



The risk of **immune escape** and the **total infections** *might* be highest at **intermediate vaccination levels**.



Any questions?

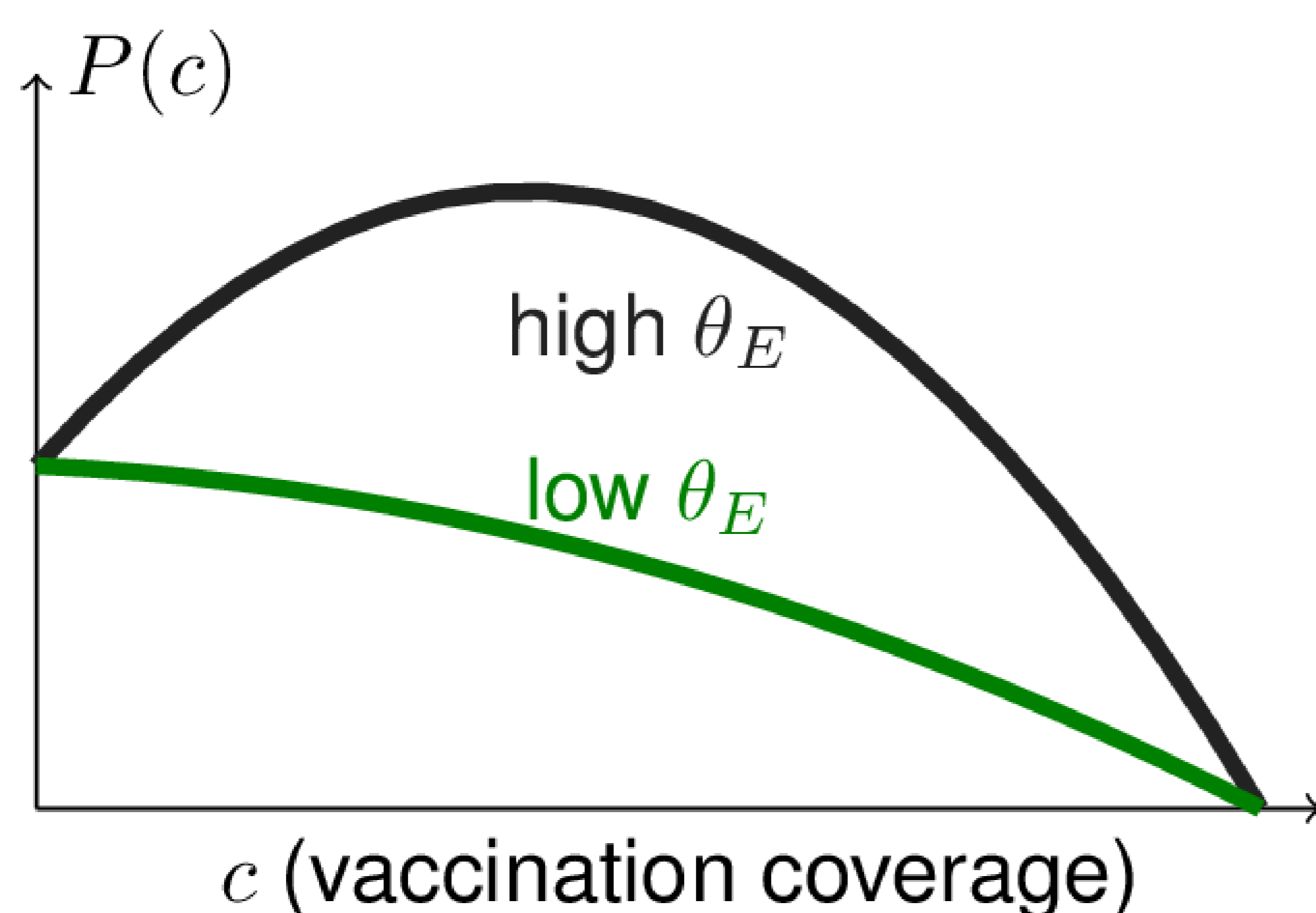
Modelling **vaccine escape**: population dynamics of infectious disease & pathogen evolution 

Motivation:

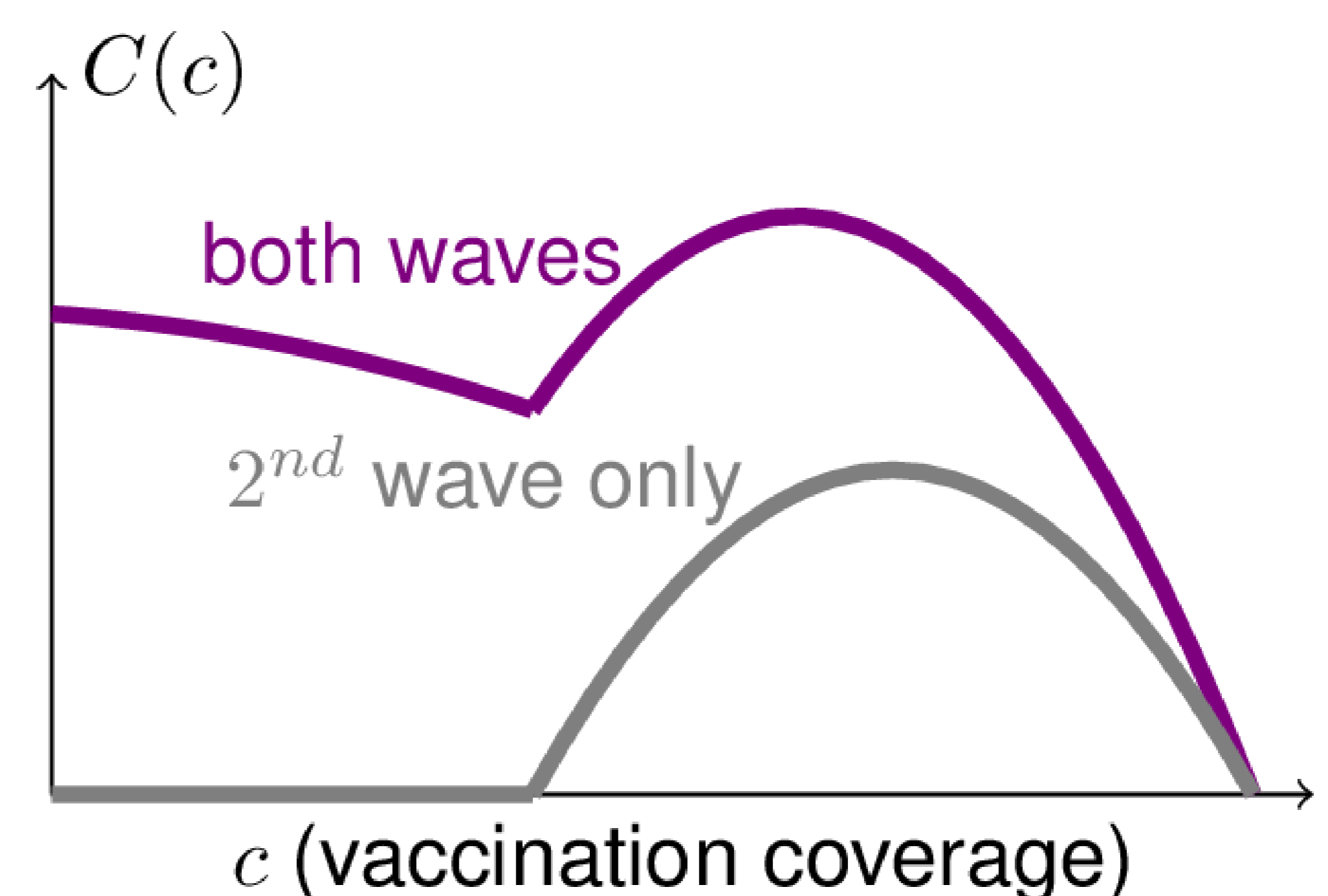
- Unknown within-host net adaptation rate during infections in vaccinees...what is the population-level effect?
- Despite escape strains, vaccination might still reduce total infections due to transmission-blocking.

Result 1: The **escape pressure** P may decrease with vaccination (c) or be unimodal, depending on θ_E , the net adaptation rate in vaccinees.

Result 2: A mutant escape strain may lead to a second epidemic, so that at intermediate vaccination levels (c) there might be more **total infections** (C).



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Methods

Deterministic model

SIR with vaccination

Antigenic escape strain

Two separate epidemics

1 Original strain generates **escape pressure**, based on final epidemic size

$$P = C_U + \theta_E C_V$$

Net adaptation rate in vaccinees

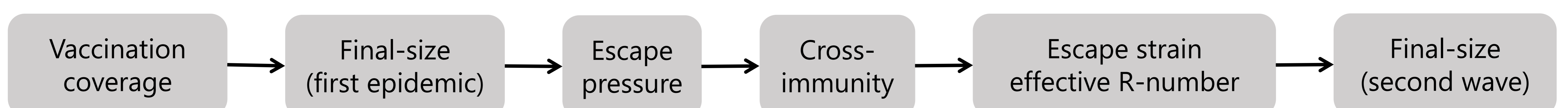
Escape pressure Infections in unvaccinated Infections in vaccinated

2 The escape pressure determines the **cross-reactivity** of vaccine immunity to a new strain.

$$\sigma = \exp(-aP)$$

Drift rate ($a > 0$)

Cross-immunity Escape pressure



Food-for-thought: What is the value of θ_E (for each pathogen & vaccine)?

- stronger selection for escape strains in vaccinated hosts
- ...but higher viral load in unvaccinated hosts means more mutations

$\theta_E > 1$?

This would mean more pathogen adaptation per infection in vaccinees.
I am not sure: what do you think?

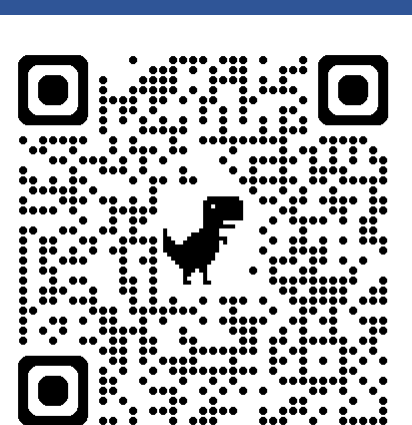
Extensions

Selection during reinfections

Immunocompromised hosts

Stochastic establishment

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