Appendix

Collapsing age-stratified contact matrices

In [37] (a study of country-specific contact rates), a 16x16 contact matrix provides contact rates between Canadians aged $0-80$ in 5-year intervals with the each row representing the age interval of an individual, and the age interval of the group being contacted listed on the columns. The highly stratified contact rates in this 16x16 matrix were then combined to create a condensed 3x3 contact matrix in accordance to our selected age groups in the following manner:

1. Columns are partitioned into the three age groups with which individuals come into contact: Group 1 (0-19), Group 2 (20-59), and Group 3 (60-80*).
2. Contacts are summed in each row in accordance with the new column partitions, yielding a 16x3 matrix, representing each of the 16 age groups' combined contacts with each of the 3 new age groups created
3. A population-weighted average of each respective cumulative contact-rate for all members of each group was taken to generate our final 3x3 matrix in accordance with our new age groups, outlined below. Each interval's population was taken from [59].

Initial start date

We choose to begin our model on February 14, after which iPHIS reports only a single day with zero new cases. While Ontario's official declaration of emergency was on March 17, 2020, we chose an earlier date for our simulated model due to the fact that March 17 is mid-work week. The majority of contacts occur in the workplace or in educational facilities. Since most workplaces and educational facilities close for the weekend, and educational facilities of all levels announced COVID-19-related closures on Friday March 13th at the latest, contact mitigation effectively began on Monday March 16th (or earlier).

5.1. Matching the delay between simulated data and iPHIS data

In theory, individuals should wait through the incubation period from time of exposure before displaying symptoms and becoming a member of I^S_{new} (3.5 days in E, 2.5 days in I^P, 6 days total). Unfortunately, the terms representing time in SEIR models (σ, ψ, κ, and γ) do not actually function as delayers, but rather dampeners. For instance $\sigma = 1/2.5$ should represent a 2.5 day latency period, and so individuals should have to wait 2.5 days from time of exposure before entering I^P, however the equation

$$I^P_{new}(t) = \sum_{i=1}^{3} \sigma \cdot E_i(t-1)$$

shows that $\sigma = 1/2.5$ of members of E will enter I^P on the very first day after entering E. Similarly, with the equation

$$I^S_{new}(t) = \sum_{i=1}^{3} \alpha \cdot \psi \cdot I^P_i(t-1)$$

we can see that $\psi \cdot \alpha = 1/2 \cdot 1/3.5 = 1/7$ of those in I^P will enter I^S on the first day after entering I^P. As a result, $\psi \cdot \alpha \cdot \sigma = 1/17.5$ of people exposed on day t will enter I^S on day $t+2$, with the remainder through the days following. With this in mind, we must introduce a delay term of at least 2-6 days from when we change q to when we match I^S_{new} with Ontario iPHIS data. This means that when finding the optimal value of q from day t to day $t+7$, we compare I^S_{new} with Ontario iPHIS on days $t + delay$ to day $t + delay + 7$, since a change in q will not result in a change I^S_{new} for $delay$ days. After testing delay terms of 0-7, and initial intervention dates from March 12 -March 17, we found an optimal combination of a 2 day matching delay with an initial intervention date of March 15 to minimize our SSE (see Figure 12).

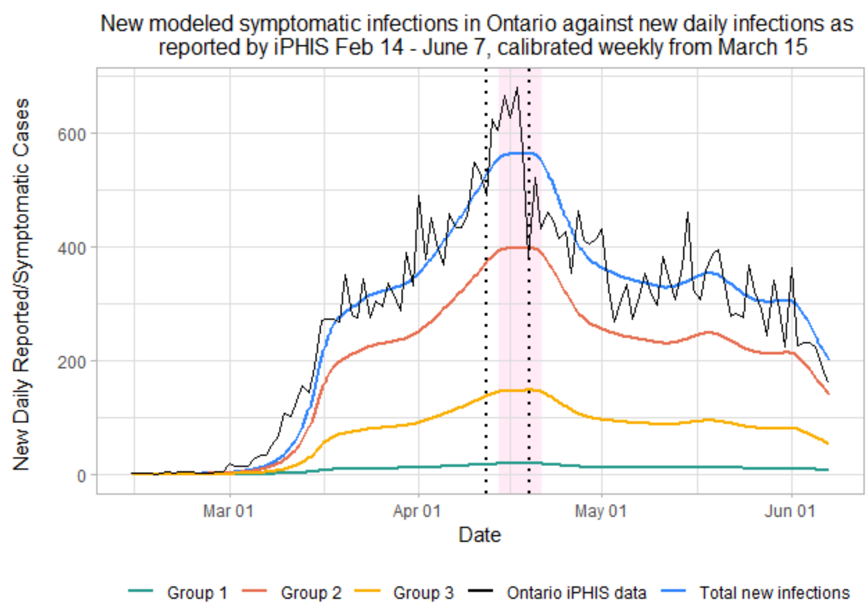

Figure 12: To solve for the q value for time interval int (between the two black lines), we find the SSE during time interval $int + 2$ (red shaded region).