Storytelling Data Visualization on Exchange Rates

there are two types of data visualization:

- Exploratory data visualization: we create graphs for ourselves to better understand and explore data.
- Explanatory data visualization: we create graphs for others to inform, make a point, or tell a story.

Throughout the Project, we focused on explanatory data visualization and learned the following:

- How to use information design principles (familiarity and maximizing the data-ink ratio) to create better graphs for an audience.
- About the elements of a story and how to create storytelling data visualizations using Matplotlib.
- How to guide the audience's attention with pre-attentive attributes.
- How to use Matplotlib built-in styles — with a case study on the FiveThirtyEight style.

In [1]:
```
import pandas as pd
import matplotlib.pyplot as plt
import warnings
warnings.filterwarnings('ignore')
```

In [2]:
```
data = pd.read_csv("euro-daily-hist_1999_2022.csv")
data.head()
```

Out[2]:

	Period\Unit:	[Australian dollar]	[Bulgarian lev]	[Brazilian real]	[Canadian dollar]	[Swiss franc]	[Chinese yuan renminbi]	[Cypriot pound]	[Czech koruna]	[Danish krone]	...	[Romanian leu]	[Russian rouble]	[Swedish krona]	[Sing
0	2023-12-15	1.6324	1.9558	5.4085	1.4653	0.9488	7.7812	NaN	24.477	7.4556	...	4.9710	NaN	11.2125	
1	2023-12-14	1.6288	1.9558	5.3349	1.4677	0.949	7.7866	NaN	24.408	7.4566	...	4.9712	NaN	11.18	
2	2023-12-13	1.6452	1.9558	5.3609	1.4644	0.9452	7.7426	NaN	24.476	7.4566	...	4.9738	NaN	11.277	
3	2023-12-12	1.6398	1.9558	5.3327	1.4656	0.9443	7.7447	NaN	24.42	7.4569	...	4.9732	NaN	11.2815	
4	2023-12-11	1.642	1.9558	5.3169	1.4609	0.9478	7.7206	NaN	24.367	7.4563	...	4.9707	NaN	11.297	

5 rows × 41 columns

In [3]:
```
data.shape
```

Out[3]:
```
(6456, 41)
```

In [4]:
```
data.info()
```

```
 21   [Korean won ]            6456 non-null   object
 22   [Lithuanian litas ]      4159 non-null   object
 23   [Latvian lats ]          3904 non-null   object
 24   [Maltese lira ]          2346 non-null   object
 25   [Mexican peso ]          6456 non-null   object
 26   [Malaysian ringgit ]     6456 non-null   object
 27   [Norwegian krone ]       6456 non-null   object
 28   [New Zealand dollar ]    6456 non-null   object
 29   [Philippine peso ]       6456 non-null   object
 30   [Polish zloty ]          6456 non-null   object
 31   [Romanian leu ]          6394 non-null   float64
 32   [Russian rouble ]        5994 non-null   object
 33   [Swedish krona ]         6456 non-null   object
 34   [Singapore dollar ]      6456 non-null   object
 35   [Slovenian tolar ]       2085 non-null   object
 36   [Slovak koruna ]         2608 non-null   object
 37   [Thai baht ]             6456 non-null   object
 38   [Turkish lira ]          6394 non-null   float64
 39   [US dollar ]             6456 non-null   object
 40   [South African rand ]    6456 non-null   object
```

Changing column name and its type

In [5]:
```
data.rename(columns={'Period\\Unit:':'Time','[US dollar ]':'USD'},inplace=True)
```

In [6]:
```
data['Time'] = pd.to_datetime(data['Time'])
```

In [7]:
```
data.info()
```

```
 24  [Maltese lira ]          2346 non-null   object
 25  [Mexican peso ]          6456 non-null   object
 26  [Malaysian ringgit ]     6456 non-null   object
 27  [Norwegian krone ]       6456 non-null   object
 28  [New Zealand dollar ]    6456 non-null   object
 29  [Philippine peso ]       6456 non-null   object
 30  [Polish zloty ]          6456 non-null   object
 31  [Romanian leu ]          6394 non-null   float64
 32  [Russian rouble ]        5994 non-null   object
 33  [Swedish krona ]         6456 non-null   object
 34  [Singapore dollar ]      6456 non-null   object
 35  [Slovenian tolar ]       2085 non-null   object
 36  [Slovak koruna ]         2608 non-null   object
 37  [Thai baht ]             6456 non-null   object
 38  [Turkish lira ]          6394 non-null   float64
 39  USD                      6456 non-null   object
 40  [South African rand ]    6456 non-null   object
dtypes: datetime64[ns](1), float64(3), object(37)
memory usage: 2.0+ MB
```

In [8]:
```
data.columns
```

Out[8]:
```
Index(['Time', '[Australian dollar ]', '[Bulgarian lev ]', '[Brazilian real ]',
       '[Canadian dollar ]', '[Swiss franc ]', '[Chinese yuan renminbi ]',
       '[Cypriot pound ]', '[Czech koruna ]', '[Danish krone ]',
       '[Estonian kroon ]', '[UK pound sterling ]', '[Greek drachma ]',
       '[Hong Kong dollar ]', '[Croatian kuna ]', '[Hungarian forint ]',
       '[Indonesian rupiah ]', '[Israeli shekel ]', '[Indian rupee ]',
       '[Iceland krona ]', '[Japanese yen ]', '[Korean won ]',
       '[Lithuanian litas ]', '[Latvian lats ]', '[Maltese lira ]',
       '[Mexican peso ]', '[Malaysian ringgit ]', '[Norwegian krone ]',
       '[New Zealand dollar ]', '[Philippine peso ]', '[Polish zloty ]',
       '[Romanian leu ]', '[Russian rouble ]', '[Swedish krona ]',
       '[Singapore dollar ]', '[Slovenian tolar ]', '[Slovak koruna ]',
       '[Thai baht ]', '[Turkish lira ]', 'USD', '[South African rand ]'],
      dtype='object')
```

