Investor Report : Video Game Industry

Focusing on the US Market

Data Bootcamp Fall 19 Final Project

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1. Introduction

1.1. Purpose of the Report

This project sets out to understand if video games are “recession proof.” Our intended user persona is an independent investor or a firm analyst looking to better understand the gaming industry. Ultimately, our project will help our user determine if video games are part of a recession investment strategy. We analyzed video game sales data across Japan, North America, and Europe to see sales trends and learn about the biggest publishers. We then focus on sales for Japan and the United States (using North America as a proxy as ~92% of “NA” sales come from the U.S.) against basic economic indicators for each country (GDP growth rates and unemployment rates). Finally, we focus on a key set of video game publishers listed on American exchanges (Take Two, Activision, Electronic Arts, and Ubisoft) and track their market performances against the S&P 500 Index.

1.2. Main Dataset Description

In [466]:
```
import numpy as np
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
import os
import statsmodels.formula.api as smf
%matplotlib inline
```

In [467]:
```
data = pd.read_csv("vgsales.csv")
data.replace('\\N',np.nan)
data
```

Out[467]:

	Rank	Name	Platform	Year	Genre	Publisher	NA_Sales	EU_Sal
0	1	Wii Sports	Wii	2006.0	Sports	Nintendo	41.49	29.
1	2	Super Mario Bros.	NES	1985.0	Platform	Nintendo	29.08	3.
2	3	Mario Kart Wii	Wii	2008.0	Racing	Nintendo	15.85	12.
3	4	Wii Sports Resort	Wii	2009.0	Sports	Nintendo	15.75	11.
4	5	Pokemon Red/Pokemon Blue	GB	1996.0	Role-Playing	Nintendo	11.27	8.
5	6	Tetris	GB	1989.0	Puzzle	Nintendo	23.20	2.
6	7	New Super Mario Bros.	DS	2006.0	Platform	Nintendo	11.38	9.
7	8	Wii Play	Wii	2006.0	Misc	Nintendo	14.03	9.

8	9	New Super Mario Bros. Wii	Wii	2009.0	Platform	Nintendo	14.59	7.
9	10	Duck Hunt	NES	1984.0	Shooter	Nintendo	26.93	0.
10	11	Nintendogs	DS	2005.0	Simulation	Nintendo	9.07	11.
11	12	Mario Kart DS	DS	2005.0	Racing	Nintendo	9.81	7.
12	13	Pokemon Gold/Pokemon Silver	GB	1999.0	Role-Playing	Nintendo	9.00	6.
13	14	Wii Fit	Wii	2007.0	Sports	Nintendo	8.94	8.
14	15	Wii Fit Plus	Wii	2009.0	Sports	Nintendo	9.09	8.
15	16	Kinect Adventures!	X360	2010.0	Misc	Microsoft Game Studios	14.97	4.
16	17	Grand Theft Auto V	PS3	2013.0	Action	Take-Two Interactive	7.01	9.
17	18	Grand Theft Auto: San Andreas	PS2	2004.0	Action	Take-Two Interactive	9.43	0.
18	19	Super Mario World	SNES	1990.0	Platform	Nintendo	12.78	3.
19	20	Brain Age: Train Your Brain in Minutes a Day	DS	2005.0	Misc	Nintendo	4.75	9.
20	21	Pokemon Diamond/Pokemon Pearl	DS	2006.0	Role-Playing	Nintendo	6.42	4.
21	22	Super Mario Land	GB	1989.0	Platform	Nintendo	10.83	2.
22	23	Super Mario Bros. 3	NES	1988.0	Platform	Nintendo	9.54	3.
23	24	Grand Theft Auto V	X360	2013.0	Action	Take-Two Interactive	9.63	5.
24	25	Grand Theft Auto: Vice City	PS2	2002.0	Action	Take-Two Interactive	8.41	5.
25	26	Pokemon Ruby/Pokemon Sapphire	GBA	2002.0	Role-Playing	Nintendo	6.06	3.
26	27	Pokemon Black/Pokemon White	DS	2010.0	Role-Playing	Nintendo	5.57	3.
27	28	Brain Age 2: More Training in Minutes a Day	DS	2005.0	Puzzle	Nintendo	3.44	5.
28	29	Gran Turismo 3: A-Spec	PS2	2001.0	Racing	Sony Computer Entertainment	6.85	5.

29	30	Call of Duty: Modern Warfare 3	X360	2011.0	Shooter	Activision	9.03	4.:
...	...	...	...	...	...	...	...	
16568	16571	XI Coliseum	PSP	2006.0	Puzzle	Sony Computer Entertainment	0.00	0.(
16569	16572	Resident Evil 4 HD	XOne	2016.0	Shooter	Capcom	0.01	0.(
16570	16573	Farming 2017 - The Simulation	PS4	2016.0	Simulation	UIG Entertainment	0.00	0.(
16571	16574	Grisaia no Kajitsu: La Fruit de la Grisaia	PSP	2013.0	Adventure	Prototype	0.00	0.(
16572	16575	Scarlett: Nichijou no Kyoukaisen	PS2	2008.0	Adventure	Kadokawa Shoten	0.00	0.(
16573	16576	Mini Desktop Racing	Wii	2007.0	Racing	Popcorn Arcade	0.01	0.(
16574	16577	Yattaman Wii: BikkuriDokkiri Machine de Mou Ra...	Wii	2008.0	Racing	Takara Tomy	0.00	0.(
16575	16578	Neo Angelique Special	PSP	2008.0	Adventure	Tecmo Koei	0.00	0.(
16576	16579	Rugby Challenge 3	XOne	2016.0	Sports	Alternative Software	0.00	0.(
16577	16580	Damnation	PC	2009.0	Shooter	Codemasters	0.00	0.(
16578	16581	Outdoors Unleashed: Africa 3D	3DS	2011.0	Sports	Mastiff	0.01	0.(
16579	16582	PGA European Tour	N64	2000.0	Sports	Infogrames	0.01	0.(
16580	16583	Real Rode	PS2	2008.0	Adventure	Kadokawa Shoten	0.00	0.(
16581	16584	Fit & Fun	Wii	2011.0	Sports	Unknown	0.00	0.(
16582	16585	Planet Monsters	GBA	2001.0	Action	Titus	0.01	0.(
16583	16586	Carmageddon 64	N64	1999.0	Action	Virgin Interactive	0.01	0.(
16584	16587	Bust-A-Move 3000	GC	2003.0	Puzzle	Ubisoft	0.01	0.(
16585	16588	Breach	PC	2011.0	Shooter	Destineer	0.01	0.(
16586	16589	Secret Files 2: Puritas Cordis	DS	2009.0	Adventure	Deep Silver	0.00	0.(
16587	16590	Mezase!! Tsuri Master DS	DS	2009.0	Sports	Hudson Soft	0.00	0.(

16588	16591	Mega Brain Boost	DS	2008.0	Puzzle	Majesco Entertainment	0.01	0.0
16589	16592	Chou Ezaru wa Akai Hana: Koi wa Tsuki ni Shiru...	PSV	2016.0	Action	dramatic create	0.00	0.0
16590	16593	Eiyuu Densetsu: Sora no Kiseki Material Collec...	PSP	2007.0	Role-Playing	Falcom Corporation	0.00	0.0
16591	16594	Myst IV: Revelation	PC	2004.0	Adventure	Ubisoft	0.01	0.0
16592	16595	Plushees	DS	2008.0	Simulation	Destineer	0.01	0.0
16593	16596	Woody Woodpecker in Crazy Castle 5	GBA	2002.0	Platform	Kemco	0.01	0.0
16594	16597	Men in Black II: Alien Escape	GC	2003.0	Shooter	Infogrames	0.01	0.0
16595	16598	SCORE International Baja 1000: The Official Game	PS2	2008.0	Racing	Activision	0.00	0.0
16596	16599	Know How 2	DS	2010.0	Puzzle	7G//AMES	0.00	0.0
16597	16600	Spirits & Spells	GBA	2003.0	Platform	Wanadoo	0.01	0.0

16598 rows × 11 columns

In [468]:
```
data.shape
```

Out[468]:
```
(16598, 11)
```

In [469]:
```
data.columns.to_list()
```

Out[469]:
```
['Rank',
 'Name',
 'Platform',
 'Year',
 'Genre',
 'Publisher',
 'NA_Sales',
 'EU_Sales',
 'JP_Sales',
 'Other_Sales',
 'Global_Sales']
```

In [470]:
```
years = data['Year'].unique().tolist()
years.sort()
```

In [471]:
```
print(years)
```

```
[1980.0, 1981.0, 1982.0, 1983.0, 1984.0, 1985.0, 1986.0, 1987.0, 198
8.0, 1989.0, 1990.0, 1991.0, 1992.0, 1993.0, 1994.0, 1995.0, 1996.0,
1997.0, 1998.0, 1999.0, 2000.0, 2001.0, 2002.0, 2003.0, 2004.0, 2005
.0, 2006.0, 2007.0, 2008.0, 2009.0, 2010.0, 2011.0, 2012.0, 2013.0,
2014.0, 2015.0, nan, 2016.0, 2017.0, 2020.0]
```

This dataset contains detailed sales data of **video games with sales greater than 100,000 copies** that were released between **1980 and 2020**. It only includes the physical copy sale of games(digital platforms excluded). It was retrieved from [https://www.kaggle.com/gregorut/videogamesales (https://www.kaggle.com/gregorut/videogamesales)](https://www.kaggle.com/gregorut/videogamesales).

The dataset includes **16598 games** with 11 fields for each game (Note: Same game on different platforms are represented as separate games)

Each column represents the following details for a game :

- **Rank** : Ranking of overall sales
- **Name** : The games name
- **Platform** : Platform of the games release (i.e. Wii, PS4, etc.)
- **Year** : Year of the game's release
- **Genre** : Genre of the game
- **Publisher** : Publisher of the game
- **NA_Sales** : Sales in North America (in millions)
- **EU_Sales** : Sales in Europe (in millions)
- **JP_Sales** : Sales in Japan (in millions)
- **Other_Sales** : Sales in the rest of the world (in millions)
- **Global_Sales** : Total worldwide sales.

