
132	2017	0.950	3500	0	0	1	1	1
194	2008	0.787	50000	0	0	1	1	1
75	2015	6.800	36000	0	0	1	0	1
111	2016	1.500	8700	0	0	1	1	1
..	...	...	...	...	...	...	...	...
188	2013	0.570	18000	0	0	1	1	1
71	2011	12.480	45000	0	1	0	0	1
106	2014	3.450	16500	1	0	1	1	1
270	2011	10.000	69341	0	0	1	0	1
102	2017	1.780	4000	0	0	1	1	1

[240 rows x 8 columns],

	Year	Present_Price	Driven_kms	Owner	Fuel_Type_Diesel	Fuel_Type_Petrol	Selling_type_Individual	Transmission_Manual
177	2016	0.57	24000	0	0	1	1	0
289	2016	13.60	10980	0	0	1	0	1
228	2012	9.40	60000	0	1	0	0	1
198	2011	0.57	35000	1	0	1	1	1
60	2013	18.61	40001	0	0	1	0	1
..	...	...	...	...	...	...	...	...
234	2015	5.70	4492	0	0	1	0	1
296	2016	11.60	33988	0	1	0	0	1
281	2006	7.60	50456	0	0	1	0	1
285	2016	8.50	15059	0	0	1	0	0
182	2013	0.58	30000	0	0	1	1	1

[61 rows x 8 columns],

```
184    0.25
132    0.75
194    0.20
75     3.95
111    1.15
       ...
188    0.25
```

```
71     4.50
106    1.35
270    4.10
102    1.65
Name: Selling_Price, Length: 240, dtype: float64,
177     0.35
289    10.11
228     4.95
198     0.15
60      6.95
       ...
234     5.50
296     9.50
281     2.10
285     7.40
182     0.30
Name: Selling_Price, Length: 61, dtype: float64)
```

In [7]:
```
model = LinearRegression()
model
```

Out[7]:
```
▾ LinearRegression

LinearRegression()
```

In [8]:
```
model.fit(X_train, y_train)
```

Out[8]:
```
▾ LinearRegression

LinearRegression()
```

In [9]:
```
y_pred = model.predict(X_test)
y_pred
```

Out[9]:
```
array([ 2.95433731,  8.17716341,  6.45612271, -1.42337164,  9.08864657,
        7.41793553,  1.33513921,  0.84032259,  1.36320242,  7.49067757,
        9.11623744,  0.58602147,  8.4171901 ,  3.42182892,  6.90176412,
        3.05018044,  0.4861294 , 10.7066932 ,  1.74950537,  2.34321858,
        0.3983127 ,  8.11856504,  6.62720292,  2.66249362,  0.78244173,
        3.69502798,  5.24822431,  2.82925881,  2.13370568,  1.75038508,
        0.39804532,  9.11715068, -0.65878346,  2.29562782,  8.5693085 ,
        4.49098276,  7.20461351,  7.54096855,  2.89153082,  7.9380318 ,
        3.94218138,  4.27826846,  4.33243831,  0.60013063,  7.34017047,
        0.47635371,  7.29115924, 11.23338227,  3.1391956 ,  5.38488332,
        6.80049399,  2.1763552 , 20.63141992, 16.99979702,  7.50636179,
        9.6950184 ,  4.47468976,  8.97255903,  1.82948926,  7.6037684 ,
        0.2226926 ])
```

