deflation_analysis_final

November 20, 2020

1 Japan Deflation Analysis

All data is taken from http://www.oecd.org/

[1]:
```
# import necessary libraries
import pandas as pd
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt
from mpl_toolkits import mplot3d

# visualization
from sklearn.decomposition import PCA
from sklearn.pipeline import Pipeline
from sklearn.impute import SimpleImputer
from sklearn.preprocessing import StandardScaler

from sklearn.cluster import KMeans

sns.set(color_codes=True)
```

[2]:
```
def transform_dataset(data):
    data = data.set_index('Unnamed: 0')
    data.index.rename('', inplace=True)
    return data
```

[3]:
```
# import relevant dataset
full_data = pd.read_csv('data/full_data.csv')
economic_index = pd.read_csv('data/ei_combined.csv')
cpi_index = pd.read_csv('data/cpi_index.csv')
gdp_production_index = pd.read_csv('data/gdp_production_index.csv')
health_index = pd.read_csv('data/health_index.csv')
population_index = pd.read_csv('data/population_index.csv')
ppp_index = pd.read_csv('data/ppp_index.csv')
productivity_ulc_index = pd.read_csv('data/productivity_ulc_index.csv')

# transform relevant dataset
full_data = transform_dataset(full_data)
```

```
economic_index = transform_dataset(economic_index)
cpi_index = transform_dataset(cpi_index)
gdp_production_index = transform_dataset(gdp_production_index)
health_index = transform_dataset(health_index)
population_index = transform_dataset(population_index)
ppp_index = transform_dataset(ppp_index)
productivity_ulc_index = transform_dataset(productivity_ulc_index)

population_index = population_index.drop(columns=['89'])
```

1.1 Introduction

Japan's economy was the envy of the world in the 1980s. With strong export sector, Japan's average annual rate grew at an average of 3.89% in the 1980s compared to the United States with 3.07%. However, in 1991 Japan's asset price bubble collapsed and started the decade of economic stagnation called the lost decade. From 1991 to 2003, the GDP grew by 1.14% annually which was well below that of other industrialized countries (1, 2).

Although the burst of economic bubbles happens here and then, such as the 2008 financial crisis, Japan's collapse of the bubble has still an effect today because of deflation. Japan has globally be know as an economy struggling to overcome longstanding deflation and deflationary mindset since the late 1990s. To combat the long-lasting deflation, in 2013 Bank of Japan announced the an aggresive quantitative and qualitative monetary easing to meet a 2% inflation target with two years. The bank of Japan decided to the double the monetary base each year (3).

What is deflation? Deflation is a general declide in prices of goods and services. Deflation causes the nomial costs (expenses of production) of capital, labor, goods, and services to fall while their relative prices remains unchanged (4).

Issues with deflation Typically deflation is a economic concern due to the following reasons:

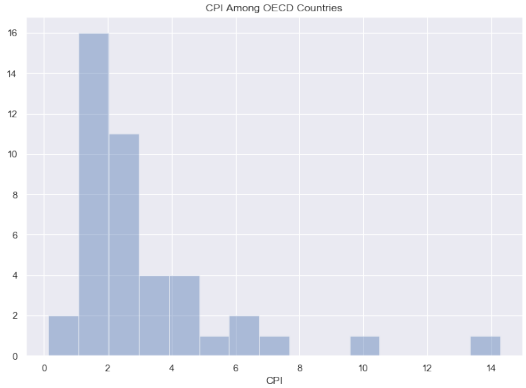
- Prices falling due to lower consumer spending, which halts economic growth
- Firms respond to falling prices by slowing down their production which leads to layoffs and salary deduction
- Deflation can harm borrowers. The money can be worth more than the money the borrowed

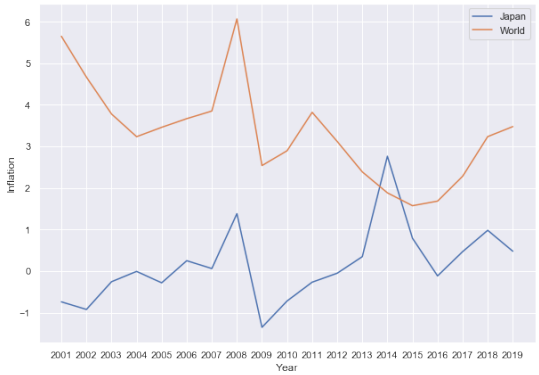
Next we look at Japan's consumer price index (CPI) which measures the average changes in prices over time that consumers pay for a basket of goods and services. From the CPI, we can see the change in inflation over the past 20 years and compared the value with the world's CPI value (4).

Sources

1. https://www.investopedia.com/articles/economics/08/japan-1990s-credit-crunch-liquidity-trap.asp#:~:text=From%201991%20through%202001%2C%20Japan,pace%20than%20other%20industrialize
2. https://www.japantimes.co.jp/opinion/2017/03/29/commentary/japan-commentary/the-truth-about-deflation/#.XwAQ15MzaHE
3. https://www.sr-sv.com/japans-quantitative-and-qualitative-easing/#:~:text=On%20April%204%20Bank%2
4. https://www.investopedia.com/terms/d/deflation.asp

[4]:
```
# import data
cpi_history = pd.read_csv('data/cpi.csv')
oecd_cpi = cpi_index['CPI: 01-12 - All items']

# select data
cpi_history = cpi_history.loc[cpi_history['Subject'] == 'CPI: 01-12 - All␣
 ↪items'][['Country', 'Time', 'Value']]
cpi_japan = cpi_history.loc[cpi_history['Country'] == 'Japan']
cpi_world = cpi_history.loc[cpi_history['Country'] != 'Japan']

# create data
time_series = cpi_world['Time'].unique()
avg_cpi = []

for time in time_series:
    avg_cpi.append(cpi_world.loc[cpi_world['Time'] == time]['Value'].mean())

# plot graph
plt.figure(figsize = (22, 7))

plt.subplot(1, 2, 1)
sns.distplot(oecd_cpi.values, kde=False)
plt.xlabel('CPI')
plt.title('CPI Among OECD Countries')

plt.subplot(1, 2, 2)
plt.plot(cpi_japan['Time'], cpi_japan['Value'], label="Japan")
plt.plot(cpi_japan['Time'], avg_cpi, label="World")
plt.xticks(range(2001, 2020, 1))
plt.xlabel('Year')
plt.ylabel('Inflation')
plt.legend()
plt.show()
```





The left graph above shows a histogram of the CPI values for all OECD countries, and the right graph shows a time series for Japan's CPI rate from 2001-2019 and the CPI rate for all other OECD countries in the same time span. The histogram shows that out of all OECD countries, only 11 countries were able to meet the target inflation rate of 2%-3% for the past 20 years. The time series plot provides a clear visualization of Japan's low inflations in the past 20 years compared to OECD countries. Japan has only reached the target inflation rate in 2014 when the Bank of Japan announced its monetary policy. However the inflation has gone back to around 0.5% in 2019, showing no signs of a possible inflation in the near future.