2. Overview of the Video Game Industry

2. 1. Industry Revenue at a Glance

In [472]:
```
#The most recent year with full-year sales record
data15 = data.loc[data['Year']==2015,:]
```

In [473]:
```
data15.describe()
```

Out[473]:

	Rank	Year	NA_Sales	EU_Sales	JP_Sales	Other_Sales	Global_Sales
count	614.000000	614.0	614.000000	614.000000	614.000000	614.000000	614.000000
mean	9797.796417	2015.0	0.167459	0.159137	0.054919	0.048876	0.430684
std	5068.232870	0.0	0.468705	0.471293	0.188058	0.153484	1.066665
min	34.000000	2015.0	0.000000	0.000000	0.000000	0.000000	0.010000
25%	5176.250000	2015.0	0.000000	0.000000	0.000000	0.000000	0.030000
50%	11165.000000	2015.0	0.010000	0.030000	0.010000	0.010000	0.090000
75%	14288.250000	2015.0	0.127500	0.127500	0.050000	0.040000	0.367500
max	16568.000000	2015.0	5.770000	6.060000	2.780000	2.310000	14.240000

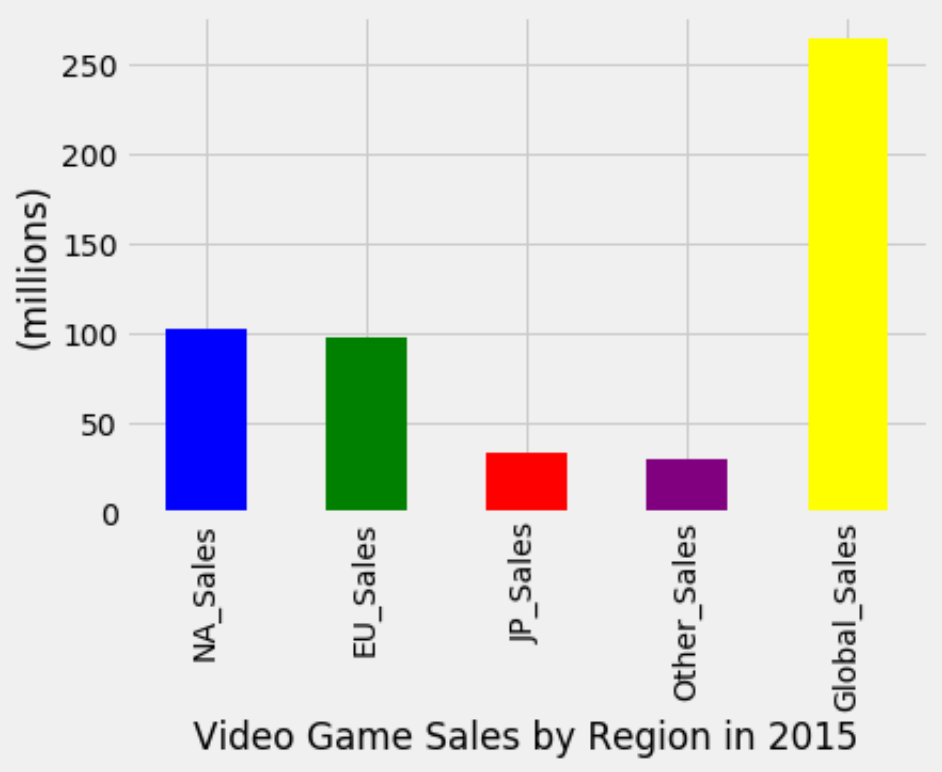
In [474]:
```
category = ['NA_Sales','EU_Sales','JP_Sales','Other_Sales','Global_Sales']
total_sales = []
for i in category:
    total = data15[i].sum()
    total_sales.append(total)

sales_2015 = pd.DataFrame({'Region': category,'total_sales':total_sales})
sales_2015
```

Out[474]:

	Region	total_sales
0	NA_Sales	102.82
1	EU_Sales	97.71
2	JP_Sales	33.72
3	Other_Sales	30.01
4	Global_Sales	264.44

In [475]:
```
plt.style.use('fivethirtyeight')
fig,ax = plt.subplots()
sales_2015.set_index('Region')['total_sales'].plot.bar(ax = ax, color
=['b','g','r','purple','yellow'])
ax.set_xlabel('Video Game Sales by Region in 2015')
ax.set_ylabel('(millions)')
```

Out[475]:
```
Text(0, 0.5, '(millions)')
```



The video game industry is a robust industry with global game sales of over **$264 million** in 2015. North American sales took up the largest part of total sales with the record of $102 million, EU sales being a close second. Although Japan's sales were relatively low at \$33.72, it is still an impressive figure considering that it is a single country unlike North America and Europe. Note that this dataset does not include other sources of revenue from video games such as hardware sales and in-game purchases. Also, this only includes games that sold over 100,000 copies. Therefore, we can suspect that total revenues for the industry are much higher.

2. 2. Genre Analysis

This section provides a brief analysis of the game genres and their respective sales performances in the industry.

In [476]:
```
genres = data['Genre'].unique().tolist()
genres
```

Out[476]:
```
['Sports',
 'Platform',
 'Racing',
 'Role-Playing',
 'Puzzle',
 'Misc',
 'Shooter',
 'Simulation',
 'Action',
 'Fighting',
 'Adventure',
 'Strategy']
```

Games in the dataset are categorized into 12 genres shown above.

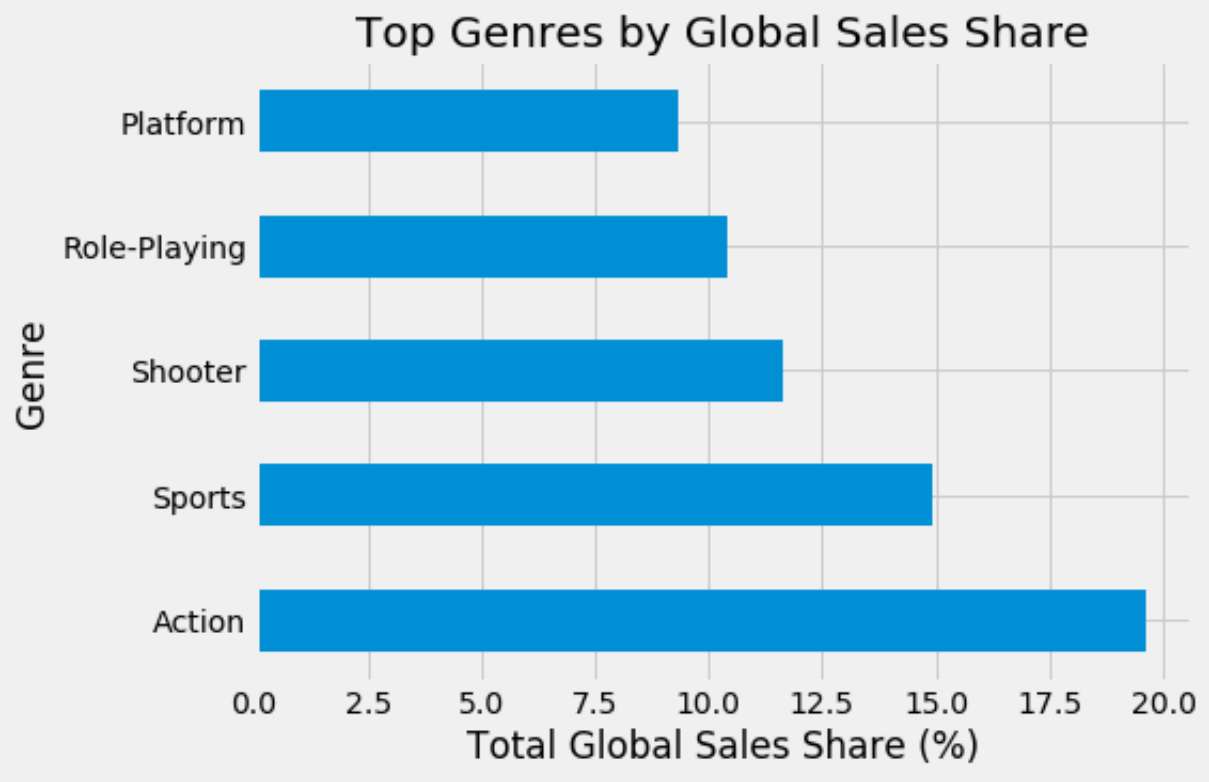
Key Genres in the Industry

In [477]:
```
topgenres_sales = data.groupby('Genre')['Global_Sales'].sum().sort_values(ascending = False).head()
topgenres_sales
```

Out[477]:
```
Genre
Action          1751.18
Sports          1330.93
Shooter         1037.37
Role-Playing     927.37
Platform         831.37
Name: Global_Sales, dtype: float64
```

In [478]:
```
topgenres_share = (topgenres_sales/data['Global_Sales'].sum())*100

fig,ax = plt.subplots(figsize = (7,5))
topgenres_share.plot.barh(ax=ax)
ax.set_title('Top Genres by Global Sales Share')
ax.set_xlabel('Total Global Sales Share (%)')
```

Out[478]:
```
Text(0.5, 0, 'Total Global Sales Share (%)')
```



In [479]:
```
(topgenres_sales.sum()/data['Global_Sales'].sum())*100
```

Out[479]:
```
65.89607687513103
```

Action, Sports, Shooter, Role-Playing and Platform are the Top 5 genres based on their total global sales. Total sales of Action games amount to almost **$1.75 billion**, taking up close to **20%of total video game sales**. Total sales of the 5 genres add up to almost **66% of total sales over the years**.

Top games(by sales) for each key genre are the following :

In [480]:
```
genretops = []
for i in genres:
    example = data.loc[data['Genre'] == i,:].sort_values('Global_Sales
', ascending = False).head()
    genretops.append(example)
```

Sports includes games such as Wii Sports and the FIFA series.

In [481]:
```
genretops[0]
```

Out[481]:

	Rank	Name	Platform	Year	Genre	Publisher	NA_Sales	EU_Sales	JP_Sales	Other_S
0	1	Wii Sports	Wii	2006.0	Sports	Nintendo	41.49	29.02	3.77	
3	4	Wii Sports Resort	Wii	2009.0	Sports	Nintendo	15.75	11.01	3.28	
13	14	Wii Fit	Wii	2007.0	Sports	Nintendo	8.94	8.03	3.60	
14	15	Wii Fit Plus	Wii	2009.0	Sports	Nintendo	9.09	8.59	2.53	
77	78	FIFA 16	PS4	2015.0	Sports	Electronic Arts	1.11	6.06	0.06	

Platform includes many of the Super Mario series games.