In [10]:
```
mse = mean_squared_error(y_test, y_pred)
mse
```

Out[10]:
```
3.4813498305149753
```

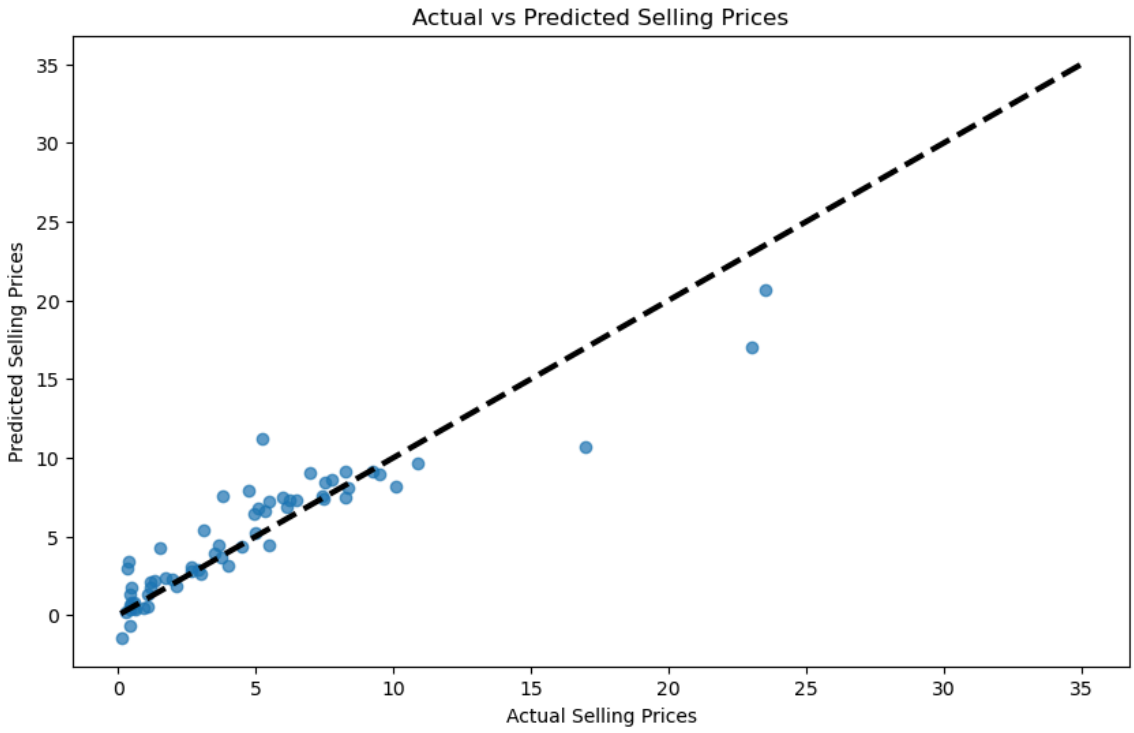
In [11]:
```
r2 = r2_score(y_test, y_pred)
r2
```

Out[11]:
```
0.8488707839191783
```

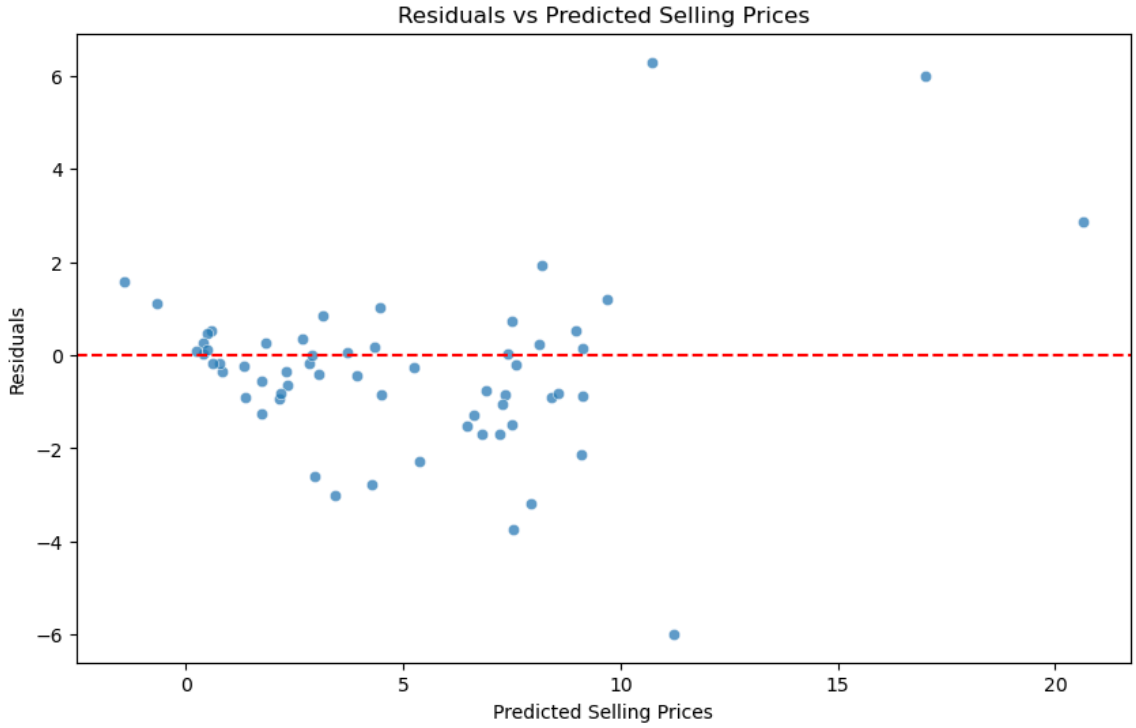
In [12]:
```
print(f'Mean Squared Error: {mse}')
print(f'R^2 Score: {r2}')
```

```
Mean Squared Error: 3.4813498305149753
R^2 Score: 0.8488707839191783
```