In [9]:
```
data.sort_values('Time',inplace=True)
```

In [10]:
```
data.head()
```

Out[10]:

	Time	[Australian dollar]	[Bulgarian lev]	[Brazilian real]	[Canadian dollar]	[Swiss franc]	[Chinese yuan renminbi]	[Cypriot pound]	[Czech koruna]	[Danish krone]	...	[Romanian leu]	[Russian rouble]	[Swedish krona]	[Singap doll
6455	1999-01-04	1.9100	NaN	NaN	1.8004	1.6168	NaN	0.58231	35.107	7.4501	...	1.3111	25.2875	9.4696	1.9
6454	1999-01-05	1.8944	NaN	NaN	1.7965	1.6123	NaN	0.58230	34.917	7.4495	...	1.3168	26.5876	9.4025	1.9
6453	1999-01-06	1.8820	NaN	NaN	1.7711	1.6116	NaN	0.58200	34.850	7.4452	...	1.3168	27.4315	9.3050	1.9
6452	1999-01-07	1.8474	NaN	NaN	1.7602	1.6165	NaN	0.58187	34.886	7.4431	...	1.3092	26.9876	9.1800	1.9
6451	1999-01-08	1.8406	NaN	NaN	1.7643	1.6138	NaN	0.58187	34.938	7.4433	...	1.3143	27.2075	9.1650	1.9

5 rows × 41 columns

In [11]:
```
euro_to_dollar = data[['Time','USD']].copy()
euro_to_dollar['USD'].value_counts()
```

Out[11]:
```
-         62
1.2276     9
1.1215     8
1.0888     7
1.0868     7
          ..
1.4304     1
1.4350     1
1.4442     1
1.4389     1
1.0804     1
Name: USD, Length: 3769, dtype: int64
```

we have 62 dashes that may be due to holidays or some other reasons

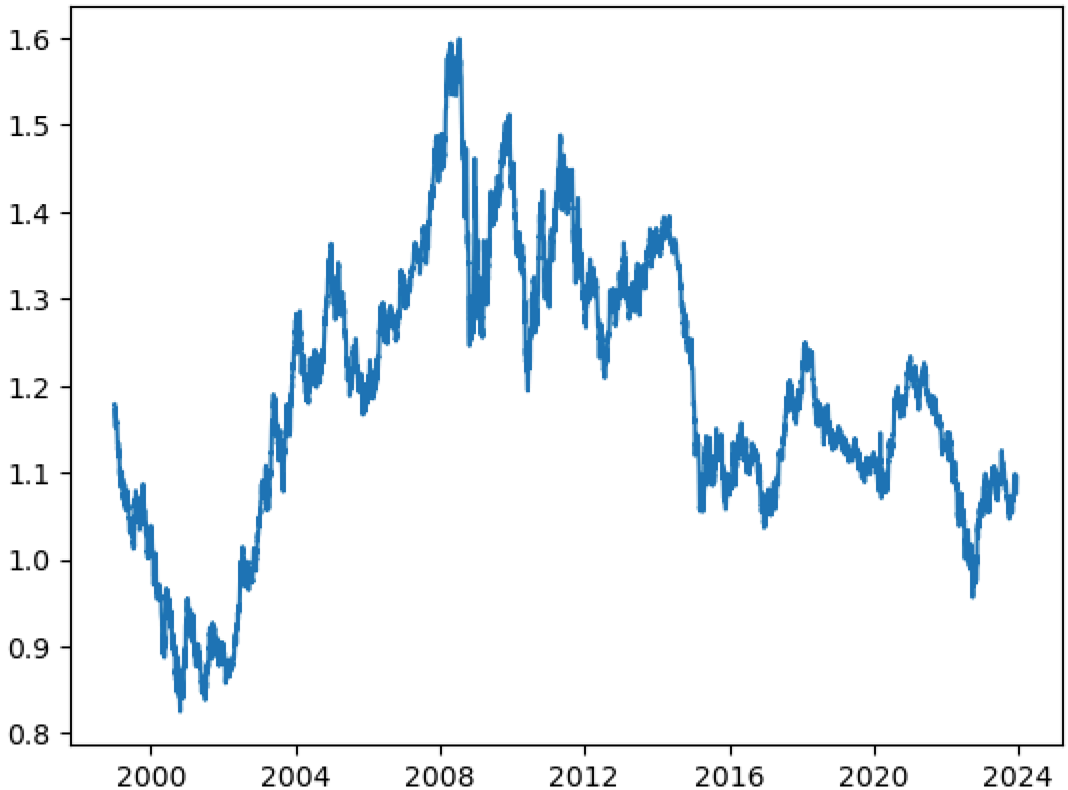
In [12]:

```
euro_to_dollar = euro_to_dollar[euro_to_dollar['USD'] != '-']
euro_to_dollar['USD'] = euro_to_dollar['USD'].astype(float)
euro_to_dollar.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 6394 entries, 6455 to 0
Data columns (total 2 columns):
 #   Column  Non-Null Count  Dtype
---  ------  --------------  -----
 0   Time    6394 non-null   datetime64[ns]
 1   USD     6394 non-null   float64
dtypes: datetime64[ns](1), float64(1)
memory usage: 149.9 KB
```

Rolling Mean

In [13]:
```
plt.plot(euro_to_dollar['Time'] , euro_to_dollar['USD'])
plt.show()
```



If we look at the line's shape, we see many small wiggles rather than seeing a smooth line. The wiggles, however, have meaning:: they are the visual representation of the daily variation in the exchange rate. The rate goes up and down, up and down again, day to day. The rate only shows clear upward or downward trends in the longer run (months or years).