In [482]:
```
genretops[1]
```

Out[482]:

	Rank	Name	Platform	Year	Genre	Publisher	NA_Sales	EU_Sales	JP_Sales	Other_
1	2	Super Mario Bros.	NES	1985.0	Platform	Nintendo	29.08	3.58	6.81	
6	7	New Super Mario Bros.	DS	2006.0	Platform	Nintendo	11.38	9.23	6.50	
8	9	New Super Mario Bros. Wii	Wii	2009.0	Platform	Nintendo	14.59	7.06	4.70	
18	19	Super Mario World	SNES	1990.0	Platform	Nintendo	12.78	3.75	3.54	
21	22	Super Mario Land	GB	1989.0	Platform	Nintendo	10.83	2.71	4.18	

The Pokemon series are the best-selling games in the **Role-Playing** genre.

In [483]:
```
genretops[3]
```

Out[483]:

	Rank	Name	Platform	Year	Genre	Publisher	NA_Sales	EU_Sales	JP_Sal
4	5	Pokemon Red/Pokemon Blue	GB	1996.0	Role-Playing	Nintendo	11.27	8.89	10.
12	13	Pokemon Gold/Pokemon Silver	GB	1999.0	Role-Playing	Nintendo	9.00	6.18	7.
20	21	Pokemon Diamond/Pokemon Pearl	DS	2006.0	Role-Playing	Nintendo	6.42	4.52	6.
25	26	Pokemon Ruby/Pokemon Sapphire	GBA	2002.0	Role-Playing	Nintendo	6.06	3.90	5.
26	27	Pokemon Black/Pokemon White	DS	2010.0	Role-Playing	Nintendo	5.57	3.28	5.

Shooter genre includes the Call of Duty series, one of the most popular video games.

In [484]:
```
genretops[6]
```

Out[484]:

	Rank	Name	Platform	Year	Genre	Publisher	NA_Sales	EU_Sales	JP_Sales	Other
9	10	Duck Hunt	NES	1984.0	Shooter	Nintendo	26.93	0.63	0.28	
29	30	Call of Duty: Modern Warfare 3	X360	2011.0	Shooter	Activision	9.03	4.28	0.13	
31	32	Call of Duty: Black Ops	X360	2010.0	Shooter	Activision	9.67	3.73	0.11	
33	34	Call of Duty: Black Ops 3	PS4	2015.0	Shooter	Activision	5.77	5.81	0.35	
34	35	Call of Duty: Black Ops II	PS3	2012.0	Shooter	Activision	4.99	5.88	0.65	

The **Action** genre is represented by games such as the Grand Theft Auto series.

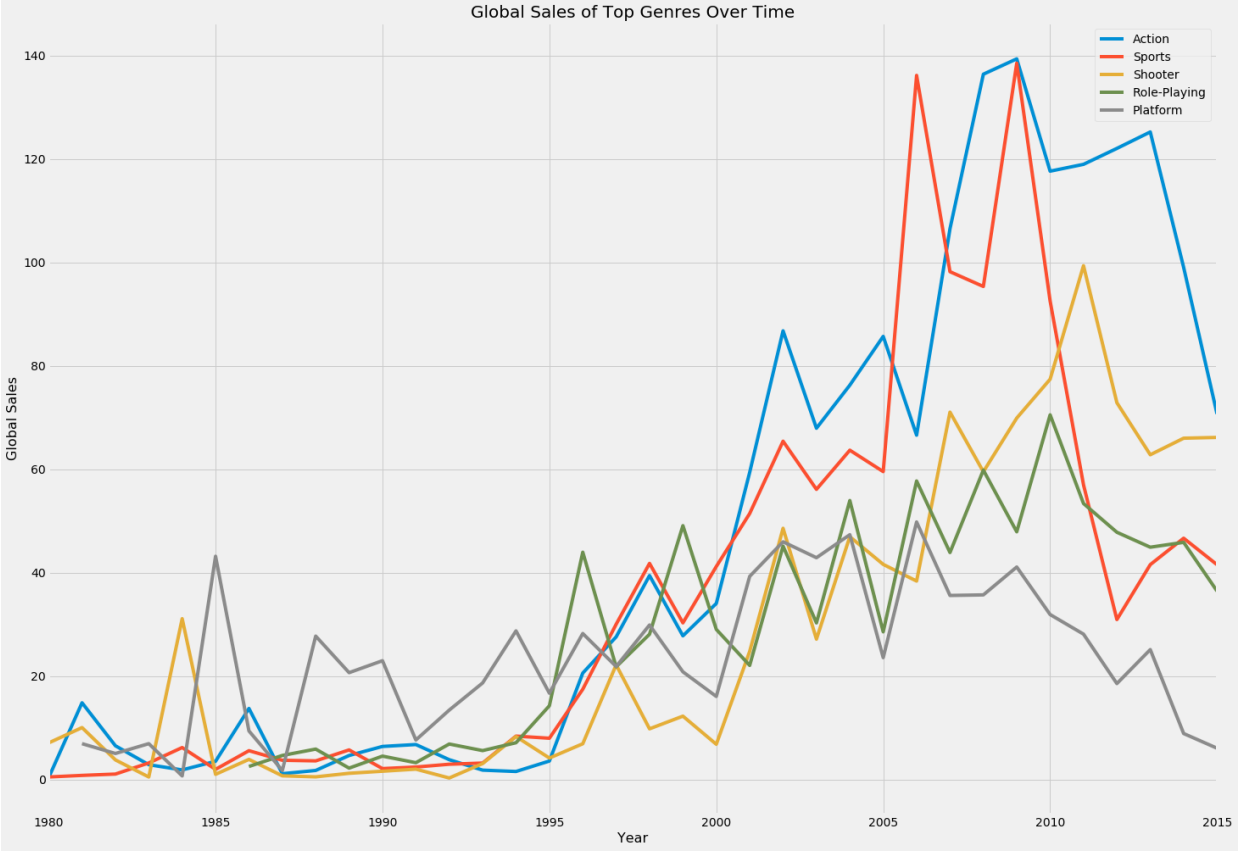
In [485]:
```
genretops[8]
```

Out[485]:

	Rank	Name	Platform	Year	Genre	Publisher	NA_Sales	EU_Sales	JP_Sales	Other_
16	17	Grand Theft Auto V	PS3	2013.0	Action	Take-Two Interactive	7.01	9.27	0.97	
17	18	Grand Theft Auto: San Andreas	PS2	2004.0	Action	Take-Two Interactive	9.43	0.40	0.41	
23	24	Grand Theft Auto V	X360	2013.0	Action	Take-Two Interactive	9.63	5.31	0.06	
24	25	Grand Theft Auto: Vice City	PS2	2002.0	Action	Take-Two Interactive	8.41	5.49	0.47	
38	39	Grand Theft Auto III	PS2	2001.0	Action	Take-Two Interactive	6.99	4.51	0.30	

In [486]:
```
topgenres = topgenres_sales.reset_index()['Genre'].unique().tolist()

fig,ax = plt.subplots(figsize=(22,16))
dfh1 = data.loc[data['Year']<=2015,['Year','Genre','Global_Sales']].gr
oupby(['Genre','Year'],as_index=False).sum()

for i in topgenres:
    dfh1[dfh1['Genre']==i].plot(x='Year',y='Global_Sales',label=i,ax=a
x)

ax.set_title('Global Sales of Top Genres Over Time',fontsize=20)
ax.set_ylabel('Global Sales',fontsize=16)
ax.set_xlabel('Year',fontsize=16)
```

Out[486]: Text(0.5, 0, 'Year')



Across these top 5 genres, sales have increased dramatically since the year 2000 as games have increased in mainstream popularity. Action and Sports, however, have consistently dominated in sales throughout the years.

2.3. Key Publishers

In this section, we identify the best-performing publishers and present their basic sales statistics.

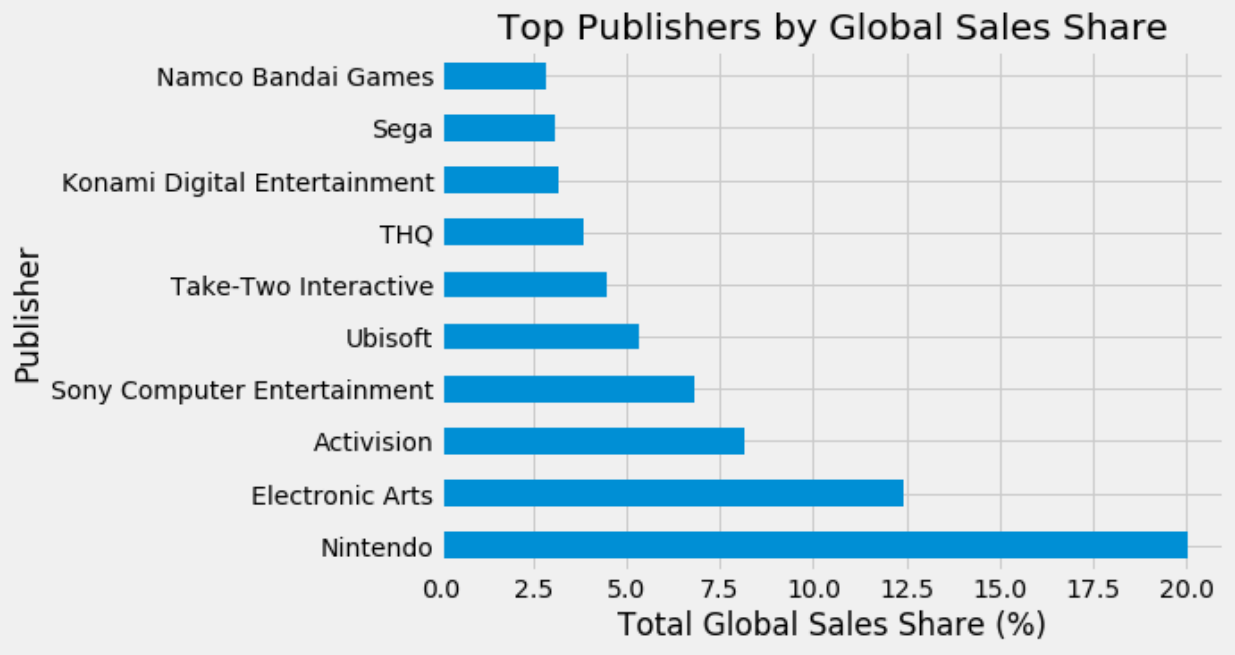
The top 10 publishers by total global sales are the following :