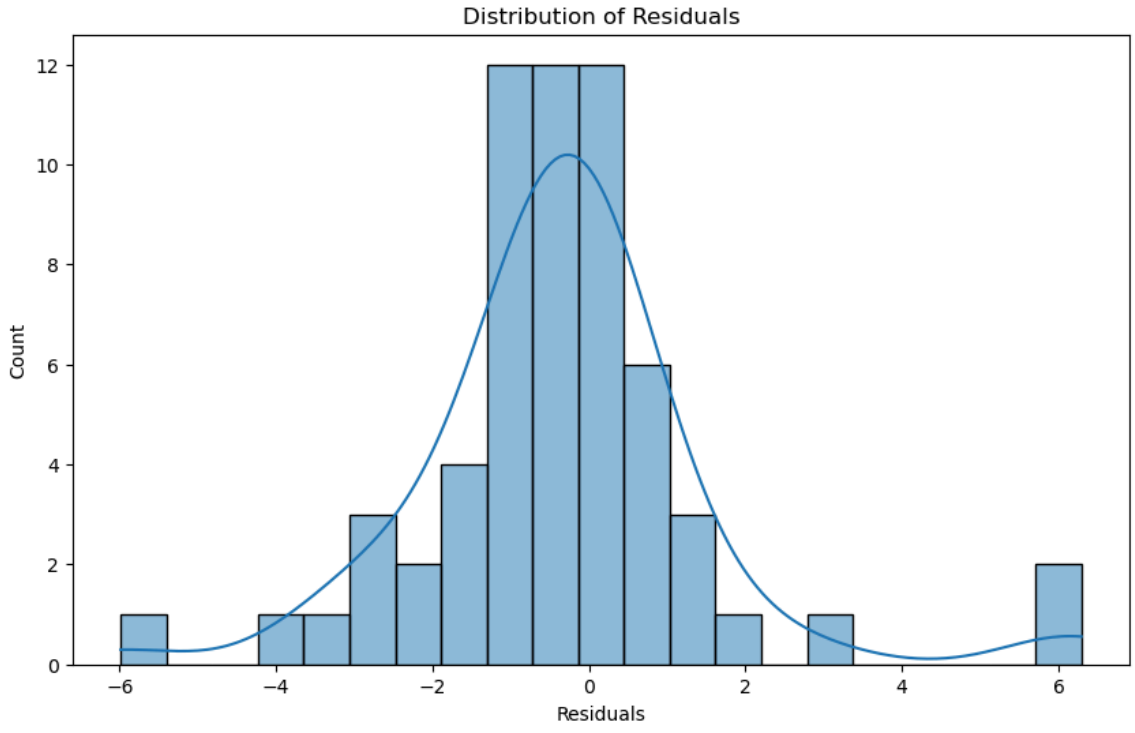
In [13]:
```
plt.figure(figsize=(10, 6))
plt.scatter(y_test, y_pred, alpha=0.7)
plt.xlabel('Actual Selling Prices')
plt.ylabel('Predicted Selling Prices')
plt.title('Actual vs Predicted Selling Prices')
plt.plot([y.min(), y.max()], [y.min(), y.max()], 'k--', lw=3)
plt.show()
```



