Storytelling Data Visualization on Exchange Rates

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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.
- How to make User-Friendly and an interactive line chart by using Plotly Express where we can see the value of the exchange rate and date while hovering over a line.

In [1]:
```
import pandas as pd
import warnings
import matplotlib.pyplot as plt
import seaborn as sns

warnings.filterwarnings("ignore")
```

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

Out[2]:
```
(6456, 41)
```

In [3]:
```
exchange_rates.head()
```

Out[3]:

	Period\Unit:	[Australian dollar]	[Bulgarian lev]	[Brazilian real]	[Canadian dollar]	[Swiss franc]	[Chinese yuan renminbi]	[Cypriot pound]	[Czech koruna]	[Da kr
0	2023-12-15	1.6324	1.9558	5.4085	1.4653	0.9488	7.7812	NaN	24.477	7
1	2023-12-14	1.6288	1.9558	5.3349	1.4677	0.949	7.7866	NaN	24.408	7
2	2023-12-13	1.6452	1.9558	5.3609	1.4644	0.9452	7.7426	NaN	24.476	7
3	2023-12-12	1.6398	1.9558	5.3327	1.4656	0.9443	7.7447	NaN	24.42	7
4	2023-12-11	1.642	1.9558	5.3169	1.4609	0.9478	7.7206	NaN	24.367	7

5 rows × 41 columns

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

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 6456 entries, 0 to 6455
Data columns (total 41 columns):
 #   Column                    Non-Null Count  Dtype  
---  ------                    --------------  -----  
 0   Period\Unit:              6456 non-null   object 
 1   [Australian dollar ]      6456 non-null   object 
 2   [Bulgarian lev ]          6054 non-null   object 
 3   [Brazilian real ]         6188 non-null   object 
 4   [Canadian dollar ]        6456 non-null   object 
 5   [Swiss franc ]            6456 non-null   object 
 6   [Chinese yuan renminbi ]  6188 non-null   object 
 7   [Cypriot pound ]          2346 non-null   object 
 8   [Czech koruna ]           6456 non-null   object 
 9   [Danish krone ]           6456 non-null   object 
 10  [Estonian kroon ]         3130 non-null   object 
 11  [UK pound sterling ]      6456 non-null   object 
 12  [Greek drachma ]          520 non-null    object 
 13  [Hong Kong dollar ]       6456 non-null   object 
 14  [Croatian kuna ]          5941 non-null   object 
 15  [Hungarian forint ]       6456 non-null   object 
 16  [Indonesian rupiah ]      6456 non-null   object 
 17  [Israeli shekel ]         6188 non-null   object 
 18  [Indian rupee ]           6188 non-null   object 
 19  [Iceland krona ]          4049 non-null   float64
 20  [Japanese yen ]           6456 non-null   object 
 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 
dtypes: float64(3), object(38)
memory usage: 2.0+ MB
```

In [5]:
```
exchange_rates.rename(columns={'[US dollar ]': 'US_dollar', 'Period\\Unit:': 'Time' },
```

In [6]:
```
exchange_rates["Time"] = pd.to_datetime(exchange_rates["Time"])
```

In [7]:
```
exchange_rates.sort_values("Time", inplace = True)
```

In [8]:
```
exchange_rates.head()
```

Out[8]:

	Time	[Australian dollar]	[Bulgarian lev]	[Brazilian real]	[Canadian dollar]	[Swiss franc]	[Chinese yuan renminbi]	[Cypriot pound]	[Czech koruna]	[Danis krone
6455	1999-01-04	1.9100	NaN	NaN	1.8004	1.6168	NaN	0.58231	35.107	7.45(
6454	1999-01-05	1.8944	NaN	NaN	1.7965	1.6123	NaN	0.58230	34.917	7.449
6453	1999-01-06	1.8820	NaN	NaN	1.7711	1.6116	NaN	0.58200	34.850	7.445
6452	1999-01-07	1.8474	NaN	NaN	1.7602	1.6165	NaN	0.58187	34.886	7.443
6451	1999-01-08	1.8406	NaN	NaN	1.7643	1.6138	NaN	0.58187	34.938	7.443

5 rows × 41 columns

In [9]:
```
euro_to_dollar = exchange_rates[["Time", "US_dollar"]].copy()
euro_to_dollar["US_dollar"].value_counts()
```

Out[9]:
```
-         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: US_dollar, Length: 3769, dtype: int64
```

To check "-" if it is avilable in more other countries

In [10]:
```
exchange_rates['[Danish krone ]'].value_counts()
```

Out[10]:
```
-         62
7.4362    52
7.4360    48
7.4366    43
7.4365    42
          ..
7.4248     1
7.4234     1
7.4251     1
7.4309     1
7.456      1
Name: [Danish krone ], Length: 493, dtype: int64
```

In [11]:
```
exchange_rates['[Canadian dollar ]'].value_counts()
```

Out[11]:
```
-         62
1.4679     9
1.5601     8
1.4931     8
1.4643     8
          ..
1.5090     1
1.5417     1
1.5980     1
1.5945     1
1.487      1
Name: [Canadian dollar ], Length: 3092, dtype: int64
```

In [12]:
```
exchange_rates['[Singapore dollar ]'].value_counts()
```

Out[12]:
```
-         62
1.6158    10
1.5921     8
1.6014     8
1.5920     8
          ..
2.0750     1
2.0767     1
2.0779     1
2.0896     1
1.456      1
Name: [Singapore dollar ], Length: 3937, dtype: int64
```

In [13]:
```
exchange_rates['[Swedish krona ]'].value_counts()
```

Out[13]:
```
-          62
9.2460      7
9.1930      6
9.1940      6
9.2400      6
           ..
10.8125     1
10.7200     1
10.8400     1
10.9135     1
11.2125     1
Name: [Swedish krona ], Length: 5013, dtype: int64
```

In [14]:
```
# Ignore the "-"

euro_to_dollar = euro_to_dollar[euro_to_dollar["US_dollar"] != "-"]
euro_to_dollar["US_dollar"] = euro_to_dollar["US_dollar"].astype(float)
```

In [15]:
```
euro_to_dollar.info()
```

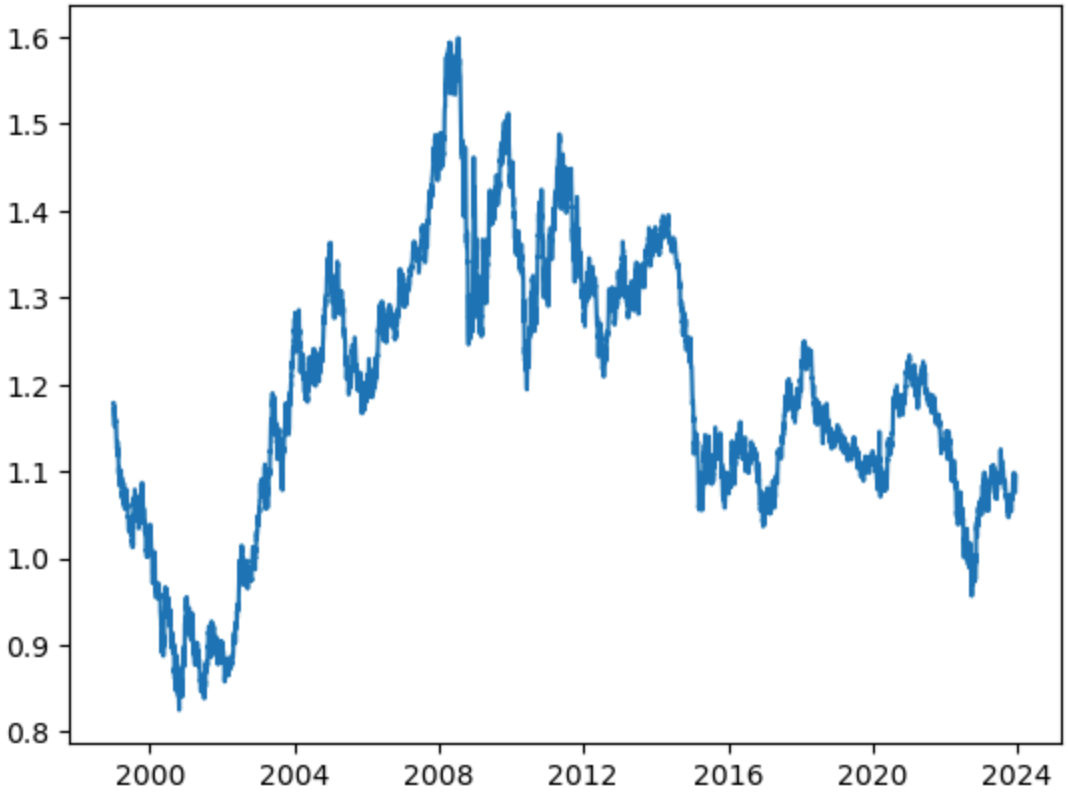
```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 6394 entries, 6455 to 0
Data columns (total 2 columns):
 #   Column     Non-Null Count  Dtype
---  ------     --------------  -----
 0   Time       6394 non-null   datetime64[ns]
 1   US_dollar  6394 non-null   float64
dtypes: datetime64[ns](1), float64(1)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

In [16]:
```
6456-62
```

Out[16]:
```
6394
```

Rolling Mean

In [17]:
```
plt.plot(euro_to_dollar["Time"], euro_to_dollar["US_dollar"])

plt.show()
```



When examining the shape of the line, one can observe numerous small fluctuations instead of a smooth curve. These fluctuations, however, carry significance as they visually represent the day-to-day variations in the exchange rate. The rate experiences regular oscillations, showcasing a pattern of upward and downward movements. Notably, the rate tends to exhibit more distinct trends over extended periods, such as months or years.