In [487]:
```
toppub = data.groupby('Publisher')['Global_Sales'].sum().sort_values(a
scending = False).head(10)
toppub
```

Out[487]:
```
Publisher
Nintendo                          1786.56
Electronic Arts                   1110.32
Activision                         727.46
Sony Computer Entertainment        607.50
Ubisoft                            474.72
Take-Two Interactive               399.54
THQ                                340.77
Konami Digital Entertainment       283.64
Sega                               272.99
Namco Bandai Games                 254.09
Name: Global_Sales, dtype: float64
```

In [488]:
```
toppub_share = (toppub/data['Global_Sales'].sum())*100

fig,ax = plt.subplots(figsize = (7,5))
toppub_share.plot.barh(ax=ax)
ax.set_title('Top Publishers by Global Sales Share')
ax.set_xlabel('Total Global Sales Share (%)')
```

Out[488]:
```
Text(0.5, 0, 'Total Global Sales Share (%)')
```



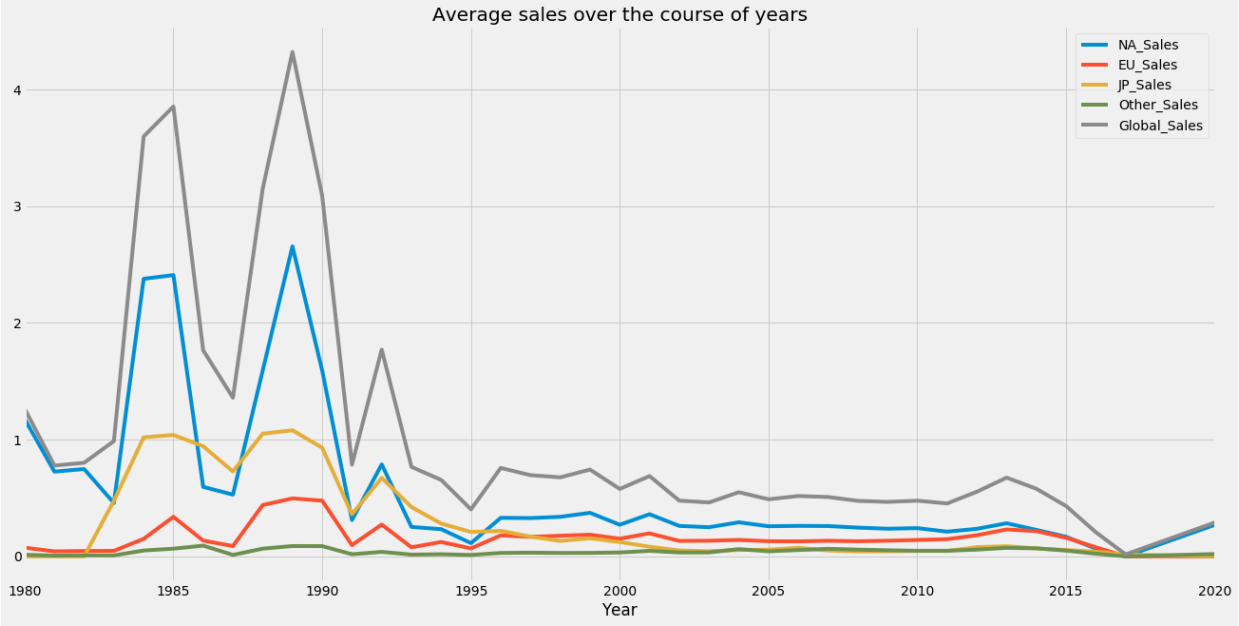
Other than Nintendo and Sony, which also produce their own respective platforms, the largest publishers are **EA, Activision, Ubisoft, Take-Two**.

3. Industry Sales Performance Analysis

3.1. Industry-wide Sales Trend over Time

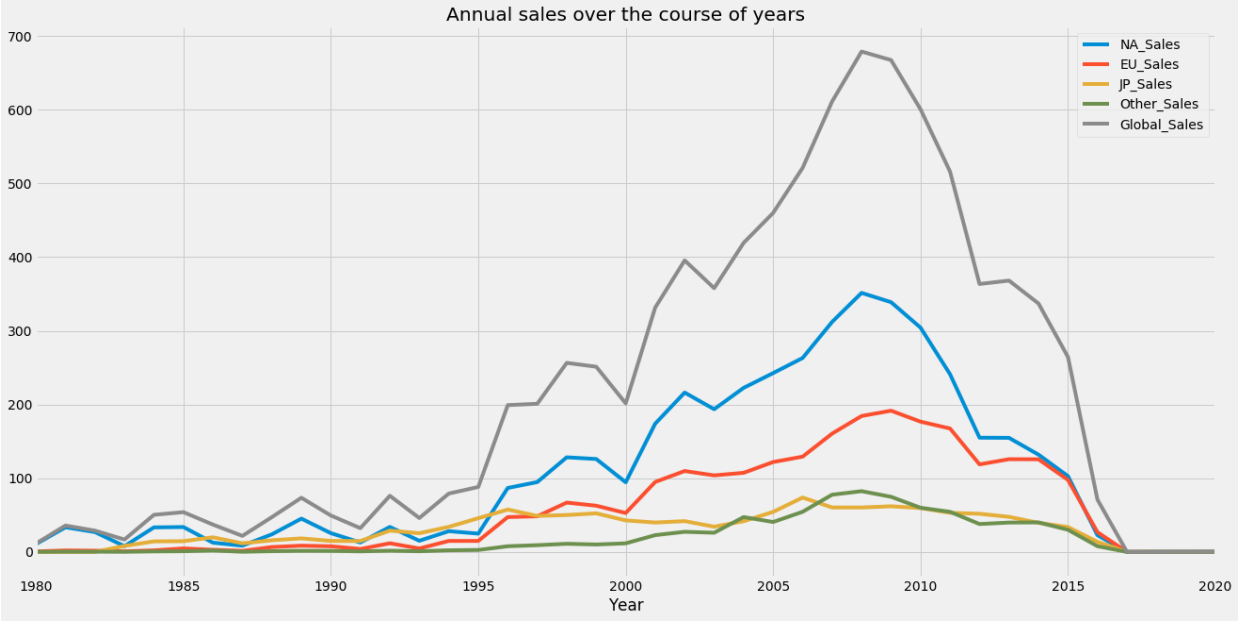
In [489]:
```
df1 = data.groupby(['Year'])
plt.figure(figsize=(10,10))
df1_mean = df1['NA_Sales','EU_Sales','JP_Sales','Other_Sales','Global_
Sales'].aggregate(np.mean)
df1_mean.plot(figsize=(20,10))
plt.title('Average sales over the course of years')
```

Out[489]:
```
Text(0.5, 1.0, 'Average sales over the course of years')

<Figure size 720x720 with 0 Axes>
```



In [490]:
```
df1 = data.groupby(['Year'])
plt.figure(figsize=(10,10))
df1_sum = df1['NA_Sales','EU_Sales','JP_Sales','Other_Sales','Global_Sales'].aggregate(np.sum)
df1_sum.plot(figsize=(20,10))
plt.title('Annual sales over the course of years')
```

Out[490]:
```
Text(0.5, 1.0, 'Annual sales over the course of years')

<Figure size 720x720 with 0 Axes>
```



In [561]:
```
pd.set_option('display.max_columns', None)
data.groupby('Year').agg({'Global_Sales':'sum','Rank':'count'})
```

Out[561]:

Year	Global_Sales	Rank
1980.0	11.38	9
1981.0	35.77	46
1982.0	28.86	36
1983.0	16.79	17
1984.0	50.36	14
1985.0	53.94	14
1986.0	37.07	21
1987.0	21.74	16
1988.0	47.22	15

1989.0	73.45	17
1990.0	49.39	16
1991.0	32.23	41
1992.0	76.16	43
1993.0	45.98	60
1994.0	79.17	121
1995.0	88.11	219
1996.0	199.15	263
1997.0	200.98	289
1998.0	256.47	379
1999.0	251.27	338
2000.0	201.56	349
2001.0	331.47	482
2002.0	395.52	829
2003.0	357.85	775
2004.0	419.31	763
2005.0	459.94	941
2006.0	521.04	1008
2007.0	611.13	1202
2008.0	678.90	1428
2009.0	667.30	1431
2010.0	600.45	1259
2011.0	515.99	1139
2012.0	363.54	657
2013.0	368.11	546
2014.0	337.05	582
2015.0	264.44	614
2016.0	70.93	344
2017.0	0.05	3
2020.0	0.29	1

The dramatic rise in the number of released games per year has resulted in a **lower average of sales** compared to the pre-2000s era, but total game sales per region have nonetheless increased dramatically in line with the increasing number of games for sale over time.

While gaming grew in mainstream popularity throughout the 2000's, increasing numbers of digital game sales on home gaming consoles have resulted in a decline in phyisical game sales throughout the 2010's.

3. 2. Volatility Analysis

In this section, we analyze the elasticity of North American average game sales conditional on US GDP Growth.

