Understanding Inflation Expectations — The Roles of Personal Experiences and Information Resonance

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Approaches to Expectation Formation

1. **Traditional**: Bayesian updating, perfect cognition, perfect information processing
   - Frictions: access to information, model uncertainty
   - Remedy: improve access to information (hence, info experiments), reduce model uncertainty

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   - Remedy: undoing, design of experiences

Example 1: COVID-19 Vaccination

What explains differences in views about COVID-19 vaccination?

1. **Traditional**: Different beliefs due to differences in information

2. **Behavioral** [social psych]: "Breakthrough cases prove vaccines are useless"
   - 0.05% of vaccinated people have been hospitalized or died from COVID-19.
   - 99.5% of COVID-19 deaths are unvaccinated people

3. **Experience effects** [neuro, cognition]: Humans change their views about vaccines after personally being infected and witnessing cum/ex vaccine differences
   - Pre-vaccine/attitudes towards C19 measures: Justin Trudeau's wife, Boris Johnson
   - Closing of the Black-White vaccination gap by employing local community members, videos with Tuskegee descendants

Example 2: Inflation Expectations

What explains the overweighting of food and gas prices?

1. **Traditional**: Different beliefs due to differences in information
2. **Behavioral** [social psych]: Biases / limited cognition
3. **Experience effects** [neuro, cognition]: Humans change their views of future inflation, as well as savings/spending decisions, after personally being affected
   - Even if fully informed about inflation data

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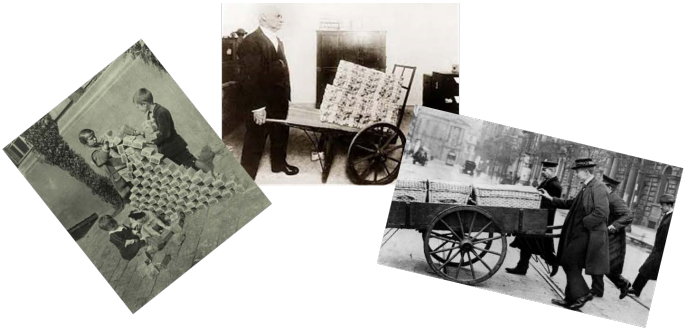
Inflation Experiences $\Longrightarrow$ Inflation Beliefs

German motivation ...



... and US motivation
Paul Volcker (1979):

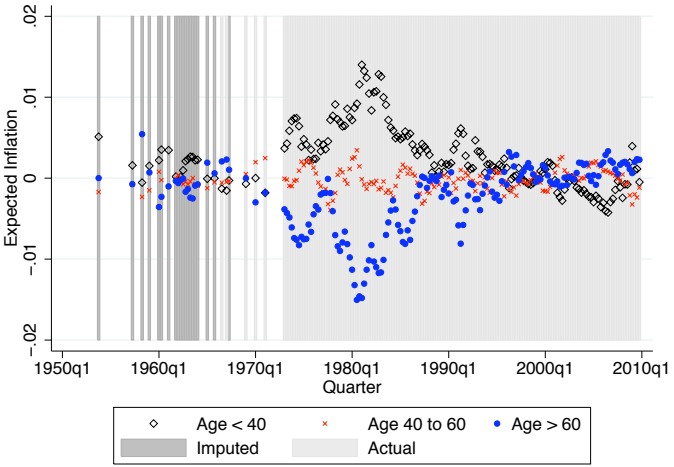
"An entire generation of young adults has grown up since the mid-1960s knowing only inflation, indeed an inflation that has seemed to accelerate inexorably. In the circumstances, it is hardly surprising that many citizens have begun to wonder whether it is realistic to anticipate a return to general price stability."

