In [9]:

```
import pandas as pd
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt
%matplotlib inline

import graphviz

from sklearn.tree import DecisionTreeClassifier, export_graphviz
from sklearn.model_selection import train_test_split, cross_val_score, G
ridSearchCV
from sklearn.metrics import accuracy_score
from sklearn.ensemble import RandomForestClassifier

import dmba
from dmba import classificationSummary
```

In [2]:

```
# Import raw data
df = pd.read_excel("ebayAuctions.xlsx", sheet_name="eBay auctions")
```

In [3]:

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1972 entries, 0 to 1971
Data columns (total 8 columns):
 #   Column        Non-Null Count  Dtype  
---  ------        --------------  -----  
 0   Category      1972 non-null   object 
 1   Currency      1972 non-null   object 
 2   sellerRating  1972 non-null   int64  
 3   Duration      1972 non-null   int64  
 4   endDay        1972 non-null   object 
 5   ClosePrice    1972 non-null   float64
 6   OpenPrice     1972 non-null   float64
 7   Competitive?  1972 non-null   int64  
dtypes: float64(2), int64(3), object(3)
memory usage: 123.4+ KB
```

In [4]:

```
df.head()
```

Out[4]:

	Category	Currency	sellerRating	Duration	endDay	ClosePrice	OpenPrice	Competit
0	Music/Movie/Game	US	3249	5	Mon	0.01	0.01	
1	Music/Movie/Game	US	3249	5	Mon	0.01	0.01	
2	Music/Movie/Game	US	3249	5	Mon	0.01	0.01	
3	Music/Movie/Game	US	3249	5	Mon	0.01	0.01	
4	Music/Movie/Game	US	3249	5	Mon	0.01	0.01	

In [5]:

```
# Data Preprocessing
# Create dummy variables for the categorical predictors
df_with_dummies = pd.get_dummies(df,
                                 prefix=['Category', 'Currency', 'endDa
y', 'Duration'],
                                 columns=['Category', 'Currency', 'endDa
y', 'Duration'])
```

In [6]:

```
pd.set_option('max_columns', 50)
df_with_dummies.head()
```

Out[6]:

	sellerRating	ClosePrice	OpenPrice	Competitive?	Category_Antique/Art/Craft	Category_Autom
0	3249	0.01	0.01	0	0	
1	3249	0.01	0.01	0	0	
2	3249	0.01	0.01	0	0	
3	3249	0.01	0.01	0	0	
4	3249	0.01	0.01	0	0	

In [7]:

```
# Target Variable
df_with_dummies['Competitive?'].value_counts()
```

Out[7]:

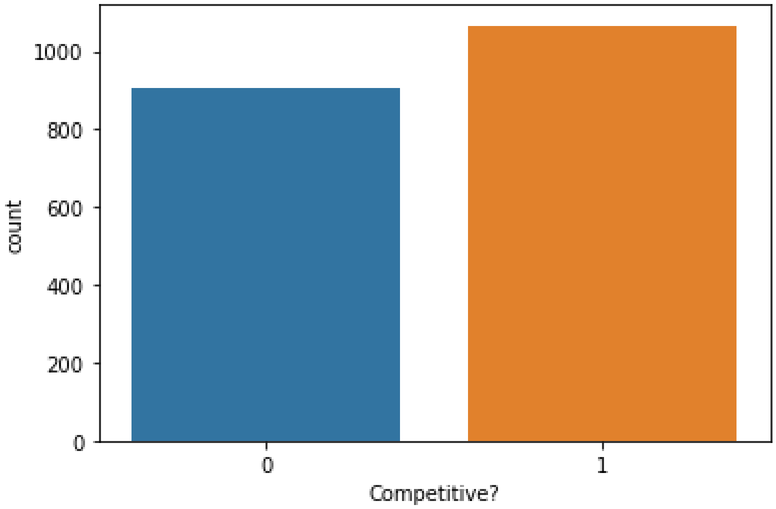
```
1    1066
0     906
Name: Competitive?, dtype: int64
```

In [10]:

```
sns.countplot(x='Competitive?', data=df_with_dummies)
plt.xlabel('Competitive?')
```

Out[10]:

```
Text(0.5, 0, 'Competitive?')
```



In [11]:

```
X = df_with_dummies.drop(columns=['Competitive?', 'ClosePrice'])
y = df_with_dummies['Competitive?']

