Dynamics of Gross Domestic Product and Population

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Background

What is Gross Domestic Product?

- Gross Domestic Product (GDP), or value added, is the value of the goods and services produced by the nation's economy less the value of the goods and services used up in production

What is Value?

- The value of goods is determined by the interaction of two entities based on the scarcity of a resource and the willingness of the entity to obtain it
- Value is subjective in nature and difficult to measure

Why is it Important?

- It's important because government agencies and businesses alike make decisions based on the strengths and weaknesses of our economy.
- Stock market trade can be based on GDP, and each can play off the other

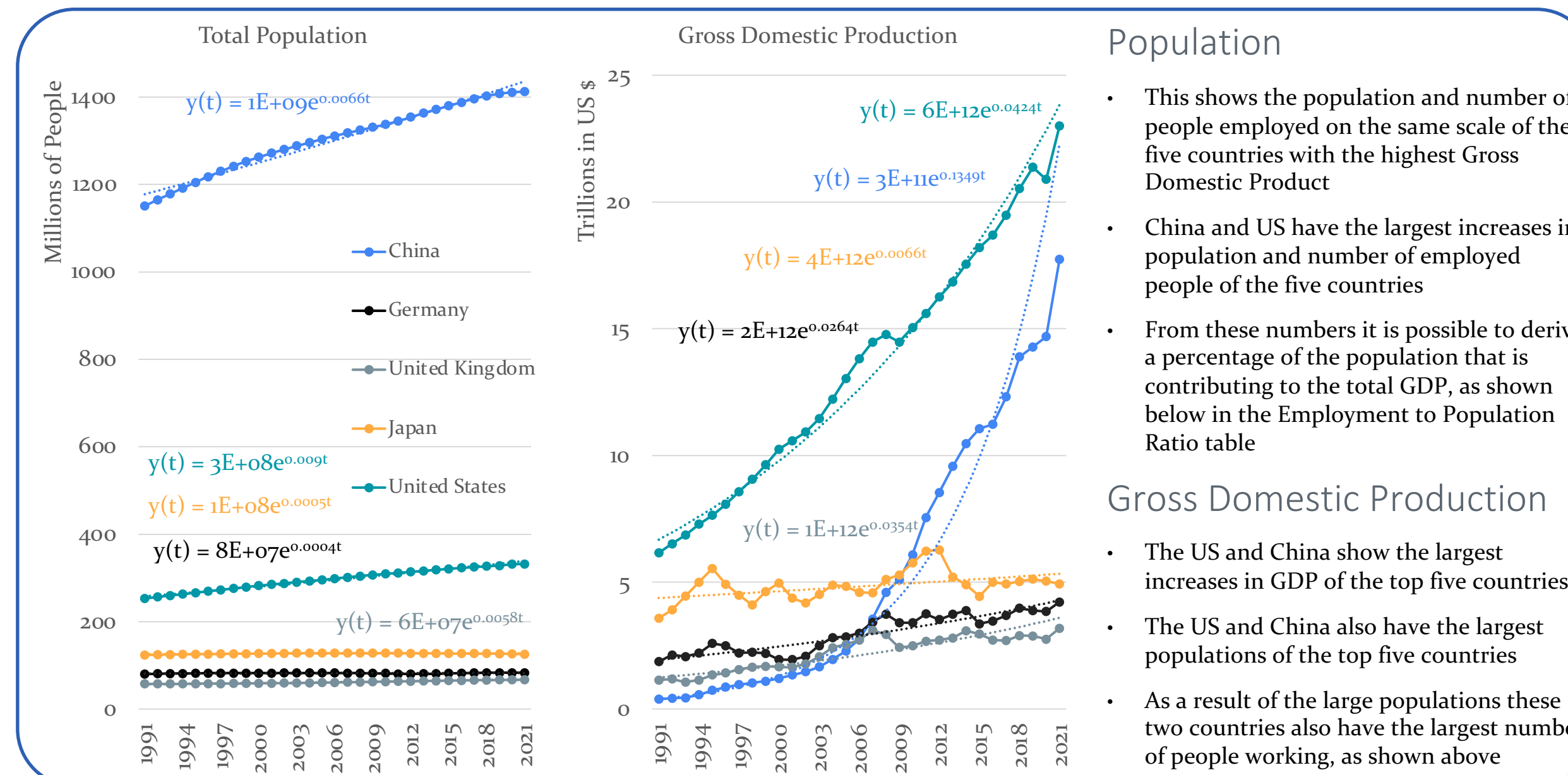## Introduction and Objectives

Population vs Total GDP

- GDP is used as a major economic indicator
- Government policy can be shaped by these indicators
- Show population increases can affect increases in GDP; Since US population has been steadily increasing so has its GDP
- Show growth rates of population alongside growth rates of GDP
- Did the recession in 2008 and during the pandemic have any affect on GDP?
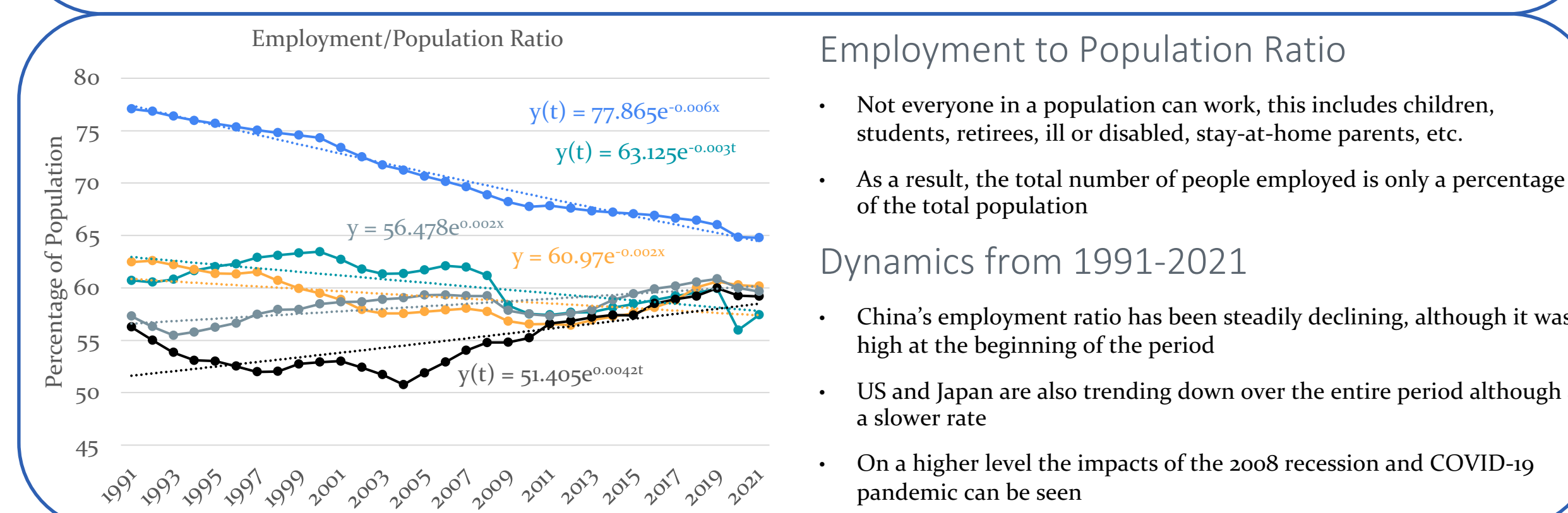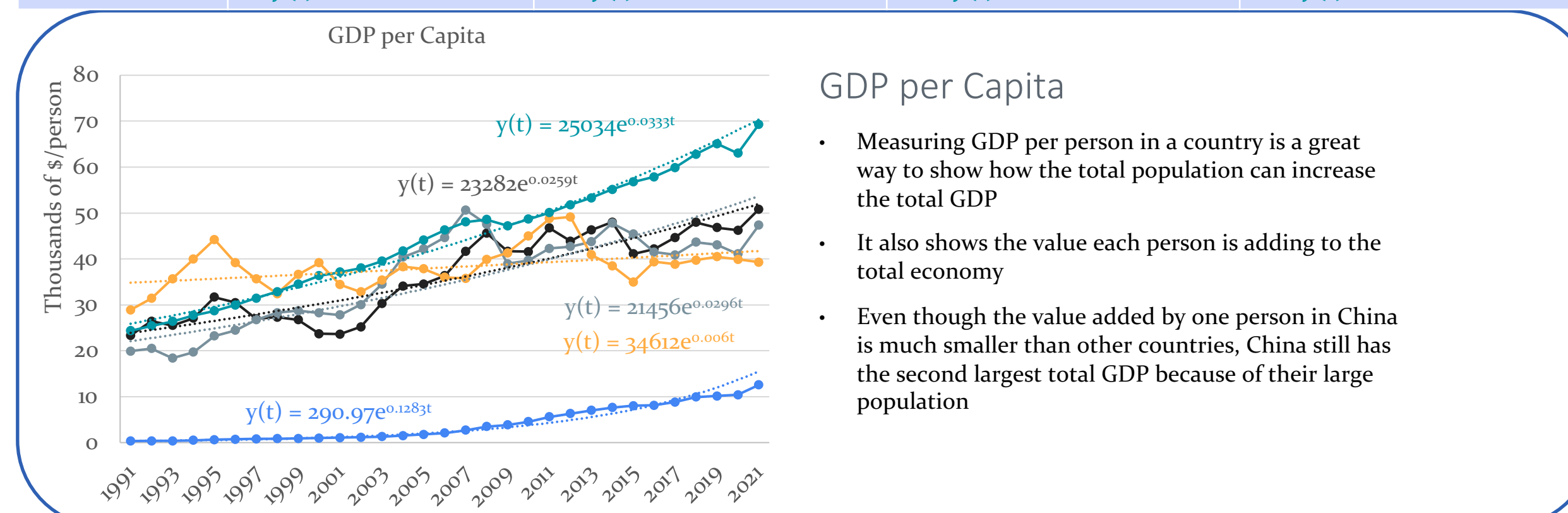
Research Questions

