Understanding Persistent ZLB: Theory and Assessment

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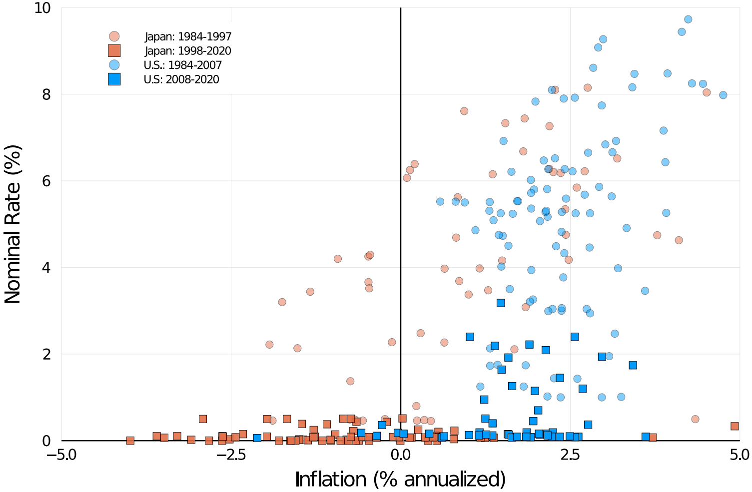
the threat of japanification



Benhabib, Schmitt-Grohé & Uribe (2001); Bullard (2010); Mertens & Ravn (2014); Schmitt-Grohé & Uribe (2017); Aruoba, Cuba-Borda & Schorfheide (2018); Lansing(2019); Ascari and Bonchi (2020); Nakata and Schmidt (*forthcoming*)

persistent ZLB hypotheses

expectations-driven liquidity traps

- Benhabib, Schmitt-Grohé & Uribe (2001); Schmitt Grohé & Uribe (2017); Aruoba, Cuba-Borda & Schorfheide (2018)

secular stagnation

- Hansen (1939), Summers (2013), Caballero & Farhi (2016), Eggertsson, Mehrotra & Robbins (2018), Michau (2018)

considered in separate frameworks!!

what we do?

- Question 1: is it possible to reconcile secular stagnation and expectation-driven traps within an unified framework?
    - allow movements in long-run real rate to kill strong Fisherian effects
    - assumptions on nominal rigidity key as to which hypothesis emerges

- Question 2: why does it matter?
    - contrasting policy implications depending on hypothesis at play
    - identify hypotheses using data $\rightarrow$ bayesian prediction-pools
        - Substantial uncertainty
        - Need many years of data
    - need for robust policies

outline

1. simple model
2. analytical results
3. quantitative evaluation

A simple new-Keynesian model: ingredients

- Euler equation with endogenous discounting: Uzawa (1968), Epstein(1983)

$$1 = \underbrace{\delta_t \tilde{C}_t \beta}_{\hat{\beta}(\tilde{C}_t)} \left[\frac{C_t}{C_{t+1}} \frac{R_t}{\Pi_{t+1}} \right], \quad 0 < \beta < 1; \quad \delta_t > 0 \tag{1}$$

  - Alternatives: Michaillat & Saez (2021), Michau (2018), Ono & Yamada (2018)

- Nominal rigidity in prices: Bhattarai, Eggertsson, Gafarov (2019)

$$\Pi_t = \kappa Y_t + (1 - \kappa \bar{Y}), \quad \kappa \equiv \frac{\alpha_p}{1 - \alpha_p} \tag{2}$$

