

Pandemic Catch-22: How effective are
mobility restrictions in halting the spread of
COVID-19?

Tushar Bharati and Adnan M.S. Fakir

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Photo by Anastasiia Chepinska

COVID-19

- ▶ COVID-19 has changed the world dramatically.
 - ▶ Around eight million infected and over 400,000 dead
 - ▶ Rise in mental health issues and domestic violence
 - ▶ Economic downturn, restructuring, automation
 - ▶ International relations issues
- ▶ Biggest state-led mobility and activity restrictions in the history of mankind.
 - ▶ Response too slow and insufficient or too extreme?
(The Lancet (2020); Foster(2020); Ravallion(2020))

Too little or too much?

- ▶ Depends on the effectiveness of these measures.
 - ▶ Not always successful, can worsen the situation.
(Markel (1999), Cetron and Landwirth (2005), WHO (2006), Coker et al. (2007), Tognotti (2013), McNeil Jr (2014), Onishi (2014), Towers et al. (2014), Bell (2016), and Espinoza et al. (2016))
- ▶ Extremely costly and controversial. Trade off
 - ▶ b/w physical and mental health
 - ▶ b/w lives lost today and tomorrow
 - ▶ b/w the welfare of the old and the young
- ▶ Especially costly in developing countries.
 - ▶ Greater reliance on the informal sector and subsistence activities

Research Question: Effectiveness

- ▶ **How effective are mobility and activity restrictions at containing the COVID-19 contagion?**
 - ▶ What factors contribute to their effectiveness?

What we know

- ▶ -ve association b/w restriction and the contagion.
 - ▶ Correlations or simulations of counterfactual scenarios (*Anderson et al. (2020)*; *Greenstone and Nigam (2020)*; *Jinjarak et al. (2020)*; *Qiu et al. (2020)*)
- ▶ Associations can mislead mitigation policy
 - ▶ Worse-hit countries might implement stricter measures.
 - ▶ Systematic measurement error disease reporting and restrictions.
 - ▶ If people themselves take precautions, government responds accordingly.

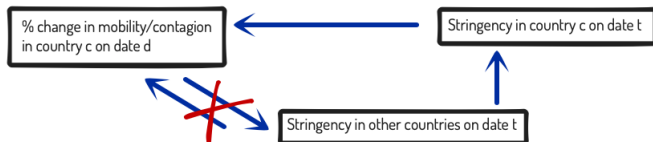
What we do not know

- ▶ A few attempts to identify the causal effects.
 - ▶ Difference-in-differences methodology.
 - ▶ Comparing regions with high and low levels of restrictions
(Fang et al. (2020); Villas-Boas et al. (2020); Yilmazkuday (2020))
- ▶ Parallel trends assumption not satisfied.
 - ▶ Restrictions in response to disease situation.
 - ▶ Worse contagion or watchful populations → early action.
 - ▶ These factors also affect the evolution of the disease scenario.

Identification Strategy

- ▶ Governments, in deciding the level of stringency of the restriction,
 - ▶ looked at disease condition in the home country, and
 - ▶ what they expected would happen in absence of strict measures.
- ▶ No way for them to predict the counterfactual scenario.
 - ▶ Expectations based on actions taken by other countries.
 - ▶ Most foreign countries imposing strict restrictions → greater pressure to enact strict restrictions.

Identification Strategy: Instrumental Variable method



- ▶ Relevance: $Cov(Stringency_{c,t}, Stringency_{w-c,t}) > 0$
- ▶ Exclusion: $Stringency_{-c,t}$ should not affect mobility and the contagion in country c directly and in real time.

Empirical specification

$$\text{1st Stage: } Stringency_{c,t} = a + b \times Stringency_{w-c,t} + \theta_c + \delta_{t-i} + \varepsilon_{c,t} \quad (1)$$

$$\text{2nd Stage: } Y_{c,t} = \alpha + \beta \times \widehat{Stringency}_{c,t} + \gamma_c + \tau_{t-i} + \varepsilon_{c,t} \quad (2)$$

- ▶ Our preferred specification: exclude all countries in the sub-region.
- ▶ In some specifications, we replace $\widehat{Stringency}_{c,t}$ with $\widehat{Stringency}_{c,t-7}$, $\widehat{Stringency}_{c,t-14}$, or $\widehat{Stringency}_{c,t-21}$

Data: Stringency

- ▶ Oxford COVID-19 Government Response Tracker (OxCGRT)
 - ▶ Daily country-level daily stringency index (0 -100)
 - ▶ Based on school closures, workplace closure, cancellation of public events, restrictions on gatherings, public transport closure, stay at home requirements, internal movement restrictions, international travel controls, and public awareness campaigns
 - ▶ Does not imply compliance

Data: Mobility

- ▶ Google mobility data (131 countries) for Feb 15-May 10
 - ▶ % Δ in traffic around six locations relative to the average for corresponding day of the week between Jan 3-Feb 6.
 - ▶ Groceries and pharmacies, retail and recreation sites, parks, transit stations, workplaces, and residences.