Depending on our goals, we may not want to show that daily variation on our graph. If we want to hide it and show only the long-term trends, we can use the rolling mean (also known as the moving average).

Moving Average

In [14]:

```python
value =pd.DataFrame() #create empty data frame and store in values
value['daily_value'] = pd.Series(range(1,20,2)) #number generate  from 1 to 20 with diff of 2 and store in daily column
value
```

Out[14]:

	daily_value
0	1
1	3
2	5
3	7
4	9
5	11
6	13
7	15
8	17
9	19

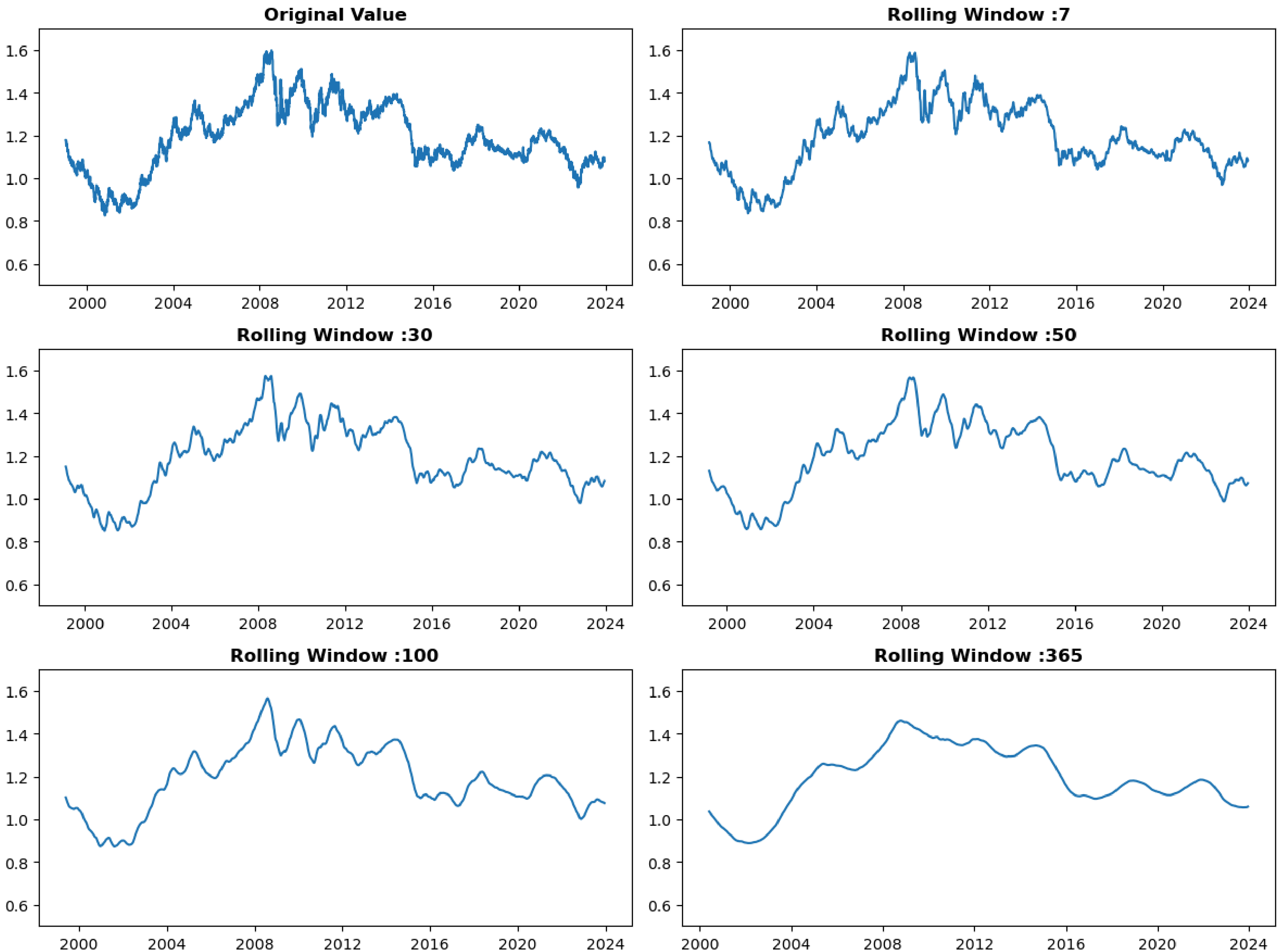
In [15]:
```
value['rolling_mean_2'] = value['daily_value'].rolling(2).mean()
value['rolling_mean_3'] = value['daily_value'].rolling(3).mean()
value['rolling_mean_4'] = value['daily_value'].rolling(4).mean()
value
```

