

Signal selection and informational persistence

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Preliminary version

Outline of the talk

- Motivation
- Our approach
- Main results
- The model
- Conclusions and extensions

Motivation

- Empirical evidence that fines or subsidies alter incentives unexpectedly
- Surveyed by Frey and Jegen (2000)
- Day-care centers in Israel (Gneezy and Rustichini, 2000)
- **Volunteering activities:**
 - Dugnads in Scandinavia (Brekke et al., 2003)
 - Volunteers in Switzerland (Frey and Gotte, 1999)
 - Experiments with volunteers (Gneezy and Rustichini, 2000)
 - Recycling (Brekke et al., 2003)

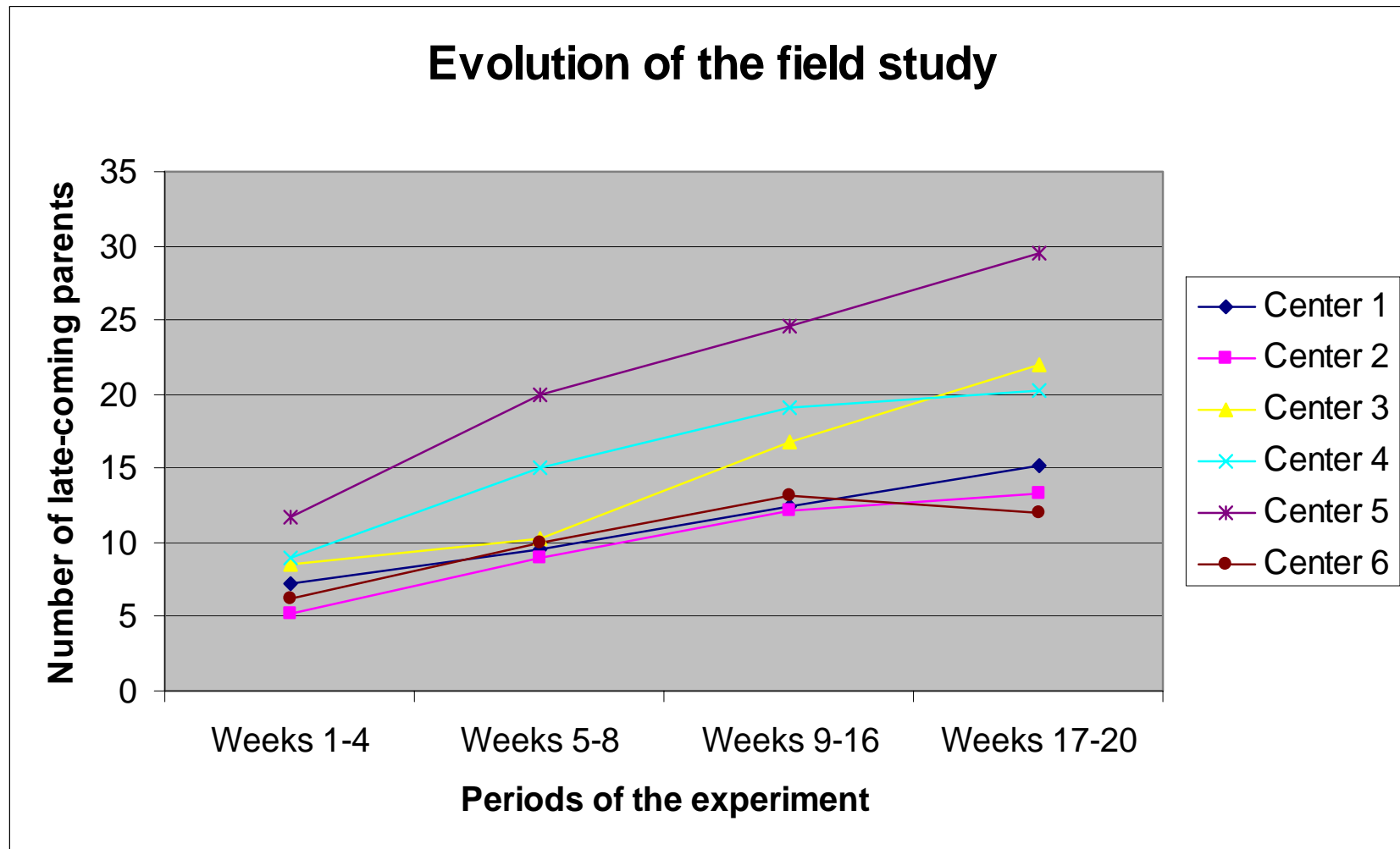
Motivation

- **Day-care centers in Israel** (Gneezy and Rustichini, *Journal of Legal Studies* 2000, *QJE* 2000): **DESCRIPTION**
 - Field study (**20 weeks**) with 10 similar day-care centers in Israel (Haifa) for young children (1-4 years old)
 - Number of parents who arrive late to collect their children in each center is recorded (**weeks 1-4**)
 - A fine (NIS 10 per delay of 10 minutes or more) for parents who arrive late to collect their children is introduced in 6 centers (**weeks 5-16**)
 - The fine is removed with no explanation and behavior is recorded (**weeks 17-20**)

Motivation

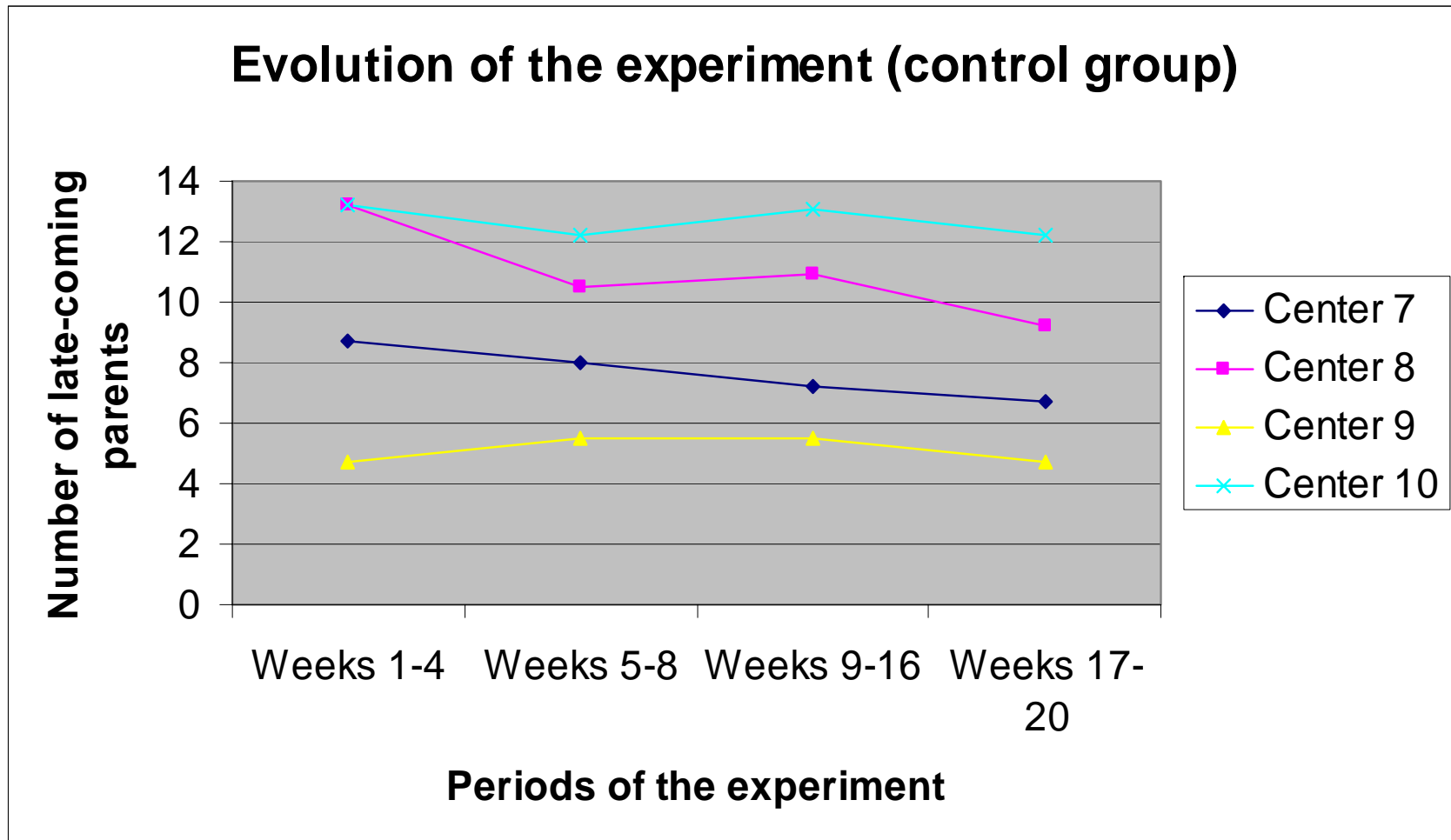
- **Day-care centers in Israel** (Gneezy and Rustichini, *Journal of Legal Studies* 2000, *QJE* 2000): **RESULTS**
 - Stable and similar rate of parents arriving late in both the test and the control groups
 - Dramatic impact of the fine in the 6 test day-care centers: the average number of parents who arrive late increases steadily and finally settles at a higher level, almost twice as large as the initial one
 - Number of late arrivals remains stable after the fine is removed. No change in the control group.
 - Effects are shown to be statistically significant

Motivation



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Motivation



Motivation

- Day-care centers in Israel (Gneezy and Rustichini, *Journal of Legal Studies* 2000, *QJE* 2000): POSSIBLE EXPLANATIONS
 - Differential information: parents test the reaction of the day-care centers to higher levels of delays
 - Shift in perception of an incomplete contract (hard to reverse)
 - Social norms:
 - “When help is offered for no compensation in a moment of need, accept it”
 - “When a service is offered for a price, buy as much as you need”
 - “Once a commodity, always a commodity”

Motivation

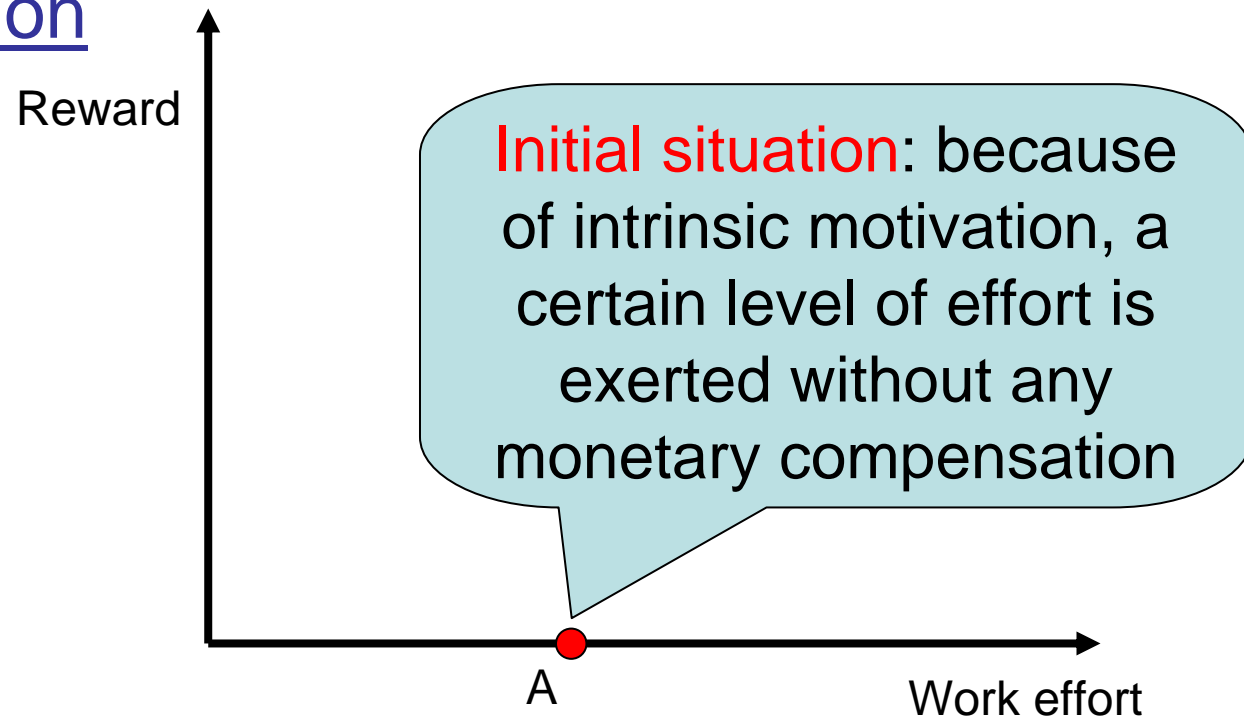
- A fee for non-participation in voluntary community work may decrease participation (Frey and Goette, 1999):
 - The incidence of monetary rewards reduce volunteering
 - The size of rewards increase volunteering
- Experiments (Gneezy and Rustichini, 2000):
 - The effect of monetary compensation on performance is not monotonic.
 - When money is offered, more money improves performance. However, offering money does not always produce an improvement (IQ experiment)

Motivation

- Which explanations have been proposed?
 - Brekke et. al (2003) develop an economic model of moral motivation. Reciprocity?
 - People follow social norms that prescribe a behavior independently of any monetary compensation (e.g. donating blood)
 - The cognitive psychology school: intrinsic motivation (motivation of its own) can be crowded out by extrinsic motivation (monetary rewards).

Motivation

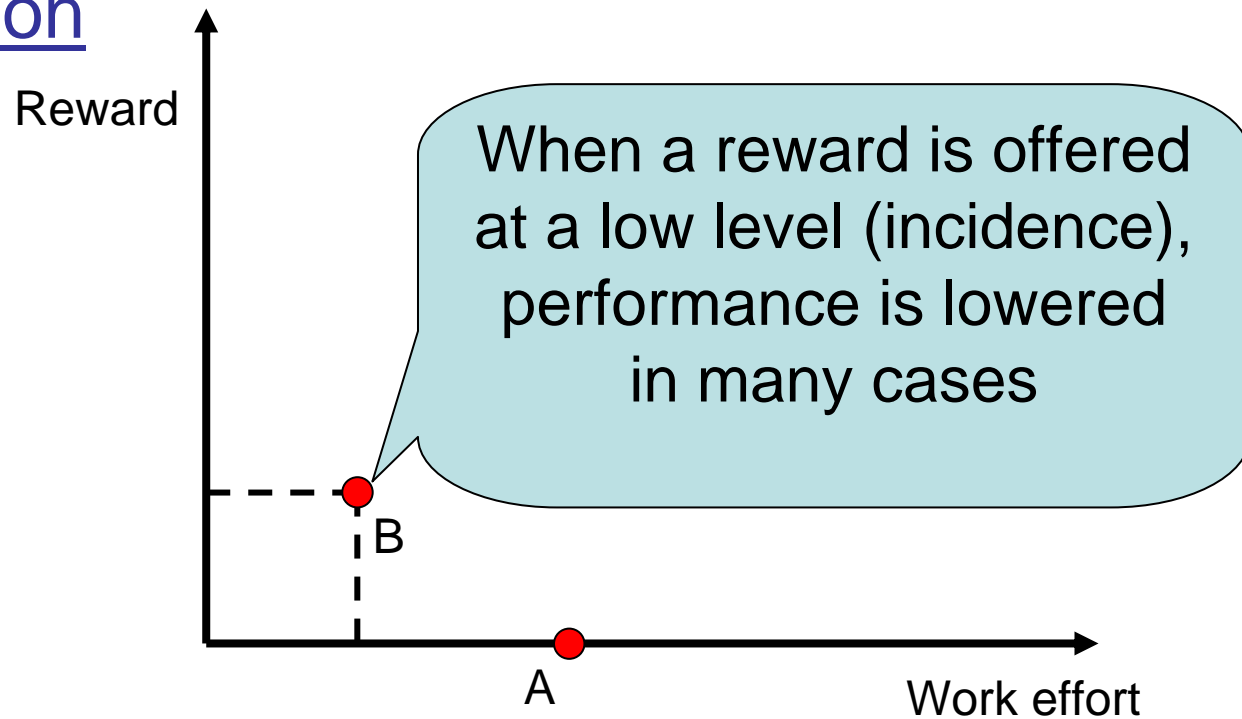
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Motivation

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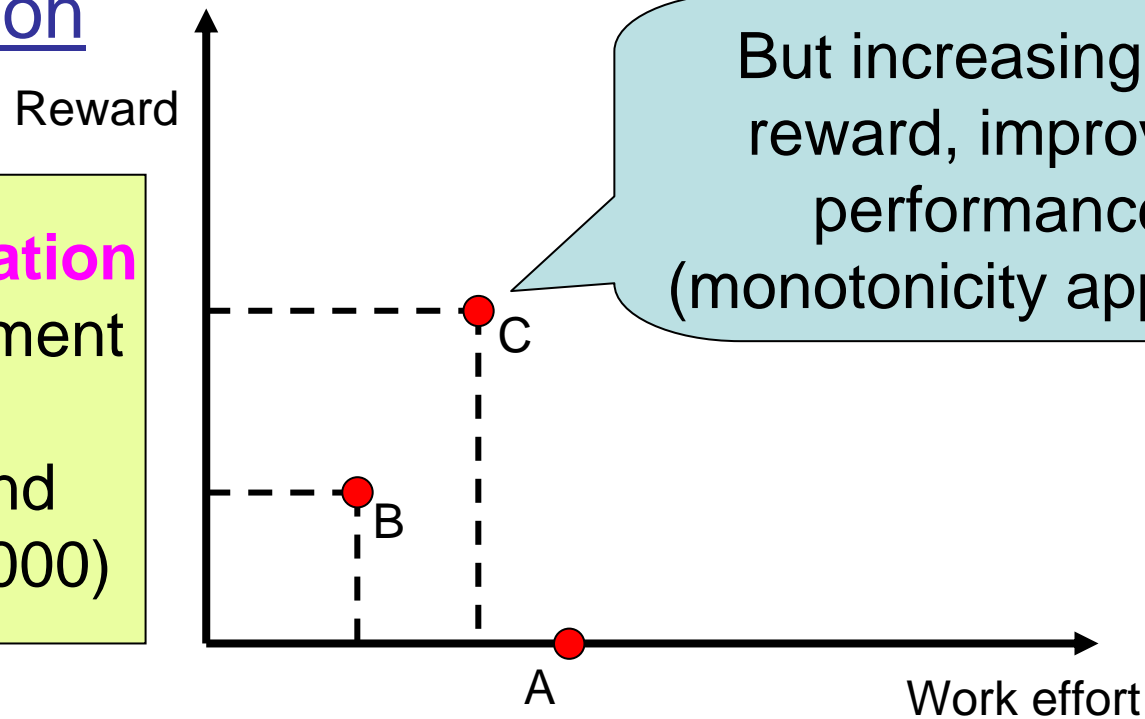


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Motivation

- Which explanations have been proposed?
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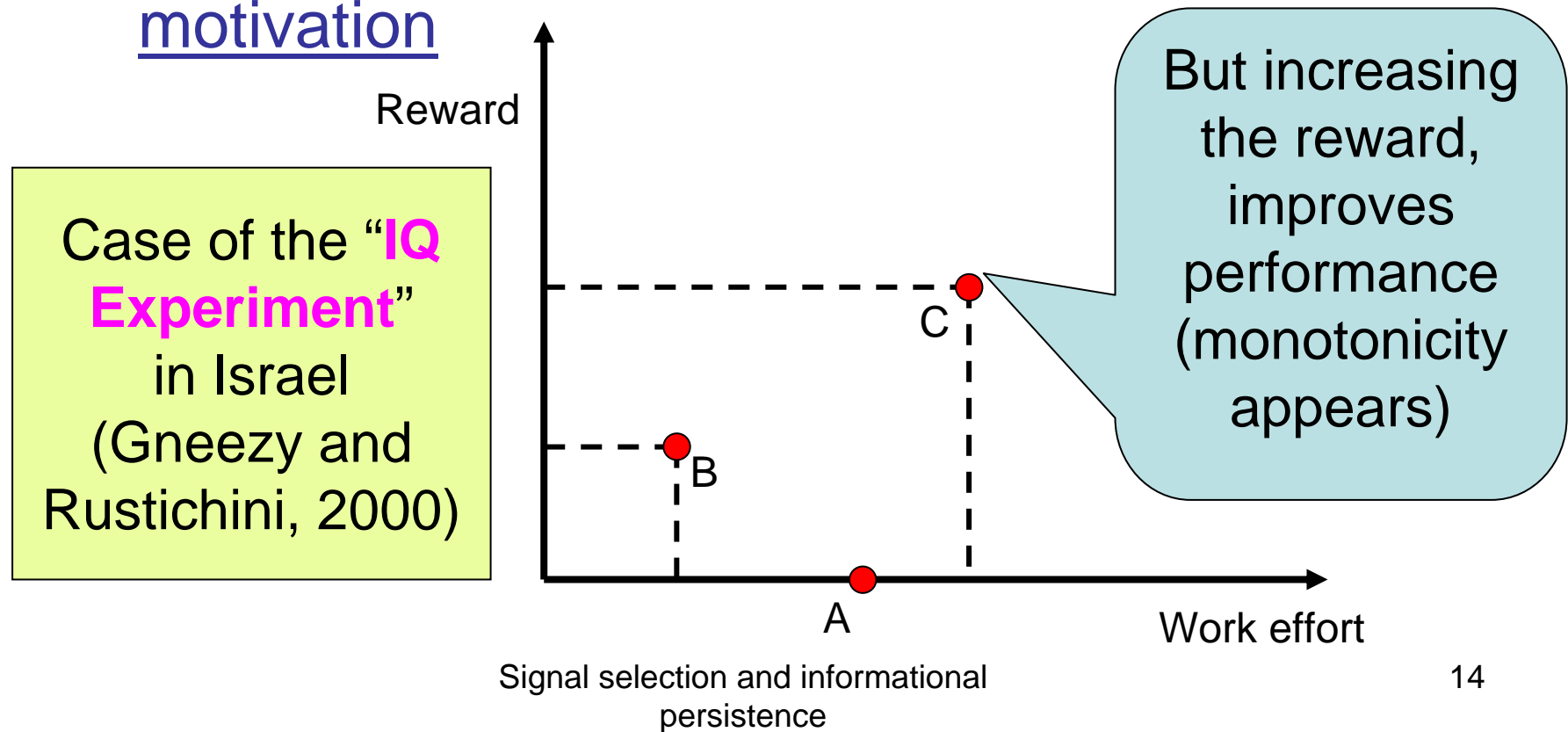
Case of “**donation days**” experiment in Israel (Gneezy and Rustichini, 2000)



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Motivation

- Which explanations have been proposed?
 - The cognitive psychology school: intrinsic motivation

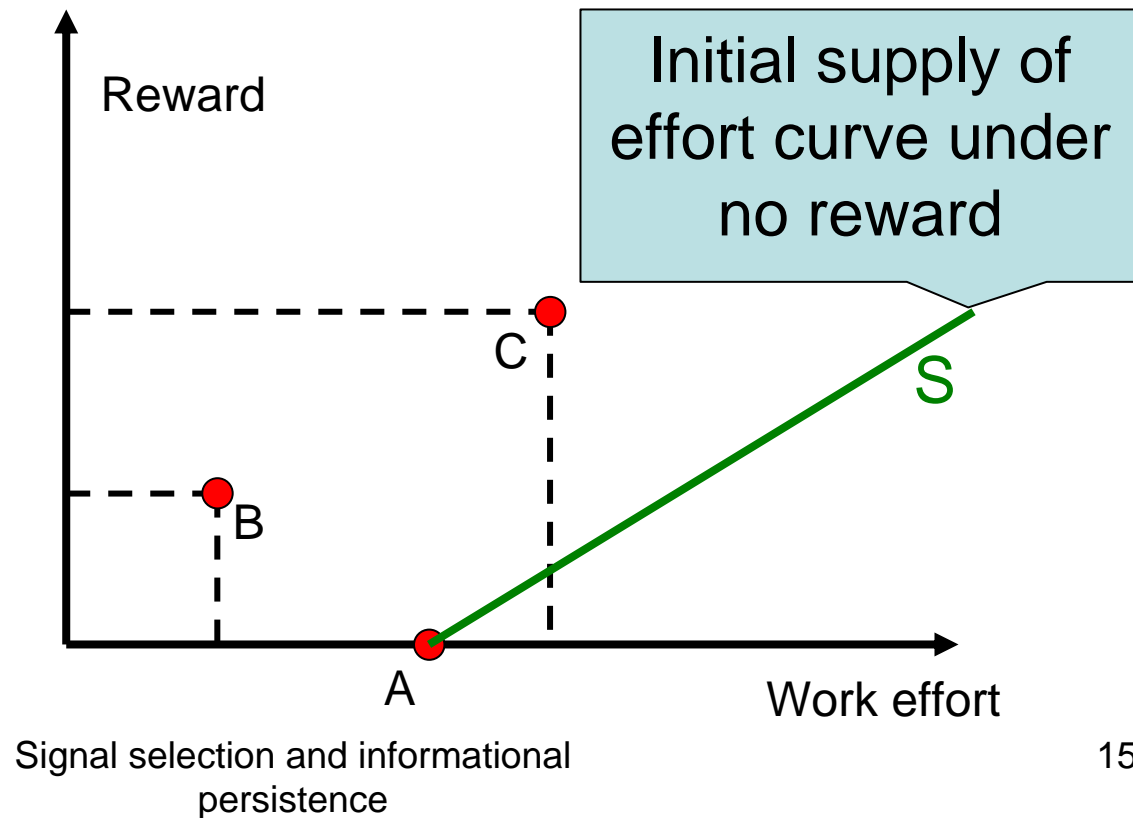


Motivation

- Which explanations have been proposed?
 - Frey and Oberholzer-Gee (1997):
 - Utility function = $U(e, r) + m(a, r)$

$$\frac{\partial u(a, r)}{\partial r} > 0$$

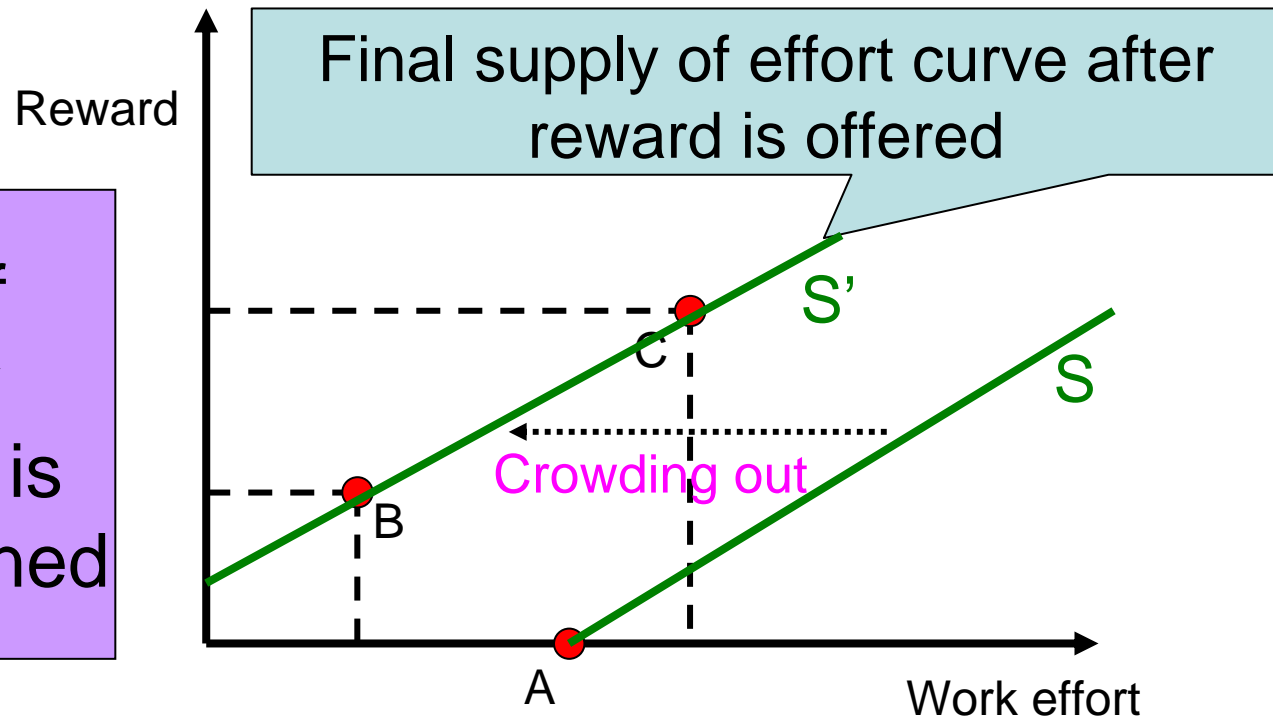
$$\frac{\partial m(a, r)}{\partial r} < 0$$



Motivation

- Which explanations have been proposed?
 - Frey and Oberholzer-Gee (1997):
 - Utility function = $U(e, r) + m(a, r)$

But lack of continuity around $r=0$ is still unexplained



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Our approach

- We propose an explanation based on the behavior of rational agents.
- We assume that there are costly activities (e.g. volunteering) that provide the agents a private benefit from social recognition, self-image, etc.
- The agent's type (willingness to cooperate, degree of altruism, etc.) is private information
- Agents with a higher type can be interested in undertaking a costly activity to credibly signal their types.

Our approach

- We develop a standard economic model of signaling.
- In our model, a rational choice of signals explains the agents' counter-intuitive response to monetary incentives.
- Our approach is based on the idea that signals “*compete with each other*” as channels of information transmission.
- If the cost of an activity increases, some agents may find it beneficial to undertake it in order to convey information about their types.

Results

- It is rational that monetary incentives induce poorer performance in activities (such as volunteering) that may serve as a signal of individuals' type.
- In particular, we show that:
 - A **subsidy** can reduce the level of a socially beneficial activity.
 - A **fine** can augment the proportion of agents that perform poorly.

The basic model

- We consider 2 possible scenarios:
 - **Scenario 1:** There are 2 activities and the possibility of not undertaking any of them; There is “no recall”. This scenario fits well in a context where volunteering activities are substitutes.
 - **Scenario 2:** Again there are 2 activities, but the possibility of doing nothing does not exist. There is “perfect recall”. This scenario is appropriate to describe the evidence of day-care centers.

The basic model

- There is a continuum of **agents**, uniformly distributed on the interval $[0,1]$
- Each agent is allowed to select only one **action** from a finite set $A = \{a_0, a_1, a_2\}$
- The **cost** of action a_j is $c(a_j) = c_j$
- The **utility function** of agent with type θ_i is

$$u_i(a_j) = E[\theta_i / a_j] - (1 - \theta_i)c(a_j)$$

Expected type given the beliefs induced by action a_j

The total cost of action a_j is decreasing on the agent's type θ_i

persistence

The basic model

- Suppose that $c_1 > c_2 > c_0 = 0$, agent of type θ_i will choose action a_1 instead of a_2 iff:

$$u_i(a_1) = E[\theta_i / a_1] - (1 - \theta_i)c_1 \geq E[\theta_i / a_2] - (1 - \theta_i)c_2 = u_i(a_2)$$

$$\frac{[1 + \alpha(c_1, c_2)]}{2} - (1 - \theta_i)c_1 \geq \frac{[\alpha(c_1, c_2) + \beta(c_1, c_2)]}{2} - (1 - \theta_i)c_2$$

$\alpha(c_1, c_2)$: type θ_i indifferent between action a_1 and a_2)

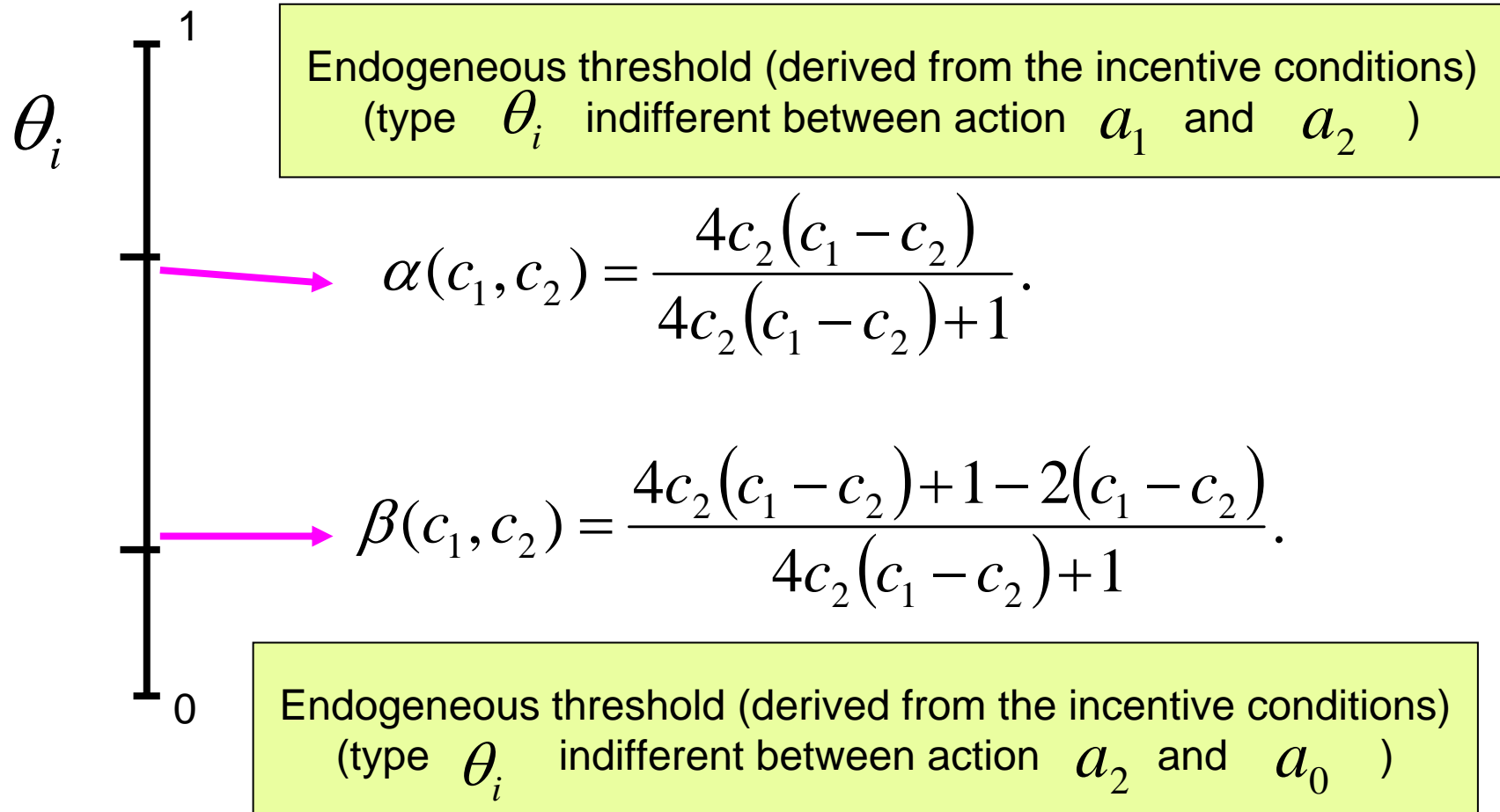
$\beta(c_1, c_2)$: type θ_i indifferent between action a_2 and a_0)

We obtain:

$$\theta_i \geq 1 - \frac{[1 - \beta(c_1, c_2)]}{2(c_1 - c_2)} = \alpha(c_1, c_2)$$

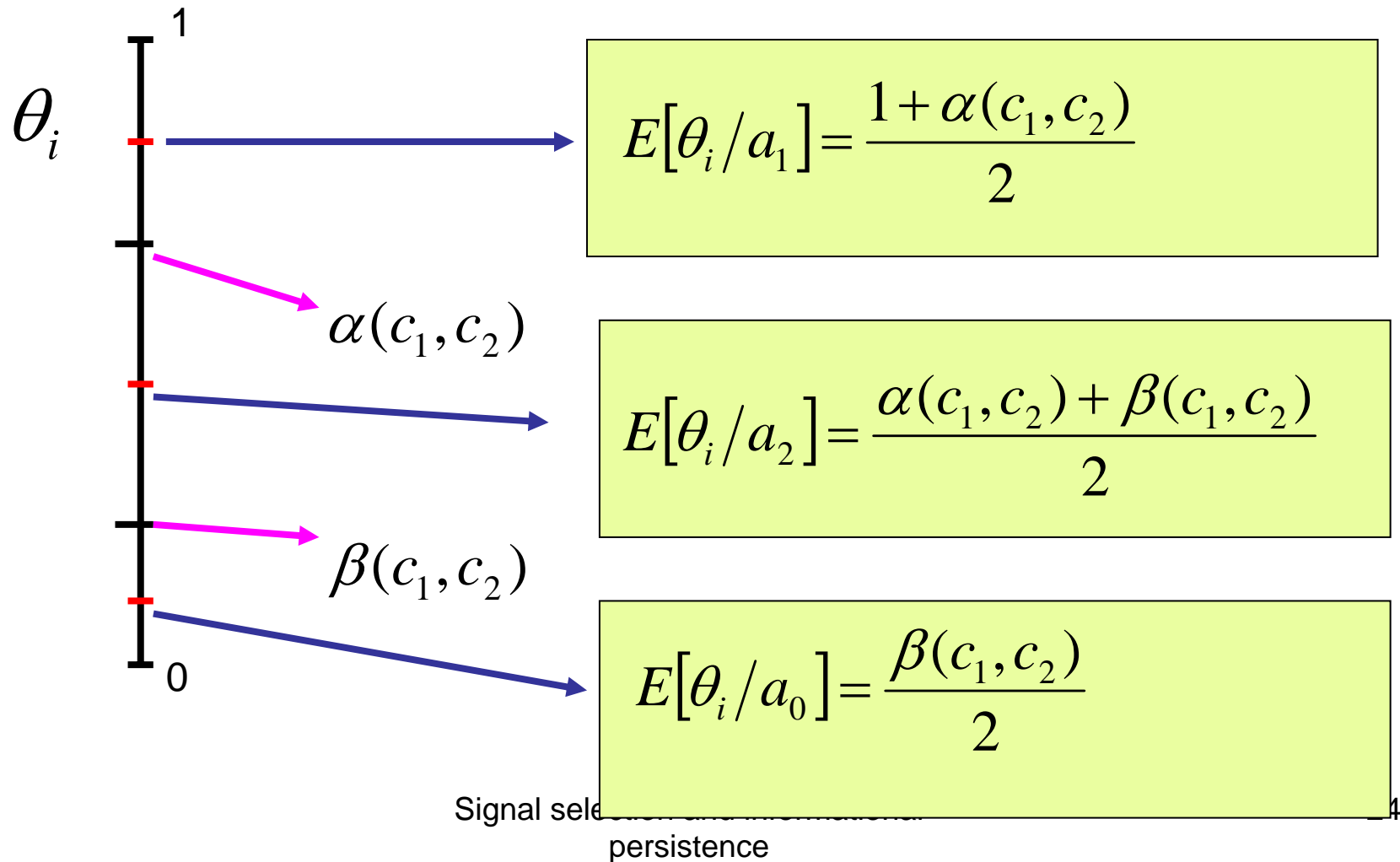
The basic model

- **Scenario 1: competing signals:** $c_1 > c_2 > 0$



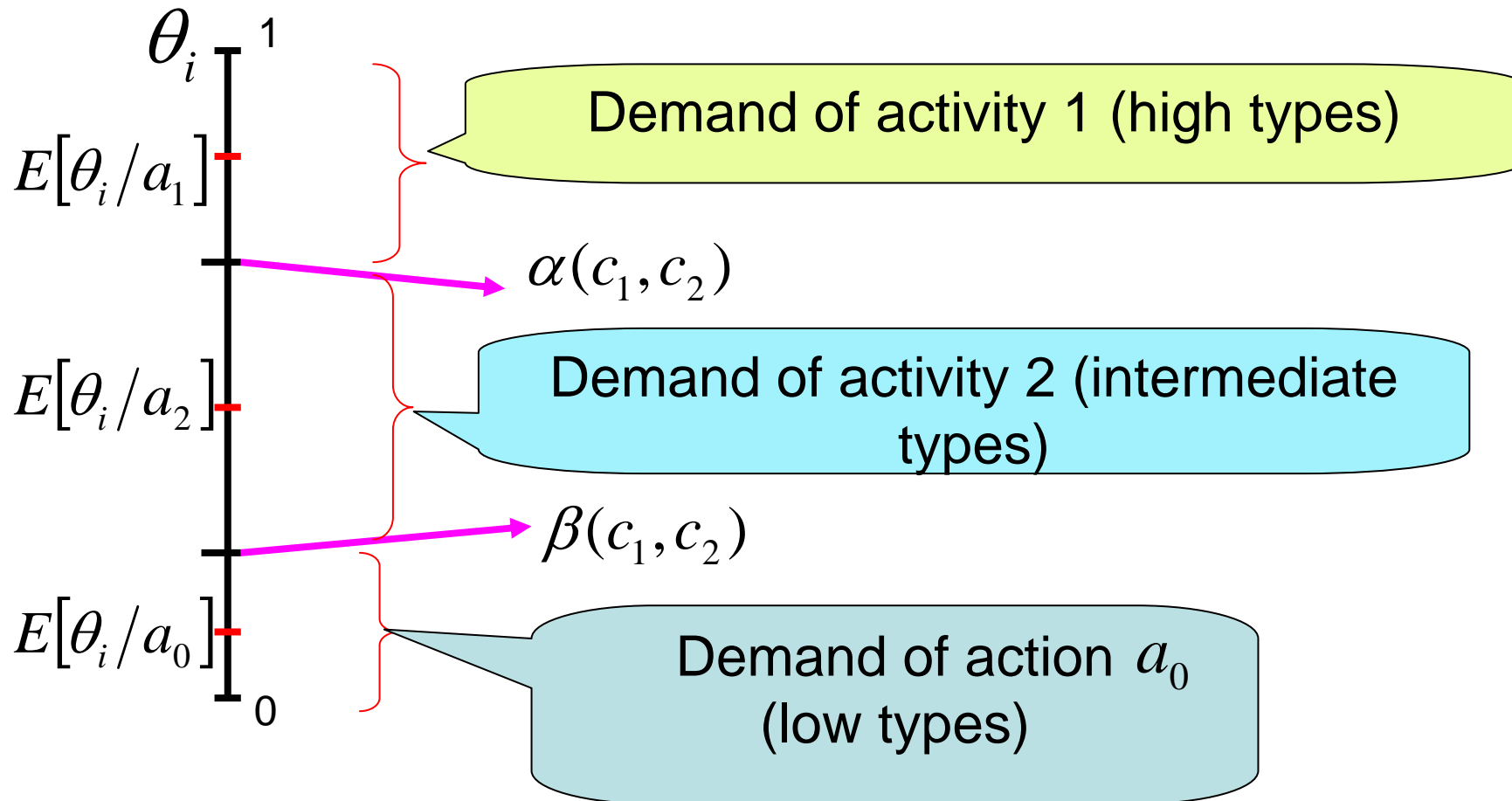
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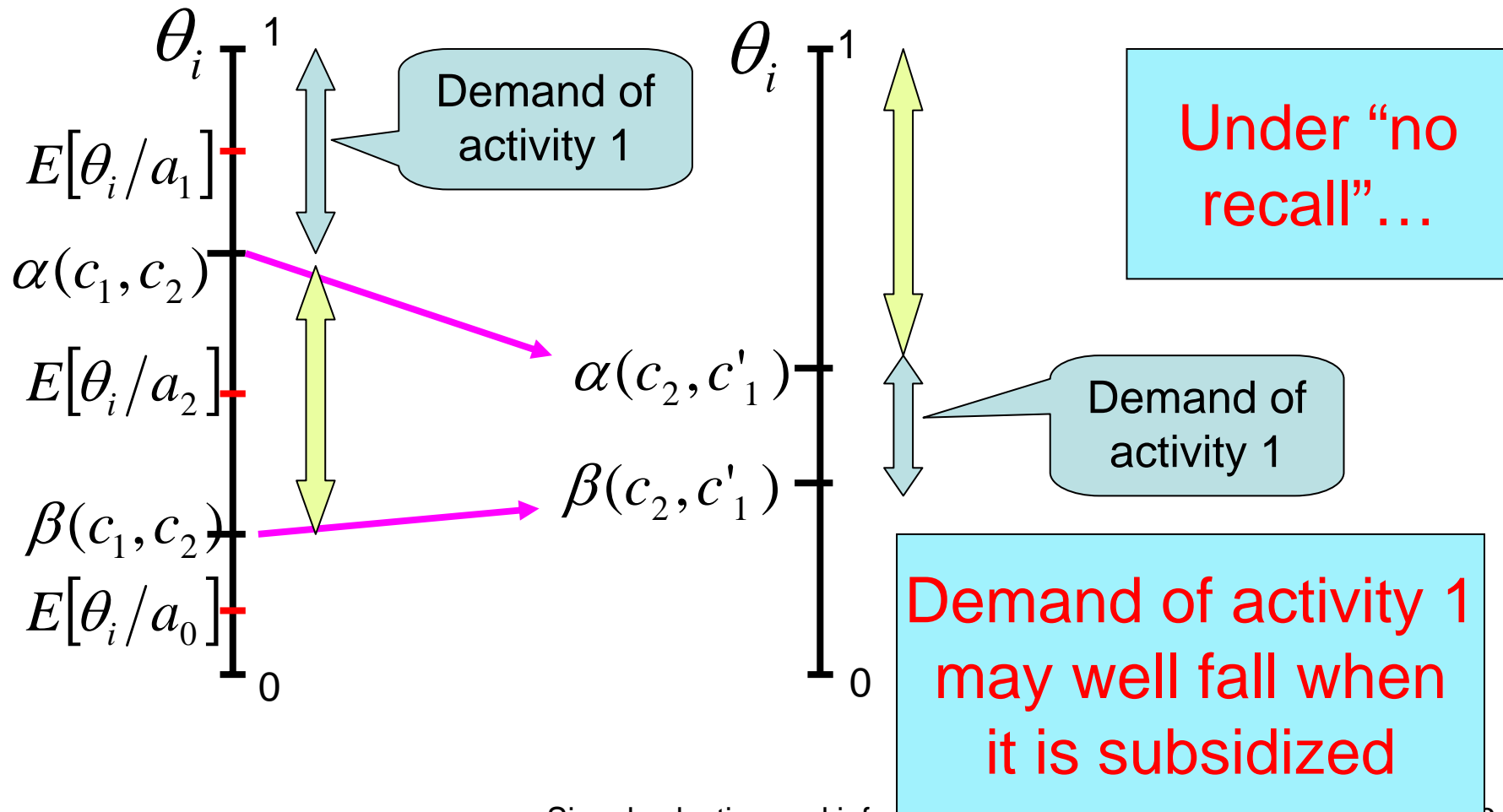
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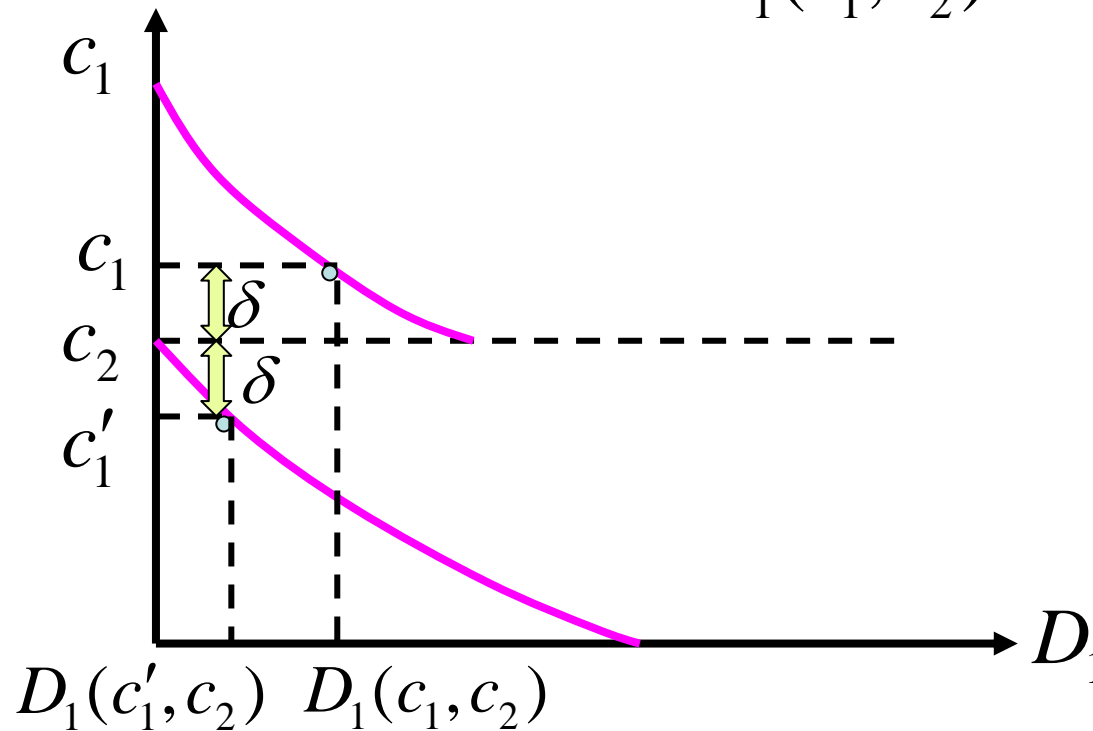
The basic model

- **Scenario 1: competing signals:** $c_1 > c_2 > c'_1 > 0$



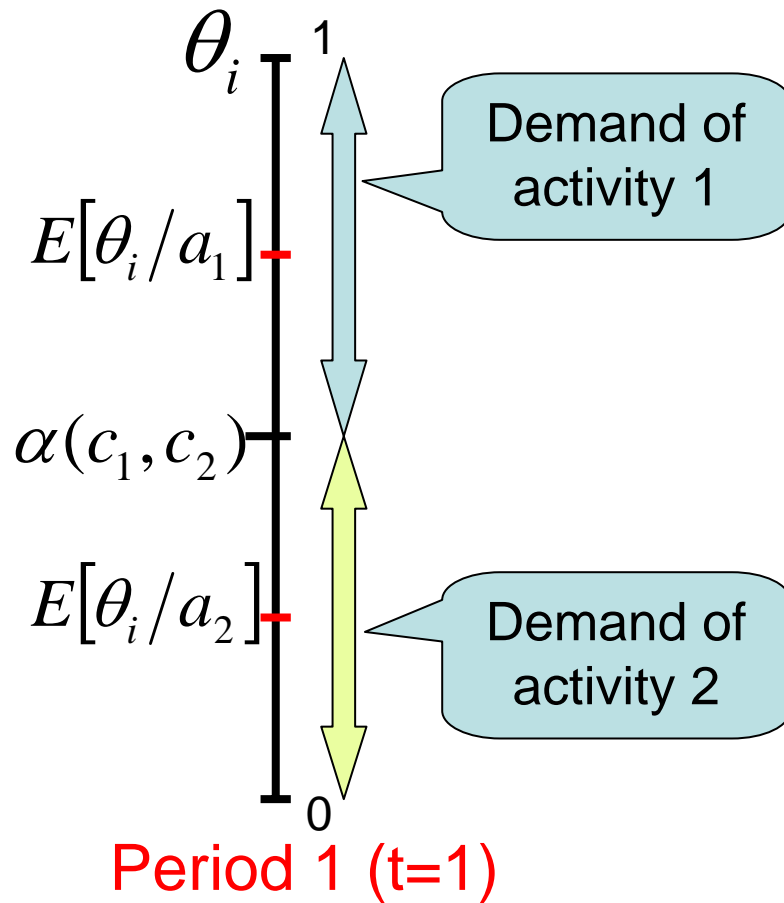
The basic model

- Let $c_1 = c_2 + \delta$, $c'_1 = c_2 - \delta$, $\delta \in \left(\frac{1}{2}, \frac{1}{4} + \frac{1}{12}\sqrt{33}\right)$
- Then, we can be sure that: $D_1(c_1, c_2) > D_1(c'_1, c_2)$



The basic model

- **Scenario 2:** informational persistence: $c_1 > c_2$

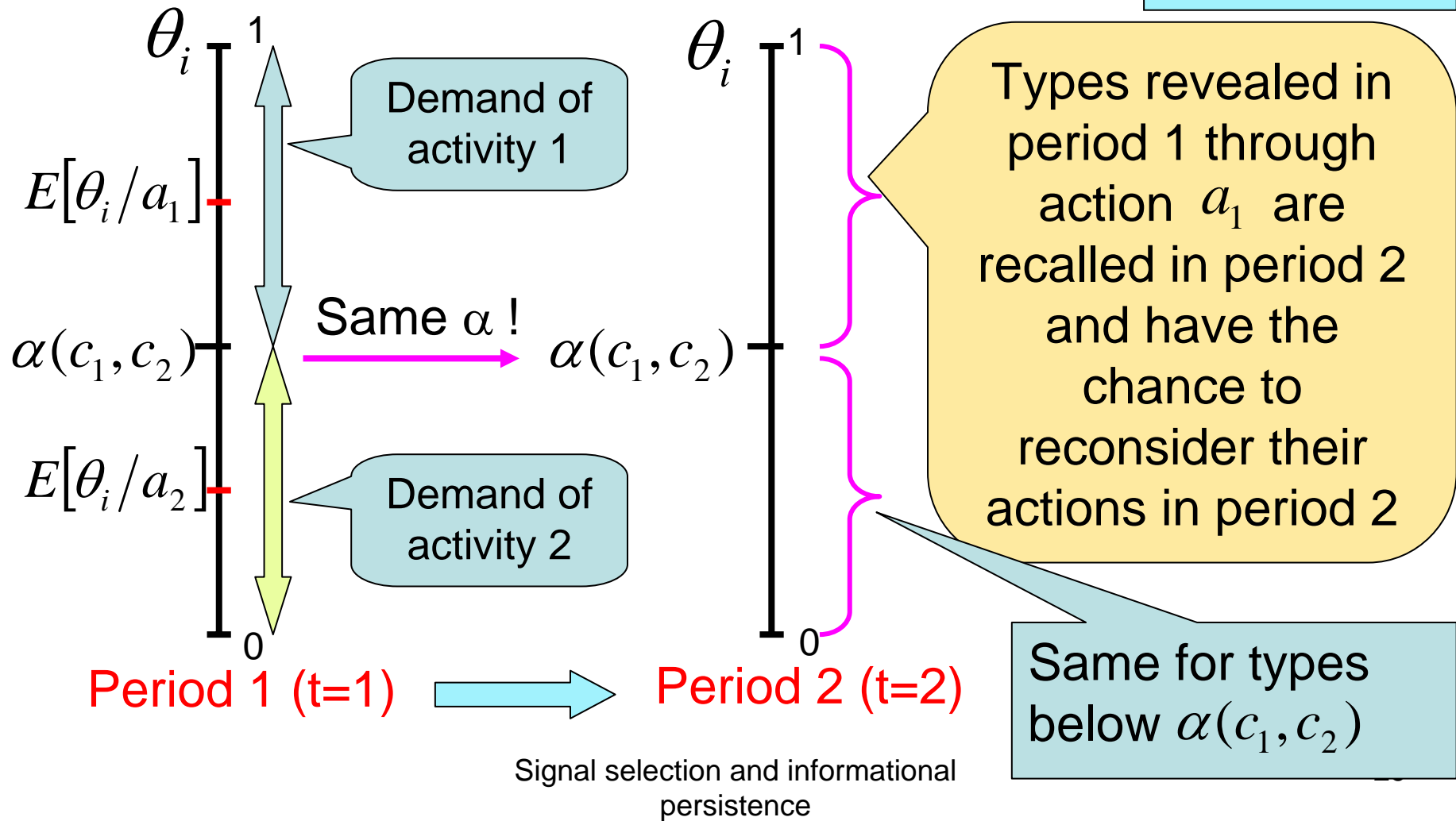


Under “perfect recall”

Activities undertaken in period 1 are recalled in period 2. This implies that inferences on the type in period 2 are conditioned upon the selected actions in period 1

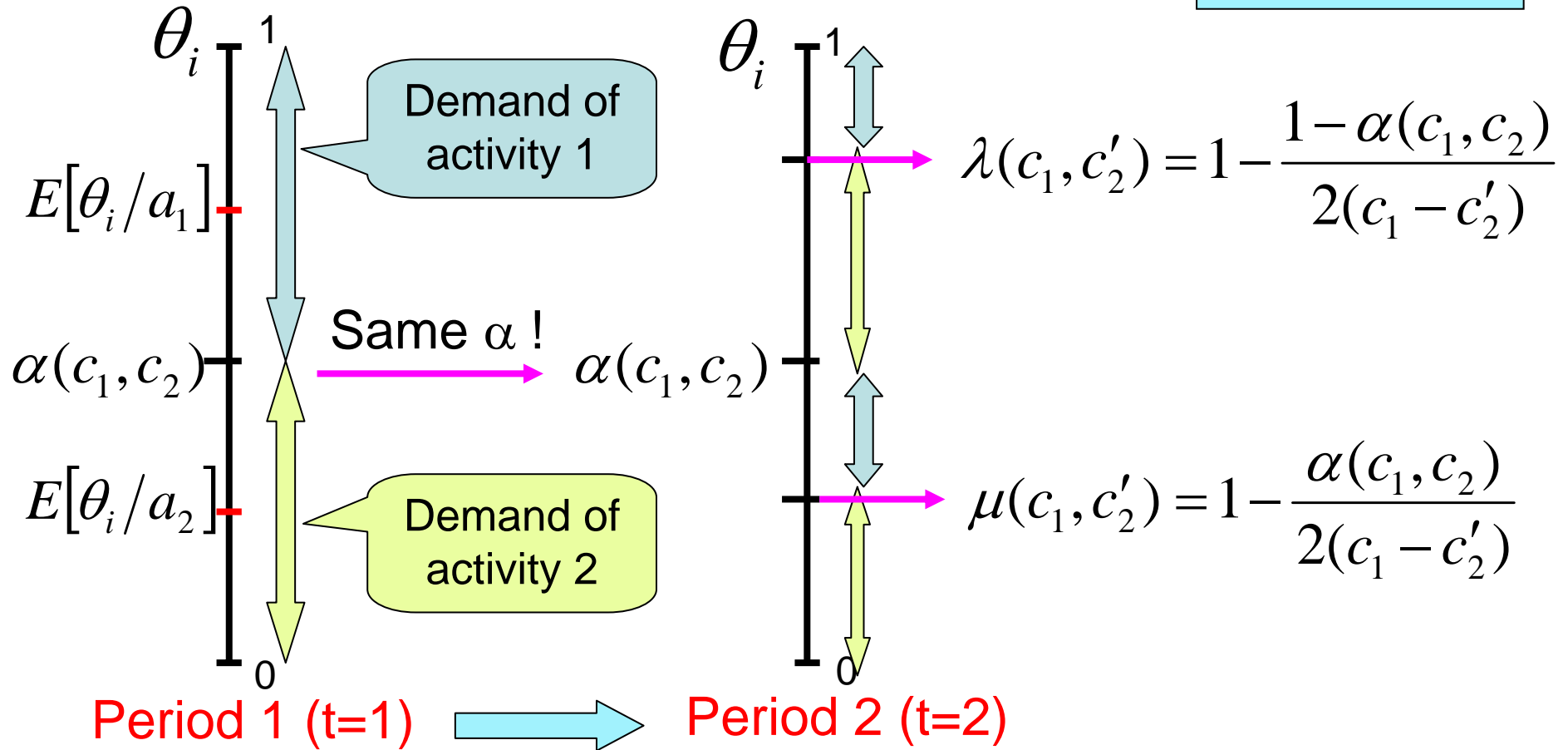
The basic model

- Scenario 2: informational persistence: $c_1 > c'_2 > c_2$



The basic model

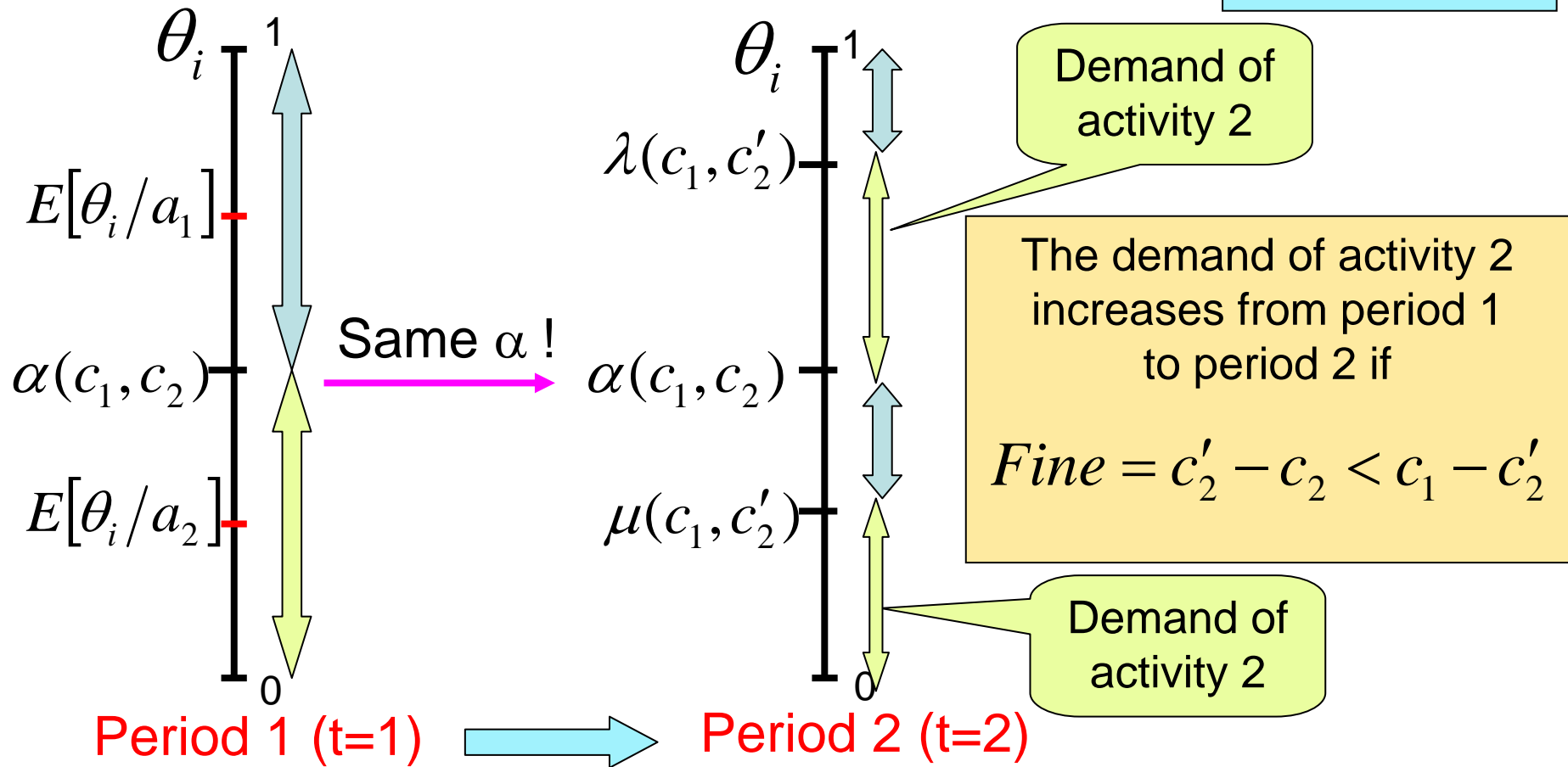
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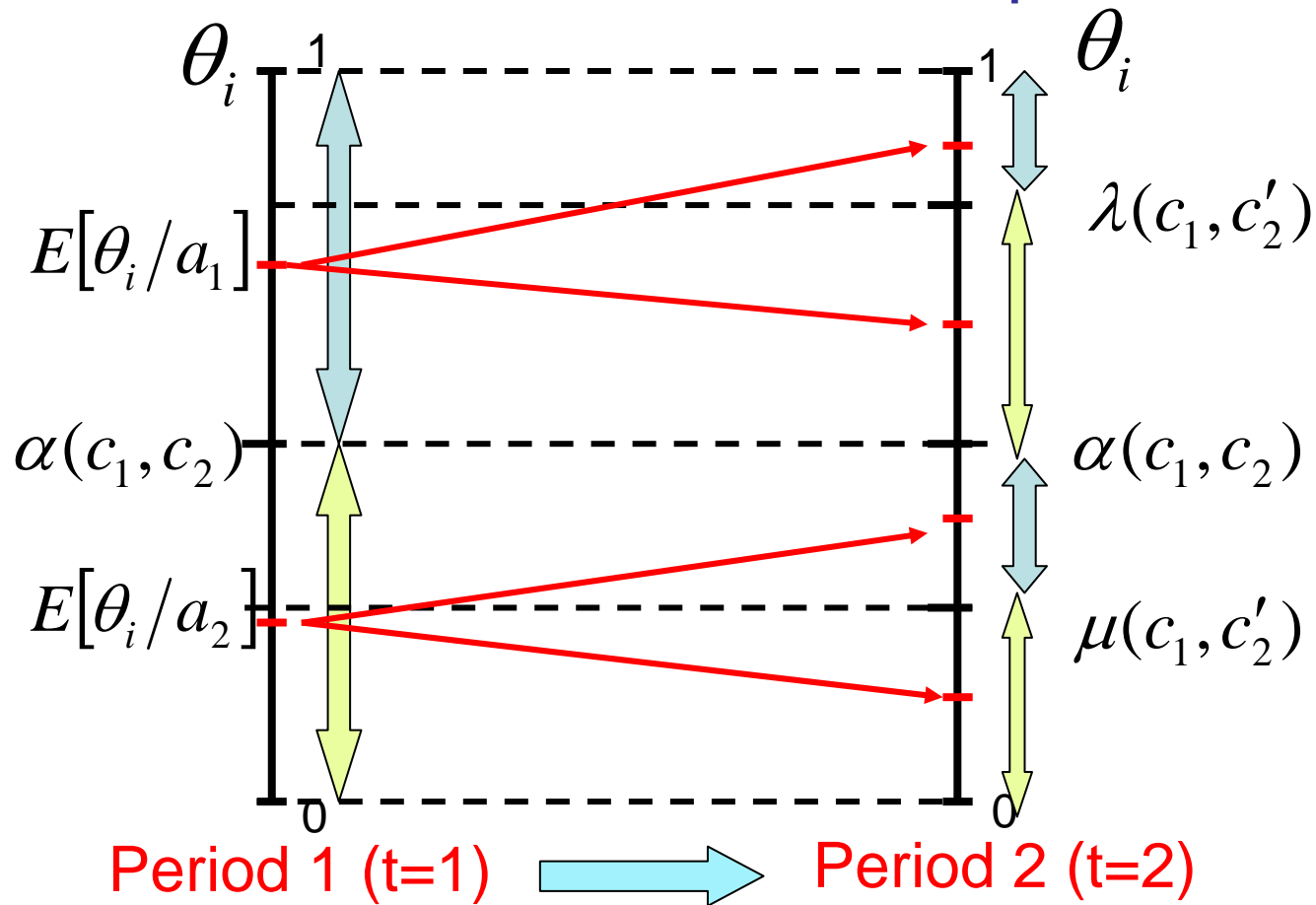
The basic model

- Scenario 2: informational persistence: $c_1 > c'_2 > c_2$



The basic model

- Scenario 2: informational persistence: $c_1 > c'_2 > c_2$



Signal selection and informational persistence

The basic model

- Numerical example:

$$c_1 - c_2 = 2, \quad c_1 - c'_2 = \frac{5}{4} \rightarrow \text{Fine} = 0.75$$

$$\alpha(c_1, c_2) = 1 - \frac{1}{2(c_1 - c_2)} = \frac{3}{4} = 0.75$$

$$\lambda(c_1, c'_2) = 1 - \frac{1}{4(c_1 - c_2)(c_1 - c'_2)} = \frac{9}{10} = 0.9$$

$$\mu(c_1, c'_2) = 1 - \frac{\alpha(c_1, c_2)}{2(c_1 - c'_2)} = \frac{7}{10} = 0.7$$

$$D_1(t=1) = 1 - \alpha(c_1, c_2) = 0,25$$

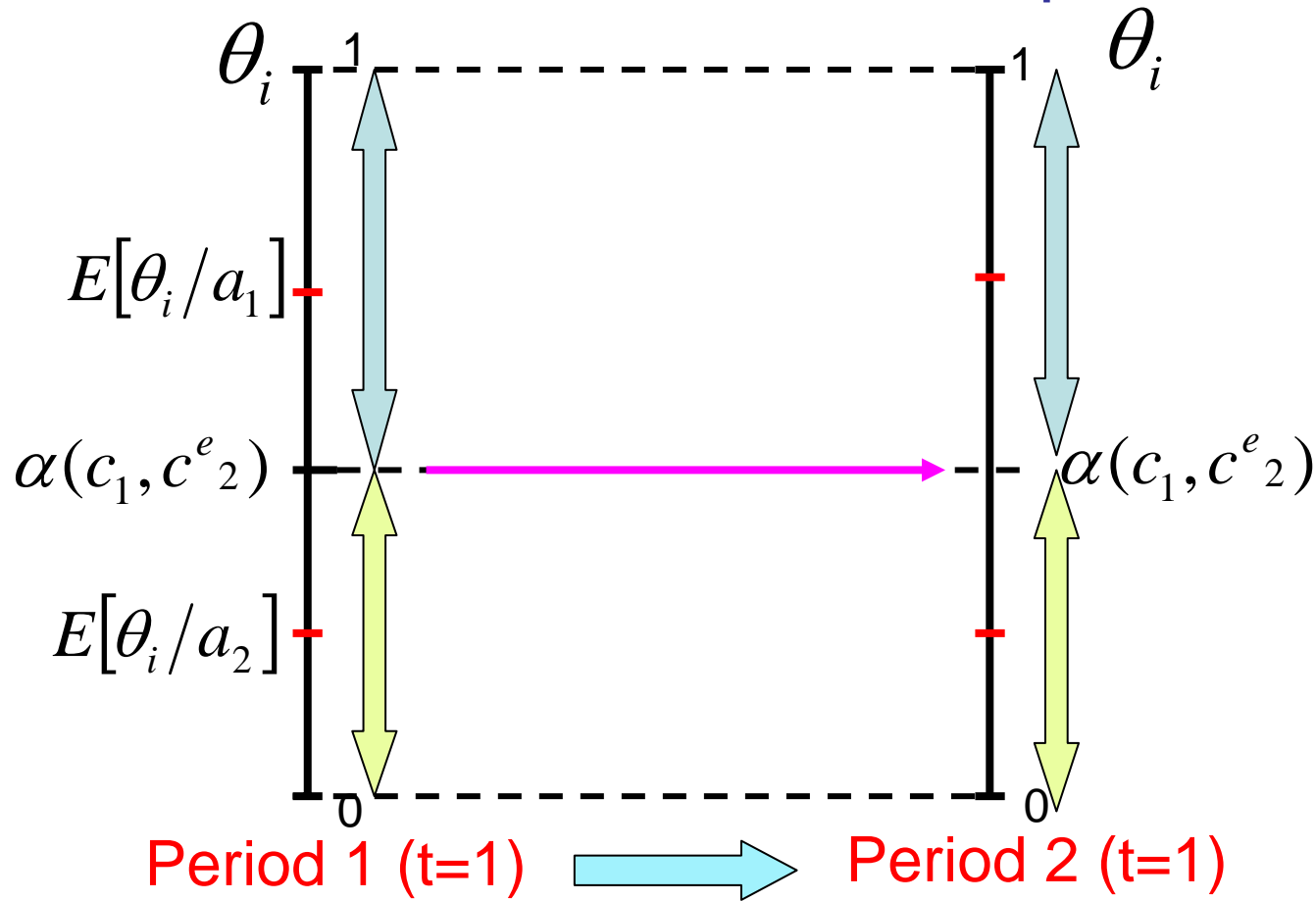
$$D_2(t=1) = 1 - D_1(t=1) = 0,75$$

$$D_1(t=2) = [1 - \lambda(c_1, c'_2)] + [\alpha(c_1, c_2) - \mu(c_1, c'_2)] = 0,15$$

$$D_2(t=2) = 1 - D_1(t=2) = 0,85$$

Extensions

- Scenario 2: informational persistence: $c_1 > c'_2 > c_2$



Announced change in cost of activity 2:
Notice that

$$c_2^e = \frac{c_2 + c'_2}{2}$$

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Conclusions

- Signalling private characteristics by means of costly activities might explain the paradox of counter-productive incentives
- **Policy implications:**
 - *Competing signals* must be detected, so:
 - Don't reward/tax when close substitute signals are available
 - Rewarding/taxing other activities may work as well!
 - Even with *just one signal*, the effect can occur when information is accumulated under:
 - Unexpected policy changes
 - Perfect recall of past actions