The impact of Lockdown Stringency during Covid-19 crisis 2020

A comparative study of GDP and unemployment in OECD-countries

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Abstract

This paper examines the impact of lockdown stringency on the cross-country variations in real GDP growth and unemployment in OECD countries following the recession caused by the covid-19 pandemic. The GDP is estimated with the Fixed Effects Model and unemployment is estimated with the Random Effects Model. The results show that Lockdown Stringency has indeed affected both the real GDP growth and the unemployment negatively. The study is done very closely to the economic crisis, and the results are therefore naturally in the short run. It is probable that the effects of the economic crisis in the long run will be very different than in the short run.

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Background

The covid-19 pandemic has thus far led to over 140 million confirmed cases worldwide and the implications for people's health, life-quality and the world economy have been serious. The crisis has cast a light on the inequalities and social issues in our societies. Because of the restrictions and lockdowns imposed by governments, the opportunities to move, meet or consume have become much limited which has had a tremendous impact on the social connectedness in the society, people's trust in institutions, their jobs, and incomes (OECD, 2020). Moreover, the global economy has suffered enormously. Because of cancelled business trips and holidays, the airlines cut their flights and the travel industry got badly damaged. Both the service and retail sector plummeted with millions of jobs lost and many companies going bankrupt, as people stayed at home (IMF, 2021). Stock markets saw huge falls with rising Covid-19 cases worldwide, as shown below. This can have a negative impact on the value of pensions and individual saving accounts (Bloomberg, 2021).
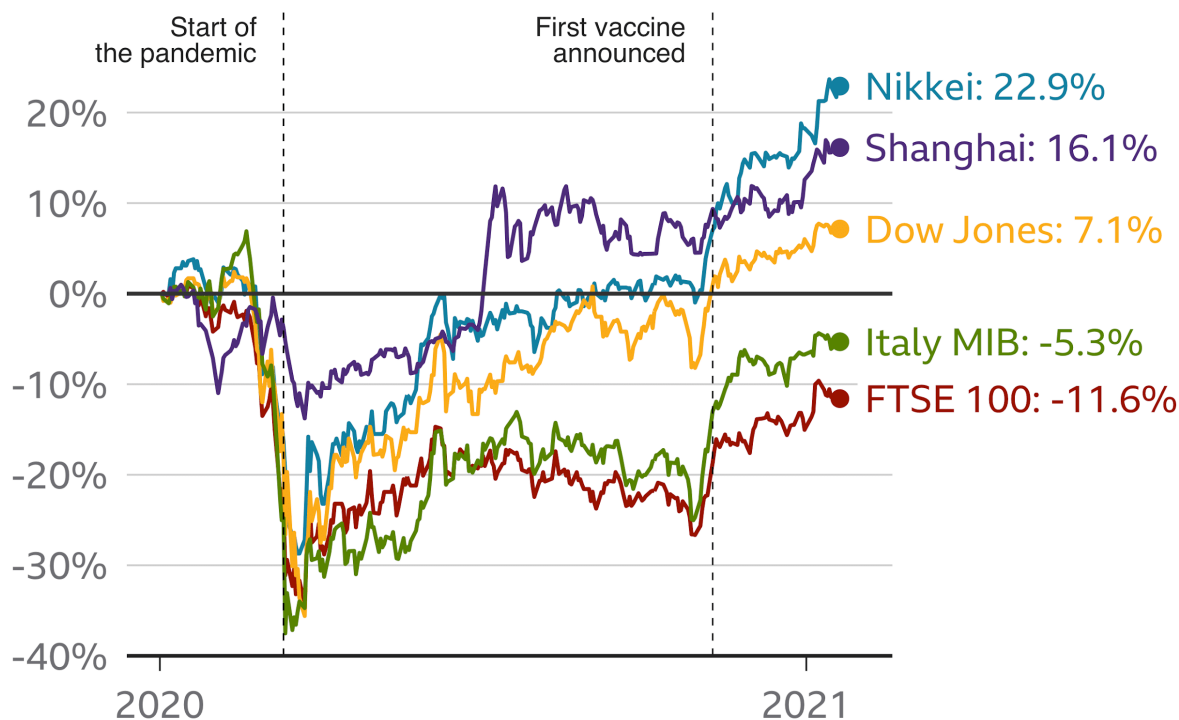

Figure 1. Source: Bloomberg, 24 January 2021, 00:01 GMT (BBC News)

Countries worldwide have been struggling with rising unemployment. To minimize the damage, governments took different measures to save jobs by putting millions of workers on

government-supported job retention schemes. Despite huge amounts of financial support to businesses, over 140 million people have lost their jobs during 2020 and the number of new job openings are still very low in many countries (IMF, 2021).

Yearly unemployment rate change, 2019 and 2020 compared

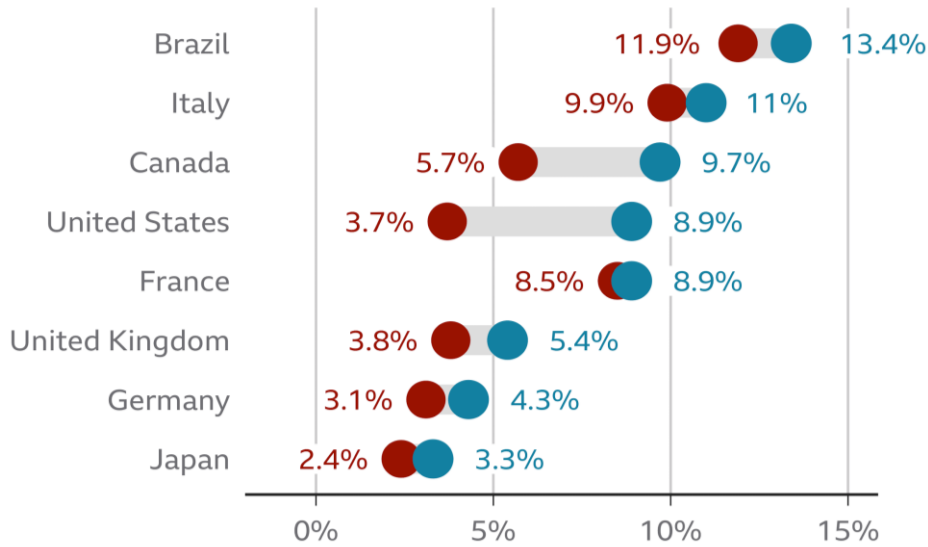|	2019	2020
Brazil	11.9%	13.4%
Italy	9.9%	11%
Canada	5.7%	9.7%
United States	3.7%	8.9%
France	8.5%	8.9%
United Kingdom	3.8%	5.4%
Germany	3.1%	4.3%
Japan	2.4%	3.3%

Figure 2. Source: IMF (BBC News)

The majority of countries fell into recession due to the pandemic. According to the IMF (2021), the global economy shrank by 4.4 % during 2020. This is the worst decline in real GDP since the Great Depression of the 1930s.

Real GDP growth

No data
-70% - -15%
-15% - -5%
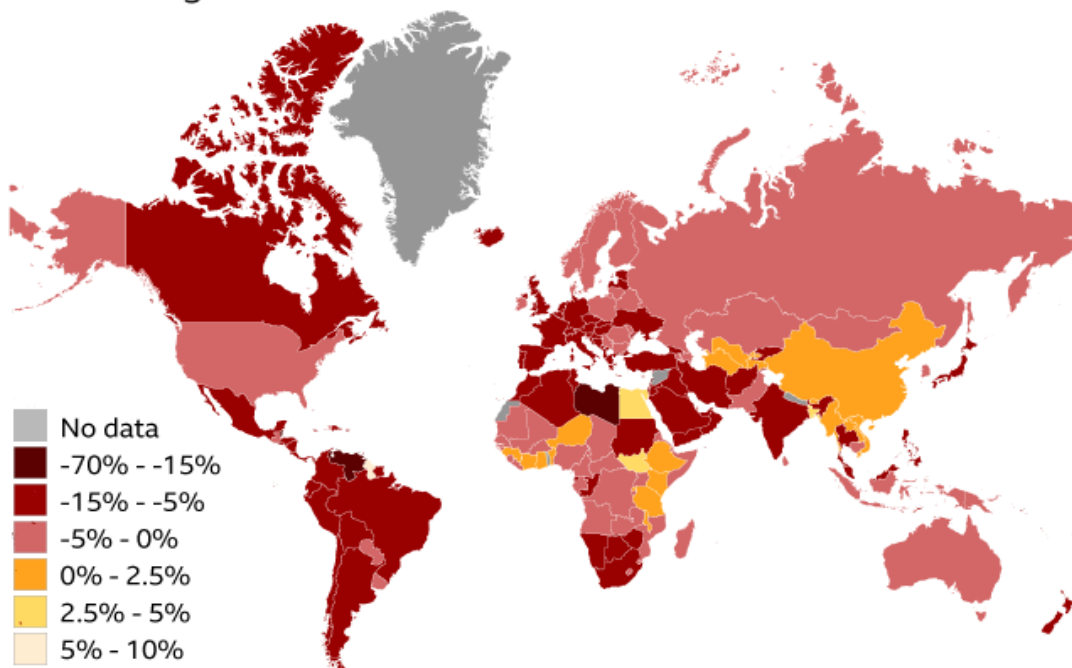-5% - 0%
0% - 2.5%
2.5% - 5%
5% - 10%

Figure 3. Source: IMF (BBC News)

Governments acted swiftly to prevent the spread of the coronavirus, but societies worldwide have had different resilience to meet the economic and social consequences of the policy responses (OECD, 2020). Resilience is defined by OECD (2020) as the capacity of a system to manage changes and continue to evolve. It is the ability to face shocks and disturbances, such as financial and economic crises, with as little damage as possible and reverse them to opportunities, to renewal and innovative thinking. Most countries experienced a fall in GDP, and rising unemployment during 2020, but to a substantially different extent. The current economic crisis differs from the previous ones. Generally, when times get worse and people have less money to move with, the demand for goods and services decreases. During the corona pandemic, the reason is different: people must keep their distance and thus do not have the opportunity to move, meet or consume as much as before. Then the demand falls and the market must adapt by reducing its production. As a result, the gross domestic product (GDP) also falls and the unemployment rises (UNCTAD, 2020). This distinction is important to understand, because traditional monetary and fiscal policy would not be able to stimulate the economy in the case of Covid-19-crisis, at least in the short-run. Consumption and investments would drop anyway because of the restrictions imposed by governments and changed behaviours in society.

Lockdown stringency index, used in this study, is defined and calculated by the Oxford Coronavirus Government Response Tracker project (Hale et al, 2021). The nine metrics used in the index are: school closures; workplace closures; cancellation of public events; restrictions on public gatherings; closures of public transport; stay-at-home requirements; public information campaigns; restrictions on internal movements; and international travel controls (see Appendix).

An important consideration is, however, that lockdown stringency has varied significantly both between countries and between different time periods during 2020. Different industries have been affected differently, some more than others. E-trading has been beneficial at the expense of traditional trade. It is therefore relevant to analyze the short-term effects of the lockdown on GDP and unemployment during the pandemic year. The study is limited to 2020, to exclude the potential effects of vaccinations that started from the beginning of 2021.

The research question is as follows:
Which implications has lockdown stringency had for the real GDP growth and the unemployment during 2020?

Crisis of 2008-2009: a comparison

GDP plummeted in connection with the financial crisis of 2008–2009, both in Sweden and in other countries. At this time, the financial markets were so integrated that what began as an American crisis quickly spread to the rest of the world (Blundell-Wignall, 2008). There are similarities with the corona crisis, as it meant a near stop to the economy, even though this time it had been an even faster process. In Sweden, the economy recovered faster than in most other countries. An important reason was that Sweden had much stronger public finances than, for example, Italy and Greece (Yeyati & Filippini, 2021). In 2008-2009, during the financial crisis, it was primarily industry that was hit hard, especially industries with large exports. The domestic economy and the service sector performed relatively well. Sharp interest rate cuts and fiscal stimulus meant that household disposable income did not fall as much despite rising unemployment. This could keep the consumption up (Blundell-Wignall, 2008).

There were large declines for both exports and imports as well as investments. However, neither household finances nor public consumption were affected to the same extent (Blundell-Wignall, 2008). The corona crisis is affecting the production of both goods and services, but especially service industries such as the trade sector, hotels and restaurants, and the transport sector. It is noteworthy that the trade has had quite good growth in recent years, while the same pattern has not been observed in the hotel, restaurant, and transport sector (Yeyati & Filippini, 2021). An important difference between the financial crisis and the covid-19 pandemic is that the financial crisis began in the financial markets and from there spread to the real economy (Blundell-Wignall, 2008). In the current crisis, the real economy has been directly affected in the form of supply and demand disruptions.