- monetary policy rule subject to ZLB constraint

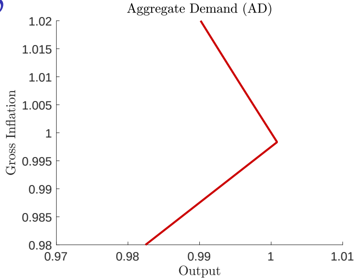
$$R_t = \max \left\{ 1, (1 + r_t^*) \Pi^* \left(\frac{\Pi_t}{\Pi^*} \right)^{\phi_\pi} \right\}, \quad 1 + r_t^* \equiv \frac{1}{\delta_t \beta} \tag{3}$$

steady state representation $\rightarrow AD - AS$

aggregate demand:

$$Y_{AD} = \frac{1}{\beta\delta} \begin{cases} \frac{1}{(1+r^*)\Pi^{\phi\pi}-1}, & \text{if } R > 1 \\ \Pi, & \text{if } R = 1 \end{cases}$$

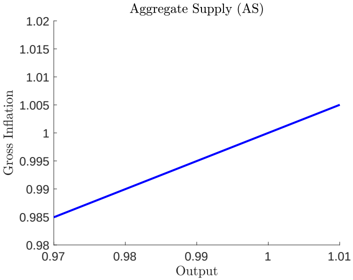
R>1: negative relation between Y and Π
R=1: positive relation between Y and Π



aggregate supply:

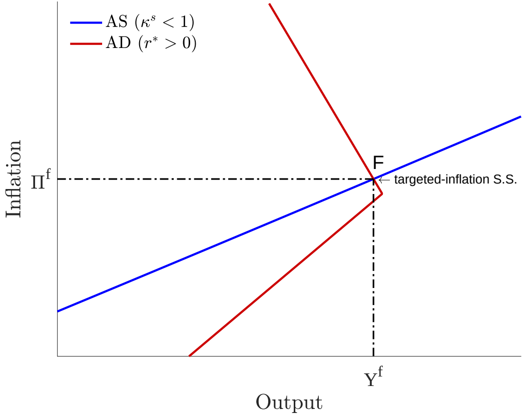
$$\Pi = \kappa Y + (1 - \kappa)$$

κ: degree of nominal rigidity
$1 - \kappa$: lower bound on inflation



Result 1 (disarming the perils)

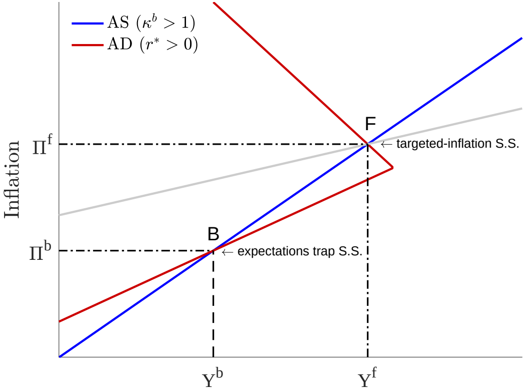
Let $\Pi^* = 1$*,* $0 < \delta < \frac{1}{\beta}$*, and when prices are rigid enough,* $\kappa < 1$*, there exists a globally unique steady state, called the targeted-inflation steady state that features* $Y = 1$*,* $\Pi = \Pi^* = 1$*,* $R = \frac{1}{\beta\delta} > 1$



Result 2 (expectations-traps)

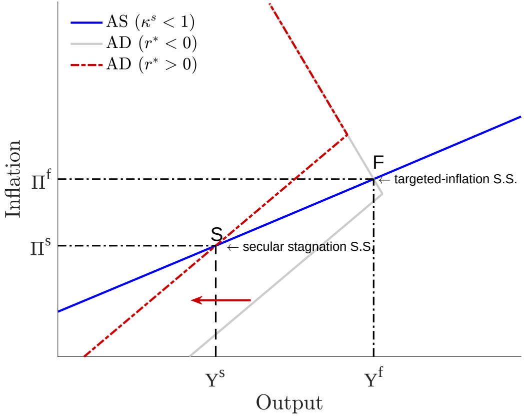
Let $\Pi^* = 1$, $0 < \delta < \frac{1}{\beta}$, *but let prices more flexible* $\kappa > 1$*.there exist two steady states:*

