Emerging approaches to the Economic Evaluation of Covid-19 Public Health Response

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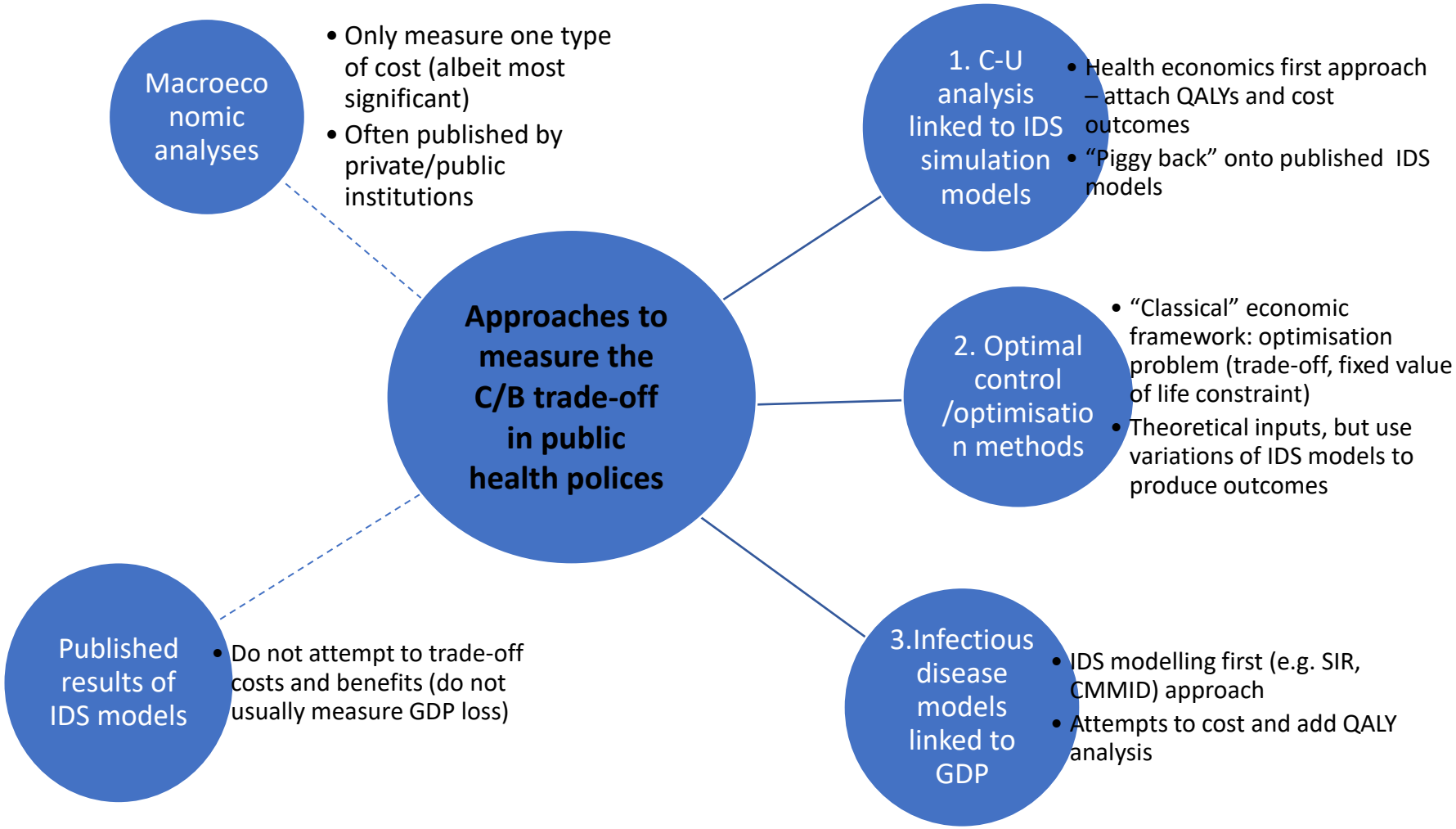
Landscape of approaches/publications



IDS, Infectious disease simulation models; SIR, susceptible-infectious-recovered models; CMMID, Centre for mathematical modelling of infectious disease (LHSTM); GDP, gross domestic product

1. C-U analysis linked to IDS simulation models

UK example publication	Decision problem	Model and Strategies compared	Evaluation horizon	Retrospective or predictive	Health economics outcomes	GDP loss estimates and source	QALY, Costs excluded	Threshold applied	Conclusion
Miles et al. 2020	Valuing excess deaths and comparing to excess GDP loss, up to the end of May 2020	No modelling undertaken. Compare a range of estimated deaths saved because of government policy up to 24th May against GDP loss estimate ranges. Compared with "no lockdown".	Up to week ending 24th May 2020 (some of wave 1)	Retrospective	HRNB with 5 or 10 QALYs lost per Covid death (assuming £30k per QALY) but not explicitly incremental	Range of GDP loss due to lockdown estimates (9%, 15%, 20%, 25%), based on various sources including OBR.	Most intangible costs/QALYs (but attempt to account for some indirect health savings from lockdown)	£30k per QALY	The costs of continuing severe restrictions are great relative to likely benefits in lives saved (i.e. net cost)

HRNB, health related net benefit; GDP, gross domestic product; QALY, quality adjusted life-years

UK example publication	Decision problem	Model and Strategies compared	Evaluation horizon	Retrospective or predictive	Health economics outcomes	GDP loss estimates and source	QALY, Costs excluded	Threshold applied	Conclusion
Zala et al. 2020	Calculates the relative cost-effectiveness of the hypothetical suppression policies found in the Imperial College COVID-19 Response Team model	Use published outputs of March Ferguson report: Hypothetical strategies including Unmitigated (do nothing), mitigated and 2 alternative suppression strategies	Same as Ferguson et al (2020) model (seeding in Jan 2020 until late 2021 assuming no vaccines)	Predictive	QALYs, ICERs conditional on GDP loss	For counterfactual unmitigated/mitigated from earlier macroeconomic study (Keogh-Brown et al, 2010). For suppression based on published estimates.	Intangible QALY/costs of lockdown	No explicit threshold, but range explored.	Difficult to claim that the hypothetical Imperial model–projected suppression policies are obviously cost-ineffective. Uncertain and sensitive to GDP loss estimates.
Thom et al. 2021	Compare health economics outcomes of observed country "mitigation" strategies vs counterfactual (modelled) "no mitigation" strategy	Use open source CMMID model: Observed "mitigation" strategy that occurred in real life (varies by country) vs. counterfactual "no mitigation"	Wave 1 (Jan 1st to 20th July)	Retrospective	Per capita QALYs, HRNB (assuming £20k per QALY)	Retrospective estimates from various sources for mitigation. Attempt to account for non-NPI reductions in GDP (trade, prophylactic behaviour), with no mitigation base-case as Swedish GDP loss.	Direct government policy costs (e.g. test and trace costs), intangible QALY/costs of lockdown	£20k per QALY	The extent that HRNB offset economic losses varies widely by country and assumed R0 under no mitigation.

CMMID, Centre for mathematical modelling of infectious disease (LHSTM); HRNB, health related net benefit; GDP, gross domestic product; QALY, quality adjusted life-years

1. C-U analysis linked to IDS simulation models

- For disease dynamics use published early estimates or open-source versions of models (no de novo inf disease models) – limit flexibility?
- All “societal” perspective and include GDP loss from external sources (exogenously determined), key uncertainty
- Horizon of evaluation not always defined to capture all long run costs/benefits – miss complex time dynamics
- No consensus among HEs on relevant threshold to apply (ICER or HRNB approaches)
- Acknowledge importance of GDP loss, but no consensus on what intangible costs/QALYs to include if at all
- No subgroup analyses – costs and benefits fall on different groups, ethical implications?

2. Optimal control /optimisation methods

UK example publication	Decision problem	Model and Strategies compared	Evaluation horizon	Retrospective or predictive	Health economics outcomes	GDP loss estimates and source	QALY, Costs excluded	Threshold applied	Conclusion
Rowthorn et al. 2020	Cost–benefit analysis to find optimal policy mix, given a fixed value of life objective set by the government	De novo mathematical SIR model of disease propagation with government policy framed in context of (traditional) economic optimisation problem with different value of life constraint Do nothing, different lockdown lengths, even vaccine available 1 or 2 years	1st April for 52 weeks	Purely predictive - estimates of death rate and R0 are not based on any data or referenced	No QALYs (value of life analysis). No incremental analysis presented (i.e. just optimal options given value of life constraint)	The per capita weekly cost of full lockdown is £200 which is in line with OBR predictions at the time	QALY loss of illness, intangible QALY/costs of lockdown	N/A	A 10-week lockdown is only optimal if the value of life for COVID-19 victims exceed £10m. Results sensitive to timing of intervention.

- Highly theoretical “what, if” approach – no referenced sources for R0, mortality rates etc
- GDP loss is endogenously determined
- No QALYs and thresholds, determine optimal polices for different assumed value of life for covid victim (e.g. 10m)
- No SG analysis – harder if no QALY component?

3.Infectious disease models linked to GDP

UK example publication	Decision problem	Model and Strategies compared	Evaluation horizon	Retrospective or predictive	Health economics outcomes	GDP loss estimates and source	QALY, Costs excluded	Threshold applied	Conclusion
Sandmann et al. 2021	Compares net monetary value of different combinations of social distancing measures with introduction of vaccination scenarios	Use de novo CMMID to compare different vaccination/revaccination scenarios assuming different vaccine efficacy and duration of protection to no vaccination scenario. In addition to different lockdown and social distancing measures (some counterfactual such as no lockdowns in 2020).	10 years from Jan 1st 2020	Largely predictive but starting Jan 2020 to allow for counterfactual scenarios (some attempt at alignment with observed 2020 data like hospitalisations)	QALYs, HRNB with assumed QALY values, scenario analysis with GDP loss included	Under voluntary distancing GDP loss accrues at a rate of 2% of daily GDP (≈ £115 million) for days with new reported cases over 1000. Under stricter distancing and lockdowns daily GDP loss can be 2% to 15% (scenario analyses).	No intangible costs/QALYs but includes wider range of direct QALY loss including symptomatic cases (no hospitalisation) and vaccine adverse events. Includes costs such as setting up a vaccine programme and govt research subsidies.	£20k per QALY, but scenarios up to £60k per QALY	At virtually all assumed QALY values (but particularly £60k per QALY) vaccination scenarios are superior to no vaccination in HRNB, with or without including GDP loss. In all distancing and lockdown scenarios, vaccination has a higher HRNB than no vaccination.

3.Infectious disease models linked to GDP

- IDS model first approach and so more flexibility (most relevant to future decision making):
  - More scenarios and sensitivity analyses
  - More meaningful horizon
- GDP loss endogenous but methods vary widely and so highly uncertain input (e.g. compare with Rowthorn optimisation)
- As with HE first approach:
  - No consensus on WTP threshold
  - No consensus on intangible costs/QALYs to include
  - No SG analysis and no ethical implications explored