1. What is the dynamic between GDP, population and employment ratio?
2. How do growth rates of GDP and population relate?
3. How did the 2008 recession and the COVID-19 Pandemic impact GDP and employment rates?

Data

- Data was collected from worldbank.org
- Analysis done in Excel spreadsheets

Total Population

$y(t) = 1E+09e^{0.0066t}$
$y(t) = 3E+08e^{0.009t}$
$y(t) = 1E+08e^{0.0005t}$
$y(t) = 8E+07e^{0.0004t}$
$y(t) = 6E+07e^{0.0058t}$

China, Germany, United Kingdom, Japan, United States

Gross Domestic Production

$y(t) = 6E+12e^{0.0424t}$
$y(t) = 3E+11e^{0.1349t}$
$y(t) = 4E+12e^{0.0066t}$
$y(t) = 2E+12e^{0.0264t}$
$y(t) = 1E+12e^{0.0354t}$

Population

- This shows the population and number of people employed on the same scale of the five countries with the highest Gross Domestic Product
- China and US have the largest increases in population and number of employed people of the five countries
- From these numbers it is possible to derive a percentage of the population that is contributing to the total GDP, as shown below in the Employment to Population Ratio table

Gross Domestic Production

- The US and China show the largest increases in GDP of the top five countries
- The US and China also have the largest populations of the top five countries
- As a result of the large populations these two countries also have the largest number of people working, as shown above

	Growth Rates for Pop.	Growth Rates for GDP	Growth Rates for GDP/Cap.	Growth Rates for Emp./Pop.
China	$y(t) = 1*10^9 e^{0.0066t}$	$y(t) = 3*10^{11} e^{0.1349t}$	$y(t) = 290.97 e^{0.1283t}$	$y(t) = 77.865 e^{-0.006t}$
Germany	$y(t) = 8*10^7 e^{0.0004t}$	$y(t) = 2*10^{12} e^{0.0264t}$	$y(t) = 23282 e^{0.0259t}$	$y(t) = 51.405 e^{0.0042t}$
United Kingdom	$y(t) = 6*10^7 e^{0.0058t}$	$y(t) = 1*10^{12} e^{0.00354t}$	$y(t) = 21456 e^{0.0296t}$	$y(t) = 56.478 e^{0.002t}$
Japan	$y(t) = 1*10^8 e^{0.0005t}$	$y(t) = 4*10^{12} e^{0.0066t}$	$y(t) = 34612 e^{0.006t}$	$y(t) = 60.97 e^{-0.002t}$
United States	$y(t) = 3*10^8 e^{0.009t}$	$y(t) = 6*10^{12} e^{0.0424t}$	$y(t) = 25034 e^{0.0333t}$	$y(t) = 63.215 e^{-0.003t}$

