Public Information in Populations with Heterogeneous Interests

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Nothing but a newspaper can drop the same thought into a thousand minds at the same moment.

De Toqueville (*Democracy in America*)

Public information

In economics, public information is special

- Public signals are particularly influential when agents interact strategically, e.g. Morris and Shin (AER 2002)
- In financial markets, public information is incorporated in prices and traders cannot expect to make higher than average profits based on public information

But exactly what do we mean when say that information is *public*?

Public information in theory and practice

The assumption that information is public in the theoretical literature is much stronger than what is implied by the everyday meaning of the word.

- "Public" means common knowledge, i.e. that everybody knows that everybody knows that everybody knows, and so on, that everybody knows .

Arguably, there is a lot of publicly available information that is not public in the common knowledge sense of the word.

Example I: EntreMed and the New York Times

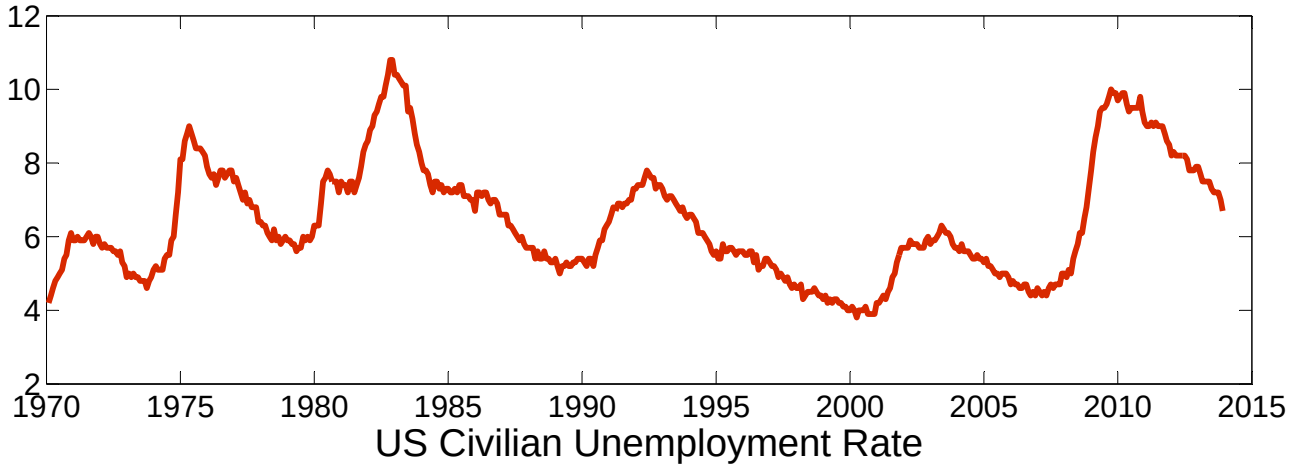
Huberman and Regev (JoF 2001): An article in the Sunday edition of the New York Times about a potential breakthrough in cancer research linked to the company *EntreMed* made the price of the company's stock soar.

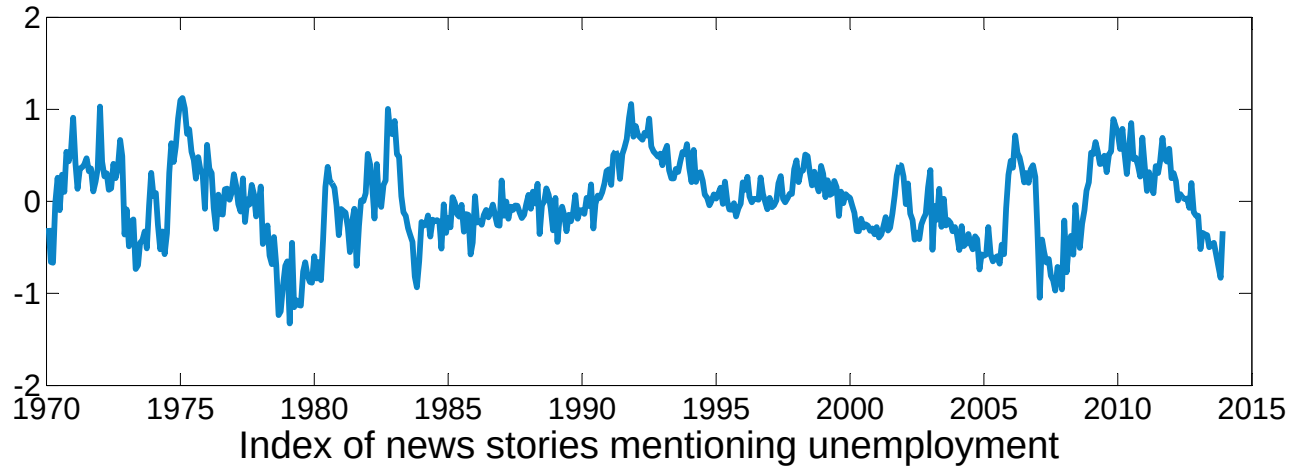
But:

- The findings had been published in *Nature* several months before as well as in a less prominent section of the New York Times.

We want a model that makes a distinction between publicly available information and information that is common knowledge.

Example II: Unemployment in the news





The editorial function of newspapers

One important function the news media performs for its consumers is editorial, i.e. choosing what to report.

- Information providers such as newspapers are specialists that monitor more events than a single person could, and choose which of these events to report.
- Information consumers have diverse interests and choose the information providers that they expect to report the most interesting information.

What an individual agent get information about thus depends on what has happened.

A simple model

Information consumers with heterogeneous interests

Agent $i \in \{1, 2\}$ take action a_i in order to maximize expected utility $E(U_i \mid \Omega_i)$ where

$$\begin{aligned} U_i &= -(1-r)\,\lambda_i\,(x_i - a_i)^2 \\ &\quad -(1-r)\,(1-\lambda_i)\,(x_{-i} - a_i)^2 \\ &\quad -r\,(a_{-i} - a_i)^2 \end{aligned}$$

We will focus on symmetric specifications where $\lambda_i = \lambda_{-i} = \lambda > \frac{1}{2}$

Agent i finds it relatively more important to take an action that is close to x_i.

- Shorthand: Agent i is *more interested* in x_i.

Information providers

Information provider i caters to agent i

- Information providers observe the state of the world, i.e. of x_1 and x_2
- Provider i chooses whether to report x_1 or x_2 with the objective of maximizing the utility agent i.

Provider i news selection function is defined as

$$S_i = \begin{cases} i & \text{if provider } i \text{ reports } \mathrm{x}_i \\ -i & \text{if provider } i \text{ reports } x_{-i} \end{cases}$$

S_i will generally be a function of x_1, x_2 and S_{-i}

Equilibrium actions

The optimal action of agent i is a convex combination of his expectations about x_1, x_2 and a_{-i}.

$$a_i = (1-r)\,\lambda E\left[x_i \mid \Omega_i\right] + (1-r)\,(1-\lambda)\,E\left[x_{-i} \mid \Omega_i\right] + rE\left[a_{-i} \mid \Omega_i\right]$$

Agent i takes his information set as given:

$S_i = i \Rightarrow \Omega_i = x_i$

$S_i = -i \Rightarrow \Omega_i = x_{-i}$

Equilibrium news selection function

The (Nash-) equilibrium news selection functions associate for each state of the world an outcome for S_i and S_{-i} so that

$$S_i(x_1, x_2, S_{-i}) = \begin{cases} i & \text{if} \quad U_i(x_1, x_2, S_i = i, S_{-i}) > U_i(x_1, x_2, S_i = -i, S_{-i}) \\ -i & \text{if} \quad U_i(x_1, x_2, S_i = i, S_{-i}) < U_i(x_1, x_2, S_i = -i, S_{-i}) \end{cases}$$

where S_{-i} are consistent with the outcomes of S_{-i} in each state of the world.

Heterogeneous interests and signals

We can isolate the effect of heterogeneous interests by assuming no strategic interactions, i.e. set $(r = 0)$

Let the exogenous fundamentals be uniformly distributed

$$x_i \sim U(-1, 1) : i \in \{1, 2\}$$

Assumptions keep things tractable but can be relaxed.

Conditional optimal actions

With $r = 0$ the utility of agent i is simply given by

$$U_i(x_1, x_2) = -\lambda \left(x_i - a_i\right)^2 - (1 - \lambda) \left(x_{-i} - a_i\right)^2$$

and the optimal action is given by

$$a_i = \lambda E \left[x_i \mid \Omega_i\right] + (1 - \lambda) E \left[x_{-i} \mid \Omega_i\right]$$

so that

$$a_i^i = \lambda x_i$$

and

$$a_i^{-i} = (1 - \lambda) x_{-i}$$

Comparing utilities for different news selections

To solve for information providers we need to evaluate agents utilities conditional on signals.

To this end, plug in conditional actions into utility function and evaluate inequalities in

$$S_i(x_1, x_2, S_{-i}) = \begin{cases} i & \text{if} \quad U_i(x_1, x_2, S_i = i, S_{-i}) > U_i(x_1, x_2, S_i = -i, S_{-i}) \\ -i & \text{if} \quad U_i(x_1, x_2, S_i = i, S_{-i}) < U_i(x_1, x_2, S_i = -i, S_{-i}) \end{cases}$$

After simplifying, we get

$$S_i = \begin{cases} i \text{ if } |x_i| > \frac{1-\lambda}{\lambda} |x_{-i}| \\ -i \text{ otherwise} \end{cases}$$

The probability of observing x_i

By the uniformity assumption of x_1 and x_2 the probability of provider i reporting event i conditional on x_i is given by

$$p\left(S_i = i \mid x_i\right) = \min\left\{1, \frac{\lambda}{1-\lambda}\left|x_i\right|\right\}$$

The probability is thus increasing in λ.

The probability of cross-reporting

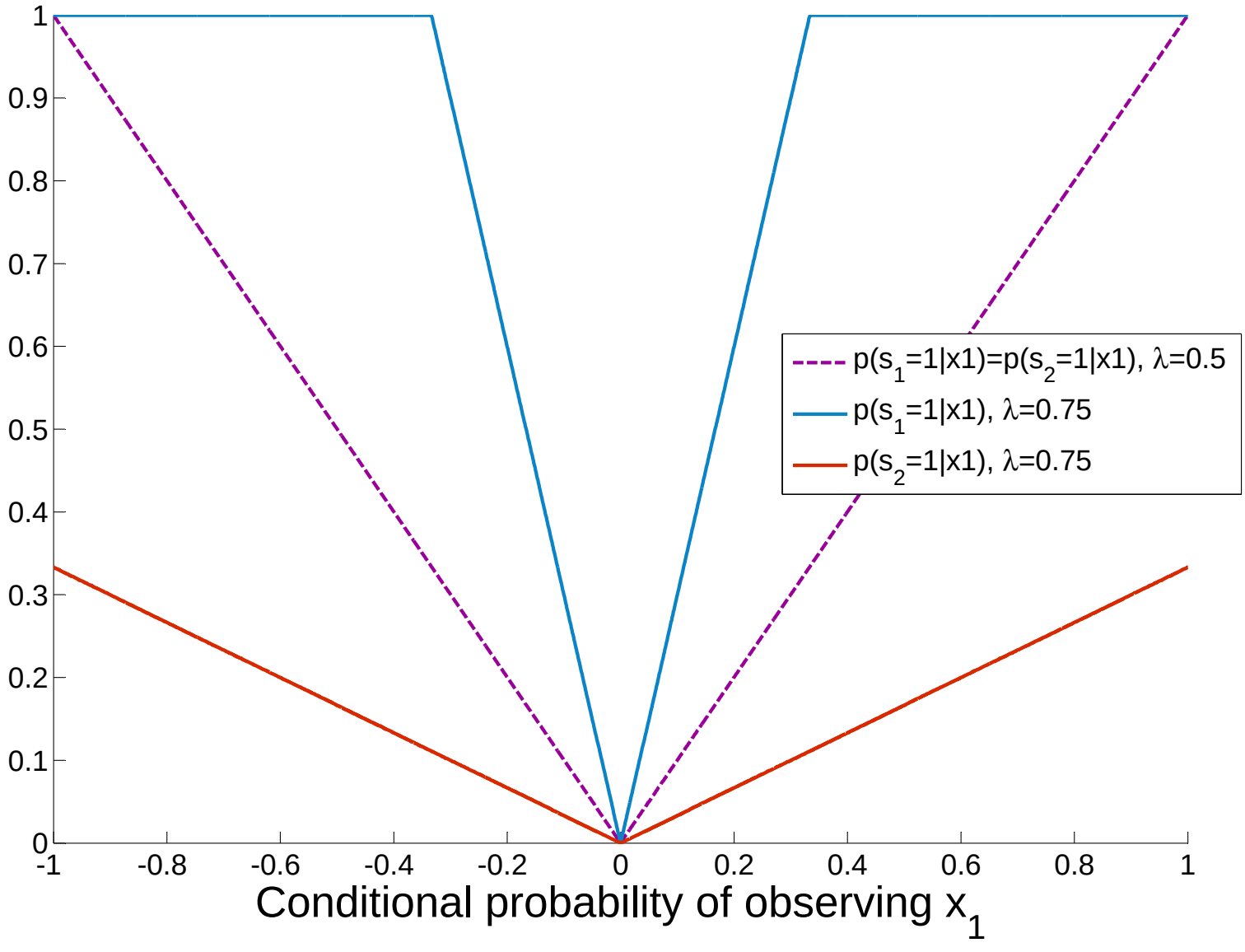
The probability of agent $-i$ observing x_i conditional on the realized value of x_i. This will be the case when

$$|x_i| > \frac{\lambda}{1-\lambda} |x_{-i}|$$

which occurs with conditional probability

$$p(S_{-i} = i \mid x_i) = \frac{1-\lambda}{\lambda} |x_i|$$

which is decreasing in λ.


1
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-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1
p(s1=1|x1)=p(s2=1|x1), λ=0.5
p(s1=1|x1), λ=0.75
p(s2=1|x1), λ=0.75
Conditional probability of observing x1

The probability that both agents observe x_i

If the agent with the least interest in x_{-i} gets a signal about x_{-i}, then so must the agent with more interest in x_{-i}.

The probability that both agents observe x_i is given by

$$\begin{aligned} p\left(S_i = i, S_{-i} = i, \mid x_i\right) &= p(S_{-i} = i \mid x_i) \\ &= \frac{1-\lambda}{\lambda} |x_i| \end{aligned}$$

- But this is only known to agent $-i$

The two agents will both observe x_i almost surely if $\lambda = \frac{1}{2}$ and $|x_i| = 1$.

- The event that both agents observed x_i is then *approximate common knowledge*.

Expected equilibrium actions

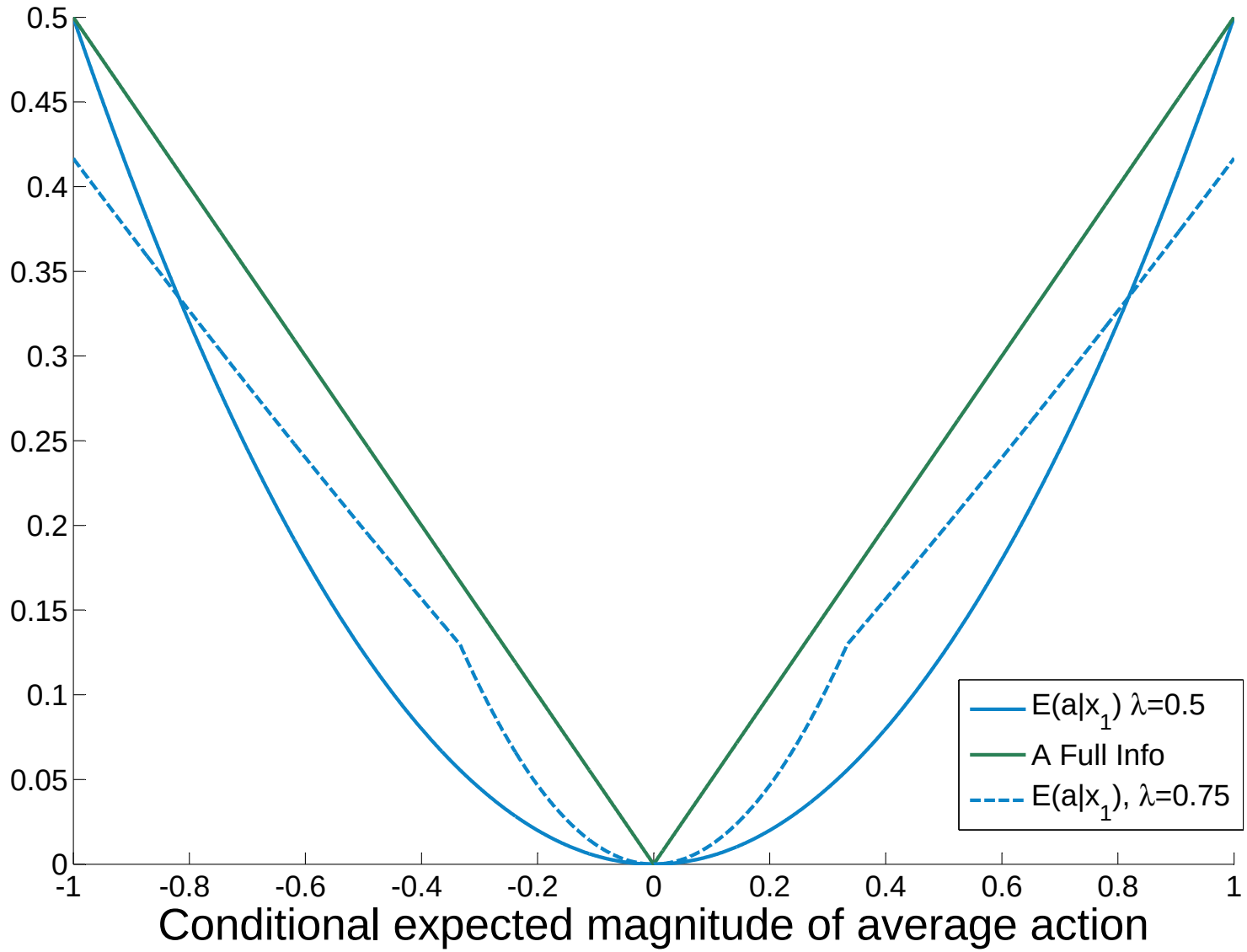
The expected average action defined as

$$\begin{aligned} E\left[\bar{a} \mid x_i\right] &= \frac{1}{2} E\left[a_i + a_{-i} \mid x_i\right] \\ &= \frac{1}{2}\Big[p\left(S_i = i \mid x_i\right) a_i^i + \left[1 - p\left(S_i = i \mid x_i\right)\right] a_i^{-i} + \\ &\quad \left[1 - p\left(S_{-i} = i \mid x_i\right)\right] a_{-i}^{-i} + p\left(S_{-i} = i \mid x_i\right) a_{-i}^{i}\Big] \end{aligned}$$

Since $E\left[x_{-i} \mid x_i\right] = 0$ this simplifies to

$$E\left[\bar{a} \mid x_i\right] = \frac{1}{2}\left[\left(\frac{\lambda^2}{1-\lambda} + \frac{(1-\lambda)^2}{\lambda}\right)|x_i|\right] x_i$$

Impact is increasing in λ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-0.2
0
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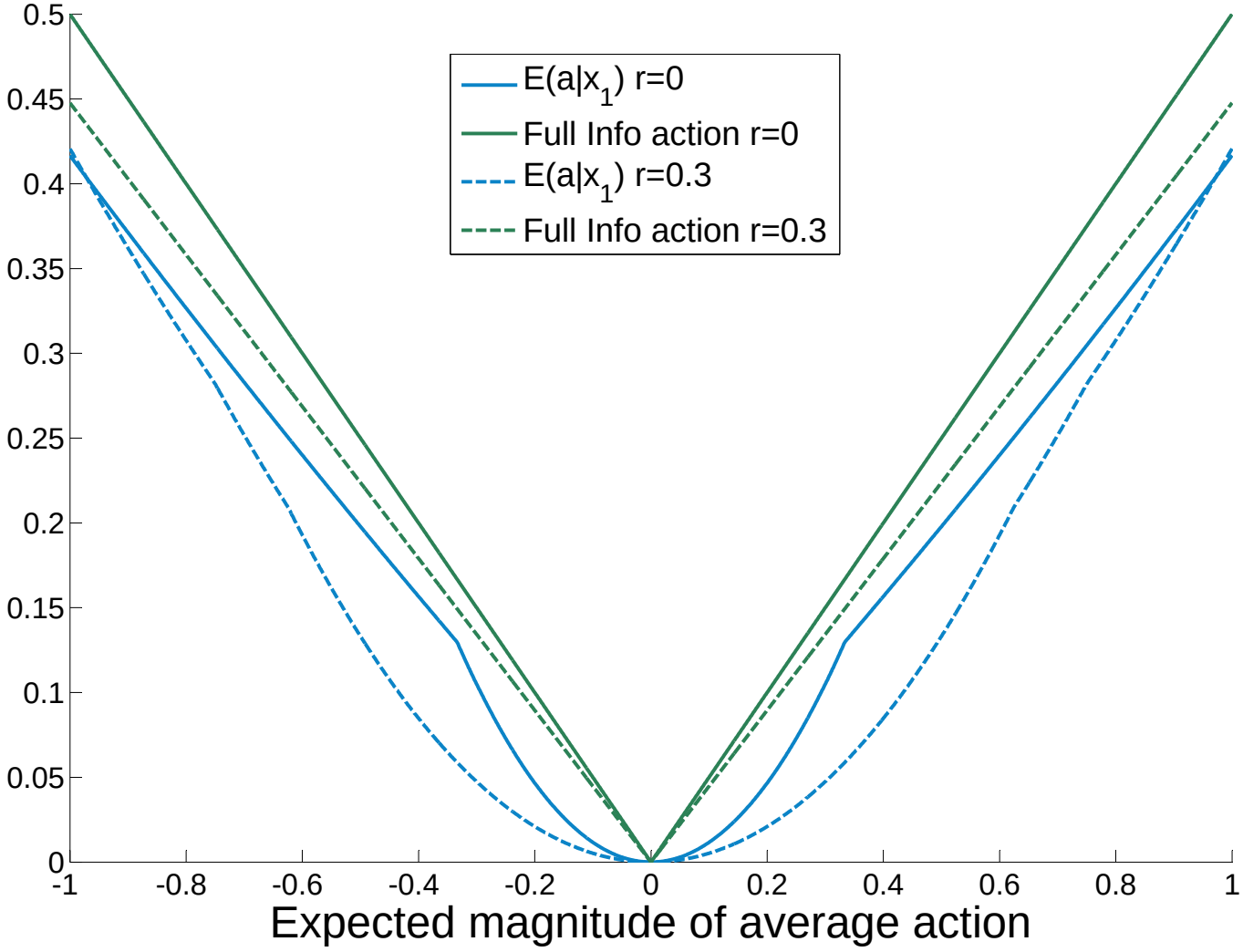
0.4
0.6
0.8
1
E(a|x1) λ=0.5
A Full Info
E(a|x1), λ=0.75
Conditional expected magnitude of average action

Introducing a coordination motive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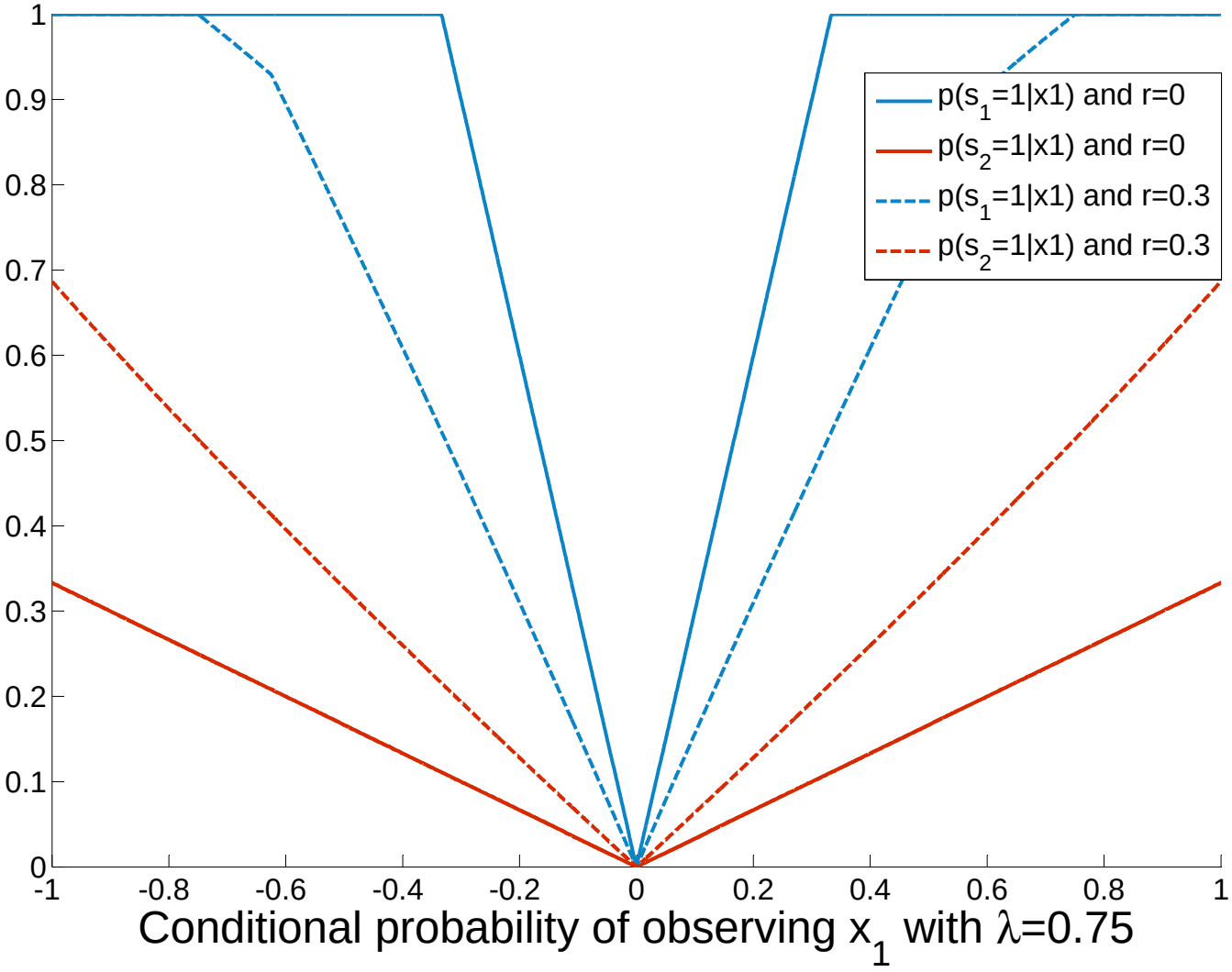
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1
E(a|x1) r=0
Full Info action r=0
E(a|x1) r=0.3
Full Info action r=0.3
Expected magnitude of average action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-0.6
-0.4
-0.2
0
0.2
0.4
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0.8
1
p(s1=1|x1) and r=0
p(s2=1|x1) and r=0
p(s1=1|x1) and r=0.3
p(s2=1|x1) and r=0.3
Conditional probability of observing x1 with λ=0.75

What have we achieved?

The publicness of a signals is a continuous quantity

- Broken the strict theoretical dichotomy

The publicness of events and what events agents get information about depends on what events has realized

- Captures the editorial role played by mass media
- Agents preferences matter for what information becomes available and how widely it is observed

Differ from ex ante perspective on information choice, e.g. Hellwig and Veldkamp (REStud 2008) and Mackowiack and Wiederholt (AER 2009).

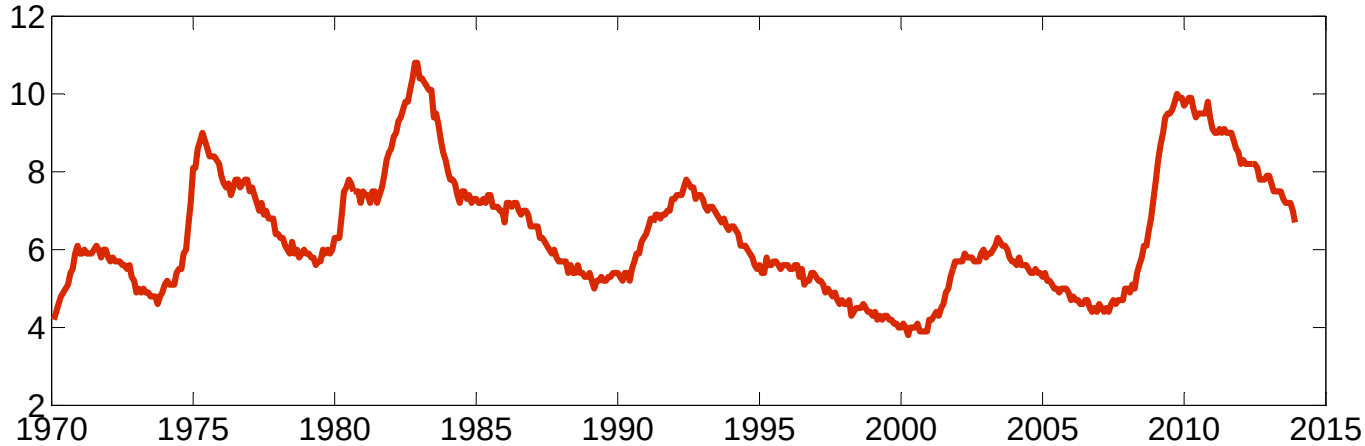
More work needed

News papers compete for audiences

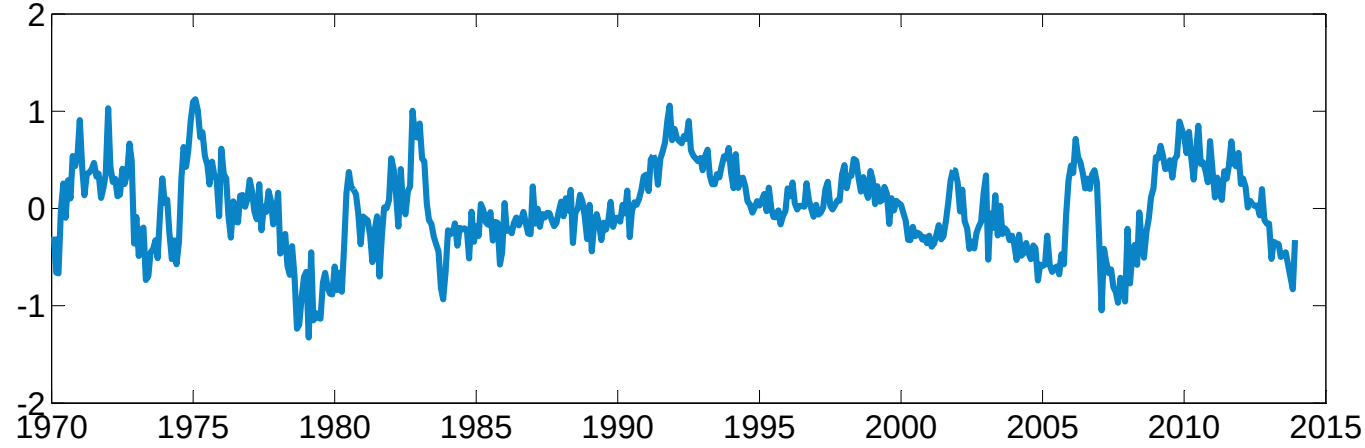
- What are the effects on the publicness of information of reducing fixed costs of circulating information?

Not yet quite macro economics

- Derive heterogeneity in interests from production/consumption heterogeneity
- Is asymmetric importance of economic sectors reflected in news coverage? What are the implications?



US Civilian Unemployment Rate



Index of news stories mentioning unemployment