1. *The targeted-inflation steady state* $Y = 1, \Pi = \Pi* = 1$, *and* $R > 1$.
2. *An expectations-driven trap steady state with* $Y = \frac{1-\kappa}{\beta\delta-\kappa} < 1$, $\Pi = \frac{\beta\delta(1-\kappa)}{\beta\delta-\kappa} < 1$ *and* $R = 1$. *The local dynamics in a neighborhood around this steady state are locally indeterminate.*



Result 3 (secular stagnation)

Let $\Pi^* = 1$, $\delta > \frac{1}{\beta}$, *and* $\kappa < 1$. *There exists a unique, secular stagnation steady-state, with* $Y = \frac{1-\kappa}{\beta\delta-\kappa} < 1$, $\Pi = \frac{\beta\delta(1-\kappa)}{\beta\delta-\kappa} < 1$ *and* $R = 1$. *The equilibrium dynamics in this steady state's neighborhood are locally determinate*



- nature of stagnation matters → assess likelihood of B vs S comp. statics robust policy

application: Japan

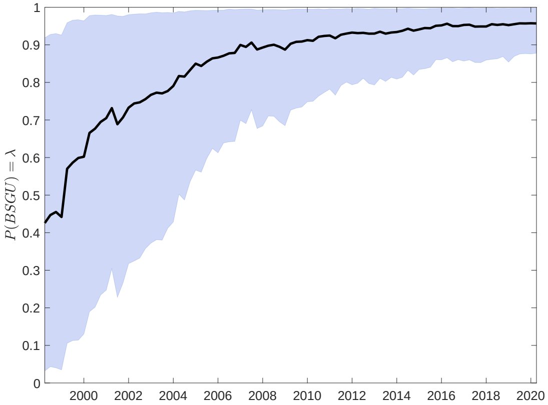
- Take An and Schorfheide (2006):
  - Add bonds-in-utility
  - monetary policy always constrained by the zero lower bound
  - structural shocks: government spending (g), technology growth (z), markups (ν)
- use likelihood-based methods to compare secular stagnation vs BSGU traps (Geweke and Amissano 2011, Del Negro et al. 2016)
- Japan data 1998:Q4-2020:Q1: output growth per capita, consumption growth per capita and GDP deflator inflation.
- Details: parameters
  - match -1.06% annualized inflation under secular stagnation and expectations-trap
  - natural interest rate: secular stagnation = -1.1% vs expectations-trap = 0%

expectations traps or secular stagnation?

- policymaker confronted with two different models: $\mathcal{M}_S$ vs $\mathcal{M}_B$

$$p\left(y_t \mid \lambda, \mathcal{P}\right) = \lambda p\left(y_t \mid y_{1:t-1}, \mathcal{M}_b\right) + (1-\lambda) p\left(y_t \mid y_{1:t-1}, \mathcal{M}_s\right), \quad 0 \leq \lambda \leq 1$$

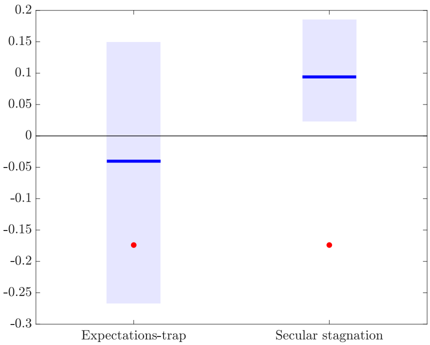
- real-time assessment is highly uncertain



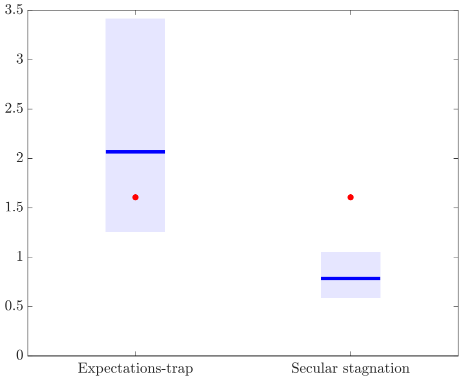
inspecting the mechanism: theoretical moments

- Why are expectation-traps a better description of the Japanese experience?
- Equilibrium indeterminacy of expectation-trap central to model fit

(a) $corr(\Delta y_t^o, \pi_t^o)$



(b) $\sigma_{\pi_t^o} / \sigma_{\Delta y_t^o}$



euro area | msv | irf | indeterminacy | correlations

conclusion

- provide first unified treatment of two sources of persistent ZLB: secular stagnation and expectation traps
- tractable theoretical framework with analytical results and AS-AD representation
- suggest robust policies to tackle contrasting policy implications
- quantitative assessment of the best-fitting hypothesis in real time
- equilibrium indeterminacy is central for quantitative performance
- similar findings in medium-scale DSGE model

Extra Slides

simple model: households

$$\max_{\{C_t, b_t\}} \sum_{t=0}^{\infty} \Theta_t \left[\log C_t - \chi h_t\right]$$

$$s.t. \quad C_t + b_t = \frac{W_t}{P_t} h_t + \frac{R_{t-1}}{\Pi_t} b_{t-1} + \Phi_t + T_t$$

- endogenous discounting (Uzawa-Epstein): $\Theta_0 = 1$ and $\Theta_{t+1} = \hat{\beta}\left(\tilde{C}_t\right)\Theta_t \forall t \geq 0$
- $\hat{\beta}(\tilde{C}) = \delta_t \beta \tilde{C}_t,$ where $0 < \beta < 1 \rightarrow$ analytical results
- $\tilde{C}_t$ is average consumption that the household takes as given
- $\delta_t > 0$ are exogenous shocks to the discount factor

$$1 = \delta_t \beta \tilde{C}_t \left[\frac{C_t}{C_{t+1}} \frac{R_t}{\Pi_{t+1}}\right] \tag{4}$$

- interpretation and microfoundation: Michaillat & Saez (2019), Ono & Yamada (2018), Del Negro, Eggertsson, Ferrero & Kiyotaki (2017), Fischer(2015), Schmitt-Grohe and Uribe (2003).

simple model: producers

- continuum of intermediate goods $Y_t(j)$, $\quad j \in [0,1]$

$$\max_{P_t(j)} \Phi_t(j) = (1+\tau) P_t(j)\, Y_t(j) - W_t h_t(j),$$
$$s.t.\, Y_t(j) = h_t(j),\; Y_t(j) = f(P_t(j)/P_t,\, Y_t)$$

- labor services $h_t(j)$ bought from competitive labor market at nominal price W_t
- Bhattarai, Eggertsson, Gafarov (2019): fraction α_p of firms can adjust prices, $(1-\alpha_p)$ indexation: $\frac{p_t^n}{P_t} = \Gamma_t \, \frac{P_{t-1}}{P_t}$
- final-good producing firms: $Y_t = \left(\int_0^1 Y_t(j)^{1-v} dj \right)^{\frac{1}{1-v}}$, $v = 1/2 \rightarrow$ linear Phillips curve

$$\Pi_t = \kappa Y_t + (1-\kappa \bar{Y}), \quad \kappa \equiv \frac{\alpha_p}{1-\alpha_p} \tag{5}$$

derivation

simple model: government policies

fiscal policy

$$B_t + T_t = R_{t-1} B_{t-1}$$

monetary policy

$$R_t = \max\left\{1, (1 + r_t^*)\Pi^* \left(\frac{\Pi_t}{\Pi^*}\right)^{\phi_\pi}\right\} \tag{6}$$

- natural rate $= (1 + r_t^*) \equiv \frac{1}{\delta_t \beta}$
- inflation target $= \Pi^* = 1$
- $\phi_\pi > 1$

market clearing

$$C_t = Y_t, \quad \text{and} \quad B_t = 0$$

simple model: competitive equilibrium

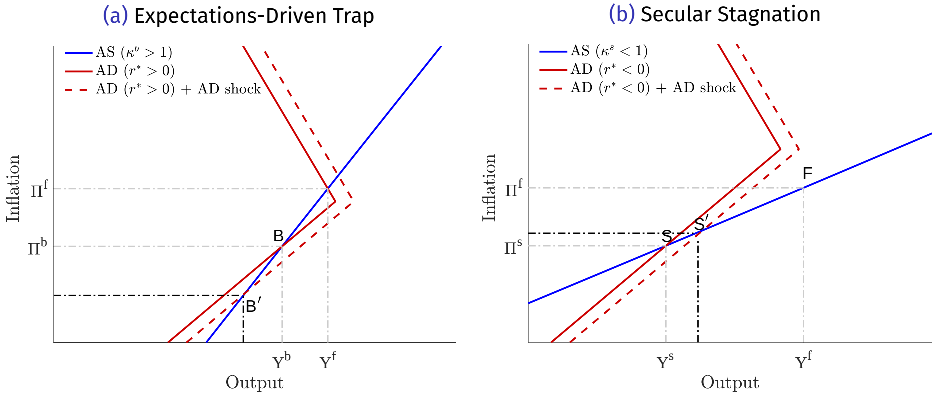
- three endogenous processes $\{Y_t, R_t, \Pi_t\}$ that satisfy :

$$1 = \delta_t \beta Y_t \left[\frac{Y_t}{Y_{t+1}} \frac{R_t}{\Pi_{t+1}} \right]$$
$$\Pi_t = \kappa Y_t + (1 - \kappa)$$
$$R_t = \max \left\{ 1, (1 + r_t^*) \Pi_t^{\phi\pi} \right\}$$

- for a given exogenous $\{\delta_t\}_{t=0}^{\infty}$, $1 + r_t^* = \frac{1}{\delta_t \beta}$ and initial price level P_{-1}
- focus on steady state representation $\rightarrow AD - AS$ diagrams

why does it matter?

Example: exogenous aggregate demand shift (e.g. government policies)



- nature of stagnation matters, hence need to assess likelihood of B vs S
- in the paper: fiscal policy, neofisherian exit, structural reforms Back

policy implications

- challenges in disentangling the source of liquidity trap, especially in real time
- need for developing policies that are robust to the source of recession
- two theoretical proposals in the paper
  - price indexation schemes in the presence of price adjustment frictions
  - minimum wage policies in the presence of downward nominal wage rigidity
- we do not analyze other potential trade-offs from these policies $\rightarrow$ future research

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robust policy

Result 4 (Price Indexation)

Consider an indexation rule where non-optimizing firms index their prices to last period's price level with indexation coefficient: $\Gamma_t = \frac{P_t}{Y_t^{-1}(P_t - \lambda P_{t-1}) + P_{t-1}}$*, then the price Phillips curve is given by:* $\Pi_t = \kappa Y_t + (\lambda - \kappa \bar{Y})$

1. *There does not exist expectations-driven liquidity trap* $\forall\ \lambda > \kappa$*.*
2. *Output and inflation under secular stagnation are increasing in* λ*.*

Intuition:

- λ can be interpreted like an increase in markups show
  - sets a lower bound on deflation to eliminate *expectations-trap* steady state
  - increasing inflation stimulates output under secular stagnation
- other policies that restrict deflation have similar effects (e.g. minimum income)
- structural reforms that increase price flexibility make the economy vulnerable to *expectation-driven traps*

calibrated parameters

calibrated parameters	β discount factor	δ Euler eq. wedge	κ Slope of NKPC
secular stagnation (S)	0.942	0.1132	0.0036
expectations trap (B)	0.942	0.1058	0.0019
	Galí & Gertler (1999)		

moments	natural rate	inflation	output gap
secular stagnation (S)	-1.1	-1.06	-7.6
expectations trap (B)	1.0	-1.06	-4.5