GDP per Capita

$y(t) = 25034e^{0.0333t}$
$y(t) = 23282e^{0.0259t}$
$y(t) = 21456e^{0.0296t}$
$y(t) = 34612e^{0.006t}$
$y(t) = 290.97e^{0.1283t}$

GDP per Capita

- Measuring GDP per person in a country is a great way to show how the total population can increase the total GDP
- It also shows the value each person is adding to the total economy
- Even though the value added by one person in China is much smaller than other countries, China still has the second largest total GDP because of their large population

Employment/Population Ratio

$y(t) = 77.865e^{-0.006x}$
$y(t) = 63.125e^{-0.003t}$
$y = 56.478e^{0.002x}$
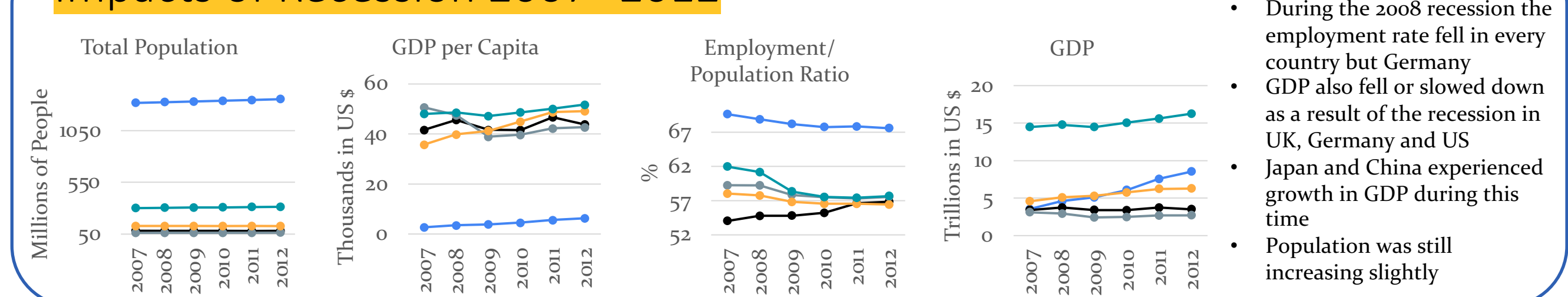$y = 60.97e^{-0.002x}$
$y(t) = 51.405e^{0.0042t}$

Employment to Population Ratio

- Not everyone in a population can work, this includes children, students, retirees, ill or disabled, stay-at-home parents, etc.
- As a result, the total number of people employed is only a percentage of the total population
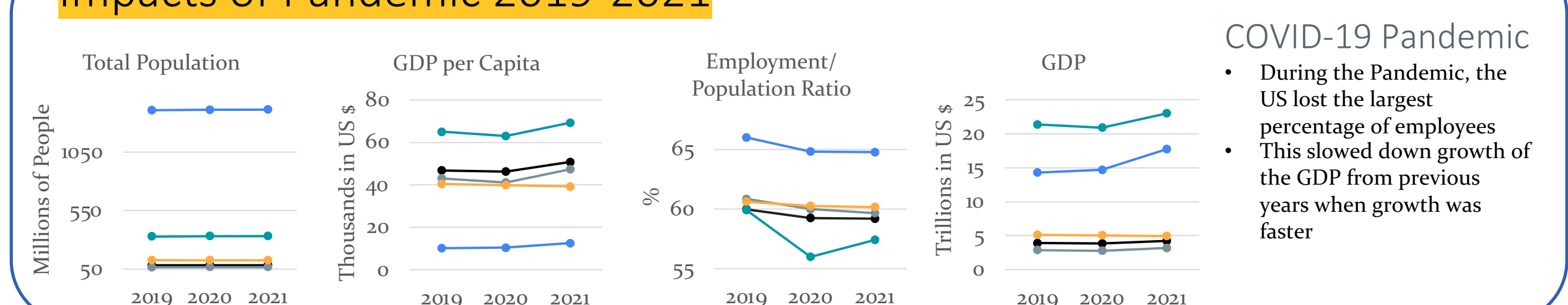
Dynamics from 1991-2021