1.2 Comparing Economic and Social Factors

To understand the possible reason behind Japan's long-standing deflation, we collect information on economic and social factors for countries that have had an inflation between 2% and 3% from 2001 ~ 2019. We first figure out the country and their inflation rate.

The economic and social factors we collected data on are the following: - Economic Index - GDP - Health Expenditures - Current expenditure on health - Population - Population based on sex and age group - Purchasing Power Parity - Compares different countries' currencies through by measuring a basket of goods which consists of various goods and products. - Production

[5]:
```
# get all countries that meet inflation target rate
country_list = cpi_index.index
cpi = cpi_index['CPI: 01-12 - All items'].values
cpi_dict = list(zip(country_list, cpi))

cpi_good = []
for cpi in cpi_dict:
    if cpi[1] >= 2 and cpi[1] <= 3:
        cpi_good.append(cpi)

cpi_series = pd.DataFrame({'CPI': [cpi[1] for cpi in cpi_good]}, index=[cpi[0]␣
↪for cpi in cpi_good])
cpi_series = cpi_series.sort_values(by=['CPI'], ascending=False)
cpi_series
```

[5]:

	CPI
Slovenia	2.759940
Australia	2.544193
Lithuania	2.508400
Korea	2.426587
China (People's Republic of)	2.326316
Czech Republic	2.156178
Poland	2.154386
United States	2.106992
New Zealand	2.103123
United Kingdom	2.057895
Norway	2.044755
Spain	2.027359

The data frame shows that 12 countries above have all had 2% ~ 3% inflation for the past 20 years.

We then collect data regarding economic index, GDP, health, population, purchasing power parity, and productivity for the 12 countries and Japan. We then use principal component analysis (PCA) to visualize the data by reducing the dimension to 2.

[6]:
```
def get_inflation_countries(data):
    """
    Get all data from the countries that have met inflation goal.
    """
    relevant_data =  data.loc[
        (data.index == 'Slovenia') |
        (data.index == 'Australia') |
        (data.index == 'Lithuania')|
        (data.index == 'Korea') |
        (data.index == 'China (People\'s Republic of)') |
        (data.index == 'Czech Republic') |
        (data.index == 'Poland') |
        (data.index == 'United States') |
        (data.index == 'New Zealand') |
        (data.index == 'United Kingdom') |
        (data.index == 'Norway') |
        (data.index == 'Spain') |
        (data.index == 'Japan')
    ]

    return relevant_data.sort_index()
```

[7]:
```
# get data from relevant country from all imported data
# drop all columns with NaN
ei_inflation = get_inflation_countries(economic_index.dropna(axis='columns'))
cpi_inflation = get_inflation_countries(cpi_index.dropna(axis='columns'))
gdp_production_inflation = get_inflation_countries(gdp_production_index.
 ↪dropna(axis='columns'))
health_inflation = get_inflation_countries(health_index.dropna(axis='columns'))
population_inflation = get_inflation_countries(population_index.
 ↪dropna(axis='columns'))
ppp_inflation = get_inflation_countries(ppp_index.dropna(axis='columns'))
productivity_inflation = get_inflation_countries(productivity_ulc_index.
 ↪dropna(axis='columns'))
```

[8]:
```
def create_standarized_dataset(data):
    """
    Substitute NaN value with mean and standarize the data. Return as pd.
 ↪DataFrame
    """
    # create pipeline
    data_copy = data.copy()
```

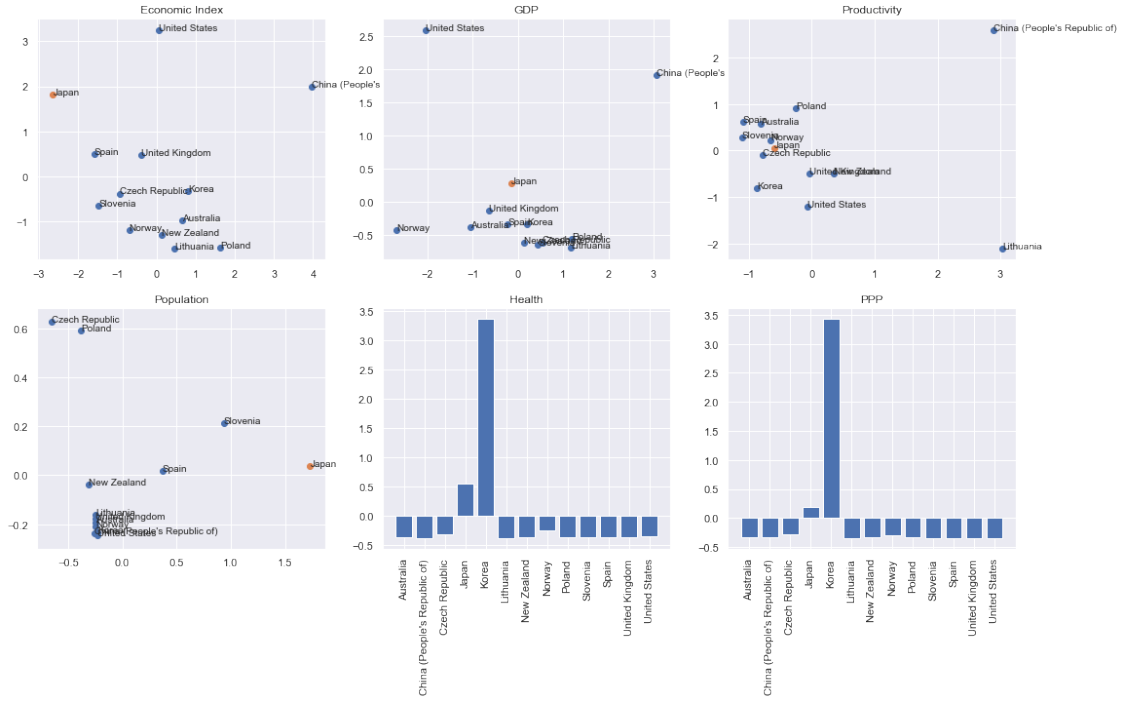
```
    if len(data.columns) > 1:
        num_pipeline = Pipeline([
            ('imputer', SimpleImputer(strategy="mean")),
            ('std_scaler', StandardScaler())
        ])
        transformed_data = num_pipeline.fit_transform(data_copy)
    else:
        transformed_data = StandardScaler().fit_transform(data)

    data_copy[:] = transformed_data
    return data_copy
```