# Split the data into training and test datasets
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.4,
random_state=1)
```

In [12]:

```
# Fit a classification tree - set the minimum number of records in a ter
minal node to 50
fullClassTree = DecisionTreeClassifier(min_samples_leaf=50, random_state
=1)
fullClassTree.fit(X_train, y_train)
```

Out[12]:

```
DecisionTreeClassifier(min_samples_leaf=50, random_state=1)
```

In [13]:

```
# Accuracy level
fullClassTree.score(X_test, y_test)
```

Out[13]:

```
0.7249683143219265
```

In [14]:

```
classificationSummary(y_test, fullClassTree.predict(X_test))
```

```
Confusion Matrix (Accuracy 0.7250)

       Prediction
Actual   0   1
     0 261  92
     1 125 311
```

In [15]:

```
classificationSummary(y_train, fullClassTree.predict(X_train))
```

```
Confusion Matrix (Accuracy 0.7219)

       Prediction
Actual   0   1
     0 402 151
     1 178 452
```

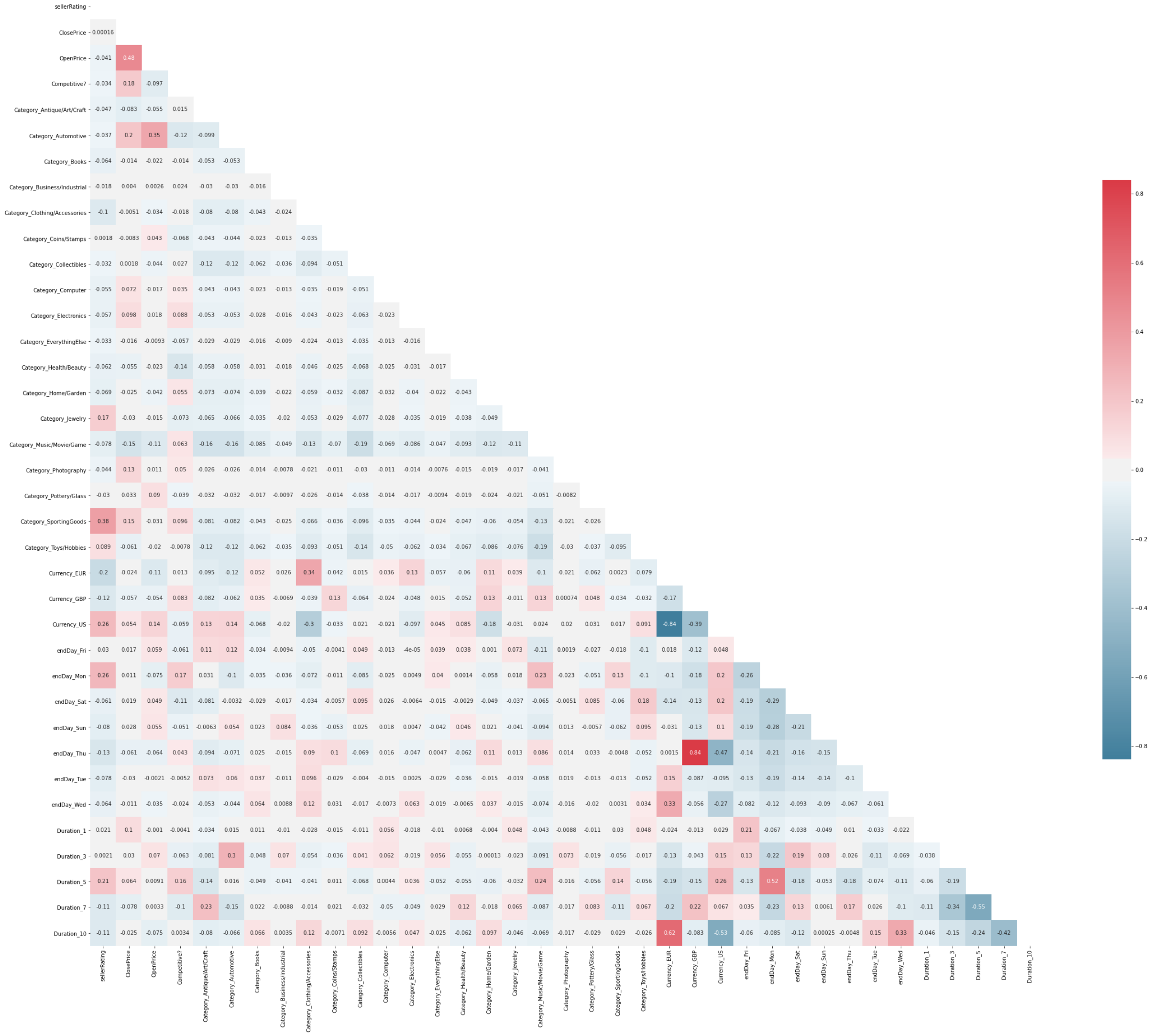
In [16]:

```
# Graph on http://webgraphviz.com/
export_graphviz(fullClassTree,
                out_file='fullClassTree_withoutClosePrice.dot',
                class_names=['0', '1'],
                filled=True,
                feature_names=X_train.columns)
```

In [17]:
```
# Correlation matrix
corr = df_with_dummies.corr()

plt.figure(figsize=(40,40))
sns.heatmap(corr,
            mask=np.triu(np.ones_like(corr, dtype=bool)),
            cmap=sns.diverging_palette(230, 10, as_cmap=True),
            square=True,
            cbar_kws={"shrink": .5},
            annot=True)
```

Out[17]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7fccabbd7790>
```



In [18]:

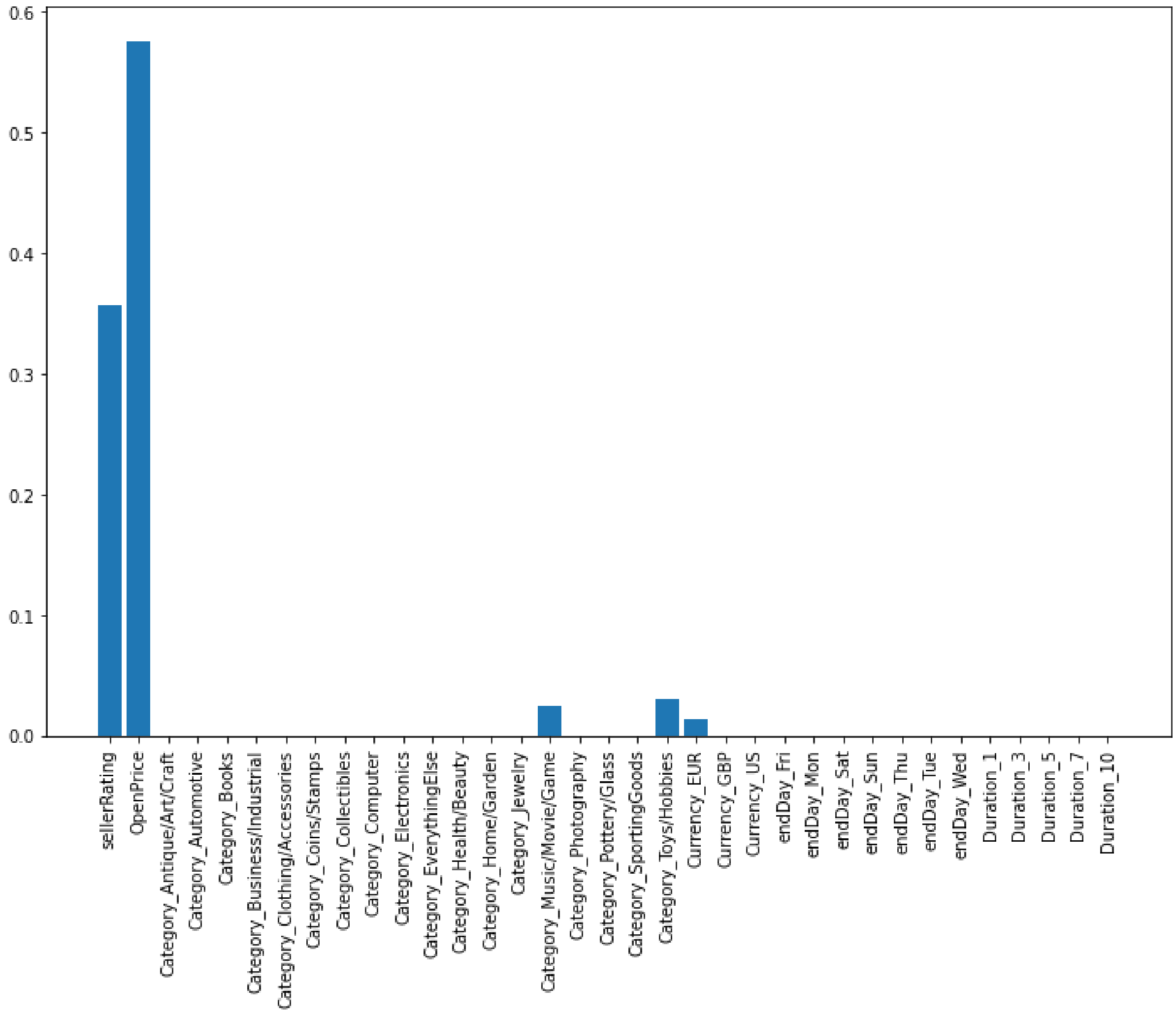
```
# Get importance
importance = fullClassTree.feature_importances_

# Summarize feature importance
for i,v in enumerate(importance):
    #print('Feature: %0d, Score: %.5f' % (i,v))
    print('Feature ' + str(i) + ' ' + X_train.columns[i] + " with scor
e:" + str(round(importance[i],5)))

# Plot feature importance
plt.figure(figsize=(12,8))
plt.bar([X_train.columns[x] for x in range(len(importance))], importance
)
plt.xticks(rotation=90)
```

```
Feature 0 sellerRating with score:0.35644
Feature 1 OpenPrice with score:0.57618
Feature 2 Category_Antique/Art/Craft with score:0.0
Feature 3 Category_Automotive with score:0.0
Feature 4 Category_Books with score:0.0
Feature 5 Category_Business/Industrial with score:0.0
Feature 6 Category_Clothing/Accessories with score:0.0
Feature 7 Category_Coins/Stamps with score:0.0
Feature 8 Category_Collectibles with score:0.0
Feature 9 Category_Computer with score:0.0
Feature 10 Category_Electronics with score:0.0
Feature 11 Category_EverythingElse with score:0.0
Feature 12 Category_Health/Beauty with score:0.0
Feature 13 Category_Home/Garden with score:0.0
Feature 14 Category_Jewelry with score:0.0
