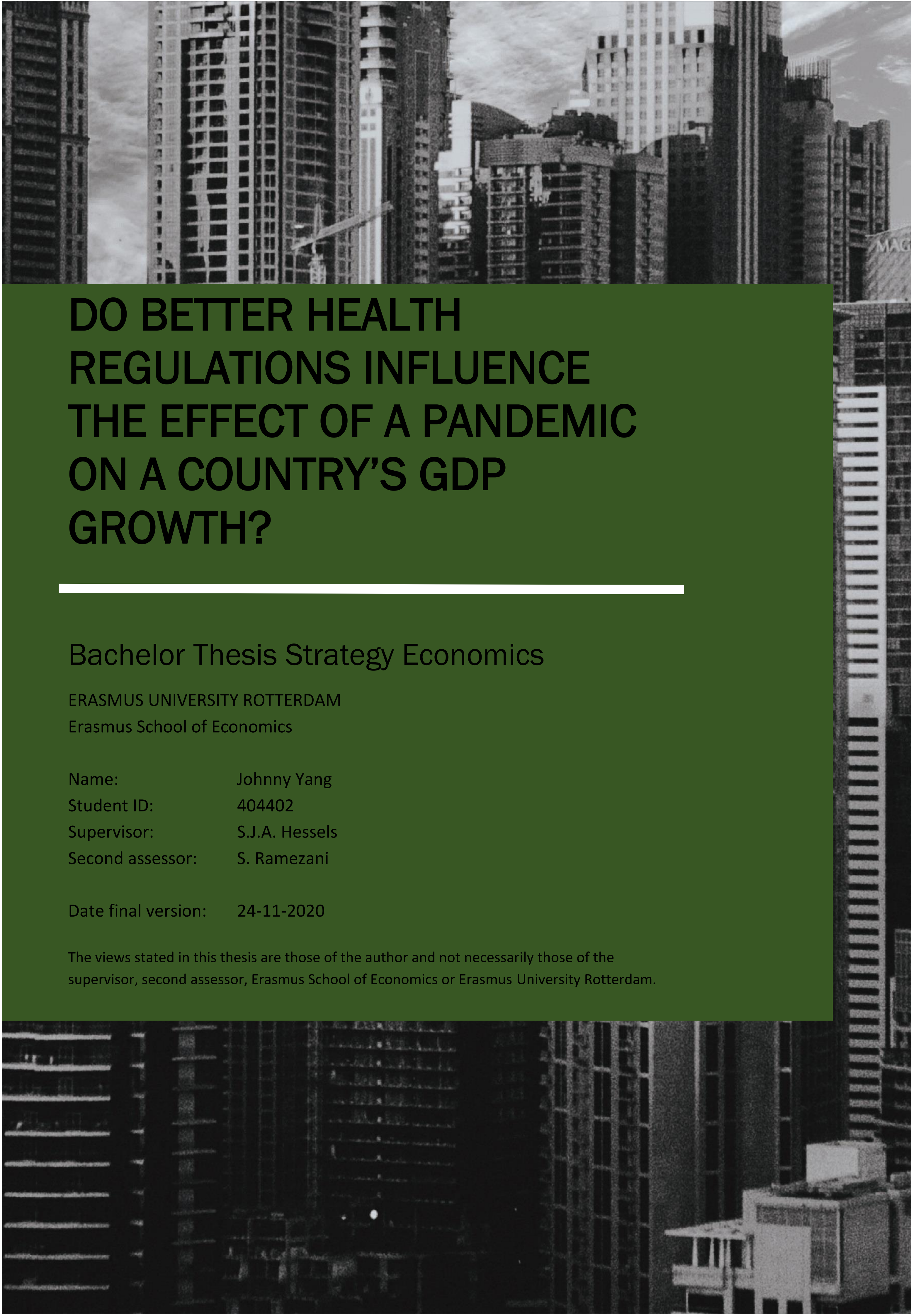

DO BETTER HEALTH REGULATIONS INFLUENCE THE EFFECT OF A PANDEMIC ON A COUNTRY'S GDP GROWTH?

Bachelor Thesis Strategy Economics

ERASMUS UNIVERSITY ROTTERDAM
Erasmus School of Economics

Name:	Johnny Yang
Student ID:	404402
Supervisor:	S.J.A. Hessels
Second assessor:	S. Ramezani

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I. Introduction

In 2020 the world has been plagued with the Covid-19 pandemic, a few years after the Swine flu pandemic in 2009. These have had a negative effect on the economy of countries in one way or another. The reasons for the negative economic effect could be due to the higher proportion of people not going to work due to being ill or the fear of catching the virus and in extension evading locations with a lot of people (e.g. shopping centres). How people react to the pandemic may be largely dependent on the rules the government enforces and their general preparedness, e.g. setting a maximum amount of people for a shopping centre or supplying easy cheap access to test for the virus. I suspect that due to the differences in each country's regulations, they have been hit differently economically. The reason being that a country's regulations might impact the population's health, which in turn impacts the economy. The purpose of this thesis is to find out whether health regulations in a country influence the economic effects of the Covid-19 pandemic on a country. I will be using the International Health Regulations (IHR), that have been created by the World Health Organization (WHO) in 2005, to codify the health regulations. The stated purpose of the IHR are "to prevent, protect against, control and provide a public health response to the international spread of disease … and which avoid unnecessary interference with international traffic and trade." The IHR grew out of the response to deadly epidemics that once overran Europe and are an instrument of international law that is legally-binding on 196 countries. The regulations are comprised of thirteen core capacity indicators (World Health Organization, 2005). These indicators assist countries to determine (and if needed to improve) their capability to identify, judge and act on large health events. Some aspects that these indicators look at would be the surveillance system, presence of rapid response teams as well as the capacity to support operations during a public health emergency.

In the past Wilson, Brownstein, & Fidler (2010) did a commentary in which they found that the use of the IHR during the Swine flu pandemic was relevant and important to protect global health. Similarly, Katz (2009) made a report describing a timeline of events that occurred during the Swine flu pandemic in which Katz tried to illustrate the need for sound international health regulations and a need for all nations to implement these regulations. My thesis will be different from the prior literature as I will look at the role of IHR, and in particular the core capacity indicators, for the economic performance of countries during the recent Covid-19 pandemic.

This thesis tries to answer the following research question:

> ***"To what extent are core capacity indicators related to a country's GDP growth over the years 2010-2019?"***

To answer this question, I will be doing an empirical analysis of the International Health regulations, taken from a dataset of WHO, on the yearly or quarterly GDP, taken from World Bank's dataset. Firstly, I will be looking at seven of these core capacity indicators (CCIs) which I suspect, based on prior literature, to be the most relevant for reducing the negative economic impact of a pandemic influenza. The seven CCIs that I will use are: Preparedness, coordination, surveillance, response, risk communication, points of entry and laboratory. I have determined that there is an underlying factor present for these variables, due to principal component analysis. Hence, this factor will be used to represent the seven CCIs. This factor will be labelled "*IHR*" to represent the seven CCIs from now on. Furthermore, I will use three models to answer the research question.

With the first and second model I will be looking at the relation between GDP growth and the CCIs in general, absent the pandemic. This is to examine initially whether and how GDP growth is dependent on the CCIs. The first model will be a multiple regression model where I will look at the initial relationship between GDP growth and the CCIs for the years 2010-2019. This allows me to assess whether countries that perform higher on the CCIs experience higher economic growth.

For the second model I will be using a fixed effects model for the period 2010-2019 to check whether the time-varying variation of GDP growth can be explained by the variation in the CCIs over time. This allows me to assess whether countries improving their performance on the CCIs will experience higher economic growth. The difference in comparison with the first model is that the fixed effects model uses within-country variation, contrary to between-country variation in the first model.

With the third model I will check the impact of the CCIs during the pandemic on GDP growth. I expect there to be a relation between GDP growth and the CCIs through the CCIs affecting health of a population, which in turn affects GDP growth. For this model, a fixed effects model will be used that will look at the GDP growth in the first and second quarters of 2020. From this model, we will try to determine whether the CCIs have had an influence on the GDP growth of a country during the pandemic.

In the following section II, I introduce the hypotheses I have chosen as well as give arguments for why I choose these seven CCIs. In part III, I will explain the Methodology. I will follow up with the Results in part IV and conclude with Conclusions and recommendations in part V.

II. Theoretical framework

In the coming sections I will clarify which CCIs will be relevant for economic growth based on prior literature. In section 2.1 the relationship between the health regulations (synonym for the CCIs) and the spread of the pandemic will be explained based on prior literature. In section 2.2 the relationship between health and economic growth will be discussed. In section 2.3 we are going to see prior literature that have written about the economic impact of pandemics. In the last section I will introduce the hypotheses that I will test.

2.1 Health regulations and spread of pandemic

To find the first CCI that is relevant, we look at Colizza, Barthelemy, Valleron, & Vespignani's study (2007), which included a mathematical model for the spread of an influenza pandemic and adjusted various parameters (for instance the reproductive rate of the potential influenza). They concluded that having a stockpile of anti-viral drugs is very important as a containment strategy. The core capacity indicator "preparedness" encapsulates this aspect as it focuses on response plans for various hazards as well as the development of appropriate stockpiles of relevant resources (for e.g. biological, chemical, radiological, and nuclear hazards).

Hashim et al. (2012) did a qualitative analysis on the pandemic of 2009 and identified not only preparedness, but also coordination and surveillance as essential elements for having successful pandemic preparedness activities. They selected seven countries to participate in a qualitative study to evaluate whether their pandemic preparedness activities prior to the 2009 pandemic were effective and generally appropriate for the response provided in 2009. Therefore, next to preparedness, this study will consider the core capacity indicators “coordination” and “surveillance”, which reflect the effectiveness of communication with all relevant sectors and stakeholders in a country and the effectiveness of surveillance (e.g. in hospitals) respectively.

The impact of airline travel on the spread of the pandemic has also been researched and been found significant by Grais, Ellis, & Glass (2003) and Colizza et al. (2007). This would imply that a country’s public health capacity at airports is relevant for dealing with a pandemic. Since it can be expected that not only the presence of airports, but also of ports and ground crossings are important for the spread of a pandemic it will also be relevant to consider public health capacity at these places. This aspect is represented by the core capacity indicator “points of entry”. Furthermore, an effective surveillance system would enable a country to react timely and restrict the spread when it appears. Proper risk communication would also enable preventive countermeasures against the spread of the virus. Hence, the core capacity indicators “response” and “risk communication” are also considered in this study, in which the former focuses on the implementation of a sensitive and flexible surveillance system and the latter on helping the government identify and assess vulnerabilities as well as communicating these to the general public.

For a team to control diseases efficiently, they will need to identify the specimens on time and ship them to the appropriate laboratories. Therefore, this study expects the core capacity indicator “laboratory” to be relevant for performing laboratory analysis on samples and which assesses the effectiveness of the mechanisms in place (e.g. shipment of specimens to the appropriate laboratories if necessary) for providing reliable and timely laboratory identification of infectious agents.

To summarize, based on the above literature, this study will focus on the following indicators: preparedness, coordination, surveillance, response, risk communication, points of entry and laboratory.

2.2 Health and economic growth

There are hints in literature that point towards an indirect relationship between better health regulations and economic growth through improved health. Ashraf, Lester, & Weil (2008) have researched whether improvements in health increase economic growth. The two types of improvements to health they focus on are an increase in life expectancy and the eradication of particular diseases. They have found that controlling for and eradicating specific diseases (malaria and tuberculosis), that are prevalent in developing countries, produces small increases in GDP per capita (2%) in the long run. This could indicate that the economic effects of better controlling and eradicating a pandemic would also have a positive economic effect. The reasoning for this would be that better health results from (better) enacting health regulations which aim to improve health. Countries that perform better in regard to health regulations may be able to achieve higher economic growth. Therefore, countries could benefit from improving their health regulations.

2.3 Economic impact of pandemics

So far only a few studies have researched the economic impact of pandemics in a country. The paper of Meltzer, Cox, & Fukuda (1999) estimated what the economic impact could be of a pandemic influenza in the United States and the impact of vaccine-based interventions. They estimated what the total deaths and total hospitalizations would be, as well as found out at what price a vaccine should be to give a net savings to society. When taking in account people not at high risk for complications, they concluded that vaccinating 60% of the population would generate the highest economic returns. Page, Song, & Wu (2012) tried to separate and estimate the effect of the swine flu pandemic and the economic crisis on the demand for U.K. inbound tourism. They looked at the visitors from the 14 major visitor source markets and found that the demand dropped by 16.9% due to the swine flu pandemic. I would like to build on this and research how the economic impact of the Covid-19 pandemic varies between countries, when each country has different health regulations in place. I expect that the spread of the pandemic relates to economic growth and is also influenced by health regulations.

2.4 Hypotheses

The research question of this thesis is as follows:

"To what extent are core capacity indicators related to a country's GDP growth in case of a pandemic?"

In order to answer this question, I have made the following hypotheses:

H1. ***Countries that score higher on the core capacity indicators experience higher economic growth.***

In section 2.1 we discussed the relation between health regulations and the spread of the pandemic, while in section 2.2 we looked at the relation between health and economic growth. The goal of hypothesis 1 is to test whether the scores on the CCIs have a correlation with economic growth when comparing between countries. This hypothesis examines whether health regulations will have the same relation with economic growth as health has with economic growth.

H2. ***When countries improve their performance on the core capacity indicators they will experience higher economic growth.***

To build further on hypothesis 1, with hypothesis 2 we want to examine the causal relationship whether improving health regulations increases economic growth within a country in the same way that improvements in health increases economic growth.

H3a. ***There is a significant positive relation between the CCIs and economic growth in the first and second quarters of 2020.***

H3b. The positive relation between the CCIs and economic growth in the first and second quarters of 2020 is mediated by the spread of the pandemic.

Section 2.3 looked at the economic impact of pandemics. The focus in the prior literature was on the economic impact on a single country. With hypothesis 3a, we will expand the scope to look for differences among countries regarding core capacity indicators and determine what their consequential economic impact has been due to these differing core capacity indicators. Hypothesis 3b will test the assumption whether the spread of the pandemic is an indirect effect between the CCIs and economic growth.

III. Methodology

3.1 Model and variables

The hypotheses will be tested using three different regression models. Before explaining what models I will use, I will first explain how the main independent variable, which is *IHR*, is defined as this variable is included in all three models.

IHR: This variable is based on the following seven core capacity indicators as indicated above: preparedness, coordination, surveillance, response, risk communication, points of entry and laboratory. The seven core capacity indicators have a value between 0 and 100 depending on the proportion of the set of specific elements that have been attained. The data has been taken from the WHO. To examine whether the seven CCIs have an underlying structure in which the variables are correlated with each other, I have done a Principle Component Analysis (PCA). The PCA reduces the number of observed variables, which are highly correlated, to a smaller number of principal components which account for most of the variance of the observed variables. Appendix 1 shows the results from this analysis. Based on the results, it shows that the seven CCIs can be represented by a single variable, which will henceforth be called *IHR* (International Health Regulations). This variable will be used in the three models to represent the CCIs.

Additionally, I have calculated Cronbach's alpha which gave a scale reliability coefficient of 0.891. Cronbach's alpha is used to determine a measure of internal consistency. Due to the relative high value for alpha, combined with the results of the PCA, we can say with high certainty that the CCIs are measuring one underlying variable. The output is shown in Appendix 2.

3.2 Model 1

Firstly, I used a multiple regression model to check whether there is a positive correlation between GDP growth and the *IHR* among 163 countries for the years 2010-2019. The list of countries will be put in Appendix 3. As only these countries have sufficient data on GDP growth when combined with the dataset regarding the CCIs, only these will be used. The dependent variable will be *GDP growth*, whereas *IHR* will be the independent variable. As control variables I will use the log of *Labour* (force) (total), *Export* (annual%), *Import* (annual%), *Household* (annual%), *Government* (annual%) and (compulsory) *Education* (duration in years). *GDP growth* as well as the control variables have been taken from World bank's database. *Labour (force)* represents the simplified approximation of the growth of the population and thus one of the drivers of GDP growth, whereas *compulsory education duration* is the proxy for education. Simonen, Svento, & Juutinen (2015) included the control variable total employment (similar to *labour force*) when looking at the linkages between regional industrial structure and economic growth. Finlay (2007) analysed the role of health and education as drivers for economic growth and found them significant. Furthermore, Greenaway, Morgen, & Wright (1999) examined the relationship between trade and growth. The results suggested that there is a strong positive relationship between exports and economic growth. They do however add that the composition of the exports is important in determining the strength of growth. The control variables *Household* and *Government* represent the annual percentage growth for the household- and government final consumption expenditure. Kirshin, Maleev, & Pachkova (2014) assessed the impact of different drivers of economic growth in their paper, from which the control variables *Household* and *Government* have been chosen.

3.3 Model 2

Secondly, to test the variation due to the variable *IHR* as well as the causality between the two variables *GDP* growth and *IHR*, a panel data model will be used throughout the years 2010-2019. A Durbin-Wu-Hausman test has been used on the panel data to choose between doing a "fixed effects model" or "random effects model". The results from this test showed that a fixed effects model is best suited for the data. For further interest, the results are shown in Appendix 4. The dependent variable will be *GDP growth*, whereas *IHR* will be the independent variable. The time-varying control variables will be *Labour (force)*, *Household, Government,* *Import* and *Export growth*. This will be done on 174 countries. The list of countries is put in Appendix 3. Afterwards, I will test for a Granger causality between *GDP growth* and the *IHR*. As the test will be done on panel data, we will be using a procedure proposed by Dumitrescu and Hurlin (2012).

3.4 Model 3

Thirdly, I will use the beforementioned individual fixed effects model and use the forecasts of GDP growth for the first and second quarter of 2020 to check for the economic impact of the pandemic. The amount of countries used will be 16 due to a lack of forecasts for the remaining countries. The list of countries will be put in Appendix 3. These two models will be using quarterly time series instead of yearly. The forecasts of the first and second quarters will solely be compared to the first and second quarters of previous years respectively, the remaining quarters will not be used as the GDP growth is nominal and non-seasonally adjusted. There will be one model solely with the first quarters and one with second quarters. The control variables *Import, Export, Government, Household,* and the log of *Labour* will be used in this model. Due to an absence of quarterly data for the control variables *Labour*, as these are formatted yearly, the variable *Labour* will be extrapolated before taking the log. The control variables *Import, Export, Government and Household* will be transformed from yearly into quarterly by taking the 4^{th} root. Here it must be noted that we assume the value for each quarter to be equal throughout the whole year.

As an alteration to test for the indirect effect of *IHR* on *GDP growth* through the spread of the pandemic, I will add the control variable *Spread* to these two models. This variable has been created by taking the cumulative amount of cases at the end of respectively March and June 2020 and dividing it by the total population of each country. These will be added to model 3a and 3c. The data has been taken from respectively the website of the World Health Organization and the website “worldometers.info”. The control variable *Spread* represents the cumulative percentage of the population that has been infected by the virus at the end of the first (March) and second (June) quarters of 2020.

IV. Results

In the following sections, I am going to discuss the results obtained from the three models. Beforehand, some descriptives and a correlation matrix are shown in 4.1 to give more clarity regarding the variables used. In 4.2 I am going to talk about the first model, the multiple regression model. In section 4.3, the fixed effects model and the test for Granger causality will be discussed. Lastly in section 4.4 the last fixed effects model will be discussed, which will look at the economic impact of the pandemic as well as test the assumption that there is an indirect relationship between GDP growth and the IHR through the spread of the pandemic.

4.1 Descriptives

Further information about the variables as well as some correlations can be found in table 4.1 and 4.2 respectively. Table 4.1 shows that GDP growth is, on average over all 163 countries, 3.4%. On average, countries' export growth (5.3%) is larger than import growth (4.8%).

Table 4.1 Descriptives

Variable	**Mean**	**Min**	**Max**
GDP growth (%)	3.444	-62.076	123.140
IHR	0.113	-3.587	1.412
Education (years)	9.609	5	16
Export (%)	5.324	-70.530	233.070
Import (%)	4.796	-62.183	123.273
Household (%)	2.945	-50.487	43.551
Government (%)	2.941	-55.349	88.763
LogLabour	15.261	10.565	20.481

In table 4.2, the correlation matrix shows a negative correlation (-0.046) between GDP growth and IHR.

Table 4.2 Correlation matrix

	GDP growth	IHR	Education	Export	Import	Household	Government	Labour
GDP growth	1.000							
IHR	-0.046	1.000						
Education	-0.057	0.155	1.000					
Export	0.558	-0.081	-0.026	1.000				
Import	0.482	-0.050	0.009	0.471	1.000			
Household	0.275	0.023	0.020	-0.010	0.407	1.000		
Government	0.155	-0.076	-0.064	0.056	0.249	0.154	1.000	
LogLabour	0.098	0.242	0.089	0.023	0.042	0.111	0.047	1.000

4.2 Multiple regression model 1

The results of the first model are shown in Table 4.3 below. This model shows that *IHR*, representing the core capacity indicators, has a positive relation of 0.071 with *GDP growth*, but is not significant.

Furthermore, the coefficients for the control variables *Education, Export*, *LogLabour* and *Household* are positive and significant. What is surprising is that *Export* has a significant and positive impact on *GDPgrowth* while *Import* is not significant. Furthermore, the variable *Education* has shown to be negative and significant. An explanation could reside in the fact that *GDP growth* of developed countries are lower compared to developing countries and have a longer duration of compulsory education. This phenomenon of developed countries having a lower *GDP growth* could be assigned to the catching-up effect, which says that developing countries have a higher economic growth compared to developed countries.

Table 4.3 Multiple linear regression results for the relationship between IHR and GDP growth

	Model 1	
Variable	*Coef.*	*Std. Error*
IHR	0.050	(0.139)
Education	-0.126**	(0.036)
Export	0.180**	(0.067)
Import	0.080	(0.053)
LogLabour	0.188**	(0.056)
Household	0.205**	(0.070)
Government	0.033	(0.027)
2011	-0.392	(0.657)
2012	1.178	(1.143)
2013	0.159	(0.825)
2014	0.232	(0.723)
2015	0.671	(0.868)
2016	0.387	(0.800)
2017	-0.575	(0.543)
2018	0.403	(0.649)
2019	-0.079	(0.868)
Constant	0.453	(1.033)
Observations	1116	
Countries	163	
R^2	0.425	

Note. Standard errors are in parentheses; * $p < 0.05$, ** $p < 0.01$.

4.3 Fixed effects model 2

The results of the second model are shown in Table 4.4. This model shows that the within-country variation of *GDP growth* cannot be explained by the variable *IHR*, as it is not significant.

Based on the Granger causality test, shown in Appendix 5, we cannot reject the null hypothesis that there is an absence of causality for all countries in the panel and conclude that there is no Granger causality. Thus, *GDP growth* does not forecast *IHR*. What is surprising is that the variable *Loglabour* shows an opposite sign for the coefficient compared to the previous model. *Import* and *Government* are significant in this model, which supports the fact that these variables are drivers of economic growth.

Table 4.4 Fixed effects results for the relationship between IHR and GDP growth

	Model 2	
Variable	*Coef.*	*Std. Err.*
IHR	-0.142	(0.206)
Export	0.205**	(0.010)
Import	0.068**	(0.012)
LogLabour	-8.289**	(2.431)
Government	0.037*	(0.015)
Household	0.116**	(0.024)
Year		
2011	-0.327	(0.496)
2012	0.873	(0.526)
2013	0.585	(0.541)
2014	0.742	(0.555)
2015	-1.075	(0.606)
2016	1.206	(0.611)
2017	0.368	(0.611)
2018	-1.226*	(0.596)
2019	1.205	(0.630)
Constant	127.018**	(36.774)
Observations	1329	
R^2(within)	0.432	
Countries	174	

Note. Standard errors are in parentheses; * $p < 0.05$, ** $p < 0.01$.

4.4 Fixed effects model 3

In Table 4.5 the results are shown of the fixed effects model where model 3a and 3b compare the GDP growth forecasts of the first quarter to all previous first quarters. Whereas model 3c and 3d do this for the second quarter. In models 3a and 3b, *IHR* is negative, but not significant. This indicates that the difference in GDP growth among countries is not significantly influenced and explained by *IHR*. Model 3c and 3d show similar results that *IHR* is not significant. The coefficient does change from negative to positive when compared to the first quarter. This difference could be explained due to the fact that *GDP growth* is not seasonally adjusted.

When the variable *Spread* is added in model 3b, the value for *IHR* remains insignificant when compared to model 3a. The coefficient does not change considerable, which could indicate that *Spread* does not have an indirect effect on *GDP growth* through *IHR*.

When adding the variable *Spread* to model 3d, the variable *IHR* changes noticeably compared to model 3c. However, due to the fact that nor *Spread* nor *IHR* is significant, we cannot say that there is an indirect effect. One thing to notice is that the coefficients for *Spread* and the constants of both models (Q1 vs. Q2) are very different from each other. This could be explained since the GDP growth of the first quarter is consistently lower than that of the second quarter. As a result of *Spread* not being significant to *GDP growth*, the notion that the spread of the pandemic influences economic growth has found no support.

Table 4.5 Fixed effects results for the relationship between IHR and GDP growth during the Covid-19 pandemic with the first and second quarters in model a-b and c-d respectively

	Model 3a (Q1)		**Model 3b (Q1)**		**Model 3c (Q2)**		**Model 3d (Q2)**	
Variable	*Coeff.*	*Std. Err.*	*Coeff.*	*Std. Err.*	*Coeff.*	*Std. Err.*	*Coeff.*	*Std. Err.*
Spread			-0.310	(22.095)			1.242	(1.585)
IHR	-2.500	(1.531)	-2.499	(1.542)	0.744	(0.445)	0.651	(0.461)
Export	1.735	(1.202)	1.734	(1.212)	-0.235	(0.382)	-0.205	(0.385)
Import	-1.461	(1.038)	-1.460	(1.048)	0.315	(0.333)	0.269	(0.339)
LogLabour	-82.413*	(33.888)	-82.490*	(34.528)	43.572**	(10.848)	42.284**	(10.997)
Government	1.037	(1.785)	1.040	(1.810)	-0.001	(0.567)	-0.003	(0.568)
Household	-1.651	(3.593)	-1.657	(3.636)	3.068**	(1.153)	3.070**	(1.155)
2015								
Q1	1.087	(1.788)	1.088	(1.800)				
Q2					-0.404	(0.575)	-0.385	(0.577)
2016								
Q1	1.268	(1.813)	1.269	(1.826)				
Q2					-0.419	(0.582)	-0.396	(0.584)
2017								
Q1	2.791	(1.947)	2.793	(1.965)				
Q2					-1.265	(0.625)	-1.233	(0.628)
2018								
Q1	1.658	(1.984)	1.661	(2.003)				
Q2					-0.747	(0.623)	-0.748	(0.624)
2019								
Q1	1.081	(1.961)	1.083	(1.981)				
Q2					-1.160	(0.618)	-1.175	(0.620)
2020								
Q1	-7.204**	(1.985)	-7.183**	(2.518)				
Q2					-9.125**	(0.625)	-9.539 **	(0.820)
Constant	1343.973*	(554.731)	1345.227*	(565.184)	-709.160**	(10.072)	-687.999**	(180.068)
Observations	112		112		112		112	
R^2 (within)	0.437		0.437		0.860		0.861	
Countries	16		16		16		16	

Note. Standard errors are in parentheses; * p < 0.05, ** p < 0.01.

V. Conclusion and recommendations

When comparing our results with our hypotheses, we can say that hypothesis 1, 2 and 3 have been rejected. With the first hypothesis, I hypothesized that countries, that score higher in terms of the core capacity indicators, experience higher economic growth. However, model 1 shows that higher scores of the core capacity indicators do not translate into higher economic growth. The relation was found positive, but not significant.
Hypothesis 2 tested the impact of improving the performance of core capacity indicators on economic growth. I expected that this effect would be positive. The results in model 2 showed that this relation is negative and not significant. One plausible explanation, for the CCIs in model 1 and 2 being not significant, might be that countries have different policies on which they base their decisions. Countries will focus on different aspects, depending on what the government will find important. Depending on whether the government is more left-wing or right-wing, this might change the decision of the government. Another simpler explanation for the CCIs not being significant could be that they are not a determining factor for economic growth. This would imply that improving performance on the CCIs does not result in an increase in economic growth.

Hypothesis 3a looked at the relationship between core capacity indicators and economic growth in the first and second quarters of 2020. I expected this effect to be positive. Model 3 showed a negative relationship between the CCIs and economic growth in the first quarter and a positive relationship in the second quarter. In both cases the core capacity indicators were not significant. One possible explanation for this difference in results would be that *GDP growth* was not seasonally adjusted, due to which the results between the two quarters cannot be compared with each other. The reason why the CCIs are not significant might be that, in case of a pandemic, the foremost priority of the government is to contain the pandemic and not to limit the economic impact of the pandemic.
Lastly, hypothesis 3b looked at the effect the spread of the pandemic has on the relation between the CCIs and economic growth in the first and second quarters of 2020. Here, the expectation was that the variable *Spread* would be an indirect effect. Due to the fact that the variables CCIs and *Spread* were not significant, we cannot say that there is an indirect effect.

The analysis shows that the spread of the pandemic does not influence how severe a country's economic growth was impacted.

In summary, in all three models we found that the relationship between the core capacity indicators and economic growth was not significant. The effect of the spread of the pandemic on economic growth was also found not to be significant.

Based on these results, the answer to our research question is that it seems that the core capacity indicators are not related to a country's GDP growth in case of a pandemic. Furthermore, based on the results of the analysis of model 1 and 2, in the period absent the pandemic, there is no support for the relation between health regulations and economic growth.

One important limitation of my study is that *GDP growth* of the first and second quarters of 2020 are forecasts. There is a level of uncertainty with using forecasts instead of the actual GDP growth. Another limitation of this study lies in the fact that more relevant control variables could be added. For instance the main industry type (agricultural, manufacturing or knowledge-based), the inter-connectiveness between various countries in regards to trade, the presence of political unrest and whether a country is already in the middle of an emergency situation would all be factors that could bias or influence the analysis. A third limitation is that inflation is not taken into account in the models as GDP growth is nominal instead of real. Additionally, GDP growth is not seasonally adjusted, which means the models with the first quarters cannot be compared with the second quarters.

Some recommendations for further research would be to look at the long-term effect of the core capacity indicators on the economic impact of the pandemic. In the current study, I examined only the first half of 2020 for the economic impact of the pandemic. Another aspect that would be useful to get more insight into is in how a government's decision on how to contain the pandemic influences the economic impact of the pandemic. One aspect that would be interesting to research would be including the political orientation of the government in the models. Even though the core capacity indicators could represent how well a country can potentially control a pandemic, this does not mean that every country is willing to take the strictest measures that they are capable of.

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Appendix

1. Principal Component Analysis

Principal Component Analysis

Factor	***Eigenvalue***	***Proportion***
Factor1	4.340	0.6200
Factor2	0.654	0.093
Factor3	0.521	0.075
Factor4	0.488	0.070
Factor5	0.394	0.056
Factor6	0.323	0.046
Factor7	0.280	0.040
Observations	1493	
Retained factors	1	
Number of params	7	

Factor loadings

Variable	*Factor1*	*Uniqueness*
Coordination	0.790	0.376
Surveillance	0.730	0.467
Response	0.869	0.245
Preparedness	0.850	0.278
Riskcommunication	0.813	0.339
Laboratory	0.752	0.435
PointsofEntry	0.692	0.521

Scoring coefficients for the prediction obtained after the estimation

Variable	*Factor1*
Coordination	0.182
Surveillance	0.168
Response	0.200
Preparedness	0.196
Riskcommunication	0.187
Laboratory	0.173
PointsofEntry	0.159

2. Cronbach's Alpha

Cronbach's Alpha	
Average interitem covariance	371.185
Number of items in the scale	7
Scale reliability coefficient	0.891

3. *List of countries*

Countries Model 1

Afghanistan	Djibouti	Lao People's	Russian Federation
Albania	Dominican Republic	-Democratic Republic	Rwanda
Algeria	Ecuador	Latvia	Saint Lucia
Angola	Egypt	Lebanon	Saint Vincent and the
Argentina	El Salvador	Lesotho	Grenadines
Armenia	Equatorial Guinea	Liberia	Samoa
Australia	Eritrea	Libya	Sao Tome and Principe
Austria	Estonia	Lithuania	Saudi Arabia
Azerbaijan	Eswatini	Luxembourg	Senegal
Bahamas	Ethiopia	Madagascar	Serbia
Bahrain	Finland	Malawi	Sierra Leone
Bangladesh	France	Malaysia	Singapore
Barbados	Gabon	Mali	Slovakia
Belarus	Gambia	Malta	Slovenia
Belgium	Georgia	Mauritania	South Africa
Belize	Germany	Mauritius	South Sudan
Benin	Ghana	Mexico	Spain
Bolivia	Greece	Mongolia	Sri Lanka
Bosnia and	Guatemala	Montenegro	Sudan
-Herzegovina	Guinea	Morocco	Suriname
Brazil	Guinea-Bissau	Myanmar	Sweden
Brunei	Guyana	Namibia	Switzerland
-Darussalam	Haiti	Nepal	Tajikistan
Bulgaria	Honduras	Netherlands	Thailand
Burkina Faso	Hungary	New Zealand	Timor-Leste
Cote d'Ivoire	Iceland	Nicaragua	Togo
Cabo Verde	India	Nigeria	Tonga
Cameroon	Indonesia	Norway	Trinidad and Tobago
Canada	Iran	Oman	Tunisia
Central African	Iraq	Pakistan	Turkey
-Republic	Ireland	Panama	Turkmenistan

Chad
Chile
China
Colombia
Comoros
Congo
Costa Rica
Croatia
Cuba
Cyprus
Czechia
Denmark
Israel
Italy
Jamaica
Japan
Jordan
Kazakhstan
Kenya
Kuwait
Kyrgyzstan
Paraguay
Peru
Philippines
Poland
Portugal
Qatar
Republic of Korea
Republic of Moldova
Republic of North Macedonia
Romania
Uganda
Ukraine
United Arab Emirates
United Kingdom of Great Britain and Northern Ireland
United Republic of Tanzania
United States of America
Uruguay
Uzbekistan
Venezuela
Viet Nam
Yemen
Zambia
Zimbabwe

Countries Model 2

Afghanistan	Dominican Republic	Libya	Saudi Arabia
Albania	Ecuador	Lithuania	Senegal
Algeria	Egypt	Luxembourg	Serbia
Angola	El Salvador	Madagascar	Sierra Leone
Argentina	Equatorial Guinea	Malawi	Singapore
Armenia	Eritrea	Malaysia	Slovakia
Australia	Estonia	Maldives	Slovenia
Austria	Eswatini	Mali	Solomon Islands
Azerbaijan	Ethiopia	Malta	South Africa
Bahamas	Fiji	Mauritania	South Sudan
Bahrain	Finland	Mauritius	Spain
Bangladesh	France	Mexico	Sri Lanka
Barbados	Gabon	Mongolia	Sudan
Belarus	Gambia	Montenegro	Suriname
Belgium	Georgia	Morocco	Sweden
Belize	Germany	Mozambique	Switzerland
Benin	Ghana	Myanmar	Tajikistan
Bhutan	Greece	Namibia	Thailand
Bolivia	Guatemala	Nepal	Timor-Leste
Bosnia and	Guinea	Netherlands	Togo
-Herzegovina	Guinea-Bissau	New Zealand	Tonga
Botswana	Guyana	Nicaragua	Trinidad and Tobago
Brazil	Haiti	Niger	Tunisia
Brunei	Honduras	Nigeria	Turkey
-Darussalam	Hungary	Norway	Turkmenistan
Bulgaria	Iceland	Oman	Uganda
Burkina Faso	India	Pakistan	Ukraine
Burundi	Indonesia	Panama	United Arab Emirates
Cote d'Ivoire	Iran	Papua New Guinea	United Kingdom of Great
Cabo Verde	Iraq	Paraguay	-Britain and Northern Ireland
Cambodia	Ireland	Peru	United Republic of Tanzania
Cameroon	Israel	Philippines	United States of America
Canada	Italy	Poland	Uruguay

Central African
-Republic
Chad
Chile
China
Colombia
Comoros
Congo
Costa Rica
Croatia
Cuba
Cyprus
Czechia
Denmark
Djibouti

Jamaica
Japan
Jordan
Kazakhstan
Kenya
Kuwait
Kyrgyzstan
Lao People’s
-Democratic Republic
Latvia
Lebanon
Lesotho
Liberia

Portugal
Qatar
Republic of Korea
Republic of Moldova
Republic of North
-Macedonia
Romania
Russian Federation
Rwanda
Saint Lucia
Saint Vincent and the
Grenadines
Samoa
Sao Tome and
-Principe

Uzbekistan
Vanuatu
Venezuela
Viet Nam
Yemen
Zambia
Zimbabwe

Countries Model 3

Austria
Belgium
Czech Rep.
France
Germany
Indonesia
Italy
Korea, Rep. of

Latvia
Lithuania
Mexico
Portugal
Singapore
Spain
Sweden
United States

4. Durbin-Wu-Hausman test

	Coefficients	
	fe	*re*
IHR	-0.142	-0.072
Export	0.205	0.174
Import	0.068	0.066
LogLabour	-8.289	0.131
Government	0.037	0.040
Household	0.116	0.179
year		
2011	-0.327	-0.462
2012	0.873	0.835
2013	0.585	0.005
2014	0.742	0.193
2015	-1.075	0.334
2016	1.206	0.219
2017	0.368	-0.649
2018	-1.226	0.152
2019	1.205	-0.159

Test: H0: difference in coefficients not systematic

Chi2(**15**) = 172.18

Prob>chi2= 0.000

5. Granger causality

Dumitrescu & Hurlin (2012) Granger non-causality test results	
Lag order: 1	
W-bar =	2.341
Z-bar =	6.074 (p-value = 0.000)
Z-bar tilde=	1.606 (p-value = 0.108)

H-: **IHR** does not Granger-cause **GDPgrowth**.

H1: **IHR** does Granger-cause **GDPgrowth** for at least one panelvar (**Country**).