Findings: Inflation Experiences $\Longrightarrow$ Inflation Beliefs

Malmendier and Nagel (2016), using MSC data since 1953

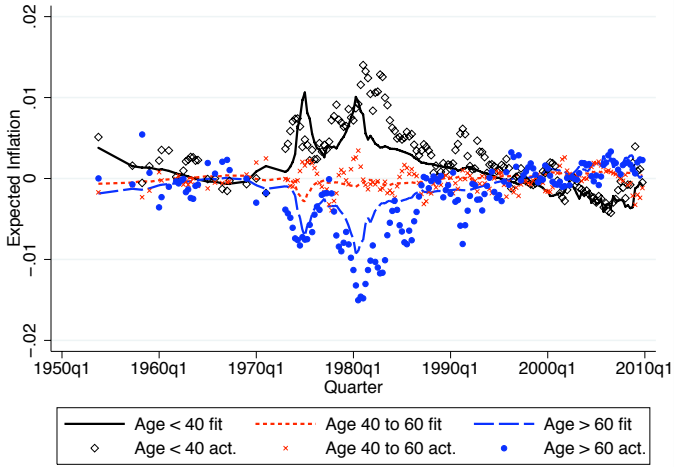
1. When forming inflation expectations, individuals put a higher weight on realizations experienced over their life-times than on other available historical data.
   - Similar to adaptive learning: people learn following simple "rules of thumb" (e.g., Bray 1982; Marcet and Sargent 1989)
   - Different from adaptive learning: people learn (more) from data realized during their lifetimes. (adaptive learning: all historical data)
2. Implicit weighting of past experiences very similar to weighting pattern in other applicaitons, e. g., stock market!
   - Roughly linearly declining weights.
3. Significant impact on individual financial decisions, namely, long-term nominal-rate borrowing and lending (tenure, ARM/FRM, refi, bonds).

Disagreement about future inflation (MSC)



Four-quarter moving averages of one-year inflation expectations shown as deviations from the cross-sectional mean.

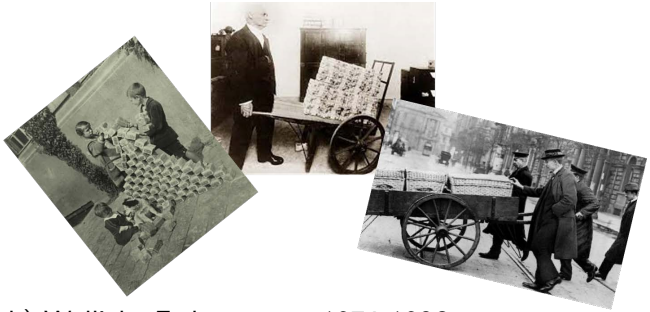
Fitted expectations



Fitted and actual relative to full-sample c.s. mean (4-quarter MA)

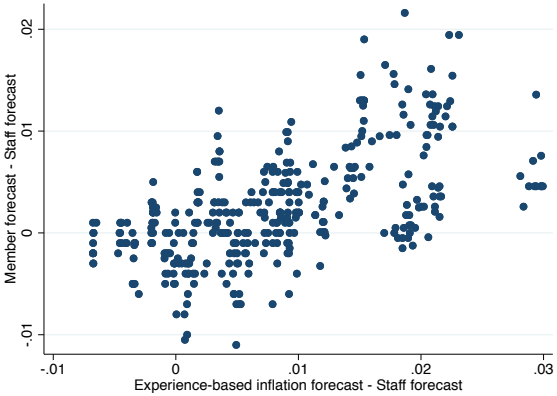
Inflation Experiences of Experts

Malmendier, Nagel, and Yan (2020)



- Henry (Heinrich) Wallich: Fed governor 1974-1986
  - Born in Germany in 1914 into a family of bankers.
  - Lived through Germany's hyperinflation in 1923.
  - Emigrated to the US in the 1930s.
- Wallich dissented 27 times (!) during his tenure on the Fed Board, the highest number of dissents in Federal Reserve history, **d**ecades later.

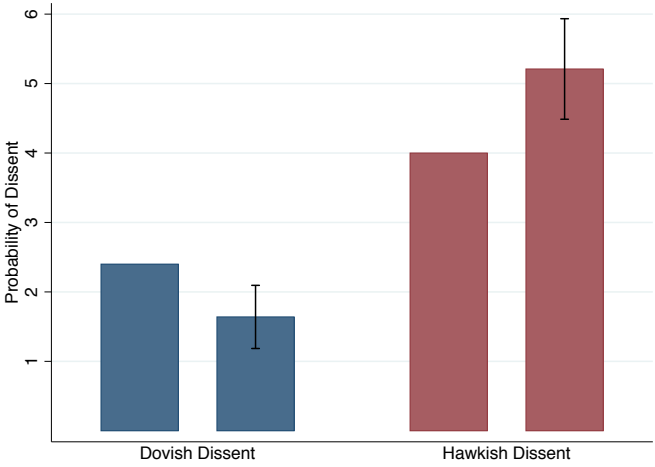
FOMC Members' Inflation Experiences and Forecasts



Member forecast: from semi-annual Monetary Policy Report to Congress, 1992 - 2004.
Staff forecast: Greenbook forecast.
Experience-based forecast: AR(1) model forecast estimated based on weighted life-time inflation data for each FOMC member.

Inflation experiences and FOMC voting behavior

Effect on dissent probabilities of +0.1pp rise in experience-based inflation forecast



Evidence on Experience Effects – Applications

Evidence of personal experiences affecting beliefs and choices from finance, macro, labor, international economics, real estate, ... (Cf. QJE, JPE, JF, JFE, AEJ Macro, JME, JIE)

- IPO investment
- stock-market investment (Depression Babies, East Germany)
- bond-market investment
- tenure decisions (buy versus rent)
- mortgage choices
- consumption spending (and unemployment experiences)
- grocery shopping

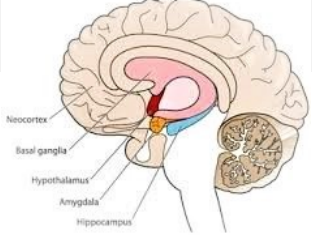
(Kaustia and Knuepfer 2008; Malmendier and Nagel 2011, 2016; Botsch and Malmendier 2021; Mamendier and Steiny 2020; Malmendier and Shen 2020; Laudenbach et al. 2021; D'Acunto et al. 2021)

Neuroplasticity

(Cf. Laudenbach, Niessen-Ruenzi, Malmendier AEA P&P 2019; NBER WP 2020)

- Every time we have a new experience, our brain forms a connection between two neurons (synapse).
  - Synapses tell our body how to react to the world around us. The govern the way we experience life.
- The brain can reorganize pathways, create new connections, and even create new neurons (neuroplasticity) in response to learning, experience, and memory foundation
- Generally, young brains tend to be more sensitive and responsive to experiences than older brains. But the brain never stops changing.

Synaptic Tagging



- How and how often we make an experience matters.
  - Repeated stimulation of hippocampal neurons can induce a prolonged increase in synaptic strength (long-term potentiation (LTP)), Cf. Frey and Morris (*Nature* 1997, *Trends in Neuroscience* 1998))
  - Emotional Tagging: **Emotional events attain privileged status in memory**, Dolan *Science* (2002), LaBar and Cabeza *Nature* (2006).
  - Prior or subsequent "learned knowledge" has very limited power to undo the effects.

- Cf. literature on trauma: Synaptic changes caused by traumatic stress (Mahan and Ressler *Trends in Neuroscience* 1998, Zhang et al, *Front Psychol* 2020).

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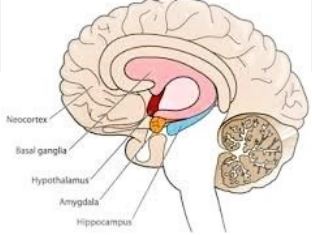

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  - Trauma with a big T: German Hyperinflation, Great Depression, Pandemics
  - trauma with a small t: Daily Exposure, daily worry about food, prices, unemployment
  - Other repeated (non-traumatic) exposure, including positive experiences

Example: Gendered Experiences

D'Acunto, Malmendier, Weber (PNAS, 2020)

Within-Household Inflation Expectations

- Women have (more) positively biased inflation expectations, even within households.
- Unconditional difference driven by differences in grocery shopping.

Generalization beyond *Personal* Experiences

- What information will be anchored in our brains? What will be "tagged"?
  - Direct personal experiences
  - Indirect experiences: people close to me, people similar to me?
- Some existing evidence from macro, finance, and labor
  - Inflation: Info experiments often less successful than expected ... but Reggae songs of Governanor of Jamaica's central bank
  - Inflation: D'Acunto, Fuster, Weber (2021): Gender and race (for Black men), gender (for white/Black women) in updating inflation expectations
  - Finance: Stolper and Walter (2018): Gender and age (for men), marital and parental status (for women) in updating financial beliefs/taking financial advice
  - Health: Alsan et al. (2019): Gender and race (for Black men) for health beliefs / taking health advice – though personal interaction more than pictures
  - Education: Large literature on role models in labor economics (STEM TAs, math professors): gender, race, especially older students (8th grade+)

Information Resonance
(Malmendier and Veldkamp 2022)

- Despite hearing information, people might ignore/do not act upon it if it does not "resonate" with them.
  - How powerfully information affects decisions depends on how firmly that information is anchored in memory/thinking.
    Emotionally identifying with an experience anchors it.
- Similar characteristics θ elicit resonance. ("That could have been me!")
  - Race, religion, politics, profession, gender, sexual orientation, ... of actor and observer matter. (Social learning theory)
  - But not uniform $||\theta_{f,race1} - \theta_{f,race2}|| \neq ||\theta_{m,race1} - \theta_{m,race2}||$

Model Set-Up

1. Agents are uncertain about payoff from choosing an action $a \in \{0, 1\}$. The payoff for agent i is z_i if $a = 1$

$$U_i(a_{it}) = a_{it} \cdot z_i + \epsilon_{it} \tag{1}$$

where $\epsilon_{it} \sim iid\ N(0, \sigma_\epsilon^2)$

2. The vector of payoffs for all agents has correlated entries: $z \sim N(\mu_z, \Sigma_z)$
3. Agents learn from observing own and other agents' experiences (action-payoff pairs) if uncertain-payoff action is taken: $(a_{jt},\ 1_{a_{jt}=1}(z_j + \epsilon_{jt}))$
4. Standard Bayesian updating, except resonance (ω_{ij}) tilts weights. For an agent i taking action $a_{it} = 1$:

$$E[z_i|\mathcal{I}_{it}] = \alpha_i \mu_z + \overline{\omega}_i \sum_{j=1}^{N} \sum_{t'=1}^{t} \omega_{ij} \beta_{ij} (z_j + \epsilon_{jt'}), \tag{2}$$

where α_i and β_{ij} are i's Bayesian weights on priors and signals from agent j and $\overline{\omega}_i$ allows ω to be scale-neutral.

Model Set-Up (2)

- β_i is the standard OLS estimator that projects individual payoff onto signal space: $\beta_i = Var(z+\epsilon)^{-1} Cov(z_i, z+\epsilon)$. $\alpha_i = 1 - \sum_{j=1}^{N} \beta_{ij}$.
- Resonance down-weights observation of others with dissimilar characteristics θ:

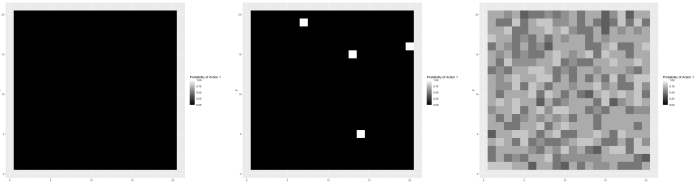
$$\omega_{ij} = 2 \cdot (1 - \Phi(\chi \underbrace{||\theta_i, \theta_j||}_{dissimilarity})$$

where Φ is a normal cdf, $||\cdot||$ is Euclidean distance.
χ indexes importance of resonance.

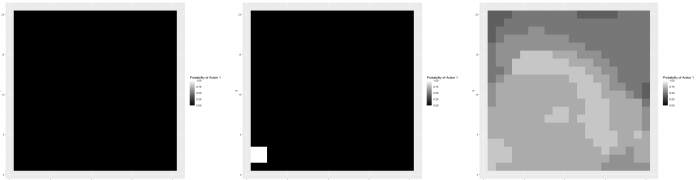
- Timing and Equilibrium:
  1. Agents, indexed by type / characteristic θ_i, have prior beliefs, μ_{it}, Σ_{it}.
  2. Each agent chooses a single action $a_{it} = 1$ or 0.
  3. All payoffs realized and observed by all agents.
     Update beliefs with (2). Repeat.

Illustration: Geographic and Characteristic Space

Geographic space at $t = 0, 5, 10$:



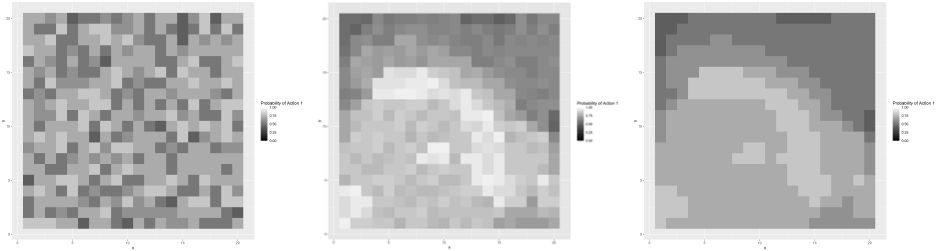
Same result in characteristic space at $t = 0, 5, 10$:



- Geographic outcomes look like random shocks, not diffusion.
- Characteristic space makes the diffusion visible.

What is the Right Characteristic Space?

Sorting on completely wrong, partially wrong and correct characteristics: at $t = 5, 10$:



- If we want to see a neat diffusion and make clear predictions, it is important to know which characteristics to sort on.
- How can we measure the resonance-relevant characteristics?

Measuring Resonance

- Suppose we see actions and characteristics.
  We know that the true covariance of payoffs is Σ_z.
- Lemma: There exists a covariance of payoffs Σ^R that rationalizes the actions of agents, with Bayesian beliefs.
- We can use this to estimate resonance.
  - With survey data: Regress the forecast on neighboring outcomes $(z + \epsilon)$

$$E[z_i|\mathcal{I}_{it}] = \alpha + \beta_i^R(z + \epsilon) + \eta_{it}$$

  - For binary actions: Estimate coefficients of a logit

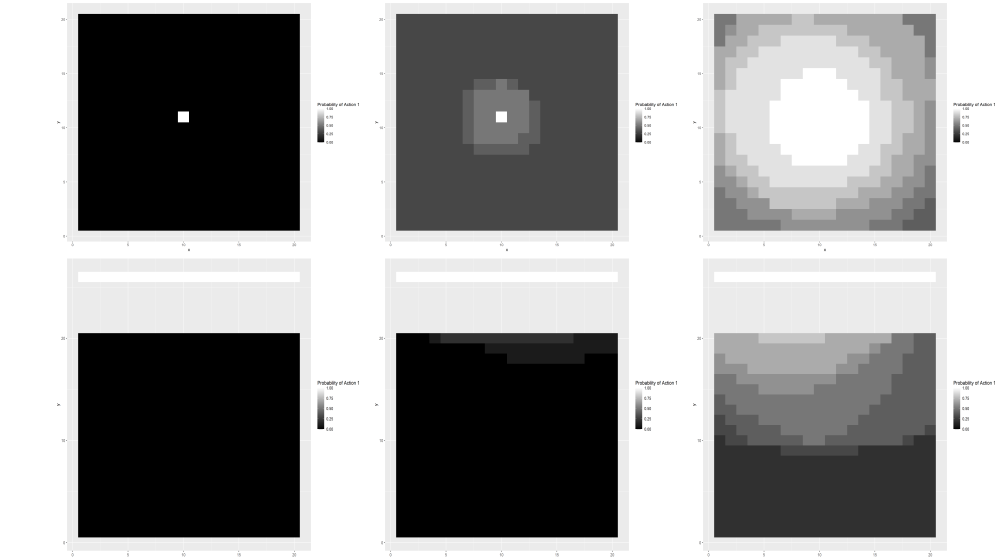
$$Pr[a_i = 1|\mathcal{I}_{it}] = \Phi\left(\alpha + \beta_i^R(z + \epsilon) + \eta_{it}\right)$$

  - Then map the sensitivity estimate β_i^R into a (scaled) resonance weight:

$$w_i\bar{w}_i = \beta_i^R./\beta_i = (I + \sigma_\epsilon^2\Sigma_z^{-1})\beta_i^R$$

    This requires knowing the true payoff covariance Σ_z.

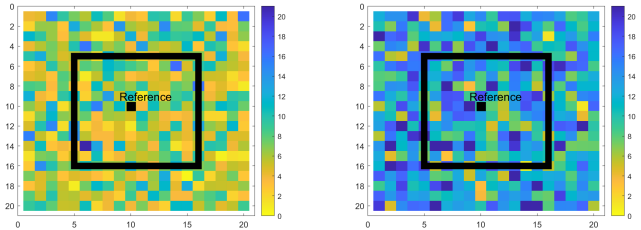
Prediction 1: Local leaders inspire change



Prediction 2: The Decline of Expertise

- Proposition: Celebrity/ expert actions have more influence on others' beliefs when agents are geography-constrained ($\partial E[z_a|\mathcal{I}]/\partial a_{celeb}$ larger)