Depending on our objectives, it might be undesirable to display the daily fluctuations on the graph. If our goal is to conceal this variability and emphasize only the longer-term trends, we

can achieve this by employing the rolling mean, also referred to as the moving average.

In [18]:
```
values = pd.DataFrame()
values["daily_values"] = pd.Series(range(1, 20, 2))
values
```

Out[18]:

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

In [19]:
```
values["rolling_mean_2"] = values["daily_values"].rolling(2).mean()
```

In [20]:
```
values
```

Out[20]:

	daily_values	rolling_mean_2
0	1	NaN
1	3	2.0
2	5	4.0
3	7	6.0
4	9	8.0
5	11	10.0
6	13	12.0
7	15	14.0
8	17	16.0
9	19	18.0

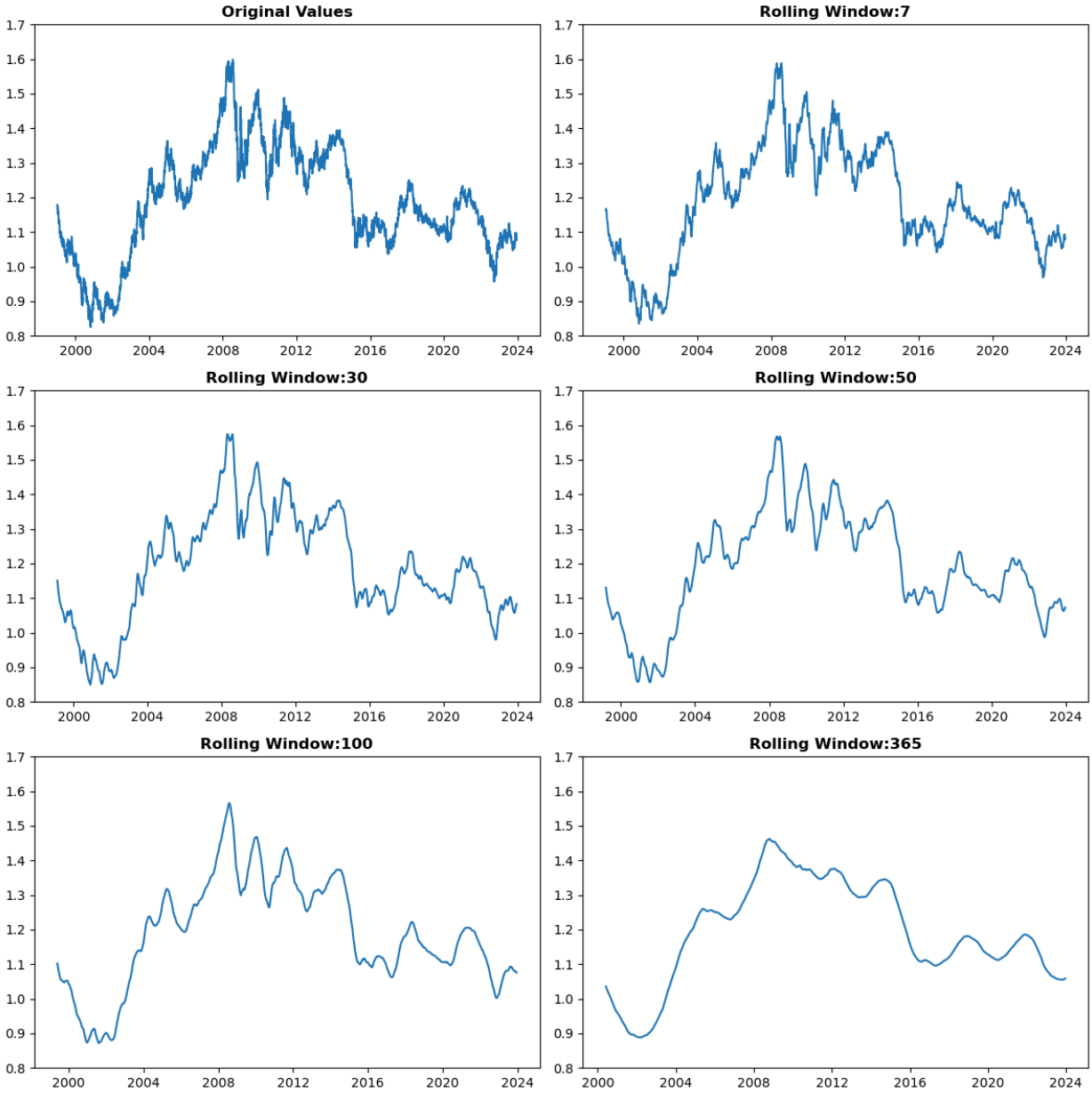
In [21]:
```
values["rolling_mean_3"] = values["daily_values"].rolling(3).mean()
values["rolling_mean_5"] = values["daily_values"].rolling(5).mean()
values
```

Out[21]:

	daily_values	rolling_mean_2	rolling_mean_3	rolling_mean_5
0	1	NaN	NaN	NaN
1	3	2.0	NaN	NaN
2	5	4.0	3.0	NaN
3	7	6.0	5.0	NaN
4	9	8.0	7.0	5.0
5	11	10.0	9.0	7.0
6	13	12.0	11.0	9.0
7	15	14.0	13.0	11.0
8	17	16.0	15.0	13.0
9	19	18.0	17.0	15.0

In [22]:

