To Vaccinate or To Wait

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In Brief

- Main question:

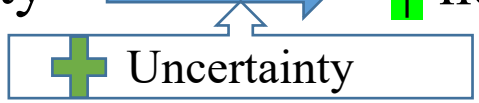
Does vaccine irreversibility influence a rational individual's decision to delay vaccination?

- Answer: Yes, even if immediate vaccination has net positive benefit

Vaccine costs < Vaccine benefits

Basic model: Irreversibility => ↑ no-vaccination likelihood

Model with uncertainty: Irreversibility → ↑ no-vaccination likelihood



Application: Effectiveness of rewarding vaxxers > taxing non-vaxxers

Motivation

Vaxxers and non-vaxxers:

- Quebec (Canada) opts for Covid non-vaxxer taxes (later cancelled).
- Some countries (e.g., Germany, Australia) fine parents who do not vaccinate their child for Measles. (Vox news 2019).

- "Instead of forcing, we need to go and see what's behind it for those who are not currently vaccinated" (public health director of the Gaspé region, Quebec)

Motivation

Vaxxers and non-vaxxers:

- Irreversibility: “I believe in vaccines’ effectiveness…yet I would rather wait for others to take it and eliminate the disease, so I avoid the vaccine sickness.”

- Irreversibility (or costly to reverse) & real options:
  - Positive Net Present Value (NPV) irreversible projects may be delayed (Siegel & McDonald-86)
  - Borrowing may be delayed with positive net debt benefits => Zero leverage firms (Lundberg & Lotfaliei-19)

- Question: Can we quantify the value in waiting?

Motivation

Irreversibility (or costly to reverse), uncertainty, & real option:

A basic example

Price=10

Cost =-6

NPV=+4

==========

Expected NPV with waiting= +7

50%

Price = 20

Cost =-6

NPV =+14

50%

Price = 0

Cost= -6

do not do: NPV=0

- Motivation question: Can we quantify the value in waiting to vaccinate?

Model 1: irreversibility

Vaccination is irreversible (or costly to reverse):

Classical assumption:

Vaccine gain H_1-V>0

→ Vaccinate

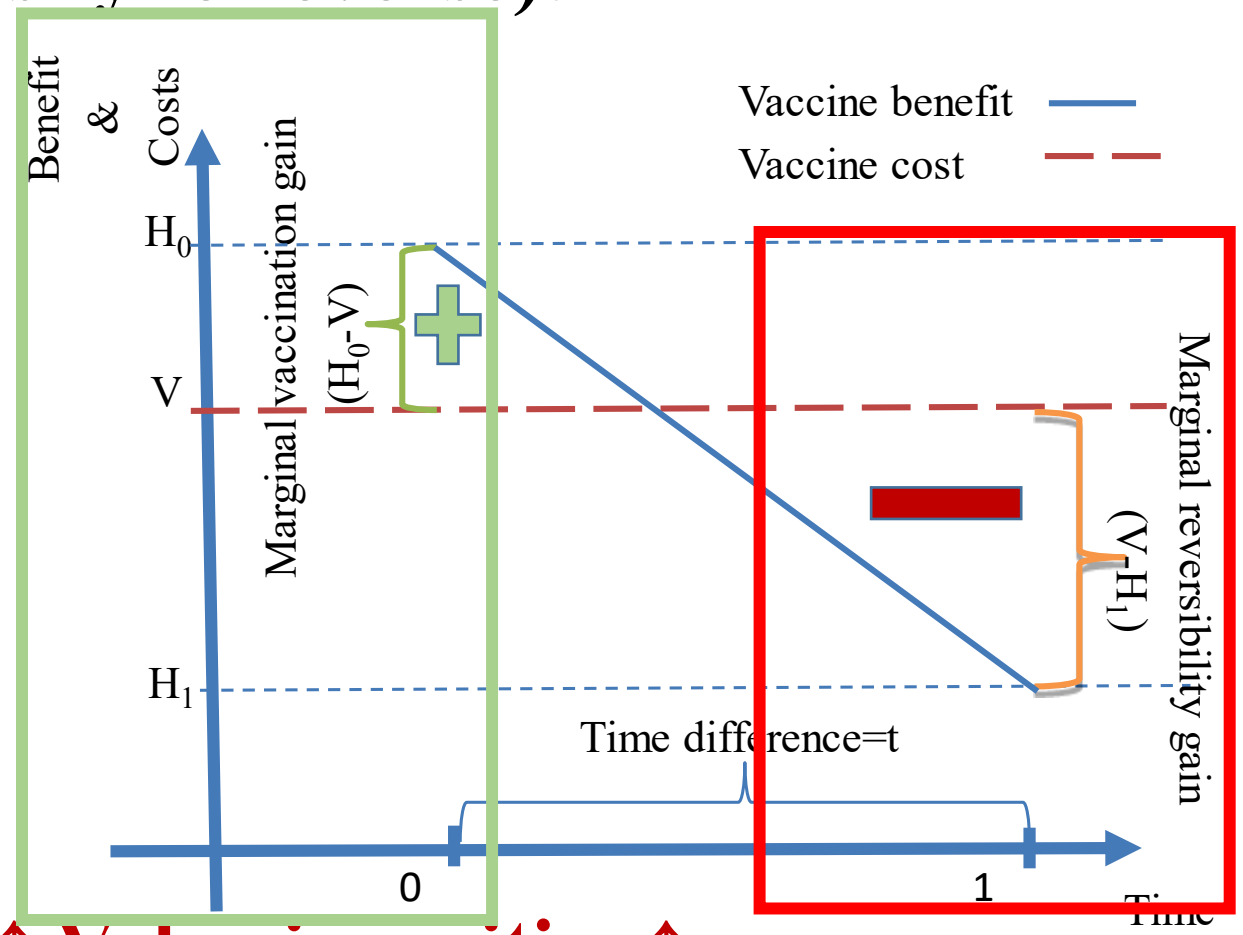
Irreversibility implication:

Vaccine gain H_1-V< $e^{-rt}(V-H_2)>0$

→ Not vaccinate

- **Future infection costs ↓↓**

→ **Irreversibility cost↑ Value in waiting↑**



Model 1: irreversibility- Intuition

Classical assumption:

Vaccine benefit = H_1>V=vaccine cost → Vaccinate

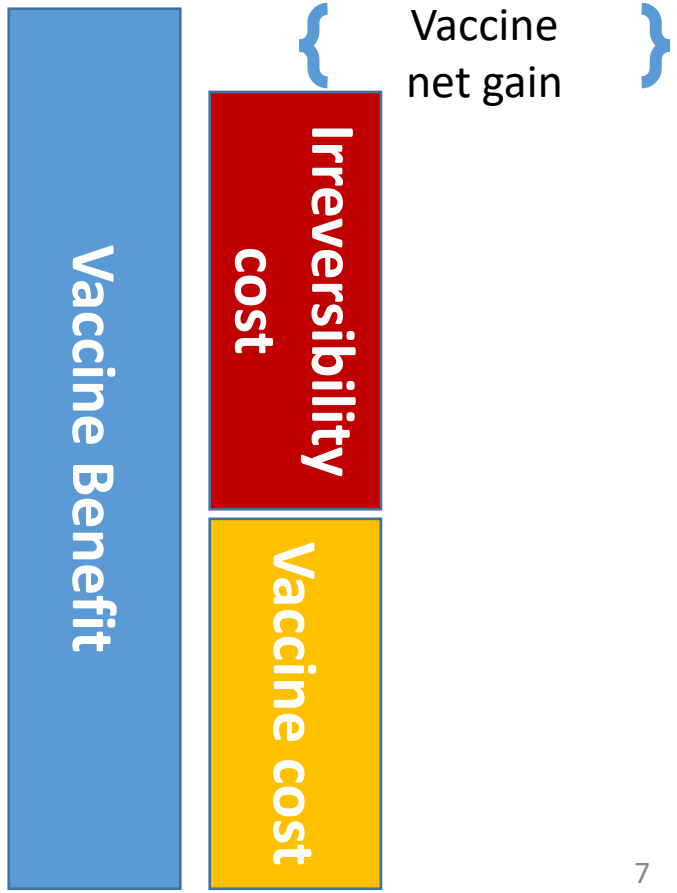
Irreversibility implication:

Vaccine benefit = H_1

>V=vaccine cost

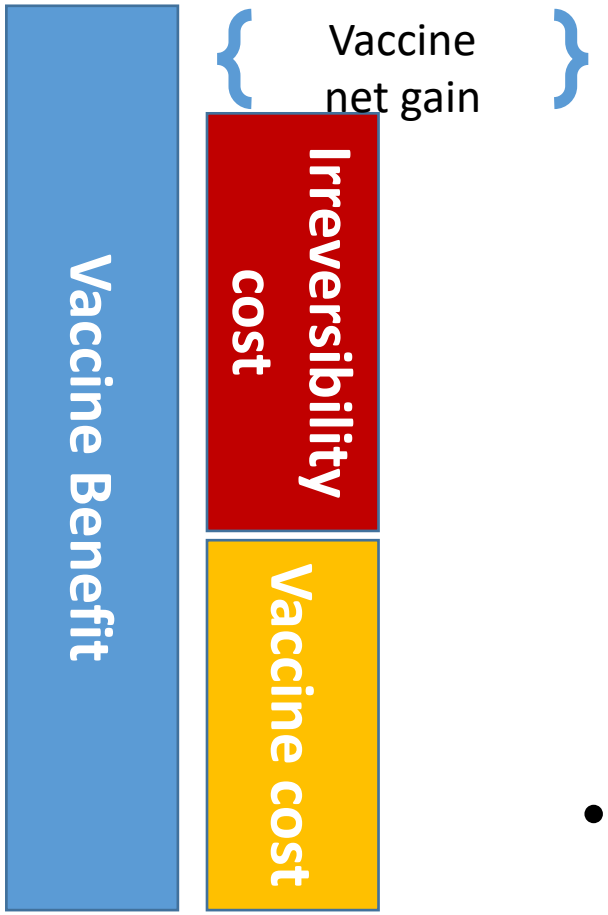
+ $e^{-rt}(V-H_2)$ =irreversibility cost

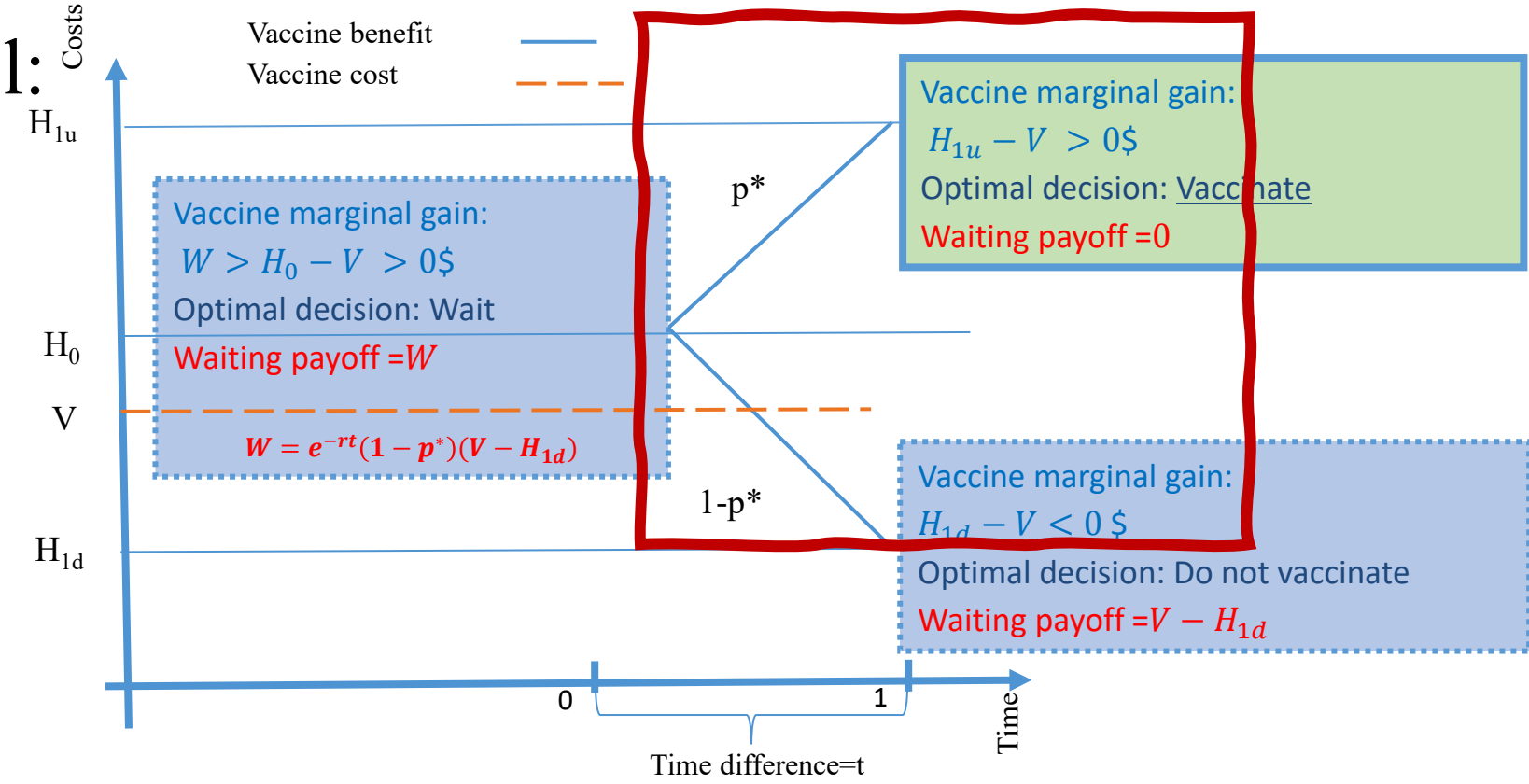
= Value in waiting



Model 2: irreversibility & **uncertainty**

- A basic binomial model:

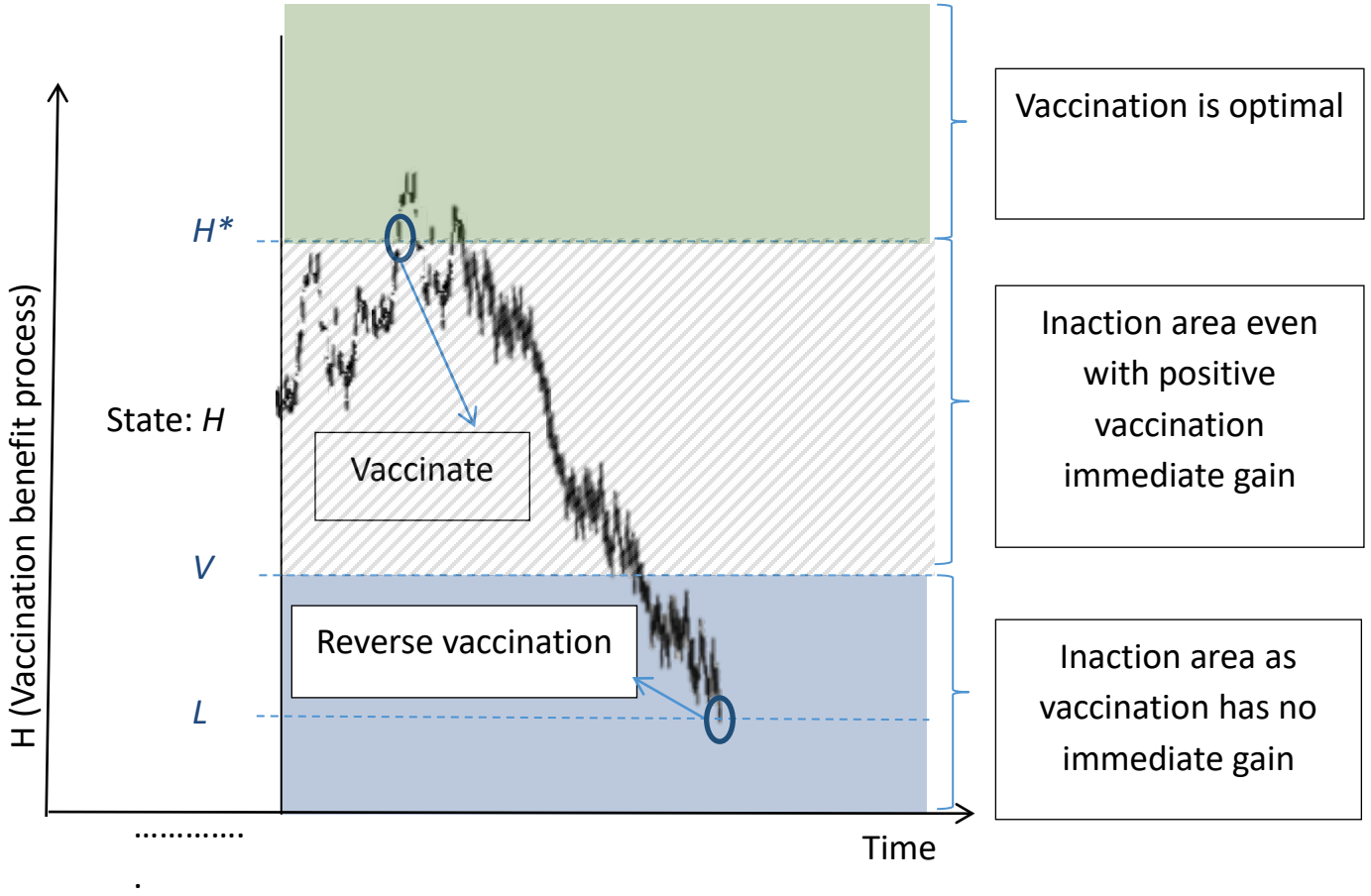




- **Uncertainty ↑ → Irreversibility cost ↑**

