A walk through the COVID-19 Pandemic Trade-offs web-tool

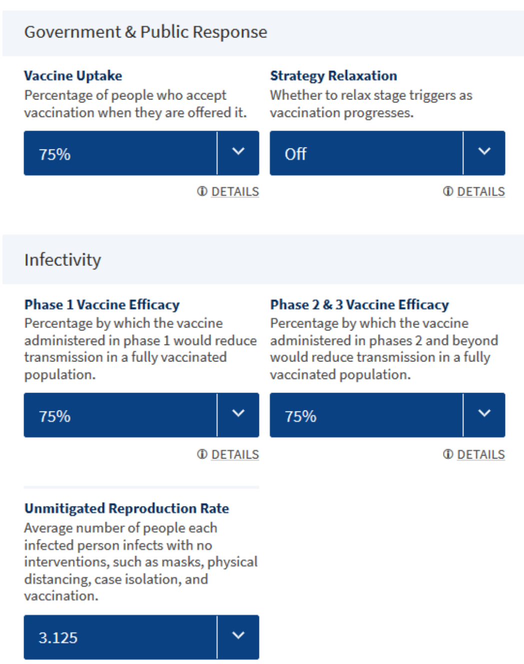
You will see four output options at the top of the page:

- infection rates by vaccine roll out phase
- health impacts
- economic impacts (coming soon)
- what is optimal (also coming soon, this will use a 'net monetary benefit' analysis of what is 'optimal' from a cost effectiveness perspective).

And a link to a page with model details.

Starting with the infection rates, you have five options you can choose from (Figure 1). Note that vaccine uptake applies to all phases, but we provide you with the ability to have difference settings for vaccine effectiveness at reducing transmissibility for Phase 1 versus Phase 2 and 3 (given our initial understanding that Phase 1 would largely be the Pfizer vaccine and Phases 2 and 3 the Oxford Astra-Zeca vaccine – but it is now more 'fluid' in reality).

Figure 1: User options



If you select the strategy relaxation to be 'on', it relaxes the thresholds or triggers used in each strategy to tighten (and loosen) stage restrictions. Using the perhaps most important trigger to go into a stage 3 lock down, the average daily case-loads are given in Table 1: Trigger in **<u>average daily cases per million</u>** in the last 7 days (or **<u>total cases in last 7 day</u>**s for Victorian population in last 7 days) to go to stage 3 (lockdown) by strategy, for strategy relaxation 'off' and 'on'.

*Table 1: Trigger in **average daily cases per million** in the last 7 days (or **total cases in last 7 day**s for Victorian population in last 7 days) to go to stage 3 (lockdown) by strategy, for strategy relaxation 'off' and 'on'*

Strategy	Relaxation 'of'	Relaxation 'on'			
	All phases	Phase 1a and 1b (priority, 70+, ATSI 65+)	Phase 2a (50+, ATSI 18+)	Phase 2b (rest adults)	Phase 3 (children)
Aggressive elimination	0.23 per million	0.23 (>10)	0.45 (>20)	0.91 (>40)	1.82 (>80)
Moderate elimination	0.9 (>42)	0.9 (>42)	1.82 (>84)	3.64 (>168)	7.27 (>336)
Tight suppression	10 (>460)	10 (>460)	20 (>924)	40 (>1,848)	80 (>3,696)
Loose suppression	50 (>2310)	50 (>2310)	100 (>4,620)	200 (>9,240)	400 (>18,480)

The web-tool is set to have the default settings as in Figure 1, generating the graph in Figure 3. The solid lines are the average of the daily infection rates across the 100 simulations, and the bands are the 90% range of the daily rate over a week across the 100 simulations. There is always a lot of stochastic or chance variation in how COVID-19 plays out, hence the wide uncertainty bands. In Figure 2, there are high rates for the two suppression scenarios – but the two elimination scenarios are not even visibly different from the x axis, or zero. Using the option to view the rates on a log scale (above the graph), Figure 3 shows the same graph but using an exponential scale for the y-axis.

Figure 2: Median (and 90% range) of average daily infections by strategy – for default settings on linear scale

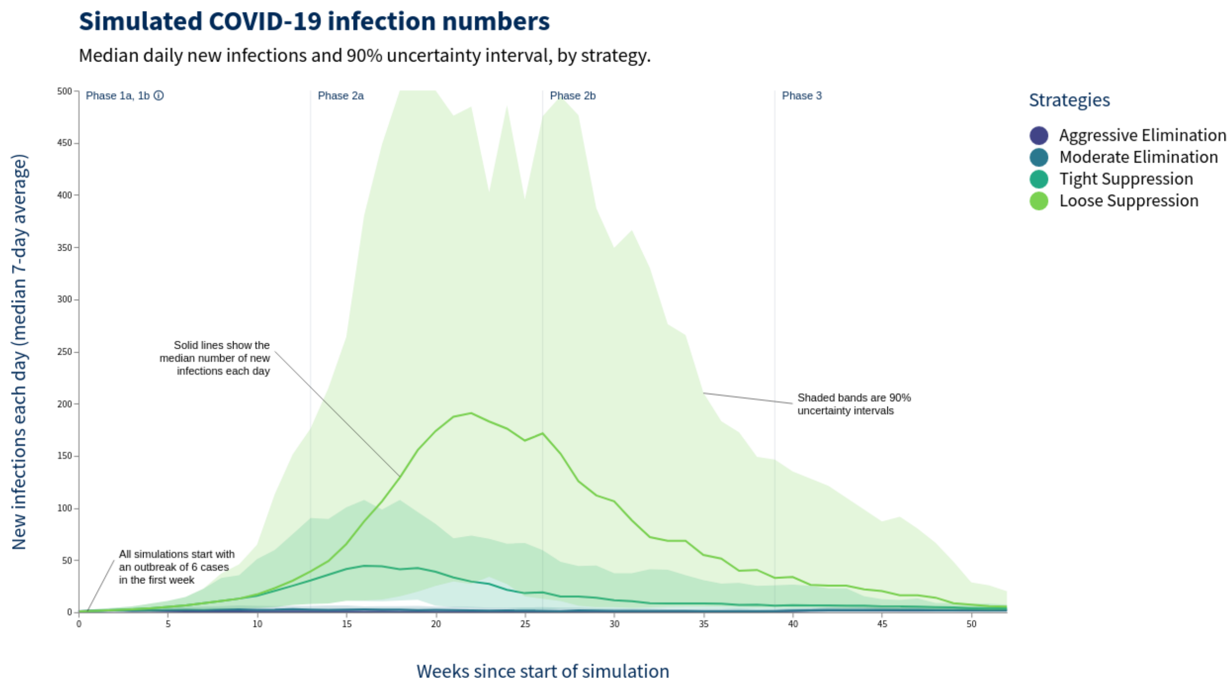
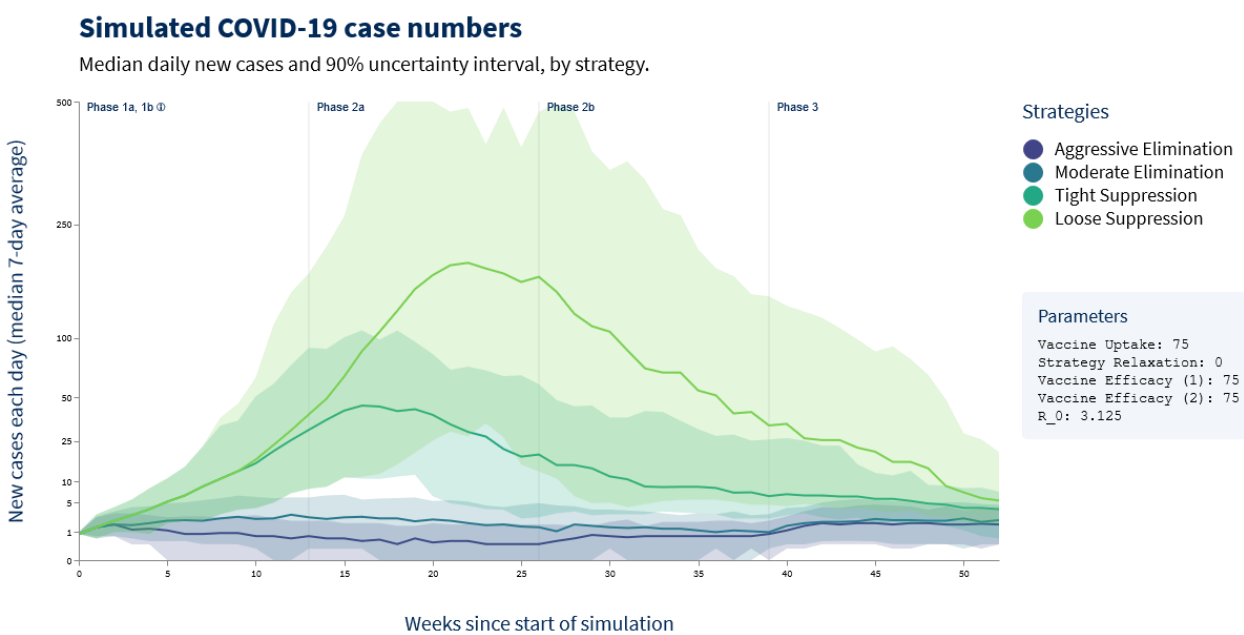


Figure 3: Median (and 90% range) of average daily infections by strategy – for default settings with average cases on exponential scale



You can see the huge variation in daily infections by strategy, although both moderate and aggressive elimination keep the average of the median across 100 iterations of this model about 1 per day (i.e. 1 per day in Victoria's population of 6.6 million) with 95% upper ranges only at about 5 per day. Of note, the daily infections fall markedly during phase 2 for both suppression options – hinting at the possibility of pivoting from (say) a moderate elimination to a suppression strategy as we (say) enter phase 2b.

A purpose of the tool is to allow you to explore what you think is most likely. Tony Blakely does not think the above 'default scenario' is the most likely scenario. He thinks that:

- we will relax whatever scenario we have over time – so he set relaxation to 'yes'
- that the vaccine(s) will reduce transmissibility by at least 90% [1] – so he set efficacy to 90% for both switches
- but he also thinks that, unfortunately, the virus getting into Australia when we open the borders will likely have an RO of about 3.75 – what we think the UK variant infectivity is.
- and finally, he thinks that we will not pivot to loose suppression with relaxing thresholds (given tight suppression with relaxing thresholds by Phase 3 in Table 1: Trigger in **average daily cases per million** in the last 7 days (or **total cases in last 7 day**s for Victorian population in last 7 days) to go to stage 3 (lockdown) by strategy, for strategy relaxation 'off' and 'on' above looks a lot like loose suppression anyway) – so we hover the mouse over 'loose suppression' on the right legend and click it off.

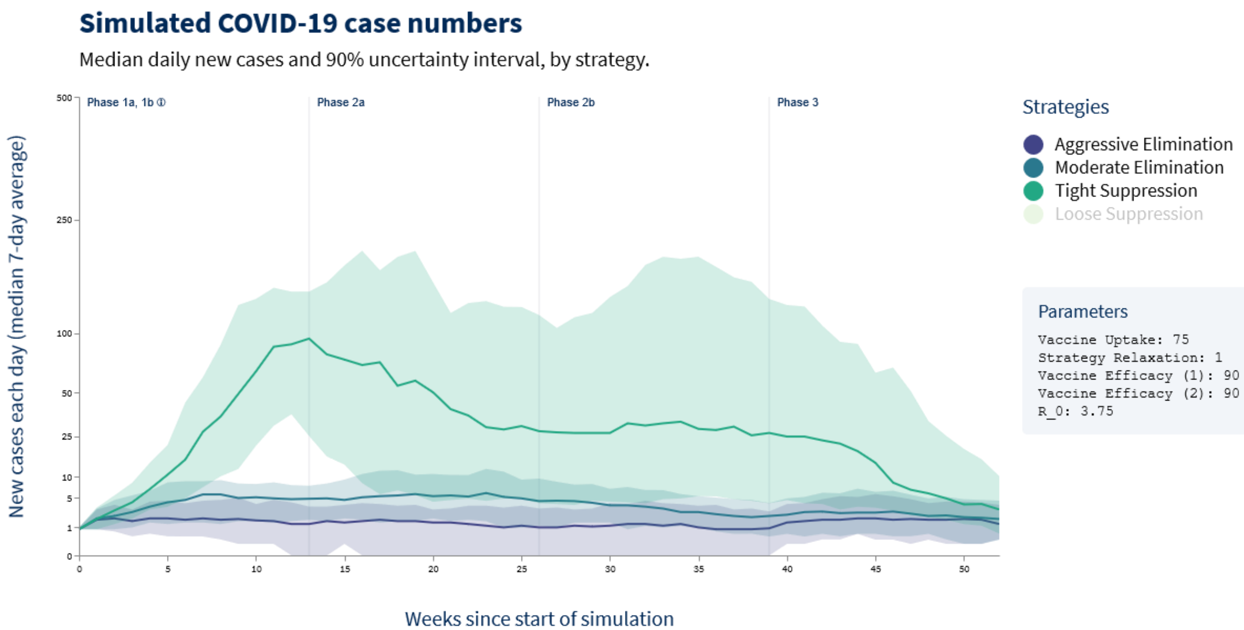
Tony Blakely's most likely scenario (holding the y axis the same as in Figure 3 for ease of comparison) is shown in Figure 4. The suppression scenarios look 'pretty good', but may even the tight suppression (with relaxing triggers over time) might be acceptable?

Figure 4: Median (and 90% range) of average daily infections by strategy – for Tony Blakely's preferred scenario settings

[1] The transmissibility reduction includes the impact of the vaccine of infections among the vaccinated – i.e. duration of infectivity, and peak infectivity of a vaccinated by infected person. Setting a 90% reduction in transmissibility sets each of the following three parameters to a 54% reduction in the model:

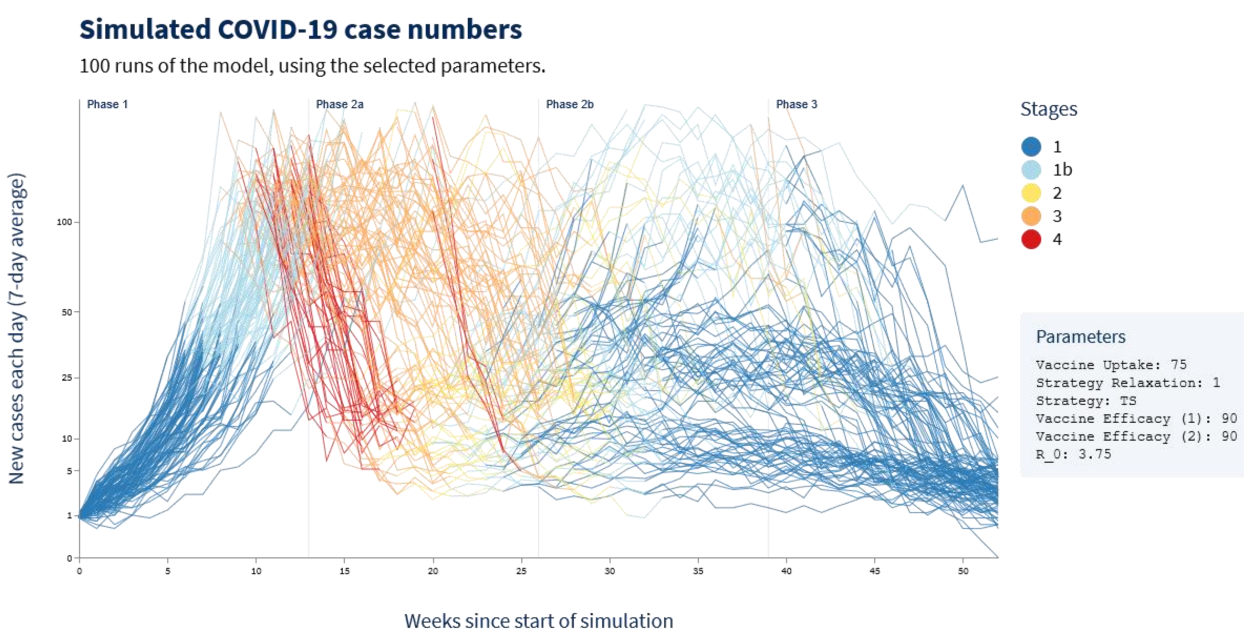
a. Risk of a vaccinated susceptible getting infected from an unvaccinated infected person
b. Duration of infection for a vaccinated infected compared to an unvaccinated infected
c. Peak infectivity for a vaccinated infected compared to an unvaccinated infected.

i.e. 90% = 1 – (1-54%)^3. Tony Blakely thinks 54% for each of these parameters is plausible, if not conservative for mechanism a at least.



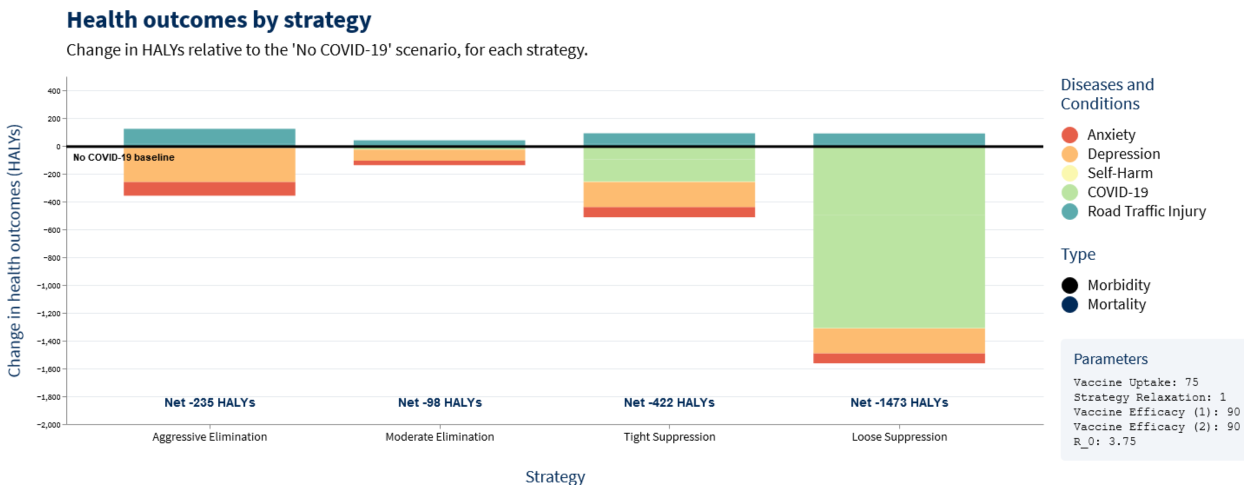
To investigate this scenario for tight suppression more deeply, the policy maker or Chief Health Officer could click on the 'explore simulations' button, set the options as above, select tight suppression, and set the y axis to the same as above. We now see all 100 iterations through the agent-based model of this scenario in Figure 5. It is likely that a policy maker would not be comfortable with the risk of 'runs' frequently going above 200 per day and the amount of red and orange (i.e. time in Stage 3 or 4 lockdowns). However, there is more still to consider before making a final decision.

Figure 5: The 100 agent-based model runs for tight suppression for TB's scenario settings



Next, we can see what the estimated net health impacts might be. By scrolling down the main COVID-19 Pandemic Trade-offs page to the health outcomes graph, you can see what is shown below in Figure 6 (continuing with Tony Blakely's preferred option). There is marked variation in net health loss, with loose suppression worst (dominated by SARS-CoV-2 morbidity and mortality), and moderate elimination least. Of note, aggressive elimination has notable health loss due to depression and anxiety (due to high time in lockdowns).

Figure 6: The expected value (no uncertainty) net health gains and losses (in health adjusted life years (HALYs)) for morbidity during the 12 months and lost years of health life due to deaths in the 12 months of the vaccine roll-out (undiscounted – future versions will also include 3% pa discounting and 90% simulation uncertainty intervals)



Next steps

The web-tool will be extended in the near-future to include:

- graphs and outputs of estimate health expenditure and GDP losses, by scenario, incremental to a counterfactual world had no COVID-19 pandemic happened
- cost effectiveness acceptability curves, to try and further assist the reader determine optimal strategies (using a 'standard' economic approach, noting of course that there are many perspectives to consider).

We will also evolve the web-tool to explore more policy options. Most importantly, in the current iteration we do not explicitly explore different options for opening international borders to more arrivals with less or no quarantine. Rather, the model includes increasing and wide uncertainty about the daily incursion rate of the virus to represent the range of likely scenarios for border openings in model 'uncertainty'; we soon will make this an option the user can control.

Finally, data and evidence on COVID-19 is constantly being updated. We will update the tool for important improvements in inputs, such as including additional health impacts of restrictions as evidence becomes available. Also, there are many moving parts in the models, and we welcome feed-back to population-interventions@unimelb.edu.au if you think there should be improvements to the model structure, input parameters and outputs options.