Feature 15 Category_Music/Movie/Game with score:0.02398
Feature 16 Category_Photography with score:0.0
Feature 17 Category_Pottery/Glass with score:0.0
Feature 18 Category_SportingGoods with score:0.0
Feature 19 Category_Toys/Hobbies with score:0.02968
Feature 20 Currency_EUR with score:0.01371
Feature 21 Currency_GBP with score:0.0
Feature 22 Currency_US with score:0.0
Feature 23 endDay_Fri with score:0.0
Feature 24 endDay_Mon with score:0.0
Feature 25 endDay_Sat with score:0.0
Feature 26 endDay_Sun with score:0.0
Feature 27 endDay_Thu with score:0.0
Feature 28 endDay_Tue with score:0.0
Feature 29 endDay_Wed with score:0.0
Feature 30 Duration_1 with score:0.0
Feature 31 Duration_3 with score:0.0
Feature 32 Duration_5 with score:0.0
Feature 33 Duration_7 with score:0.0
Feature 34 Duration_10 with score:0.0
```

```
Out[18]: ([0,
           1,
           2,
           3,
           4,
           5,
           6,
           7,
           8,
           9,
           10,
           11,
           12,
           13,
           14,
           15,
           16,
           17,
           18,
           19,
           20,
           21,
           22,
           23,
           24,
           25,
           26,
           27,
           28,
           29,
           30,
           31,
           32,
           33,
           34],
          <a list of 35 Text major ticklabel objects>)
```



In [19]:
```
# Reduce the number of predictors
X_2 = df_with_dummies[['OpenPrice', 'sellerRating']]
y_2 = df_with_dummies['Competitive?']

X_train_2, X_test_2, y_train_2, y_test_2 = train_test_split(X_2, y_2, te
st_size=0.4, random_state=1)
```

In [20]:
```
# Fit another classification tree
subsetClassTree = DecisionTreeClassifier(min_samples_leaf=50, random_sta
te=1)
subsetClassTree.fit(X_train_2, y_train_2)
```