[9]:
```
# exclude purchasing power parity, and health as only one column
ei_standarized = create_standarized_dataset(ei_inflation)
gdp_production_standarized = ␣
↪create_standarized_dataset(gdp_production_inflation)
population_standarized = create_standarized_dataset(population_inflation)
productivity_standarized = create_standarized_dataset(productivity_inflation)
health_standarized = create_standarized_dataset(health_inflation)
ppp_standarized = create_standarized_dataset(ppp_inflation)
```

[10]:
```
# apply PCA transformation
pca = PCA(n_components=2)

ei_reduced = pca.fit_transform(ei_standarized)
gdp_production_reduced = pca.fit_transform(gdp_production_standarized)
population_reduced = pca.fit_transform(population_inflation)
productivity_reduced = pca.fit_transform(productivity_standarized)
```

[11]:
```
# plot data
plt.figure(figsize=(18, 10))

index = 1
reduced_data = [("Economic Index", ei_reduced), ("GDP", gdp_production_reduced),
                ("Productivity", productivity_reduced), ("Population",␣
↪population_reduced), ("Health", health_standarized),
               ("PPP", ppp_standarized)]

for title, data in reduced_data:
    plt.subplot(2, 3, index)

    if isinstance(data, pd.DataFrame):
        plt.title(title)
        plt.xticks(rotation=90)
        plt.bar([x for x in data.index], np.ndarray.flatten(data.values))
    else:
```

```
        japan = data[3]
        others = np.delete(data, 3, 0)

        plt.scatter(others[:, 0], others[:, 1])
        plt.scatter(japan[0], japan[1])

        country_data = [x for x in ei_inflation.index if x != 'Japan']
        for i, txt in enumerate(country_data):
            plt.annotate(txt, (others[:, 0][i], others[:, 1][i]))
        plt.annotate("Japan", (japan[0], japan[1]))
        plt.title(title)

    index += 1
plt.show()
```



From the 6 graphs we can deduce the following information:

- Economic Index
  - The scatter plot shows that Japan is located far away from China. Since China's economy is growing in a high rate, exploring the differences between Japan and China can provide possible insight.
- GDP
  - For GDP, USA and China are the two countries that are located further away from the rest of the country. Japan is the closest country to the two countries in terms of distance.
- Productivity

  - The productivity data suggests that Japan is mostly similar with the other OECD countries.
- Population
  - The population scatter plot shows that Japan is located away from the majority of the countries.
- Health
  - Japan's current expenditure on health is high compared to other countries. This may be the reason for Japanese people having a long life expectancy.
- Purchasing Power Parity
  - From the bar chart we can also see that Japan's purchasing power parity is higher than all countries except for Korea.

1.3 Looking into Economic and Social Factors

In this section we look into important economic and social factors that can be used to understand the differences between Japan and the other countries. The factors includes ones that were used for PCA analysis, and new factors that can possibly provide new insights.

1.3.1 Economic Index

[12]:
```
ei_inflation
```

[12]:

	Exports in goods, s.a.	Imports in goods, s.a.	\
Australia	65.066161	62.010703	
China (People's Republic of)	516.261858	435.157550	
Czech Republic	50.526682	46.654352	
Japan	219.260484	214.209076	
Korea	144.481164	132.210814	
Lithuania	16.718985	16.775606	
New Zealand	14.263578	15.094824	
Norway	41.554862	27.571758	
Poland	60.829151	63.049286	
Slovenia	15.504454	15.020115	
Spain	88.816808	108.731110	
United Kingdom	137.454389	186.797876	
United States	418.975096	652.235183	

	Share prices	Consumer prices: all items	\
Australia	4.435165	31.276290	
China (People's Republic of)	7.711203	30.965639	
Czech Republic	5.720108	32.023710	
Japan	2.033844	32.824824	
Korea	6.875917	31.425293	
Lithuania	15.079314	31.495382	
New Zealand	5.327814	31.740922	
Norway	11.007439	32.040802	

Poland	8.414118	31.065411
Slovenia	8.391123	32.282241
Spain	0.931825	32.107921
United Kingdom	1.356957	31.524336
United States	4.195332	32.011974

	Gross domestic product; constant prices, s.a. \
Australia	2.846152
China (People's Republic of)	9.172153
Czech Republic	2.786704
Japan	0.804440
Korea	3.853836
Lithuania	4.169892
New Zealand	2.883612
Norway	1.598191
Poland	3.791841
Slovenia	2.345181
Spain	1.667267
United Kingdom	1.761037
United States	1.993668

	Overnight interbank rate \
Australia	3.706842
China (People's Republic of)	3.067895
Czech Republic	1.544737
Japan	0.070305
Korea	2.846316
Lithuania	1.373325
New Zealand	3.924211
Norway	2.647895
Poland	4.434211
Slovenia	1.042419
Spain	1.193111
United Kingdom	2.094842
United States	1.402105

	Current account as a % of GDP, s.a.
Australia	-3.954578
China (People's Republic of)	3.539535
Czech Republic	-1.939866
Japan	2.969035
Korea	3.056706
Lithuania	-3.171408
New Zealand	-3.701504

```
Norway                                                  11.027120
Poland                                                  -3.014520
Slovenia                                                 0.997804
Spain                                                   -2.457681
United Kingdom                                          -3.296185
United States                                           -3.416689
```

The data frame above shows two indicators in which Japan has very different values from the rest of the countries:

- Gross domestic product (constant prices)
  - Real gross domestic product is a macroeconomic statistic that measures the value of the goods and services produced by an economy in a specific period, adjusted for inflation.
  - Japan shows little growth with an average of 0.8, while all the other countries growth higher than 1.5.
- Overnight interbank rate
  - The overnight rate is the interest rate at which a depository institution (generally banks) lends or borrows funds with another depository institution in the overnight market. In many countries, the overnight rate is the interest rate the central bank sets to target monetary policy.
  - Japan's overnight interbank rate is much smaller compared to the other countries which means that banks are more encourage to borrow from each other. This may be due to boost economic production to increase prices.