- China's employment ratio has been steadily declining, although it was high at the beginning of the period
- US and Japan are also trending down over the entire period although at a slower rate
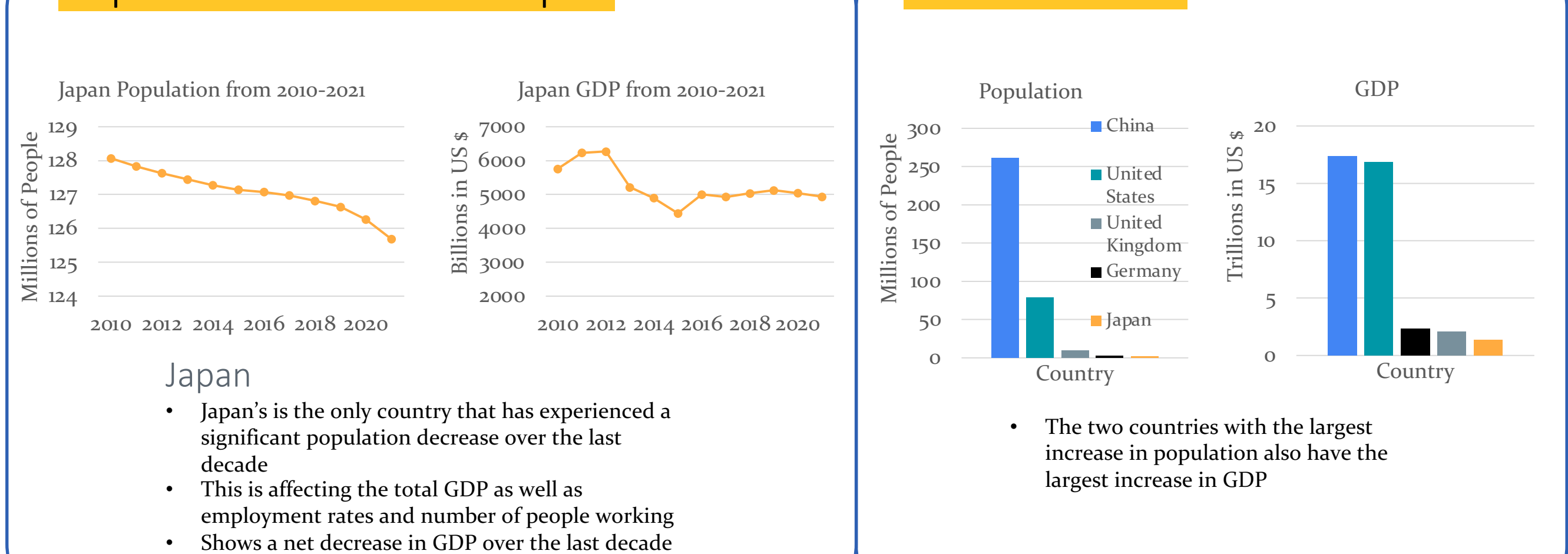- On a higher level the impacts of the 2008 recession and COVID-19 pandemic can be seen
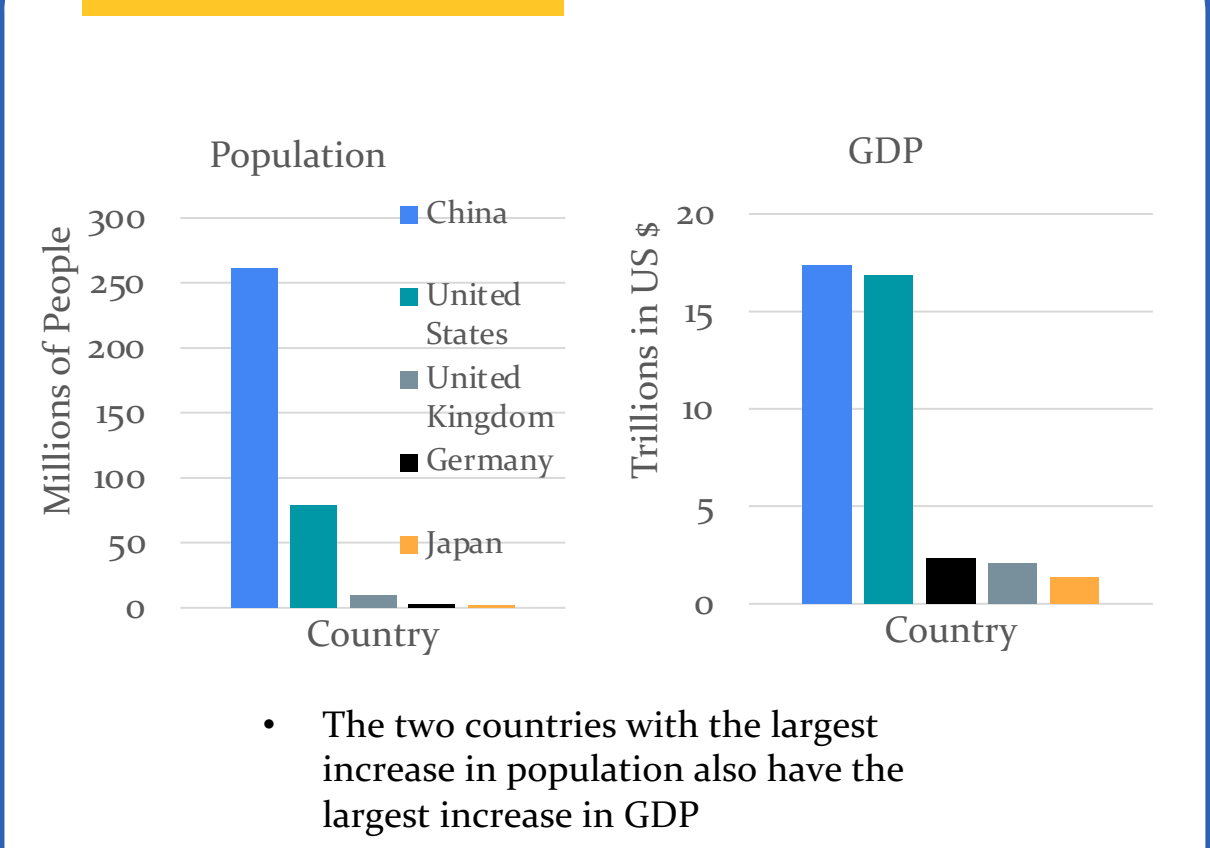
Impacts of Recession 2007- 2012

Total Population

GDP per Capita

Employment/ Population Ratio

GDP

2007-2012 Recession

- During the 2008 recession the employment rate fell in every country but Germany
- GDP also fell or slowed down as a result of the recession in UK, Germany and US
- Japan and China experienced growth in GDP during this time
- Population was still increasing slightly

Impacts of Pandemic 2019-2021

Total Population

GDP per Capita

Employment/ Population Ratio

GDP

COVID-19 Pandemic

- During the Pandemic, the US lost the largest percentage of employees
- This slowed down growth of the GDP from previous years when growth was faster

Population Decline in Japan

Japan Population from 2010-2021

Japan GDP from 2010-2021

Japan

- Japan's is the only country that has experienced a significant population decrease over the last decade
- This is affecting the total GDP as well as employment rates and number of people working
- Shows a net decrease in GDP over the last decade

Total Increase

Population

China, United States, United Kingdom, Germany, Japan

GDP

- The two countries with the largest increase in population also have the largest increase in GDP

Conclusions

- Employment rates seem to have a larger impact on the economy
- If population is growing it can indirectly increase the total workforce of a country, even if employment ratio is decreasing
- Japan's population is decreasing, decreasing the workforce and slowing down growth of GDP
- The recession and pandemic certainly decreased the percentage of people working but did not slow down growth of the population
- The economy is a complex system with influences coming from many different areas

References & Acknowledgements

Baffes, J., Yonzan, N., Ansar, S., & Atamanov, A. (2022, November 8). World Bank Open Data. Data. Retrieved November 13, 2022, from https://data.worldbank.org/