Sequential Learning Under Informational Ambiguity

Jaden Yang Chen, PhD Candidate
Department of Economics, Cornell University

Introduction

Herding behavior is an important phenomenon in real life. Past literature mostly assumes that individuals know the true data-generating processes. As a result, many aspects of social learning rely on the statistical properties of the true data-generating processes. For example, past literature shows that

$$\boldsymbol{Information\ Cascades = f(DGP)}$$

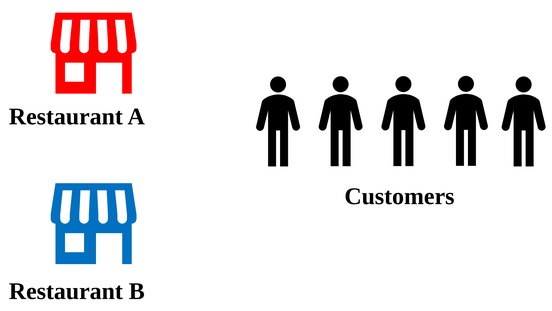
This paper allows individuals to be ambiguous about the true signal structures and finds that

$$\boldsymbol{Information\ Cascades = f(uncertainty)}$$

Therefore, this paper interprets herding and incomplete learning as a universal result under sufficient informational uncertainty.

Model Setup

- State space $\Theta = \{0,1\}$
- Individuals $N=\{1,2,\ldots\}$ take an action from $A = \{0,1\}$ to match the state.



- Individuals receive signals before taking the action. They are **ambiguous** about the other individuals' data-generating processes and perceive a set of models $\mathcal{F}$ as possible.
- They have **max-min expected utility** and update beliefs using full Bayesian rule (i.e., update model by model).

Main Results

Under sufficient ambiguity, for all possible true data-generating processes,

- an **information cascade** occurs almost surely as opposed to standard results that cascades arise only for the DGPs that satisfy specific statistical properties.
- Even when signals are **unbounded**, complete learning does not arise, and an **incorrect herding** occurs with a strictly positive probability as opposed to standard results that complete learning arises under unbounded signals.

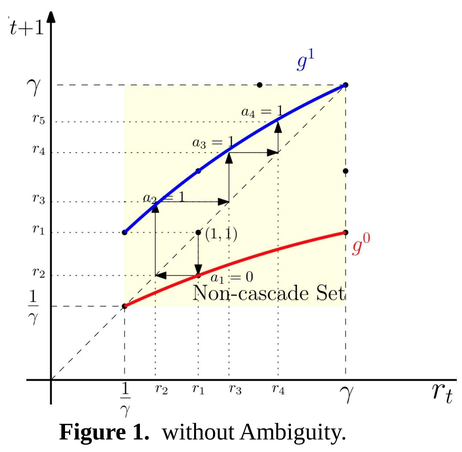


Figure 1. without Ambiguity.

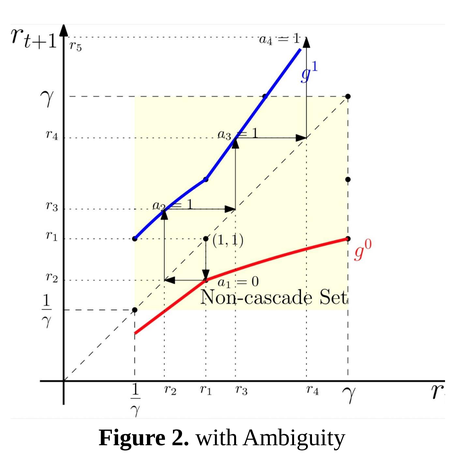
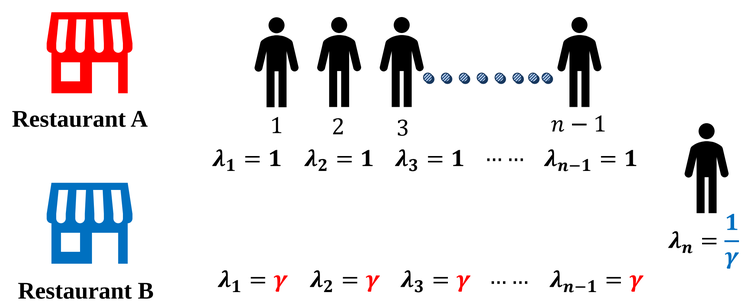


Figure 2. with Ambiguity

In many cases, only a *slight* degree of ambiguity suffices to produce these results. This suggests that standard results can be fragile to uncertainty.

Intuition

- Under huge ambiguity, there are **two opposing forces:**
  - the possibility that other people's signals are uninformative encourages overturning a herd;
  - the possibility that other people's signals are very informative encourages following a herd.



- If $a_n = \boldsymbol{A}$, follow the herd, in the worst case
  $f_1 = \cdots = f_n = \underline{f}$, where $supp\left(\underline{f}\right) = 1$, uninformative
- Cost of $\boldsymbol{A}$, Herding, is acting against one signal $\frac{1}{\gamma}$:
- If $a_n = \boldsymbol{B}$, break the herd, in the worst case
  $f_1 = \cdots = f_n = \bar{f}$, where $supp(\bar{f}) = \left\{\gamma, \frac{1}{\gamma}\right\}$, the most informative
- Cost of $\boldsymbol{B}$, breaking a herd, is:
  - acting against $n-1$ signal γ but following 1 signal $\frac{1}{\gamma}$

- These two forces are **asymmetric**. As n increases, the cost of breaking a herd increases consistently whereas the cost of herding remains the same. For large n, cascade on $\boldsymbol{A}$.

Extension

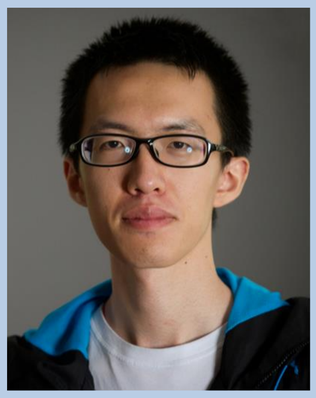
1. **Other Ambiguity Preferences**: the analysis can be extended to other ambiguity preferences and ambiguity attitudes (e.g., α-max-min, smooth ambiguity)
2. **Multiple Actions**: for example, a safe outside action. Under sufficient ambiguity, when individuals are **ambiguity-averse**, an information cascade can occur on the safe outside action (e.g., non-participation or non-exploration) as opposed to standard results that the outside action only matters in the knife-edge case.

Conclusion

This paper finds that informational uncertainty has an important impact on social learning and provides new insights on the mechanism behind herding behavior. This paper claims that whether an information cascade or an incorrect herding occurs is a result of individuals' ambiguity level instead of specific statistical features of the actual signal processes as suggested by previous literature.

> *"When the situation is unclear or ambiguous, when uncertainty reigns, we are most likely to look to and accept the actions of others as correct"**

*cited from Robert Cialdini, *Influence: The psychology of persuasion*



Jaden Yang Chen, Department of Economics, Cornell University
PhD Candidate, expected graduation May 2022
My research field is microeconomic theory. My current research focuses on learning under a broader sense of uncertainty and learning with boundedly rational agents.
Personal Website: www.jadenchen95.com
Contact Information: yc2325@cornell.edu