In [15]:
```
residuals = y_test - y_pred
plt.figure(figsize=(10, 6))
sns.scatterplot(x=y_pred, y=residuals, alpha=0.7)
plt.axhline(y=0, color='r', linestyle='--')
plt.xlabel('Predicted Selling Prices')
plt.ylabel('Residuals')
plt.title('Residuals vs Predicted Selling Prices')
plt.show()
```

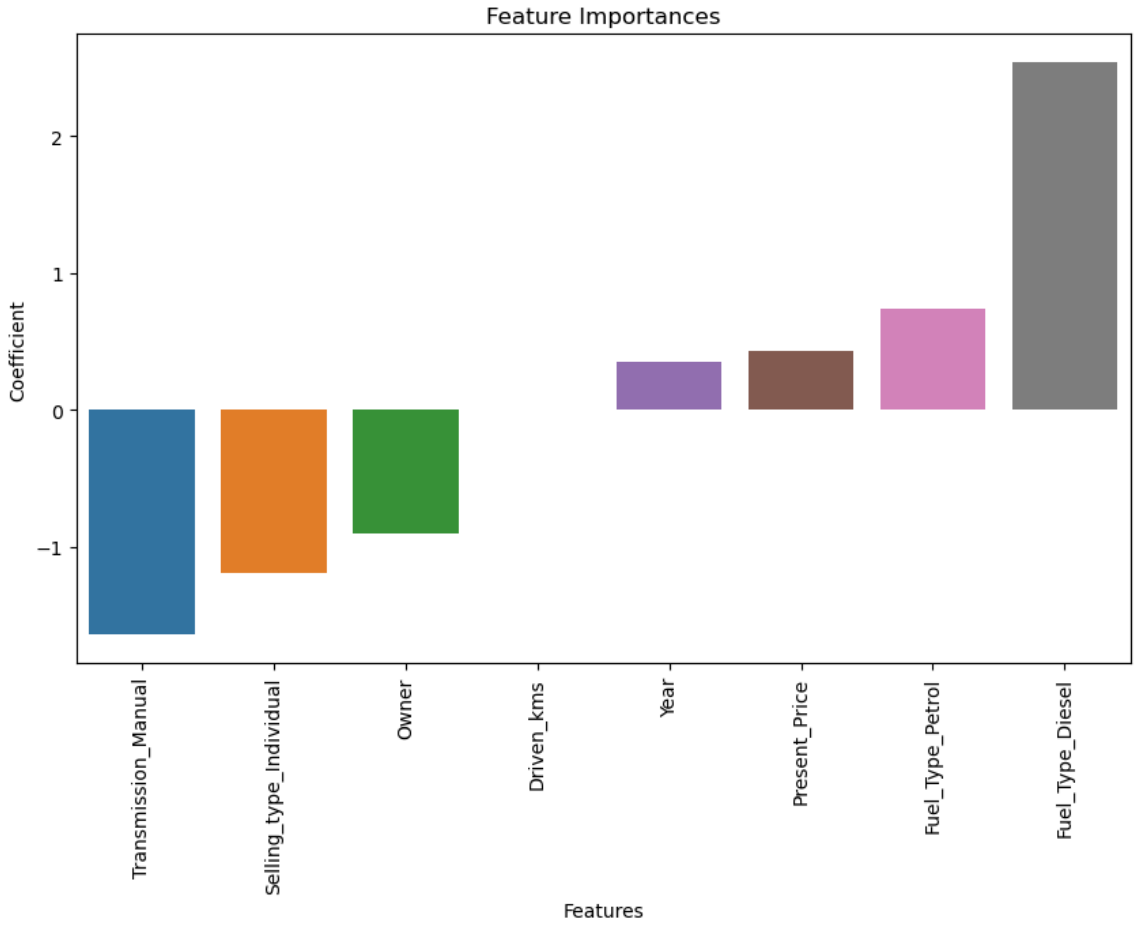


In [16]:
```
plt.figure(figsize=(10, 6))
sns.histplot(residuals, kde=True)
plt.xlabel('Residuals')
plt.title('Distribution of Residuals')
plt.show()
```



In [17]:
```
coefficients = pd.DataFrame(model.coef_, X.columns, columns=['Coefficient']
coefficients = coefficients.sort_values(by='Coefficient')
```

