In [1]:
```
import pandas as pd
import numpy as np
from prettytable import PrettyTable
```

In [2]:
```
df = pd.read_pickle('marketdata.pkl')
```

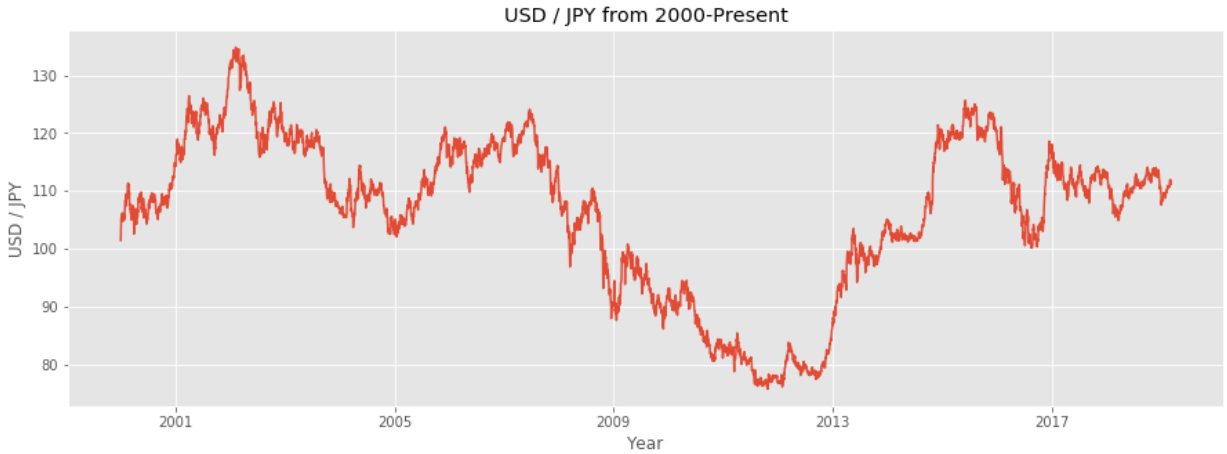
In [3]:
```
# Quick inspection of what the provided data looks like (recent spot prices
df.tail()
```

Out[3]:

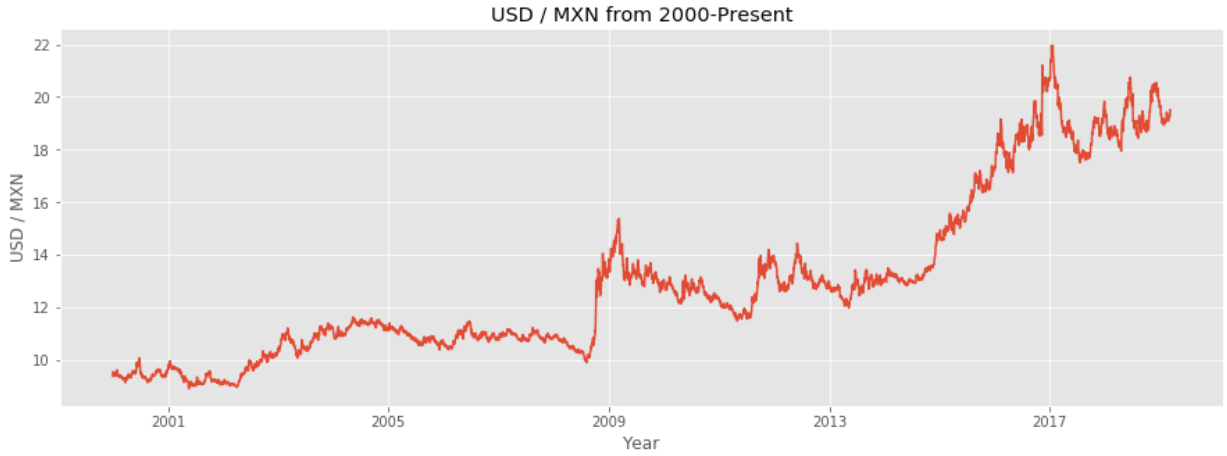
| ticker | USDJPY | USDMXN |
|---|---|---|
| date | | |
| **2019-03-04** | 111.845 | 19.3194 |
| **2019-03-05** | 111.895 | 19.2570 |
| **2019-03-06** | 111.725 | 19.3435 |
| **2019-03-07** | 111.535 | 19.4915 |
| **2019-03-08** | 111.135 | 19.5090 |

In [4]:
```
import matplotlib.pyplot as plt
plt.style.use('ggplot')
```

In [5]:
```
# Cursory plot of JPY
plt.figure(figsize = (15, 5))
plt.plot(df['USDJPY'])
plt.title("USD / JPY from 2000-Present")
plt.xlabel("Year")
plt.ylabel("USD / JPY")
plt.show()
```



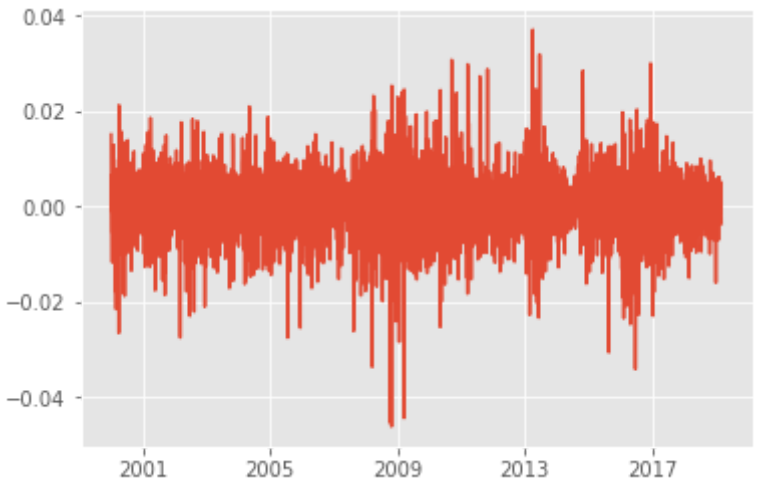
In [6]:
```
# Cursory plot of MXN
plt.figure(figsize = (15, 5))
plt.plot(df['USDMXN'])
plt.title("USD / MXN from 2000-Present")
plt.xlabel("Year")
plt.ylabel("USD / MXN")
plt.show()
```




In [7]:
```
# Compute log change for JPY (instantaneous rate of return)
df['changeJPY'] = np.log(df['USDJPY'] / df['USDJPY'].shift())
```

In [8]:
```
# Cursory plot of log change for JPY reveals noisy data centered around 0
plt.plot(df.changeJPY)
```

Out[8]:
```
[<matplotlib.lines.Line2D at 0x12101ccd0>]
```




In [9]:
```
# Compute log change for MXN (instantaneous rate of return)
df['changeMXN'] = np.log(df['USDMXN'] / df['USDMXN'].shift())
```

In [10]:
```
# Cursory plot of log change for MXN reveals noisy data too but surpisingly
# appear to be more volatile than JPY
plt.plot(df.changeMXN)
```

Out[10]:
```
[<matplotlib.lines.Line2D at 0x1210b3050>]
```


In [11]:
```
# 5-day and 20-day moving averages for each pair
df['5maJPY'] = df['USDJPY'].rolling(window=5, min_periods=0).mean()
df['20maJPY'] = df['USDJPY'].rolling(window=20, min_periods=0).mean()
df['5maMXN'] = df['USDMXN'].rolling(window=5, min_periods=0).mean()
df['20maMXN'] = df['USDMXN'].rolling(window=20, min_periods=0).mean()
# Inspect recent moving averages
df.tail()
```

Out[11]:

| ticker | USDJPY | USDMXN | changeJPY | changeMXN | 5maJPY | 20maJPY | 5maMXN | 20maMXN |
|---|---|---|---|---|---|---|---|---|
| date | | | | | | | | |
| 2019-03-04 | 111.845 | 19.3194 | -0.000492 | 0.001417 | 111.341 | 110.65975 | 19.26360 | 19.223102 |
| 2019-03-05 | 111.895 | 19.2570 | 0.000447 | -0.003235 | 111.571 | 110.75900 | 19.27325 | 19.232727 |
| 2019-03-06 | 111.725 | 19.3435 | -0.001520 | 0.004482 | 111.737 | 110.85425 | 19.29630 | 19.244195 |
| 2019-03-07 | 111.535 | 19.4915 | -0.001702 | 0.007622 | 111.780 | 110.94325 | 19.34069 | 19.265770 |
| 2019-03-08 | 111.135 | 19.5090 | -0.003593 | 0.000897 | 111.627 | 111.01350 | 19.38408 | 19.287732 |

In [12]:
```
# The rules:
# Buy JPY against USD if 5-day moving avg is >= 20-day moving avg
df['JPYtxn'] = np.where(df['5maJPY'] >= df['20maJPY'], 'long', 'short')
# Buy MXN against USD if 5-day moving avg is >= 20-day moving avg
df['MXNtxn'] = np.where(df['5maMXN'] >= df['20maMXN'], 'long', 'short')
```

In [13]:
```
# Normalize reciprocal currencies so returns can be calculated easier
df['JPYUSD'] = 1 / df['USDJPY']
df['MXNUSD'] = 1 / df['USDMXN']
```

In [14]:
```
# Resampled by end of month when portfolio rebalancing will occur
df_grouped = df.resample('M').last()
```

In [15]:
```
# Create frames for 2016-2018 selection period
df_2016 = df_grouped['1-2016':'12-2016']
df_2017 = df_grouped['1-2017':'12-2017']
df_2018 = df_grouped['1-2018':'12-2018']
# Inspect 2016
df_2016
```

Out[15]:

| ticker | USDJPY | USDMXN | changeJPY | changeMXN | 5maJPY | 20maJPY | 5maMXN | 20maMXN | JPY |
|---|---|---|---|---|---|---|---|---|---|
| date | | | | | | | | | |
| 2016-01-31 | 121.065 | 18.16775 | 0.019770 | -0.007881 | 119.101 | 118.21050 | 18.39138 | 18.072697 | I |
| 2016-02-29 | 112.875 | 18.08700 | -0.009259 | -0.002728 | 112.547 | 114.32525 | 18.17339 | 18.474385 | s |
| 2016-03-31 | 112.395 | 17.13775 | -0.000534 | -0.002404 | 112.831 | 112.81375 | 17.38960 | 17.607877 | I |
| 2016-04-30 | 106.995 | 17.12925 | -0.014521 | -0.003613 | 109.785 | 109.43775 | 17.35398 | 17.496935 | I |
| 2016-05-31 | 110.905 | 18.40315 | -0.001532 | -0.004189 | 110.357 | 109.18325 | 18.45732 | 18.232815 | I |
| 2016-06-30 | 102.590 | 18.44925 | -0.000536 | -0.004529 | 102.376 | 104.94150 | 18.78465 | 18.661507 | s |
| 2016-07-31 | 102.485 | 18.73675 | -0.022671 | -0.008577 | 104.740 | 104.20500 | 18.81721 | 18.617845 | I |
| 2016-08-31 | 103.435 | 18.86875 | 0.006304 | 0.003132 | 101.881 | 101.17050 | 18.58494 | 18.407302 | I |
| 2016-09-30 | 101.265 | 19.35350 | -0.003647 | -0.002335 | 100.872 | 101.66675 | 19.53705 | 19.260370 | s |
| 2016-10-31 | 105.085 | 18.80750 | -0.003088 | 0.003942 | 104.912 | 104.01900 | 18.71450 | 18.868270 | I |
| 2016-11-30 | 113.945 | 20.47250 | 0.009258 | -0.008718 | 113.069 | 109.03025 | 20.61091 | 20.218785 | I |
| 2016-12-31 | 116.635 | 20.60150 | 0.001630 | -0.002649 | 117.114 | 116.18450 | 20.67133 | 20.500397 | I |

In [16]:
```
# Calc results of rules-based strategy: looping through dataframe is not ba
# dealing with 3 small frames only (i.e., 2016-2018)
def calc_results(df, txn=None, cur=None):
    long, short = [], []
    for index, row in df.iterrows():
        if getattr(row, txn) == 'long':
            long.append(getattr(row, cur))
        else:
            short.append(getattr(row, cur))
    avg_long, avg_short = np.mean(long), np.mean(short)
    avg_return = format(((avg_short / avg_long) - 1) * 100, '.2f')
    avg_long_reciprocal, avg_short_reciprocal = format(1 / avg_long, '.3f')
    return avg_long_reciprocal, avg_short_reciprocal, avg_return
```

In [17]:
```
# Get USD/JPY results
JPY_long_16, JPY_short_16, JPY_return_16 = calc_results(df_2016, 'JPYtxn',
JPY_long_17, JPY_short_17, JPY_return_17 = calc_results(df_2017, 'JPYtxn',
JPY_long_18, JPY_short_18, JPY_return_18 = calc_results(df_2018, 'JPYtxn',
```

In [18]:
```
# Get USD/MXN results
MXN_long_16, MXN_short_16, MXN_return_16 = calc_results(df_2016, 'MXNtxn',
MXN_long_17, MXN_short_17, MXN_return_17 = calc_results(df_2017, 'MXNtxn',
MXN_long_18, MXN_short_18, MXN_return_18 = calc_results(df_2018, 'MXNtxn',
```

In [19]:
```
# Calc total returns
total_return_16 = format(float(JPY_return_16) + float(MXN_return_16), '.2f'
total_return_17 = format(float(JPY_return_17) + float(MXN_return_17), '.2f'
total_return_18 = format(float(JPY_return_18) + float(MXN_return_18), '.2f'
```

In [20]:
```
# Summarize results in table
def results_table(titlename=None, cur=None):
    table = PrettyTable()
    setattr(table, 'title', titlename)
    table.field_names = ["Year", "Avg. Long", "Avg. Short", "Avg. Return"]
    table.add_row(['2016', globals()[cur+"_long_16"], globals()[cur+"_short
    table.add_row(['2017', globals()[cur+"_long_17"], globals()[cur+"_short
    table.add_row(['2018', globals()[cur+"_long_18"], globals()[cur+"_short
    return table
```

In [21]:
```
# Summarize aggregate returns of each pair
def returns_table():
    table = PrettyTable()
    table.title = "Aggregate returns"
    table.field_names = ["Year", "Avg. Total Return"]
    table.add_row(['2016', total_return_16])
    table.add_row(['2017', total_return_17])
    table.add_row(['2018', total_return_18])
    return table
```

In [22]:
```
# Output summary of results
def output_results():
    jpy_title = "Results for (5, 20) USD/JPY momentum strategy"
    mxn_title = "Results for (5, 20) USD/MXN momentum strategy"
    print(results_table(jpy_title, "JPY"))
    print(results_table(mxn_title, "MXN"))
    print(returns_table())
```

In [23]:
```
output_results()
```

```
+------+-----------+------------+-------------+
| Year | Avg. Long | Avg. Short | Avg. Return |
+------+-----------+------------+-------------+
| 2016 |  110.009  |  105.330   |     4.44    |
| 2017 |  112.531  |  111.270   |     1.13    |
| 2018 |  111.618  |  109.291   |     2.13    |
+------+-----------+------------+-------------+
+------+-----------+------------+-------------+
| Year | Avg. Long | Avg. Short | Avg. Return |
+------+-----------+------------+-------------+
| 2016 |   19.093  |   17.763   |     7.49    |
| 2017 |   18.944  |   18.784   |     0.85    |
| 2018 |   19.541  |   18.908   |     3.35    |
+------+-----------+------------+-------------+
+------+--------------------+
| Year | Avg. Total Return |
+------+--------------------+
| 2016 |       11.93        |
| 2017 |        1.98        |
| 2018 |        5.48        |
+------+--------------------+
```