Theoretical framework

In this section the concept of GDP, unemployment and economic crisis are discussed from a theoretical point of view, to give a broad understanding of factors impacting them.

GDP

Gross domestic product (GDP) is a measurement of all the final goods and services produced in a country over a certain period of time and can be calculated using either expenditures, production or incomes. Adjusted for inflation it is called real GDP, while adjusted for

population we are dealing with GDP per capita. These adjustments are important in economic research and can provide deeper insights. GDP has of course its limitations because it tells nothing about how the production is distributed in the society, however it is still an important tool that guides policy-makers, investors and businesses in their strategic decision-making. According to Gottfries (2013), the equation for GDP is:

GDP= Consumption (C) + Investment (I) + Government Spending (G) + Net exports (NX)

Consumption (C) encompasses the market value of all goods and services purchased by households. Generally household consumption is more stable over time compared to investment purchases made by firms, but because household consumption is the main part of the GDP (about 60 %), even small fluctuations can have implications for the overall economy. Investments in its turn can be defined as gross fixed capital formation and include several factors such as construction of roads, different kinds of buildings, purchase of machinery and equipment. Business cycles are highly affected by the fluctuations in investments. During recessions, investments usually decline sharply. Government spendings include all kinds of government consumptions and investments, however military expenditures that are part of government capital formation, are excluded. Finally, net export is the difference between a country's export and import. Exports are goods and services that are provided to other countries and import is all goods and services that are purchased from other countries (Gottfries, 2013).

Real GDP is adjusted for inflation which means that the value of real GDP describes the quantity of goods and services produced in a given year. The prices are held constant over time in order to ensure that inflation or deflation is not affecting the trend in GDP. The real GDP growth rate reflects in its turn the change in the economic output over time. It is usually presented on an annual basis, but even quarterly and monthly data can be used in economic research. During recessions, real GDP growth rate usually shrinks (Gottfries, 2013).

Unemployment

The main four unemployment types are frictional, structural, classical, and cyclical unemployment (George & Borjas, 2019). Frictional unemployment is when people who have left their previous employer, have not yet found a new place to work. Structural unemployment refers to the case when something in the economy creates a rift between job seekers skills and the skills needed by the employers. This can, for example, include when

companies require more highly educated workers and the population's education level is lower than the job market requires. Classical unemployment occurs when wages are kept too high compared to the market equilibrium. Lastly, cyclical unemployment is caused by cyclical changes in the economy, in other words the unemployment caused by the economic cycle being in recession. In theory, this rise in unemployment should go down when the economic cycle turns towards recovery, but this is not always the case. Unemployment has a tendency to stay at higher levels than before an economic crisis even in times of economic booms. This phenomenon is called hysteresis. (Blanchard et al, 1986).

A deteriorating economic situation in the market is associated with rising unemployment, while an improved economic situation is said to lead to declining unemployment. The negative connection between unemployment and GDP growth was first described by Artur Okun and is known as Okun's law. It is the value of the Okun's coefficient that shows how much unemployment decreases when GDP growth rate increases. Okun (1962) found that a 1 percent increase in GDP growth was associated with a 3 % decrease in unemployment. However, Okun's law is just an approximation and when other factors, such as hours worked or capacity utilization, are considered the above mentioned relationship becomes much smaller. In a later research, the estimation has shown that 1 point increase in GDP growth leads to a decreased unemployment only by about 0.6 % (Prachowny, 1993).

Many people lost their jobs during 2020, but the explanation may be more complex than just dropped GDP growth. It is highly relevant to analyze the effect of lockdown stringency on unemployment, given that real GDP growth is controlled in the model.

Economic Crisis

Economic disruptions are often a consequence of the financial crisis. There are several types of such. Claessens & Kose (2013) summarize the most common ones as currency crises, sudden stop crisis, foreign debt crisis, domestic public debt crisis and systemic banking crisis. It is important to note that these classifications are not mutually exclusive. Real world crisis often overlap several of these classifications. It is also integral to make a distinction between financial and economic crisis. Although they both refer to economic challenges and imbalances, the causes and the impact on the economy as a whole can be different.

Financial crisis generally start in the banking sector and other financial institutions, and are often caused by financial bubbles, stock market crashes or sovereign default. These disturbances can be limited to financial institutions but they often affect the entire economy. An economic crisis is instead characterized by declining GDP and consumer spending, high interest rates and rising unemployment directly (Claessens & Kose, 2013). The implication of financial crisis is in many cases an economic crisis; however, the economic crisis following the covid-19 pandemic did not start as a financial crisis. The closest financial crisis classification would be a sudden stop crisis, i.e. a crisis where, especially international, capital flow is suddenly stopped. This is definitely the case for this crisis, but it primarily stopped the trading of goods rather than financial capital. During parts of 2020, more than half of the world's population were in lockdown, leading to a huge economic disruption of everyday life (IMF, 2020). This was a never before seen occurrence and naturally affected all parts of the economy, leading to an enormously complex crisis from a policy standpoint.

To counteract the negative effects of an economic crisis, Keynesian theory states that the government should raise government spending, to dampen the depth of the crisis (Keynes, 1936). This Keynesian approach is relatively widespread among countries today, albeit often in combination with central banks lowering interest rates to drive consumption back up. The aforementioned approach was part of the recipe recommended to nations by the International Monetary Fund in April of 2020 (IMF, 2020). There are several macroeconomic factors that, in theory, either could help the country's economic response to the crisis, or be a risk factor regarding the countries' ability to respond properly. Both the International Monetary Fund and the European Central Bank advocate borrowing funds for investment, to help the economy get back on track- the ECB even implemented a €750 billion programme, the Pandemic Emergency Purchase Programme (IMF, 2020) (ECB, 2020). This approach has also been taken by virtually every country.

Previous research

The research on the economic crisis caused by the covid-19 pandemic is, understandably due to the crisis still going on, not very broad. Some preliminary studies have been released. Goolsbee et al., (2021) has reported findings pointing towards that the vast majority of the drop in economic activity comes from individual's decisions rather than strict government restrictions such as lockdowns. Milne (2020) also argues that a swift fiscal response was

necessary, but that the cost of that bill would be 2% of GDP, or less. This is especially interesting, since many countries, i.e. the US, have spent significantly more than that.