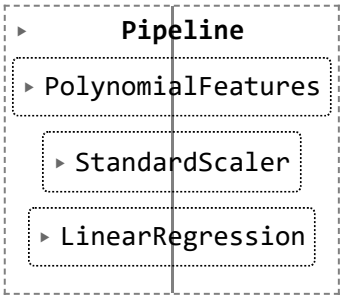
In [18]:
```
plt.figure(figsize=(10, 6))
sns.barplot(x=coefficients.index, y='Coefficient', data=coefficients)
plt.xticks(rotation=90)
plt.xlabel('Features')
plt.ylabel('Coefficient')
plt.title('Feature Importances')
plt.show()
```



In [21]:
```
pipeline = Pipeline([
    ('poly_features', PolynomialFeatures(degree=2, include_bias=False)),
    ('scaler', StandardScaler()),
    ('linear_regression', LinearRegression())
])
```

In [22]:
```
pipeline.fit(X_train, y_train)
```

Out[22]:



In [23]:
```
y_pred = pipeline.predict(X_test)
y_pred
```

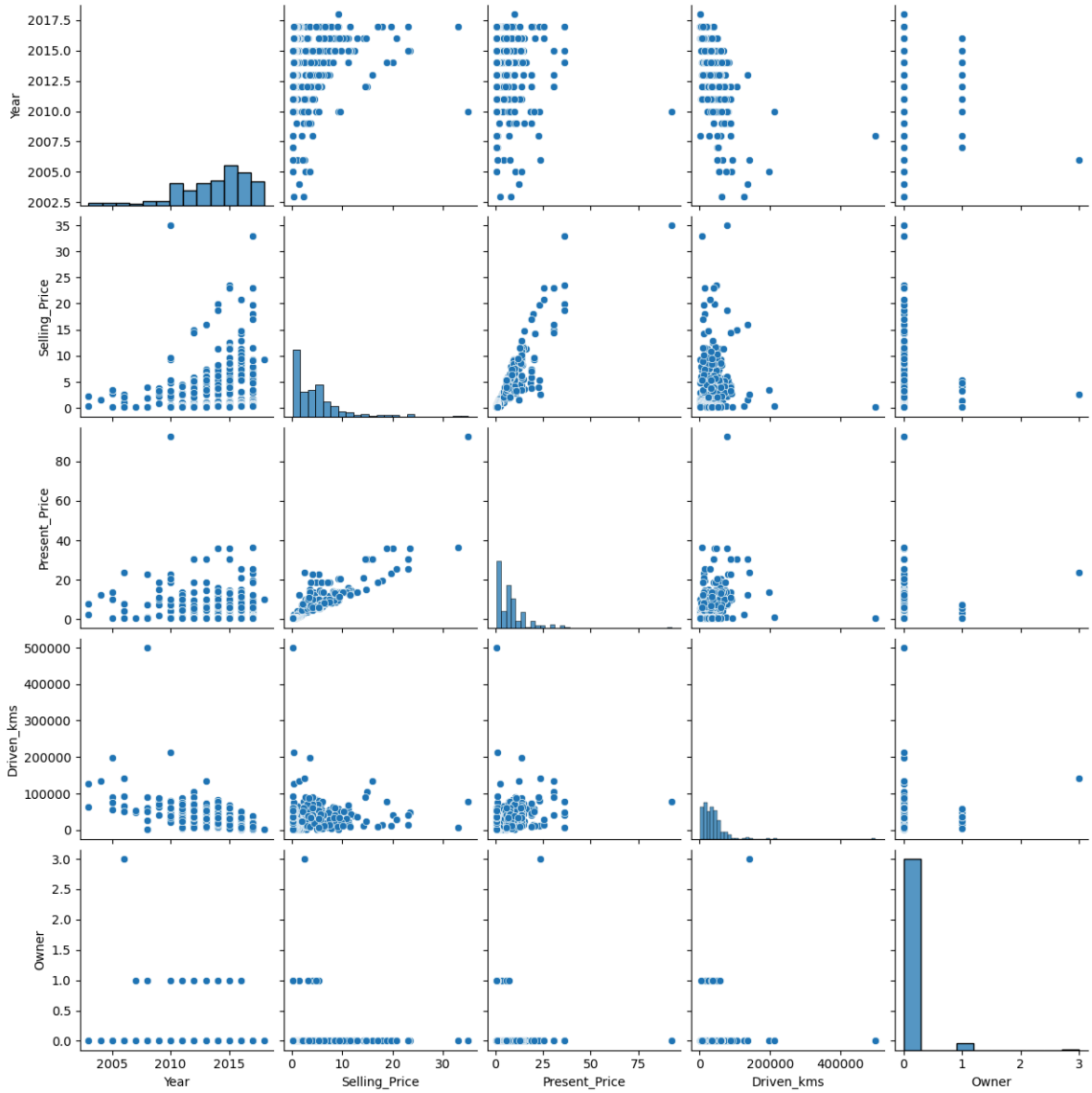
Out[23]:
```
array([ 0.1040764 , 10.17499925,  5.10926439,  0.08613206,  9.26459886,
        6.82685472,  0.95844652,  0.55878831,  0.40613939,  6.88569261,
       10.28974535,  0.68476488,  8.49909593,  0.65974046,  5.76765062,
        2.62952806,  0.97071458, 14.81672288,  0.5952263 ,  1.96870042,
        0.32209398,  8.07264329,  5.05366136,  2.69269945,  0.47919847,
        3.54114915,  4.92884447,  2.74512865,  1.47034837,  1.22742845,
        0.33308031,  9.70576097,  0.27253343,  2.27643968,  9.15382005,
        4.34125902,  6.56702806,  4.70765306,  2.495739  ,  5.97840501,
        1.2459221 ,  0.3462639 ,  4.27570726,  0.18854906,  6.59058763,
        0.50281908,  7.71235277,  5.71003343,  2.86909105,  3.4811516 ,
        6.0103264 ,  1.57868577, 25.21735765, 22.58015062,  7.17304613,
       10.17634202,  4.45539476,  9.92621995,  1.88825609,  7.6509514 ,
        0.07624437])
```

