

Economic Evaluation of Public Health Response to Covid-19: Is Health Economics up to the Job?

Macroeconomic Modelling

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What is Macroeconomic CGE Modelling?

Computable General Equilibrium (CGE) model

- System of equations which specify behaviour of:
 - Firms (or producers)
 - Households (main consumers & labour suppliers)
 - Government
 - Foreign agents (imports and exports)
- Equations calibrated with economic data from a Social Accounting Matrix
 - All sectors and economic flows in the economy
 - Can have multiple households
 - Can have multiple labour types

	Activities sectors	Commodities sectors	Labour (by type)	capital	Single/mult. Households	Savings & Investment	Total
Activities sectors							
Commodities sectors							
Labour (by type)							
Capital							
Single/mult. Households							
Savings & Investment							
Total							

Initial solution: Model is solved to find baseline equilibrium

Policy simulation: Model is shocked and solved to find new equilibrium

Difference between Initial and policy simulation is macroeconomic impact

Our simulations

- **Uncontrolled C-19 Baseline** (illness only)
- **Mitigation scenario**
 - Slow the spread of the epidemic
- **Suppression scenario**
 - Reduce case numbers to reduce and **maintain** lower levels of transmission

Direct health effects

Rates: $\pm 50\%$ change for sensitivity analysis

- Clinical Attack Rate: 49%
- Case Fatality Rate: 1.5%
- Hospitalisation Rate: 4.4% of those infected
- Intensive care admission rate: 30% of those hospitalised

Durations: Work absence

- Disease only: 7 working days, Home quarantine 10 working days
- Hospitalised: 15 work days (cost includes 8 days in hospital)
- ICU: 20 work days (cost includes 6 days in hospital & 10 days in ICU)
- Fatal: worker replacement: 115 work days (cost includes 6 days in hospital & 10 days in ICU)

Costs (per day):

Hospital: £840

Hospital ICU (child): £2,685

Hospital ICU (adult): £2,470

Ferguson, N., et. al (2020). Impact of non-pharmaceutical interventions (NPIs) to reduce COVID19 mortality and healthcare demand, Imperial College COVID-19 Response Team.

Mitigation and Suppression Scenarios

Combined Non-Pharmaceutical Interventions & health effects



For BOTH Mitigation and Suppression Scenarios, NPIs include:

- 90% closure of hotels, restaurants, entertainment and recreation businesses
- 50% closure of non-essential business
- School closure: 50% of working mothers take time off work
- Home Quarantine: Increased work absence to 10 working days per infection

For Mitigation Scenario

- NPIs apply for 12 weeks from March 23rd 2020
- 30% reduction in deaths to 348,000 deaths

For Suppression Scenario

- NPIs apply for 74% of year from March 23rd 2020
- >95% reduction in deaths to 24,000 deaths

Clinical Health Effects

	C19 baseline	Mitigation	Suppression
Symptomatic Infections	32,686,000	32,686,000	32,686,000
Total Fatalities	490,000	348,000	24,000
- hospitalised	439,000	312,000	22,000
- non-hospitalised	52,000	37,000	3,000
Hospitalised	3,286,000	3,286,000	3,286,000
- ICU	907,000	907,000	907,000
- non-ICU	2,379,000	2,379,000	2,379,000
Symptomatic (not hospitalised)	29,400,000	29,400,000	29,400,000

Results: C-19 Baseline (Illness Only)

C-19 Baseline	Real GDP (£bn)	Real GDP (%)
Total health-related costs	-39.6	-1.73%
- Hospital Costs, total	-0.7	-0.03%
- hospitalised fatalities	-0.3	-0.01%
- hospitalised recovered ICU	-0.3	-0.01%
- hospitalised recovered non-ICU	-0.1	0.00%
- Labour supply losses, total	-38.9	-1.70%
- hospitalised fatalities	-2.8	-0.12%
- hospitalised recovered	-4.7	-0.21%
- non-hospitalised recovered	-30.8	-1.35%