In [493]:
```
us_gdp = pd.read_csv('USGDP.csv')
```

In [494]:
```
vg_fixed_years = data.loc[(data['Year']>=2000.0)&(data['Year']<=2015),
:]

na_yearly_avgsales = vg_fixed_years.groupby('Year')['NA_Sales'].mean()
```

In [495]:
```
us_gdp['Year'] = us_gdp.DATE.str[:4]
us_gdp['Year'] = us_gdp['Year'].astype('int')
us_gdp = us_gdp.iloc[:16,:]
us_gdp_s = us_gdp['Year']
us_gdp.columns = ['Date','GDP','Year']
us_gdp_series = us_gdp['GDP']
us_gdp_sales = pd.DataFrame({'GDP': us_gdp_s.tolist(), 'avgsales': na_
yearly_avgsales.tolist()})
reg_usgdp_sales = smf.ols('np.log(avgsales) ~ np.log(GDP)',us_gdp_sale
s).fit()
print(reg_usgdp_sales.summary())
```

```
                            OLS Regression Results
==============================================================================
==========
Dep. Variable:       np.log(avgsales)   R-squared:
0.466
Model:                            OLS   Adj. R-squared:
0.428
Method:                 Least Squares   F-statistic:
12.21
Date:                Mon, 16 Dec 2019   Prob (F-statistic):
0.00358
Time:                        15:31:50   Log-Likelihood:
11.979
No. Observations:                  16   AIC:
-19.96
Df Residuals:                      14   BIC:
-18.41
Df Model:                           1
Covariance Type:            nonrobust
==============================================================================
===========
                 coef    std err          t      P>|t|      [0.025
0.975]
------------------------------------------------------------------------------
-----------
Intercept     352.5165    101.298      3.480      0.004     135.253
569.780
np.log(GDP)   -46.5373     13.321     -3.494      0.004     -75.107
-17.967
==============================================================================
==========
Omnibus:                        1.771   Durbin-Watson:
2.029
Prob(Omnibus):                  0.413   Jarque-Bera (JB):
0.536
Skew:                           0.415   Prob(JB):
0.765
Kurtosis:                       3.337   Cond. No.
2.56e+04
==============================================================================
==========

Warnings:
[1] Standard Errors assume that the covariance matrix of the errors
is correctly specified.
[2] The condition number is large, 2.56e+04. This might indicate tha
t there are
strong multicollinearity or other numerical problems.
```

```
//anaconda3/lib/python3.7/site-packages/scipy/stats/stats.py:1450: U
serWarning: kurtosistest only valid for n>=20 ... continuing anyway,
n=16
  "anyway, n=%i" % int(n))
```

In [496]:
```
reg_usgdp_sales2 = smf.ols('avgsales ~ GDP',us_gdp_sales).fit()
print(reg_usgdp_sales2.summary())
```

```
                            OLS Regression Results
==============================================================================
==========
Dep. Variable:                avgsales   R-squared:
0.446
Model:                            OLS   Adj. R-squared:
0.407
Method:                 Least Squares   F-statistic:
11.28
Date:                Mon, 16 Dec 2019   Prob (F-statistic):
0.00469
Time:                        15:31:50   Log-Likelihood:
33.704
No. Observations:                  16   AIC:
-63.41
Df Residuals:                      14   BIC:
-61.86
Df Model:                           1
Covariance Type:            nonrobust
==============================================================================
==========
                 coef    std err          t      P>|t|      [0.025
0.975]
------------------------------------------------------------------------------
----------
Intercept     11.7602      3.426      3.432      0.004       4.411
19.109
GDP           -0.0057      0.002     -3.358      0.005      -0.009
-0.002
==============================================================================
==========
Omnibus:                        5.553   Durbin-Watson:
2.257
Prob(Omnibus):                  0.062   Jarque-Bera (JB):
3.079
Skew:                           1.032   Prob(JB):
0.214
Kurtosis:                       3.599   Cond. No.
8.74e+05
==============================================================================
==========

Warnings:
[1] Standard Errors assume that the covariance matrix of the errors
is correctly specified.
[2] The condition number is large, 8.74e+05. This might indicate tha
t there are
strong multicollinearity or other numerical problems.
```

The first regression shows that the elasticity of North American video game sales against US GDP growth between 2000 and 2015 is negative. The coefficient of the second regression (β_1 = -0.0057) indicates that as US GDP growth increases by 1 percent(unit), the North American average sales decrease by 5700 dollars. The relationship is statistically significant at the 95% confidence level.

Such results suggest that video game sales may have a characteristic of an inferior good. However, we cannot be entirely conclusive as other factors, such as increasing popularity of digital game sales, may be affecting the sales numbers in the dataset.

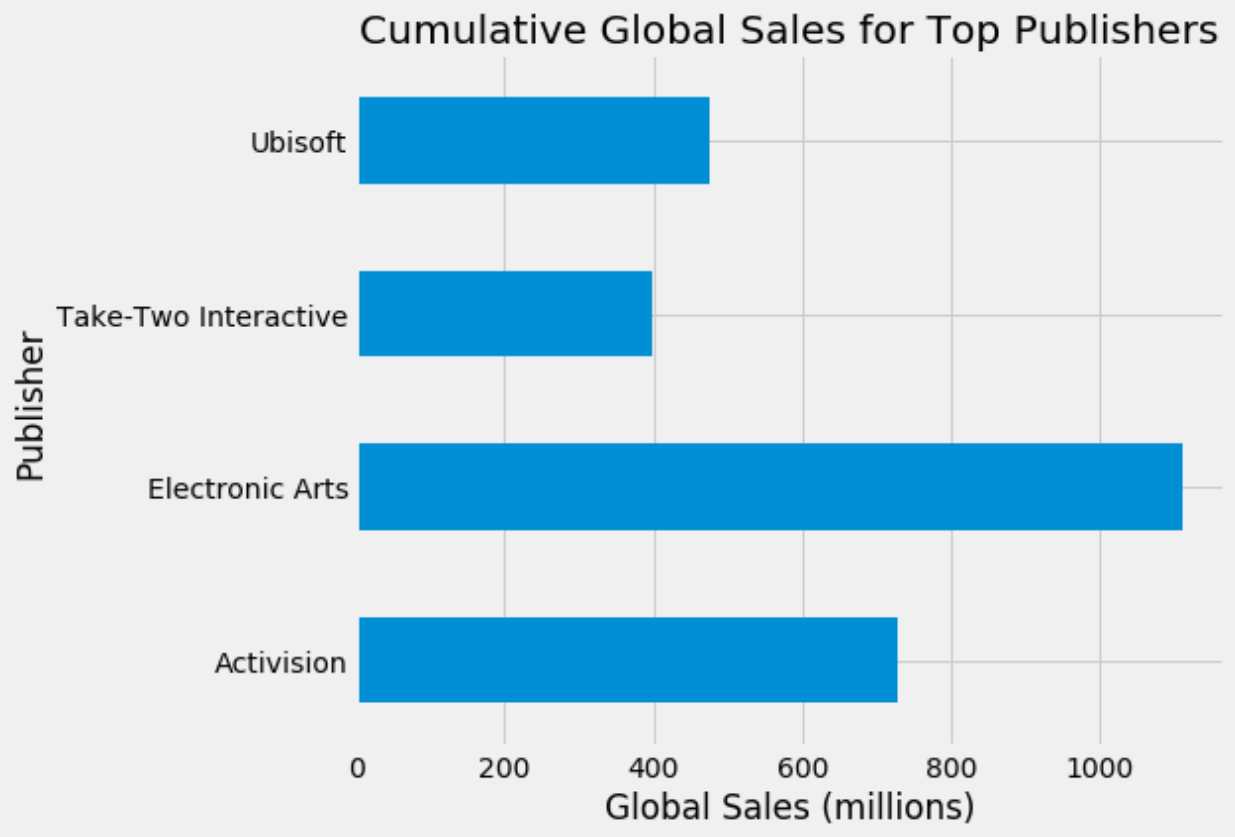
4. Publisher Performance Analysis

In this section, we conduct a detailed analysis on some of key publishers that we identified in 2.3. We will be focusing on **Electronic Arts, Activision, Ubisoft and Take-Two**, which are all public companies traded in the US stock market.

In [510]:
```
keypub = ['Electronic Arts','Activision','Ubisoft','Take-Two Interacti
ve']

keypubdata = data.loc[data['Publisher'].isin(keypub),]
```

In [526]:
```
fig,ax = plt.subplots()
keypubdata.groupby('Publisher')['Global_Sales'].sum().plot.barh(ax=ax,
figsize = (7, 6))
ax.set_title('Cumulative Global Sales for Top Publishers')
ax.set_xlabel('Global Sales (millions)')
```

Out[526]:
```
Text(0.5, 0, 'Global Sales (millions)')
```



Amongst top publishers, **EA** leads in global sales to date.

Now we will look into the leading products, sales trends and finally the stock price volatility against the S&P 500 Index for each publisher.

The S&P 500 index data was retrieved from https://finance.yahoo.com/quote/%5EGSPC/history/ (https://finance.yahoo.com/quote/%5EGSPC/history/). The dataset includes monthly prices of the index.

In [528]:
```
sp500_long = pd.read_csv('sp500total.csv')
sp500_long = sp500_long.rename(columns = {'Close' : 'sp500_close'})
```

Electronic Arts

In [529]:
```
ea = data.loc[data['Publisher']=='Electronic Arts',:]
ea.sort_values('Global_Sales',ascending = False).head(10)
```