Out[20]:
```
DecisionTreeClassifier(min_samples_leaf=50, random_state=1)
```

In [21]:
```
# Accuracy level
subsetClassTree.score(X_test_2, y_test_2)
```

Out[21]:
```
0.714828897338403
```

In [22]:

```
classificationSummary(y_test_2, subsetClassTree.predict(X_test_2))
```

```
Confusion Matrix (Accuracy 0.7148)

       Prediction
Actual   0   1
     0 222 131
     1  94 342
```

In [23]:

```
classificationSummary(y_train_2, subsetClassTree.predict(X_train_2))
```

```
Confusion Matrix (Accuracy 0.7270)

       Prediction
Actual   0   1
     0 363 190
     1 133 497
```

In [24]:

```
# Graph on http://webgraphviz.com/
export_graphviz(subsetClassTree,
                out_file='subsetClassTree.dot',
                class_names=['0', '1'],
                filled=True,
                feature_names=X_train_2.columns)
```

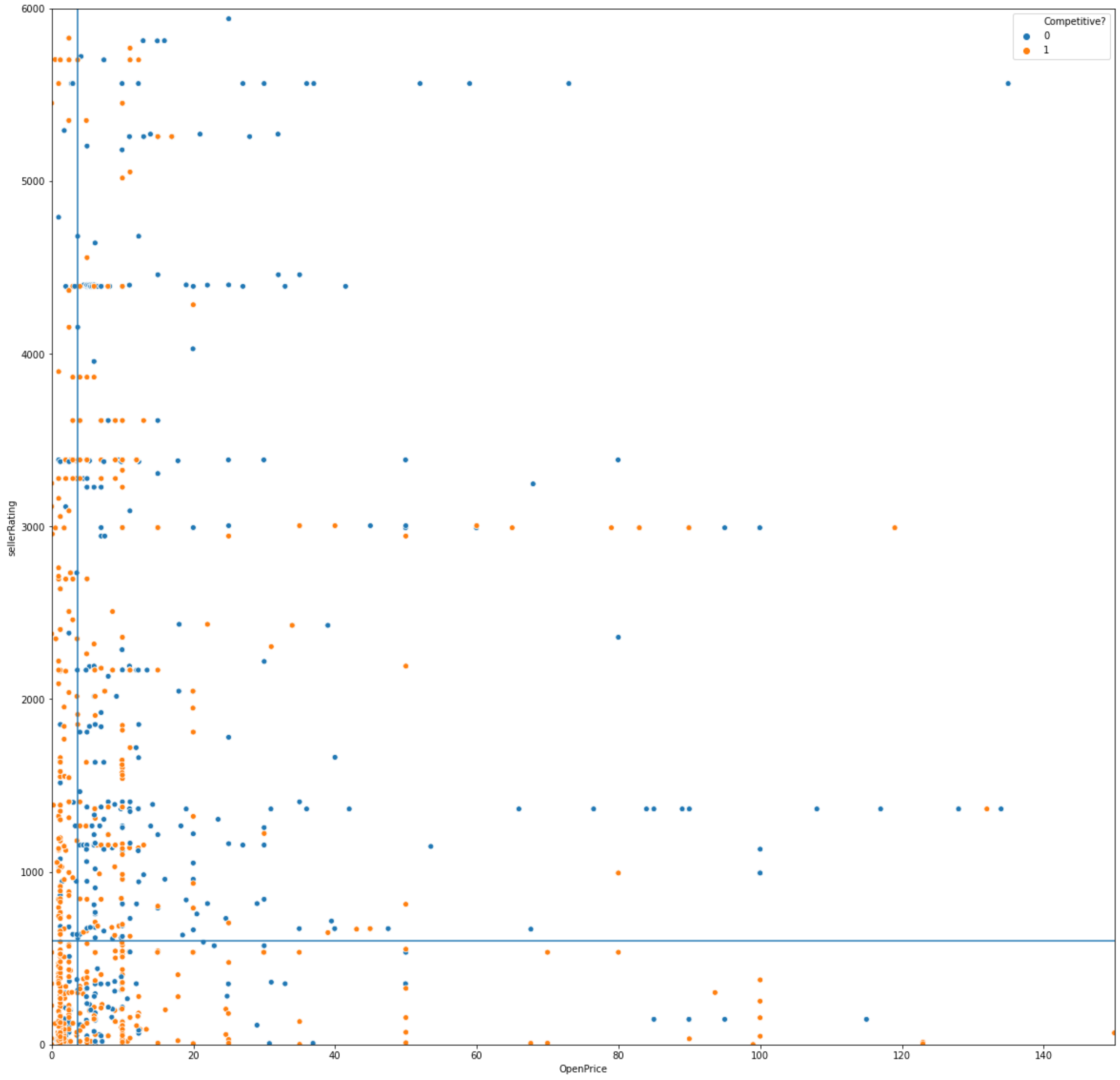
In [25]:

```
# Plot the resulting tree on a scatter plot: Use the two axes for the two best (quantitative) predictors
plt.figure(figsize=(20,20))
sns.scatterplot(x='OpenPrice', y='sellerRating', hue='Competitive?', data=df_with_dummies)
plt.xlim(0,150)
plt.ylim(0,6000)

# Draw lines at the values that create split
plt.axvline(3.615)
plt.axhline(601.5)
```

Out[25]:

```
<matplotlib.lines.Line2D at 0x7fccae297a00>
```



In [26]:

```
# Linear regression - determine variable significance
rfmodel = RandomForestClassifier(random_state=1)
rfmodel.fit(X_train, y_train)

# Get importance
importance = rfmodel.feature_importances_
```

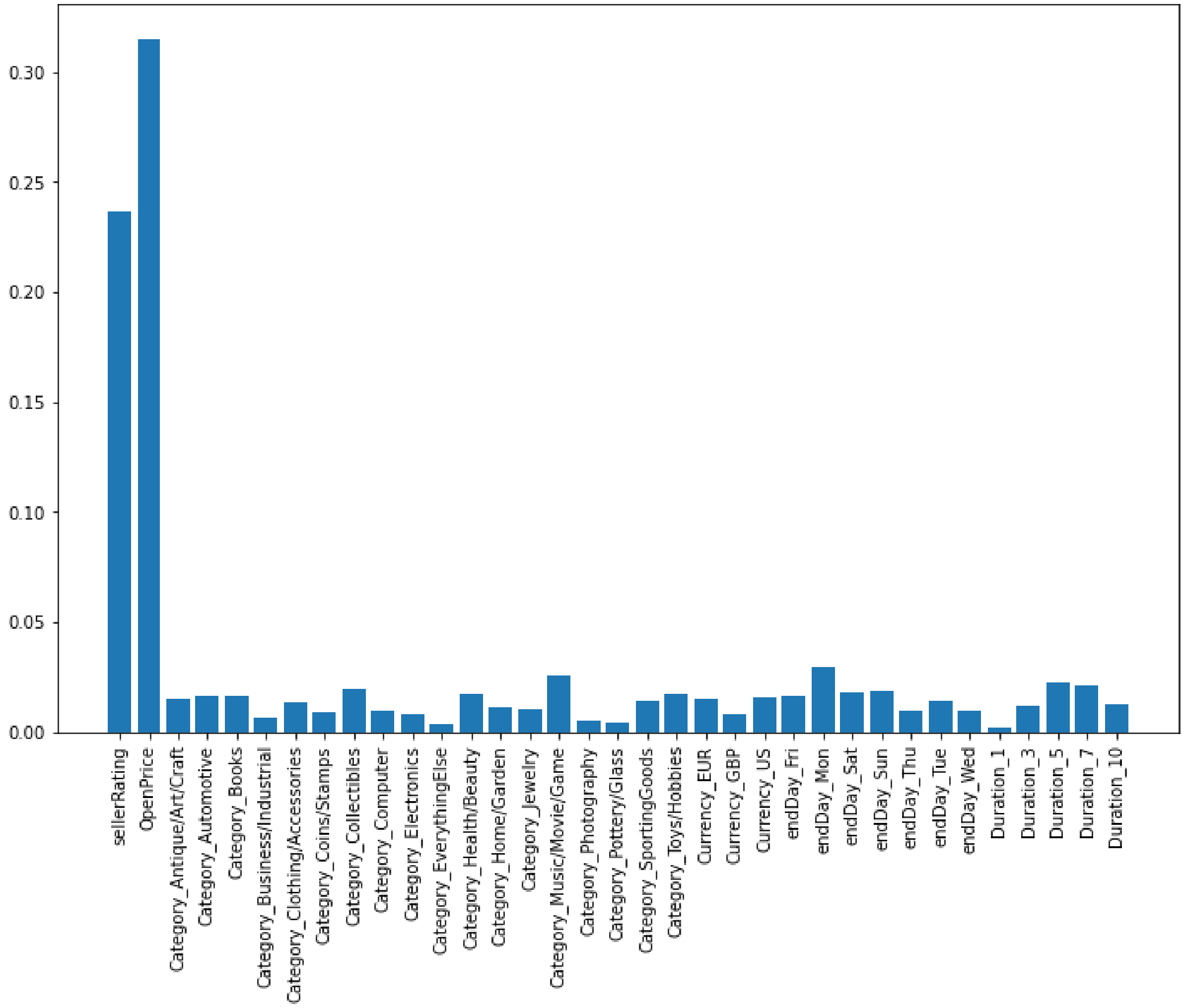
In [27]:

```
# Summarize feature importance
for i,v in enumerate(importance):
    #print('Feature: %0d, Score: %.5f' % (i,v))
    print('Feature ' + str(i) + ' ' + X_train.columns[i] + " with scor
e:" + str(round(importance[i],5)))

# Plot feature importance
plt.figure(figsize=(12,8))
plt.bar([X_train.columns[x] for x in range(len(importance))], importance
)
plt.xticks(rotation=90)
```

```
Feature 0 sellerRating with score:0.23637
Feature 1 OpenPrice with score:0.31534
Feature 2 Category_Antique/Art/Craft with score:0.01462
Feature 3 Category_Automotive with score:0.01639
Feature 4 Category_Books with score:0.01632
Feature 5 Category_Business/Industrial with score:0.00659
Feature 6 Category_Clothing/Accessories with score:0.01371
Feature 7 Category_Coins/Stamps with score:0.00891
Feature 8 Category_Collectibles with score:0.01963
Feature 9 Category_Computer with score:0.00959
Feature 10 Category_Electronics with score:0.00834
Feature 11 Category_EverythingElse with score:0.00382
Feature 12 Category_Health/Beauty with score:0.01707
Feature 13 Category_Home/Garden with score:0.01144
Feature 14 Category_Jewelry with score:0.01042
Feature 15 Category_Music/Movie/Game with score:0.02538
Feature 16 Category_Photography with score:0.00499
Feature 17 Category_Pottery/Glass with score:0.00429
Feature 18 Category_SportingGoods with score:0.01422
Feature 19 Category_Toys/Hobbies with score:0.01762
Feature 20 Currency_EUR with score:0.01483
Feature 21 Currency_GBP with score:0.00819
Feature 22 Currency_US with score:0.01593
Feature 23 endDay_Fri with score:0.01636
Feature 24 endDay_Mon with score:0.0293
Feature 25 endDay_Sat with score:0.01777
Feature 26 endDay_Sun with score:0.01876
Feature 27 endDay_Thu with score:0.00971
Feature 28 endDay_Tue with score:0.01399
Feature 29 endDay_Wed with score:0.0097
Feature 30 Duration_1 with score:0.00223
Feature 31 Duration_3 with score:0.01166
Feature 32 Duration_5 with score:0.0229
Feature 33 Duration_7 with score:0.02111
Feature 34 Duration_10 with score:0.01249
```

```
Out[27]: ([0,
           1,
           2,
           3,
           4,
           5,
           6,
           7,
           8,
           9,
           10,
           11,
           12,
           13,
           14,
           15,
           16,
           17,
           18,
           19,
           20,
           21,
           22,
           23,
           24,
           25,
           26,
           27,
           28,
           29,
           30,
           31,
           32,
           33,
           34],
          <a list of 35 Text major ticklabel objects>)
```


0.30
0.25
0.20
0.15
0.10
0.05
0.00
sellerRating
OpenPrice
Category_Antique/Art/Craft
Category_Automotive
Category_Books
Category_Business/Industrial
Category_Clothing/Accessories
Category_Coins/Stamps
Category_Collectibles
Category_Computer
Category_Electronics
Category_EverythingElse
Category_Health/Beauty
Category_Home/Garden
Category_Jewelry
Category_Music/Movie/Game
Category_Photography
Category_Pottery/Glass
Category_SportingGoods
Category_Toys/Hobbies
Currency_EUR
Currency_GBP
Currency_US
endDay_Fri
endDay_Mon
endDay_Sat
endDay_Sun
endDay_Thu
endDay_Tue
endDay_Wed
Duration_1
Duration_3
Duration_5
Duration_7
Duration_10

In [ ]: