# Die Wirksamkeit von Lockdowns

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# Präventionsparadox

Szenarien im März 2020

- Virologe Drosten in Osnabrücker Zeitung: Pandemie kommt zum Stillstand wenn 2/3 infiziert, also 56 Mio in Deu; bei Mortalität von 0.5%: 278.000 Tote
- Bundeskanzlerin Merkel: 60-70% Infizierte. Eichenbaum et al (2020) beziehen sich darauf und kalibrieren Modell auf 1 Mio Tote für USA als baseline Szenario

Situation im Juni 2020

- Deutschland: 9.000 Tote
- USA: 130.000 Tote

Präventionsparadox

- Erfolg einer Präventionsmaßnahme lässt sie unnötig erscheinen
- Aber: Ausbleiben der Katastrophe beweist nicht Erfolg der Maßnahme

# Messung der Wirksamkeit des Lockdowns erfordert kontrafaktische Analysen

Wird in Wirtschaftswissenschaften ständig gemacht

- Beitrag zur interdisziplinären Analyse der Coronakrise

Do Lockdowns work? A counterfactual for Sweden

- Mit Benjamin Born (Frankfurt School)  und Alexander Dietrich (Tübingen) 
- Publiziert in COVID-Economics: Vetted and real-time papers (Ausgabe 16), Mai 2020
- Neufassung in Vorbereitung: nun liegen Daten bis zum Ende des lockdowns vor

Im Folgenden: Vorstellung der laufenden Arbeit

- Foliensprache: Englisch

# 1. Introduction

Many countries imposed some kind of lockdown in order to limit the spread of COVID-19

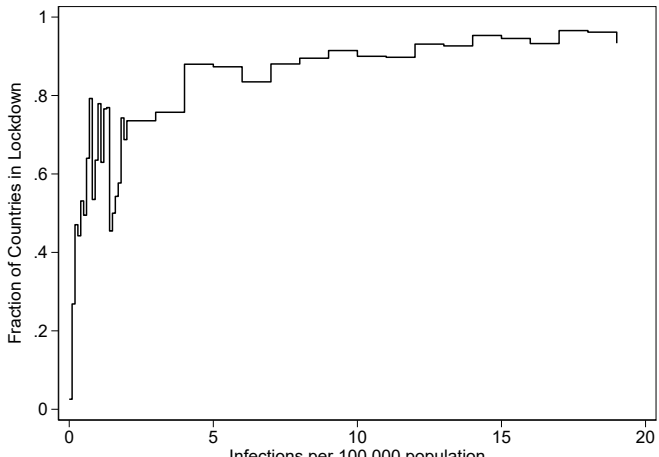
- Lockdowns impose severe economic and social costs (still to be assessed)
- Understanding trade-offs, requires us to quantify benefits: By how much did lockdowns limit the number of COVID-19 infections and/or deaths?

Alternative strategies to quantify the effect of lockdowns or more generally, non-pharmaceutical interventions (NPI)

- Model simulations: requires restrictive assumptions
- Data analysis: little cross-country variation in (timing of) lockdowns

# Many countries implemented lockdown measures early on

## Observations for 90 countries (and 3.5 billion people)

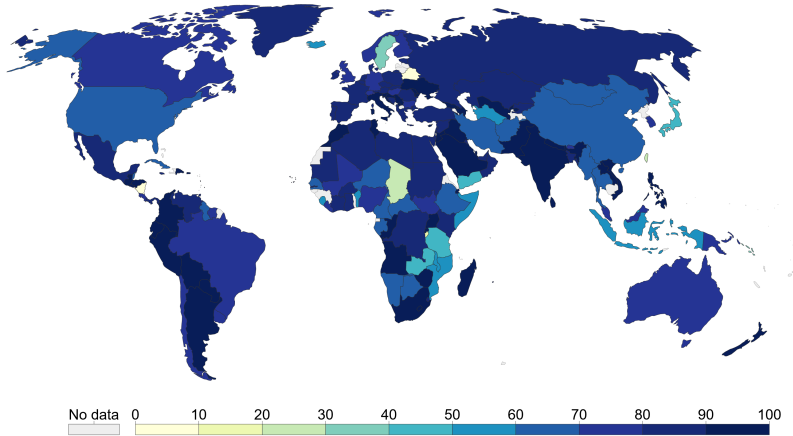


# COVID-19: Government Response Stringency Index, Apr 1, 2020

Our World in Data

The Government Response Stringency Index is a composite measure based on nine response indicators including school closures, workplace closures, and travel bans, rescaled to a value from 0 to 100 (100 = strictest response).

This index simply records the number and strictness of government policies, and should not be interpreted as 'scoring' the appropriateness or effectiveness of a country's response.




Source: Hale, Webster, Petherick, Phillips, and Kira (2020). Oxford COVID-19 Government Response Tracker – Last Updated 20th May.
OurWorldInData.org/coronavirus • CC BY

# This paper: case study for Sweden

One of the few countries w/o lockdown or large-scale NPIs

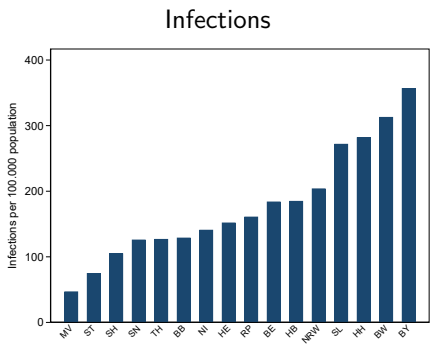
- Some recommendations regarding social distancing
- Ban on gathering of 50 people or more

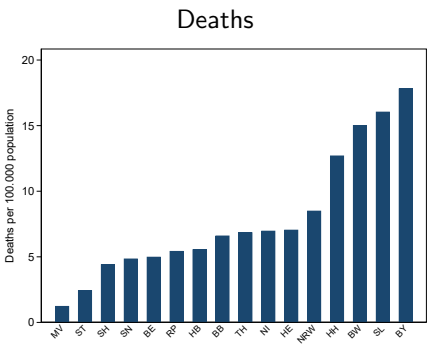
Public discussion

- Compares Sweden to say Norway, observes larger number of death and concludes that not having a lockdown is very costly
- But difference in outcome (infections/deaths) does not identify effect of policy
- Just because two countries are neighbors does not mean any difference in outcomes is the result of different policies

# Example: different outcomes for German states . . .

As of May 18, 2020



# This paper: appropriate benchmark for Sweden

Build synthetic control unit (Abadie and Gardeazabal 2003; Abadie et al. 2010, 2015)

- Use "donor pool" of European countries with lockdowns
- High degree of homogeneity with Sweden, but wide range of COVID-19 outcomes

Study effect of counterfactual lockdown imposed from March 18–May 19, 2020

- Effect kicks in late: detect virtually no effect during first 4 weeks (first version of the paper, published on May 11 in *Covid Economics: vetted and real-time papers*)
- At the end of lockdown period: infections reduced by 45% and deaths by 33%
- NB: focus on lockdown period in control unit because infection dynamic change afterwards to the extent that virus still around

# Estimates of lockdown effect in the literature

Flaxman et al (Nature 2020): Estimate the effect of NPI up to May 4

- Germany: 570,000 deaths instead of 6,800 (reduction due to NPI: 99%)
- But also Sweden: 28,000 instead of 2,800 (reduction due to NPI: 90%)

Friedson et al (2020): synthetic control to study California's shelter-in-place-order issued

- W/o lockdown 2100 rather than 1200 deaths by end of April (reduction: 42%)

Dehning et al (Science 2020): quantify lockdown effect in estimated SIR models

- Growth rate of infections declines from 0.43 to 0.09

Chudik et al (2020) simulate SIR model and confront with data from Chinese provinces

- Mandated social distancing required to flatten the curve

# 2. Approach and data

Construct lockdown-scenario counterfactual for Sweden using data-driven approach

- "Doppelganger" (Born et al 2019)

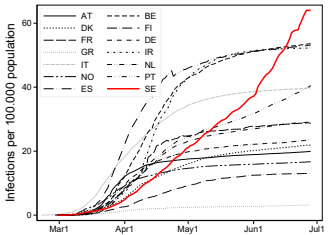
Synthetic control approach (Abadie and Gardeazabal 2003; Abadie et al. 2010, 2015)

1. Set up **donor pool**: 13 countries European countries with population larger than 1 million (Western EU, plus Norway)
2. Compute weighted average across countries in the donor pool (doppelganger) in order to match targets prior to any lockdown: **lockdown treatment** arguably random
3. Developments in doppelganger after treatment serves as counterfactual for Sweden: difference in outcomes captures **causal effect** of treatment

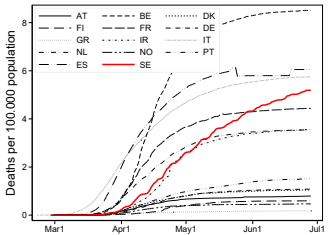
# Sweden v countries in donor pool against calender time

Data source: Johns Hopkins University (Dong et al 2020)

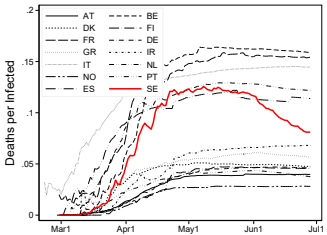
Infections




Deaths




Deaths per infected



# Aligning observations across countries

Countries in donor pool

- First cases by mid March in most countries
- Initialize observations: day 1 is when number of infected larger than one per million inhabitants

Time until lockdown similar in donor pool countries

- Minimum time: 13 days in Spain and Portugal
- Maximum time: 24 days in Ireland

Lockdown phased out in most countries in second half of May

# Lockdowns in donor pool countries v Sweden

| | Lockdown | | | | Days to | |
|---|---|---|---|---|---|---|
| | Start | End | | Day 1 | Lockdown 1 | death per $10^5$ |
| Austria | 16.03 | 01.05 | non-essential shops closed, ban on gatherings $> 5$ | 29.02 | 16 | 30 |
| Belgium | 18.03 | 11.05 | non-essential shops closed, ban on gatherings $> 2$ | 03.03 | 15 | 21 |
| Denmark | 18.03 | 18.05 | non-essential shops closed | 03.03. | 15 | 25 |
| Finland | 16.03 | 01.06 | governm. agencies closed, ban on gatherings $>10$ | 01.03. | 15 | 42 |
| France | 17.03 | 11.05 | non-essential shops closed, ban on gatherings $>2$ | 29.02. | 17 | 22 |
| Germany | 23.03 | 06.05 | non-essential shops closed, ban on gatherings $>2$ | 01.03. | 22 | 31 |
| Greece | 23.03 | 04.05 | non-essential shops closed, stay-at-home-order | 05.03. | 18 | 43 |
| Ireland | 28.03 | 08.06 | non-essential shops closed, stay-at-home-order | 04.03. | 24 | 24 |
| Italy | 09.03 | 18.05 | non-essential shops closed, stay-at-home-order | 22.02. | 16 | 17 |
| Netherlands | 24.03 | 11.05 | non-essential shops closed, ban on gatherings | 02.03. | 22 | 20 |
| Norway | 13.03 | 01.06 | restaurants, bars closed, ban on gatherings $>5$ (24.03) | 28.02 | 14 | 35 |
| Portugal | 19.03 | 01.06 | no shops closed, governm. agencies closed, stay-at-home advice | 06.03 | 13 | 23 |
| Spain | 14.03 | 08.06 | non-essential shops closed, stay-at-home-order | 01.03. | 13 | 16 |
| Sweden | - | - | No Lockdown imposed, ban on gatherings $>50$ | 29.02. | - | 27 |

# Construction of doppelganger: country weights

Vector of 15 observations for Sweden: $\mathbf{x_1}$

- Time series for Log(infections) between day 1 and day 13
- Country size (10.2 million) and urbanization rate (87%)

Matrix of 15 observations for 13 countries in donor pool: $\mathbf{X_0}$

- Determine vector of 13 country weights $\mathbf{w}$ such that

$$\min(\mathbf{x_1} - \mathbf{X_0}\mathbf{w})'\mathbf{V}(\mathbf{x_1} - \mathbf{X_0}\mathbf{w}),$$

- subject to $w_j >= 0$ for $j = 2, \ldots, 14$, $\sum_{j=2}^{14} w_j = 1$, and $\mathbf{V}$ diagonal weighting matrix

# 3. Results: composition of doppelganger

| | Baseline | I | II | III | IV | V |
|---|---|---|---|---|---|---|
| Austria | $< 0.01$ | $< 0.01$ | 0.43 | $< 0.01$ | 0.10 | $< 0.01$ |
| Belgium | $< 0.01$ | $< 0.01$ | $< 0.01$ | 0.19 | $< 0.01$ | $< 0.01$ |
| **Denmark** | 0.26 | NA | 0.24 | 0.31 | 0.33 | 0.26 |
| **Finland** | 0.19 | 0.13 | NA | 0.14 | 0.18 | 0.19 |
| France | $< 0.01$ | $< 0.01$ | $< 0.01$ | $< 0.01$ | $< 0.01$ | $< 0.01$ |
| Germany | $< 0.01$ | $< 0.01$ | $< 0.01$ | 0.04 | $< 0.01$ | $< 0.01$ |
| Greece | $< 0.01$ | $< 0.01$ | $< 0.01$ | 0.05 | 0.04 | $< 0.01$ |
| Ireland | $< 0.01$ | 0.01 | 0.01 | $< 0.01$ | $< 0.01$ | $< 0.01$ |
| Italy | $< 0.01$ | $< 0.01$ | $< 0.01$ | $< 0.01$ | $< 0.01$ | $< 0.01$ |
| **Netherlands** | 0.39 | 0.41 | 0.27 | NA | 0.35 | 0.40 |
| **Norway** | 0.15 | 0.46 | 0.05 | 0.27 | NA | 0.15 |
| **Portugal** | 0.01 | $< 0.01$ | $< 0.01$ | $< 0.01$ | $< 0.01$ | NA |
| Spain | $< 0.01$ | $< 0.01$ | $< 0.01$ | $< 0.01$ | $< 0.01$ | $< 0.01$ |

# Lockdown period

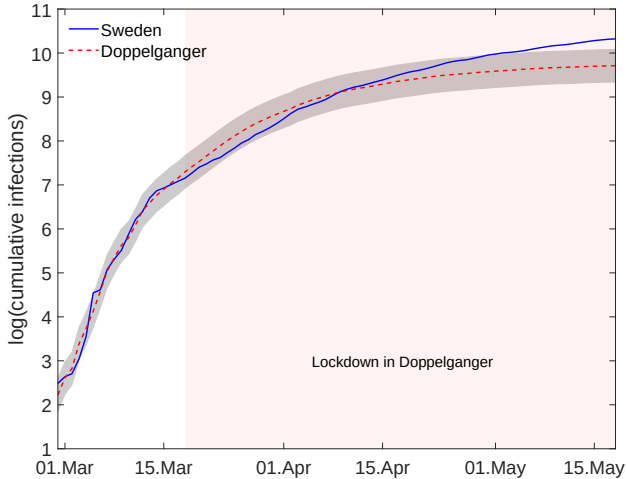
Use doppelganger weights to determine lockdown counterfactual for Sweden

- Start: March 18
- End: May 19

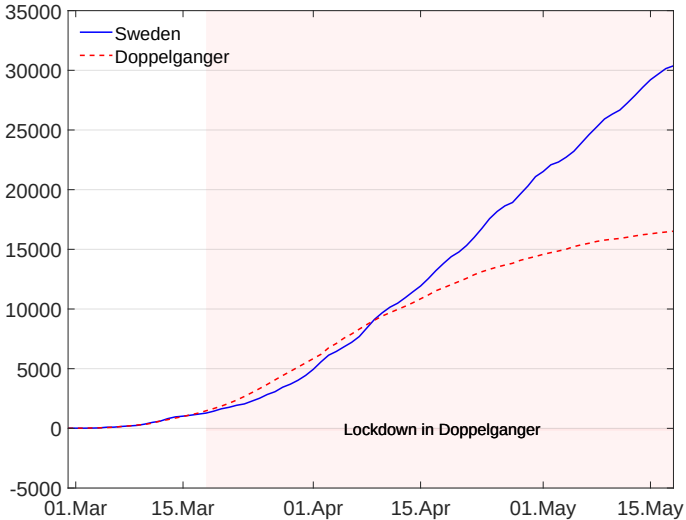
Focus assessment on these 8.5 weeks when lockdown in place

- Lockdown likely to reduce infections and number of deaths for some time after it is lifted
- On the other hand: infection dynamics in doppelganger may change once lookdown is phased out ("second wave")

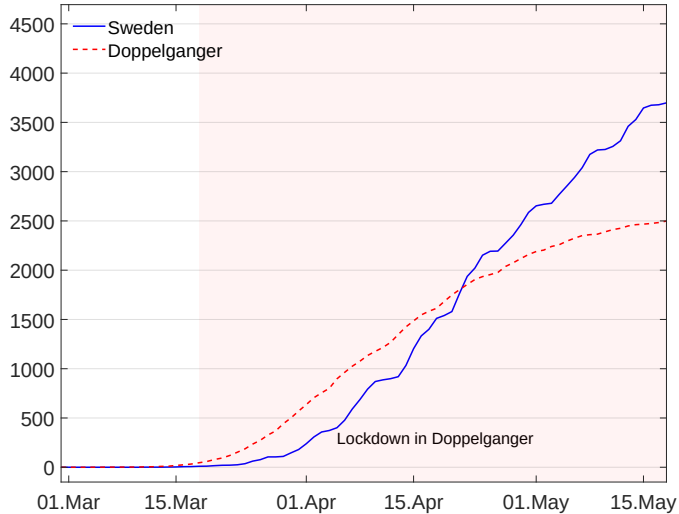
# Infection dynamics Feb 28–May 19, Sweden vs doppelganger



# Absolute number of infections Feb 28–May 19, Sweden vs doppelganger



# Covid-19 deaths Feb 28–May 19: Sweden vs doppelganger



# Lockdown effect delayed and smaller than what some estimates suggests

Counterfactual lockdown in Sweden on March 18

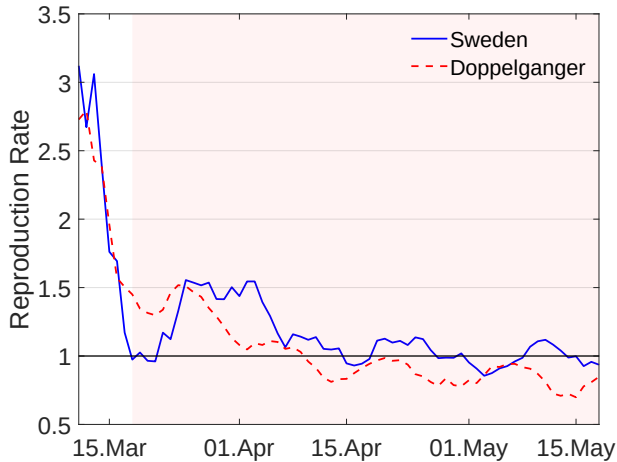
- Basically no effect during first 4 weeks
- Effect becomes visible only from week 5 onwards

At the end of the lockdown period (May 19)

- Number of infections reduced from 30800 to 16600 (45%)
- Number of deaths reduced from 3743 to 2484 (33%)

# Reproduction rate declines strongly before lockdown, but not below 1

Seven-day average



# 4. Alternative doppelgangers

| | Baseline | I | II | III | IV | V |
|---|---|---|---|---|---|---|
| Austria | $< 0.01$ | $< 0.01$ | 0.43 | $< 0.01$ | 0.10 | $< 0.01$ |
| Belgium | $< 0.01$ | $< 0.01$ | $< 0.01$ | 0.19 | $< 0.01$ | $< 0.01$ |
| **Denmark** | 0.26 | NA | 0.24 | 0.31 | 0.33 | 0.26 |
| **Finland** | 0.19 | 0.13 | NA | 0.14 | 0.18 | 0.19 |
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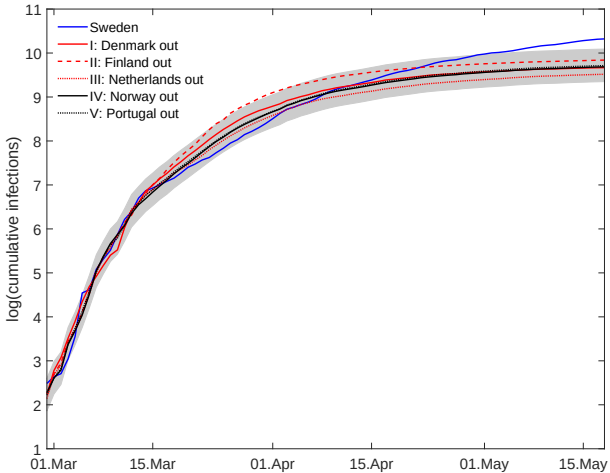
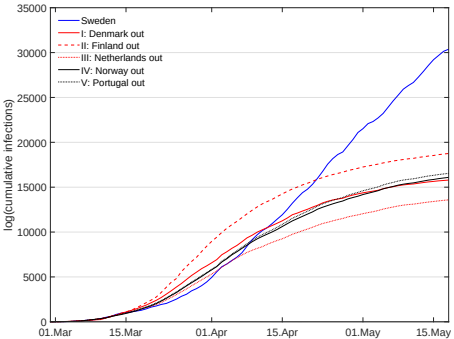
| Germany | $< 0.01$ | $< 0.01$ | $< 0.01$ | 0.04 | $< 0.01$ | $< 0.01$ |
| Greece | $< 0.01$ | $< 0.01$ | $< 0.01$ | 0.05 | 0.04 | $< 0.01$ |
| Ireland | $< 0.01$ | 0.01 | 0.01 | $< 0.01$ | $< 0.01$ | $< 0.01$ |
| Italy | $< 0.01$ | $< 0.01$ | $< 0.01$ | $< 0.01$ | $< 0.01$ | $< 0.01$ |
| **Netherlands** | 0.39 | 0.41 | 0.27 | NA | 0.35 | 0.40 |
| **Norway** | 0.15 | 0.46 | 0.05 | 0.27 | NA | 0.15 |
| **Portugal** | 0.01 | $< 0.01$ | $< 0.01$ | $< 0.01$ | $< 0.01$ | NA |
| Spain | $< 0.01$ | $< 0.01$ | $< 0.01$ | $< 0.01$ | $< 0.01$ | $< 0.01$ |

# Sweden vs doppelganger: result does not depend on any single country

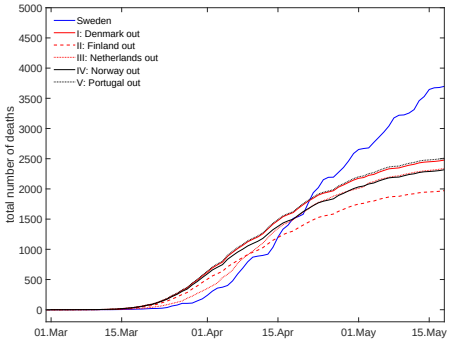


# Sweden vs alternative doppelgangers: Feb 28–May 19

Infections

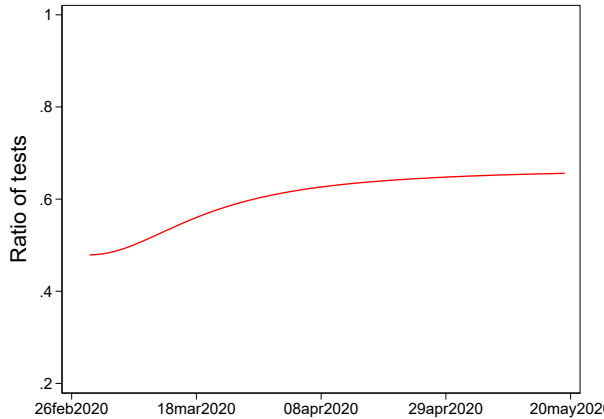



Deaths

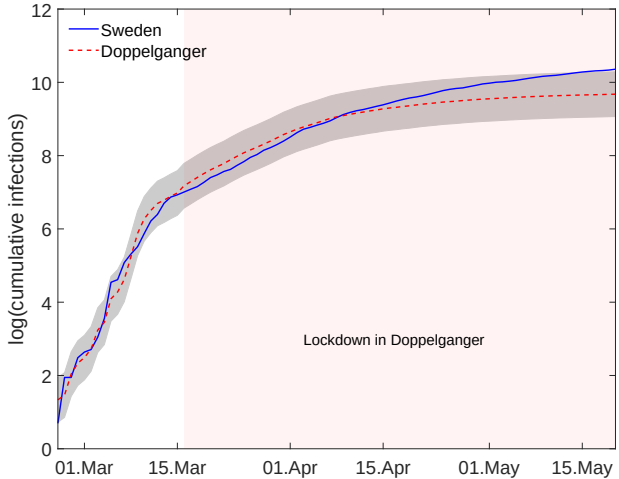


# Sweden vs doppelganger: frequency of testing

Data source: Hasell et al. (2020)



# Sweden vs doppelganger: day 1 when least 1 death per 100000 - 30 days



# 5. A tentative explanation

Voluntary social restraint

- People reduce social interactions voluntarily to reduce risk of becoming infected
- Many extensions of basic SIR model to account for "economic" decisions/behavioral adjustment (Alvarez et al., 2020 Farboodi et al., 2020)

Infection externality

- But adjustment costly since people fail to internalize the costs they impose on others as they become infected
- Size of externality depends on costs of adjustment:
  Eichenbaum et al (2020) v Krueger et al (2020)

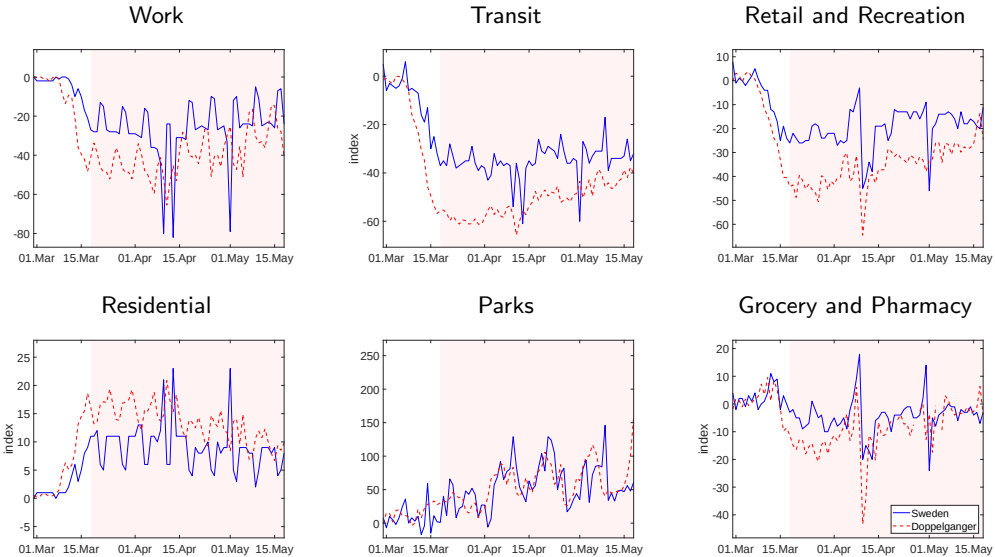
# Why does lockdown effect take so much time to materialize?

Voluntary social restraint goes some way to limit infections

- Measure voluntary restraint

Google COVID-19 Community Mobility Reports

- Google collects location data in various ways using mobile phone positions (users need to share "Location History")
- Locations categories: Grocery and Pharmacy, Parks, Residential, Retail and Recreation, Transit stations, and Workplaces
- Reports measure the change in the number and the length of stays at these locations relative to the median value of the same weekday between January 3 and February 6, 2020


Work
Transit
Retail and Recreation
Residential
Parks
Grocery and Pharmacy
index
01.Mar
15.Mar
01.Apr
15.Apr
01.May
15.May
Sweden
Doppelganger

# 6. Conclusion

How large is the lockdown effect?

- Counterfactual scenario for Sweden: control unit with lockdown from March 18 to May 19
- Effect delayed and moderate (compared to other estimates): infections reduced by 45%, deaths by 33%

Remarks

- Consider only lockdown period
- Do not analyze costs of lockdown
- Delayed & limited impact: lockdown as implemented blunt instrument
- Quest for smarter NPIs is on