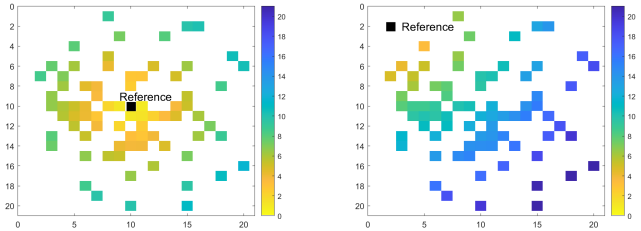
An centrist agent (left) and one with extreme characteristics (right)
(a) in geographic space:



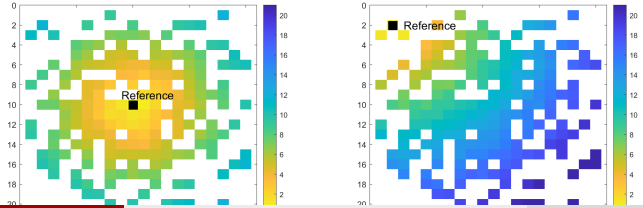
- Warmer colors represent social proximity.
- Agent on the right has few warm dots = few neighbors whose experiences resonate.
- Without social networks, people see physical neighbors (inside black box). With social network, everyone is visible.

Prediction 2: The Decline of Expertise

(b) in characteristic space, with geographic information constraints (in box):



(c) in characteristic space, with no information constraint:



Prediction 3: Crisis as a Time of Re-invention

Proposition: When no agents in a community choose action 1 and both actions suffer a negative payoff shock, an agent in that community is more likely to choose 1 next period.

- Both payoffs get worse. But you only observe the payoff in your community from action 0 fall. You do not know the other payoff also fell. Agents switch actions.
- The grass looks greener on the other side.

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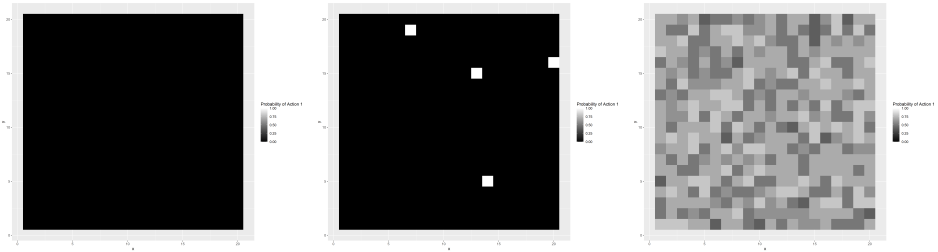

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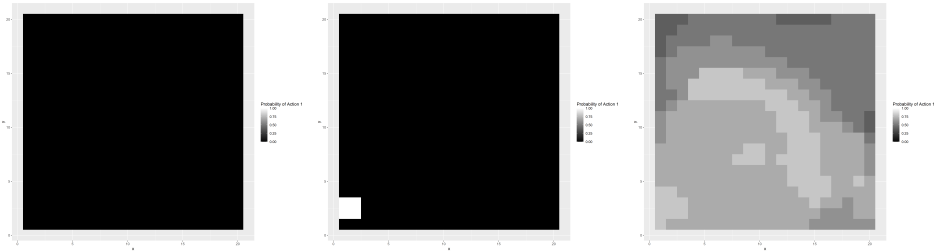

Take Aways

- Experience Effects: Longlasting effects of personal experiences on beliefs and risk-taking ("econ-PTSD")
  - From $y_{t,i} = f(x_{i,t})$
    to $y_{i,t} = f(x_{i,t}, A(x_{i,t-1}, x_{i,t-2}, x_{i,t-3}, \dots x_{i,0}))$
- Resonance Effects: Longlasting effects of others' personal experiences on beliefs and risk-taking ("That could have been me.")
  - From $y_{t,i} = f(x_{i,t})$
    to $y_{i,t} = f(x_{i,t}, A(x_{i,t-1}, x_{i,t-2}, x_{i,t-3}, \dots x_{i,0}; x_{j,t-1}, x_{j,t-2}, x_{j,t-3}, \dots x_{j,0}); \omega_{ij})$
- Evidence from macro, labor, finance, political economy
  $\Longrightarrow$ broadly applicable to learning and choice behavior
  - Feasibility of accounting for experience effects: "Big Data" within-person
  - Welfare and policy implications: information campaigns versus exposure/experiences (cf. 2021/22 inflation experiences), spill-over to the role of media and communication: limited effect unless "experiential" (cf. reggae songs of Central Bank of Jamaica, Netflix movies).