- natural rate:
  - expectations trap: match real rate in data during sample period
  - secular stagnation: Fujiwara et al (2016) , Jórda & Taylor (2019) estimates
- implied output gap for Japan: Haussman and Wieland (2014) $\sim$ 5%

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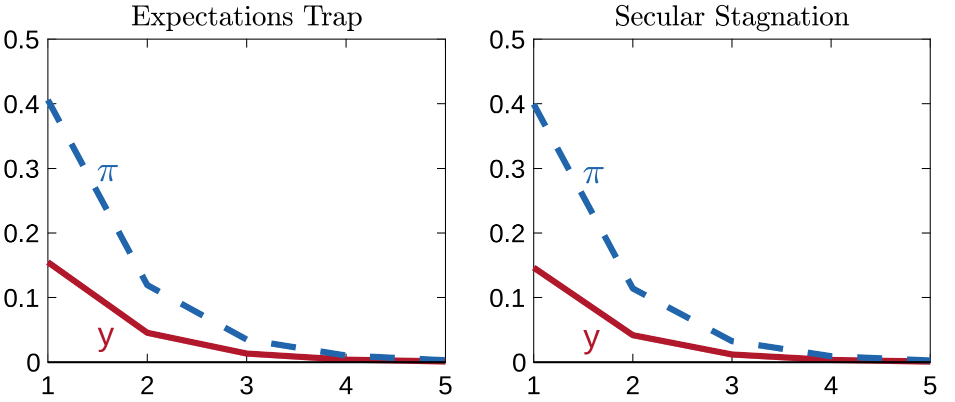
why sunspots matter?

- Consider MSV solution criterion (McCallum, 2003)
- Prediction-pool cannot distinguish between hypothesis of stagnation under MSV



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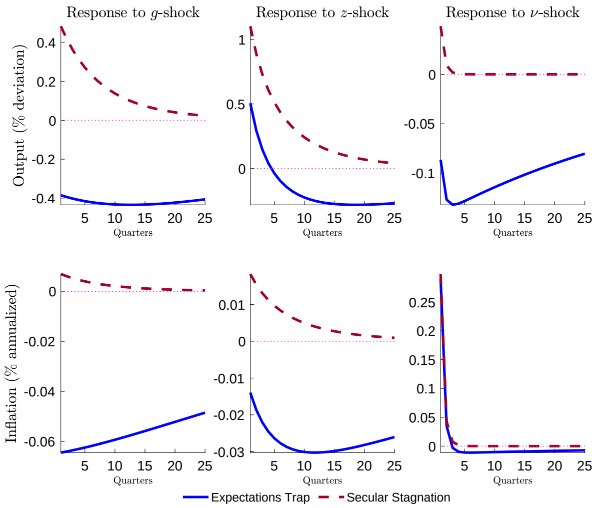
inspecting the mechanism

- equilibrium indeterminacy breaks positive relation between π and y at the ZLB



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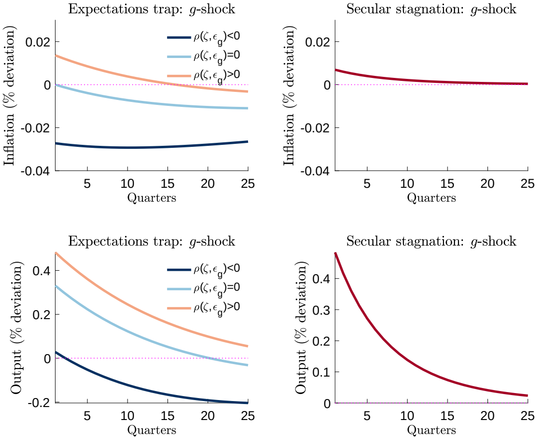
role of indeterminacy

- In an expectations trap $\zeta_t = \hat{\pi}_t - \mathbb{E}_{t-1}\hat{\pi}_t$ not unique
- Use likelihood to pin down correlation of ζ with fundamental innovations



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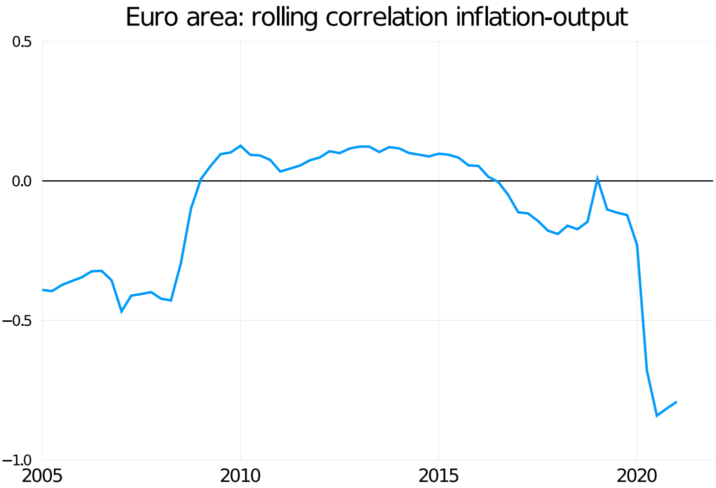
euro area: correlation $\pi, \Delta y$

- 10-year rolling correlation of GDP deflator inflation and GDP growth



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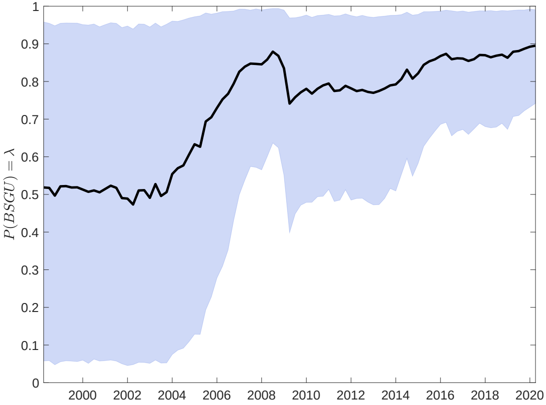
which correlation matters?

$$corr(\zeta, g) = 0$$



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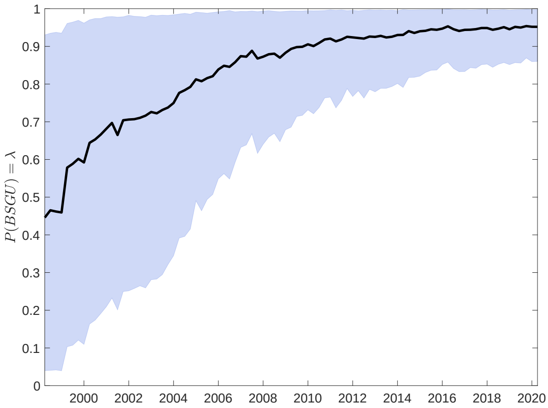
which correlation matters?

$$corr(\zeta, z) = 0$$



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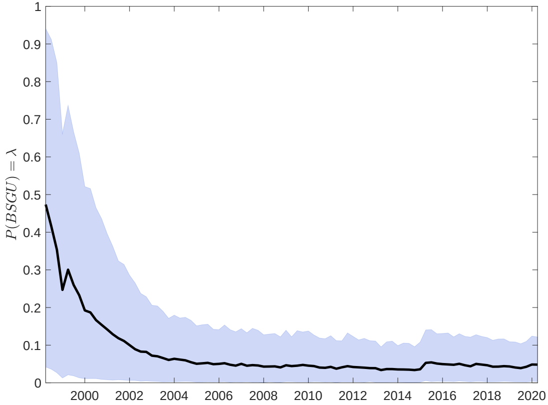
which correlation matters?

$$corr(\zeta, v) = 0$$



- $\rho(\zeta, v) > 0$, induce $\rho(\pi, y) < 0$, consistent with Wieland (2019)

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