1 Data Insights into Making a Successful Movie

- Sergio Rodriguez
- Student pace: Full time
- Scheduled project review date/time: Wednesday**
- Instructor name: Abhineet Kulkarni
- Blog post URL: Still need to make a blog post

1.1 Overview

Microsoft is looking to expand its footprint outside of their core lines of business, and start a new movie studio arm. The goal of our project is to analyze movie data in order to provide meaningful insights for Microsoft's new movie studio. The analysis provided answers some of the main questions a movie studio would ask for such a business venture to be successful, namely, when to release a prospective film, which genres to produce, and which studios to use, all in an attempt to generate the highest rate of return for Microsoft and their clients.

1.2 1. Which genres generate the highest ROI?

```
    -Investigate from a profitabilty perspective i.e. ROI, which genres lead to the highest return
    -Of the genres with the highest ROI, are there any differneces that would prefer one genre to anothe
r?
```

In [2]:

```
#importing all of the libraries I plan to use
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from glob import glob
from  matplotlib.ticker import FuncFormatter
```

executed in 875ms, finished 20:32:24 2020-12-08

In [3]:

```
#creating variable with last of all files for the project
csv_files = glob('zippedData/*.csv.gz')
```

executed in 4ms, finished 20:32:24 2020-12-08

In [4]:

```
csv_files
```

executed in 6ms, finished 20:32:24 2020-12-08

Out[4]:

```
['zippedData\\bom.movie_gross.csv.gz',
 'zippedData\\imdb.name.basics.csv.gz',
 'zippedData\\imdb.title.akas.csv.gz',
 'zippedData\\imdb.title.basics.csv.gz',
 'zippedData\\imdb.title.crew.csv.gz',
 'zippedData\\imdb.title.principals.csv.gz',
 'zippedData\\imdb.title.ratings.csv.gz',
 'zippedData\\tmdb.movies.csv.gz',
 'zippedData\\tn.movie_budgets.csv.gz']
```

In [5]:

```
#Using a for loop to create a dictionary with cleaned filenames
import os
csv_files_dict = {}
for filename in csv_files:
    filename_cleaned = os.path.basename(filename).replace('.csv','').replace('.','_')
    filename_df = pd.read_csv(filename, index_col = 0)
    csv_files_dict[filename_cleaned] = filename_df
```

executed in 3.18s, finished 20:32:28 2020-12-08

In [6]:

```
#creating variable for movie budgets file
budgets = csv_files_dict['tn_movie_budgets_gz']
```

executed in 4ms, finished 20:32:28 2020-12-08

In [7]:
```
budgets.head()
```
executed in 10ms, finished 20:32:28 2020-12-08

Out[7]:

	release_date	movie	production_budget	domestic_gross	worldwide_gross
id					
1	Dec 18, 2009	Avatar	$425,000,000	$760,507,625	$2,776,345,279
2	May 20, 2011	Pirates of the Caribbean: On Stranger Tides	$410,600,000	$241,063,875	$1,045,663,875
3	Jun 7, 2019	Dark Phoenix	$350,000,000	$42,762,350	$149,762,350
4	May 1, 2015	Avengers: Age of Ultron	$330,600,000	$459,005,868	$1,403,013,963
5	Dec 15, 2017	Star Wars Ep. VIII: The Last Jedi	$317,000,000	$620,181,382	$1,316,721,747

In [8]:
```
budgets.info()
```
executed in 9ms, finished 20:32:28 2020-12-08

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 5782 entries, 1 to 82
Data columns (total 5 columns):
 #   Column             Non-Null Count  Dtype 
---  ------             --------------  ----- 
 0   release_date       5782 non-null   object
 1   movie              5782 non-null   object
 2   production_budget  5782 non-null   object
 3   domestic_gross     5782 non-null   object
 4   worldwide_gross    5782 non-null   object
dtypes: object(5)
memory usage: 271.0+ KB
```

In [9]:
```
budgets.reset_index(inplace=True)
```
executed in 4ms, finished 20:32:28 2020-12-08

In [10]:

```
#id column provides no value so dropping
budgets.drop('id',axis=1,inplace=True)
```

executed in 5ms, finished 20:32:29 2020-12-08

In [11]:

```
#checking
budgets.head()
```

executed in 8ms, finished 20:32:40 2020-12-08

Out[11]:

	release_date	movie	production_budget	domestic_gross	worldwide_gross
0	Dec 18, 2009	Avatar	$425,000,000	$760,507,625	$2,776,345,279
1	May 20, 2011	Pirates of the Caribbean: On Stranger Tides	$410,600,000	$241,063,875	$1,045,663,875
2	Jun 7, 2019	Dark Phoenix	$350,000,000	$42,762,350	$149,762,350
3	May 1, 2015	Avengers: Age of Ultron	$330,600,000	$459,005,868	$1,403,013,963
4	Dec 15, 2017	Star Wars Ep. VIII: The Last Jedi	$317,000,000	$620,181,382	$1,316,721,747

In [12]:

```
#our budget and revenue columns are objects, we need to convert them to int or float in order to use them
#I do this using a lambda function and map method
budgets['worldwide_gross'] = budgets['worldwide_gross'].astype(str).apply(lambda x: int(x.replace(',','').replac
budgets['production_budget'] = budgets['production_budget'].astype(str).apply(lambda x: int(x.replace(',','').re
budgets['domestic_gross'] = budgets['domestic_gross'].astype(str).apply(lambda x: int(x.replace(',','').replace(
```

executed in 20ms, finished 20:32:44 2020-12-08

In [13]:

```
#I also would like to convert our release date column into date time format instead of an object for later on
budgets.info()
```

executed in 8ms, finished 20:32:45 2020-12-08

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 5782 entries, 0 to 5781
Data columns (total 5 columns):
 #   Column             Non-Null Count  Dtype 
---  ------             --------------  ----- 
 0   release_date       5782 non-null   object
 1   movie              5782 non-null   object
 2   production_budget  5782 non-null   int64 
 3   domestic_gross     5782 non-null   int64 
 4   worldwide_gross    5782 non-null   int64 
dtypes: int64(3), object(2)
memory usage: 226.0+ KB
```

In [14]:

```
# converting release date to a date time format, creating a column for months with number (1-12) and for written
import calendar
budgets['release_date'] = pd.to_datetime(budgets.release_date).sort_values(axis=0, ascending=False)
budgets['month'] = pd.DatetimeIndex(budgets.release_date).month
budgets['Month'] = budgets['month'].apply(lambda x: calendar.month_abbr[x])
```

executed in 518ms, finished 20:32:46 2020-12-08

In [15]:

```
budgets.head()
```

executed in 10ms, finished 20:32:51 2020-12-08

Out[15]:

	release_date	movie	production_budget	domestic_gross	worldwide_gross	month	Month
0	2009-12-18	Avatar	425000000	760507625	2776345279	12	Dec
1	2011-05-20	Pirates of the Caribbean: On Stranger Tides	410600000	241063875	1045663875	5	May
2	2019-06-07	Dark Phoenix	350000000	42762350	149762350	6	Jun
3	2015-05-01	Avengers: Age of Ultron	330600000	459005868	1403013963	5	May
4	2017-12-15	Star Wars Ep. VIII: The Last Jedi	317000000	620181382	1316721747	12	Dec

In [16]:

```
#checking columns for recurring values, nothing sticks out here
for col in budgets:
    print(f"Currently checking values from col: {col}")
    print(f"Top 5 values:\n{budgets[col].value_counts(normalize=True)[:5]}")
    print('-----------------------')
```

executed in 18ms, finished 20:32:51 2020-12-08

```
Currently checking values from col: release_date
Top 5 values:
2014-12-31    0.004151
2015-12-31    0.003978
2010-12-31    0.002594
2008-12-31    0.002421
2013-12-31    0.002248
Name: release_date, dtype: float64
-----------------------
Currently checking values from col: movie
Top 5 values:
King Kong    0.000519
Halloween    0.000519
Home         0.000519
RoboCop      0.000346
Legend       0.000346
Name: movie, dtype: float64
-----------------------
Currently checking values from col: production_budget
Top 5 values:
20000000    0.039952
10000000    0.036666
30000000    0.030612
15000000    0.029920
25000000    0.029575
Name: production_budget, dtype: float64
-----------------------
Currently checking values from col: domestic_gross
Top 5 values:
0           0.094777
8000000     0.001557
2000000     0.001211
7000000     0.001211
10000000    0.001038
Name: domestic_gross, dtype: float64
```

```
-----------------------
Currently checking values from col: worldwide_gross
Top 5 values:
0          0.063473
8000000    0.001557
7000000    0.001038
2000000    0.001038
4000000    0.000692
Name: worldwide_gross, dtype: float64
-----------------------
Currently checking values from col: month
Top 5 values:
12    0.128848
10    0.099101
8     0.085783
9     0.085265
11    0.084054
Name: month, dtype: float64
-----------------------
Currently checking values from col: Month
Top 5 values:
Dec    0.128848
Oct    0.099101
Aug    0.085783
Sep    0.085265
Nov    0.084054
Name: Month, dtype: float64
-----------------------
```

Now that we have cleaned our data we can move on to creating an ROI column for our movies

In [17]:

```python
#In order to get to ROI I am  first making a column for Profit
budgets['Profit'] = budgets['worldwide_gross'] - budgets['production_budget']
```

executed in 4ms, finished 20:32:55 2020-12-08

In [18]:

```python
#checking to see our new column and sorting by profit
budgets.sort_values(by='Profit', ascending=False, inplace=True)
```

executed in 5ms, finished 20:32:59 2020-12-08

In [19]:
```
budgets.head()
```
executed in 10ms, finished 20:32:59 2020-12-08

Out[19]:

	release_date	movie	production_budget	domestic_gross	worldwide_gross	month	Month	Profit
0	2009-12-18	Avatar	425000000	760507625	2776345279	12	Dec	2351345279
42	1997-12-19	Titanic	200000000	659363944	2208208395	12	Dec	2008208395
6	2018-04-27	Avengers: Infinity War	300000000	678815482	2048134200	4	Apr	1748134200
5	2015-12-18	Star Wars Ep. VII: The Force Awakens	306000000	936662225	2053311220	12	Dec	1747311220
33	2015-06-12	Jurassic World	215000000	652270625	1648854864	6	Jun	1433854864

In [20]:
```
#Now to add a column for ROI
budgets['ROI'] = (budgets['Profit'] / budgets['production_budget']) * 100
```
executed in 3ms, finished 20:33:03 2020-12-08

In [21]:
```
#Sorting and viewing movies with top ROI
budgets = budgets.sort_values(by='ROI',ascending=False)
```
executed in 4ms, finished 20:33:03 2020-12-08

In [22]:
```
# I can already see that the 5 top movies by profit are not among the top 5 movies by ROI
budgets.head()
```
executed in 9ms, finished 20:33:07 2020-12-08

Out[22]:

	release_date	movie	production_budget	domestic_gross	worldwide_gross	month	Month	Profit	ROI
5745	1972-06-30	Deep Throat	25000	45000000	45000000	6	Jun	44975000	179900.00000
5613	1980-03-21	Mad Max	200000	8750000	99750000	3	Mar	99550000	49775.00000
5492	2009-09-25	Paranormal Activity	450000	107918810	194183034	9	Sep	193733034	43051.78533
5679	2015-07-10	The Gallows	100000	22764410	41656474	7	Jul	41556474	41556.47400
5406	1999-07-14	The Blair Witch Project	600000	140539099	248300000	7	Jul	247700000	41283.33333

Now I have ROI which is the target variable I will use for my investigations.

In [25]:
```
#importing relevant data table with genre data, and resetting index so we have tconst as a column for later
genres = csv_files_dict['imdb_title_basics_gz']
genres.reset_index(inplace=True)
```
executed in 5ms, finished 20:33:50 2020-12-08

In [26]:
```
genres.head()
```

executed in 10ms, finished 20:33:50 2020-12-08

Out[26]:

	index	tconst	primary_title	original_title	start_year	runtime_minutes	genres
0	0	tt0063540	Sunghursh	Sunghursh	2013	175.0	Action,Crime,Drama
1	1	tt0066787	One Day Before the Rainy Season	Ashad Ka Ek Din	2019	114.0	Biography,Drama
2	2	tt0069049	The Other Side of the Wind	The Other Side of the Wind	2018	122.0	Drama
3	3	tt0069204	Sabse Bada Sukh	Sabse Bada Sukh	2018	NaN	Comedy,Drama
4	4	tt0100275	The Wandering Soap Opera	La Telenovela Errante	2017	80.0	Comedy,Drama,Fantasy

In [27]:
```
# Renaming column we want to join on
genres.rename(columns={'primary_title' : 'movie'}, inplace=True)
```

executed in 3ms, finished 20:33:51 2020-12-08

In [28]:
```
#dfBG for dataframe Budget Genres
dfBG = budgets.set_index('movie').join(genres.set_index('movie'), how='left', on='movie')
```

executed in 61ms, finished 20:33:52 2020-12-08

In [29]:
```
#resetting index as i dont want my data to be indexed by movies
dfBG.reset_index(inplace=True)
```

executed in 5ms, finished 20:33:52 2020-12-08

In [30]:

```
dfBG.info()
```

executed in 11ms, finished 20:33:52 2020-12-08

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 7221 entries, 0 to 7220
Data columns (total 15 columns):
 #   Column             Non-Null Count  Dtype         
---  ------             --------------  -----         
 0   movie              7221 non-null   object        
 1   release_date       7221 non-null   datetime64[ns]
 2   production_budget  7221 non-null   int64         
 3   domestic_gross     7221 non-null   int64         
 4   worldwide_gross    7221 non-null   int64         
 5   month              7221 non-null   int64         
 6   Month              7221 non-null   object        
 7   Profit             7221 non-null   int64         
 8   ROI                7221 non-null   float64       
 9   index              3815 non-null   float64       
 10  tconst             3815 non-null   object        
 11  original_title     3814 non-null   object        
 12  start_year         3815 non-null   float64       
 13  runtime_minutes    3328 non-null   float64       
 14  genres             3743 non-null   object        
dtypes: datetime64[ns](1), float64(4), int64(5), object(5)
memory usage: 846.3+ KB
```

In [31]:

```
#48% of our rows for genre are missing but cannot do anything about the data we received at least for this proje
dfBG.isna().sum()
```

executed in 7ms, finished 20:33:55 2020-12-08

Out[31]:

```
movie                  0
release_date           0
production_budget      0
domestic_gross         0
worldwide_gross        0
month                  0
Month                  0
Profit                 0
ROI                    0
index               3406
tconst              3406
original_title      3407
start_year          3406
runtime_minutes     3893
genres              3478
dtype: int64
```

In [32]:

```
#dropping na values as they dont have our ROI data
dfBG.dropna(inplace=True)
```

executed in 10ms, finished 20:33:55 2020-12-08

In [33]:

```
#checking
dfBG.isna().sum()
```

executed in 7ms, finished 20:34:01 2020-12-08

Out[33]:

```
movie              0
release_date       0
production_budget  0
domestic_gross     0
worldwide_gross    0
month              0
Month              0
Profit             0
ROI                0
index              0
tconst             0
original_title     0
start_year         0
runtime_minutes    0
genres             0
dtype: int64
```

In [34]:

```
#checking for dupes
dfBG.movie.duplicated().sum()
```

executed in 3ms, finished 20:34:01 2020-12-08

Out[34]:

```
1106
```

In [35]:
```
#investigating dupes, seems in the join multiple entries were made for same release date
dfBG[dfBG.movie.duplicated()]
```
executed in 21ms, finished 20:34:06 2020-12-08

Out[35]:

	movie	release_date	production_budget	domestic_gross	worldwide_gross	month	Month	Profit	ROI
35	Cinderella	1950-02-15	2900000	85000000	263591415	2	Feb	260691415	8989.359138
36	Cinderella	1950-02-15	2900000	85000000	263591415	2	Feb	260691415	8989.359138
37	Cinderella	1950-02-15	2900000	85000000	263591415	2	Feb	260691415	8989.359138
38	Cinderella	1950-02-15	2900000	85000000	263591415	2	Feb	260691415	8989.359138
42	Home	2009-04-23	500000	15433	44793168	4	Apr	44293168	8858.633600
...	...	...	...	...	...	...	...	...	..
7174	Ten	2015-04-21	25000	0	0	4	Apr	-25000	-100.000000
7190	Irreplaceable	2015-02-24	600000	0	0	2	Feb	-600000	-100.000000
7191	Irreplaceable	2015-02-24	600000	0	0	2	Feb	-600000	-100.000000
7200	Treading Water	2015-03-10	4700000	0	0	3	Mar	-4700000	-100.000000
7201	Treading Water	2015-03-10	4700000	0	0	3	Mar	-4700000	-100.000000

1106 rows × 15 columns

In [36]:
```
#dropping duplicates below using subset release date as some movies indeed have multiple remakes
dfBG.drop_duplicates(subset=['release_date', 'movie'], inplace=True)
```
executed in 6ms, finished 20:34:06 2020-12-08

In [37]:
```
#checking results
dfBG[dfBG.movie.duplicated(keep=False)].sort_values('movie', ascending=True).head()
```

executed in 15ms, finished 20:34:08 2020-12-08

Out[37]:

	movie	release_date	production_budget	domestic_gross	worldwide_gross	month	Month	Profit	ROI
1980	A Nightmare on Elm Street	2010-04-30	35000000	63075011	117729621	4	Apr	82729621	236.370346
327	A Nightmare on Elm Street	1984-11-09	1800000	25504513	25504513	11	Nov	23704513	1316.917389
254	Aladdin	1992-11-11	28000000	217350219	504050219	11	Nov	476050219	1700.179354
1958	Aladdin	2019-05-24	182000000	246734314	619234314	5	May	437234314	240.238634
1206	Alice in Wonderland	2010-03-05	200000000	334191110	1025491110	3	Mar	825491110	412.745555

In [38]:

```
dfBG.info()
```

executed in 9ms, finished 20:34:09 2020-12-08

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 2264 entries, 3 to 7220
Data columns (total 15 columns):
 #   Column             Non-Null Count  Dtype         
---  ------             --------------  -----         
 0   movie              2264 non-null   object        
 1   release_date       2264 non-null   datetime64[ns]
 2   production_budget  2264 non-null   int64         
 3   domestic_gross     2264 non-null   int64         
 4   worldwide_gross    2264 non-null   int64         
 5   month              2264 non-null   int64         
 6   Month              2264 non-null   object        
 7   Profit             2264 non-null   int64         
 8   ROI                2264 non-null   float64       
 9   index              2264 non-null   float64       
 10  tconst             2264 non-null   object        
 11  original_title     2264 non-null   object        
 12  start_year         2264 non-null   float64       
 13  runtime_minutes    2264 non-null   float64       
 14  genres             2264 non-null   object        
dtypes: datetime64[ns](1), float64(4), int64(5), object(5)
memory usage: 283.0+ KB
```

In [39]:
```
#investigating our genres column and need to make into string, create a list, and then make columns with indivia
dfBG.genres
```
executed in 5ms, finished 20:34:10 2020-12-08

Out[39]:
```
3         Horror,Mystery,Thriller
6           Biography,Documentary
8                          Horror
9             Action,Comedy,Drama
11                Horror,Thriller
                   ...
7214        Drama,Romance,Sci-Fi
7217              Comedy,Romance
7218             Sci-Fi,Thriller
7219             Horror,Thriller
7220                    Thriller
Name: genres, Length: 2264, dtype: object
```

In [40]:
```
#our lambda funciton is useful for this with split method creates our list
dfBG['genres_split'] = dfBG['genres'].map(lambda x: x.split(',') if x else x)
dfBG.head()
```
executed in 15ms, finished 20:34:13 2020-12-08

Out[40]:

	movie	release_date	production_budget	domestic_gross	worldwide_gross	month	Month	Profit	ROI	i
3	The Gallows	2015-07-10	100000	22764410	41656474	7	Jul	41556474	41556.474000	3
6	Bambi	1942-08-13	858000	102797000	268000000	8	Aug	267142000	31135.431235	4
8	Night of the Living Dead	1968-10-01	114000	12087064	30087064	10	Oct	29973064	26292.161404	5
9	Rocky	1976-11-21	1000000	117235147	225000000	11	Nov	224000000	22400.000000	5
11	Halloween	1978-10-17	325000	47000000	70000000	10	Oct	69675000	21438.461538	

In [41]:
```
#resetting index since when we dropped dupes our index values no longer match our shape
dfBG.reset_index(inplace=True)
```
executed in 3ms, finished 20:34:15 2020-12-08

In [42]:
```
dfBG.drop('index',axis=1,inplace=True)
```
executed in 5ms, finished 20:34:15 2020-12-08

In [43]:
```
dfBG.head()
```
executed in 13ms, finished 20:34:17 2020-12-08

Out[43]:
```
   level_0                       movie  release_date  production_budget  domestic_gross  worldwide_gross  month  Month      Profit
0        3                 The Gallows    2015-07-10             100000        22764410         41656474      7    Jul    41556474  4155
1        6                       Bambi    1942-08-13             858000       102797000        268000000      8    Aug   267142000  3113
2        8  Night of the Living Dead    1968-10-01             114000        12087064         30087064     10    Oct    29973064  2629.
3        9                       Rocky    1976-11-21            1000000       117235147        225000000     11    Nov   224000000  2240
4       11                   Halloween    1978-10-17             325000        47000000         70000000     10    Oct    69675000  2143
```

In [44]:
```
#below we are taking our list and creating a new column with first entry in that list
dfBG['genre1'] = dfBG['genres_split'].map(lambda x: x[0])
```
executed in 4ms, finished 20:34:18 2020-12-08

In [45]:

```
#checking our genres_split to make sure is indeed list
type(dfBG.genres_split[1])
```

executed in 4ms, finished 20:34:18 2020-12-08

Out[45]:

```
list
```

In [46]:

```
#Checking value counts to see distribution, notice that family and below have few observations in our dataset
dfBG.genre1.value_counts()
```

executed in 6ms, finished 20:34:19 2020-12-08

Out[46]:

```
Action         545
Drama          477
Comedy         410
Adventure      199
Biography      150
Documentary    137
Horror         135
Crime          122
Thriller        22
Animation       22
Sci-Fi          11
Family           8
Fantasy          7
Mystery          6
Romance          5
Musical          4
Music            2
Western          1
War              1
Name: genre1, dtype: int64
```

In [47]:

```
#using our lambda function again here but create a variable to use as reference if movie only has 1 genre
y = 'NA'
dfBG['genre2'] = dfBG['genres_split'].map(lambda x: y if len(x) < 2 else x[1])
```

executed in 5ms, finished 20:34:21 2020-12-08

In [48]:

```
dfBG['genre3'] = dfBG['genres_split'].map(lambda x: y if len(x) < 3 else x[2])
```

executed in 5ms, finished 20:34:21 2020-12-08

In [49]:

```
#Great so now we have Genres separated and ROI time to plot
dfBG.head()
```

executed in 18ms, finished 20:34:22 2020-12-08

Out[49]:

	level_0	movie	release_date	production_budget	domestic_gross	worldwide_gross	month	Month	Profit	
0	3	The Gallows	2015-07-10	100000	22764410	41656474	7	Jul	41556474	4155
1	6	Bambi	1942-08-13	858000	102797000	268000000	8	Aug	267142000	3113
2	8	Night of the Living Dead	1968-10-01	114000	12087064	30087064	10	Oct	29973064	2629
3	9	Rocky	1976-11-21	1000000	117235147	225000000	11	Nov	224000000	2240
4	11	Halloween	1978-10-17	325000	47000000	70000000	10	Oct	69675000	2143

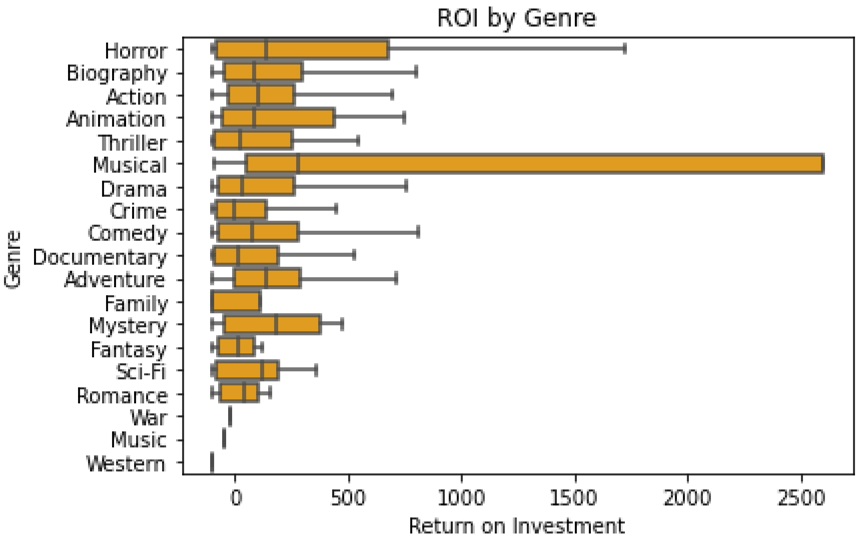
In [52]:

```
#running boxplot to have an idea of preliminary data looks like
#notice here that Musical although not the top has extremely large outlier as shown by error bar

sns.boxplot(x ='ROI' , y = 'genre1', data=dfBG.sort_values(by='ROI', ascending=False),showfliers=False,
            color='Orange').set(xlabel='Return on Investment', ylabel='Genre', title="ROI by Genre")
```

executed in 326ms, finished 20:35:39 2020-12-08

Out[52]:

```
[Text(0.5, 0, 'Return on Investment'),
 Text(0, 0.5, 'Genre'),
 Text(0.5, 1.0, 'ROI by Genre')]
```



In [53]:

```
#investigating why musical has such a large of ROI and notice it only has 4 occurences in our data
dfBG.genre1.value_counts()
```

executed in 6ms, finished 20:35:44 2020-12-08

Out[53]:

```
Action         545
Drama          477
Comedy         410
Adventure      199
Biography      150
Documentary    137
Horror         135
Crime          122
Thriller        22
Animation       22
Sci-Fi          11
Family           8
Fantasy          7
Mystery          6
Romance          5
Musical          4
Music            2
Western          1
War              1
Name: genre1, dtype: int64
```

In [54]:
```
#We can see the original cinderalla was extremely successful, and heavily skews the ROI data for that genre
dfBG[dfBG.genre1 == 'Musical']
```
executed in 13ms, finished 20:35:46 2020-12-08

Out[54]:

	level_0	movie	release_date	production_budget	domestic_gross	worldwide_gross	month	Month	Profit	
9	33	Cinderella	1950-02-15	2900000	85000000	263591415	2	Feb	260691415	898
325	1058	Cinderella	2015-03-13	95000000	201151353	534551353	3	Mar	439551353	46
1049	3198	The Covenant	2006-09-08	20000000	23364784	38164784	9	Sep	18164784	9
1877	6135	Standing Ovation	2010-07-16	5600000	531806	531806	7	Jul	-5068194	-9

In [130]:
```
#For context there are only 10 movies in our entire data set that have an ROI greater than 8000%
dfBG[dfBG.ROI > 8000].head()
```
executed in 13ms, finished 20:59:00 2020-12-08

Out[130]:

	level_0	movie	release_date	production_budget	domestic_gross	worldwide_gross	month	Month	Profit	
0	3	The Gallows	2015-07-10	100000	22764410	41656474	7	Jul	41556474	4155
1	6	Bambi	1942-08-13	858000	102797000	268000000	8	Aug	267142000	3113
2	8	Night of the Living Dead	1968-10-01	114000	12087064	30087064	10	Oct	29973064	2629
3	9	Rocky	1976-11-21	1000000	117235147	225000000	11	Nov	224000000	2240
4	11	Halloween	1978-10-17	325000	47000000	70000000	10	Oct	69675000	2143

In [56]:

```
#create new df with groupby for genres aggregated by median and count
#resetting the index to reference genres for our plot
# and checking our new df
genrestats = dfBG.groupby(by='genre1').agg(['median','mean', 'count'])
genrestats.reset_index(inplace=True)
genrestats.head()
```

executed in 44ms, finished 20:37:17 2020-12-08

Out[56]:

	genre1	level_0			production_budget			domestic_gross			...	month	Profi
		median	mean	count	median	mean	count	median	mean	count	...	count	me
0	Action	3089.0	3442.772477	545	42500000	7.014503e+07	545	38362475.0	7.707130e+07	545	...	545	4164
1	Adventure	2742.0	3129.150754	199	50000000	6.884572e+07	199	55483770.0	8.452708e+07	199	...	199	5194
2	Animation	3291.0	3438.818182	22	28500000	4.148987e+07	22	28010636.5	8.094487e+07	22	...	22	1681
3	Biography	3290.0	3421.440000	150	17000000	2.212839e+07	150	15613098.5	3.229156e+07	150	...	150	1018
4	Comedy	3413.5	3639.200000	410	12000000	2.040214e+07	410	16416490.5	3.200412e+07	410	...	410	972

5 rows × 25 columns

In [57]:

```
#most importantly here we are filtering out the genres with less than 10 observations as they dont have enough a
#for us to make a conclusion about that genre and to minimize the skew in our data i.e. musicals
genrestats1 = genrestats[genrestats['production_budget']['count'] >10]
```

executed in 4ms, finished 20:37:17 2020-12-08

In [58]:
```
budgets.describe()
```

executed in 22ms, finished 20:37:20 2020-12-08

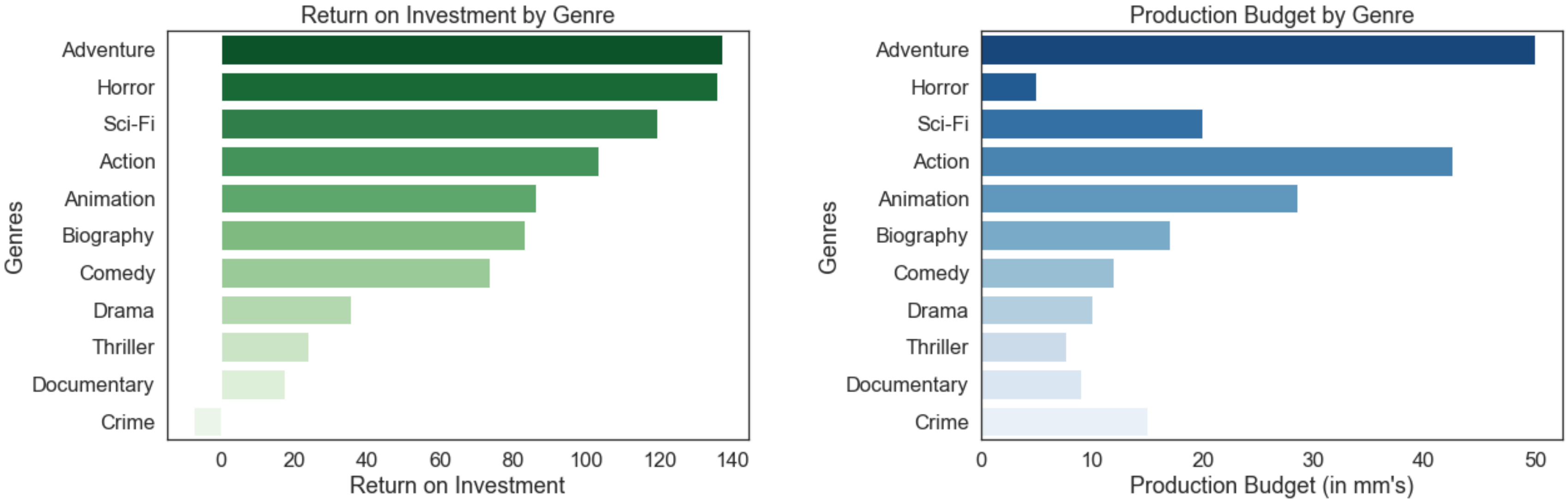
Out[58]:

	production_budget	domestic_gross	worldwide_gross	month	Profit	ROI
count	5.782000e+03	5.782000e+03	5.782000e+03	5782.000000	5.782000e+03	5782.000000
mean	3.158776e+07	4.187333e+07	9.148746e+07	7.050675	5.989970e+07	380.016137
std	4.181208e+07	6.824060e+07	1.747200e+08	3.480147	1.460889e+08	2953.028231
min	1.100000e+03	0.000000e+00	0.000000e+00	1.000000	-2.002376e+08	-100.000000
25%	5.000000e+06	1.429534e+06	4.125415e+06	4.000000	-2.189071e+06	-50.770440
50%	1.700000e+07	1.722594e+07	2.798445e+07	7.000000	8.550286e+06	70.830983
75%	4.000000e+07	5.234866e+07	9.764584e+07	10.000000	6.096850e+07	275.834608
max	4.250000e+08	9.366622e+08	2.776345e+09	12.000000	2.351345e+09	179900.000000

In [137]:

```
#Both plots below are sorted by ROI descending. The left plot show median ROI of each Genre, while the
#right plot shows production budget of each genre

plt.figure(figsize=(20,6))
sns.set(font_scale = 1.5)
sns.set_style("white")
ax1 = plt.subplot(1,2,1)
ax1 = sns.barplot(x=('ROI','median'), y=('genre1'), data=genrestats1.sort_values(('ROI','median'), ascending=Fal
            palette='Greens_r').set(ylabel='Genres', xlabel=('Return on Investment'), title=("Return on Investme

ax2 = plt.subplot(1,2,2)
ax2 = sns.barplot(x=('production_budget','median'), y=('genre1'), data=genrestats1.sort_values(('ROI','median'),
            palette='Blues_r').set(ylabel='Genres', xlabel=("Production Budget (in mm's)"), title=("Production B
plt.gca().xaxis.set_major_formatter(FuncFormatter(lambda x, _: int(x/1000000)))

plt.subplots_adjust(wspace=.4)

plt.savefig('images/ROIbyGenres1')

#(*To note this does not include the genres we dropped with less than 10 data points where otherwise)
#(*the musical genre would have been the genre with the highest ROI)
```

executed in 486ms, finished 21:00:27 2020-12-08



Firstly, we can see that the top 5 genres by ROI (left-plot) are Adventure, Horror, Sci-Fi, Action, and Animation Secondly, and more importantly is that among the top 5 genres by ROI, Horror had the smallest budget yet still yielded the second highest ROI of the genres in our data set

In conclusion, on a purely profitability basis, I would suggest that MSFT make a movie in one of the top 5 genres mentioned. If budget constraint is a material factor in this decision, horror movies would require the least amount of investment.

2 What are the best months to release a film?

```
-Investigate how the release month of a film influences profitability and viewer metrics
-Investigate which months would be most beneficial for profitability and viewer metrics
-Investigate the relationship between viewer metrics and budget metrics
```

In [60]:

```
#importing file with popularity and vote information (2 versions 1 for investigating on its own and other for me
#When table is joined will lose substantial amount of data for audience participation so can plot that data in a
tmdb_movies = csv_files_dict['tmdb_movies_gz']
tmdb_movies1 = csv_files_dict['tmdb_movies_gz']
tmdb_movies.head()
```

executed in 11ms, finished 20:37:42 2020-12-08

Out[60]:

	genre_ids	id	original_language	original_title	popularity	release_date	title	vote_average	vote_count
0	[12, 14, 10751]	12444	en	Harry Potter and the Deathly Hallows: Part 1	33.533	2010-11-19	Harry Potter and the Deathly Hallows: Part 1	7.7	10788
1	[14, 12, 16, 10751]	10191	en	How to Train Your Dragon	28.734	2010-03-26	How to Train Your Dragon	7.7	7610
2	[12, 28, 878]	10138	en	Iron Man 2	28.515	2010-05-07	Iron Man 2	6.8	12368
3	[16, 35, 10751]	862	en	Toy Story	28.005	1995-11-22	Toy Story	7.9	10174
4	[28, 878, 12]	27205	en	Inception	27.920	2010-07-16	Inception	8.3	22186

In [61]:

```
#no missing values
tmdb_movies.isna().sum()
```

executed in 9ms, finished 20:37:43 2020-12-08

Out[61]:

```
genre_ids            0
id                   0
original_language    0
original_title       0
popularity           0
release_date         0
title                0
vote_average         0
vote_count           0
dtype: int64
```

In [62]:

```
#making the release date into a date time so easier to plot
import calendar
tmdb_movies['release_date'] = pd.to_datetime(tmdb_movies.release_date).sort_values(axis=0, ascending=False)
tmdb_movies['month'] = pd.DatetimeIndex(tmdb_movies.release_date).month
tmdb_movies['Month'] = tmdb_movies['month'].apply(lambda x: calendar.month_abbr[x])
```

executed in 109ms, finished 20:37:43 2020-12-08

In [63]:

```
#checking our datetime conversion was succesful
tmdb_movies.info()
```

executed in 19ms, finished 20:37:44 2020-12-08

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 26517 entries, 0 to 26516
Data columns (total 11 columns):
 #   Column             Non-Null Count  Dtype         
---  ------             --------------  -----         
 0   genre_ids          26517 non-null  object        
 1   id                 26517 non-null  int64         
 2   original_language  26517 non-null  object        
 3   original_title     26517 non-null  object        
 4   popularity         26517 non-null  float64       
 5   release_date       26517 non-null  datetime64[ns]
 6   title              26517 non-null  object        
 7   vote_average       26517 non-null  float64       
 8   vote_count         26517 non-null  int64         
 9   month              26517 non-null  int64         
 10  Month              26517 non-null  object        
dtypes: datetime64[ns](1), float64(2), int64(3), object(5)
memory usage: 2.4+ MB
```

In [64]:
```
tmdb_movies[tmdb_movies.title.duplicated()].sort_values('title')
```
executed in 22ms, finished 20:37:44 2020-12-08

Out[64]:

	genre_ids	id	original_language	original_title	popularity	release_date	title	vote_average	vote_count	n
9191	[99]	95383	en	$ellebrity	1.420	2013-01-11	$ellebrity	5.6	12	
26340	[99, 36, 10770]	430364	en	'85: The Greatest Team in Pro Football History	0.600	2018-01-29	'85: The Greatest Team in Pro Football History	7.5	2	
21298	[18, 10749]	416691	en	1 Night	5.409	2017-02-10	1 Night	6.4	107	
14850	[18, 10749]	253251	en	10.000 KM	4.205	2015-07-10	10,000 km	6.5	49	
21096	[18]	334532	en	100 Streets	7.317	2016-06-08	100 Streets	6.2	91	
...	...	...	...	...	...	...	...	...	...	
1501	[28, 18]	36410	en	Zero	0.840	2010-02-06	Zero	5.8	6	
14765	[53, 28, 80]	273238	en	Zero Tolerance	5.242	2015-12-01	Zero Tolerance	4.4	23	
25031	[99]	507389	en	Zion	3.201	2018-01-18	Zion	6.4	14	
2854	[28, 27, 878]	75735	en	Zombie Apocalypse	6.667	2011-10-29	Zombie Apocalypse	4.4	56	
25188	[10752, 10751, 36]	472553	en	Zoo	2.550	2018-06-08	Zoo	6.6	17	

1829 rows × 11 columns

In [65]:
```
#dropping movies with multiple lines for same release date
tmdb_movies.drop_duplicates(subset=['release_date', 'title'],inplace=True)
```
executed in 12ms, finished 20:37:44 2020-12-08

In [66]:

```
#dropped ~1000 rows that were dupes
tmdb_movies.info()
```

executed in 12ms, finished 20:37:45 2020-12-08

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 25490 entries, 0 to 26516
Data columns (total 11 columns):
 #   Column             Non-Null Count  Dtype         
---  ------             --------------  -----         
 0   genre_ids          25490 non-null  object        
 1   id                 25490 non-null  int64         
 2   original_language  25490 non-null  object        
 3   original_title     25490 non-null  object        
 4   popularity         25490 non-null  float64       
 5   release_date       25490 non-null  datetime64[ns]
 6   title              25490 non-null  object        
 7   vote_average       25490 non-null  float64       
 8   vote_count         25490 non-null  int64         
 9   month              25490 non-null  int64         
 10  Month              25490 non-null  object        
dtypes: datetime64[ns](1), float64(2), int64(3), object(5)
memory usage: 2.3+ MB
```

In [67]:

```
#popularity has ~25% values of.6 but vote count also has around the same of vote count of 1,
#is logical that if a movie has only 1 vote count it is not popular
for col in tmdb_movies:
    print(f"Currently checking values from col: {col}")
    print(f"Top 6 values:\n{tmdb_movies[col].value_counts(normalize=True)[:6]}")
    print('-----------------------')
```

executed in 45ms, finished 20:37:45 2020-12-08

```
Currently checking values from col: genre_ids
Top 6 values:
[99]    0.139820
[]      0.096469
[18]    0.083052
[35]    0.063633
[27]    0.044135
[53]    0.018282
Name: genre_ids, dtype: float64
-----------------------
Currently checking values from col: id
Top 6 values:
71677     0.000039
121173    0.000039
298459    0.000039
414455    0.000039
226788    0.000039
139519    0.000039
Name: id, dtype: float64
```

In [68]:

```
#merging our budgets data with our tmdb movie data
dfBM = pd.merge(budgets, tmdb_movies1, left_on='movie',right_on='title', how='left')
dfBM.isna().sum()
```

executed in 22ms, finished 20:37:47 2020-12-08

Out[68]:

```
release_date_x          0
movie                   0
production_budget       0
domestic_gross          0
worldwide_gross         0
month_x                 0
Month_x                 0
Profit                  0
ROI                     0
genre_ids            3805
id                   3805
original_language    3805
original_title       3805
popularity           3805
release_date_y       3805
title                3805
vote_average         3805
vote_count           3805
month_y              3805
Month_y              3805
dtype: int64
```

In [69]:

```
#cleaning up nas
dfBM.dropna(inplace=True)
```

executed in 8ms, finished 20:37:48 2020-12-08

In [70]:
```
#checking for dupes
dfBM[dfBM.movie.duplicated()].sort_values('movie').head()
```
executed in 20ms, finished 20:37:48 2020-12-08

Out[70]:

	release_date_x	movie	production_budget	domestic_gross	worldwide_gross	month_x	Month_x	Profit	R
4966	2011-06-24	A Better Life	10000000	1759252	1884251	6	Jun	-8115749	-81.15
1720	2010-04-30	A Nightmare on Elm Street	35000000	63075011	117729621	4	Apr	82729621	236.37
3061	2018-06-01	Adrift	35000000	31445011	57897191	6	Jun	22897191	65.42
5873	2012-12-31	After	650000	0	0	12	Dec	-650000	-100.00
5661	1951-07-28	Alice in Wonderland	3000000	0	0	7	Jul	-3000000	-100.00

In [71]:
```
#dropping dupes of movies with multiple entries for same release date
dfBM.drop_duplicates(subset=['release_date_x', 'movie'], inplace=True)
```
executed in 7ms, finished 20:37:49 2020-12-08

In [72]:

```
#checking for unique values after join, no issues
for col in dfBM:
    print(f"Currently checking values from col: {col}")
    print(f"Top 6 values:\n{dfBM[col].value_counts(normalize=True)}")
    print('-----------------------')
```

executed in 47ms, finished 20:37:50 2020-12-08

```
Currently checking values from col: release_date_x
Top 6 values:
2014-12-31    0.005058
2012-12-31    0.005058
2015-11-20    0.004047
2011-04-01    0.004047
2010-10-08    0.004047
                ...   
2012-07-05    0.000506
2019-12-31    0.000506
2011-06-29    0.000506
2014-04-16    0.000506
2016-03-01    0.000506
Name: release_date_x, Length: 887, dtype: float64
-----------------------
Currently checking values from col: movie
Top 6 values:
Halloween                        0.001517
Home                             0.001517
Fantastic Four                   0.001012
```

In [73]:
```
dfBM.head()
```
executed in 19ms, finished 20:37:50 2020-12-08

Out[73]:

	release_date_x	movie	production_budget	domestic_gross	worldwide_gross	month_x	Month_x	Profit	R
3	2015-07-10	The Gallows	100000	22764410	41656474	7	Jul	41556474	41556.47
8	1968-10-01	Night of the Living Dead	114000	12087064	30087064	10	Oct	29973064	26292.16
10	1978-10-17	Halloween	325000	47000000	70000000	10	Oct	69675000	21438.46
26	2012-01-06	The Devil Inside	1000000	53262945	101759490	1	Jan	100759490	10075.94
29	1915-02-08	The Birth of a Nation	110000	10000000	11000000	2	Feb	10890000	9900.00

In [74]:
```
dfBM.drop(['month_y','Month_y', 'genre_ids', 'id', 'original_language'],axis=1, inplace=True)
```
executed in 5ms, finished 20:37:51 2020-12-08

In [75]:
```
dfBMgroupmonth = dfBM.groupby('Month_x').median()
```
executed in 6ms, finished 20:37:52 2020-12-08

In [76]:
```
dfBMgroupmonth.rename(columns={'month_x':'month','Month_x':'Month'},inplace=True)
```
executed in 4ms, finished 20:37:53 2020-12-08

In [77]:

```
dfBMgroupmonth.sort_values('month')
```

executed in 13ms, finished 20:37:54 2020-12-08

Out[77]:

	production_budget	domestic_gross	worldwide_gross	month	Profit	ROI	popularity	vote_average	v
Month_x									
Jan	23000000.0	22395806.0	41699612.0	1.0	13618920.0	79.640925	9.5410	6.10	
Feb	21500000.0	23323780.0	43953337.0	2.0	15002294.5	73.205699	9.0905	5.90	
Mar	16900000.0	18525139.5	25923720.5	3.0	7731684.0	50.499016	9.1365	6.10	
Apr	15000000.0	10749115.5	21900456.5	4.0	4662703.5	39.113181	8.3785	6.25	
May	20000000.0	34121140.0	45671512.0	5.0	15852177.0	82.230542	9.6070	6.20	
Jun	24500000.0	40494279.5	68997876.0	6.0	28963580.5	125.384939	10.8320	6.30	
Jul	20000000.0	33618855.0	69688384.0	7.0	31449135.0	140.459267	10.1960	6.30	
Aug	19200000.0	24719879.0	40966716.0	8.0	15965567.0	80.199437	9.7810	6.10	
Sep	15000000.0	13414714.0	25621449.0	9.0	6962436.0	41.770253	8.9740	6.30	
Oct	13000000.0	9479390.0	17499242.0	10.0	4328516.0	52.238776	8.8230	6.30	
Nov	22000000.0	33104041.0	62417075.5	11.0	31051540.5	128.833542	11.1840	6.60	
Dec	20000000.0	13960394.0	28717667.0	12.0	10883171.0	54.997616	9.1390	6.10	

In [78]:

```
dfBMgroupmonth.reset_index(inplace=True)
```

executed in 4ms, finished 20:37:55 2020-12-08

In [79]:

```
dfBMgroupmonth.head()
```

executed in 10ms, finished 20:37:57 2020-12-08

Out[79]:

	Month_x	production_budget	domestic_gross	worldwide_gross	month	Profit	ROI	popularity	vote_average
0	Apr	15000000.0	10749115.5	21900456.5	4.0	4662703.5	39.113181	8.3785	6.25
1	Aug	19200000.0	24719879.0	40966716.0	8.0	15965567.0	80.199437	9.7810	6.10
2	Dec	20000000.0	13960394.0	28717667.0	12.0	10883171.0	54.997616	9.1390	6.10
3	Feb	21500000.0	23323780.0	43953337.0	2.0	15002294.5	73.205699	9.0905	5.90
4	Jan	23000000.0	22395806.0	41699612.0	1.0	13618920.0	79.640925	9.5410	6.10

In [80]:

```
a = budgets.drop('movie',axis=1).sort_values('month')
```

executed in 5ms, finished 20:37:57 2020-12-08

In [81]:

```
#Creating budgets grouped by month
monthgroup = a.groupby('Month').median()
```

executed in 6ms, finished 20:37:58 2020-12-08

In [82]:

```
monthgroup = monthgroup.sort_values('month')
```

executed in 4ms, finished 20:37:58 2020-12-08

In [83]:

```
monthgroup= monthgroup.reset_index().set_index('month')
```

executed in 5ms, finished 20:37:59 2020-12-08

In [84]:

```
monthgroup.head()
```

executed in 9ms, finished 20:38:00 2020-12-08

Out[84]:

	Month	production_budget	domestic_gross	worldwide_gross	Profit	ROI
month						
1.0	Jan	14000000.0	14218868.0	20169934.0	5322212.0	51.205360
2.0	Feb	17250000.0	19096003.0	33097834.5	10443556.0	74.028042
3.0	Mar	15000000.0	15303247.5	25599836.0	7811580.5	53.132902
4.0	Apr	15000000.0	12222522.5	20068010.0	4639885.0	39.986575
5.0	May	16000000.0	19894664.0	29934477.0	13609577.0	107.574875

In [163]:

```
#using to esetablish 1 std move from median
budgets.describe()
```

executed in 20ms, finished 09:28:29 2020-12-07

Out[163]:

	production_budget	domestic_gross	worldwide_gross	month	Profit	ROI
count	5.782000e+03	5.782000e+03	5.782000e+03	5782.000000	5.782000e+03	5782.000000
mean	3.158776e+07	4.187333e+07	9.148746e+07	7.050675	5.989970e+07	380.016137
std	4.181208e+07	6.824060e+07	1.747200e+08	3.480147	1.460889e+08	2953.028231
min	1.100000e+03	0.000000e+00	0.000000e+00	1.000000	-2.002376e+08	-100.000000
25%	5.000000e+06	1.429534e+06	4.125415e+06	4.000000	-2.189071e+06	-50.770440
50%	1.700000e+07	1.722594e+07	2.798445e+07	7.000000	8.550286e+06	70.830983
75%	4.000000e+07	5.234866e+07	9.764584e+07	10.000000	6.096850e+07	275.834608
max	4.250000e+08	9.366622e+08	2.776345e+09	12.000000	2.351345e+09	179900.000000

In [85]:
```
#creating a df for blockbuster movies i.e. movies with production budgets larger than 1 std away from median
largemovies = budgets[budgets.production_budget > 75000000]
```
executed in 4ms, finished 20:38:23 2020-12-08

In [86]:
```
largegroup = largemovies.groupby('Month').agg(['median', 'count'])
```
executed in 15ms, finished 20:38:23 2020-12-08

In [87]:
```
largegroup = largegroup.sort_values(('month','median')).reset_index().set_index(('month', 'median'))
largegroup.head()
```
executed in 16ms, finished 20:38:24 2020-12-08

Out[87]:

	Month	production_budget		domestic_gross		worldwide_gross		month	Profit		ROI	
		median	count	median	count	median	count	count	median	count	median	count
(month, median)												
1	Jan	92500000	8	39134289.5	8	136038280.0	8	8	56038280.0	8	70.047850	
2	Feb	93250000	30	81199301.0	30	211758557.5	30	30	116263694.0	30	112.738034	
3	Mar	122500000	50	107044925.0	50	279396532.5	50	50	169535050.0	50	111.179115	
4	Apr	107500000	26	80907698.0	26	228658316.5	26	26	123658316.5	26	114.076375	
5	May	150000000	86	180432521.5	86	456971172.0	86	86	335273376.5	86	224.137303	

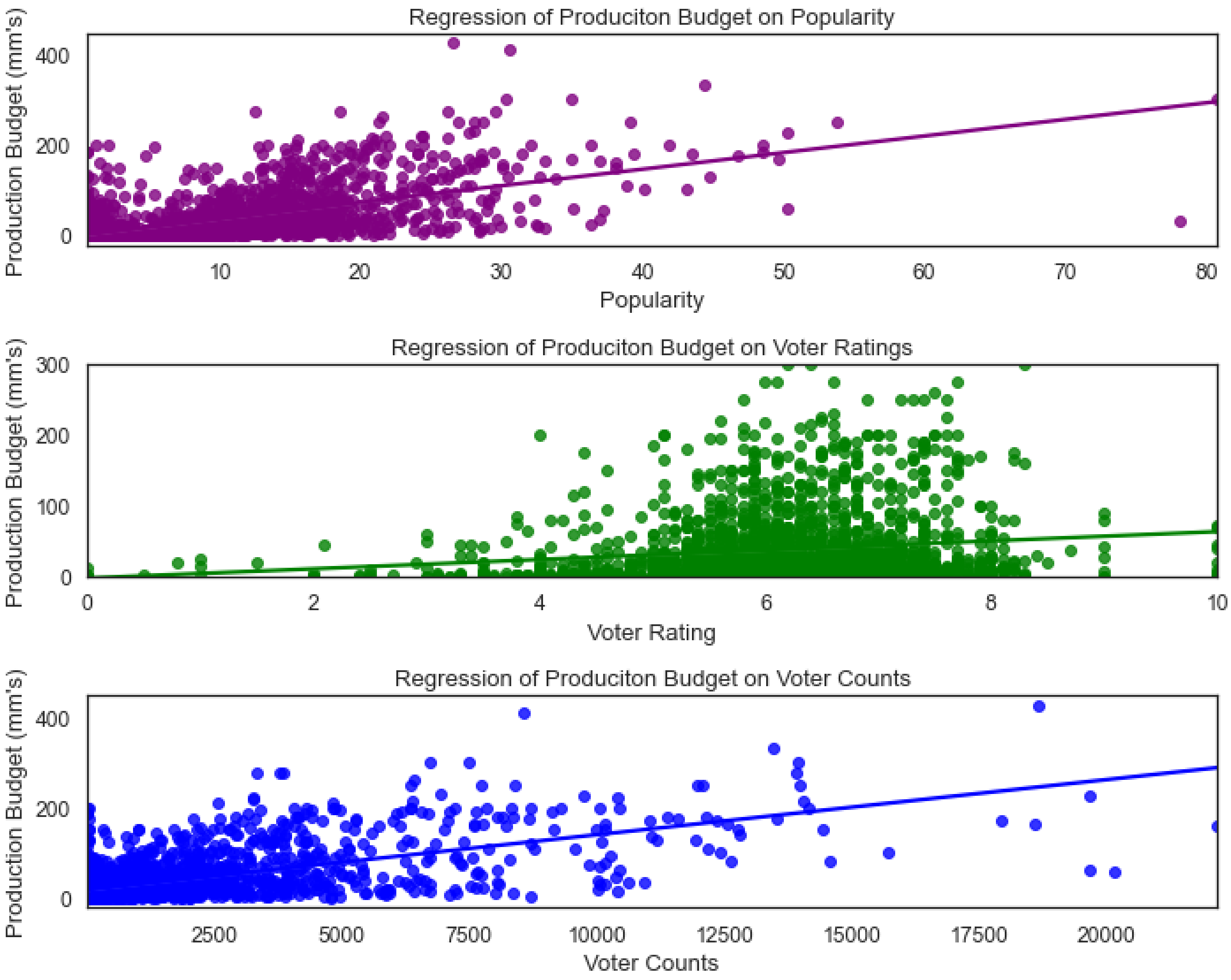
Now that we have all of our relevant data, we are ready to plot.

In [88]:
```
budgets['budget_range'] = budgets.production_budget.map(
    lambda x: '$0 - $50mm' if x<50000000 else('$50mm - $100mm' if x<100000000 else '$100mm+'))
```
executed in 5ms, finished 20:38:29 2020-12-08

First, I am going to look into to see how popularity, vote counts(viewer counts) and vote rating vary by production budget

In [89]:
```
#Below I am running a regression on Popularity Vote average(vote/movie ratings), and vote counts
#by production budget
plt.figure(figsize=(10,8))
sns.set(font_scale = 1.1)
sns.set_style('white')
ax = plt.subplot(3,1,1)
ax = sns.regplot(y='production_budget', x='popularity', data=dfBM.sort_values('month_x'), marker="o",
             color='Purple', ci=False).set(
    xlabel='Popularity', title='Regression of Produciton Budget on Popularity', ylabel="Production Budget (mm's)
plt.gca().yaxis.set_major_formatter(FuncFormatter(lambda x, _: int(x/1000000)))

ax1 = plt.subplot(3,1,2)
ax1 = sns.regplot(y='production_budget', x='vote_average', data=dfBM.sort_values('month_x'), ci=False,
             color='Green', marker="o").set(
    xlabel='Voter Rating', title='Regression of Produciton Budget on Voter Ratings', ylabel="Production Budget (
    ylim=(0,300000000))
plt.gca().yaxis.set_major_formatter(FuncFormatter(lambda x, _: int(x/1000000)))

ax1 = plt.subplot(3,1,3)
ax1 = sns.regplot(y='production_budget', x='vote_count', data=dfBM.sort_values('month_x'), ci=False,
             color='Blue', marker="o").set(
    xlabel='Voter Counts', title='Regression of Produciton Budget on Voter Counts', ylabel="Production Budget (m
plt.gca().yaxis.set_major_formatter(FuncFormatter(lambda x, _: int(x/1000000)))


plt.tight_layout()
plt.savefig('images/prodvoteregress')
```

executed in 993ms, finished 20:38:32 2020-12-08



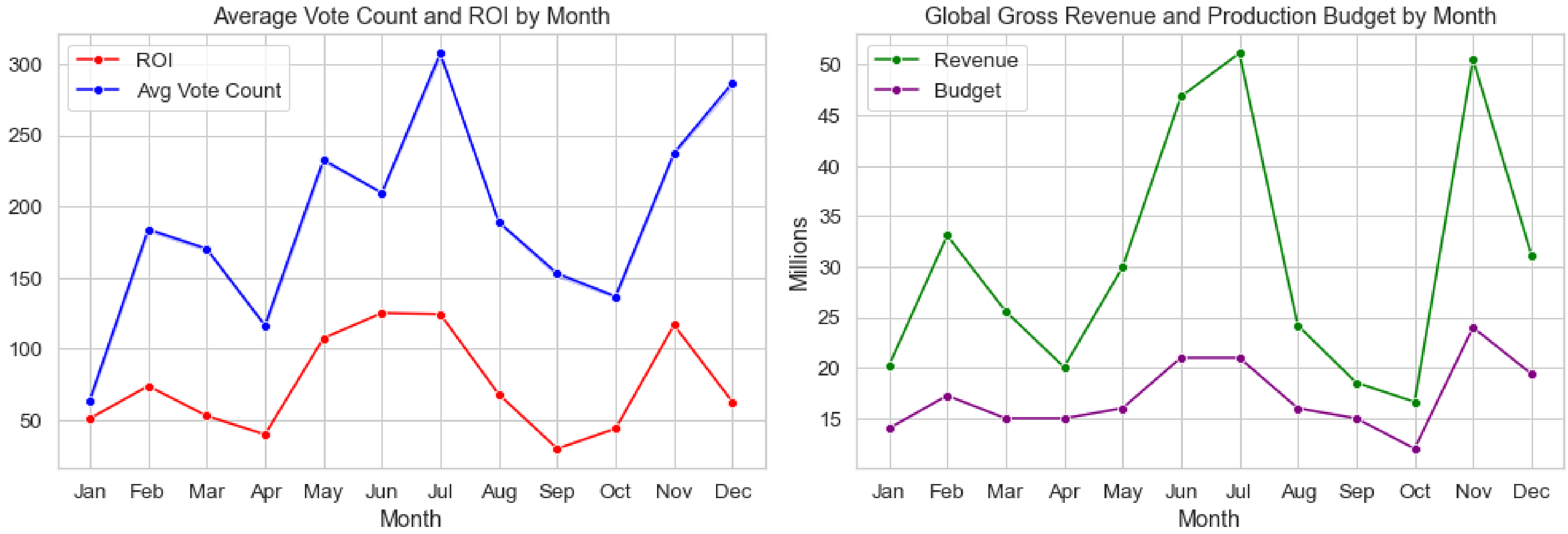
We can see that production budget is positively related from the upward sloping line for all three variables, most with popularity. With respect to voter ratings the relationship is less meaningful and leads us to conclude that although a larger production budget is beneficial to making a movie lower budget films can still be big hits to our viewers

Now we will look at Gross Revenue, Budget, ROI, and Voter Participation by Month

In [90]:

```
plt.figure(figsize=(14,5))

sns.set(font_scale = 1.2)
sns.set_style('whitegrid')
ax = plt.subplot(1,2,1)
ax = sns.lineplot(x='Month', y='ROI', data=monthgroup.sort_values('month'),
                  marker='o', legend='brief', label='ROI', ci=False, color='red')

ax = sns.lineplot(x='Month', y='vote_count', data=tmdb_movies.sort_values('month'),
                   ci=False, marker='o', legend='brief', color='blue', label='Avg Vote Count')
plt.xlabel('Month')
plt.ylabel('')
plt.title('Average Vote Count and ROI by Month')

ax1 = plt.subplot(1,2,2)
ax1 = sns.lineplot(x='Month', y='worldwide_gross', data=monthgroup.sort_values('month'),
                   ci=False, marker='o', legend='brief', color='Green', label='Revenue')
ax1 = sns.lineplot(x='Month', y='production_budget', data=monthgroup.sort_values('month'),
                   ci=False, marker='o', legend='brief', color='Purple', label='Budget')
plt.xlabel('Month')
plt.ylabel('Millions')
plt.title('Global Gross Revenue and Production Budget by Month')


plt.gca().yaxis.set_major_formatter(FuncFormatter(lambda x, _: int(x/1000000)))
plt.savefig('images/monthcharts1')

plt.tight_layout()
```

executed in 1.02s, finished 20:39:12 2020-12-08



We can see in the graphs above the months with highest participation of viewers are July, December, November, and May respectively. From a gross revenue perspective, the highest grossing months are July, November, June, and December

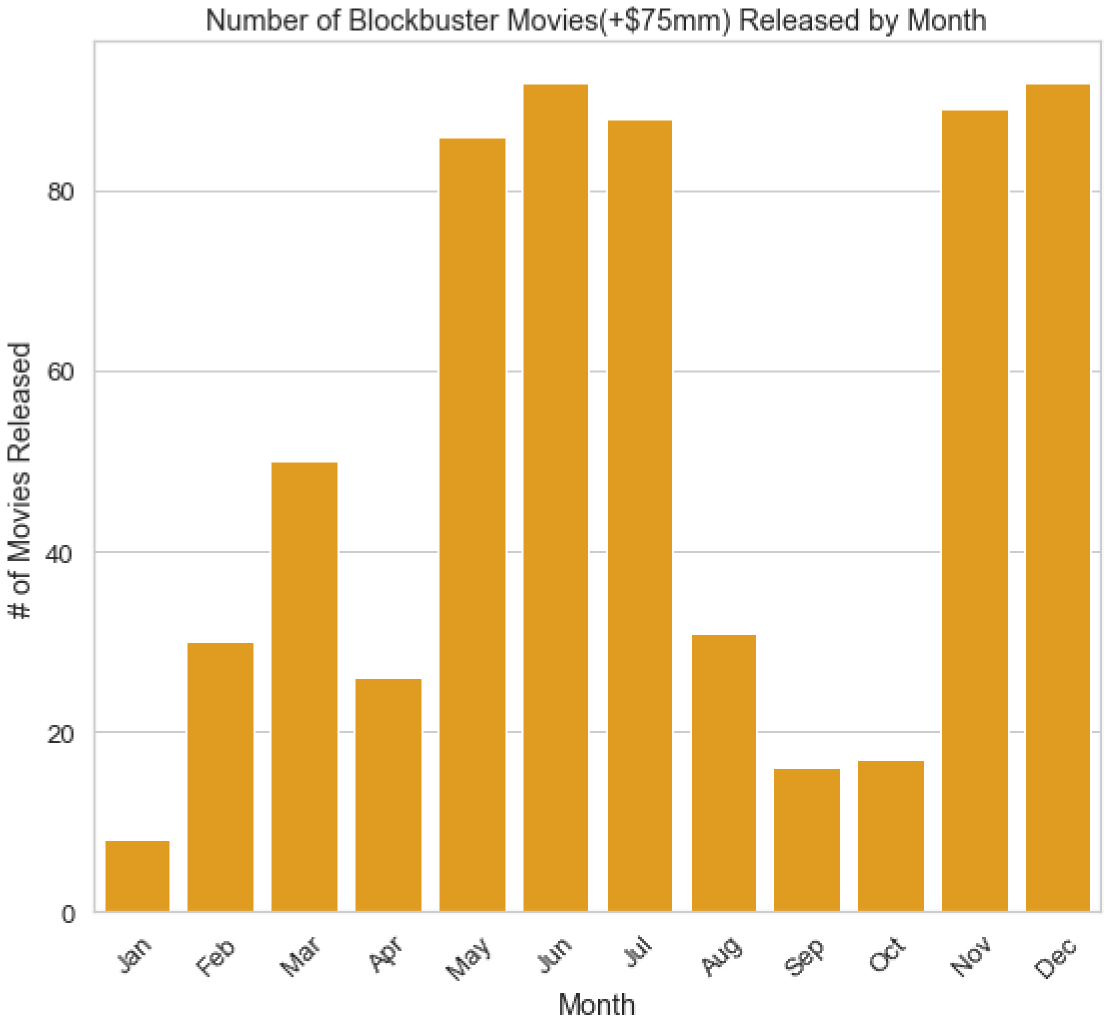
So whether the goal of the film is for critical acclaim or maximizing return, July and November are the best months.

One additonal consideration is when are the 'Blockbuster' movies released? Given viewers only have a finite amount of time of which they can consume movies, it is likely viewers will not see every movie that is in theatres for a given month, but they will gravitate towards the top movies to be released that month.

In [92]:

```
#Here I plot number of movies with a production budget greater than 75mio by month to see when the larger movies
plt.figure(figsize=(9,8))
sns.set_style("whitegrid")
sns.barplot(y=('production_budget','count'), x='Month',
             data=largegroup, color='orange',
             ci=False).set(ylabel='# of Movies Released', title='Number of Blockbuster Movies(+$75mm) Released b

plt.xticks(rotation=45)
plt.savefig('images/blockbuster1')
```

executed in 273ms, finished 20:40:22 2020-12-08



As shown above, the months with highest number of movies released unsurprisingly are June, July, November and December. If MSFT plans on testing the waters first in film making and/or has a lower production budget for the film I would suggest they consider releasing their film in May or February as they are not the most crowded months with movie releases and still have higher ROI's then the other months

3 Which studios have a proven track record of producing high ROI films?

```
-Find highest ROI producing studios
-Investigate whether high ROI studio's are consistent across production budget constraint
```

In [93]:

```
#importing file with studio data
studio = csv_files_dict['bom_movie_gross_gz']
```

executed in 3ms, finished 20:40:26 2020-12-08

In [94]:

```
studio.head()
```

executed in 8ms, finished 20:40:31 2020-12-08

Out[94]:

	studio	domestic_gross	foreign_gross	year
title				
Toy Story 3	BV	415000000.0	652000000	2010
Alice in Wonderland (2010)	BV	334200000.0	691300000	2010
Harry Potter and the Deathly Hallows Part 1	WB	296000000.0	664300000	2010
Inception	WB	292600000.0	535700000	2010
Shrek Forever After	P/DW	238700000.0	513900000	2010

In [95]:

```
#resetting index to move movie names into column
studio.reset_index(inplace=True)
```

executed in 4ms, finished 20:40:32 2020-12-08

In [96]:

```
#foreign gross column values are objects not int
studio.info()
```

executed in 9ms, finished 20:40:32 2020-12-08

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 3387 entries, 0 to 3386
Data columns (total 5 columns):
 #   Column          Non-Null Count  Dtype  
---  ------          --------------  -----  
 0   title           3387 non-null   object 
 1   studio          3382 non-null   object 
 2   domestic_gross  3359 non-null   float64
 3   foreign_gross   2037 non-null   object 
 4   year            3387 non-null   int64  
dtypes: float64(1), int64(1), object(3)
memory usage: 132.4+ KB
```

In [97]:

```
#converting foreign gross datatype to int
studio['foreign_gross'] = studio['foreign_gross'].astype(str).apply(lambda x: float(x.replace(',','')))
```

executed in 6ms, finished 20:40:33 2020-12-08

In [98]:

```
#all movies with na values in foreign gross column have a domestic gross revenue so
#possible films were not aired internationally. filling with 0
studio[(studio.foreign_gross.isna()) & (studio.domestic_gross == 0)]
```

executed in 8ms, finished 20:40:33 2020-12-08

Out[98]:

	title	studio	domestic_gross	foreign_gross	year

In [99]:

```
#all domestic gross values with NaN have foreign gross so will convert to 0 not drop as they could be foreign fi
studio[studio.domestic_gross.isna()]
```

executed in 12ms, finished 20:40:33 2020-12-08

Out[99]:

	title	studio	domestic_gross	foreign_gross	year
230	It's a Wonderful Afterlife	UTV	NaN	1300000.0	2010
298	Celine: Through the Eyes of the World	Sony	NaN	119000.0	2010
302	White Lion	Scre.	NaN	99600.0	2010
306	Badmaash Company	Yash	NaN	64400.0	2010
327	Aashayein (Wishes)	Relbig.	NaN	3800.0	2010
537	Force	FoxS	NaN	4800000.0	2011
713	Empire of Silver	NeoC	NaN	19000.0	2011
871	Solomon Kane	RTWC	NaN	19600000.0	2012
928	The Tall Man	Imag.	NaN	5200000.0	2012
933	Keith Lemon: The Film	NaN	NaN	4000000.0	2012
936	Lula, Son of Brazil	NYer	NaN	3800000.0	2012
966	The Cup (2012)	Myr.	NaN	1800000.0	2012
1017	Dark Tide	WHE	NaN	432000.0	2012
1079	The Green Wave	RF	NaN	70100.0	2012
1268	22 Bullets	Cdgm.	NaN	21300000.0	2013
1308	Matru Ki Bijlee Ka Mandola	FIP	NaN	6000000.0	2013
1340	The Snitch Cartel	PI	NaN	2100000.0	2013
1342	All the Boys Love Mandy Lane	RTWC	NaN	1900000.0	2013
1368	6 Souls	RTWC	NaN	852000.0	2013
1659	Jessabelle	LGF	NaN	7000000.0	2014
1681	14 Blades	RTWC	NaN	3800000.0	2014
1685	Jack and the Cuckoo-Clock Heart	Shout!	NaN	3400000.0	2014

	title	studio	domestic_gross	foreign_gross	year
1739	Lila Lila	Crnth	NaN	1100000.0	2014
1975	Surprise - Journey To The West	AR	NaN	49600000.0	2015
2392	Finding Mr. Right 2	CL	NaN	114700000.0	2016
2468	Solace	LGP	NaN	22400000.0	2016
2595	Viral	W/Dim.	NaN	552000.0	2016
2825	Secret Superstar	NaN	NaN	122000000.0	2017

In [100]:

```
#filling Nan values with 0 as in both cases where 1 column is Nan the other has a value
studio.domestic_gross = studio.domestic_gross.fillna(0)
studio.foreign_gross = studio.foreign_gross.fillna(0)
```

executed in 4ms, finished 20:40:36 2020-12-08

In [101]:

```
studio.info()
```

executed in 8ms, finished 20:40:37 2020-12-08

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 3387 entries, 0 to 3386
Data columns (total 5 columns):
 #   Column          Non-Null Count  Dtype  
---  ------          --------------  -----  
 0   title           3387 non-null   object 
 1   studio          3382 non-null   object 
 2   domestic_gross  3387 non-null   float64
 3   foreign_gross   3387 non-null   float64
 4   year            3387 non-null   int64  
dtypes: float64(2), int64(1), object(2)
memory usage: 132.4+ KB
```

In [102]:

```
studio[studio.studio.isna()]
```

executed in 10ms, finished 20:40:37 2020-12-08

Out[102]:

	title	studio	domestic_gross	foreign_gross	year
210	Outside the Law (Hors-la-loi)	NaN	96900.0	3300000.0	2010
555	Fireflies in the Garden	NaN	70600.0	3300000.0	2011
933	Keith Lemon: The Film	NaN	0.0	4000000.0	2012
1862	Plot for Peace	NaN	7100.0	0.0	2014
2825	Secret Superstar	NaN	0.0	122000000.0	2017

In [103]:

```
#dropping studio rows with missing values
studio.dropna(inplace=True)
```

executed in 4ms, finished 20:40:37 2020-12-08

In [104]:

```
dfBS = pd.merge(budgets, studio, left_on='movie', right_on='title', how='left')
```

executed in 10ms, finished 20:40:38 2020-12-08

In [105]:

```
dfBS.info()
```

executed in 9ms, finished 20:40:38 2020-12-08

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 5782 entries, 0 to 5781
Data columns (total 15 columns):
 #   Column             Non-Null Count  Dtype         
---  ------             --------------  -----         
 0   release_date       5782 non-null   datetime64[ns]
 1   movie              5782 non-null   object        
 2   production_budget  5782 non-null   int64         
 3   domestic_gross_x   5782 non-null   int64         
 4   worldwide_gross    5782 non-null   int64         
 5   month              5782 non-null   int64         
 6   Month              5782 non-null   object        
 7   Profit             5782 non-null   int64         
 8   ROI                5782 non-null   float64       
 9   budget_range       5782 non-null   object        
 10  title              1246 non-null   object        
 11  studio             1246 non-null   object        
 12  domestic_gross_y   1246 non-null   float64       
 13  foreign_gross      1246 non-null   float64       
 14  year               1246 non-null   float64       
dtypes: datetime64[ns](1), float64(4), int64(5), object(5)
memory usage: 722.8+ KB
```

In [106]:

```
#our studio data has 4.5k movies without studio data, will drop
dfBS.isna().sum()
```

executed in 8ms, finished 20:40:39 2020-12-08

Out[106]:

```
release_date          0
movie                 0
production_budget     0
domestic_gross_x      0
worldwide_gross       0
month                 0
Month                 0
Profit                0
ROI                   0
budget_range          0
title              4536
studio             4536
domestic_gross_y   4536
foreign_gross      4536
year               4536
dtype: int64
```

In [107]:

```
#dropping values where we have no studio data
dfBS.dropna(inplace=True)
```

executed in 6ms, finished 20:40:39 2020-12-08

In [108]:

```
#index values out of whack from dropping values earlier
dfBS.reset_index(inplace=True)
```

executed in 3ms, finished 20:40:40 2020-12-08

In [109]:

```
#cleaning up our DF
dfBS.drop('index',axis=1, inplace=True)
```

executed in 5ms, finished 20:40:40 2020-12-08

In [110]:

```
dfBS.info()
```

executed in 9ms, finished 20:40:40 2020-12-08

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1246 entries, 0 to 1245
Data columns (total 15 columns):
 #   Column             Non-Null Count  Dtype         
---  ------             --------------  -----         
 0   release_date       1246 non-null   datetime64[ns]
 1   movie              1246 non-null   object        
 2   production_budget  1246 non-null   int64         
 3   domestic_gross_x   1246 non-null   int64         
 4   worldwide_gross    1246 non-null   int64         
 5   month              1246 non-null   int64         
 6   Month              1246 non-null   object        
 7   Profit             1246 non-null   int64         
 8   ROI                1246 non-null   float64       
 9   budget_range       1246 non-null   object        
 10  title              1246 non-null   object        
 11  studio             1246 non-null   object        
 12  domestic_gross_y   1246 non-null   float64       
 13  foreign_gross      1246 non-null   float64       
 14  year               1246 non-null   float64       
dtypes: datetime64[ns](1), float64(4), int64(5), object(5)
memory usage: 146.1+ KB
```

In [111]:
```
#nothing sticks out here
for col in dfBS:
    print(f"Currently checking values from col: {col}")
    print(f"Top 5 values:\n{dfBS[col].value_counts(normalize=True)}")
    print('-----------------------')
```
executed in 34ms, finished 20:40:41 2020-12-08

```
Currently checking values from col: release_date
Top 5 values:
2010-10-08    0.007223
2014-10-10    0.005618
2013-12-25    0.004815
2011-04-01    0.004815
2016-03-11    0.004815
                ...   
2012-01-06    0.000803
2013-05-16    0.000803
2015-12-30    0.000803
2017-06-23    0.000803
2014-08-27    0.000803
Name: release_date, Length: 544, dtype: float64
-----------------------
Currently checking values from col: movie
Top 5 values:
Unknown           0.001605
Robin Hood        0.001605
The Karate Kid    0.001605
```

In [112]:
```
#no dupes either
dfBS.duplicated().sum()
```
executed in 7ms, finished 20:40:42 2020-12-08

Out[112]:
```
0
```

In [113]:
```
studiogroup = dfBS.groupby('studio').agg(['median','mean','count'])
```
executed in 21ms, finished 20:40:43 2020-12-08

In [114]:
```
studiogroup.reset_index(inplace=True)
```
executed in 5ms, finished 20:40:45 2020-12-08

In [115]:

```
studiogroup = studiogroup.sort_values(('ROI','count'), ascending=False)
```

executed in 5ms, finished 20:40:45 2020-12-08

In [116]:

```
studiogroup.head()
```

executed in 24ms, finished 20:40:46 2020-12-08

Out[116]:

	studio	production_budget			domestic_gross_x			worldwide_gross			...	ROI	do
		median	mean	count	median	mean	count	median	mean	count	...	count	n
90	Uni.	40000000	5.639060e+07	117	62495645.0	9.151146e+07	117	124827316.0	2.335837e+08	117	...	117	63
32	Fox	58000000	7.050455e+07	110	64538760.5	8.554758e+07	110	166785054.0	2.435983e+08	110	...	110	64
94	WB	51500000	8.036961e+07	102	54588611.0	8.951498e+07	102	113214342.5	2.175864e+08	102	...	102	55
82	Sony	55000000	6.825000e+07	74	79417722.0	9.540486e+07	74	180694801.0	2.378623e+08	74	...	74	79
69	Par.	42500000	6.445946e+07	74	67964766.5	8.117842e+07	74	132270082.0	1.951109e+08	74	...	74	68

5 rows × 28 columns

Now that we've cleaned our data and created a group by for studios in the data we can begin plotting.

In [117]:

```
#plotting Studio vs ROI for studios that have made at least 3 films in our data set for top ROI studios
#for same top ROI studios, i plot beside the related production budget
plt.figure(figsize=(15,8))
ax = plt.subplot(1,2,1)
ax = sns.barplot(x=('ROI','median'), y='studio',
             data=studiogroup[studiogroup['ROI','count'] >10].sort_values(('ROI','median'),ascending=False).heac
            palette='mako_r',
             ci=False).set(ylabel='Studio', title='Top 10 Studios by ROI', xlabel="Return on Investment" )
plt.gca().xaxis.set_major_formatter(FuncFormatter(lambda x, _: int(x)))

ax2 = plt.subplot(1,2,2)
ax2 = sns.barplot(x=('production_budget','median'), y='studio',
             data=studiogroup[studiogroup['ROI','count'] >10].sort_values(('ROI','median'),ascending=False).heac
            color='darksalmon',
             ci=False).set(ylabel='', title='Production Budget for Top ROI Studios', xlabel="Production Budget (
plt.gca().xaxis.set_major_formatter(FuncFormatter(lambda x, _: int(x/1000000)))

plt.tight_layout()
plt.savefig('images/topstudios')
```

executed in 513ms, finished 20:40:49 2020-12-08

In [118]:

```
studiogroup[studiogroup[('ROI','count')] < 10]
```

executed in 35ms, finished 20:40:56 2020-12-08

Out[118]:

	studio	production_budget			domestic_gross_x			worldwide_gross			...	ROI	dc
		median	mean	count	median	mean	count	median	mean	count	...	count	n
7	Anch.	10000000	9.805556e+06	9	139034.0	2.135824e+06	9	1605139.0	3.601722e+06	9	...	9	
73	RTWC	3500000	9.318750e+06	8	321281.0	2.587725e+06	8	4206119.5	1.685029e+07	8	...	8	
37	Gold.	6150000	1.016250e+07	8	1444007.5	1.876920e+06	8	3922929.0	6.460682e+06	8	...	8	1
93	W/Dim.	22000000	2.406250e+07	8	21345042.0	2.854878e+07	8	54192647.0	7.610649e+07	8	...	8	21
11	BG	11900000	1.588571e+07	7	6069605.0	9.808936e+06	7	20718104.0	1.652466e+07	7	...	7	6
...	...	...	...	...	...	...	...	...	...	...	...	...	
56	NFC	3000000	3.000000e+06	1	205842.0	2.058420e+05	1	1022453.0	1.022453e+06	1	...	1	
57	NM	70000000	7.000000e+07	1	619423.0	6.194230e+05	1	38992292.0	3.899229e+07	1	...	1	
58	Neon	11000000	1.100000e+07	1	30014534.0	3.001453e+07	1	53797409.0	5.379741e+07	1	...	1	30
59	OMNI/FSR	20000000	2.000000e+07	1	1186538.0	1.186538e+06	1	6093725.0	6.093725e+06	1	...	1	1
49	LGP	2000000	2.000000e+06	1	36336.0	3.633600e+04	1	6328516.0	6.328516e+06	1	...	1	

73 rows × 28 columns

Above we have the top 10 studios by ROI as well as the median production budget for the respective studios. It seems that ROI is more a function of production budget. Let's investigate the top studio's shown above and if they still produce a high level of ROI across the spectrum of production budgets

In [119]:

```
#created new column with budget classifications
dfBS['budget_range'] = dfBS.production_budget.map(
    lambda x: '$0-$50mm' if x<50000000 else('$50mm - $100mm' if x<100000000 else '$100mm+'))
```

executed in 4ms, finished 20:41:04 2020-12-08

In [120]:

```
#checking to see values populated for all ranges
dfBS.budget_range.value_counts()
```

executed in 5ms, finished 20:41:04 2020-12-08

Out[120]:

```
$0-$50mm           869
$50mm - $100mm     190
$100mm+            187
Name: budget_range, dtype: int64
```

In [121]:

```
#using the count from the agg method passed into my groupby I am creating a new df with studios that have made
#more than 3 films
x = studiogroup[studiogroup['production_budget','count'] >3].sort_values(('ROI','median'), ascending=False)
```

executed in 4ms, finished 20:41:05 2020-12-08

In [122]:

```
#I am then making a list out of those studios
studiolist = list(x.studio)
```

executed in 4ms, finished 20:41:05 2020-12-08

In [123]:

```
#checking list
len(studiolist)
```

executed in 3ms, finished 20:41:06 2020-12-08

Out[123]:

```
37
```

In [124]:

```
#i only want a dataframe of the above studios
test = dfBS.set_index('studio')
```

executed in 4ms, finished 20:41:06 2020-12-08

In [125]:

```
#creating new df of studios that meet requirements of >3 movies made
stud = test[test.index.isin(studiolist)]
```

executed in 4ms, finished 20:41:07 2020-12-08

In [126]:

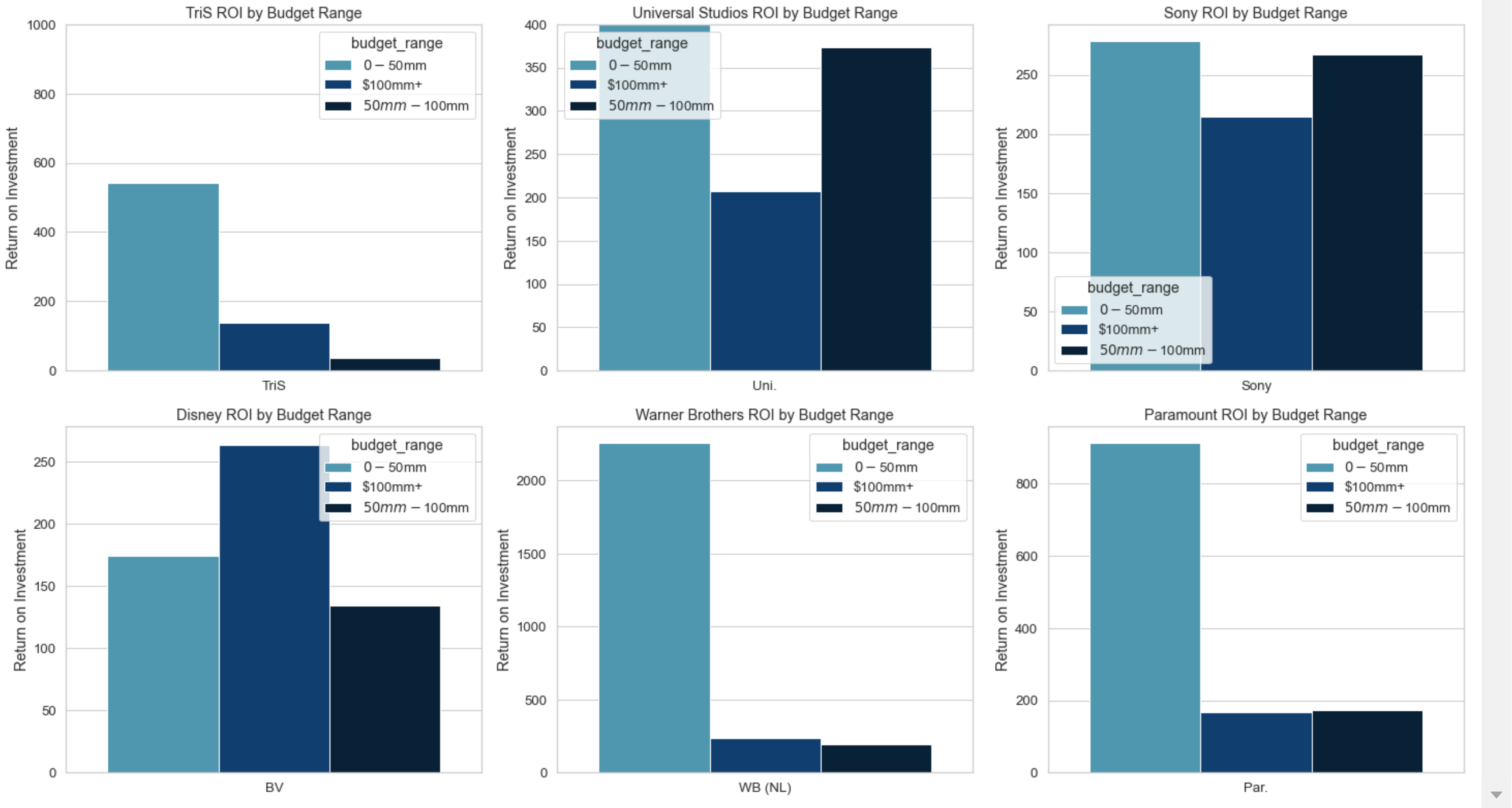
```
#resetting to be able to call studio in graph
stud.reset_index(inplace=True)
```

executed in 4ms, finished 20:41:07 2020-12-08

In [127]:

```
plt.figure(figsize=(20,11))
ax = plt.subplot(2,3,1)
ax = sns.barplot(x='studio', y='ROI', hue='budget_range',
             data=stud[stud['studio'] == 'TriS'].sort_values('budget_range'),
                 palette='ocean_r',ci=False).set(ylabel='Return on Investment', title='TriS ROI by Budget Range'
                                      xlabel="", ylim=(0,1000) )
ax2 = plt.subplot(2,3,2)
ax2 =sns.barplot(x='studio', y='ROI', hue='budget_range',
             data=stud[stud['studio'] == 'Uni.'].sort_values('budget_range'),
                 palette='ocean_r',ci=False).set(ylabel='Return on Investment', title='Universal Studios ROI by
                                      xlabel="",  ylim=(0,400))
ax3 = plt.subplot(2,3,5)
ax3 = sns.barplot(x='studio', y='ROI', hue='budget_range',
             data=stud[stud['studio'] == 'WB (NL)'].sort_values('budget_range'),
                 palette='ocean_r',ci=False).set(ylabel='Return on Investment', title='Warner Brothers ROI by Bu
                                      xlabel="" )
ax4 = plt.subplot(2,3,3)
ax4 = sns.barplot(x='studio', y='ROI', hue='budget_range',
             data=stud[stud['studio'] == 'Sony'].sort_values('budget_range'),
                 palette='ocean_r',ci=False).set(ylabel='Return on Investment', title='Sony ROI by Budget Range'
                                      xlabel="" )
ax5 = plt.subplot(2,3,4)
ax5 = sns.barplot(x='studio', y='ROI', hue='budget_range',
             data=stud[stud['studio'] == 'BV'].sort_values('budget_range'),
                 palette='ocean_r',ci=False).set(ylabel='Return on Investment', title='Disney ROI by Budget Rang

ax6 = plt.subplot(2,3,6)
ax6 = sns.barplot(x='studio', y='ROI', hue='budget_range',
             data=stud[stud['studio'] == 'Par.'].sort_values('budget_range'),
                 palette='ocean_r',ci=False).set(ylabel='Return on Investment', title='Paramount ROI by Budget R

plt.tight_layout()

plt.savefig('images/studioroi')
```

executed in 1.71s, finished 20:41:09 2020-12-08



We can see that not all studios are made equal. While our top ROI studio was Tris, they are only succesful at making movies at the low end of the budget spectrum. Paramount and Warner Brothers share this same characteristic as well

Looking at other studios like Disney, Universal, and Sony they have been able to produce movies across the spectrum of production budgets while maintaining a high ROI.

In conclusion, when selecting a studio for a film Microsoft should consider the production budget of the film. For the following production budgets they should consider these studios:

```
-Low budget(0-50mm) film: TriS, Paramount, or Warner Brothers
-Medium Budget(50-100mm) film: Universal Studios or Sony
-High Budget(>100mm)film: Disney or Warner Brothers
```