Results: Mitigation & Suppression Scenarios

MITIGATION	Real GDP (bn GBP, 2015 prices)	Real GDP (%)
Total health and prevention-related costs	-308.0	-13.5%
Total health-related costs	-53.1	-2.3%
- Hospital Costs, total	-0.7	0.0%
- hospitalised intensive-care	-0.3	0.0%
- hospitalised non-intensive-care	-0.3	0.0%
- Labour supply losses, total	-52.4	-2.3%
- hospitalised fatalities	-2.0	-0.1%
- hospitalised recovered	-4.9	-0.2%
- non-hospitalised recovered	-44.8	-2.0%
Total public prevention-related costs	-261.4	-11.4%
- School closures	-66.1	-2.9%
- Business closures	-200.9	-8.8%
- domestic business closures - other non-essential	-154.8	-6.8%
- recreational services sector	-17.3	-0.8%
- hotels & restaurants sector	-38.5	-1.7%

SUPPRESSION	Real GDP (bn GBP, 2015 prices)	% Real GDP
Total health and prevention-related costs	-668.4	-29.2%
Total health-related costs	-51.4	-2.2%
- Hospital Costs, total	-0.7	0.0%
- hospitalised intensive-care	-0.3	0.0%
- hospitalised non-intensive-care	-0.3	0.0%
- Labour supply losses, total	-50.7	-2.2%
- hospitalised fatalities	-0.1	0.0%
- hospitalised recovered	-5.2	-0.2%
- non-hospitalised recovered	-44.8	-2.0%
Total public prevention-related costs	-632.9	-27.7%
- School closures	-166.2	-7.3%
- Business closures	-501.5	-21.9%
- domestic business closures - other non-essential	-386.6	-16.9%
- recreational services sector	-44.3	-1.9%
- hotels & restaurants sector	-95.5	-4.2%

Implications:

Found covid-19 to have potential to impose unprecedented economic costs on the UK economy

Duration of school and business closures are key to determining the economic cost

Initial economic support package promised by the UK government might have been proportionate to the costs of **mitigating** Covid-19, but insufficient for **suppression**

Satellite Modelling Application: Covid-19

LSHTM Covid-19 Transmission Model as Satellite to Pakistan CGE

- Conservative basic reproduction assumed ($R_0=1.7$)
- Detailed epidemiological modelling of province-level epidemics

CGE model of Pakistan Economy

- 4 representative households = 4 province populations
- Disaggregated using 2015-16 HILCS household survey
 - Khyber Pakhtunkhwa (KPK)
 - Punjab
 - Sindh
 - Balochistan

Scenarios modeled in two ways

- **Direct health effects** (illness only impact for unmitigated pandemic)
 - Productivity and health sector costs imposed on CGE model
- **Non-Pharmaceutical interventions and health effects**
 - Applied for only for 10 weeks from March to May 2020
 - Applied Intermittently: 1 month lockdown/2 months opening-up March 2020 to December 2021

Scenario 1: Uncontrolled C19 epidemic

Scenario 2 (90 days from March 2020):

- Complete school closure
- 20% closure of non-essential businesses
- Home quarantine

Scenario 3 (90 days from March 2020):

- Complete school closure
- 40% closure of non-essential businesses
- Home quarantine

Scenario 4: (1 month on, 2 months off; March 2020 to December 2021)

- Complete school closure
- 40% closure of non-essential businesses
- Home quarantine

Macro-intervention and pandemic costs (GDP impacts; mio. USD) & trade-offs with clinical outcomes



		Scenario 1 (Unmitigated)		Scenario 2 (20% Business)		Scenario 3 (40% Business)		Scenario 4 (Intermit. Scen)	
		2020	2021	2020	2021	2020	2021	2020	2021
Overall Balance	GDP impact - macro interventions & pandemic costs	-503	-218	-6,591	-1,209	-12,191	-1,545	-15,505	-22,362
Macro interventions	GDP impact - macro interventions			-6,566	-532	-12,172	-865	-15,483	-21,966
	- Business Lockdown			-5,550	-302	-11,170	-633	-14,578	-20,718
	- School Closure			-837	-12	-837	-12	-761	-958
	- Quarantine (+3 days)			-8	-189	-6	-191	-7	-118
Hospital Costs	GDP impact - hospital costs	57	6	1	75	1	75	1	43
	- ICU unit costs	41	5	1	55	1	55	1	32
	- non-ICU unit costs	15	2	0	19	0	19	0	11
	- critically ill patient costs	44	5	1	58	1	58	1	33
	- severely ill patient costs	12	1	0	16	0	16	0	9
Labour Supply losses	GDP impact - labour supply losses	-559	-223	-21	-579	-16	-584	-19	-357
	- Hospitalized patients' labour losses	-46	-5	-1	-49	-1	-49	-1	-28
	- critically ill patients' labour losses	8	2	0	-16	0	-16	0	-9
	- severely ill patients' labour losses	-30	-3	-1	-32	0	-32	-1	-18
	- Case fatalities labour losses	-74	-188	-1	-86	-1	-86	-1	-52
	- Non-hospitalized symptomatic cases' labour losses (7days)	-439	-29	-5	-441	-14	-446	-2	-275
Memorandum items	- critically ill patient admissions (1000')	582.9	68.7	12.0	638.6	8.9	641.7	13.3	367.6
	- severely ill patient admissions (1000')	1366.2	154.2	29.4	1490.6	21.8	1497.2	32.1	858.0
	- case fatalities (1000')	345.3	60.0	4.5	399.9	3.3	401.7	6.7	230.4
	- symptomatic cases (1000')	35,902.0	2,000.7	1,745.4	36,066.3	1,274.6	36,466.3	1,410.6	22,523.6
	- real GDP (mio. USD) (baseline)	298,440	306,814	298,440	306,814	298,440	306,814	298,440	306,814

Macro-interventions & labour supply changes - GDP impacts (mio. USD) by household

	Scenario 1 (Unmitigated)		Scenario 2 (20% Business)		Scenario 3 (40% Business)		Scenario 4 (Intermit. Scen)	
	Year 1	Year 2	Year 1	Year 2	Year 1	Year 2	Year 1	Year 2
Macro interventions			-6,566	-532	-12,172	-865	-15,483	-21,966
- Business Lockdown			-5,550	-302	-11,170	-633	-14,578	-20,718
- School Closure			-837	-12	-837	-12	-761	-958
- Quarantine (+3 days)			-8	-189	-6	-191	-7	-118
Labour Supply losses	-559	-223	-21	-579	-16	-584	-19	-357
- Household 1 – KPK	-16	-6	-3	-14	-2	-14	-3	-8
- Household 2 – PUNJAB	-350	-145	-6	-376	-4	-378	-6	-233
- Household 3 – SINDH	-125	-63	-7	-166	-5	-167	-6	-101
- Household 4 – BALOCHISTAN	-27	-10	-5	-23	-4	-24	-4	-14
Hospital Costs	57	6	1	75	1	75	1	43
- Household 1 - KPK	3	0	0	3	0	3	0	2
- Household 2 - PUNJAB	36	6	0	50	0	50	0	29
- Household 3 - SINDH	16	1	0	20	0	20	0	11
- Household 4 - BALOCHISTAN	3	0	0	3	0	3	0	2
Memorandum item:								
- real GDP	298,440	306,814	298,440	306,814	298,440	306,814	298,440	306,814

Conclusions from scenario analysis

- Lockdown scenarios 2020-21
 - **One-off 10-week lockdown (2020):**
 - postponement/no aggregate reduction in total clinical outcomes
 - GDP cost: 10-20 x “uncontrolled C19 baseline”
 - **Intermittent lockdown (2020-21):**
 - postponement and reduction in aggregate total clinical outcomes
 - GDP cost: 50 x “uncontrolled C19 baseline”
 - **Negative impacts of business closures on investment** cause impacts to persist and accumulate
 - **Substantial QALY gains in 2020** and, if limited in duration, potentially cost-effective/could buy time for vaccine delivery
- Epidemic and NPI costs would have been highest among most populous provinces

Full Model Integration

