Public Economics

Level 2

2020-2021

Conférence de méthode

Session 4

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Semester's plan

Session 1 : **introduction**
& maths recaps

Session 2 : **research in economics**
& a look at taxation

Session 3: **concentrated markets**
& informational problems

Send an email with your group's composition

MARKET FAILURES

Session 4: **collusion & externalities**

Send an email with your topic

handing of written report (November 23)

Session 5: **public goods**

Session 6: **group projects presentations**
(December 2 / 9)

Content of the 4^{th} session

1. **Collusion**
   1. Small complements to the lecture
   2. Exercise 1: strategic interactions under game theory framework
   3. Exercise 2: Cournot competition

2. **Research article discussion: externalities**
   1. Short intro to externalities
   2. Bethune & Korinek (2020) about Covid-19 infections

1. Collusion

1. **Short recap & complements**
2. Quantitative exercise 1
3. Quantitative exercise 2

Oligopoly's decision

- Under perfect competition or as a monopoly, other firms' actions do not matter

- On the contrary, an oligopoly needs to consider the effect of the strategy chosen by the rival on its **residual demand curve**.

  - Residual demand curve: demand curve faced by the oligopoly once competitor has set its production decision

Repeated games

- Same game repeated a finite or infinite number of periods

- Payoffs of future repetitions is discounted by a certain factor δ $(\delta < 1)$
  - The intuition is that we value less future payoffs than current ones
  - The first period is valued 1, the second δ, the third δ^2, etc.
  - And for a repeated payoff k, we have $\boldsymbol{k + k\delta + k\delta^2 + k\delta^3 + \cdots = \frac{k}{(1-\delta)}}$

Repeated games: finite number of repetitions

- If there are K number of stages,
  - in the last stage, it is as if players were playing the game once;
  - in the penultimate stage, whatever happens, the players will play the next one as if it was played once, so it is as if they played the game once;
  - in the antepenultimate stage, same reasoning...
  - etc.

- The unique equilibrium is to play at each stage the Nash equilibrium (if there is a NE).

Repeated games: infinite number of repetitions

- An **infinite** number of repetitions can allow to **escape the prisoner's dilemma** through **cooperation**

- For cooperation to work, we need a credible punishment strategy from deviation

1. Collusion

1. Short recap & complements
2. **Quantitative exercise 1**
3. Quantitative exercise 2

1. Collusion

1. Short recap & complements

2. Quantitative exercise 1

3. **Quantitative exercise 2**

2. Research article: externalities

1. Short introduction on **externalities** (will be studied in the lecture)

2. Bethune & Korinek (2020) about Covid-19 infections

Definition of externalities

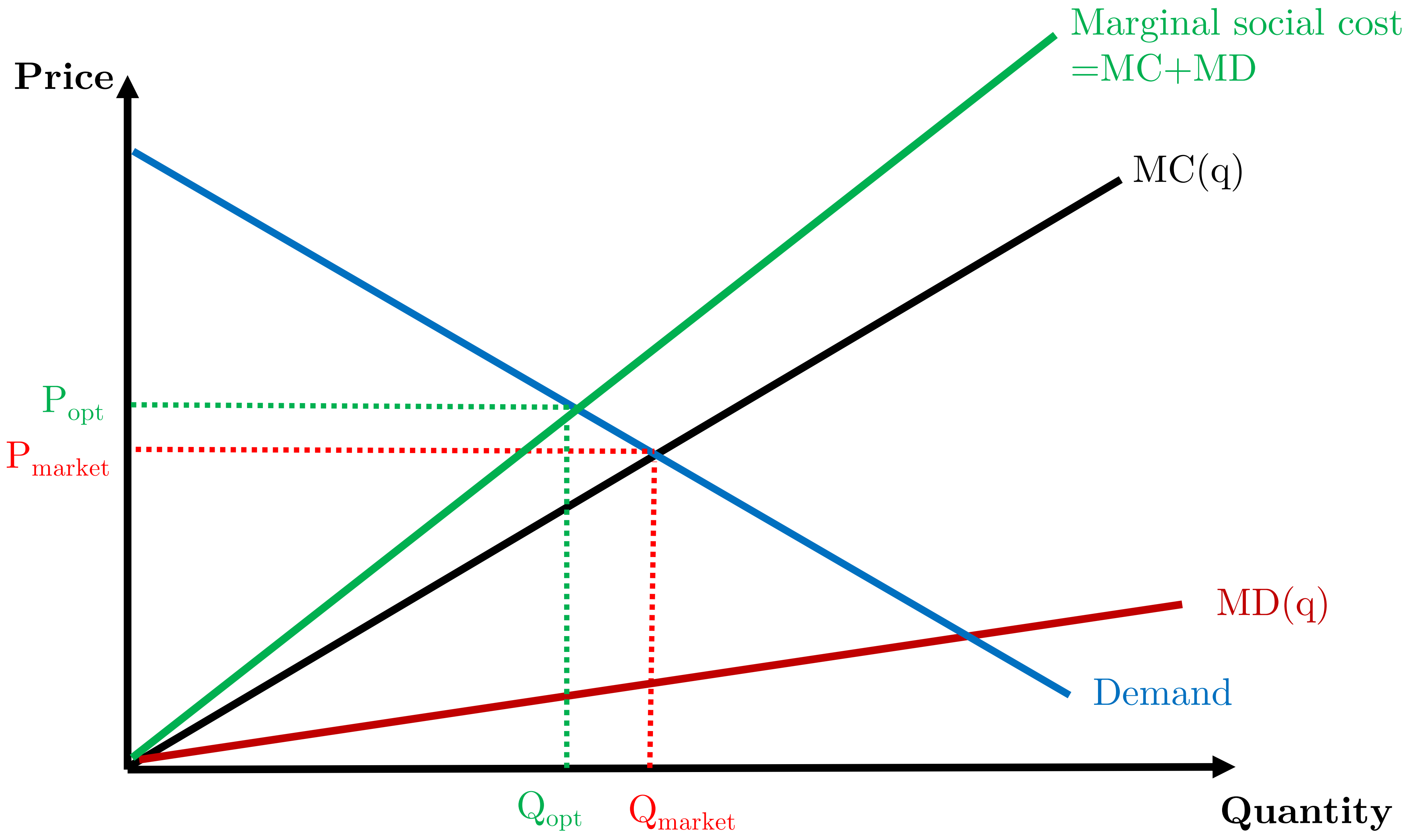
- An **externality** is present whenever the **welfare** of an economic agent is **directly affected (+/-)** by the actions of another agent in the economy **without going though the market (prices)**

- Those (+/-) effects on others are **not internalized by rational self-interested individuals** in their **personal cost-benefit analysis**

Negative externalities

- Marginal costs (MC) are higher
  Social MC = Private MC + Marginal Damage (or called External MC)

Optimal outcome vs market outcome



Positive externalities

- Actions more beneficial socially than individually

  Ex: vaccination, R&D, education, etc.

- Demand lower than social advantage

  (incl. external advantages)

Correcting negative externalities

- **Norms**

  Example: a legal maximal volume of pollution

  Advantage: sure about the level of production;

  Disadvantage: differences of adjustment costs of enterprises irrelevant

- **Pigouvian taxes**: tax on the externality, equal to reduction cost

  Example: tax on alcohol, etc.

  Advantage: internalize the social cost with a price signal; use the differences of adjustment costs of companies; **raises a tax revenue** (double dividend)

  Disadvantage: difficult to calibrate (gov. must know cost and damage functions)

Which correction to chose?

- **Norms** if the level of production is critical to the damages

  Example: nuclear wastes

- **Pigouvian taxes** if marginal costs vary across producers

  Example: tax on polluting chemical companies

- Specific case of **Pigouvian subsidy** (paying producer to produce less)
  Should not be used: **wrong incentives** and **ethically doubtful**

Additional options

- **Negotiable permits** (e.g. emission permits)

  The **total level of permits is fixed** and **distributed to companies**, which can also **transfer** (sell) them.

  At equilibrium, price of permit = marginal cost of output reduction

- **Property rights (Coase theorem)**

  If externalities affect individuals, they should **negotiate with externalities generators**. They may be legally protected (*dommages et intérêts*)

  Major limit: many times, individual impacts are too small, rights insufficiently characterized, the value affected is uncertain, or there are transaction costs

=> less applicable for positive externalities

2. Research article: externalities

1. Short introduction on externalities (will be studied in the lecture)

2. **Bethune & Korinek (2020)** about **Covid-19 infections**

Externalities

Bethune & Korinek (2020)

"Covid-19 infection externalities: trading off lives vs livelihoods"

NBER Working Paper Series

Motivation

- State response to covid-19 pandemic:
  - Are individuals going to adapt properly themselves or should the State constraint?
  - Containment vs heard immunity debate (paper from April 2020)

- Infectious diseases encompass negative externalities

  Self-interested indiv. consider their own risks but not the full social costs of infecting someone else
  Particularly large externality for Covid-19 pandemic

- This calls for mandatory public health interventions, such as lockdowns and quarantines.

- Objective of the paper: quantify the externality

Method

- Combine epidemiological models and economic reasoning & data (USA)
  - SIS and SIR models (will be presented by Emeric Henry in detail)
    3 “compartments”: Susceptible (S), infected (I) or recovered/resistant (R)
    Outbreak at 1% of prevalence
  - Rationally optimizing individuals choosing their social & economic activity levels
    +: gains from activity; -: costs from increasing their risk of infection
  - Calibration of parameters on the US
    statistical value of mortality risk;

- Compare decentralized (=individual) vs “social planner” (=State)
  - Individuals would themselves lower their interactions
  - However, while infected they may not internalize fully the risk of transmission, especially if their income depends on their activity level

Does only account for statistical value of mortality risk, not potential long-term health effects; recovered are forever immune which is quite not sure (modelization always simplifies reality)

Calibration

- Initial prevalence of Covid-19: 1% of pop
- Time unit: weeks
- $\gamma = \frac{1}{3}$ (avrg duration of disease of 3 weeks)
- $B_0 = \frac{2.5}{3}$ implying $R_0 = \frac{\gamma}{B_0} = 2.5$ (taken from Atkeson, 2020)
- Annual discount rate of 4% (to actualize future utilities)
- $\phi = 0.25$ the share of economic activity requiring physical presence
  influencing the effect of the level of activity a on the economy
- The cost of infection is linked to the potential risk of death (next slide)

Cost of disease

- Cost rises as the number of infected grows to capture the potential that limited hospital capacity may increase the fatality rate of the virus.

- "Estimates of the implied cost of adverse health events are obtained by evaluating how much individuals are willing to spend to avoid a given risk of an adverse event"

- Estimate in the US of the "value of a statistical life" is around $10.3m at the age of the median worker (40 years)

- But fatality rate of Covid-19 depends heavily on age

Table A1: Calculation of population-weighted expected loss of VSLYs (Value of Statistical Life Years) in US given infection

Age group	Population		Life Expectancy		Value of statistical life*		Case fatality rate	E[loss] given infection*	
	Men	Women	Men	Women	Men	Women		Men	Women
0–9	20.45	19.56	72.0	76.9	$ 12,171	$ 12,305	0.002%	$ 0.2	$ 0.2
10–19	21.43	20.54	62.2	67.1	$ 11,810	$ 12,006	0.007%	$ 0.8	$ 0.8
20–29	23.22	22.21	52.8	57.3	$ 11,304	$ 11,571	0.031%	$ 3.5	$ 3.6
30–39	21.98	21.71	43.6	47.7	$ 10,598	$ 10,947	0.084%	$ 8.9	$ 9.2
40–49	20.06	20.40	34.5	38.3	$ 9,600	$ 10,058	0.161%	$ 15.5	$ 16.2
50–59	20.95	21.88	26.0	29.3	$ 8,266	$ 8,839	0.595%	$ 49.2	$ 52.6
60–69	17.76	19.65	18.3	20.9	$ 6,628	$ 7,243	1.930%	$ 127.9	$ 139.8
70–79	10.35	12.31	11.6	13.4	$ 4,713	$ 5,280	4.280%	$ 201.7	$ 226.0
≥80	4.92	7.76	6.2	7.4	$ 2,810	$ 3,240	7.800%	$ 219.2	$ 252.7
	Total:	327.14						Wgt. Average	$ 50.0

* in thousands of USD

Sources:
Population numbers: US Census Bureau (2018)
Life Expectancy: US Social Security Administration, Period Life Table (2016): https://www.ssa.gov/oact/STATS/table4c6.html
Case fatality rate: Verity et al. (2020), Table 1

Epidemiological model (presented by EH)

Epidemiology We denote the fraction of recovered/resistant individuals by R and normalize the population to $S + I + R = 1$. The epidemiological laws of motion in our SIR model are

$$\dot{S} = -\beta(\cdot) IS \tag{18}$$

$$\dot{I} = \beta(\cdot) IS - \gamma I \tag{19}$$

$$\dot{R} = \gamma I \tag{20}$$

where the last compartment reflects that infected individuals recover at rate γ

Individual decision process

$$\max_{\{a_S, a_I\}} U = \int_t E_i \left[e^{-rt} u_i \left(a_i \right) \right]$$

$$\dot{I} = \beta \left(a_S, \bar{a}_I \right) \bar{I} \left(1 - I \right) - \gamma I$$

- Intertemporal with several periods t (infinite)
- Maximize the actualized utility derived from the activity level a
  - Take as given the activity level of others and the share of infected in the pop.
- Subject to the impact of this activity on the probability of being infected
- $\dot{I}$ is the law of evolution of the infected population
  - It depends on the rate of infection β, which is Covid-19 specific and is also a function of the activity level of both the susceptible (a_S) and the infected (a_I)
  - γ is the recovery rate

Individual decision process, optimality conditions

The rational agent:

- equates the marginal utility of activity a_S to the marginal expected cost of becoming infected (=lifetime utility loss of infection times the marginal probability of infection)

- picks the maximum level of activity $a_I = 1$ when he or she is infected to maximize the derived utility, not considering the epidemiological spillovers

Social planner (State) decision process

$$W = \int U \, dj$$

- The planner maximizes overall social welfare the integral over the utility of the unit mass of agents j ∈ [0, 1]

- The State accounts for the risk of infection of susceptible agents in a similar manner as individual agents do

- Whereas this was disregarded by individual agents, the State takes into account that the activity of infected agents increases the infection risk of the susceptible, who may in turn infect more individuals

- Therefore, the planner finds it optimal to impose more stringent isolation measures on infected individuals.

Results

- Individuals perceive the cost of themselves becoming infected to be around $80,000

- The social cost for the State (including externalities) is more than three times higher, around $286,000

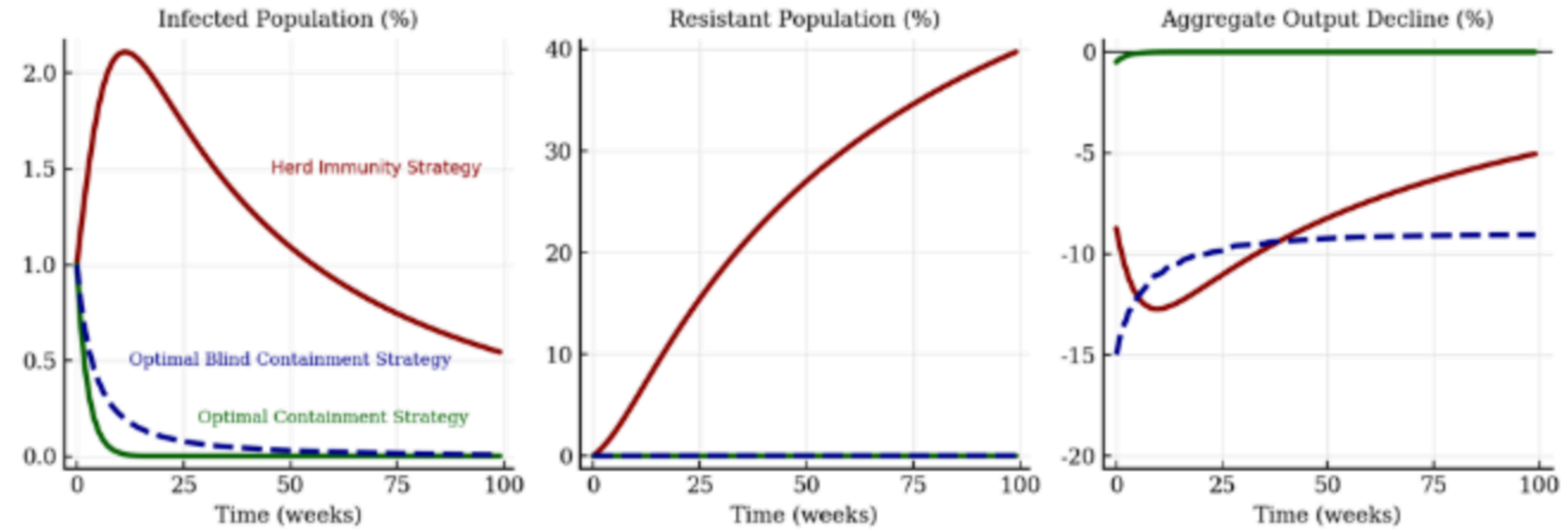
- Social cost of an additional infection when we are somewhat blind on who is infected is $576,000 (next slide)

Blindness

- Uncertainty about the I or S status because:
  - Long incubation period
  - Many asymptomatic individuals
  - Shortage or dysfunction in testing

- In an extreme case, individuals and the State would choose a uniform level of activity, independent from the epidemiological status

Results



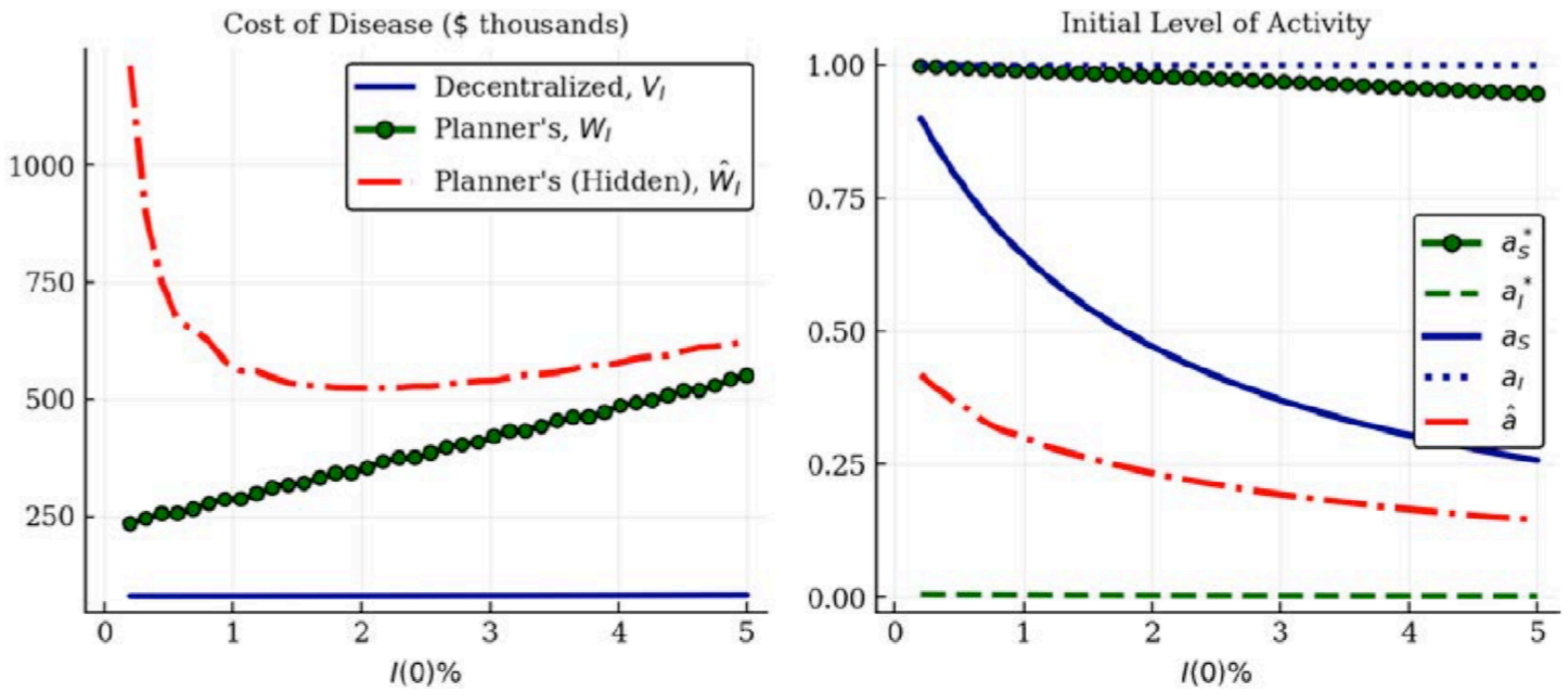
Heard immunity: larger fraction of the population infected, associated with larger economic decline in the short run and slow recovery

Optimal public health intervention quickly contains the disease, targeting the infected individuals (isolated and quarantined) with mild restrictions on others; minor economic impact (difficult in practice because many asymptomatic and test kits shortage in the first place or high prevalence later)

"Blind containment": general lockdown due to complicated contact tracing. Larger economic conseq.

Results

Figure 8: Cost of disease and economic activity as a function of I under hidden status (for $R = 0$)



All estimations **depend on the calibration**. e.g. differences wrt initial level of prevalence

Recall what I told you about theoretical models and the fact that you could provide an **infinity of simulations**...

Public policy implications

- Generalized lockdown should rather be a tool to buy time and organize a functional testing, tracing and isolation strategy that enable the optimal containment strategy. Otherwise too costly economically.

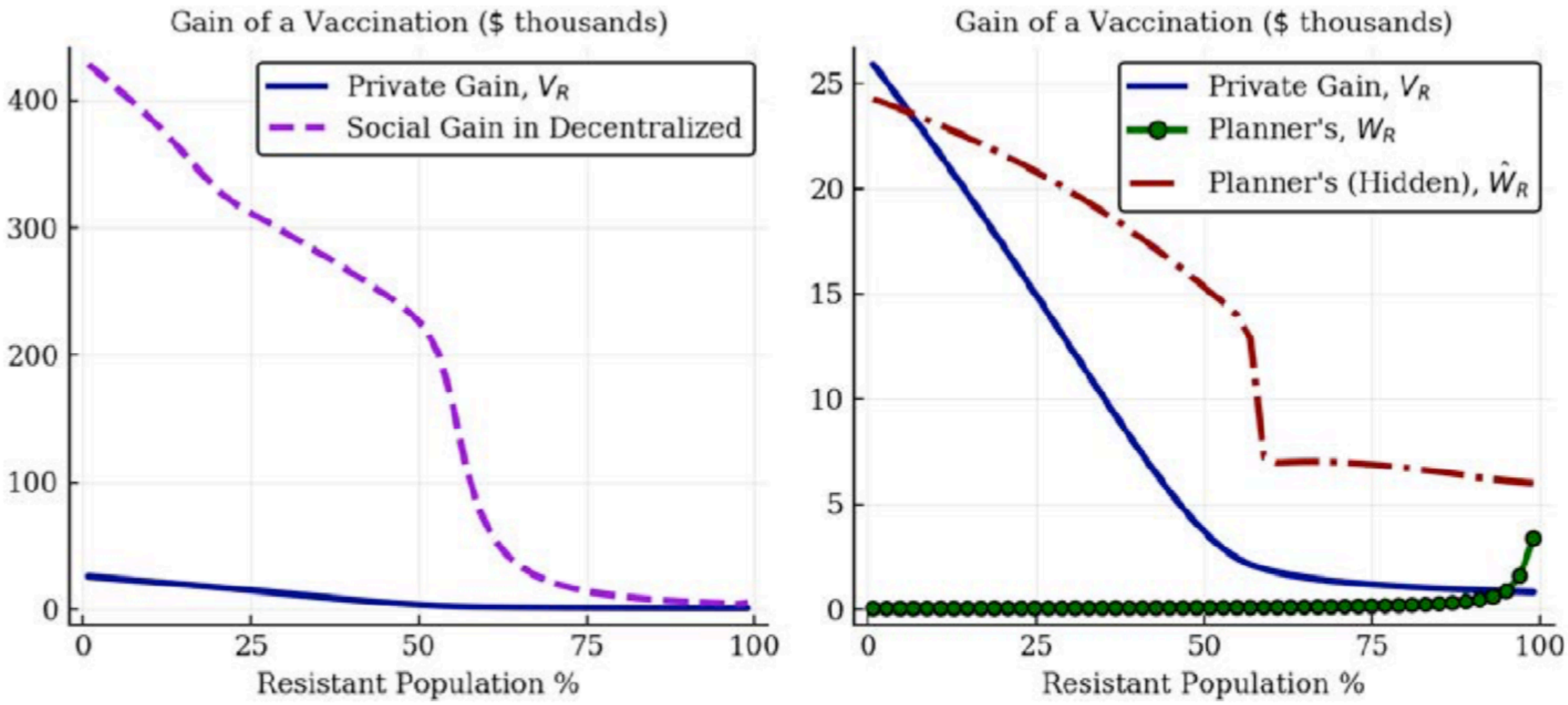
- However, the optimal containment strategy is still subject to potential periodic outbreaks, if imported from other countries

Add-on about vaccines

- Large positive externalities not internalized by individuals
- Computed when there is about no immunity in the society:
  social benefit of vaccinating one more person: $430,000
  individually perceived benefit: $26,000
- State should subsidize the development of an effective vaccine

Add-on about vaccines

Figure 9: Private versus social gains from vaccination, given $I = 1\%$



Additional externalities of infection

- We may think if many additional negative externalities of one infection
- The more infections the more likely schooling will be affected, implying long term negative externalities
- More inequality with home schooling (Oreopoulos, Page & Stevens, 2006)
- Some potential benefits though with some degrees awarded to students that may not have pass it otherwise. Maurin & McNally (2008) showed that the automatic 1968 *baccalauréat* (A-level) in France had long-term favorable labor market effects

Alternative to infected / general lockdown

- Acemoglu, Chernozhukov, Werning and Whinston (2020) about **targeting the risky population**

- Also a SIR model & macroeconomic dynamics
  3 groups: young aged 20–49; middle-aged 50–64; old 65+
  mortality rate conditional on Covid-19 infection: 0.001%; 0.01%; 0.06%
  $\neq$ incomes too

- Targeted policies imply a much shorter lockdown for age groups below 65

Does not account for income inequalities within groups, other comorbidities, etc.
(modelization always simplifies reality)

Alternative to infected / general lockdown

Targeted Policies

Favor low mortality

⚰ **0.2%** ; ↘**24.8%** GDP

Economic priority:

⚰ **0.48%** ; ↘**10%** GDP

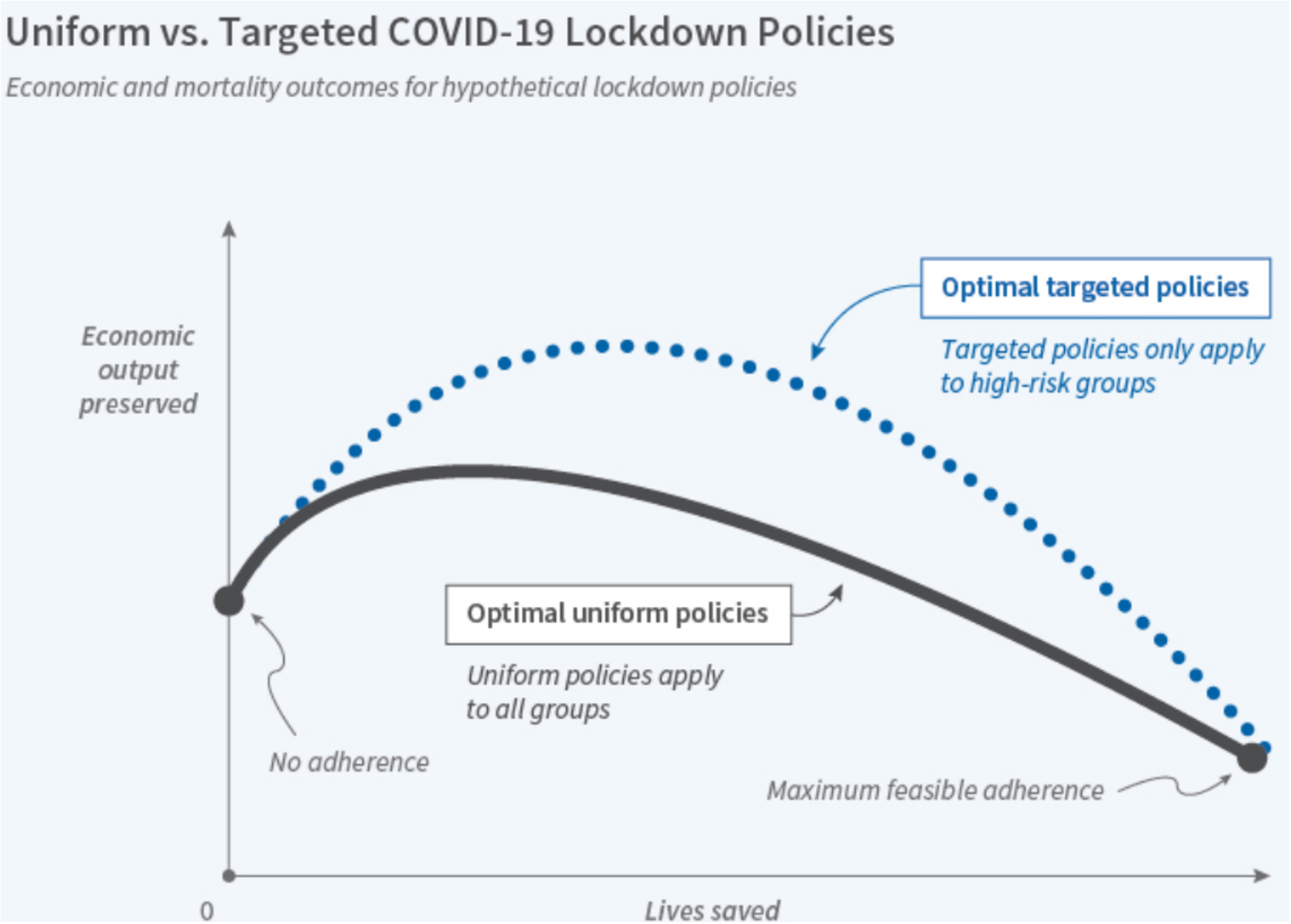
Uniform Policies

Favor low mortality

⚰ **0.2%** ; ↘**37.3%** GDP

Economic priority:

⚰ **1%** ; ↘**10%** GDP



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