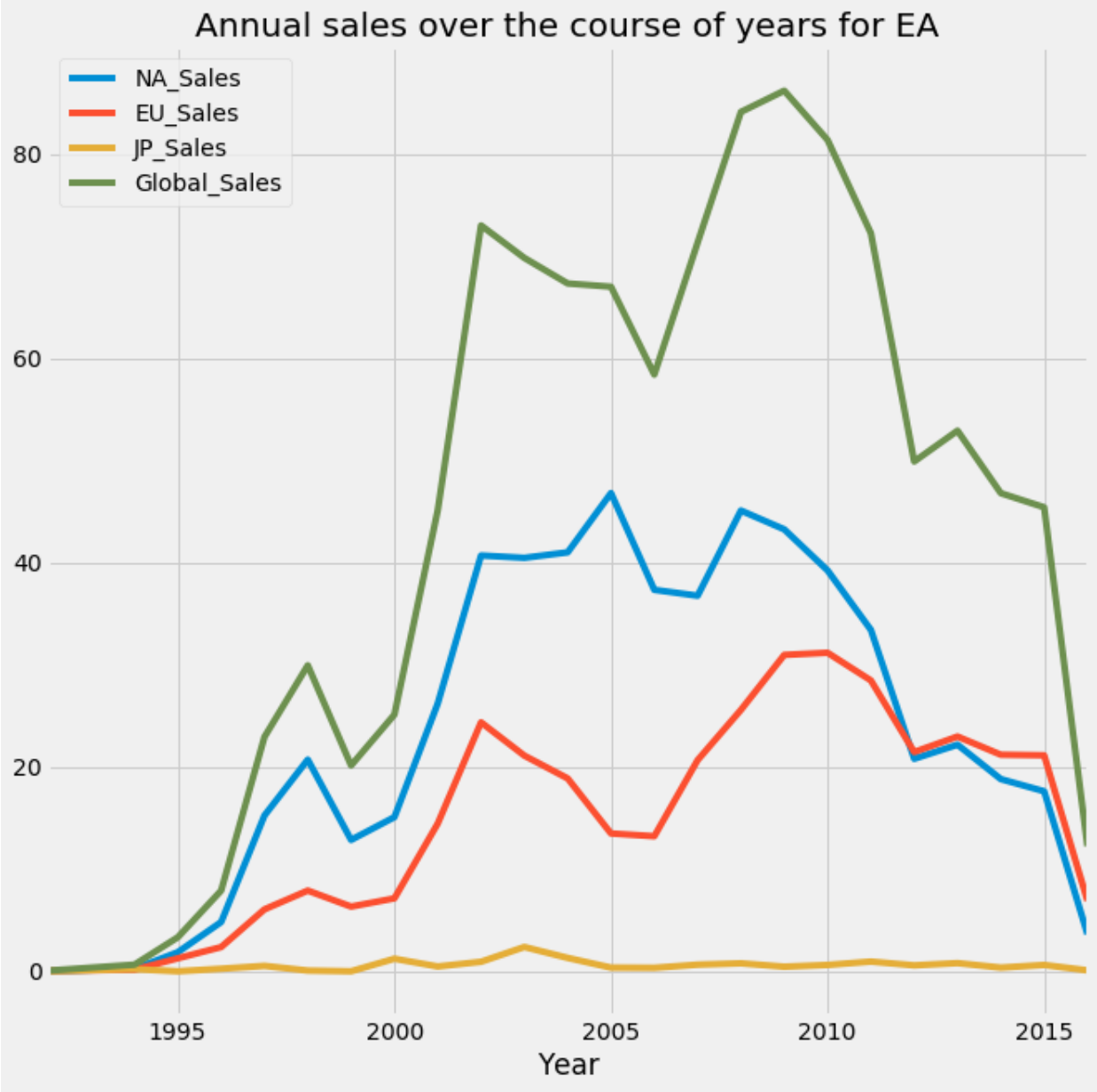
Out[529]:

	Rank	Name	Platform	Year	Genre	Publisher	NA_Sales	EU_Sales	JP_Sales
77	78	FIFA 16	PS4	2015.0	Sports	Electronic Arts	1.11	6.06	0.06
82	83	FIFA Soccer 13	PS3	2012.0	Action	Electronic Arts	1.06	5.05	0.13
83	84	The Sims 3	PC	2009.0	Simulation	Electronic Arts	0.98	6.42	0.00
92	93	Star Wars Battlefront (2015)	PS4	2015.0	Shooter	Electronic Arts	2.93	3.29	0.22
99	100	Battlefield 3	X360	2011.0	Shooter	Electronic Arts	4.46	2.13	0.06
103	104	Battlefield 3	PS3	2011.0	Shooter	Electronic Arts	2.85	2.93	0.35
104	105	Need for Speed Underground	PS2	2003.0	Racing	Electronic Arts	3.27	2.83	0.08
112	113	FIFA 14	PS3	2013.0	Sports	Electronic Arts	0.78	4.32	0.07
113	114	Need for Speed Underground 2	PS2	2004.0	Racing	Electronic Arts	2.71	3.02	0.08
114	115	Medal of Honor: Frontline	PS2	2002.0	Shooter	Electronic Arts	2.93	2.75	0.17

Popular franchises in top genres like sports, action, and shooters helps EA outperform its peers. In particular, FIFA as an annual franchise performs well in Europe and North America.

In [530]:
```
plt.style.use('fivethirtyeight')
eaplot = ea.groupby(['Year'])
plt.figure(figsize=(10,10))
eaplot_sum = eaplot['NA_Sales','EU_Sales','JP_Sales','Global_Sales'].a
ggregate(np.sum)
eaplot_sum.plot(figsize=(10,10))
plt.title('Annual sales over the course of years for EA')
```

Out[530]:
```
Text(0.5, 1.0, 'Annual sales over the course of years for EA')

<Figure size 720x720 with 0 Axes>
```



EA has been a strong global performer throughout the 2000s. North American sales are boosted by another annual franchise, Madden.

In [531]:
```
ea = pd.read_csv('EA.csv')
ea = ea.rename(columns = {'Close':'ea_close'})

ea_merge = ea.merge(sp500_long, how='left', on='Date')
ea_merge.head()

ea_reg = smf.ols('np.log(ea_close) ~ np.log(sp500_close)', ea_merge).f
it()
print(ea_reg.summary())
```

```
                            OLS Regression Results
==============================================================================
==========
Dep. Variable:       np.log(ea_close)   R-squared:
0.800
Model:                            OLS   Adj. R-squared:
0.799
Method:                 Least Squares   F-statistic:
1445.
Date:                Mon, 16 Dec 2019   Prob (F-statistic):
1.95e-128
Time:                        15:51:47   Log-Likelihood:
-314.45
No. Observations:                 364   AIC:
632.9
Df Residuals:                     362   BIC:
640.7
Df Model:                           1
Covariance Type:            nonrobust
==============================================================================
===================
                         coef    std err          t      P>|t|
[0.025      0.975]
------------------------------------------------------------------------------
-------------------
Intercept             -10.6834      0.360    -29.717      0.000
-11.390      -9.976
np.log(sp500_close)     1.9505      0.051     38.012      0.000
1.850       2.051
==============================================================================
==========
Omnibus:                       17.513   Durbin-Watson:
0.042
Prob(Omnibus):                  0.000   Jarque-Bera (JB):
8.209
Skew:                          -0.124   Prob(JB):
0.0165
Kurtosis:                       2.308   Cond. No.
85.2
==============================================================================
==========

Warnings:
[1] Standard Errors assume that the covariance matrix of the errors
is correctly specified.
```

This regression result indicates that EA's stock price elasticity against the S&P 500 Index (β_1) is positive, with a significant p-value close to zero. This means that EA's share prices are more likely to rise with the overall stock market, but also more likely to decline with the market.

Activision

In [555]:
```
activision = data.loc[data['Publisher']=='Activision',:]
activision.sort_values('Global_Sales',ascending = False).head(10)
```

Out[555]:

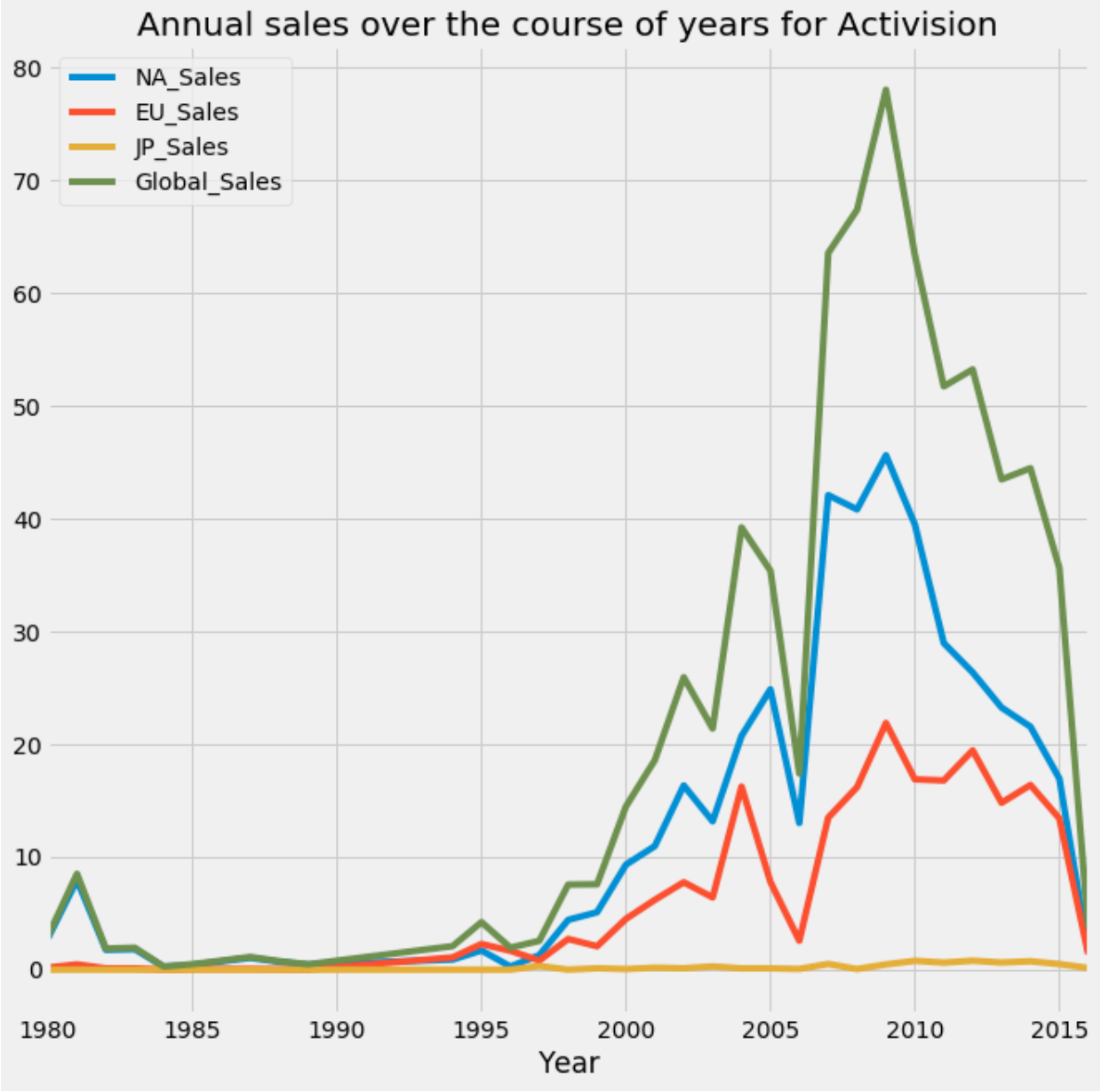
	Rank	Name	Platform	Year	Genre	Publisher	NA_Sales	EU_Sales	JP_Sales	Other
29	30	Call of Duty: Modern Warfare 3	X360	2011.0	Shooter	Activision	9.03	4.28	0.13	
31	32	Call of Duty: Black Ops	X360	2010.0	Shooter	Activision	9.67	3.73	0.11	
33	34	Call of Duty: Black Ops 3	PS4	2015.0	Shooter	Activision	5.77	5.81	0.35	
34	35	Call of Duty: Black Ops II	PS3	2012.0	Shooter	Activision	4.99	5.88	0.65	
35	36	Call of Duty: Black Ops II	X360	2012.0	Shooter	Activision	8.25	4.30	0.07	
36	37	Call of Duty: Modern Warfare 2	X360	2009.0	Shooter	Activision	8.52	3.63	0.08	
37	38	Call of Duty: Modern Warfare 3	PS3	2011.0	Shooter	Activision	5.54	5.82	0.49	
40	41	Call of Duty: Black Ops	PS3	2010.0	Shooter	Activision	5.98	4.44	0.48	
55	56	Call of Duty: Modern Warfare 2	PS3	2009.0	Shooter	Activision	4.99	3.69	0.38	
61	62	Call of Duty: Ghosts	X360	2013.0	Shooter	Activision	6.72	2.63	0.04	

The Call of Duty franchise is the most successful franchise of Activision by far.

In [536]:
```
plt.style.use('fivethirtyeight')
aplot = activision.groupby(['Year'])
plt.figure(figsize=(10,10))
aplot_sum = aplot['NA_Sales','EU_Sales','JP_Sales','Global_Sales'].agg
regate(np.sum)
aplot_sum.plot(figsize=(10,10))
plt.title('Annual sales over the course of years for Activision')
```

Out[536]:
```
Text(0.5, 1.0, 'Annual sales over the course of years for Activision
')
```

```
<Figure size 720x720 with 0 Axes>
```



While posessing a number of strong franchises, the disproportionate success of the Call of Duty franchise resulted in a peak in Activision's sales during the early to mid 2010's.

In [556]:
```
activision2 = pd.read_csv('ATVI.csv')
activision2 = activision2.rename(columns = {'Close' : 'atvi_close'})
activision_merge = activision2.merge(sp500_long, how='left', on='Date'
)
activision_merge.head()
activision_reg = smf.ols('np.log(atvi_close) ~ np.log(sp500_close)', a
ctivision_merge).fit()
print(activision_reg.summary())
```

```
                            OLS Regression Results
==============================================================================
==========
Dep. Variable:     np.log(atvi_close)   R-squared:
0.682
Model:                            OLS   Adj. R-squared:
0.681
Method:                 Least Squares   F-statistic:
670.0
Date:                Mon, 16 Dec 2019   Prob (F-statistic):
8.96e-80
Time:                        16:53:46   Log-Likelihood:
-384.24
No. Observations:                 315   AIC:
772.5
Df Residuals:                     313   BIC:
780.0
Df Model:                           1
Covariance Type:            nonrobust
==============================================================================
==================
                         coef    std err          t      P>|t|
[0.025      0.975]
------------------------------------------------------------------------------
------------------
Intercept             -16.9915      0.727    -23.365      0.000
-18.422     -15.561
np.log(sp500_close)     2.6306      0.102     25.885      0.000
2.431       2.831
==============================================================================
==========
Omnibus:                       58.447   Durbin-Watson:
0.032
Prob(Omnibus):                  0.000   Jarque-Bera (JB):
92.390
Skew:                          -1.098   Prob(JB):
8.67e-21
Kurtosis:                       4.488   Cond. No.
115.
==============================================================================
==========

Warnings:
[1] Standard Errors assume that the covariance matrix of the errors
is correctly specified.
```

Activision's stock price elasticity is also positive with a significant p-value. The elasticity of 2.63 indicates that Activision's share prices may be more sensitive to the stock market compared to EA's(1.95).

Ubisoft

In [557]:
```
ubisoft = data.loc[data['Publisher']=='Ubisoft',:]
ubisoft.sort_values('Global_Sales',ascending = False).head(10)
```

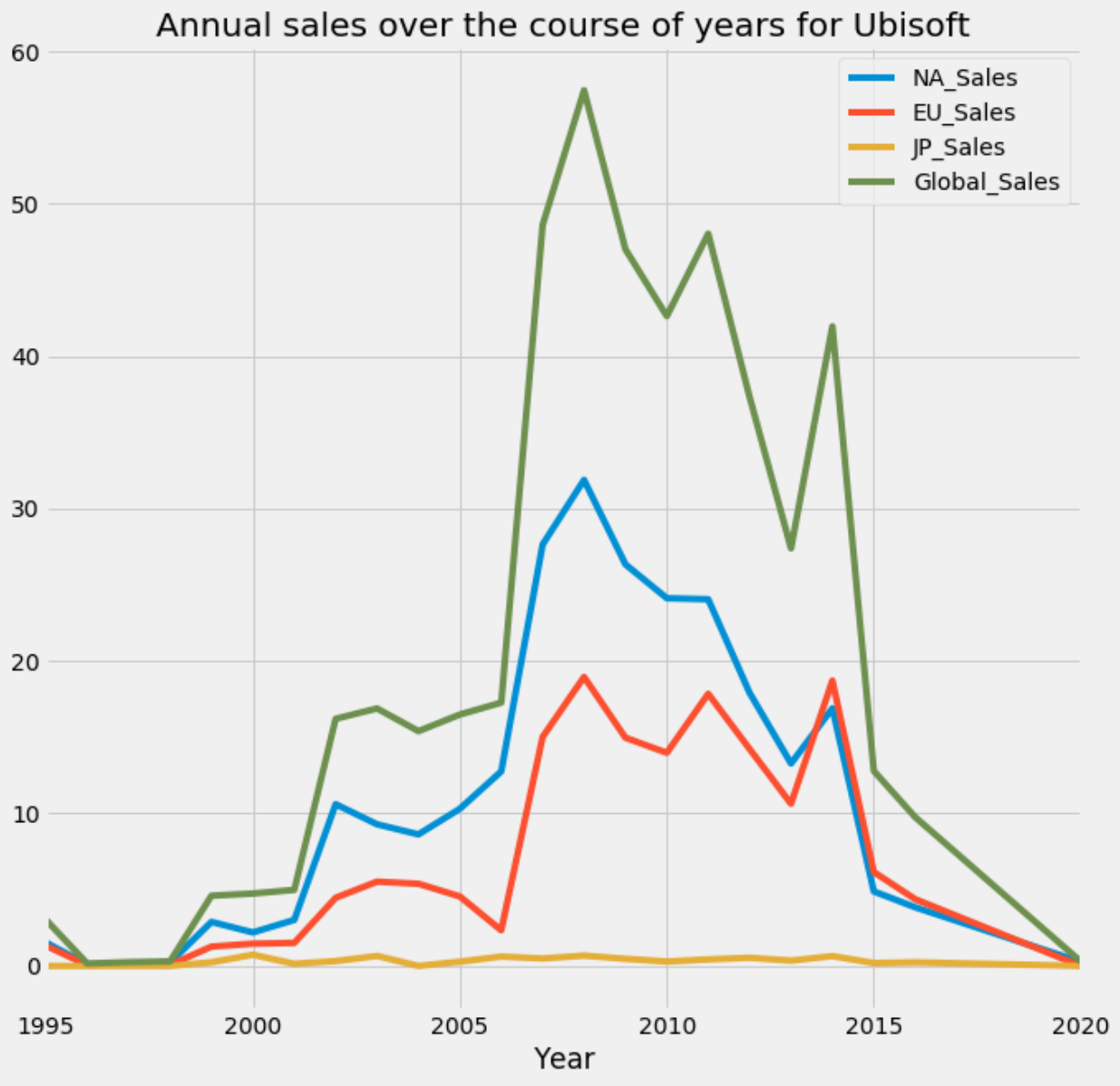
Out[557]:

	Rank	Name	Platform	Year	Genre	Publisher	NA_Sales	EU_Sales	JP_Sales
60	61	Just Dance 3	Wii	2011.0	Misc	Ubisoft	6.05	3.15	0.00
68	69	Just Dance 2	Wii	2010.0	Misc	Ubisoft	5.84	2.89	0.01
102	103	Just Dance	Wii	2009.0	Misc	Ubisoft	3.51	3.03	0.00
111	112	Just Dance 4	Wii	2012.0	Misc	Ubisoft	4.14	2.21	0.00
128	129	Assassin's Creed III	PS3	2012.0	Action	Ubisoft	2.64	2.56	0.16
156	157	Assassin's Creed II	PS3	2009.0	Action	Ubisoft	2.54	1.95	0.21
158	159	Assassin's Creed	X360	2007.0	Adventure	Ubisoft	3.28	1.65	0.07
172	173	Assassin's Creed III	X360	2012.0	Action	Ubisoft	3.13	1.71	0.03
176	177	Assassin's Creed II	X360	2009.0	Action	Ubisoft	3.10	1.56	0.08
218	219	Assassin's Creed	PS3	2007.0	Adventure	Ubisoft	1.91	2.00	0.09

Ubisoft's two most successful franchises are Just Dance and Assassin's Creed.

In [558]:
```
plt.style.use('fivethirtyeight')
uplot = ubisoft.groupby(['Year'])
plt.figure(figsize=(10,10))
uplot_sum = uplot['NA_Sales','EU_Sales','JP_Sales','Global_Sales'].agg
regate(np.sum)
uplot_sum.plot(figsize=(10,10))
plt.title('Annual sales over the course of years for Ubisoft')
```

Out[558]:
```
Text(0.5, 1.0, 'Annual sales over the course of years for Ubisoft')

<Figure size 720x720 with 0 Axes>
```



Ubisoft's total sales have declined to a greater degree than Activision and EA as its two largest franchines, Just Dance and Assasin's Creed, have declined in popularity since 2000. Interestingly, this peak in sales took place during the Great Recession. Also, there has been a general gap between the NA sales and the EU Sales while showing similar trends, However, starting around 2013, the two regional figures seem to be converging.

In [562]:
```
ubi_price = pd.read_csv('UbisoftPriceHistory.csv')

ubi_price = ubi_price.rename(columns = {'Close' : 'ubi_close'})

ubi_merge = ubi_price.merge(sp500_long, how='left', on='Date')
ubi_merge.head()
ubi_reg = smf.ols('np.log(ubi_close) ~ np.log(sp500_close)', ubi_merge
).fit()
print(ubi_reg.summary())
```

```
                            OLS Regression Results
==============================================================================
==========
Dep. Variable:      np.log(ubi_close)   R-squared:
0.849
Model:                            OLS   Adj. R-squared:
0.847
Method:                 Least Squares   F-statistic:
660.9
Date:                Mon, 16 Dec 2019   Prob (F-statistic):
3.49e-50
Time:                        22:17:22   Log-Likelihood:
-42.725
No. Observations:                 120   AIC:
89.45
Df Residuals:                     118   BIC:
95.03
Df Model:                           1
Covariance Type:            nonrobust
==============================================================================
==================
                         coef    std err          t      P>|t|
[0.025      0.975]
------------------------------------------------------------------------------
------------------
Intercept             -16.6497      0.770    -21.613      0.000
-18.175     -15.124
np.log(sp500_close)     2.6252      0.102     25.709      0.000
2.423       2.827
==============================================================================
==========
Omnibus:                        6.863   Durbin-Watson:
0.111
Prob(Omnibus):                  0.032   Jarque-Bera (JB):
4.630
Skew:                           0.333   Prob(JB):
0.0987
Kurtosis:                       2.305   Cond. No.
186.
==============================================================================
==========

Warnings:
[1] Standard Errors assume that the covariance matrix of the errors
is correctly specified.
```

Ubisoft's stock price elasticity is positive(2.625). The level of elasticity is fairly similar to that of Activision.

Take-Two

In [550]:
```
take2 = data.loc[data['Publisher']=='Take-Two Interactive',:]
take2.sort_values('Global_Sales',ascending = False).head(10)
```

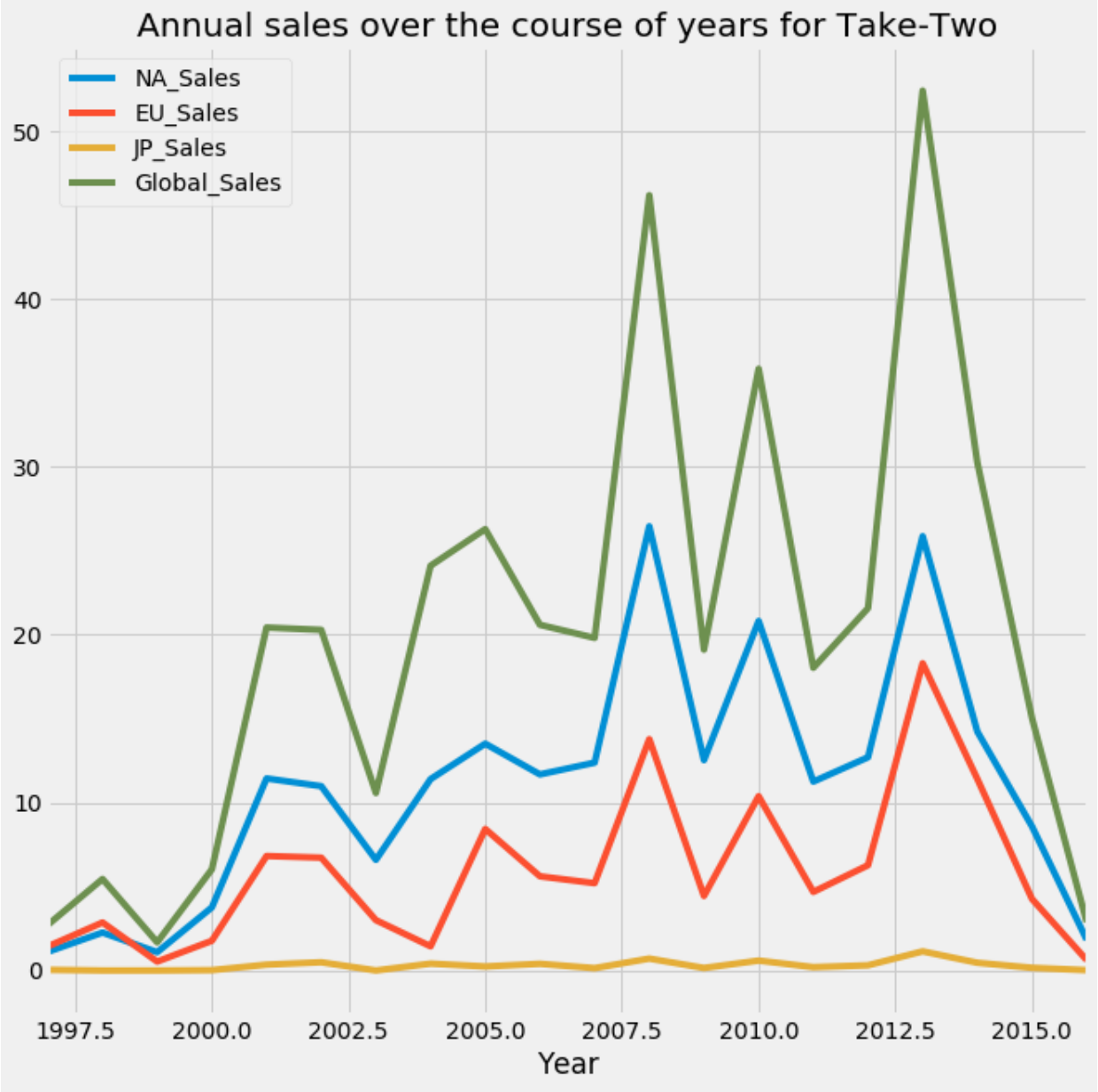
Out[550]:

	Rank	Name	Platform	Year	Genre	Publisher	NA_Sales	EU_Sales	JP_Sales	O
16	17	Grand Theft Auto V	PS3	2013.0	Action	Take-Two Interactive	7.01	9.27	0.97	
17	18	Grand Theft Auto: San Andreas	PS2	2004.0	Action	Take-Two Interactive	9.43	0.40	0.41	
23	24	Grand Theft Auto V	X360	2013.0	Action	Take-Two Interactive	9.63	5.31	0.06	
24	25	Grand Theft Auto: Vice City	PS2	2002.0	Action	Take-Two Interactive	8.41	5.49	0.47	
38	39	Grand Theft Auto III	PS2	2001.0	Action	Take-Two Interactive	6.99	4.51	0.30	
44	45	Grand Theft Auto V	PS4	2014.0	Action	Take-Two Interactive	3.80	5.81	0.36	
51	52	Grand Theft Auto IV	X360	2008.0	Action	Take-Two Interactive	6.76	3.10	0.14	
56	57	Grand Theft Auto IV	PS3	2008.0	Action	Take-Two Interactive	4.76	3.76	0.44	
90	91	Grand Theft Auto: Liberty City Stories	PSP	2005.0	Action	Take-Two Interactive	2.90	2.83	0.24	
123	124	Red Dead Redemption	PS3	2010.0	Action	Take-Two Interactive	2.79	2.61	0.17	

The biggest franchise of Take-Two by far is Grand Theft Auto.

In [551]:
```
takeplot = take2.groupby(['Year'])
plt.figure(figsize=(10,10))
takeplot_sum = takeplot['NA_Sales','EU_Sales','JP_Sales','Global_Sales
'].aggregate(np.sum)
takeplot_sum.plot(figsize=(10,10))
plt.title('Annual sales over the course of years for Take-Two')
```

Out[551]:
```
Text(0.5, 1.0, 'Annual sales over the course of years for Take-Two')

<Figure size 720x720 with 0 Axes>
```



Take-Two's annual sales figures are highly dependent on Grand Theft Auto. While GTA sells as well as FIFA from EA, it is not released on an annual bases, meaning investors cannot expect consistency in annual sales revenue.

In [563]:
```
taketwo = pd.read_csv('TTWO.csv')
taketwo = taketwo.rename(columns = {'Close':'taketwo_close'})

taketwo_merge = taketwo.merge(sp500_long, how='left', on='Date')
# taketwo_merge.head()

taketwo_reg = smf.ols('np.log(taketwo_close) ~ np.log(sp500_close)', t
aketwo_merge).fit()
print(taketwo_reg.summary())
```

```
                            OLS Regression Results
==============================================================================
=============
Dep. Variable:     np.log(taketwo_close)   R-squared:
0.656
Model:                               OLS   Adj. R-squared:
0.655
Method:                    Least Squares   F-statistic:
516.6
Date:                   Mon, 16 Dec 2019   Prob (F-statistic):
9.85e-65
Time:                           22:19:51   Log-Likelihood:
-203.07
No. Observations:                    273   AIC:
410.1
Df Residuals:                        271   BIC:
417.4
Df Model:                              1
Covariance Type:               nonrobust
==============================================================================
===================
                         coef    std err          t      P>|t|
[0.025      0.975]
------------------------------------------------------------------------------
-------------------
Intercept             -12.0503      0.658    -18.311      0.000
-13.346     -10.755
np.log(sp500_close)     2.0562      0.090     22.729      0.000
1.878       2.234
==============================================================================
==========
Omnibus:                       13.216   Durbin-Watson:
0.078
Prob(Omnibus):                  0.001   Jarque-Bera (JB):
6.235
Skew:                          -0.117   Prob(JB):
0.0443
Kurtosis:                       2.297   Cond. No.
158.
==============================================================================
==========

Warnings:
[1] Standard Errors assume that the covariance matrix of the errors
is correctly specified.
```

Like the other 3 publishers, Take-Two's share prices changes are positively correlated with the overall stock market changes. Its level of elasticity is close to EA's.

5. Conclusion

Our analyses of potential investment opportunities in the video game industry can be concluded as follows:

- Videos games overall appear to posess the qualities of the inferior good, suggesting video game sales fluctuate on an anti-cyclical basis compared to the economy as a whole
- While video game sales are possibly "recession proof" in this regard, the stock prices of the four major publishers we anlayzed correlate positively to changes in the overall market suggesting sales figures alone due not drive the variability in publisher's stock prices
- Amongst these publishers, EA showed the lowest correlation to overall market trends while posting high sales figures from multiple annual franchises across several generes, suggesting it is the most promising long-term amongst the four major publishers

For future analyses:

While physical games sales are still the primary driver of industry sales, this analyses excluded the impact of increasingly prevalent digital distribution models. Additional insight may be gathered from analyzing the role of digital sales as they relate to nascent industry trends, including free-to-play titles and in-game-purchase-based revenue models, as they grow in popularity in the coming years.