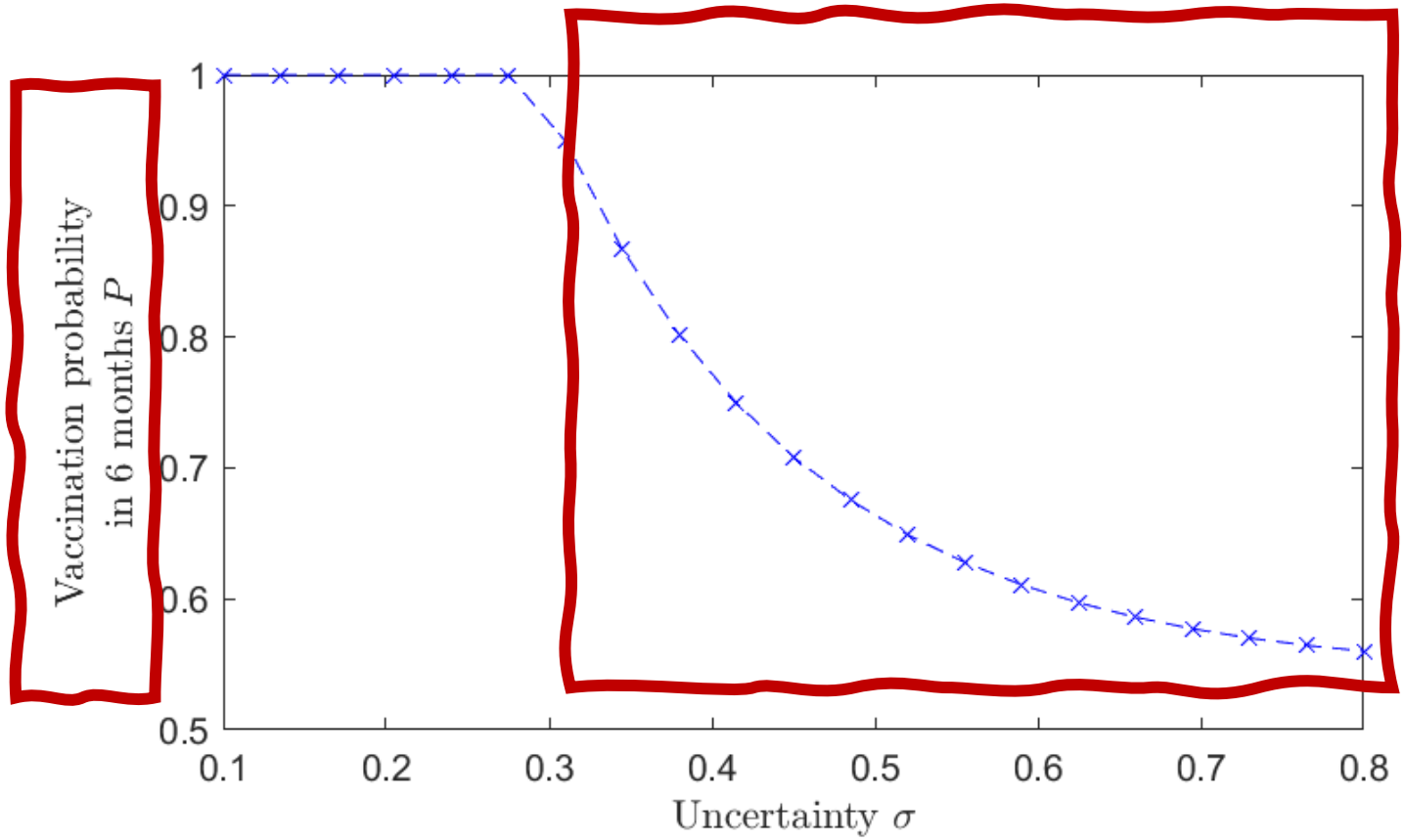
Model 3: irreversibility & **uncertainty**

- A continuous-time model: **Uncertainty ↑ → Irreversibility cost ↑**



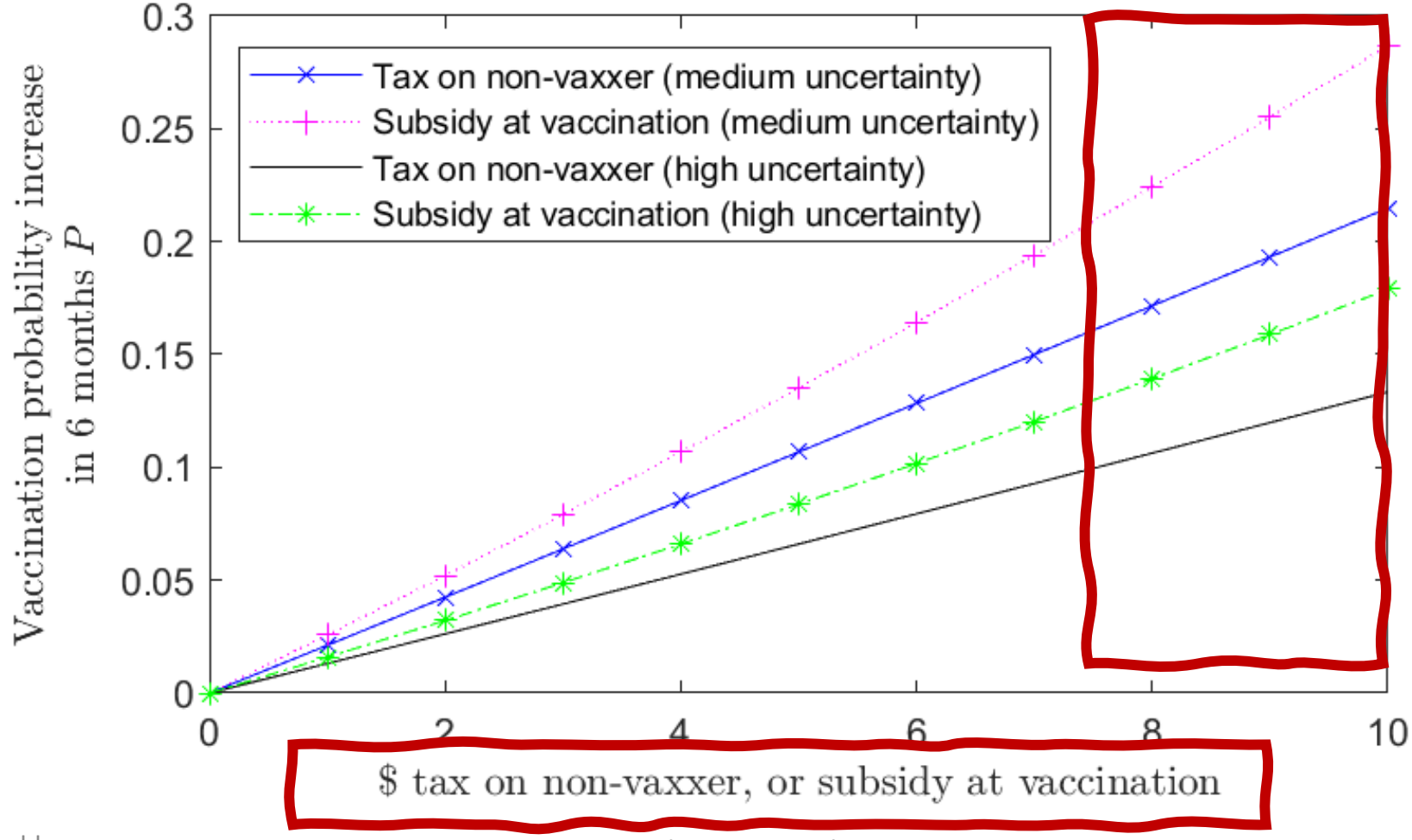
Model 3: irreversibility & **uncertainty**

- A continuous-time model: **Uncertainty ↑ → Irreversibility cost ↑**



Model 3: application

- A continuous-time model: **Tax < Reward=subsidy at vaccination**



Contributions

Irreversibility (value in waiting) + uncertainty = Magnifying glass on costs

✓We extend real option theory to individual health decisions

Rational model that complements irrational models for vaccination:

- Assumption required by some studies: "inflated perceived vaccination cost" (Bhattacharyya and Bauch 2011):
  - ➢E.g., regret theory: "an agent may have inaccurate perceptions of the probabilities of states occurring or may have imperfect information about the efficacy of the vaccination technology" (Sadique et al. 2005)
  - ➢Rumors (Verelst, Willem, and Beutels 2016)

✓This paper: with perfect information & perception, inaction may be optimal

Conclusion

Rational individuals with perfect information may delay vaccination

1- We develop **3 models** that **show irreversibility & uncertainty reduces probability of vaccination**

2- Demonstrate an example of application:

- **Reward (subsidy) at vaccination > tax on non-vaxxers**

- **Future research:**

Check the model & implications with empirical and behavioral tests

Thank you