Out[15]:

	daily_value	rolling_mean_2	rolling_mean_3	rolling_mean_4
0	1	NaN	NaN	NaN
1	3	2.0	NaN	NaN
2	5	4.0	3.0	NaN
3	7	6.0	5.0	4.0
4	9	8.0	7.0	6.0
5	11	10.0	9.0	8.0
6	13	12.0	11.0	10.0
7	15	14.0	13.0	12.0
8	17	16.0	15.0	14.0
9	19	18.0	17.0	16.0

Graph

In [16]:
```
plt.figure(figsize=(12,9))
plt.subplot(3,2,1)
plt.plot(euro_to_dollar['Time'],euro_to_dollar['USD'])
plt.title('Original Value', weight = 'bold')
plt.ylim(0.5, 1.7)

for i, rolling_mean in zip([2,3,4,5,6 ], # second grapg , third graph , ..
                           [7,30,50,100,365 ]): #7 days rolling for second graph , 30 days rolling , ...
    plt.subplot(3,2,i)
    plt.plot(euro_to_dollar['Time'], #x-axis
             euro_to_dollar['USD'].rolling(rolling_mean).mean()) #y-axis
    plt.title('Rolling Window :' + str(rolling_mean), weight = 'bold')
    plt.ylim(0.5, 1.7)

plt.tight_layout()
plt.show()
```


Original Value
Rolling Window :7
Rolling Window :30
Rolling Window :50
Rolling Window :100
Rolling Window :365
0.6
0.8
1.0
1.2
1.4
1.6
2000
2004
2008
2012
2016
2020
2024

So we can see that last graph clearly that between '2001 to 2003' Euro to USD rates were down while in 2008 it was at peak.

Now we will find out the reasons or factors like Govt. Financial crisis etc

Coming up with an Idea

Here are a few story ideas for our data:

- We show how the euro-dollar rate has changed during the coronavirus pandemic. We can show the 2020 data and the 2016-2019 data as a baseline. We can use a line plot.
- We show how the euro-dollar rate changed during the 2007-2008 financial crisis. We can also show the data for 2006 and 2009 for comparison. We can use a line plot.
- We show comparatively how the euro-dollar rate changed under the last three US presidents (George W. Bush (2001-2009), Barack Obama (2009-2017), and Donald Trump (2017-2021)). We can use a line plot.

In [17]:
```
euro_to_dollar['Rolling_Mean_30'] = euro_to_dollar['USD'].rolling(30).mean()
euro_to_dollar
```

Out[17]:

	Time	USD	Rolling_Mean_30
6455	1999-01-04	1.1789	NaN
6454	1999-01-05	1.1790	NaN
6453	1999-01-06	1.1743	NaN
6452	1999-01-07	1.1632	NaN
6451	1999-01-08	1.1659	NaN
...	...	...	...
4	2023-12-11	1.0757	1.080143
3	2023-12-12	1.0804	1.080760
2	2023-12-13	1.0787	1.081593
1	2023-12-14	1.0919	1.082453
0	2023-12-15	1.0946	1.083267

6394 rows × 3 columns

Story Telling & Visulization

Financial Crisis 2007 - 2008

In [18]:
```
risis = euro_to_dollar.copy()[(euro_to_dollar['Time'].dt.year >= 2006) & (euro_to_dollar['Time'].dt.year <= 2009)]
risis_7_8 = euro_to_dollar.copy()[(euro_to_dollar['Time'].dt.year >= 2007) & (euro_to_dollar['Time'].dt.year <= 2008)]
```

In [19]:
```
financial_crisis
```

Out[19]:

	Time	USD	Rolling_Mean_30
4630	2006-01-02	1.1826	1.183087
4629	2006-01-03	1.1875	1.183300
4628	2006-01-04	1.2083	1.184573
4627	2006-01-05	1.2088	1.185613
4626	2006-01-06	1.2093	1.186647
...	...	...	...
3592	2009-12-24	1.4398	1.477640
3590	2009-12-28	1.4405	1.476097
3589	2009-12-29	1.4433	1.474323
3588	2009-12-30	1.4338	1.472533
3587	2009-12-31	1.4406	1.470697