In [24]:
```
mse = mean_squared_error(y_test, y_pred)
r2 = r2_score(y_test, y_pred)
```

In [25]:
```
print(f'Mean Squared Error: {mse}')
print(f'R^2 Score: {r2}')
```

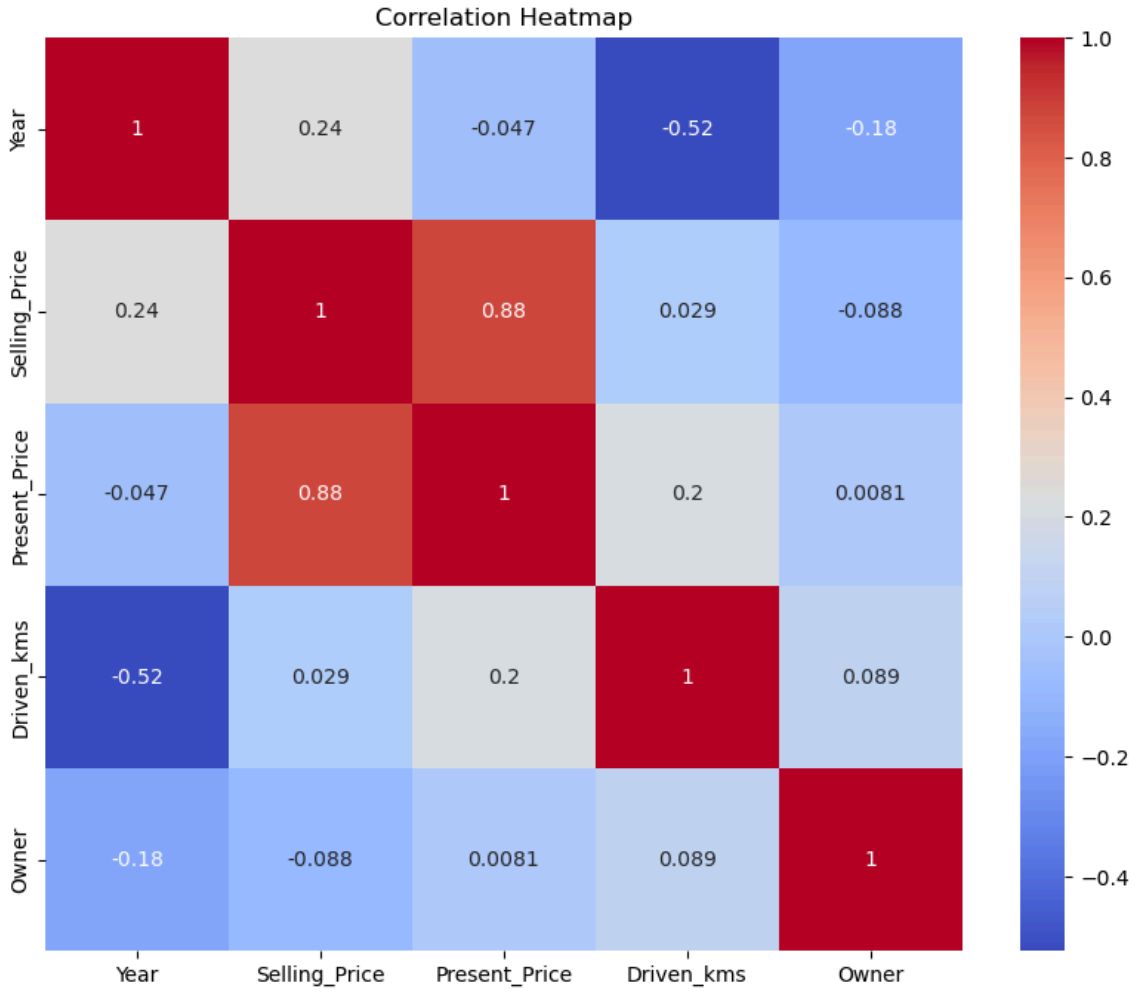
```
Mean Squared Error: 0.6603247220346687
R^2 Score: 0.9713345792700402
```

In [27]:
```
sns.pairplot(df)
plt.show()
```



In [28]:
```
plt.figure(figsize=(10, 8))
sns.heatmap(df.corr(), annot=True, cmap='coolwarm')
plt.title('Correlation Heatmap')
plt.show()
```

```
C:\Users\Aditya Kudva\AppData\Local\Temp\ipykernel_15920\1703484852.py:2:
FutureWarning: The default value of numeric_only in DataFrame.corr is depr
ecated. In a future version, it will default to False. Select only valid c
olumns or specify the value of numeric_only to silence this warning.
  sns.heatmap(df.corr(), annot=True, cmap='coolwarm')
```

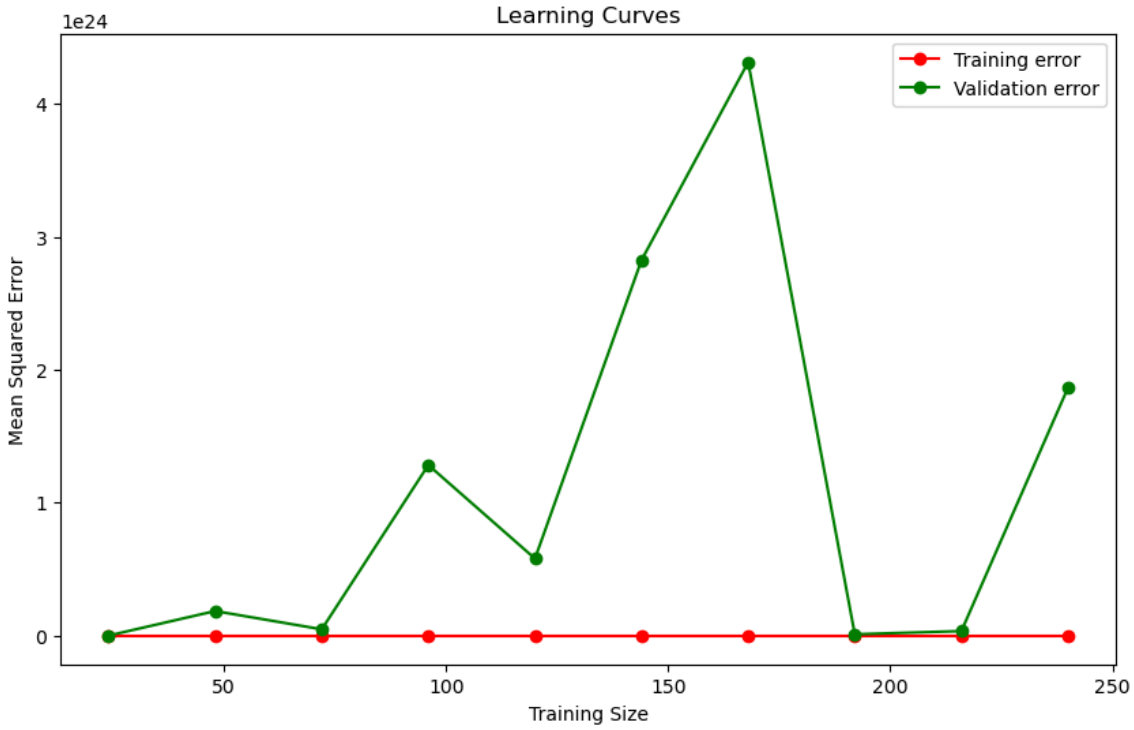


In [31]:
```
train_sizes, train_scores, test_scores = learning_curve(pipeline, X, y, cv=
train_sizes, train_scores, test_scores
```

Out[31]:
```
(array([ 24,  48,  72,  96, 120, 144, 168, 192, 216, 240]),
 array([[-0.0501817 , -0.07571879, -0.07571879, -0.07571879, -0.07571879],
        [-0.47132889, -0.14623978, -0.14623978, -0.14623978, -0.14623978],
        [-0.35012011, -0.24790623, -0.43733808, -0.43733808, -0.43733808],
        [-0.26991532, -0.19095776, -0.73569316, -0.73569316, -0.73569316],
        [-0.2363127 , -0.15601609, -0.70213232, -0.70213232, -0.70213232],
        [-0.24367529, -0.13700329, -0.62300888, -0.60061386, -0.60061386],
        [-0.33509282, -0.22961672, -0.6243216 , -0.52065555, -0.52065555],
        [-0.34127273, -0.27284926, -0.61569563, -0.49540278, -0.47864475],
        [-0.34493704, -0.27114582, -0.58394134, -0.48297896, -0.46598378],
        [-0.36933595, -0.28927183, -0.56769158, -0.47097342, -0.4970701
