Understanding the effectiveness of non-pharmaceutical interventions against the COVID-19-pandemic in Nordic countries

I. Abstract

II. Introduction

Background:

- COVID-19 caused biggest lockdowns in European countries since the second world war.
- Politicians and researchers were under a lot of pressure to decide the best solution with little amount of data and time to deal with the pandemic.
- *A key challenge*: The estimate for potential future deaths should be an important factor for a country to create a strategy against the pandemic but it should not be the only one. Lockdowns have many negative side effects which may be very difficult to calculate numerically. F.e. loneliness, drug problems, unemployment, which all strongly correlate with mental health problems, increase during lockdowns.

What is the goal of this research?

- Understanding the nature how non-pharmaceutical interventions worked in Europe.
- Understanding the reasons why the COVID-19-pandemic did not effect as much on Nordic countries as on many other European countries.

What is this research important?

- This research provides data and discussion what kind of strategy Nordic countries should have against the possible second wave of COVID-19 or future pandemics.

Hypothesis:

- In future pandemics, Nordic countries should be critical before implementing as strong non-pharmaceutical interventions as the majority of other European countries.

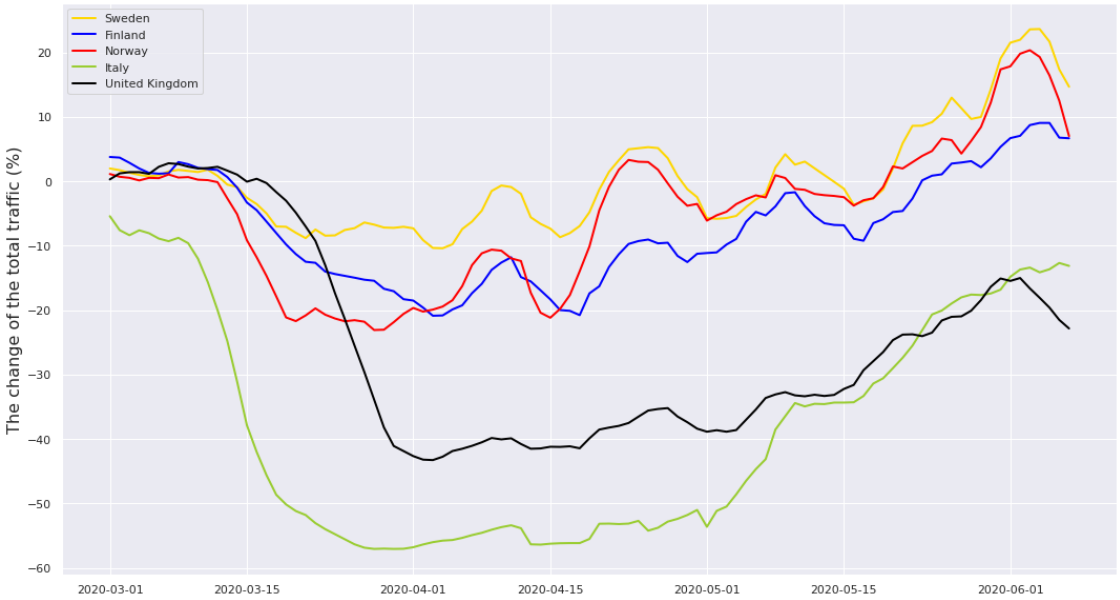

Fig. 1. The Nordics had to change their behaviour less than Brits or Italians

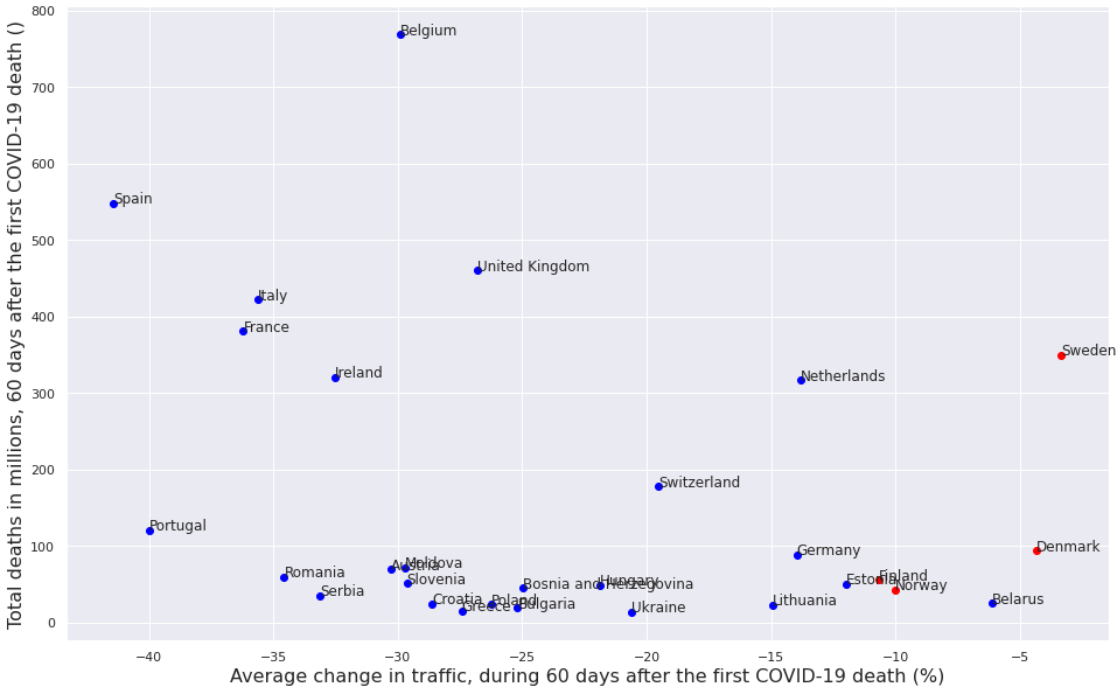

Fig. 2. Getting the traffic data down inside a country did not imply that the country would do particularly well against the pandemic!

III. METHOLOGY

Data used in the research:

- *Our World in Data COVID-19 dataset:* 'Our World in Data'-organisation has collected a lot of interesting data about the COVID-19 from different sources including ECDC, United Nations, World Bank and Global Burden of Disease. This research paper's most essential data collected by them is the data on infected and deaths in different countries. Also, country-wise data like the population density, the percentage of over 65-year-olds of the population, the proportion of male and female smokers in the country, country-wise information about the GDP and diabetes, is used in this project.
- *Google's traffic data:* Google provides anonymized insights from products such as Google Maps for researchers to help them to make critical analysis to combat COVID-19. Google has divided their traffic data country-wise into 6 parts: retail & recreation, grocery & pharmacy, parks, transit stations, workplaces and residential. The traffic data's baseline is counted as a median value of multiple days. Day-to-day changes should not be emphasized too much because they are effected on many different factors, f.e. the weather and public events. Also comparing weekdays to weekends is not recommended by Google.
- *The Oxford COVID-19 Government Response Tracker (OxCGRT):* A team of over one hundred Oxford University students and staff has collected information on several different common policy responses that governments have taken to respond to the pandemic. For information about school closing, workplace closing, cancelling public events, restrictions on gathering size, closing public transport, staying at home requirements, restrictions on internal movement and international travel and public information campaign, has been created a score taking the ordinal value and adding an extra half-point if the policy is general rather than targeted, if applicable. Furthermore, these variables are rescaled by their maximum value to create a score between 0 and 100.

Assumptions:

- Getting the traffic data down slows down the spread of the virus. Reasoning: Several articles (Ferretti et al 2020, ECDC report, LSHTM report) have pointed out pre-symptomatic and asymptomatic infections play a significant role in the spread of COVID-19. Indeed, this observation is an argument it may not be enough to get the symptomatic cases to stay at home but also governmental restrictions should be implemented to get the people's

movement down and therefore the pandemic under control.

- Getting the traffic data down has a strong correlation with mental health and economy.

Definitions:

- Let's define a death limit $d = 5$. Let's denote the first date when at least d people die with $t_{i,d}$. Let's denote the order of this date with $t'_{i,d} = 10$. The time interval that is investigated is $T_i = \{0, 1, \ldots, 9, t'_{i,d}, 11, \ldots, 69, 70\}$. The time interval is defined this way because COVID-19 hit the European countries on very different dates.
- Let's define the total negative harm of the COVID-19-pandemic in a country $H(\alpha, \beta)$ to be a positive non-decreasing function where $\alpha \in \mathbb{R}$ is the decrease of the traffic data and $\beta \in \mathbb{N}$ the number of deaths per million in a country i during the time period T_i. The fundamental aim is to minimize $H(\alpha, \beta)$ even if it is not defined what the trade-off between the change in average traffic and deaths should be.
- Each country's time interval is divided to NPI-intervals. A new NPI-interval starts when a country is implementing new non-pharmaceutical interventions. Let's denote a country i's NPI-interval j with $N_{i,j} \subset T_i$.
- Let a NPI-interval $N_{i,j}$ be called successful if
    1) The average traffic during the new period must be lower than the average of previous time period
    2) More conditions can be defined (f.e. if the traffic data changes during the time period too much, the NPI is considered unsuccesful)

Method 1, Finding correlations between the infected and the traffic coefficients:

- *Moral:* People actively follow the media. If there occurs more infected cases than before, people will take the implemented non-pharmaceutical interventions seriously. On contrary if the number of new infected cases does not increase, it is difficult to discover major changes in people's traffic behaviour or people change their behaviour only for a short time period.
- Practically, this behaviour is investigated with the correlation between infected and traffic coefficients. The following pictures 3, 4, 5, 6 and 7 explain what the infected and the traffic coefficients are and how they correlate with each other. In the pictures 5, 6 and 7 there has been filtered out all the NPI-intervals $N_{i,j}$ which are shorter than 3 days.

Method 2, making analysis of indicators which prevented the success of Nordic countries:

- No analysis done yet.

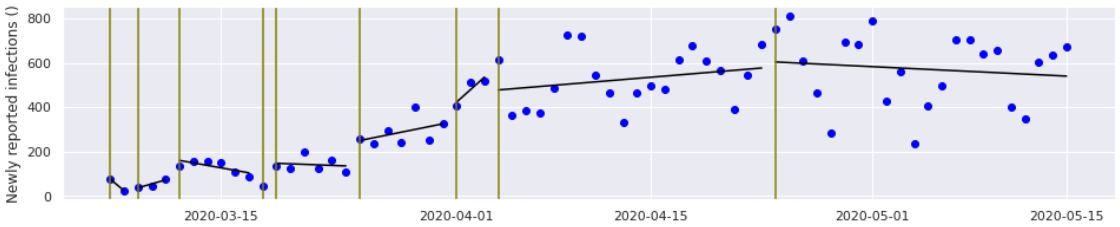

Fig. 3. Example: Sweden. There has been fitted a line using linear regression for each NPI-interval's infected data. A line's infected coefficient can be interpreted as the average change of newly infected.

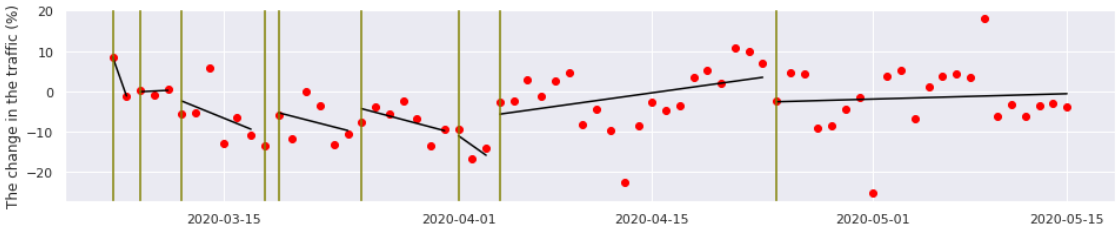

Fig. 4. Example: Sweden. There has been fitted a line using linear regression for each NPI-interval's change in traffic data. A line's traffic coefficient can be interpreted as the average change of the total traffic.

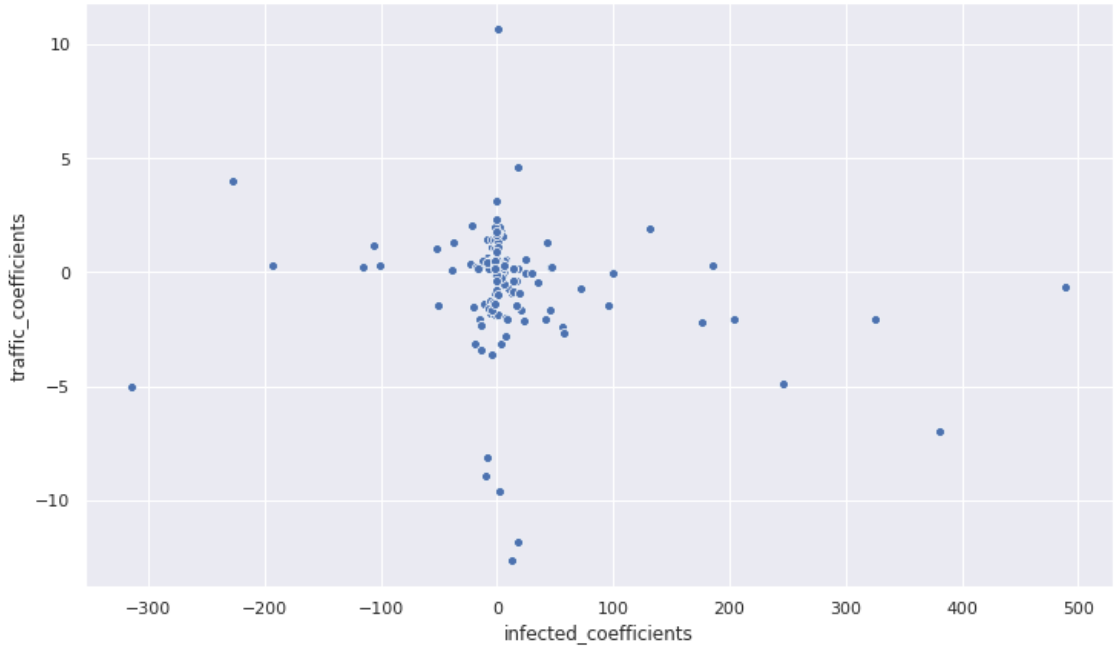

Fig. 5. All the infected and traffic coefficients of long enough NPI-intervals in European countries

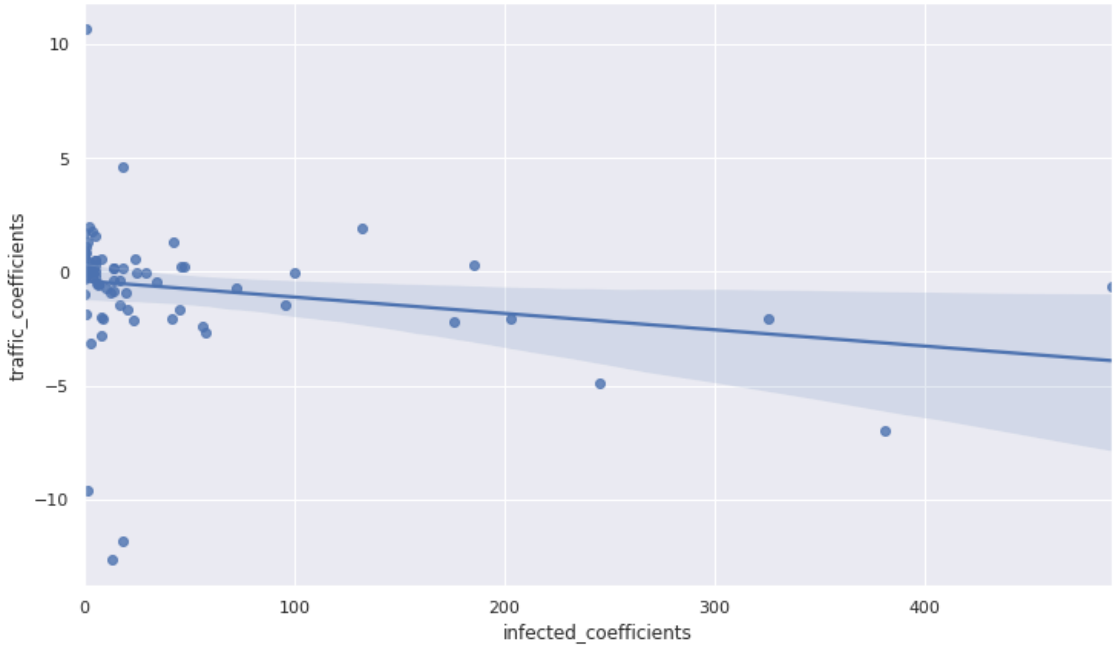

Fig. 6. Considering only positive infected coefficients, infected and traffic coefficients correlated negatively with each other. Correlation: -0.21 and its p-value: 0.068

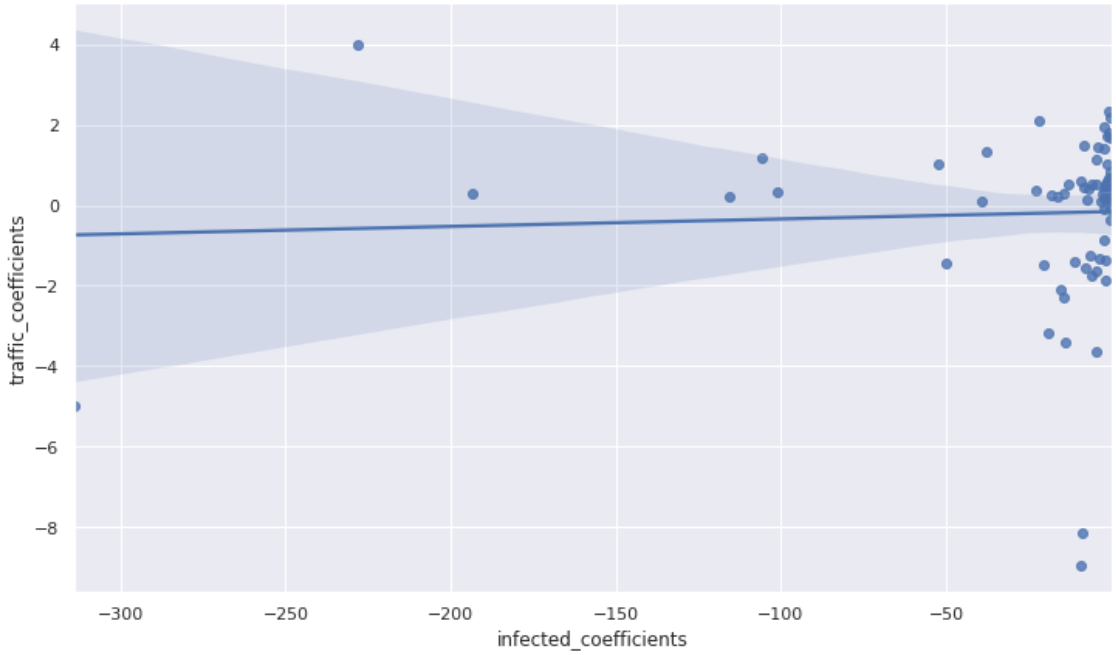

Fig. 7. Considering only negative infected coefficients, it is difficult to say anything about the correlation between infected and traffic coefficients

IV. Potential results

1) There is a huge possibility that people's own voluntary decision about how they behave is shaping more their behaviour than what the governments are telling people to do.
2) There are many reasons why COVID-19-pandemic does not spread as fast in Nordic countries as in many other European countries.

V. Discussion

- *Which countries are doing well in this pandemic?* Many European countries implemented very strong lockdowns but based on the antibody tests many of these countries have now a very small proportion of the population with immunity. Also, the number of COVID-19 infections is more or less the same than at the beginning of the pandemic. Has there been any practical development with the pandemic except there were implemented strong and expensive lockdowns? Can European countries keep the infections down without as strong NPIs as they implemented in the first wave of COVID-19?
- If the result of this research is that in general European citizens wanted to stay at home when the epidemic rapidly started to spread, a government's passive, suggestion-based strategy should work particularly well in Nordic countries. Namely, the Nordics are among those who have the highest trust in public institutions in the world.
- The new decade will show how mental problems and drug use increased in countries with strong NPIs.

VI. Some new references/ links

- https://www.google.com/covid19/mobility/
- https://ourworldindata.org/coronavirus-source-data
- https://www.bsg.ox.ac.uk/research/research-projects/coronavirus-government-response-tracker
- https://www.bsg.ox.ac.uk/sites/default/files/2020-05/BSG-WP-2020-032-v6.0.pdf
- https://www.fhi.no/en/id/infectious-diseases/coronavirus/coronavirus-modelling-at-the-niph-fhi/