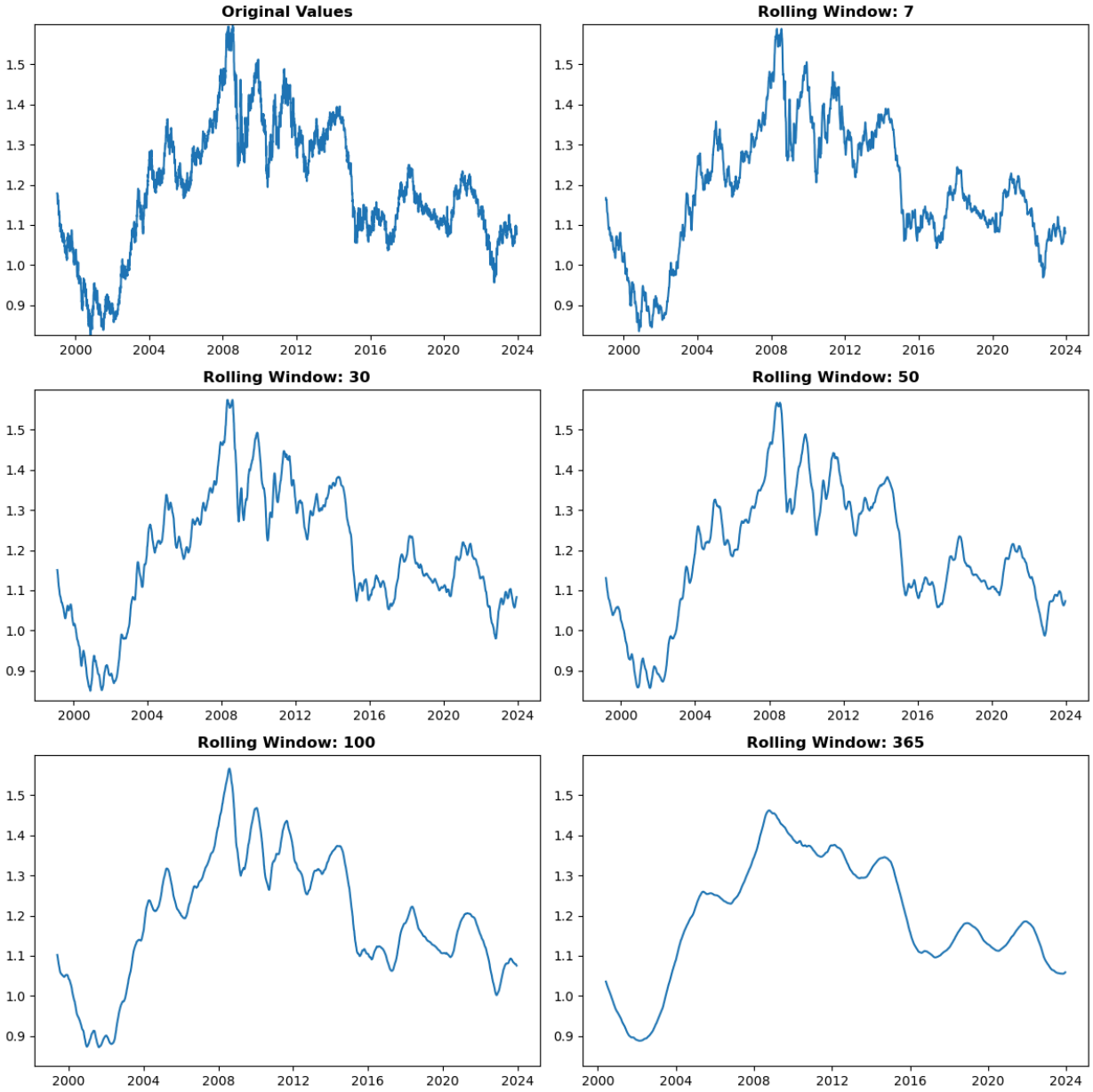
```
plt.figure(figsize=(12, 12))

plt.subplot(3, 2, 1)
plt.plot(euro_to_dollar["Time"], euro_to_dollar["US_dollar"])
plt.title("Original Values", weight="bold")
plt.ylim(0.8,1.7) # Set the y limit here

for i, rolling_mean in zip([2, 3, 4, 5, 6], [7, 30, 50, 100, 365]):
    plt.subplot(3, 2, i)
    plt.plot(euro_to_dollar["Time"], euro_to_dollar["US_dollar"].rolling(rolling_mean)
    plt.title("Rolling Window:" + str(rolling_mean), weight="bold")
    plt.ylim(0.8,1.7)  # Set the y limit here

plt.tight_layout()  # Auto-adjusts the space between subplots
plt.show()
```



Set y-axis limit on the basis of min and max value of US_dollar

In [23]:
```
plt.figure(figsize=(12, 12))

plt.subplot(3, 2, 1)
plt.plot(euro_to_dollar["Time"], euro_to_dollar["US_dollar"])
plt.title("Original Values", weight="bold")
plt.ylim(euro_to_dollar["US_dollar"].min(), euro_to_dollar["US_dollar"].max() )  # Set

for i, rolling_mean in zip([2, 3, 4, 5, 6], [7, 30, 50, 100, 365]):
    plt.subplot(3, 2, i)
    plt.plot(euro_to_dollar["Time"], euro_to_dollar["US_dollar"].rolling(rolling_mean)
    plt.title(f"Rolling Window: {rolling_mean}", weight="bold")

    # Set y limit on the basis of min and max value of US_dollar
    plt.ylim(euro_to_dollar["US_dollar"].min(), euro_to_dollar["US_dollar"].max())
```

```
plt.tight_layout()  # Auto-adjusts the space between subplots
plt.show()
```



Let's explore the historical events and crises about the Euro to USD exchange rate over the years.

Certainly! Here's the revised structured storytelling without using bullet points:

1. **The Impact of the Coronavirus Pandemic (2020):** Present a line plot depicting how the euro-dollar rate fluctuated during the 2020 coronavirus pandemic, using 2016-2019 data as a baseline.

1. **The 2007-2008 Financial Crisis:** Showcase the changes in the euro-dollar rate during the 2007-2008 financial crisis, focusing on 2008 and the subsequent years. Utilize a line plot for comparison.

1. **Presidential Influence on Exchange Rates:** Compare the euro-dollar rate changes under three U.S. presidents: George W. Bush (2001-2009), Barack Obama (2009-2017), and Donald Trump (2017-2021). Visualize this trend using a single plot.

1. **Impact of the Dot-Com Bubble (2000-2001):** Explore the influence of the Dot-Com Bubble on the Euro to USD exchange rate during 2000-2001.

1. **Eurozone Crisis (2010-2012) and Its Effect on Exchange Rates:** Analyze the impact of the Eurozone Crisis during 2010-2012 on the exchange rate of Euro to USD, showcasing this period's trends with a line plot.

1. **Brexit's Impact on Exchange Rates (2016):** Examine the effect of Brexit on the exchange rate of Euro to USD, following the United Kingdom's decision to leave the European Union in 2016.

1. **Interactive Line Chart for Exchange Rate Exploration:** Create an interactive line chart that enables users to hover over lines and observe the exchange rate values and corresponding dates. This interactive tool enhances the exploration of exchange rate trends.

Brief summary of the dataset, highlighting the time range

In [24]:
```
start_date = exchange_rates['Time'].min()
end_date = exchange_rates['Time'].max()

print(f"The dataset covers the period from {start_date} to {end_date}.")
```

```
The dataset covers the period from 1999-01-04 00:00:00 to 2023-12-15 00:00:00.
```

In [25]:
```
euro_to_dollar["rolling_mean_30"] = euro_to_dollar["US_dollar"].rolling(30).mean()
euro_to_dollar
```

Out[25]:

	Time	US_dollar	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

Storytelling Data Visualization

Euro-Dollar Financial Crisis 2007 - 2008

In [26]:
```
financial_crisis_2006_2009 = euro_to_dollar.copy()[(euro_to_dollar["Time"].dt.year >=
financial_crisis_2007_2008 = euro_to_dollar.copy()[(euro_to_dollar["Time"].dt.year >=
```

In [27]:
```
financial_crisis_2006_2009
```

Out[27]:

	Time	US_dollar	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 [28]:
```
financial_crisis_2007_2008
```

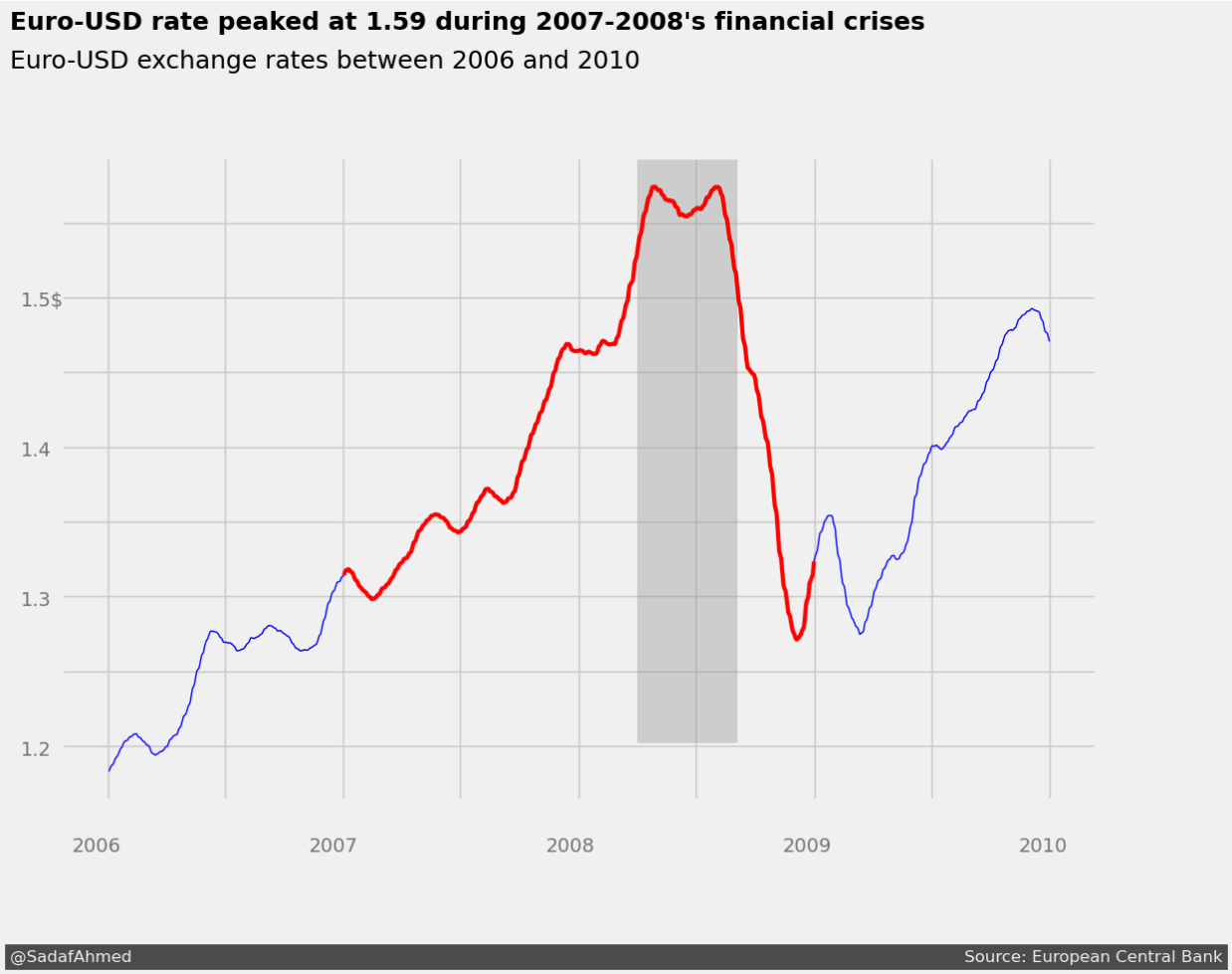
Out[28]:

	Time	US_dollar	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 [29]:
```
import matplotlib.style as styl

styl.use("fivethirtyeight")

# Adding the plot
fig, ax = plt.subplots(figsize = (12,8))
ax.plot(financial_crisis_2006_2009["Time"],financial_crisis_2006_2009["rolling_mean_30

# Highlighting the 2007-2008
```

```
ax.plot(financial_crisis_2007_2008["Time"],financial_crisis_2007_2008["rolling_mean_30


# Adding separate tick labels
ax.set_xticklabels([])

x= 0.01
for year in ["2006", "2007", "2008", "2009", "2010"]:
    ax.text(x,-0.08,year,alpha=0.5, transform = plt.gca().transAxes)
    x+=0.2288

ax.set_yticklabels([])
y=0.07
for rate in ['1.2','1.3','1.4','1.5$']:
    ax.text(-0.04, y, rate, alpha=0.5,transform= plt.gca().transAxes)
    y+= 0.2333

# Adding a title and a subtitle
ax.text(-0.05,1.2,"Euro-USD rate peaked at 1.59 during 2007-2008's financial crises",
        weight='bold', fontsize= 18, transform = plt.gca().transAxes)
ax.text(-0.05,1.14,"Euro-USD exchange rates between 2006 and 2010", fontsize=18,
        transform = plt.gca().transAxes)

# Adding a signature
ax.text(-0.05,-0.25, "@SadafAhmed" + '  '*80 + 'Source: European Central Bank',
        color = '#f0f0f0',
        backgroundcolor = '#4d4d4d', size=12, transform = plt.gca().transAxes)

# Highlighting the peak of the crisis
ax.axvspan(xmin=pd.to_datetime("2008-04-01"), xmax=pd.to_datetime("2008-09-01"), ymin=
           alpha=0.3, color='grey')


plt.show()
```



Corona

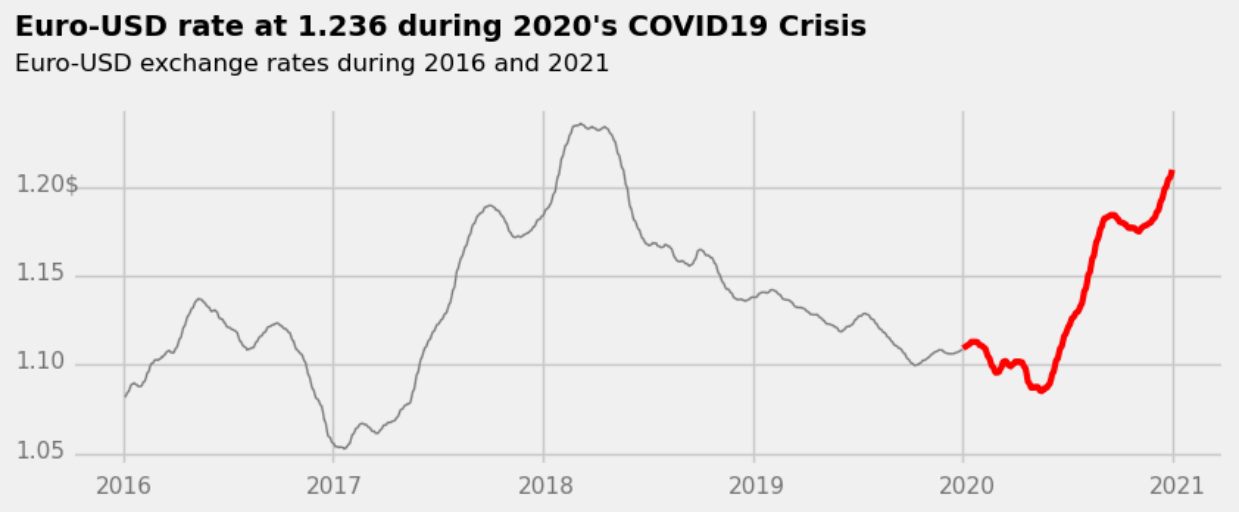
In [30]:
```
Corona_crisis2020 = euro_to_dollar.loc[(euro_to_dollar["Time"]>= "2020-01-01") & (euro

Corona_crisis = euro_to_dollar.loc[(euro_to_dollar["Time"]>= "2016-01-01") & (euro_to_
```

In [31]:
```
Corona_crisis["rolling_mean_30"].value_counts(bins = 5).sort_index()
```

Out[31]:
```
(1.0510000000000002, 1.089]    146
(1.089, 1.126]                 354
(1.126, 1.162]                 257
(1.162, 1.199]                 179
(1.199, 1.236]                  86
Name: rolling_mean_30, dtype: int64
```

In [32]:
```
import matplotlib.style as style

style.use("fivethirtyeight")

# Adding the plot
fig, ax = plt.subplots(figsize=(9, 3))

ax.plot(Corona_crisis["Time"], Corona_crisis["rolling_mean_30"],
        linewidth=1, color="grey")

# Highlighting the 2007 to 2008 period
```

```
ax.plot(Corona_crisis2020["Time"],
        Corona_crisis2020["rolling_mean_30"],
        linewidth=3, color="red")

ax.set_xticklabels([])

x = 0.02
for year in ["2016", "2017", "2018", "2019", "2020", "2021"]:
    ax.text(x, -0.08, year, alpha=0.5, fontsize=11,
            transform=plt.gca().transAxes)
    x += 0.183

ax.set_yticklabels([])

y = 0.02
for rate in ["1.05", "1.10", "1.15", "1.20$"]:
    ax.text(-0.05, y, rate, alpha=0.5, fontsize=11,
            transform=plt.gca().transAxes)
    y += 0.248

# Adding a title and a subtitle
ax.text(-0.05, 1.2, "Euro-USD rate at 1.236 during 2020's COVID19 Crisis",
        weight="bold", transform=plt.gca().transAxes)

ax.text(-0.05, 1.1, "Euro-USD exchange rates during 2016 and 2021",
        size=12, transform=plt.gca().transAxes)

plt.show()
```



USD during three US presidences

In [33]:
```
bush_obama_trump = euro_to_dollar.copy()[(euro_to_dollar["Time"].dt.year >= 2001) & (e
bush = bush_obama_trump.copy()[bush_obama_trump["Time"].dt.year < 2009]
obama = bush_obama_trump.copy()[(bush_obama_trump["Time"].dt.year >= 2009) & (bush_oba
trump = bush_obama_trump.copy()[(bush_obama_trump["Time"].dt.year >= 2017) & (bush_oba
```

In [34]:
```
bush["rolling_mean_30"].value_counts(bins = 5).sort_index()
```

Out[34]:
```
(0.85, 0.996]     491
(0.996, 1.141]    176
(1.141, 1.285]    741
(1.285, 1.43]     406
(1.43, 1.574]     232
Name: rolling_mean_30, dtype: int64
```

In [35]:
```
obama["rolling_mean_30"].value_counts(bins = 5).sort_index()
```

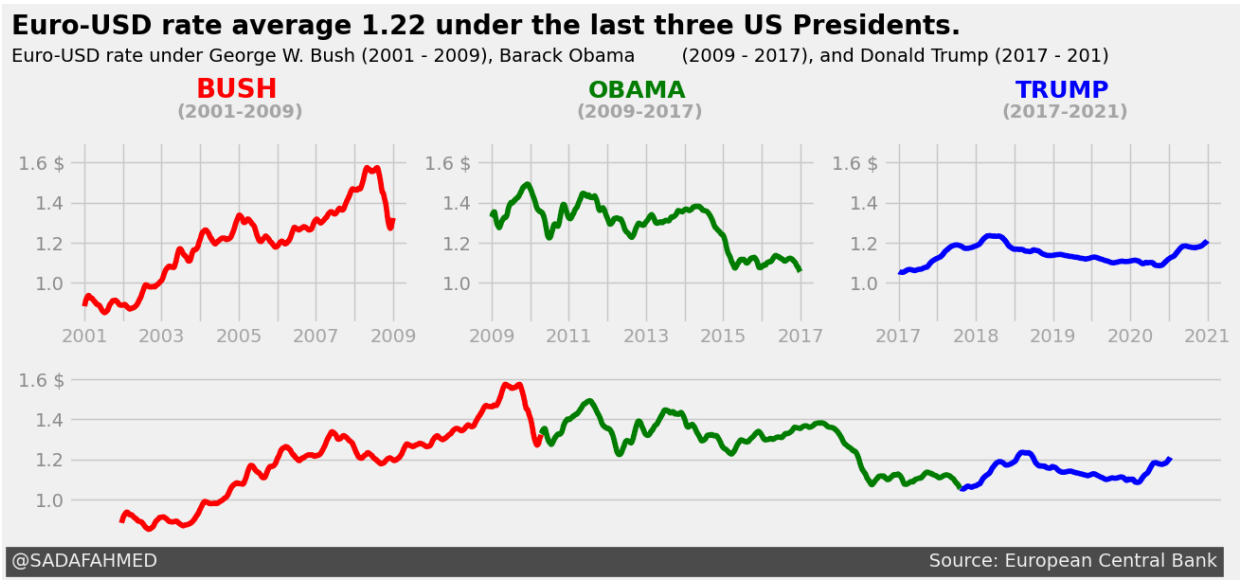
Out[35]:
```
(1.0550000000000002, 1.143]    477
(1.143, 1.231]                  60
(1.231, 1.318]                 534
(1.318, 1.405]                 717
(1.405, 1.493]                 262
Name: rolling_mean_30, dtype: int64
```

In [36]:
```
trump["rolling_mean_30"].value_counts(bins=5).sort_index()
```

Out[36]:
```
(1.0510000000000002, 1.089]    124
(1.089, 1.126]                 295
(1.126, 1.162]                 241
(1.162, 1.199]                 267
(1.199, 1.236]                  95
Name: rolling_mean_30, dtype: int64
```

In [37]:
```
# Adding the fiveThirtyEight Style
style.use("fivethirtyeight")

# Adding the subplots
plt.figure(figsize=(14,8))

#pattern 1

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

#pattern 2
ax4 = plt.subplot(3,1,2)

#pattern 3
axes= [ax1,ax2,ax3,ax4]

#changes to all subplot

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=0.4)

# AX1: Bush
ax1.plot(bush["Time"], bush["rolling_mean_30"],color = "red" )
ax1.set_xticklabels([" ", "2001"," ", "2003", " ", "2005", " ", "2007", " ", "2009"],
ax1.text(0.11, 2.45, "BUSH", fontsize=20, weight="bold", color="red", transform = plt.
ax1.text(0.093, 2.34, "(2001-2009)", weight="bold", alpha=0.3, transform = plt.gca().t

# AX2: Obama
ax2.plot(obama["Time"], obama["rolling_mean_30"],color = "green" )
ax2.set_xticklabels([" ", "2009"," ", "2011", " ", "2013", " ", "2015", " ", "2017"],
ax2.text(0.45, 2.45, "OBAMA", fontsize=18, weight="bold", color="green", transform = p
```

```
ax2.text(0.44, 2.34, "(2009-2017)", weight="bold", alpha=0.3, transform = plt.gca().tr

# AX3: Trump
ax3.plot(trump["Time"], trump["rolling_mean_30"],color = "blue" )
ax3.set_xticklabels(["2017"," ", "2018", " ", "2019", " ", "2020", " ", "2021"], alpha
ax3.text(0.82, 2.45, "TRUMP", fontsize=18, weight="bold", color="blue", transform = pl
ax3.text(0.808, 2.34, "(2017-2021)", weight="bold", alpha=0.3, transform = plt.gca().t

# AX4: Bush-Obama-Trump
ax4.plot(bush["Time"], bush["rolling_mean_30"],color = "red" )
ax4.plot(obama["Time"], obama["rolling_mean_30"],color = "green" )
ax4.plot(trump["Time"], trump["rolling_mean_30"],color = "blue" )

ax4.set_xticks([])

# Adding a title and a subtitle
ax1.text(-0.05, 2.8, "Euro-USD rate average 1.22 under the last three US Presidents.",
         fontsize=20, weight="bold", transform= plt.gca().transAxes)
ax1.text(-0.05, 2.65, "Euro-USD rate under George W. Bush (2001 - 2009), Barack Obama\
        (2009 - 2017), and Donald Trump (2017 - 201)",  fontsize=14, transform= plt.gc

# Adding a signature
ax.text(-0.05, -0.15, "@SADAFAHMED" + ' ' * 133 + 'Source: European Central Bank',
        color='#f0f0f0',
        backgroundcolor='#4d4d4d',
        size=14, transform=plt.gca().transAxes)

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



Let's Explore some more events

1) Impact of the Dot-Com Bubble (2000-2001) on the Euro to USD exchange rate

The Dot-Com Bubble, which occurred roughly from 1995 to 2000, refers to the rapid rise and subsequent crash of stock prices in the technology sector, particularly related to internet-based companies. The burst of the Dot-Com Bubble had several impacts on various aspects of the economy, including exchange rates.

Let's see did this affact the Euro - USD?

In [38]:
```
Dot_Com_Bubble_2k_2k1 = euro_to_dollar.copy()[(euro_to_dollar["Time"].dt.year >= 2000)
                        & (euro_to_dollar["Time"].dt.year <= 2001)]
Dot_Com_Bubble_99_2k3 = euro_to_dollar.copy()[(euro_to_dollar["Time"].dt.year >= 1999)
                        & (euro_to_dollar["Time"].dt.year <= 2003)]
```

In [39]:
```
Dot_Com_Bubble_2k_2k1
```

Out[39]:

	Time	US_dollar	rolling_mean_30
6195	2000-01-03	1.0090	1.012743
6194	2000-01-04	1.0305	1.012723
6193	2000-01-05	1.0368	1.012900
6192	2000-01-06	1.0388	1.013477
6191	2000-01-07	1.0284	1.013777
...	...	...	...
5682	2001-12-20	0.8973	0.888723
5681	2001-12-21	0.8943	0.888767
5680	2001-12-24	0.8798	0.888363
5677	2001-12-27	0.8823	0.888300
5676	2001-12-28	0.8813	0.888333

509 rows × 3 columns

In [40]:
```
Dot_Com_Bubble_99_2k3.tail()
```

Out[40]:

	Time	US_dollar	rolling_mean_30
5159	2003-12-23	1.2392	1.205407
5158	2003-12-24	1.2407	1.208097
5155	2003-12-29	1.2499	1.210827
5154	2003-12-30	1.2496	1.213263
5153	2003-12-31	1.2630	1.216023

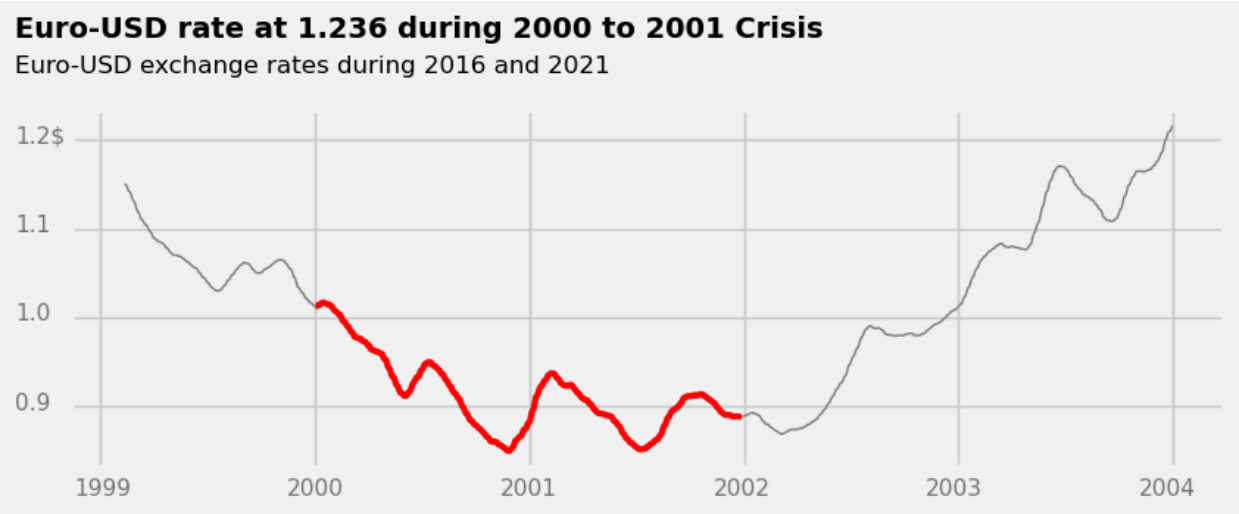
In [41]:
```
Dot_Com_Bubble_99_2k3["rolling_mean_30"].value_counts(bins = 5).sort_index()
```

Out[41]:
```
(0.848, 0.923]    441
(0.923, 0.996]    270
(0.996, 1.07]     250
(1.07, 1.143]     189
(1.143, 1.216]     99
Name: rolling_mean_30, dtype: int64
```

In [42]:
```
Dot_Com_Bubble_2k_2k1["rolling_mean_30"].value_counts(bins=5).sort_index()
```

Out[42]:
```
(0.849, 0.883]    130
(0.883, 0.917]    178
(0.917, 0.95]     117
(0.95, 0.984]      39
(0.984, 1.017]     45
Name: rolling_mean_30, dtype: int64
```

In [43]:
```
import matplotlib.style as style

