Problem Set 3

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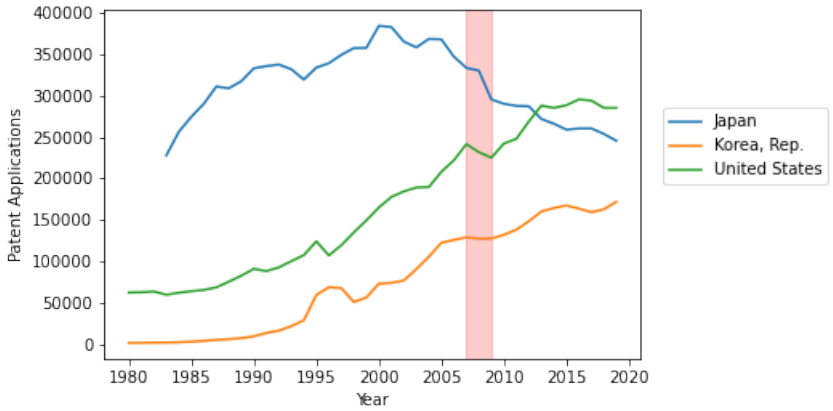
1 Visual 1 & 2: Innovation and patents

My first year qualifying exam was a research proposal on the dynamics of clustered firms in terms of innovative activity. Because I am still trying to figure out how to access patent data, I wanted to see if some of my initial assumptions hold. Therefore, I decided to plot country patent application activity (figure 1) as well as country R&D expenses / GDP (figure 2).

```
# imports
import numpy as np
import pandas as pd
import plotly.express as px
import plotly.io as pio
# pio.renderers.default = 'jupyterlab'
pio.renderers.default = 'notebook'
import matplotlib.pyplot as plt
from datetime import datetime
%matplotlib inline

patentapp = pd.read_csv('ps3patentapp.csv',
                        header=0, index_col=0)
patentapp = patentapp.T

patentapp.plot(xlabel="Year", ylabel="Patent Applications")
plt.axvspan(2007 - 1980, 2009 - 1980, color='red', alpha=0.2)

plt.legend(loc=(1.04,0.5))

plt.savefig('patentapp.png', bbox_inches='tight')
```

Figure 1 shows a clear decrease in patent applications during the financial crisis for the US and Japan, but only a slight decrease for South Korea. Figure

Figure 1: Patent Applications per Year



2 shows a delayed reaction by the US and Japan, but no effect for South Korea. This is most likely because figure 2 is a ratio data per GDP and it is likely that GDP dropped relatively more than R&D expenditures, but that after the crisis has passed, GDP increased again but firms were slower to reallocate money to R&D, which resulted in the lagged response in figure 2.

```
rdexpenditures = pd.read_csv('rdexpenditures.csv',
                             header=0, index_col=0)
rdexpenditures = rdexpenditures.T

rdexpenditures.plot(xlabel="Year", ylabel="R&D Expenditures")
plt.axvspan(2007-1996, 2009-1996, color='red', alpha=0.2)

plt.legend(loc=(1.04,0.5))

plt.savefig('rdexpenditures.png', bbox_inches='tight')
```

2 Visual 3: Tech stocks

Out of personal interest I decided to take this opportunity to see how I can use Python for stock data retrieval and plotting. I've included text in the python code (see box below) for clarification.

```
# Import packages
import yfinance as yf
import pandas as pd

# Set the start and end date
start_date = '1990-01-01'
```

Figure 2: R&D Expenditures as a Percentage of GDP


```
end_date = '2021-07-12'

# Define the ticker list
tickers_list = ['AAPL', 'IBM', 'MSFT', 'AMZN', 'GOOGL']

# Create placeholder for data
data = pd.DataFrame(columns=tickers_list)

# Fetch the data
for ticker in tickers_list:
    data[ticker] = yf.download(ticker,
                               start_date,
                               end_date)['Adj Close']

# Plot all the close prices
data.plot(figsize=(10, 7))

# Show the legend
plt.legend()

# Define the label for the title of the figure
plt.title("Adjusted Close Price", fontsize=16)

# Define the labels for x-axis and y-axis
plt.ylabel('Price', fontsize=14)
plt.xlabel('Year', fontsize=14)

plt.show()
plt.savefig('techstocks.jpg', bbox_inches='tight')
```

Figure 3 below shows the time-series for our 5 chosen stocks. We can see that both *Amazon* and *Google* did very well, especially the past 8 years where they

seem to have run away from the other tech giants.

Figure 3: Tech Stocks