1.3.2 Population

To get a better understanding of the population structure of each country, we import a new data that has the following information:

- Total Population
- Percentage of population over 65
- Percentage of population between 15 and 64
- Percentage of population under 15

[13]:
```
# import data
population_data = pd.read_csv('data/population_total.csv')
population_data = population_data.drop(columns=['LOCATION', 'SEX', 'Sex',␣
 ↪'AGE', 'TIME', 'Flag Codes', 'Flags'])
population_data.head()
```

[13]:

	Country	Age	Time	Value
0	Australia	Total	2001	19274701.0
1	Australia	Total	2002	19495210.0
2	Australia	Total	2003	19720737.0
3	Australia	Total	2004	19932722.0
4	Australia	Total	2005	20176844.0

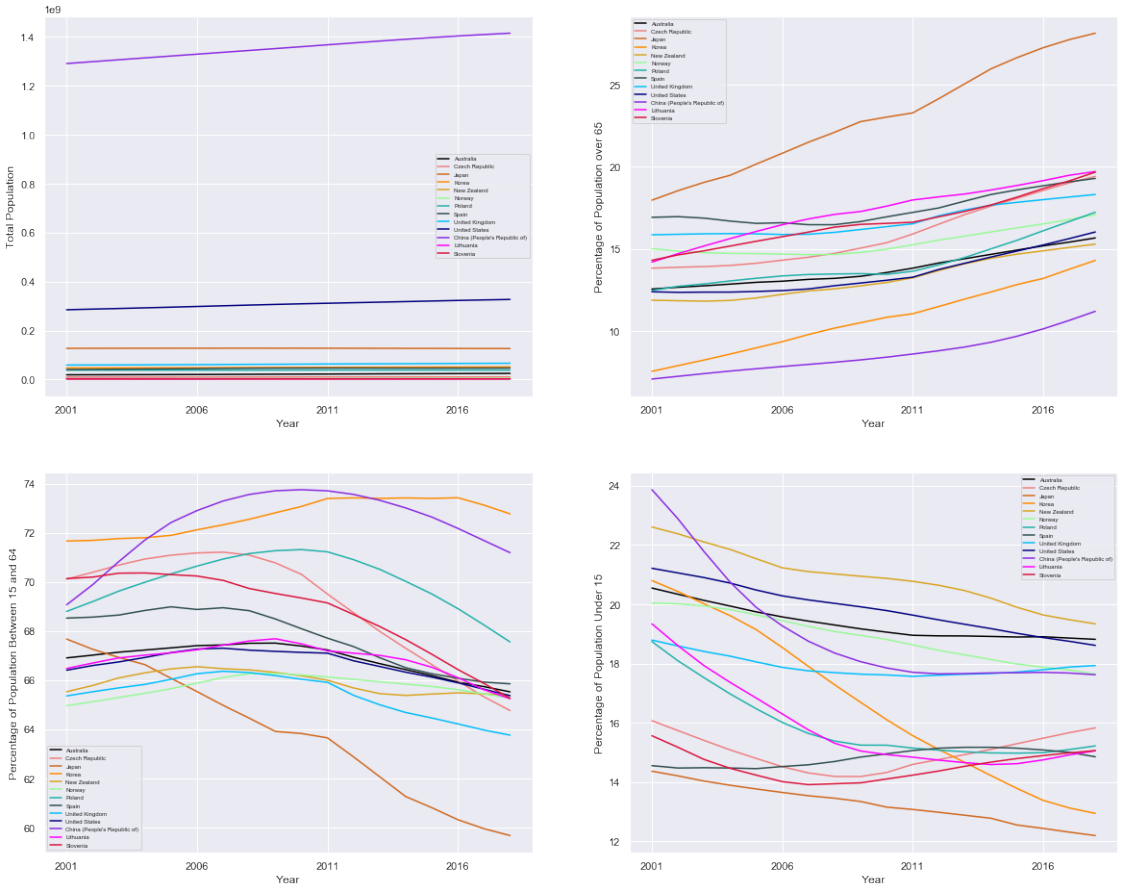
[14]:
```
total_population = population_data.loc[population_data['Age'] == 'Total']
over_65 = population_data.loc[population_data['Age'] == 'Share of 65 and over -␣
↪elderly']
from_15_64 = population_data.loc[population_data['Age'] == 'Share of 15 to 64 -␣
↪working age']
under_15 = population_data.loc[population_data['Age'] == 'Share of under 15 -␣
↪children']
```

[15]:
```
country_list_population = population_data['Country'].unique()

def get_dict_data(data, country_list):
    """
    Create a dictionary of {'country': , 'data': , 'color': }. Used for␣
↪plotting graph.
    """
    data_arr = []

    for country in country_list:
        data_country = data.loc[data['Country'] == country][['Time', 'Value']].
↪values
        data_arr.append(data_country)

    colors = ['black', 'lightcoral', 'chocolate', 'darkorange', 'goldenrod',␣
↪'palegreen', 'lightseagreen',
              'darkslategray', 'deepskyblue', 'navy', 'blueviolet', 'magenta',␣
↪'crimson']

    list_zip = list(zip(country_list, data_arr, colors))
    return list_zip
```

[16]:
```
population_countries = get_dict_data(total_population, country_list_population)
over_65_countries = get_dict_data(over_65, country_list_population)
from_15_64_countries = get_dict_data(from_15_64, country_list_population)
under_15_countries = get_dict_data(under_15, country_list_population)
```

[17]:
```
def plot_line_graph(data):
    """
    Plot line graph of data
    """
    for datum in data:
        plt.plot(datum[1][:, 0], datum[1][:, 1], datum[2], label=datum[0])
    plt.xticks(range(2001, 2019, 5))
    plt.legend(prop={'size': 6})
    plt.xlabel('Year')
```

[18]:
```
plt.figure(figsize=(20, 16))

plt.subplot(2, 2, 1)
plot_line_graph(population_countries)
plt.ylabel('Total Population')

plt.subplot(2, 2, 2)
plot_line_graph(over_65_countries)
plt.ylabel('Percentage of Population over 65')

plt.subplot(2, 2, 3)
plot_line_graph(from_15_64_countries)
plt.ylabel('Percentage of Population Between 15 and 64')

plt.subplot(2, 2, 4)
plot_line_graph(under_15_countries)
plt.ylabel('Percentage of Population Under 15')

plt.show()
```



From the top left line graph we can see that Japan's total population is in a downward trend; however, there seems to be no major decrease in the total population. Considering the decline in population we can see some troubling information from the three other graphs. The top right graph shows that the population over 65 is increasing each year with the percentage reaching close to 30%. On the other hand the bottom two graphs shows that the working population is decreasing and the amount of children are also decreasing as well.

If such trend continues, Japan will have a population structure in which a small working population supports a large popualtion of elderly people who doesn't work. This can cause major issues in the future as the working population will be taxed more to support the pension fund. Therefore, the working population may spend less on goods and services that can prevent an inflationary trend.

1.3.3 GDP

In this section KMeans clustering algorithm was used to classify countries.

[19]:
```
gdp_production_inflation
```

[19]:

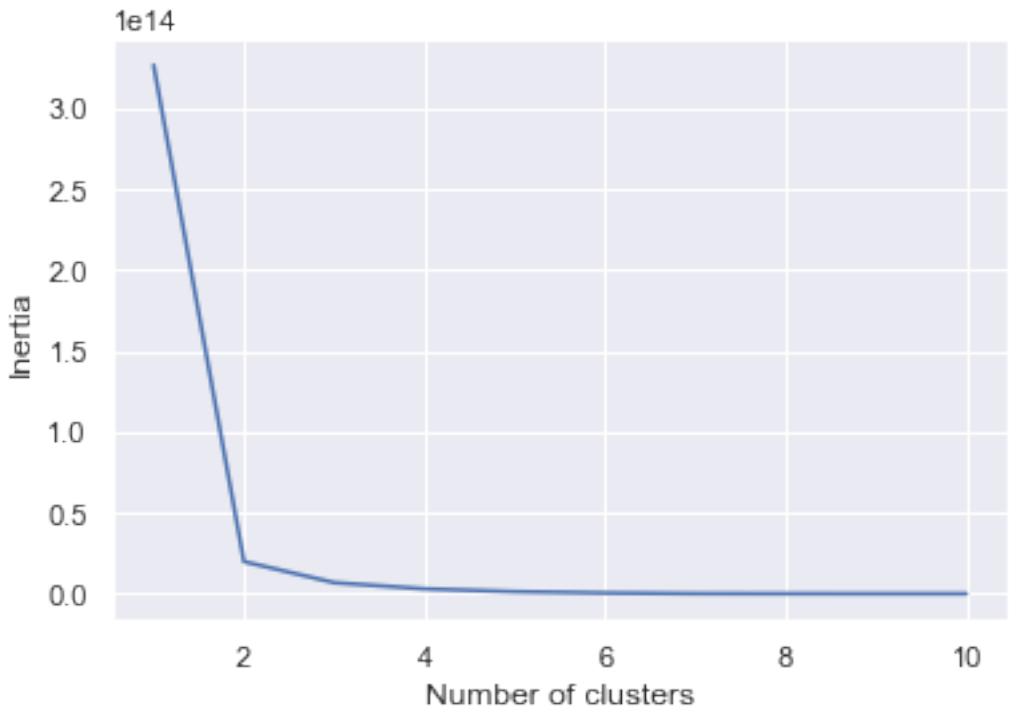
	Gross Domestic Product (GDP); millions	\
Australia	9.495379e+05	
China (People's Republic of)	1.367807e+07	
Czech Republic	2.983312e+05	
Japan	4.515240e+06	
Korea	1.574108e+06	
Lithuania	6.753784e+04	
New Zealand	1.431837e+05	
Norway	2.785042e+05	
Poland	8.028952e+05	
Slovenia	5.858123e+04	
Spain	1.460873e+06	
United Kingdom	2.376273e+06	
United States	1.553505e+07	

	GDP per head of population	\
Australia	42361.716217	
China (People's Republic of)	10059.324015	
Czech Republic	28508.055581	
Japan	35448.689094	
Korea	31532.284260	
Lithuania	22315.196059	
New Zealand	32243.940811	
Norway	56242.856037	
Poland	20920.863079	
Slovenia	28676.835592	
Spain	32112.573865	
United Kingdom	37610.552739	

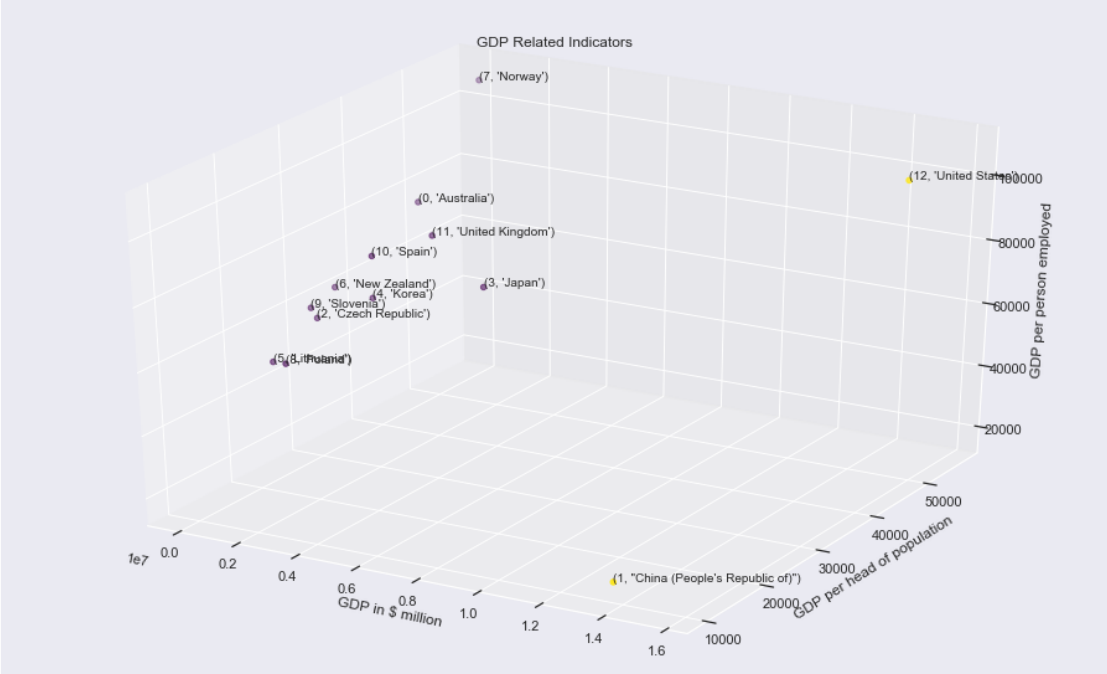
```
United States                                50003.912674
```

```
                                GDP per person employed

Australia                                    82876.488548
China (People's Republic of)                 17852.530240
Czech Republic                               58144.373383
Japan                                        68223.444759
Korea                                        63686.265288
Lithuania                                    49887.903082
New Zealand                                  64090.023236
Norway                                      108003.587378
Poland                                       51960.398046
Slovenia                                     60816.883816
Spain                                        76157.879133
United Kingdom                               78933.926706
United States                               105208.451537
```

[20]:
```
inertia_scores = []

for num in range(1, 11, 1):
    kmeans = KMeans(n_clusters=num)
    gdp_production_kmeans = kmeans.fit(gdp_production_inflation.values)
    inertia_scores.append(kmeans.inertia_)

plt.plot(list(range(1, 11, 1)), inertia_scores)
plt.xlabel("Number of clusters")
plt.ylabel("Inertia")
plt.show()
```



[21]:
```
gdp_prod_kmeans = KMeans(n_clusters=2).fit_predict(gdp_production_inflation.
 ↪values)
gdp = gdp_production_inflation['Gross Domestic Product (GDP); millions'].values
gdp_per_head = gdp_production_inflation['GDP per head of population'].values
gdp_per_employed = gdp_production_inflation['GDP per person employed'].values
country_data = list(zip(range(len(gdp_production_inflation)),␣
 ↪gdp_production_inflation.index))

plt.figure(figsize=(16, 10))
ax = plt.axes(projection = '3d')
ax.scatter(gdp, gdp_per_head, gdp_per_employed, c=gdp_prod_kmeans ,␣
 ↪cmap='viridis')

for i, txt in enumerate(country_data):
    ax.text(gdp[i], gdp_per_head[i], gdp_per_employed[i], txt)
ax.set_title("GDP Related Indicators")
ax.set_xlabel("GDP in $ million")
ax.set_ylabel('GDP per head of population')
ax.set_zlabel('GDP per person employed')
plt.show()
```



The 3D scatter plot above shows that GDP is not a direct indicator for inflation as Japan is located near a cluster. If GDP is a direct indicator then Japan has have a higher inflation rate as Japan shows strong resemblance to most countries.

However, China provides an example that a country with a lower GDP per capita can maintain an inflation target of 2% ~ 3%. China's GDP per head of population and GDP per person employed is significantly lower than the other countries; while their GDP is higher than all countries except for the US. Such phenomenon shows that the population making more than the average income are spending enough on goods and services which keeps inflation at a stable rate.

1.3.4 Balance of Payments

Balance of payment is a statement of all transaction made between an organization is one country and the rest of the world over a period of time. The BOP statement consists of two accounts: the current account and the capital account. The current account includes transaction in goods, services, investment income, and current transfers. On the other hand the capital account keeps tracks of the net change in a nation's assets and liabilities during a year.

[22]:
```
# import data and drop unnecessary columns
balance_payment = pd.read_csv('data/balance_payment.csv')
balance_payment = balance_payment[['Subject', 'Country', 'Time', 'Value']] #␣
 ↪units all in million
balance_payment.head()
```

[22]:

	Subject	Country	Time	Value
0	Current account, balance	Korea	2001	2165.2

```
1  Current account, balance   Korea  2002   4066.1
2  Current account, balance   Korea  2003  11308.3
3  Current account, balance   Korea  2004  29289.9
4  Current account, balance   Korea  2005  12208.6
```

[23]:
```
# seperate data frame by subject
current_account = balance_payment.loc[balance_payment['Subject'] == 'Current␣
 ↪account, balance']
goods = balance_payment.loc[balance_payment['Subject'] == 'Goods, balance']
services = balance_payment.loc[balance_payment['Subject'] == 'Services,␣
 ↪balance']
primary_income = balance_payment.loc[balance_payment['Subject'] == 'Primary␣
 ↪income, balance']
secondary_income = balance_payment.loc[balance_payment['Subject'] == 'Secondary␣
 ↪income, balance']
capital_account = balance_payment.loc[balance_payment['Subject'] == 'Capital␣
 ↪account, balance']
```

[24]:
```
country_list_bop = current_account['Country'].unique()

ca_by_country = get_dict_data(current_account, country_list_bop)
goods_by_country = get_dict_data(goods, country_list_bop)
services_by_country = get_dict_data(services, country_list_bop)
pi_by_country = get_dict_data(primary_income, country_list_bop)
si_by_country = get_dict_data(secondary_income, country_list_bop)
capital_by_country = get_dict_data(capital_account, country_list_bop)
```

[25]:
```
plt.figure(figsize=(22, 15))

plt.subplot(2, 3, 1)
plot_line_graph(ca_by_country)
plt.ylabel('Current Account Balance ($ Million)')
plt.xlabel('Year')

plt.subplot(2, 3, 2)
plot_line_graph(goods_by_country)
plt.ylabel('Goods Balance ($ Million)')
plt.xlabel('Year')

plt.subplot(2, 3, 3)
plot_line_graph(services_by_country)
plt.ylabel('Services, Balance ($ Million)')
plt.xlabel('Year')

plt.subplot(2, 3, 4)
plot_line_graph(pi_by_country)
plt.ylabel('Primary Income Balance ($ Million)')
```

```
plt.xlabel('Year')

plt.subplot(2, 3, 5)
plot_line_graph(si_by_country)
plt.ylabel('Secondary Income Balance ($ Million)')
plt.xlabel('Year')

plt.subplot(2, 3, 6)
plot_line_graph(capital_by_country)
plt.ylabel('Capital Account Balance ($ Million)')
plt.xlabel('Year')

plt.show()
```

The current account balance shows that Japan has been running on a surplus for the past 20 years which means that Japan has been exporting more goods and services than importing them. When we take a closer look into goods and services, Japan is on a surplus with goods but is on a deficit with services (1).

Before we look into primary and secondary income balance, we define the terms (2): - Primary income is the income that resident earn from the rest of the world from working and from financial investments - Secondary income consists of two parts - The income that residents earn from the rest of the world from the government - Transaction between residents and the rest of the world where one part provides something to be consumer by another party without receiving anything in

return

The primary income balance shows that Japan has a surplus meaning that Japanese residents earns more from the rest of the world than they lose. On ther other hand, Japan has a secondary income deficit. The deficit represents that Japanese citizens are losing income to the world or are giving more goods and services to other countries (2).