]]),
 array([[-2.43831540e+05, -2.71098222e+04, -5.32870092e+03,
         -4.98814288e+03, -2.69516862e+02],
        [-9.24281860e+23, -5.57867053e+03, -1.24586538e+00,
         -3.95172162e+00, -4.04444764e+00],
        [-2.36613489e+23, -9.88265517e+03, -6.38484102e+05,
         -2.63431943e+06, -1.67007305e+03],
        [-6.41727338e+24, -3.65062885e+04, -1.80034515e+02,
         -1.53669031e+02, -4.55360579e-01],
        [-2.89679292e+24, -1.10609443e+04, -1.43564453e+06,
         -7.57263498e+05, -1.07378045e+02],
        [-1.40176981e+25, -1.28531962e+03, -4.05385305e-01,
         -1.11758106e+23, -4.11835553e+16],
        [-2.15697512e+25, -1.67620270e+03, -4.05047446e-01,
         -4.75655664e+04, -2.09578189e+02],
        [-4.91440786e+22, -5.23817268e+02, -3.08303390e-01,
         -5.82952911e+03, -4.58239953e-01],
        [-1.69870672e+23, -4.70148541e+04, -2.82202754e-01,
         -4.56921625e+03, -3.80987137e-01],
        [-9.32535509e+24, -1.97411181e+03, -2.90678447e-01,
         -2.67168159e+02, -3.84903435e-01]]))
```

In [32]:
```
train_scores_mean = -train_scores.mean(axis=1)
test_scores_mean = -test_scores.mean(axis=1)
```

In [33]:
```
plt.figure(figsize=(10, 6))
plt.plot(train_sizes, train_scores_mean, 'o-', color='r', label='Training er
plt.plot(train_sizes, test_scores_mean, 'o-', color='g', label='Validation
plt.xlabel('Training Size')
plt.ylabel('Mean Squared Error')
plt.title('Learning Curves')
plt.legend(loc='best')
plt.show()
```



In [ ]: