

Table of notations

Model states	Symbol
Susceptible not yet vaccinated (o65 and y65)	S_O, S_Y
Received vaccine, waiting for it to take effect (o65 and y65)	V_O, V_Y
Received vaccine but was not effective (o65 and y65)	N_O, N_Y
Susceptible, refusing or unable to receive vaccine (o65 and y65)	U_O, U_Y
Exposed (o65 and y65)	E_O, E_Y
Infectious (o65 and y65)	I_O, I_Y
Recovered (o65 and y65)	R_O, R_Y
Protected from vaccine (o65 and y65)	P_O, P_Y
Total number of people in age group (o65 and y65)	T_O, T_Y
Model Parameters	Symbol
Rate at which an o65 person infects an o65 person	β_{OO}
Average number of o65 people infected by an o65 person	R_{OO}
Rate at which a y65 person infects an o65 person	β_{YO}
Average number of o65 people infected by a y65 person	R_{YO}
Rate at which an o65 person infects a y65 person	β_{OY}
Average number of y65 people infected by an o65 person	R_{OY}
Rate at which a y65 person infects a y65 person	β_{YY}
Average number of y65 people infected by a y65 person	R_{YY}
Rate at which exposed becomes infected	γ_E
Rate at which infected becomes recovered	γ_I
Rate at which vaccinated becomes protected	γ_V
Vaccine effectiveness	α_V
Percentage of over 65s refusing the vaccine	r_O
Percentage of under 65s refusing the vaccine	r_Y
Control functions	Symbol
Percentage of over 65s to get vaccinated at time t	$u_O(t)$
Percentage of under 65s to get vaccinated at time t	$u_Y(t)$
Optimisation Functions and Parameters	Symbol
Hamiltonian function	H
Cost function	\mathcal{F}
Age specific weight constants	W_O, W_Y