From the bottom right graph Japan is on a capital account deficit for the past 20 years. The deficit meamss money is flowing out of the country and suggests the Japan is increasing ownership of foreign assets (1).

Sources

1. https://www.investopedia.com/terms/b/bop.asp
2. https://www.rba.gov.au/education/resources/explainers/the-balance-of-payments.html

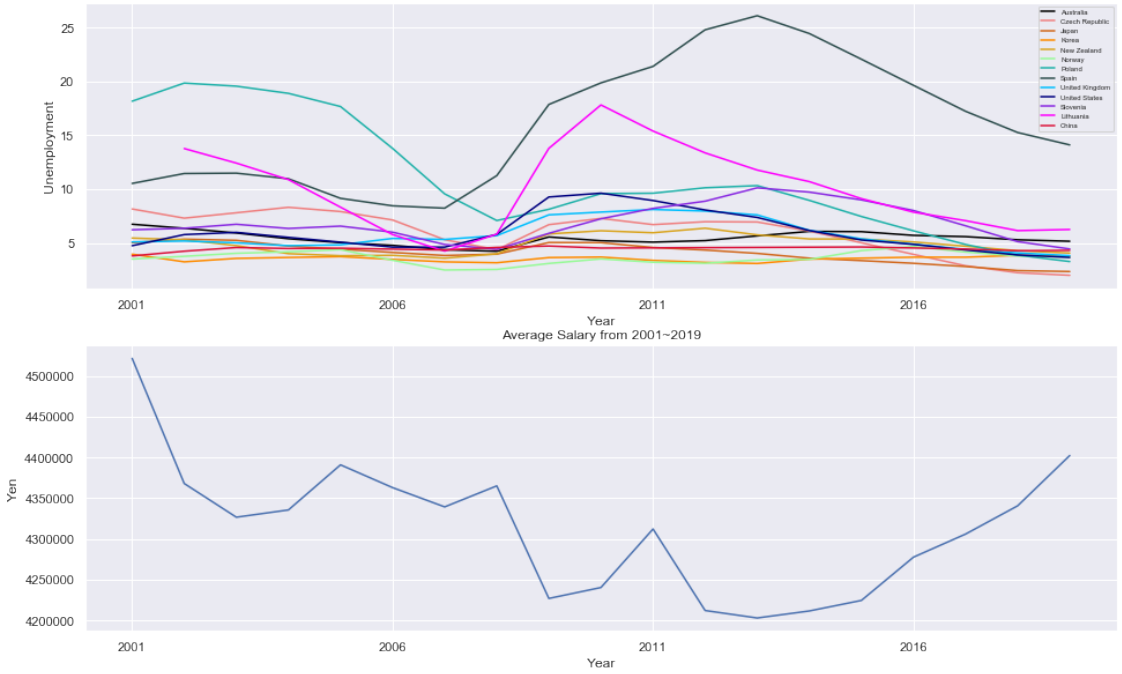
1.3.5 Unemployment Rate

[26]:
```
unemployment_interest_data = pd.read_csv('data/unemployment_&_interest_rate.
 ↪csv')
unemployment_data = unemployment_interest_data.
 ↪loc[unemployment_interest_data['Variable'] == 'Unemployment rate']
unemployment_data = unemployment_data[['Country', 'Variable', 'Time', 'Value']]
```

[27]:
```
country_data = unemployment_data['Country'].unique()
unemployment_time_series = get_dict_data(unemployment_data, country_data)

china_unemployment = ('China', np.array([
    [2001., 3.80], [2002., 4.24], [2003., 4.58], [2004., 4.49], [2005., 4.52],␣
 ↪[2006., 4.43], [2007., 4.35],
    [2008., 4.59], [2009., 4.72], [2010., 4.53], [2011., 4.55], [2012., 4.57],␣
 ↪[2013., 4.59], [2014., 4.61],
    [2015., 4.63], [2016., 4.54], [2017., 4.44], [2018., 4.28], [2019., 4.32]
]), 'crimson')

unemployment_time_series.append(china_unemployment)
```

[37]:
```
japan_salary = pd.read_csv('data/japan_salary.csv')
plt.figure(figsize=(16, 10))

plt.subplot(2, 1, 1)
plot_line_graph(unemployment_time_series)
plt.xlabel('Year')
plt.ylabel('Unemployment')

plt.subplot(2, 1, 2)
plt.plot(japan_salary['Time'].values, japan_salary['Value'].values)
plt.xticks(range(2001, 2019, 5))
```

```
plt.xlabel('Year')
plt.ylabel('Yen')
plt.title('Average Salary from 2001~2019')

plt.show()
```



The line graph on the top shows the unemployment time series graph. From the graph we can see that Japan has a very low unemployment rate for the past 20 years with unemployment rate around 4%. The line graph on the bottom show's Japan's average annual salary from 2001-2019 which has been fluctuating a lot. The peak was in 2001 and from there the average salary has been decreasing. From 2013, the salary has been increasing steadly.

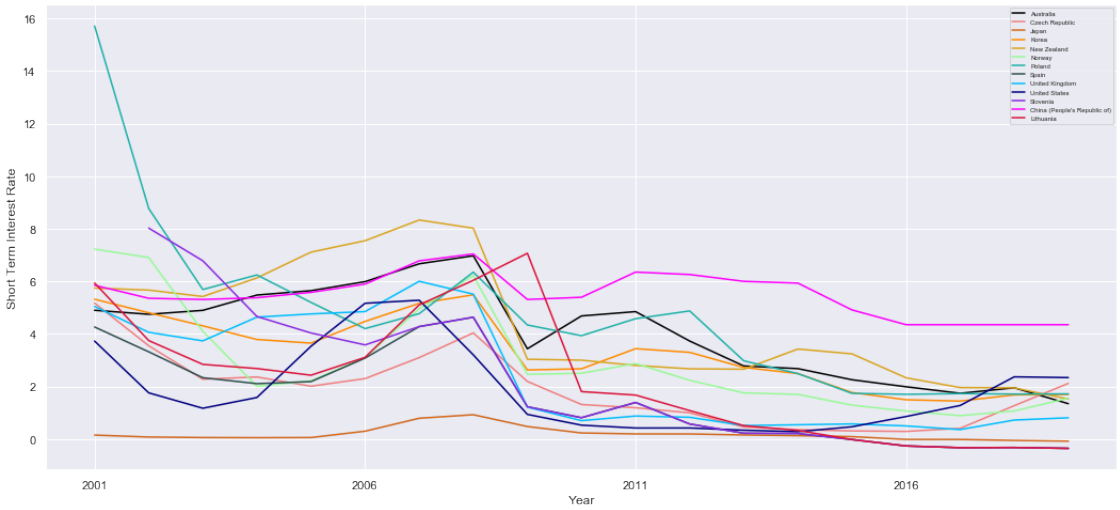
From the Phillips curve, inflation in wage and unemployment is inveresly proportional. Therefore to increase inflation Japan can try to reduce its unemployment rate which may be hard because the rate is very low.

1.3.6 Interest Rates

Short Term Interest Rate

[29]:
```
short_interest = unemployment_interest_data.
 ↪loc[unemployment_interest_data['Variable'] == 'Short-term interest rate']
short_interest = short_interest[['Country', 'Variable', 'Time', 'Value']]
country_data = short_interest['Country'].unique()

short_interest_time_series = get_dict_data(short_interest, country_data)
```

[30]:
```
plt.figure(figsize=(18, 8))
plot_line_graph(short_interest_time_series)
plt.ylabel('Short Term Interest Rate')
plt.xlabel('Year')
plt.show()
```

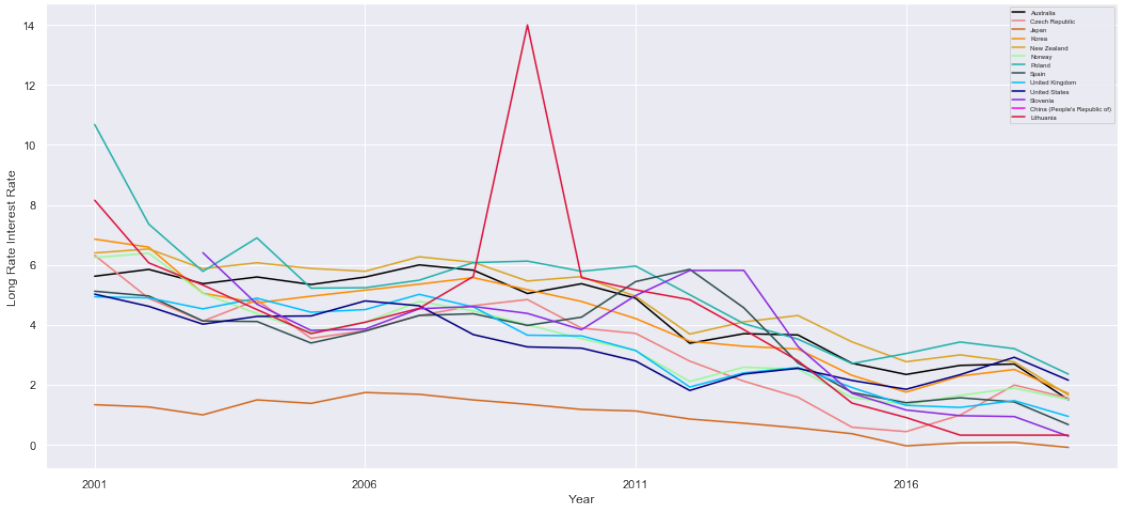


The short term interest rate are the rates at which short-term borrowings are effected between financial institutions or the rate at which short-term government paper is issued or traded in the market. Japan's low short-term interest rate represents Japan's effort to make people borrow money to make large purchases to boost the economy. However, seeing that Japan's interest rate has consistenly below 1%, we can see that Japan's effort to encourage purchases are not paying off.

Long Term Interest Rate

[31]:
```
long_interest = unemployment_interest_data.
 ↪loc[unemployment_interest_data['Variable'] ==
                                                'Long-term interest rate on␣
 ↪government bonds']
long_interest = long_interest[['Country', 'Variable', 'Time', 'Value']]

long_interest_time_series = get_dict_data(long_interest, country_data)
```

[32]:
```
plt.figure(figsize=(18, 8))
plot_line_graph(long_interest_time_series)
plt.ylabel('Long Rate Interest Rate')
plt.xlabel('Year')
plt.show()
```



Long-term interest rate (LTIR) refers to government bonds that mature in 10 years and tends to reflect investor's speculation on the country's future econonmic wellbeing. Looking at Japan's long-term interest rate, we can see that Japan's LTIR was the highest in 2006 with close to 2%; from 2006 the value has been decreasing and is currently near 0%. Although such trend may simply reflect the anxiety for Japan's economic wellbeing, from 2013 the Bank of Japan has introduced an aggresive quantitative and qualitative monetary easing which has caused the LTIR to decrease as well.

1.4 Why Can't Japan get out of a Deflation?

Although there is no single answer to the reason Japan's long deflation, from the analysis we can deduce the following possible reasons:

- Japan's increase in the population over 65, while the working force and population under 15 is decreasing.
- Japan's small growth in average annual wage.
- Japan's long term interest rate has been low for the past 20 years. This reflects people's view that they do not expect the Japanese Economgy to grow any time soon.

Around 30% of the Japanese population is above the age of 65, while the percentage of working population and population below 15 has dropped to 60% and around 12%. From the population graphs we can also see that the trend is likely to continue as well. This can cause major problems for Japan as with the growing elderly population, maintaining the pension funds becomes harder. The working force would be taxed more to sustain the large elderly population which can result in consumers cutting back on spending more. Producers may not be able to produce products at an cost-efficiently and can lead to more imports; therefore, halting Japan's economic growth backed up by exports. Furthermore, the growing elderly population would prefer deflation as many elderly live on fixed incomes or saving. Being on a deflation will increase the elderly's purchasing power.

Japan's average annual wage has has peaked around 2001 with 4.6 million yen, but after 20 years the amount has decreased to 4.4 million yen. With the annual wage decreasing, the consumer's purchasing power has decreased as prices have been relatively stable. Therefore finding a way to

increase wages that outweights the inflation rate may push inflation as consumers have more money to purchase goods and services.

Althought Japan's recent monetary policies has lowered the long-term interest rate, Japan's long-term interest rate has been very low compared to other countries from 2001 to 2019. Japan has not be able to recover from the collapse of the bubble in the late 1990s and with low GDP growth (0.3% in 2018) investor and Japanese citizens are not conviced of a growth. Economic growth is necessary for inflation. Econmic growth will lead to unemployment dropping and puts upward pressure on wages which leads to inflation.