1022 rows × 3 columns

In [20]:
```
finacnial_crisis_7_8
```

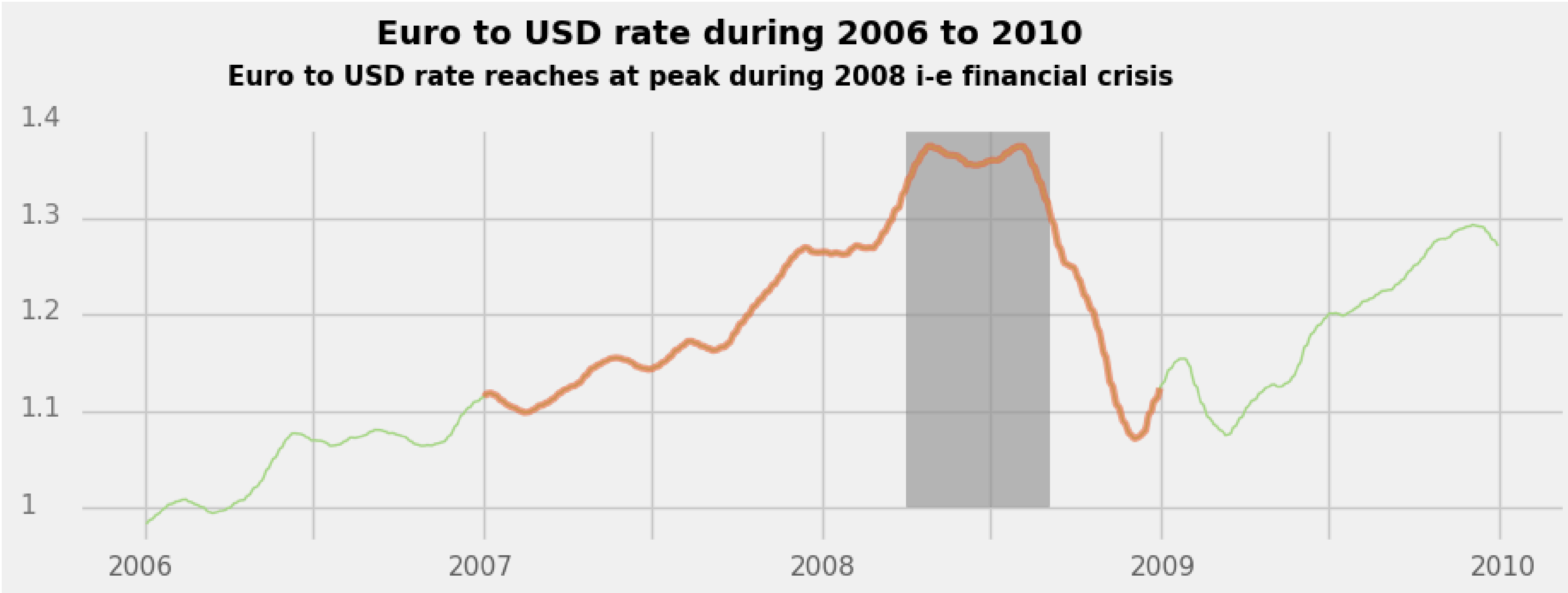
Out[20]:

	Time	USD	Rolling_Mean_30
4369	2007-01-02	1.3270	1.314257
4368	2007-01-03	1.3231	1.315780
4367	2007-01-04	1.3106	1.316663
4366	2007-01-05	1.3084	1.317563
4365	2007-01-08	1.3006	1.317963
...	...	...	...
3854	2008-12-23	1.3978	1.303717
3853	2008-12-24	1.4005	1.308633
3850	2008-12-29	1.4270	1.314450
3849	2008-12-30	1.4098	1.319193
3848	2008-12-31	1.3917	1.323383

511 rows × 3 columns

In [33]:

```python
import matplotlib.style as style
style.use('fivethirtyeight')

fig,ax = plt.subplots(figsize=(10,3))
ax.plot(financial_crisis['Time'],financial_crisis['Rolling_Mean_30'], linewidth = 1, color = '#A6D785')
ax.plot(finacnial_crisis_7_8['Time'], finacnial_crisis_7_8['Rolling_Mean_30'],linewidth = 3, color = '#eb6534',alpha=0.

ax.set_xticklabels([])

x=0.02#
for year in ['2006','2007','2008','2009','2010']:
    ax.text(x,-0.08, year, alpha =0.6, fontsize=11, transform=plt.gca().transAxes)
    x += 0.22888

ax.set_yticklabels([])
y=0.07
for rate in ['1','1.1','1.2','1.3','1.4']:
    ax.text(-0.04,y,rate,alpha =0.5, fontsize=11, transform=plt.gca().transAxes)
    y += 0.2333

ax.text(0.2,1.2, "Euro to USD rate during 2006 to 2010", weight='bold',transform = plt.gca().transAxes)
ax.text(0.1,1.1, "Euro to USD rate reaches at peak during 2008 i-e financial crisis", weight='bold',size = 11, transfor

ax.axvspan(xmin=pd.to_datetime("2008-04-1"), xmax=pd.to_datetime("2008-09-1"),ymin=0.09, color='gray',alpha=0.5)
plt.show()
```



Covid19

In [37]:
```
covid_20 = euro_to_dollar.loc[(euro_to_dollar['Time'] >= '2020-01-01') & (euro_to_dollar['Time'] <= '2020-12-31')]
covid = euro_to_dollar.loc[(euro_to_dollar['Time'] >= '2016-01-01') & (euro_to_dollar['Time'] <= '2019-12-31')]
```

In [38]:
```
covid
```

Out[38]:

	Time	USD	Rolling_Mean_30
2040	2016-01-04	1.0898	1.081743
2039	2016-01-05	1.0746	1.081937
2038	2016-01-06	1.0742	1.082307
2037	2016-01-07	1.0868	1.083030
2036	2016-01-08	1.0861	1.083947
...	...	...	...
1023	2019-12-23	1.1075	1.106783
1022	2019-12-24	1.1080	1.107000
1021	2019-12-27	1.1153	1.107490
1020	2019-12-30	1.1189	1.108130
1019	2019-12-31	1.1234	1.108797

1022 rows × 3 columns

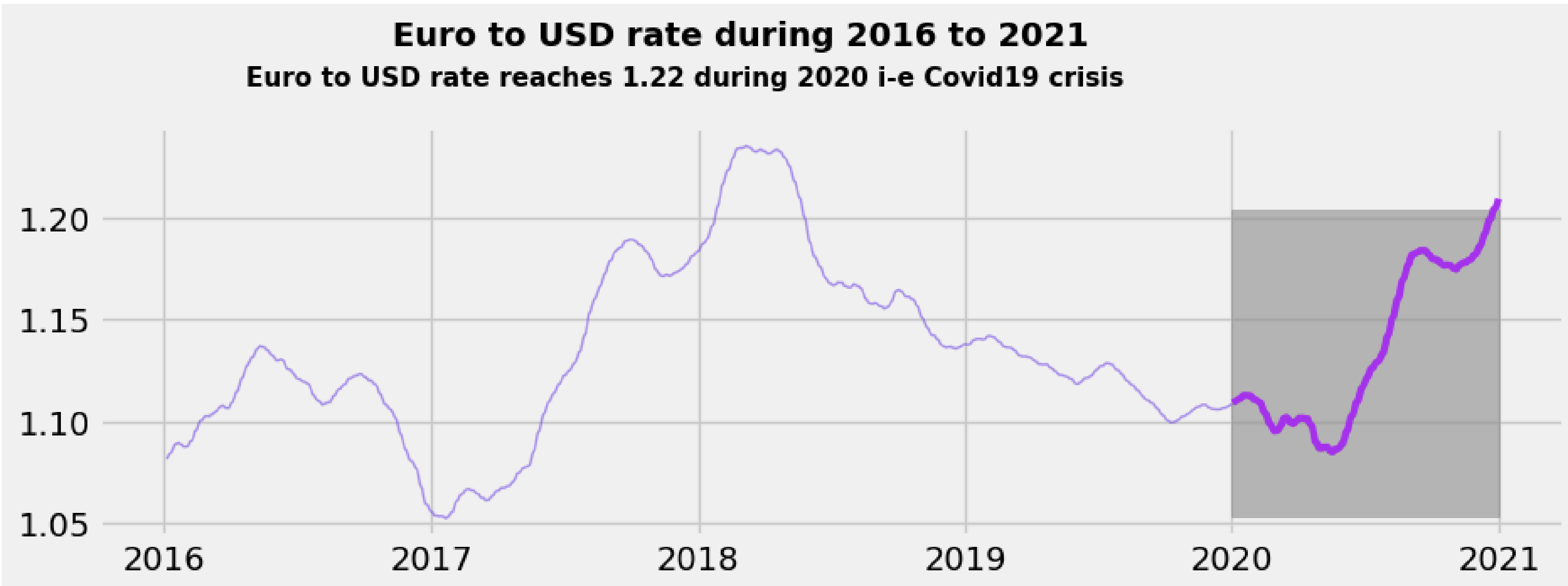
In [39]:
```
covid_20
```

Out[39]:

	Time	USD	Rolling_Mean_30
1018	2020-01-02	1.1193	1.109237
1017	2020-01-03	1.1147	1.109470
1016	2020-01-06	1.1194	1.109920
1015	2020-01-07	1.1172	1.110190
1014	2020-01-08	1.1115	1.110380
...	...	...	...
766	2020-12-24	1.2193	1.204173
765	2020-12-28	1.2219	1.205520
764	2020-12-29	1.2259	1.206950
763	2020-12-30	1.2281	1.208280
762	2020-12-31	1.2271	1.209623

257 rows × 3 columns

In [42]:
```
import matplotlib.style as style
style.use('fivethirtyeight')

fig, ax = plt.subplots(figsize=(10,3))
ax.plot(covid['Time'],covid['Rolling_Mean_30'],linewidth=1,color='#6434eb', alpha = 0.5)
ax.plot(covid_20['Time'],covid_20['Rolling_Mean_30'],linewidth=3,color='#a534eb')

ax.text(0.2,1.2, "Euro to USD rate during 2016 to 2021", weight='bold',transform = plt.gca().transAxes)
ax.text(0.1,1.1, "Euro to USD rate reaches 1.22 during 2020 i-e Covid19 crisis", weight='bold',size = 11, transform = p

ax.axvspan(xmin=pd.to_datetime("2020-01-1"), xmax=pd.to_datetime("2020-12-31"),ymin=0.05,ymax=0.8, color='gray',alpha=0

plt.show()
```



The Thress US Presidents Example

In [48]:
```
all = euro_to_dollar.copy()[(euro_to_dollar['Time'].dt.year >= 2001) & (euro_to_dollar['Time'].dt.year < 2021)]
bush = all.copy()[(all['Time'].dt.year < 2009)]
obama = all.copy()[all['Time'].dt.year >= 2009 & (all['Time'].dt.year < 2017)]
trump = all.copy()[all['Time'].dt.year >= 2017 & (all['Time'].dt.year < 2021)]
```

In [49]:
```
all
```

Out[49]:

	Time	USD	Rolling_Mean_30
5934	2001-01-02	0.9423	0.883343
5933	2001-01-03	0.9530	0.886660
5932	2001-01-04	0.9458	0.889893
5931	2001-01-05	0.9545	0.893463
5930	2001-01-08	0.9497	0.897023
...	...	...	...
766	2020-12-24	1.2193	1.204173
765	2020-12-28	1.2219	1.205520
764	2020-12-29	1.2259	1.206950
763	2020-12-30	1.2281	1.208280
762	2020-12-31	1.2271	1.209623

5118 rows × 3 columns

In [45]:
```
bush
```

Out[45]:

	Time	USD	Rolling_Mean_30
5934	2001-01-02	0.9423	0.883343
5933	2001-01-03	0.9530	0.886660
5932	2001-01-04	0.9458	0.889893
5931	2001-01-05	0.9545	0.893463
5930	2001-01-08	0.9497	0.897023
...	...	...	...
3854	2008-12-23	1.3978	1.303717
3853	2008-12-24	1.4005	1.308633
3850	2008-12-29	1.4270	1.314450
3849	2008-12-30	1.4098	1.319193
3848	2008-12-31	1.3917	1.323383

2046 rows × 3 columns

In [46]:
```
obama
```

Out[46]:

	Time	USD	Rolling_Mean_30
5934	2001-01-02	0.9423	0.883343
5933	2001-01-03	0.9530	0.886660
5932	2001-01-04	0.9458	0.889893
5931	2001-01-05	0.9545	0.893463
5930	2001-01-08	0.9497	0.897023
...	...	...	...
766	2020-12-24	1.2193	1.204173
765	2020-12-28	1.2219	1.205520
764	2020-12-29	1.2259	1.206950
763	2020-12-30	1.2281	1.208280
762	2020-12-31	1.2271	1.209623

5118 rows × 3 columns

In [47]:
```
trump
```

Out[47]:

	Time	USD	Rolling_Mean_30
5934	2001-01-02	0.9423	0.883343
5933	2001-01-03	0.9530	0.886660
5932	2001-01-04	0.9458	0.889893
5931	2001-01-05	0.9545	0.893463
5930	2001-01-08	0.9497	0.897023
...	...	...	...
766	2020-12-24	1.2193	1.204173
765	2020-12-28	1.2219	1.205520
764	2020-12-29	1.2259	1.206950
763	2020-12-30	1.2281	1.208280
762	2020-12-31	1.2271	1.209623

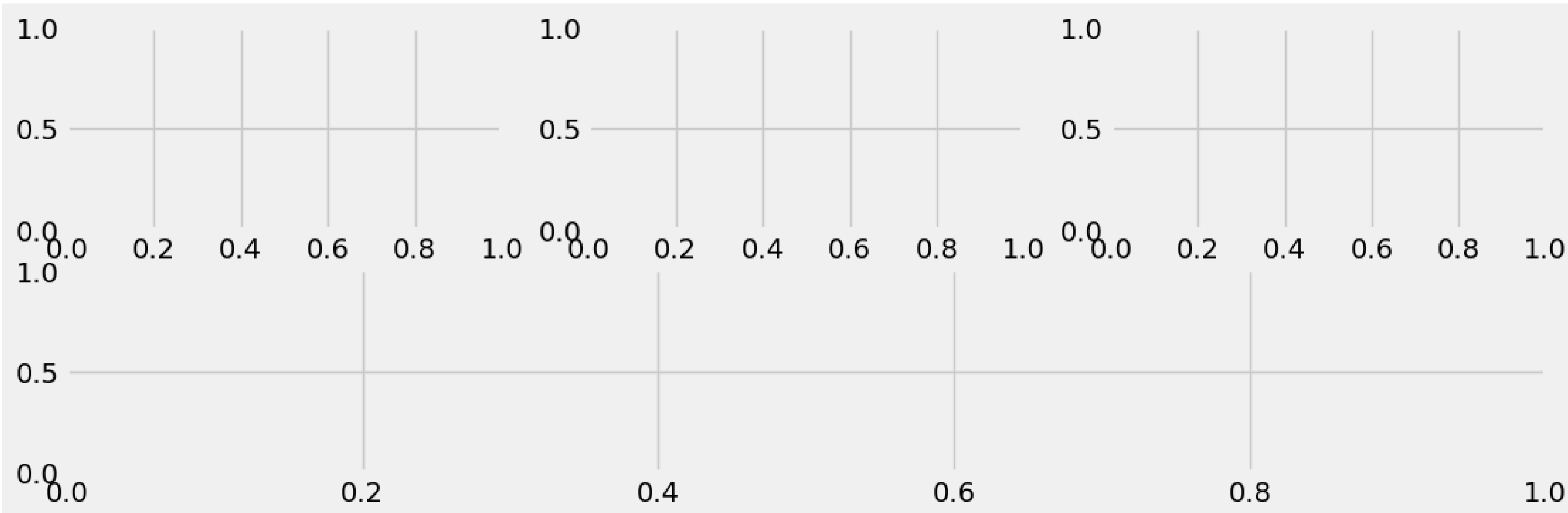
5118 rows × 3 columns

Below, you'll notice we used matplotlib's functional approach to build the graphs. We use this approach because it offers more flexibility in arranging the subplots:

- We first build three of the graphs on a 2-by-3 grid (this grid should have six subplots, but we only build three; the bottom row remains empty).
- We then build only the bottom graph of a 2-by-1 grid (this grid should have two subplots; the top row remains empty).
- The two grids are merged, and we end up with three graphs on the top row and one graph on the bottom row.

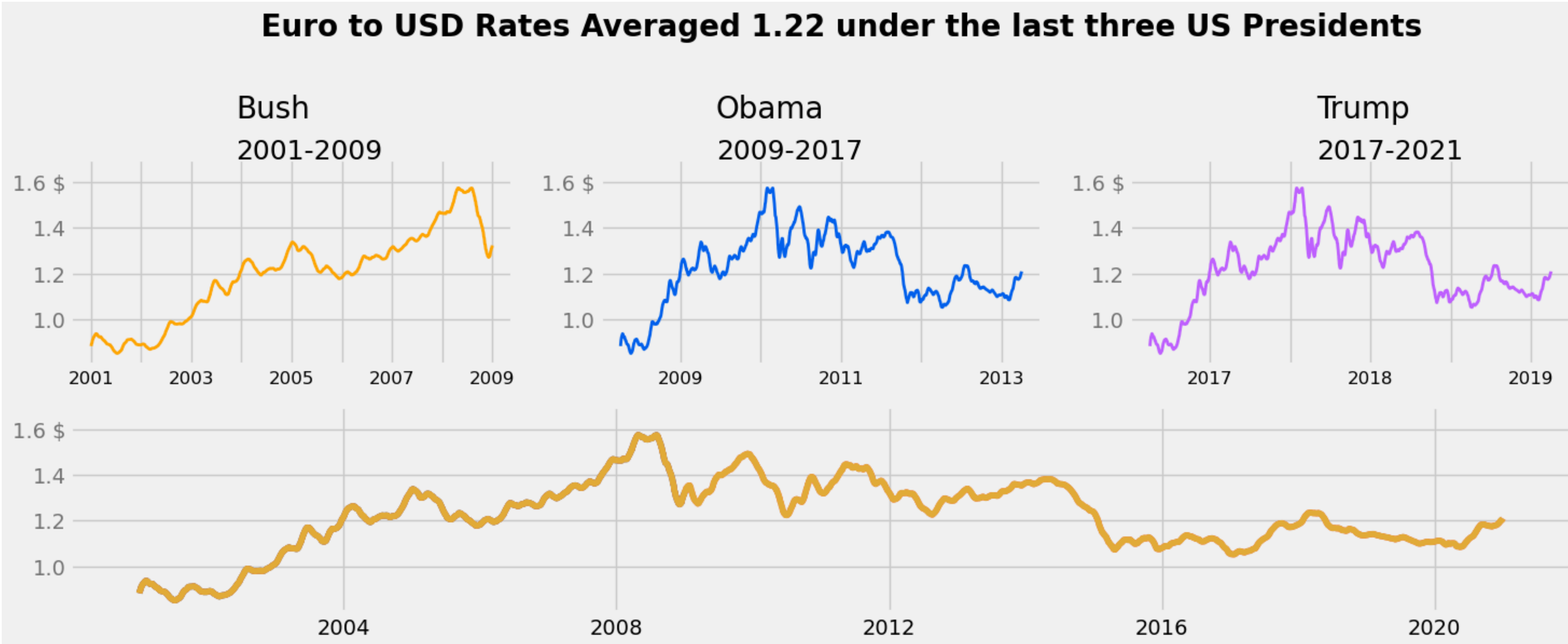
In [50]:

```
style.use('fivethirtyeight')

plt.figure(figsize=(12,6))

ax1 = plt.subplot(3,3,1)
ax2 = plt.subplot(3,3,2)
ax3 = plt.subplot(3,3,3)

ax4 = plt.subplot(3,1,2)
```



```
In [94]: style.use('fivethirtyeight')

plt.figure(figsize=(16,8))

# for subplots
ax1 = plt.subplot(3,3,1)
ax2 = plt.subplot(3,3,2)
ax3 = plt.subplot(3,3,3)

#for large plot
ax4 = plt.subplot(3,1,2)

axes = [ax1,ax2,ax3,ax4]
for ax in axes:
    ax.set_ylim(0.8,1.7)
    ax.set_yticks([1.0,1.2,1.4,1.6])
    ax.set_yticklabels(['1.0','1.2','1.4','1.6 $'],alpha=0.5)

#Bush
ax1.plot(bush['Time'],bush['Rolling_Mean_30'],linewidth=2,color='#ffa500')
ax1.set_xticklabels(['','2001','','2003','','2005','','2007','','2009'],fontsize=12)
ax1.text(0.11,2.4,'Bush',fontsize=20,color='black',transform=plt.gca().transAxes)
ax1.text(0.11,2.2,'2001-2009',fontsize=18,color='black',transform=plt.gca().transAxes)

#Obama
ax2.plot(obama['Time'],obama['Rolling_Mean_30'],linewidth=2,color='#0062EE')
ax2.set_xticklabels(['','2009','','2011','','2013','','2015','','2017'],fontsize=12)
ax2.text(0.43,2.4,'Obama',fontsize=20,color='black',transform=plt.gca().transAxes)
ax2.text(0.43,2.2,'2009-2017',fontsize=18,color='black',transform=plt.gca().transAxes)

#Trump
ax3.plot(trump['Time'],trump['Rolling_MeanP_30'],linewidth=2,color='#BF5FFF')
ax3.set_xticklabels(['','2017','','2018P','','2019','','2020','','2021'],fontsize=12)
ax3.text(0.83,2.4,'Trump',fontsize=20,color='black',transform=plt.gca().transAxes)
ax3.text(0.83,2.2,'2017-2021',fontsize=18,color='black',transform=plt.gca().transAxes)

#merging
ax4.plot(bush['Time'],bush['Rolling_Mean_30'])
ax4.plot(obama['Time'],obama['Rolling_Mean_30'])
ax4.plot(trump['Time'],trump['Rolling_Mean_30'])


ax1.text(0.12, 2.8, ' Euro to USD Rates Averaged 1.22 under the last three US Presidents ', fontsize=20, weight='bold',
```

```
plt.show()
```



Findings

Euro to USD exchange rates reached at peak during 2008 in Financial Crisis in the era of president Bush.

```
In [ ]:
```