style.use("fivethirtyeight")

# Adding the plot
fig, ax = plt.subplots(figsize=(9, 3))

ax.plot(Dot_Com_Bubble_99_2k3["Time"], Dot_Com_Bubble_99_2k3["rolling_mean_30"],
        linewidth=1, color="grey")

# Highlighting the 2000 to 2001 period
ax.plot(Dot_Com_Bubble_2k_2k1["Time"],
        Dot_Com_Bubble_2k_2k1["rolling_mean_30"],
        linewidth=3, color="red")

ax.set_xticklabels([])

x = 0.001
for year in ["1999", "2000", "2001", "2002", "2003", "2004"]:
    ax.text(x, -0.08, year, alpha=0.5, fontsize=11,
            transform=plt.gca().transAxes)
    x += 0.185

ax.set_yticklabels([])

y = 0.16
for rate in ["0.9", "1.0", "1.1","1.2$"]:
    ax.text(-0.05, y, rate, alpha=0.5, fontsize=11,
            transform=plt.gca().transAxes)
    y += 0.248

# Adding a title and a subtitle
ax.text(-0.05, 1.2, "Euro-USD rate at 1.236 during 2000 to 2001 Crisis",
        weight="bold", transform=plt.gca().transAxes)

ax.text(-0.05, 1.1, "Euro-USD exchange rates during 2016 and 2021",
        size=12, transform=plt.gca().transAxes)

plt.show()
```



Conclussion:

The examination of the Euro to USD exchange rate between 2000 and 2001 suggests that the US dollar did not exhibit initial strength at the beginning of 2000. However, it gradually gained strength over time. In the early part of 2001, there was a reversal, and the US dollar began to weaken again. By the end of 2001, it had surpassed the Euro in value.

Factors:

In 2000 to 2001, the US dollar was stronger than the euro. Factors contributing to this were economic, such as a strong US economy and political stability, as well as interest rates. The US' central bank, the Federal Reserve, maintained a tight monetary policy during this time, which also contributed to the dollar's stronger position. A weak euro market and massive government spending was also a significant factor, resulting in a dark economic period for the eurozone.

But it's worth noting that the Euro's position has updated over time.

Let's Explore Eurozone Crisis (2010-2012):

The Eurozone crisis of 2010-2012 was a complex economic and financial crisis that primarily affected several European countries that use the euro as their currency. One of the key aspects of this crisis was the sovereign debt crisis, which emerged when certain Eurozone member countries faced significant challenges in servicing their sovereign debts.

Let see how did this affact the Euro to USD exchange rate:

In [44]:
```
euro_to_dollar["rolling_mean_100"] = euro_to_dollar["US_dollar"].rolling(100).mean()
euro_to_dollar["rolling_mean_200"] = euro_to_dollar["US_dollar"].rolling(200).mean()
euro_to_dollar["rolling_mean_365"] = euro_to_dollar["US_dollar"].rolling(365).mean()
```

```
euro_to_dollar
```

Out[44]:

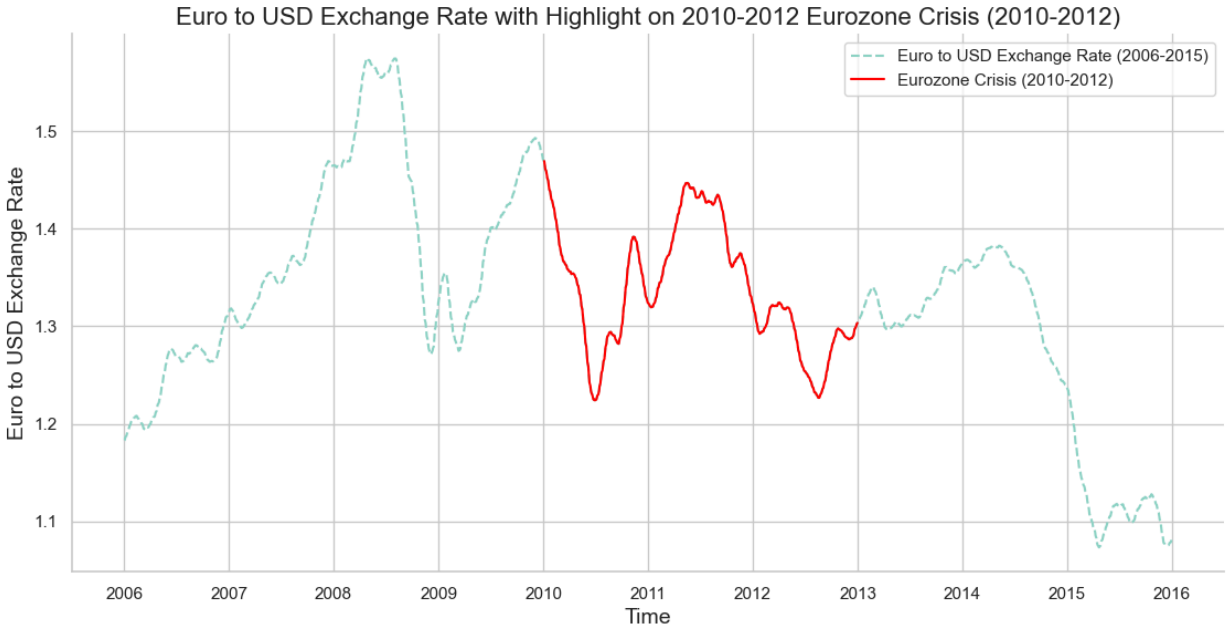
	Time	US_dollar	rolling_mean_30	rolling_mean_100	rolling_mean_200	rolling_mean_365
6455	1999-01-04	1.1789	NaN	NaN	NaN	NaN
6454	1999-01-05	1.1790	NaN	NaN	NaN	NaN
6453	1999-01-06	1.1743	NaN	NaN	NaN	NaN
6452	1999-01-07	1.1632	NaN	NaN	NaN	NaN
6451	1999-01-08	1.1659	NaN	NaN	NaN	NaN
...	...	...	...	...	...	...
4	2023-12-11	1.0757	1.080143	1.076332	1.081908	1.057977
3	2023-12-12	1.0804	1.080760	1.076085	1.082008	1.058179
2	2023-12-13	1.0787	1.081593	1.075813	1.082094	1.058393
1	2023-12-14	1.0919	1.082453	1.075607	1.082230	1.058629
0	2023-12-15	1.0946	1.083267	1.075543	1.082370	1.058852

6394 rows × 6 columns

In [45]:

```
import seaborn as sns
import matplotlib.pyplot as plt

# Set Seaborn style and color palette
sns.set(style="whitegrid", palette="Set3")

# Filter the data for the Eurozone crisis period (2006-2015) and 2010-2012
crisis_eurozone = euro_to_dollar.copy()[(euro_to_dollar["Time"].dt.year >= 2006) & (eu
eurozone2010_2012 = euro_to_dollar.copy()[(euro_to_dollar["Time"].dt.year >= 2010) & (

# Create a line plot for the entire crisis period with a dashed line
plt.figure(figsize=(12, 6))
sns.lineplot(crisis_eurozone["Time"], crisis_eurozone["rolling_mean_30"], label='Euro