There is, however, research regarding the economic effects of the 1918 influenza pandemic. It is important to note that the conclusions to be drawn from these studies are limited, given the vast changes the economic system has seen since. Moreover, the magnitude of the Influenza Pandemic 1918 was much greater with a mortality rate of 2.1 percent of the world population, which is substantially higher than the mortality rate of covid-19. Following the influenza pandemic, GDP declined by 6% and private consumption by 8%. Other consequences were short-term disturbances on stock markets and on government bonds (Barro et al, 2020).

There are several factors that according to previous research can potentially affect both the GDP and the unemployment either positively or negatively. As previously mentioned, government expenditure is one of the key variables that explain GDP and a sharp increase of government spendings can mitigate the negative effects that other factors can have on the GDP growth (Dudzevičiūtė et al, 2018). A lower government debt before the crisis could be an indication of a country faring the crisis comparatively well, as a lower debt might lead to a higher possibility of acquiring loans with a lower interest rate, and a higher tendency to acquire new loans, compared to countries with already high levels of debt (Pegkas, 2018).

Similarly, studies have found a negative correlation between high inequality in the distribution of wealth, and economic growth (Alesina et al., 1994). This has been the finding in newer research as well, which has suggested a negative correlation between income inequality and growth in GDP (Cingano, 2014). Therefore, it is possible that countries with a lower Gini coefficient, a measurement of income inequality within a country, could get through the crisis easier. Another possible risk factor for a country's economy is how export dependent it is (Ramzan et al, 2019). With large parts of the world closing their borders and restricting movement during 2020, trade suffered as well. A country's reliance on trade can be captured by the macroeconomic variable trade openness, which equals a country's imports and exports divided by the country's GDP (Our World in Data, 2021). Countries with a higher trade openness could therefore fare worse than countries with a low ditto.

Further, labour market structure could also be a potential risk factor. Due to the previously discussed unique nature of the corona crisis, many countries have been forced into

lockdowns, or at least restrictions of movement, events, and social gatherings. This naturally led to a decline in the service sector industry, which could imply that countries with a higher percentage of service jobs in the labour market structure are affected harder than similar countries with a different structure (Yeyati & Filippini, 2021). Regarding unemployment, a recent study confirms the general validity of Okun's law by showing the differences in Okun's coefficient between developed and developing countries and furthermore, it gives evidence on the impact of financial crisis on the unemployment in developed economies (Bartolucci et al, 2018).

COVID-19-Policy Tracker

The International Monetary Fund, IMF, (2021) has compiled a Policy Tracker, meant to summarize different countries policy responses to the economic crisis following the covid-19 pandemic. Among the OECD countries, there are many similarities in their fiscal policy response. Virtually all countries implemented some kind of short time work allowance or short time furlough to dampen the massive amount of layoffs following the crisis. This response was especially prevalent in Europe and the European Union.

Furthermore, both the United States and the European Union approved massive rescue packages containing 1.9 trillion dollars and 750 billion euro respectively. The money was allocated somewhat differently, with the American rescue plan among other things sending 1400 dollar checks to a large part of the population, while the European plan focused on sustainable reforms and investments for the member countries. In both cases, a large part of the money was borrowed. Many larger OECD countries, such as Germany, Italy and France, spent part of their national rescue packages in the beginning of the pandemic, on increasing hospital capacity and healthcare equipment. In the later stages, virtually all OECD countries allocated money to benefits for SMEs, and to guarantee liquidity in otherwise healthy companies. Although The United States did this as well, their economic response stands out from others, primarily due to the aforementioned stimulus checks the government sent out to large parts of the American public (IMF, 2021).

There were also some discrepancies in the countries' response regarding health policy. A vast majority of OECD countries spent part of 2020 in some kind of lockdown, quarantine or curfew. This was especially true for island countries such as Australia, New Zealand and Japan. These countries also implemented stricter or longer entry bans on foreigners than most

other countries and all three, especially New Zealand, have relatively low death tolls. Some OECD countries, such as Sweden and Iceland, opted out of the lockdown response and instead chose to focus on voluntary measures. Other countries, the most prominent being New Zealand, chose to localize its lockdowns instead of locking down the entire country (IMF, 2021).

Method

Panel data regression analysis is the most appropriate method for examining if and to what extent Lockdown Stringency has affected the real GDP growth and the unemployment in the course of 2020. Panel data can be defined as a combination of cross-sectional data and time series data, by studying the same objects recurrently over time. This combination gives less collinearity, more degrees of freedom and more efficiency. Thus, panel data is particularly well suited for studying change dynamics (Angrist & Pischke, 2015). This particular study is carried out on the basis of quarterly data, which means that each country included in the study is observed at four different time points during the year.

There are several different methods for performing panel data analyzes; pooled OLS model, fixed effects least squares dummy variable (LSDV) model, fixed effects within-group model and random effects model (REM). In the pooled Ordinary Least Squares (OLS) regression, multiple observations are included to estimate coefficients in a linear regression model so that the sum of all squared error terms is minimized. Robust standard errors are used to generate consistent estimates despite potential heteroscedasticity. Fixed effect model and random effect model, unlike pooled OLS model, take into account individual characteristics of each unit, while pooled OLS model places them in the error term. Such a placement can result in the error term being correlated with the independent variables and thus estimate skewed and inconsistent coefficients.

Common to FEM and REM is also that time-specific effects are assumed to exist, which is highly relevant in this study because both our study variables and Lockdown Stringency vary a lot during 2020. The differences between these two models are, however, that with the Fixed Effects Model, country- and time specific effects are assumed to be correlated with the explanatory variables in the regression model and it is controlled by keeping them constant when explanatory variables vary. On the other side, when using the Random Effects Model, the country-specific effects are assumed to be random and thus uncorrelated with the

explanatory variables. The country-specific effects are thus not controlled but are included in the model's error term. Robust standard errors are used to correct for potential heteroscedasticity.

Equation 1. Random Effects Model

$$y_{it} = \beta_0 + \beta_1 x_{it1} + \gamma controls_{it} + \varepsilon_{it}; \varepsilon_{it} = \alpha_{it} + \mu_{it}$$

Equation 2. Fixed Effects Model

$$y_{it} = \beta_0 + \alpha_{it} + \beta_1 x_{it1} + \gamma controls_{it} + \mu_{it}$$

y_{it} = dependent variable for individual **i** at time point **t**

β_0 = intercept

β_1 = coefficient for independent variables

x_{it} = explanatory variable for individual **i** at time point **t**

γ = coefficient for control variables

ε_{it} = error term

α_{it} = country – specific effect for country **i**

μ_{it} = unobserved part of the error term

There are, as previously mentioned, two forms of fixed effects model, namely fixed effects least squares dummy variable (LSDV) model and fixed effects within-group model. The difference between these two methods is that the fixed effects least squares dummy variable (LSDV) model uses dummy variables to give each unit an intercept, while fixed effects the within-group model expresses each variable as a deviation from its mean value for each unit and then makes an OLS regression on the mean – value-corrected values. In the presence of many units in the fixed effects least squares dummy variable (LSDV) model, a high number of degrees of freedom is lost and the risk of multicollinearity increases, resulting in the estimated coefficients becoming unreliable. Fixed effects within-group model is instead sensitive to variables that are constant over time, and within-group estimators can also eliminate long-term effects by distorting the parameter values. However, to avoid possible problems with multicollinearity, the fixed effects within-group model is preferred as an estimation method.

With endogeneity in a dataset, the explanatory variable correlates with the error term. This fact can be used to distinguish which type of model is most suitable through a Hausman test. The null hypothesis in such a test is that the dataset is not characterized by endogeneity, which means that the Random Effects Model should be used. If the null hypothesis can be rejected, however, the Fixed Effects Model should be used. In other words, if the test proves to be significant, it is assumed that a fixed effect model is more effective than a random effect model.

Significance assessment

The intercept of a regression line shows the location where it intersects the Y-axis, i.e. the value of GDP when all independent variables are 0. The slope of the line in its turn shows the steepness of the line, i.e. the average rate of change between our variables. When Lockdown stringency index increases by 1, GDP will decrease or increase by β_1 when all other predictors are held constant. The same is true for unemployment. To estimate the strength of the relationship between the dependent and independent variables, a coefficient of determination, also called R^2, can be used. This value goes from 0 to 1. If R^2 is 0 then there is no relationship and if R^2 is 1 then there is a perfect relationship, which means that the variation in the independent variables can explain the whole variation in the dependent variable (Angrist & Pischke, 2015).

A key question is whether the relationship between these variables is statistically significant. This actually falls within the scope of hypothesis testing. In this context, the null hypothesis is that there is no relationship between independent and dependent variables. The null hypothesis is tested with a t-test. High absolute t-values indicate that the null hypothesis should be rejected. A generally accepted significance level is 5 %. If the P-value of the t-statistics is < 0.05 the null hypothesis can be rejected and it can be assumed that there is a relationship between our dependent and independent variables. However, assuming that there is a relationship does not necessarily mean that the relationship is causal. There can be a covariation without causality, meaning that there can be other underlying variables that affect both the independent and dependent variables.

Correlation analysis

A correlation includes two variables and both variables are treated equally, which means that neither of the variables is considered a predictor or an outcome measure. The correlation ranges from -1 to +1 and this value - called the correlation coefficient - lacks unity. If the correlation coefficient is +1, it indicates a perfect positive linear relationship between two variables. If the coefficient is instead -1, it indicates a perfect negative linear relationship between these variables. On the other hand, if the correlation coefficient is 0, there is no relationship between the two variables of interest. The most common correlation coefficient is Pearson's correlation coefficient, abbreviated by the letter r. Pearson's correlation coefficient is obtained by dividing the covariance of two variables by the product of their standard deviations (Angrist & Pischke, 2015).

Variable description

The real GDP is chosen, instead of nominal GDP, to adjust it for inflation. It is important to mention that even before the pandemic broke out, there were differences between countries regarding real GDP- and unemployment levels. However, the eventual change from previous year, due to the pandemic, is captured by the panel data regression because the fluctuation in the course of 2020 is observed starting from quarter 1 and there were no lockdowns in the beginning of the year.

Some of the control variables are analyzed on the basis of data from 2019. These are government debt, trade openness index, share of industry, share of services and Gini inequality index. It is relevant to examine the effect of these variables on the real GDP growth and the unemployment based on data from 2019, because preconditions that different countries had before the pandemic may have been crucial for how well each of the countries have been able to handle the pandemic, from an economic perspective. However, because these are time-invariant variables, they may be excluded from the model if the Hausman test shows that the Fixed Effects Model is a more appropriate estimation method.

Government expenditure is chosen as a control variable because it affects the GDP and possibly even the unemployment, and certainly mitigates the effect of lockdowns. The actual data shows that in most of the countries included in our sample, government expenditure has increased sharply during 2020. Without this increase, the real GDP could have had a greater fall and the unemployment could have increased even more. However, the private

consumption, the investments and the net-export, which also define the GDP are not included in the study separately because Lockdown Stringency is assumed to affect these variables directly which has an implication even on the GDP growth and the unemployment.

Last but not least, the Lockdown Stringency Index and the spread of Covid-19 per million people are reported on a daily basis. For the Lockdown, the average has been calculated for each quarter and for the spread of Covid-19, the value has been added for each quarter. The calculations have been carried out automatically in Excel.

Finally, we chose to study only OECD-member-countries to minimize the differences between the economies. This has the implication that other factors that are characteristic, for instance for fragile states, don't affect the relationship between our independent and dependent variables. All countries that are members of the OECD are developed economies and democracies with well-functioning institutions. Thus, we need to control for fewer omitted variables in the regression analysis. For more detailed description of the variables, see Appendix.

Results

The descriptive statistics is summarized in Table 1. We can see that the standard deviation, which shows how much the data is dispersed in relation to the mean, is high for lockdown stringency and spread of covid-19. It indicates that there have been pretty big differences during 2020. Whether the differences have been bigger between countries or between different time points within the same countries, cannot be seen in this table. However, the standard variations for real GDP growth, unemployment and government expenditure are relatively low.

Table 1. Descriptive statistics

variable	mean	sd	median	min	max
Lockdown Stringency	53,90	16,6	55,5	20,00	87.33
Spread of Covid-19	7887	1331	1917	9,00	60555
Real GDP Growth	-4,46	5,23	-3,5	-21,6	8,92
Unemployment rate	7,08	3,68	6,31	1,93	20,33
Government expenditure	20,68	4,31	20,92	9,79	29,44
Government debt	63,34	44,6	48,7	8,4	223,81
Trade openness	104	65,9	85,9	26,3	381
Share of industry	23,75	5,34	24,19	11,32	35,18
Share of services	64,1	5,87	64,8	56,4	79,1
Gini coefficient	33,34	5,66	32,5	25,4	49,7

Graph 4 and graph 5 show the fluctuations in the real GDP growth and in the unemployment respectively. Regarding real GDP growth, we can observe a clear pattern. In almost all countries the GDP falls during quarter 1-2, then rises a bit during quarter 2-3 and finally stabilizes during quarter 3-4. The pattern is the same in all countries regardless of the actual level of the GDP. The same cannot be said about unemployment. The unemployment rate increases in the course of 2020, but the pattern is not the same in all countries. There have been differences both regarding the actual level of the unemployment and its periodic fluctuations. The different lines are not labeled with country-names because it is difficult to separate the lines from each other. The ambition is just to show the general trend.

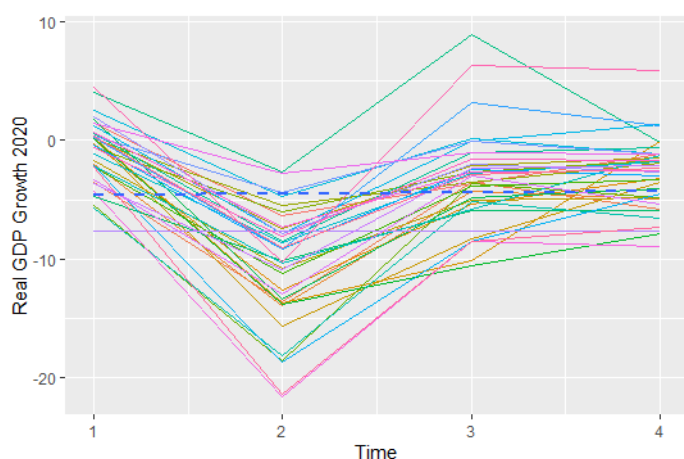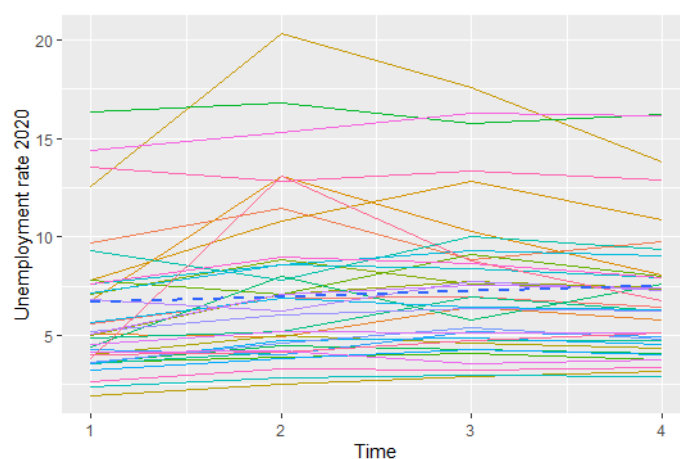| **Figure 4. Fluctuation of the real GDP growth**	**Figure 5. Fluctuations in the unemployment**

Real GDP Growth

The Hausman test shows that P – value is less than 0,05 and the Fixed Effects Model is therefore more appropriate to use an estimation method for real GDP growth.

Hausman test
(fixed; random)
P – value = 0.02935 < 0,05
Choose the Fixed Effect Model

R^2 is the explanatory power of the regression model. In this case, all predictors together can explain 61 % of the quarterly variation in the real GDP growth (see Table 2). Regardless of the significance of the variables in the model, R^2 will always show a higher value when more variables are added. It is therefore important to look at the value of adj. R^2 that improves the model by considering the significance levels of the variables. We can see that adj. R^2 is lower (47 %). The overall model is significant according to the P-value of the F-test ($P < 0.05$).

Table 2. Fixed effects model for real GDP growth

R-Squared	0,61555
Adj. R-Squared	0,47672
F-statistic	57,6402
P – value	0,00

The Fixed Effects Model analysis excludes the time-invariant variables and we can see that both the Lockdown Stringency Index, the Spread of Covid-19 and the Government Expenditure are significant, because the P-values for the estimates of all three variables < 0.05. Increased lockdown stringency by 1 unit means decreased real GDP growth by 0.16 units. Similarly, greater spread of Covid-19 over time indicates decreased real GDP growth, even though the estimate is very little. Increased government expenditure in its turn means increased real GDP growth.

Table 3. Fixed effects model for real GDP growth

Coefficients	Estimate	Std. Error	t-value	Pr(>|t|)
Lockdown Stringency Index	– 0,16825	0,00231	– 7,2639	0,00
Spread of Covid-19	– 0,00137	0,00002	– 6,2563	0,00
Government expenditure	1,0450	0,2186	4,7792	0,00

Unemployment rate

In the case of unemployment, the Hausman test shows that the random effects model should be preferred over the Fixed Effects Model, because $P > 0.05$.

Hausman test
(random; fixed)
P – value = 0.9867 > 0,05
Choose the Random Effect Model

The adjusted explanatory power of the model (R^2 adj) is pretty low (25 %) according to Table 4, but the overall model is significant because P – value of Chisq – test < 0.05.

Table 4. Random effects model for unemployment

R-Squared	0,30274
Adj. R-Squared	0,25185
Chisq	59,4837
p-value	0,00

The random effects model analysis shows that only lockdown stringency, government debt, share of industry, share of services and Gini coefficient are significant at 0.05 significance level. Increased lockdown stringency means increased unemployment. Similarly, higher government debt, bigger share of industry and services, as well as higher Gini coefficient indicate higher unemployment.

Table 5. Random effects model for unemployment

Coefficients	Estimate	Std. Error	z-value	Pr(>|t|)
Intercept	0,338	0,127	2.6646	0.007708
Real GDP Growth	-0,0344	0,034	-1.0132	0.310951
Lockdown Stringency	0,03	0,0101	2.9621	0.003055
Spread of Covid-19	0,00002	0,000009	0.3253	0.744947
Government debt	0,0265	0,0127	2.0829	0.037259
Share of industry	0,394	0,185	2.1251	0.033576
Share of services	0,430	0,135	3.1680	0.001535
Gini Coefficient	0,287	0,100	2.8783	0.003999
Trade Openess	0,00249	0,00892	0.2794	0.779950
Government expenditure	-0,0754	0,0817	-0.9239	0.355523

The correlation matrix shows that there is no risk for high multicollinearity. The time variable, which represents the four different quarters, is numerically defined as 1, 2, 3, and 4. Thus, higher value means later in 2020. We can see that there is a positive and pretty high correlation between the Time and lockdown stringency, as well as spread of Covid-19 which means that lockdown stringency and spread of Covid-19 increases with time-progression. The correlation between the time-invariant variables and the Time cannot be calculated because the aforementioned are constant during the year.

Table 6. Correlation Matrix

	Time	Lockdown Stringency	Spread of Covid-19	Real GDP	Unemployment	Government debt	Trade Openess	Share of industry	Share of services	Gini	Government expenditure
Time	1	0,37	0,62	0,02	0,08	0,00	0,00	0,00	0,00	0,00	0,08
Lockdown Stringency		1	0,29	-0,54	0,31	0,02	-0,04	0,04	-0,07	0,30	0,01
Spread of Covid-19			1	0,04	0,01	-0,04	0,17	-0,11	0,12	-0,01	0,09
Real GDP				1	-0,22	-0,27	0,17	0,16	-0,12	-0,05	-0,30
Unemployment					1	0,18	-0,23	-0,20	-0,02	0,53	-0,03
Government debt						1	-0,32	-0,19	0,33	-0,01	0,12
Trade Openess							1	-0,09	0,06	-0,35	-0,12
Share of industry								1	-0,75	-0,02	-0,38
Share of services									1	0,05	0,14
Gini										1	-0,50
Government expenditure											1

Discussion

It is important to keep in mind that only a relatively small sample of countries has been selected to study, the 37 OECD member countries, because of their economies' relative similarity to each other, in the interest of achieving tangible results. This can, however, also lead to a too narrow dataset, and it is important to keep this in mind when reading the results. Furthermore, virtually all countries in the OECD are wealthy countries with a long history of strong institutions. Because of the relative homogeneity of the countries in the sample, it is important to remember that the conclusions drawn from this study are not necessarily applicable to other countries outside the OECD, especially not countries which differ drastically in the underlying components of their economies.

GDP

The model for real GDP growth has an adjusted R^2 value of 0.47. This can appear to be relatively low, but it is important to take into account how big the concept GDP truly is. Given the countless variables that are part of determining GDP, the adjusted R^2 value of 0.47 means a relatively high degree of explanation. The model as a whole is significant. In the fixed effects model, the time-invariant variables are excluded and the remaining ones that are lockdown stringency, government expenditure, and spread of Covid-19 are all significant in

the model ($P < 0.05$), and to some extent can explain the cross country variations in the real GDP growth. When lockdown stringency increases by 1 unit, the real GDP growth decreases by 1.6 units.

It was important to control the spread of Covid-19 to be able to isolate the effect of lockdown stringency. Since both lockdown stringency and spread of covid-19 are significant in the regression model and there is no multicollinearity between them according to the correlation matrix, we can conclude that lockdown stringency indeed can explain part of the cross-country variation in real GDP growth during 2020. However, it is an important observation that even the spread of covid-19 has its part in explaining the fluctuations in real GDP growth. In practice, stricter lockdown measures mean that a country has imposed more restrictions of mobility, and that these restrictions have had implications for factors that in turn affect GDP, for instance private consumption and investments. There is also a possibility that higher lockdown stringency is the only thing that is stopping a higher spread of the virus, which otherwise would lead to a steeper drop in GDP, effectively mitigating the negative effects on GDP. It is therefore difficult to state a causality between lockdown stringency and real GDP growth solely based on this study. Possibly a difference-in-difference estimation with a control group would give stronger evidence for a causal relationship, something that should be considered in future research.

The data analysis confirms the impact government expenditure has on real GDP growth. This is by no means a surprise, and shows that the mainstream fiscal policy response to the pandemic seems to be working in the short run. It would be interesting to see the long-run effect being researched in later years, especially given the unprecedented, enormous rescue plans adopted by major countries and federations like the US and the EU, and the resurgence of this very Keynesian macroeconomic response.

It is also important to remember that the case could be made for higher lockdown stringency leading to a lower spread of infection in the society, leading to fewer cases and a faster return to the normal state. As this study only takes into account the change in real GDP during 2020, it is possible for the long-term effects to substantially differ from these results. It is in other words imperative to keep the short-term perspective in mind when analyzing the results. As the data analysis was done using GDP instead of GDP per capita, there is a possibility that population changes in the countries investigated can play a role in the changes in real GDP. However, as the range of the data is only one year, this risk is relatively minimal, especially

given the fact that all countries in the OECD region were hit by covid-19, and that the pandemic led to lower mobility due to lockdowns and stricter government mobility interventions.

Unemployment

The results of the data analysis regarding unemployment varies from the results regarding GDP. The model for unemployment has an adjusted R^2 value of 0.25. This is relatively low, but the model still yields relevant results. Once again, the model as a whole is significant. Lockdown stringency, government debt, gini coefficient, share of industry and share of services are the significant variables in the model.

The connection between lockdown stringency index and unemployment is interesting for the same reasons as in the case of GDP. Stricter lockdown seems to lead to an increased unemployment, which is reasonable since stricter restrictions means that more people have to stay at home and more companies are being affected. However, the spread of Covid-19 is not significant in the model and it cannot be asserted that the spread of the virus itself could have had implications for unemployment. It might be the case that the data set is not big enough to see the eventual cross-country variations, but that was a risk regarding the GDP model too, which still yielded significant results for spread of Covid-19 even though the estimate is small. Important to mention is also that the correlation between lockdown stringency and spread of Covid-19 is rather low (0.29) which can be explained by the fact that different countries chose different strategies to manage the virus, regardless of the amplitude of the spread. The combination of these facts give some evidence for the unemployment being affected by lockdown stringency rather than by the spread of the virus itself. However, the estimate of lockdown stringency is 0.03 which means that the effect is only slightly positive.

It is also once again important to remember the short-term perspective. It is not unthinkable that stricter lockdown has shortened the pandemic's life span, which hopefully helps to reduce unemployment in the long run. Furthermore, in many cases governments and corporations have managed to adapt their work forces to the pandemic with remote working, rigorous testing, and short-time furloughs. In future research, it would be interesting to analyze whether countries with a higher degree of digital development and high lockdown stringency suffered a lower economic impact than countries with a lower degree of digital development and high lockdown stringency.

It is important to keep in mind that the unemployment rate differed a lot between countries before the pandemic broke out and even though the unemployment increased in most countries during 2020, the differences still remained which means that there are more complex underlying factors that need to be considered when discussing the rate of the unemployment. The termination of workers following the economic crisis caused by the pandemic primarily hit low-skilled workers. Many service industries, especially restaurants and the tourism sector, were hit hard, and workers in these sectors are often paid fairly low wages. This can be a possible explanation for the Gini Inequality Index and for the Share of Services being significant in the regression model. When value added by the services sector in a country increases by 1 unit, the unemployment increases by 0.4 units while the Gini Coefficient increases by 0.2 units. However, the positive and significant relationship between share of industry and unemployment indicates that many jobs have been lost even in the industry sector that includes even the manufacturing.

An interesting observation is that neither the effect of real GDP growth nor government expenditure are significant in the model, in the short run. It is possible that the effect of increased government expenditures have been indirect and are not captured by the regression model. It is likely that many more companies would be bankrupt and many more jobs would consequently be lost without the enormous grants provided by the governments and job retention schemes.

The majority of the rise in unemployment between 2019 and 2020 can probably be classified as cyclical unemployment, as it is caused by the economic recession. Therefore, it should in theory bounce back when the economy recovers. However, as previously discussed, unemployment has a tendency to stay at the higher levels achieved despite economic recovery. This tendency for hysteresis is crucial for governments to combat when trying to get back to the pre-pandemic levels. The fact that there were rather big differences between countries regarding the unemployment levels, even before the pandemic, can possibly be explained by the degree of structural unemployment in different countries. In future studies, it would be interesting to control the effect of structural unemployment when estimating the implications of the COVID-19 pandemic on the unemployment rate.

Potential improvements

Firstly, the sample of countries is as previously discussed relatively small. For the purpose of the analysis using multiple regression models, this way of sampling works. However, it could be possible to draw broader conclusions using a larger sample of countries. This could potentially lead to more conclusive results, as well as giving an opportunity to study the differences in macroeconomic variables' effects on GDP and unemployment in different kinds of economies with different levels of development.

Secondly, the control variables used could be adjusted. The current variables used were chosen partly because of the support for their impact in economic theory, partly because of the practical implications of the restrictions imposed, and partly because of the availability of data for the OECD countries. It is important to note that adding more variables may be a cost issue, as some possibly interesting data is not available for free.

Lastly, a similar analysis regarding the lockdown stringency could be made, studying the effects in the long run. This analysis could investigate possible connections between lockdown stringency index and long-term pandemic effects, and between lockdown stringency index and long-term unemployment.

Conclusions

We can conclude from our models that lockdown stringency seems to be an important variable in the short-run for explaining cross-country variations in real GDP growth, and for explaining the unemployment, with a higher lockdown stringency leading to a greater fall in real GDP and a greater increase in unemployment. The impact on real GDP growth seems to be higher than that on unemployment. The potential risk of multicollinearity in the models, especially with the variable spread of Covid-19, is disproven, further strengthening our findings. This also points towards the fact that the OECD-countries have indeed chosen very different strategies to deal with the Covid-19 pandemic, making them a reliable sample.

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Appendix

Variable	Description	Source
Lockdown Stringency	The nine metrics used to calculate the Stringency Index are: school closures; workplace closures; cancellation of public events; restrictions on public gatherings; closures of public transport; stay-at-home requirements; public information campaigns; restrictions on internal movements; and international travel controls. A higher score indicates a stricter response (i.e. 100 = strictest response).	Our World in Data
Spread of Covid-19	New confirmed Covid cases per million people per day.	The Global Economy
Real GDP Growth		CEIC
Unemployment rate	Unemployment refers to the share of the labor force that is without work but available for and seeking employment.	CEIC
Trade Openness	Exports plus imports as percent of GDP.	The Global Economy
Government Debt	Debt is the entire stock of direct government fixed-term contractual obligations to others outstanding on a particular date. It includes domestic and foreign liabilities such as currency and money deposits, securities other than shares, and loans. It is the gross amount of government liabilities reduced by the amount of equity and financial derivatives held by the government. Because debt is a stock rather than a flow, it is measured as of a given date, usually the last day of the fiscal year.	The Global Economy
Share of industry	Industry corresponds to ISIC divisions 10-45 and includes manufacturing (ISIC divisions 15-37). It comprises value added in mining, manufacturing (also reported as a separate subgroup), construction, electricity, water, and gas. Value added is the net output of a sector after adding up all outputs and subtracting intermediate inputs. It is calculated without making deductions for depreciation of fabricated assets or depletion and degradation of natural resources. The origin of value added is	The Global Economy

	determined by the International Standard Industrial Classification (ISIC), revision 3 or 4.	
Share of Services	Services correspond to ISIC divisions 50-99 and they include value added in wholesale and retail trade (including hotels and restaurants), transport, and government, financial, professional and personal services such as education, health care, and real estate services. Also included are imputed bank service charges, import duties, and any statistical discrepancies noted by national compilers as well as discrepancies arising from rescaling. Value added is the net output of a sector after adding up all outputs and subtracting intermediate inputs. It is calculated without making deductions for depreciation of fabricated assets or depletion and degradation of natural resources.	The Global Economy
Gini Coefficient	Gini index measures the extent to which the distribution of income (or, in some cases, consumption expenditure) among individuals or households within an economy deviates from a perfectly equal distribution. A Lorenz curve plots the cumulative percentages of total income received against the cumulative number of recipients, starting with the poorest individual or household. The Gini index measures the area between the Lorenz curve and a hypothetical line of absolute equality, expressed as a percentage of the maximum area under the line. Thus a Gini index of 0 represents perfect equality, while an index of 100 implies perfect inequality.	The Global Economy
Government Expenditure	Government expenditure is the total spending by all levels of government, excluding public enterprises.	The Global Economy