Data: COVID-19

- ▶ Our World In Data
 - ▶ Tests per million population for 78 countries
- ▶ Johns Hopkins Center for Systems Science and Engineering COVID-19 data repository
 - ▶ Cases and deaths per million for 117 countries
- ▶ Selected testing and under-reporting
 - ▶ Related to country characteristics - country FE controls for.
 - ▶ Changes over time can bias results.
- ▶ Country characteristics from different sources (Table A2)

Impact of restrictions on mobility

VARIABLES	Retail Recreation	Grocery Pharmacy	Parks	Transit Stations	Workplaces	Residential
2SLS: Excluding Subregion IV						
Stringency Index (Lag 0)	-1.10*** (0.04)	-0.66*** (0.04)	-0.73*** (0.08)	-1.08*** (0.04)	-0.96*** (0.04)	0.38*** (0.02)
Mean of DV	-43.57	-22.38	-23.33	-44.99	-33.86	16.38
F-Stat	303.46	303.40	303.46	303.46	303.46	302.39
Stringency Index (Lag 7)	-0.98*** (0.05)	-0.74*** (0.04)	-0.64*** (0.07)	-0.97*** (0.05)	-0.94*** (0.04)	0.37*** (0.02)
Mean of DV	-44.51	-22.87	-24.001	-46.05	-34.60	16.73
F-Stat	306.08	306.03	306.08	306.08	306.08	303.96
Stringency Index (Lag 14)	-0.41*** (0.05)	-0.44*** (0.05)	-0.20*** (0.05)	-0.41*** (0.05)	-0.52*** (0.05)	0.18*** (0.02)
Mean of DV	-45.80	-23.56	-24.85	-47.39	-35.59	17.19
F-Stat	299.85	299.69	299.85	299.85	299.85	297.28
Stringency Index (Lag 21)	0.04 (0.15)	-0.12 (0.11)	-0.29 (0.15)	0.08 (0.24)	-0.01 (0.13)	0.03 (0.05)
Mean of DV	-48.34	-25.04	-26.35	-49.98	-37.70	18.09
F-Stat	59.14	59.11	59.14	59.14	59.14	59.27
Fixed Effects	Country; Days since first case					
Number of country	117	117	117	117	117	117
Observations (Lag 0)	7,701	7,697	7,701	7,701	7,701	7,655
Observations (Lag 7)	7,617	7,613	7,617	7,617	7,617	7,570
Observations (Lag 14)	7,389	7,385	7,389	7,389	7,389	7,342
Observations (Lag 21)	6,983	6,979	6,983	6,983	6,983	6,936

Impact of restrictions on mobility

- ▶ Stringent mobility and activity restrictions have large intended impacts.
- ▶ Contemporaneous measures matter more than lagged measures.
- ▶ Significant difference between OLS and IV estimates (not presented here).

Impact of restrictions on the contagion

VARIABLES	Tests	Cases	Deaths
2SLS: Excluding Subregion IV			
Stringency Index (Lag 0)	-0.0047 (0.0030)	-0.0009* (0.0005)	-0.0009 (0.0013)
Mean of DV	0.112	0.149	0.116
F-Stat	77.081	299.485	46.873
Stringency Index (Lag 7)	-0.0033* (0.0018)	-0.0029*** (0.0005)	-0.0024*** (0.0007)
Mean of DV	0.110	0.150	0.115
F-Stat	114.377	305.991	127.046
Stringency Index (Lag 14)	-0.0005 (0.0006)	-0.0029*** (0.0005)	-0.0032*** (0.0005)
Mean of DV	0.098	0.145	0.114
F-Stat	128.357	298.155	244.166
Stringency Index (Lag 21)	0.0003 (0.0008)	0.0003 (0.0006)	-0.0027*** (0.0004)
Mean of DV	0.092	0.134	0.112
F-Stat	100.106	237.133	244.085
Fixed Effects	Country; Days since first case		
Number of country	72	117	108
Observations (Lag 0)	4,113	7,607	5,277
Observations (Lag 7)	4,063	7,525	5,333
Observations (Lag 14)	4,008	7,319	5,300
Observations (Lag 21)	3,867	6,932	5,240

Impact of restrictions on the contagion

- ▶ Significant negative effect on # of confirmed cases and deaths.
- ▶ Stringency of the measures 7 to 14 days ago matter more.
 - ▶ In line with the current scientific understanding
 - ▶ Incubation and infection period of up to fourteen days
- ▶ Effect on testing weak and not robust.

Heterogeneous impact on mobility

VARIABLES	Transit	Workplaces	Residential	Transit	Workplaces	Residential
	Stations			Stations		
< Median			> Median			
Population Density						
Stringency Index (Lag 14)	-0.3893*** (0.0777)	-0.5110*** (0.0756)	0.1621*** (0.0306)	-0.5251*** (0.0723)	-0.5097*** (0.0645)	0.1965*** (0.0276)
Observations	3,513	3,513	3,499	3,878	3,878	3,845
Number of country	58	58	58	59	59	59
Mean of DV	-45.481	-33.615	16.332	-49.126	-37.375	17.961
F-Stat	155.829	155.829	153.769	125.467	125.467	125.219
Poverty Head Count						
Stringency Index (Lag 14)	-0.3438*** (0.0817)	-0.4193*** (0.0696)	0.1557*** (0.0303)	-0.5512*** (0.0749)	-0.6424*** (0.0730)	0.2392*** (0.0309)
Observations	3,441	3,441	3,439	3,950	3,950	3,905
Number of country	51	51	51	66	66	66
Mean of DV	-47.607	-37.839	16.281	-47.207	-33.627	17.981
F-Stat	126.350	126.350	126.203	154.908	154.908	152.585
Gini Index						
Stringency Index (Lag 14)	-0.3976*** (0.0834)	-0.4974*** (0.0803)	0.1666*** (0.0289)	-0.4734*** (0.0703)	-0.5590*** (0.0650)	0.2161*** (0.0297)
Observations	3,480	3,480	3,478	3,911	3,911	3,866
Number of country	52	52	52	65	65	65
Mean of DV	-44.932	-34.470	14.497	-49.584	-36.582	19.603
F-Stat	98.720	98.720	98.593	199.702	199.702	197.319
FE	Country; Days since first case					

Heterogeneous impact on mobility

VARIABLES	Transit	Workplaces	Residential	Transit	Workplaces	Residential
	Stations			Stations		
	< Median			> Median		
PM2.5						
Stringency Index (Lag 14)	-0.4022*** (0.0690)	-0.5205*** (0.0666)	0.1860*** (0.0297)	-0.4789*** (0.0795)	-0.5449*** (0.0744)	0.2032*** (0.0311)
Observations	3,761	3,761	3,752	3,630	3,630	3,592
Number of country	57	57	57	60	60	60
Mean of DV	-48.224	-37.724	17.266	-46.533	-33.375	17.101
F-Stat	176.502	176.502	175.536	119.232	119.232	117.192
Cardiovascular Diseases Death Rate						
Stringency Index (Lag 14)	-0.3991*** (0.0679)	-0.5182*** (0.0646)	0.1814*** (0.0271)	-0.4492*** (0.0794)	-0.5290*** (0.0763)	0.1915*** (0.0308)
Observations	3,790	3,790	3,764	3,601	3,601	3,580
Number of country	58	58	58	59	59	59
Mean of DV	-49.565	-38.488	18.567	-45.108	-32.536	15.732
F-Stat	174.289	174.289	169.300	109.755	109.755	109.745
Age 65 & Older						
Stringency Index (Lag 14)	-0.5122*** (0.0767)	-0.5472*** (0.0704)	0.2133*** (0.0310)	-0.3741*** (0.0744)	-0.5166*** (0.0701)	0.1818*** (0.0290)
Observations	3,512	3,512	3,485	3,879	3,879	3,859
Number of country	59	59	59	58	58	58
Mean of DV	-46.549	-32.707	17.672	-48.158	-38.196	16.745
F-Stat	133.420	133.420	132.017	135.047	135.047	137.220
FE	Country; Days since first case					

Heterogeneous impact on mobility

VARIABLES	Transit Stations	Workplaces	Residential	Transit Stations	Workplaces	Residential
	< Median			> Median		
Hospital Beds per 100k						
Stringency Index (Lag 14)	-0.4501*** (0.0717)	-0.5076*** (0.0665)	0.1894*** (0.0285)	-0.4025*** (0.0705)	-0.5276*** (0.0668)	0.1859*** (0.0275)
Observations	3,271	3,271	3,251	4,120	4,120	4,093
Number of country	54	54	54	63	63	63
Mean of DV	-47.988	-34.815	18.474	-46.922	-36.201	16.161
F-Stat	189.553	189.553	187.191	130.292	130.292	130.560
Democracy Score						
Stringency Index (Lag 14)	-0.4281*** (0.0789)	-0.3849*** (0.0757)	0.1814*** (0.0309)	-0.4700*** (0.0702)	-0.5942*** (0.0641)	0.2168*** (0.0280)
Observations	3,344	3,344	3,337	4,047	4,047	4,007
Number of country	55	55	55	62	62	62
Mean of DV	-45.116	-32.235	16.751	-49.276	-38.358	17.546
F-Stat	129.313	129.313	128.962	137.939	137.939	135.267
Government Effectiveness						
Stringency Index (Lag 14)	-0.4161*** (0.0762)	-0.3741*** (0.0731)	0.1750*** (0.0300)	-0.4926*** (0.0784)	-0.6096*** (0.0744)	0.2211*** (0.0322)
Observations	3,518	3,518	3,504	3,873	3,873	3,840
Number of country	59	59	59	58	58	58
Mean of DV	-45.882	-34.003	17.370	-48.766	-37.028	17.016
F-Stat	119.758	119.758	118.808	138.460	138.460	136.651

Heterogeneous impact on mobility

- ▶ Stricter restrictions work better in
 - ▶ densely populated,
 - ▶ poorer, more unequal,
 - ▶ more polluted countries
 - ▶ with younger but unhealthier populations
 - ▶ and worse health infrastructure.
- ▶ Relatively less-developed countries

Heterogeneous impact on the contagion

VARIABLES	Cases		Deaths	
	< Median		> Median	
	Population Density			
Stringency Index (Lag 14)	-0.0027*** (0.0007)	-0.0026** (0.0010)	-0.0041*** (0.0007)	-0.0028** (0.0010)
Observations	3,518	2,422	4,009	2,914
Number of country	58	53	59	55
Mean of DV	0.150	0.114	0.151	0.116
F-Stat	184.961	134.058	122.684	55.175
	Poverty Head Count			
Stringency Index (Lag 14)	-0.0040*** (0.0005)	-0.0019** (0.0009)	-0.0020** (0.0008)	-0.0020 (0.0013)
Observations	3,556	2,723	3,971	2,613
Number of country	51	50	66	58
Mean of DV	0.154	0.131	0.147	0.098
F-Stat	170.724	94.956	123.444	22.485
	Gini Index			
Stringency Index (Lag 14)	-0.0025*** (0.0007)	-0.0017** (0.0009)	-0.0026*** (0.0008)	-0.0014 (0.0015)
Observations	3,595	2,590	3,932	2,746
Number of country	52	48	65	60
Mean of DV	0.149	0.131	0.151	0.100
F-Stat	132.052	85.478	149.001	25.938
FE	Country; Days since first case			

Heterogeneous impact on the contagion

VARIABLES	Cases		Deaths	
	< Median	> Median	< Median	> Median
PM2.5				
Stringency Index (Lag 14)	-0.0032*** (0.0004)	-0.0029*** (0.0010)	-0.0026** (0.0010)	-0.0007 (0.0006)
Observations	3,848	2,960	3,679	2,376
Number of country	57	55	60	53
Mean of DV	0.152	0.131	0.149	0.096
F-Stat	201.158	110.374	120.273	23.316
Cardiovascular Diseases Death Rate				
Stringency Index (Lag 14)	-0.0035*** (0.0005)	-0.0034** (0.0009)	-0.0022** (0.0009)	-0.0019* (0.0011)
Observations	3,909	3,039	3,618	2,297
Number of country	58	57	59	51
Mean of DV	0.155	0.123	0.145	0.104
F-Stat	166.194	79.668	122.073	85.867
Age 65 & Older				
Stringency Index (Lag 14)	-0.0022** (0.0010)	-0.0018* (0.0010)	-0.0032*** (0.0005)	-0.0019** (0.0010)
Observations	3,532	2,238	3,995	3,098
Number of country	59	50	58	58
Mean of DV	0.150	0.099	0.151	0.127
F-Stat	156.680	87.763	126.848	71.324
FE	Country; Days since first case			

Heterogeneous impact on the contagion

VARIABLES	Cases		Deaths	
	< Median	> Median	< Median	> Median
Hospital Beds per 100k				
Stringency Index (Lag 14)	-0.0028*** (0.0009)	-0.0009 (0.0006)	-0.0028*** (0.0005)	-0.0025*** (0.0005)
Observations	3,311	2,335	4,216	3,001
Number of country	54	50	63	58
Mean of DV	0.157	0.106	0.145	0.122
F-Stat	215.723	102.682	132.499	73.230
Democracy Score				
Stringency Index (Lag 14)	-0.0010 (0.0010)	-0.0007 (0.0009)	-0.0035*** (0.0005)	-0.0026*** (0.0009)
Observations	3,376	2,131	4,151	3,205
Number of country	55	48	62	60
Mean of DV	0.152	0.099	0.149	0.126
F-Stat	118.138	79.102	166.684	81.403
Government Effectiveness				
Stringency Index (Lag 14)	-0.0022*** (0.0004)	-0.0006 (0.0010)	-0.0032*** (0.0005)	-0.0024*** (0.0007)
Observations	3,524	2,323	4,003	3,013
Number of country	59	51	58	57
Mean of DV	0.153	0.108	0.148	0.120
F-Stat	129.661	135.962	142.381	58.642
FE	Country; Days since first case			

Heterogeneous impact on the contagion

- ▶ Compared to the impact on mobility, stricter measures work better in containing the contagion in
 - ▶ richer, more equal,
 - ▶ less-polluted countries with
 - ▶ older but healthier populations,
 - ▶ and better health infrastructure.
- ▶ Also work better in more democratic countries, with better government effectiveness.
- ▶ These are relatively more-developed countries

Less mobility \neq contagion contained

- ▶ Stricter restrictions worked better at limiting mobility in relatively less-developed countries.
- ▶ But did not do better at containing the contagion.
(Barnett-Howell and Mobarak (2020); Ravallion (2020))

$$\frac{d(\text{growth rate of cases or deaths})}{d(\text{mobility})} = \frac{\frac{d(\text{growth rate of cases or deaths})}{d(\text{Stringency Index})}}{\frac{d(\text{mobility})}{d(\text{Stringency Index})}}$$
$$\Rightarrow \frac{d(\text{growth rate of cases or deaths})}{d(\text{mobility})} = \frac{\beta_{\text{growth}}}{\beta_{\text{mobility}}}$$

Are stricter restrictions more effective?

VARIABLES	(1)	(2)	(3)	(4)
	Cases	Deaths	Cases	Deaths
	< Median		> Median	
Population Density	0.007	0.007	0.008	0.005
Poverty Head Count	0.012	0.006	0.004	0.004
Gini Index	0.006	0.004	0.005	0.003
PM2.5	0.008	0.007	0.005	0.001
Cardiovascular Diseases Death Rate	0.009	0.009	0.005	0.004
Age 65 & Older	0.004	0.004	0.009	0.005
Hospital Beds per 100k	0.006	0.002	0.007	0.006
Democracy Score	0.002	0.002	0.007	0.006
Government Effectiveness	0.005	0.001	0.007	0.005

Reducing mobility work better in developed countries

- ▶ Why do developing countries benefited less from a reduction in mobility?
- ▶ Stringent restrictions cannot counter immunodeficiency.
 - ▶ More immuno-compromised → fewer people can fight it off.
(Shi et al. (2020))
- ▶ Stricter restrictions have economic costs.
 - ▶ Affects food consumption → compromising their immune system further.
 - ▶ Handwash/sanitizers not on the top of the shopping list.
(Ravallion (2020))

Reducing mobility work better in developed countries

- ▶ Why do developing countries benefited less from a reduction in mobility?
- ▶ Flattening the curve is only marginally useful
 - ▶ Health infrastructure already over-whelmed and inaccessible
- ▶ Lack of awareness
 - ▶ Best practices when quarantined/isolated.
 - ▶ Poor government effectiveness → sluggish enforcement of recommended best-practices.
- ▶ High pop. density → higher rate of human-to-human contact even with reduced mobility.

Conclusion

- ▶ Mobility restrictions not sufficient in developing countries
 - ▶ or in poorer areas of developed countries
- ▶ Economic cost are also higher in these regions.
 - ▶ Weaker social security and high reliance on daily wages.
- ▶ Need to complement restriction policies with awareness, economic and health assistance schemes.
 - ▶ What can these policies be? How to fund them?
 - ▶ Global long-term costs → Global cooperation required.
- ▶ Not the last pandemic, vaccine might take years
 - ▶ Optimizing our current response prepare us better for future disease outbreaks.

Thank You