# Highlight the 2010-2012 period with a solid red line
sns.lineplot(eurozone2010_2012["Time"], eurozone2010_2012["rolling_mean_30"], color='r

# Customize labels and title
plt.xlabel('Time', fontsize=14)
plt.ylabel('Euro to USD Exchange Rate', fontsize=14)
plt.title('Euro to USD Exchange Rate with Highlight on 2010-2012 Eurozone Crisis (2010
```

```
# Add legend
plt.legend()

# Add grid lines and remove unnecessary spines
sns.despine()

# Show the plot
plt.show()
```

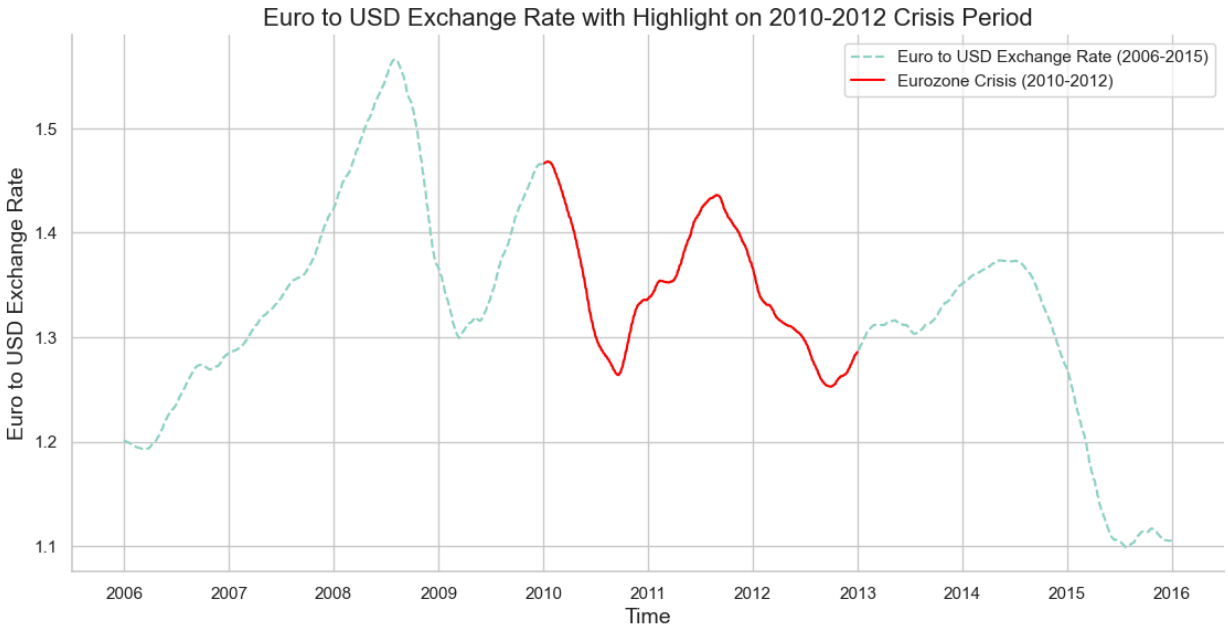


Eurozone Crisis (2010-2012) with 100 rolling mean

In [46]:

```
import seaborn as sns
import matplotlib.pyplot as plt

# Set Seaborn style and color palette
sns.set(style="whitegrid", palette="Set3")

# Filter the data for the Eurozone crisis period (2006-2015) and 2010-2012
crisis_eurozone = euro_to_dollar.copy()[(euro_to_dollar["Time"].dt.year >= 2006) & (eu
eurozone2010_2012 = euro_to_dollar.copy()[(euro_to_dollar["Time"].dt.year >= 2010) & (

# Create a line plot for the entire crisis period with a dashed line
plt.figure(figsize=(12, 6))
sns.lineplot(crisis_eurozone["Time"], crisis_eurozone["rolling_mean_100"],\
             label='Euro to USD Exchange Rate (2006-2015)', linestyle='dashed')

# Highlight the 2010-2012 period with a solid red line
sns.lineplot(eurozone2010_2012["Time"], eurozone2010_2012["rolling_mean_100"],\
             color='red', label='Eurozone Crisis (2010-2012)')

# Customize labels and title
plt.xlabel('Time', fontsize=14)
plt.ylabel('Euro to USD Exchange Rate', fontsize=14)
plt.title('Euro to USD Exchange Rate with Highlight on 2010-2012 Crisis Period', fonts
```

```
# Adding a conclusion inside the chart
plt.text(0.5, -0.30, '''The graph illustrating the Euro to USD exchange rate during th
         horizontalalignment="center", fontsize=9, transform=plt.gca().transAxes, colo

# Add legend
plt.legend()

# Add grid lines and remove unnecessary spines
sns.despine()

# Show the plot
plt.show()
```



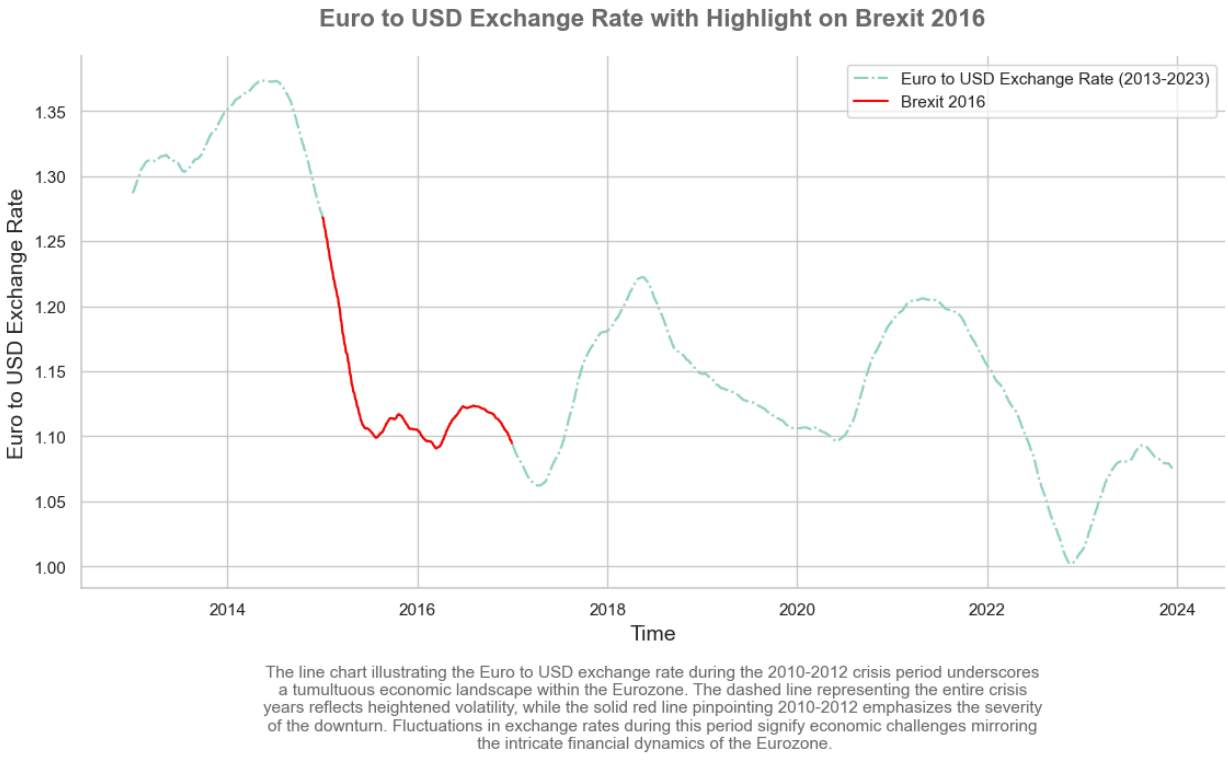
The graph illustrating the Euro to USD exchange rate during the 2010-2012 crisis period underscores a tumultuous economic landscape within the Eurozone. The dashed line representing the entire crisis years reflects heightened volatility, while the solid red line pinpointing 2010-2012 emphasizes the severity of the downturn. Fluctuations in exchange rates during this period signify economic challenges, mirroring the intricate financial dynamics of the Eurozone.

Brexit, "British Exit"

Overview: The United Kingdom's referendum vote to leave the European Union. Impact on Exchange Rates: Significant volatility in the British Pound as uncertainty surrounded the Brexit process.

In [47]:
```
import seaborn as sns
import matplotlib.pyplot as plt

# Set Seaborn style and color palette
sns.set(style="whitegrid", palette="Set3")

# Filter the data before and after the Brexit 2013 - 2023
euro_usd2013to2023 = euro_to_dollar.copy()[(euro_to_dollar["Time"].dt.year >= 2013) &
brexit2016 = euro_to_dollar.copy()[(euro_to_dollar["Time"].dt.year >= 2015) & (euro_to

# Create a line plot for the entire crisis period with a dashdot line
plt.figure(figsize=(12, 6))
```

```
sns.lineplot(euro_usd2013to2023["Time"], euro_usd2013to2023["rolling_mean_100"],\
             label='Euro to USD Exchange Rate (2013-2023)', linestyle='dashdot')

# Highlight the 2015-2016 period with a solid red line
sns.lineplot(brexit2016["Time"], brexit2016["rolling_mean_100"],\
             color='red', label='Brexit 2016')

# Customize labels and title
plt.xlabel('Time', fontsize=14)
plt.ylabel('Euro to USD Exchange Rate', fontsize=14)

plt.title('Euro to USD Exchange Rate with Highlight on Brexit 2016',\
          fontsize=16, fontweight='bold' , color="dimgrey", pad=20)


# Adding a conclusion inside the chart
plt.text(0.5, -0.30, '''The line chart illustrating the Euro to USD exchange rate duri
a tumultuous economic landscape within the Eurozone. The dashed line representing the
years reflects heightened volatility, while the solid red line pinpointing 2010-2012 e
of the downturn. Fluctuations in exchange rates during this period signify economic ch
mirroring\n the intricate financial dynamics of the Eurozone.''',
         horizontalalignment="center", fontsize=11, transform=plt.gca().transAxes, col

# Add legend
plt.legend()

# Add grid lines and remove unnecessary spines
sns.despine()

# Show the plot
plt.show()
```



Brexit, United Kingdom's decision to leave the European Union, following a referendum held in 2016. The process has led to significant political, economic, and financial implications, and it has indeed had an impact on currency exchange rates, including the Euro to USD exchange rate.

The relationship between Brexit and the Euro to USD exchange rate can be complex, and various factors contribute to the fluctuations:

1. **Market Uncertainty:** The uncertainty surrounding the Brexit process has led to fluctuations in currency markets. Investors often seek stability, and uncertainty regarding the economic and trade future between the UK and the EU can influence the Euro to USD exchange rate.

2. **Economic Indicators:** Economic indicators, such as GDP growth, inflation rates, and employment figures, in both the UK and the Eurozone can impact their respective currencies. Brexit-related developments can influence these indicators, thus affecting the exchange rate.

3. **Trade Relations:** Changes in trade relations resulting from Brexit, including new trade agreements or disruptions to existing ones, can impact the economies of the UK and the Eurozone. Such changes can influence the exchange rate between the Euro and the US Dollar.

4. **Central Bank Policies:** The monetary policies of the European Central Bank (ECB), the Bank of England (BoE), and the Federal Reserve (Fed) play a role in exchange rate movements. Changes in interest rates and policy decisions in response to Brexit-related developments can affect the Euro to USD exchange rate.

5. **Investor Sentiment:** Investor sentiment and market perception of Brexit-related news can lead to short-term fluctuations in exchange rates. News about trade negotiations, agreements, or disagreements can influence currency values.

It's essential to note that exchange rates are influenced by a multitude of factors, and Brexit is just one of them. Additionally, the impact may vary over time as negotiations progress and new developments occur. For the most up-to-date and accurate information, it's advisable to monitor financial news, economic indicators, and expert analyses.

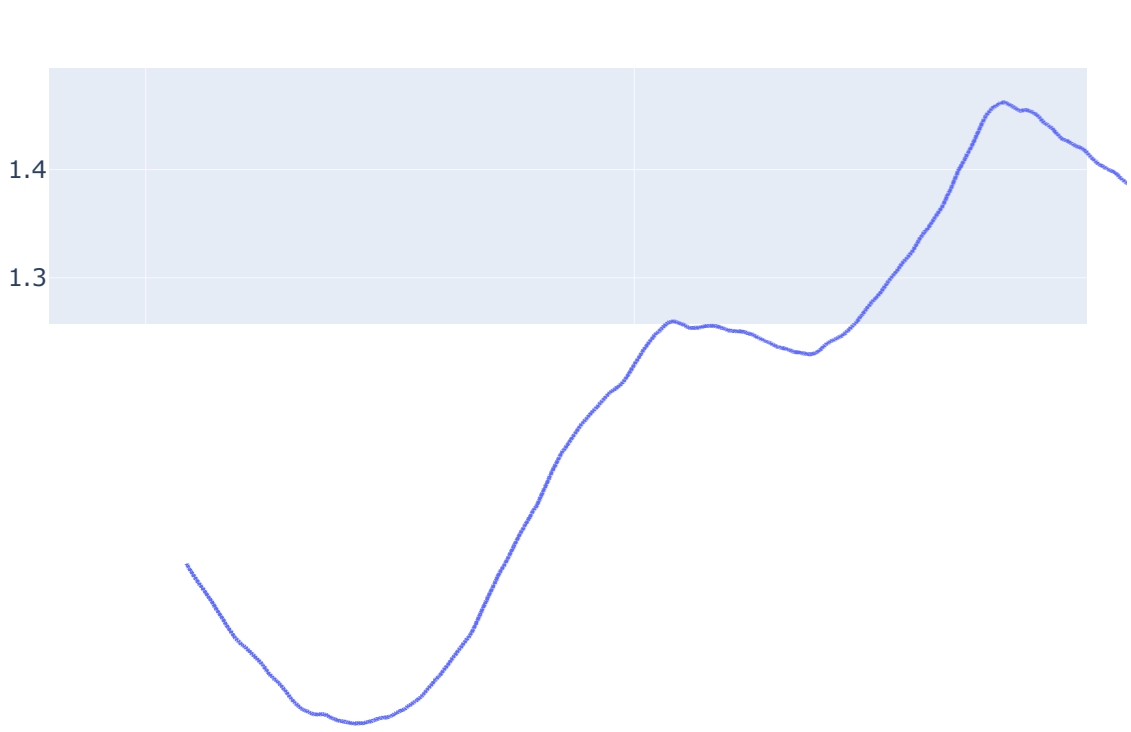
An interactive line chart by using Plotly Express

where we can see the value of the Euro-USD exchange rate and date 1999 to 2023 while hovering over a line.

In [48]:
```
%pip install plotly
import plotly.express as px

Euro_to_USD = euro_to_dollar["US_dollar"].rolling(365).mean()

# Create an interactive line chart with hover information
fig = px.line(euro_to_dollar, x="Time", y=Euro_to_USD,
              labels={'US_dollar': 'Euro-USD Exchange Rate'},
              title='Interactive Exchange Rate Chart: Euro to USD during 1999 to 2023'
              hover_data={'Time': '|%Y-%m-%d'})
```

```
# Set x axis ticks
#start_year = 1999  # Update start_year to 1999
#end_year = 2023  # Update end_year to 2023
#custom_x_ticks = [f"{year}" for year in range(start_year, end_year + 1)]
#fig.update_xaxes(tickvals=custom_x_ticks, tickangle=90)

# Hide x axis ticks
#fig.update_xaxes(tickvals=custom_x_ticks, showticklabels=False)

# Set y axis ticks
custom_y_ticks = ["0.9","1.0", "1.1", "1.2", "1.3", "1.4$"]
fig.update_yaxes(tickvals=custom_y_ticks)

# Add y-axis label
fig.update_yaxes(title_text='Euro to USD')

# Show the plot
fig.show()

print("The interactive line chart created using Plotly Express provides a dynamic visu
```

```
Requirement already satisfied: plotly in c:\users\hp\anaconda3\lib\site-packages (5.
9.0)Note: you may need to restart the kernel to use updated packages.

Requirement already satisfied: tenacity>=6.2.0 in c:\users\hp\anaconda3\lib\site-pack
ages (from plotly) (8.0.1)
```



The interactive line chart created using Plotly Express provides a dynamic visualization of Euto to USD exchange rate fluctuations. Hovering over the chart reveals precise values and corresponding dates, offering a user-friendly experience. This insightful tool enhances data exploration, making it easy to analyze trends and pinpoint key moments in the exchange rate over time. Overall, the interactive features empower users to gain valuable insights effortlessly.

--------- CONCLUSION ---------

The Euro to USD exchange rate data from 1999 to 2023 reveals a complex economic narrative shaped by various crises within the Eurozone. The graph illustrates notable peaks and troughs, each corresponding to distinct crisis periods. The 2008 global financial crisis, the Eurozone debt crisis of 2010-2012 while recovery phases follow, reflecting resilience in the Euro's value. Upswings often coincide with positive economic indicators and policy interventions, while downturns align with financial instability, political uncertainties, and sovereign debt concerns.

In [ ]: