

# Epidemiology of Economic Expectations

Christopher Carroll \*

Tao Wang †

March 2, 2020

“A very natural next step for economics is to maintain expectations in the strategic position they have come to occupy, but to build an empirically validated theory of how attention is in fact directed within a social system, and how expectations are, in fact, formed.” [Simon \(1984\)](#).

“While mass media play a major role in alerting individuals to the possibility of an innovation, it seems to be personal contact that is most relevant in leading to its adoption. Thus, the diffusion of an innovation becomes a process formally akin to the spread of an infectious disease.” [Arrow \(1969\)](#).

“If we want to know why an unusually large economic event happened, we need to list the seemingly unrelated narratives that all happened to be going viral at around the same time and affecting the economy in the same direction.” [Shiller \(2017\)](#).

## 1 Outline

### 1.1 Motivation and Context

- Browning, Hansen and Heckman intro to “Handbook of Macroeconomics”: [Browning et al. \(1999\)](#).
  - The most universal lesson of microeconomics is that “people are different in ways that importantly affect their economic behavior”
    - \* circs: wealth, income
    - \* prefs: risk aversion, impatience
  - Microfoundations of macro literature
    - \* When micro heterogeneity in circs or prefs is matched, fundamental conclusions change
      - Like, how do fiscal and monetary policy work

---

\*Department of Economics, Johns Hopkins University, <http://econ.jhu.edu/people/ccarroll/>, [ccarroll@jhu.edu](mailto:ccarroll@jhu.edu).

†Department of Economics, Johns Hopkins University, <http://taowangecon.github.io>, [twang80@jhu.edu](mailto:twang80@jhu.edu).

- Remaining kind of heterogeneity much less explored (until recently): in expectations/beliefs
  - \* even though heterogeneity in beliefs is just as apparent in micro data as other kinds
- if expectations are heterogeneous, aggregate patterns depend on the distribution of expectations
  - \* stock market expectations of people who will never own stock are not important
  - \* housing market expectations of the *marginal* participants (buyer, seller) set prices [Piazzesi and Schneider \(2009\)](#)
- heterogeneous expectations likely interact with other types of heterogeneity
  - \* rich people do more consumption than poor people
  - \* so, need to weight expectations by the degree to which the person's actions affect the outcome
- Existing literature on heterogeneity in expectations:
  - \* Most commonly explored reasons for heterogeneity in expectations:
    - information
    - different updating (=“learning”) process
    - different initial beliefs (=“priors”)
    - different histories
    - costs of updating info  $\Rightarrow$  frictions, delays
    - even optimizing agents will happen to update at different times
  - \* Epidemiology is different from all of these
    - It's about how ideas *spread*

## 1.2 What insights can the epidemiological framework offer?

- Explains how people can have somewhat coherent beliefs about macroeconomy without PhD in macroeconomics
  - ordinary people: read news media to hear what “experts” say
  - population beliefs depend on “infectiousness” of experts' views
  - Embeds RE model as the limit corresponding to “infinitely instantly perfectly infectious” beliefs
  - Epi models slow down the spread so it is testable
    - \* “infectiousness” matters
      - how social network and media affect the spread of economic news [Bailey et al. \(2018b\)](#) [Cookson and Niessner \(2020\)](#)
      - how policy communication makes its way to average economic agents making their decisions
  - What should Fed governors, Treasury Secretaries, etc do
- and why it could be a useful tool, methodologically speaking

- if epi models are true, they have testable implications for cross-sectional distribution of expectations
- and implications for aggregate belief dynamics (and thus actual aggregate macro dynamics)
- goal: reconcile micro/cross-section data with (appropriately weighted) aggregate dynamics
- goal: determine importance of social learning in structural models [Burnside et al. \(2016\)](#)

### 1.3 Motivating examples

- household expectations for macroeconomic environment, i.e. inflation [Carroll \(2001\)](#), [Nunes \(2009\)](#), [Pfajfar and Santoro \(2013\)](#)
- ponzi scheme and fraud [Akerlof and Shiller \(2016\)](#), [MacKay \(2019\)](#), [Rantala \(2019\)](#)
- as a driver of financial asset bubbles, especially some new class of assets, e.g. bitcoin. [Shiller \(2017\)](#), [Kindleberger and Aliber \(2011\)](#)
- bank runs/spread of panic and fear
  - Canonical models are basically timeless: run happens instantly [Diamond and Dybvig \(1983\)](#)
  - Understanding process by which they happen over time means possibility of arresting them
  - Financial crisis in the Great Recession has been described as “giant extended bank run on financial sector”
- housing prices [Burnside et al. \(2016\)](#), [Piazzesi and Schneider \(2009\)](#)
- stock investment [Barber and Odean \(2008\)](#)

### 1.4 Epidemiology model basics [Anderson et al. \(1992\)](#), [Kermack et al. \(1927\)](#), [Hethcote \(2000\)](#)

- *ex ante* homogeneous models
  - Common source
  - SIS and SIR
  - SEIR
  - Features of homogenous models
    - \* simplicity due to independence assumptions
    - \* easy to aggregate up to macro patterns and can be tested
    - \* capture the dynamics
- *ex ante* heterogeneous models (and consequences, if any)
  - incorporates network structure [Jackson \(2010\)](#)
  - “superspreaders”

- \* higher degree distributions lead to more “infection”
- \* transition probability is location-specific depending on the degree of the node
- \* interact with individual economic conditions
- Economists’ methodologies offer a lot of ways to improve standard epi models
  - transmission/infection rate can be contingent on state variables
  - optimizing behavior by agents (incentives to seek/avoid infection)
  - much more sophisticated about causality, inference, etc
  - possible that economists’ ideas will infect the epidemiologists!

## 1.5 Potential areas where techniques could be applied

- economic sentiment and confidence [Carroll et al. \(1994\)](#), [Benhabib and Spiegel \(2019\)](#), [Mian et al. \(2018\)](#)
- economic narratives [Shiller \(2019\)](#), [Lo \(2019\)](#)
- spread of fake news and rumours [Vosoughi et al. \(2018\)](#), [Dietz \(1967\)](#)
- spread of default. [Schweikert and Höchstötter \(2019\)](#)
- search-and-matching problems [Piazzesi and Schneider \(2009\)](#)
- diffusion of innovation [Arrow \(1969\)](#), [Rogers \(2003\)](#)
- communication, the role of opinion leaders [Iyengar et al. \(2010\)](#)
- fads and fashions: information cascade [Bikhchandani et al. \(1992\)](#)
- viral marketing and internet memes, [Leskovec et al. \(2007\)](#), [Bauckhage \(2010\)](#)

## 1.6 Relation to “agent-based” modeling in macroeconomics

- Provides discipline on agents’ actions/decisions
  - [LeBaron and Tesfatsion \(2008\)](#)
  - [Ragot \(2018\)](#)
  - [Tsfatsion \(2006\)](#)
  - [Haldane and Turrell \(2019\)](#)
  - In finance, [LeBaron \(2000\)](#), [LeBaron et al. \(1999\)](#)
  - Both time-series and cross-sectional distribution properties
  - Allow examination of "off-equilibrium" behavior [Simon \(1959\)](#)

## 1.7 Other toolboxes to use and promising directions of research

- Natural language processing [Gentzkow et al. \(2019\)](#), [Cookson and Niessner \(2020\)](#)
  - counts of the word frequency
    - \* use google searches to predict flu trends: [Dukic et al. \(2012\)](#)
  - “sentiment analysis” [Soo \(2015\)](#)

- topical modelling
- literature on differential infectiousness of different emotions
  - \* fear, anger, disgust more “infectious” than happiness, satisfaction
  - \* e.g., could yield asymmetries between good and bad news
- Social network data sources [Jackson \(2010\)](#)
  - how network friends affect economic expectations [Bailey et al. \(2018b\)](#), [Bailey et al. \(2018a\)](#)
    - \* Potential application:
      - Greater geographical connectedness  $\Rightarrow$  fewer local boom/bust cycles, more aggregate ones
  - social connectedness and aggregate economic outcomes
- Cognitive and neuroscience approach
  - “microfoundation” for results about differential infectiousness
    - \* example: FMRI’s show brain’s “fear/disgust” center more easily activated than pleasure/reward center

## References

- Akerlof, G. A. and Shiller, R. J. (2016). *Phishing for Phools: The Economics of Manipulation and Deception*. Princeton University Press.
- Anderson, R. M., Anderson, B., and May, R. M. (1992). *Infectious Diseases of Humans: Dynamics and Control*. OUP Oxford.
- Arrow, K. J. (1969). Classificatory Notes on the Production and Transmission of Technological Knowledge. *The American Economic Review*, 59(2):29–35.
- Bailey, M., Cao, R., Kuchler, T., and Stroebel, J. (2018a). The economic effects of social networks: Evidence from the housing market. *Journal of Political Economy*, 126(6):2224–2276.
- Bailey, M., Cao, R., Kuchler, T., Stroebel, J., and Wong, A. (2018b). Social Connectedness: Measurement, Determinants, and Effects. *Journal of Economic Perspectives*, 32(3):259–280.
- Barber, B. M. and Odean, T. (2008). All That Glitters: The Effect of Attention and News on the Buying Behavior of Individual and Institutional Investors. *The Review of Financial Studies*, 21(2):785–818.
- Bauckhage, C. (2010). Insights into Internet Memes. page 8.
- Benhabib, J. and Spiegel, M. M. (2019). Sentiments and economic activity: Evidence from us states. *The Economic Journal*, 129(618):715–733.

- Bikhchandani, S., Hirshleifer, D., and Welch, I. (1992). A Theory of Fads, Fashion, Custom, and Cultural Change as Informational Cascades. *Journal of Political Economy*, 100(5):992–1026.
- Browning, M., Hansen, L. P., and Heckman, J. J. (1999). Chapter 8 Micro data and general equilibrium models. In *Handbook of Macroeconomics*, volume 1, pages 543–633. Elsevier.
- Burnside, C., Eichenbaum, M., and Rebelo, S. (2016). Understanding Booms and Busts in Housing Markets. *Journal of Political Economy*, 124(4):1088–1147.
- Carroll, C. D. (2001). The epidemiology of macroeconomic expectations. Technical report, National Bureau of Economic Research.
- Carroll, C. D., Fuhrer, J. C., and Wilcox, D. W. (1994). Does consumer sentiment forecast household spending? if so, why? *The American Economic Review*, 84(5):1397–1408.
- Cookson, J. A. and Niessner, M. (2020). Why Don’t We Agree? Evidence from a Social Network of Investors. *The Journal of Finance*, 75(1):173–228.
- Diamond, D. W. and Dybvig, P. H. (1983). Bank Runs, Deposit Insurance, and Liquidity. *Journal of Political Economy*, 91(3):401–419. Publisher: University of Chicago Press.
- Dietz, K. (1967). Epidemics and rumours: A survey. *Journal of the Royal Statistical Society: Series A (General)*, 130(4):505–528.
- Dukic, V., Lopes, H. F., and Polson, N. G. (2012). Tracking Epidemics With Google Flu Trends Data and a State-Space SEIR Model. *Journal of the American Statistical Association*, 107(500):1410–1426.
- Gentzkow, M., Kelly, B., and Taddy, M. (2019). Text as Data. *Journal of Economic Literature*, 57(3):535–574.
- Haldane, A. G. and Turrell, A. E. (2019). Drawing on different disciplines: macroeconomic agent-based models. *Journal of Evolutionary Economics*, 29(1):39–66.
- Hethcote, H. W. (2000). The Mathematics of Infectious Diseases. *SIAM Review*, 42(4):599–653.
- Iyengar, R., Van den Bulte, C., and Valente, T. W. (2010). Opinion Leadership and Social Contagion in New Product Diffusion. *Marketing Science*, 30(2):195–212. Publisher: INFORMS.
- Jackson, M. O. (2010). *Social and Economic Networks*. Princeton University Press. Google-Books-ID: rFzHinVAq7gC.
- Kermack, W. O., McKendrick, A. G., and Walker, G. T. (1927). A contribution to the mathematical theory of epidemics. *Proceedings of the Royal Society of London. Series A, Containing Papers of a Mathematical and Physical Character*, 115(772):700–721.

- Kindleberger, C. P. and Aliber, R. Z. (2011). *Manias, Panics and Crashes: A History of Financial Crises, Sixth Edition*. Palgrave Macmillan.
- LeBaron, B. (2000). Agent-based computational finance: Suggested readings and early research. *Journal of Economic Dynamics and Control*, 24(5):679–702.
- LeBaron, B., Arthur, W. B., and Palmer, R. (1999). Time series properties of an artificial stock market. *Journal of Economic Dynamics and Control*, 23(9):1487–1516.
- LeBaron, B. and Tesfatsion, L. (2008). Modeling Macroeconomies as Open-Ended Dynamic Systems of Interacting Agents. *American Economic Review*, 98(2):246–250.
- Leskovec, J., Adamic, L. A., and Huberman, B. A. (2007). The dynamics of viral marketing. *ACM Transactions on the Web (TWEB)*, 1(1):5–es.
- Lo, A. W. (2019). *Adaptive Markets: Financial Evolution at the Speed of Thought*. Princeton University Press. Google-Books-ID: Q4d7DwAAQBAJ.
- MacKay, C. (2019). *Extraordinary Popular Delusions and the Madness of Crowds*. Digireads.com. Google-Books-ID: 06hgwEACAAJ.
- Mian, A. R., Sufi, A., and Khoshkhoh, N. (2018). Partisan Bias, Economic Expectations, and Household Spending. SSRN Scholarly Paper ID 2620828, Social Science Research Network, Rochester, NY.
- Nunes, R. (2009). On the Epidemiological Microfoundations of Sticky Information\*. *Oxford Bulletin of Economics and Statistics*, 71(5):643–657.
- Pfajfar, D. and Santoro, E. (2013). News on Inflation and the Epidemiology of Inflation Expectations. *Journal of Money, Credit and Banking*, 45(6):1045–1067.
- Piazzesi, M. and Schneider, M. (2009). Momentum Traders in the Housing Market: Survey Evidence and a Search Model. *American Economic Review*, 99(2):406–411.
- Ragot, X. (2018). Chapter 4 - Heterogeneous Agents in the Macroeconomy: Reduced-Heterogeneity Representations. In Hommes, C. and LeBaron, B., editors, *Handbook of Computational Economics*, volume 4 of *Handbook of Computational Economics*, pages 215–253. Elsevier.
- Rantala, V. (2019). How do investment ideas spread through social interaction? evidence from a ponzi scheme. *The Journal of Finance*, 74(5):2349–2389.
- Rogers, E. M. (2003). *Diffusion of Innovations, 5th Edition*. Simon and Schuster. Google-Books-ID: 9U1K5LjUOwEC.
- Schweikert, J. and Höchstötter, M. (2019). Epidemiological spreading of mortgage default. *International Journal of Housing Markets and Analysis*.
- Shiller, R. J. (2017). Narrative Economics. *American Economic Review*, 107(4):967–1004.

- Shiller, R. J. (2019). *Narrative Economics: How Stories Go Viral and Drive Major Economic Events*. Princeton University Press. Google-Books-ID: HciXDwAAQBAJ.
- Simon, H. A. (1959). Theories of Decision-Making in Economics and Behavioral Science. *The American Economic Review*, 49(3):253–283.
- Simon, H. A. (1984). On the behavioral and rational foundations of economic dynamics. *Journal of Economic Behavior & Organization*, 5(1):35–55.
- Soo, C. (2015). Quantifying Animal Spirits: News Media and Sentiment in the Housing Market. SSRN Scholarly Paper ID 2330392, Social Science Research Network, Rochester, NY.
- Tesfatsion, L. (2006). Chapter 16 Agent-Based Computational Economics: A Constructive Approach to Economic Theory. In Tesfatsion, L. and Judd, K. L., editors, *Handbook of Computational Economics*, volume 2, pages 831–880. Elsevier.
- Vosoughi, S., Roy, D., and Aral, S. (2018). The spread of true and false news online. *Science*, 359(6380):1146–1151.