Why Has the U.S. Economy Stagnated Since the Great Recession?

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Workshop on Nonlinear Models at the Norges Bank
January 26, 2018

The Great Recession and its Recovery

Impact of the Great Recession on U.S. economy

- Level shift vs Transitory effect (vs Slower trend growth) ?

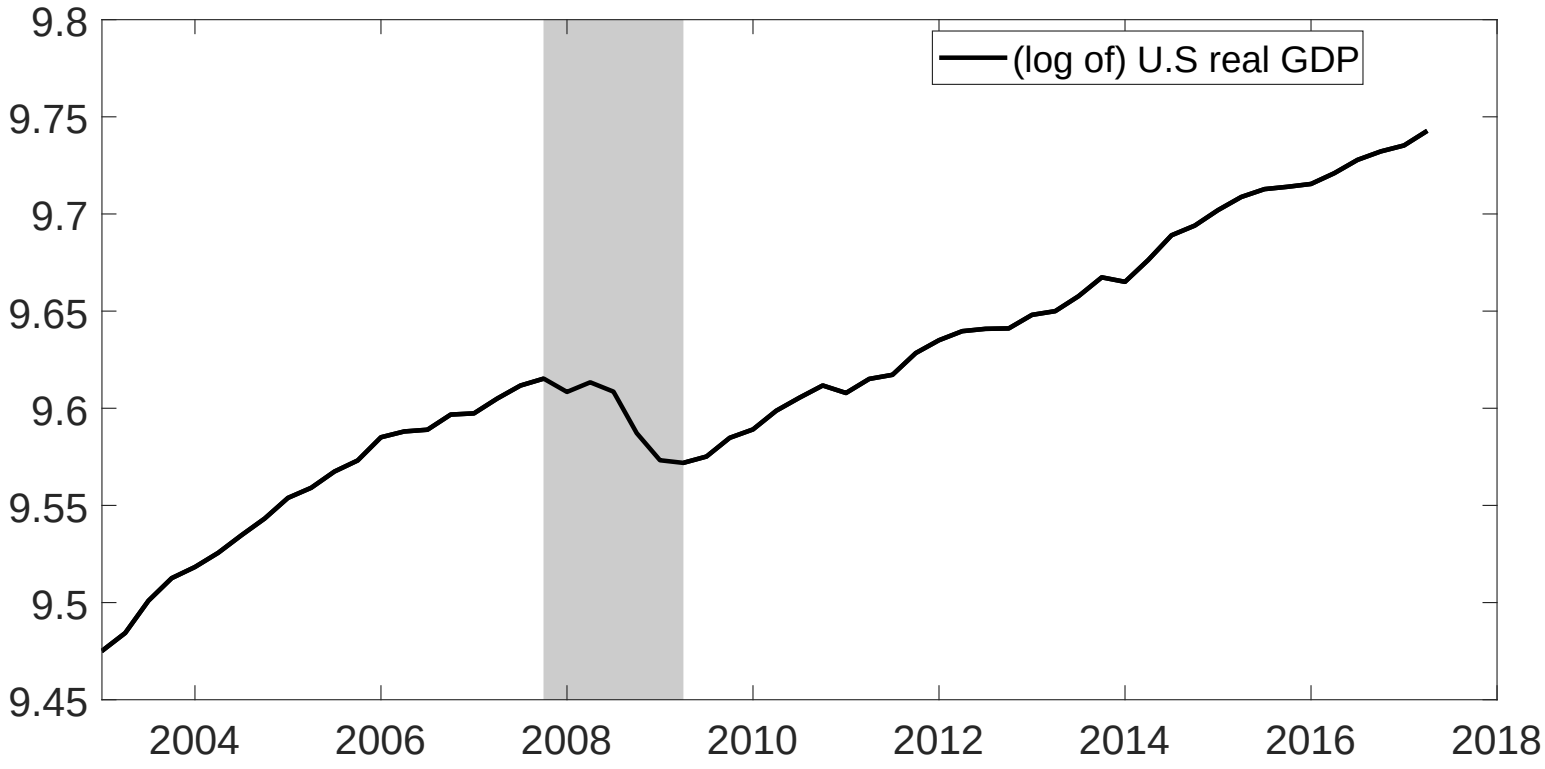


Illustration of L-shaped vs U-shaped Recessions

- L-shape: Permanent recession effect (i.e. Level effect, Hamilton (1989) model)
- U-shape: Bounce-back effect following recession *exactly* cancels out the contractionary effect (i.e. Transitory effect)

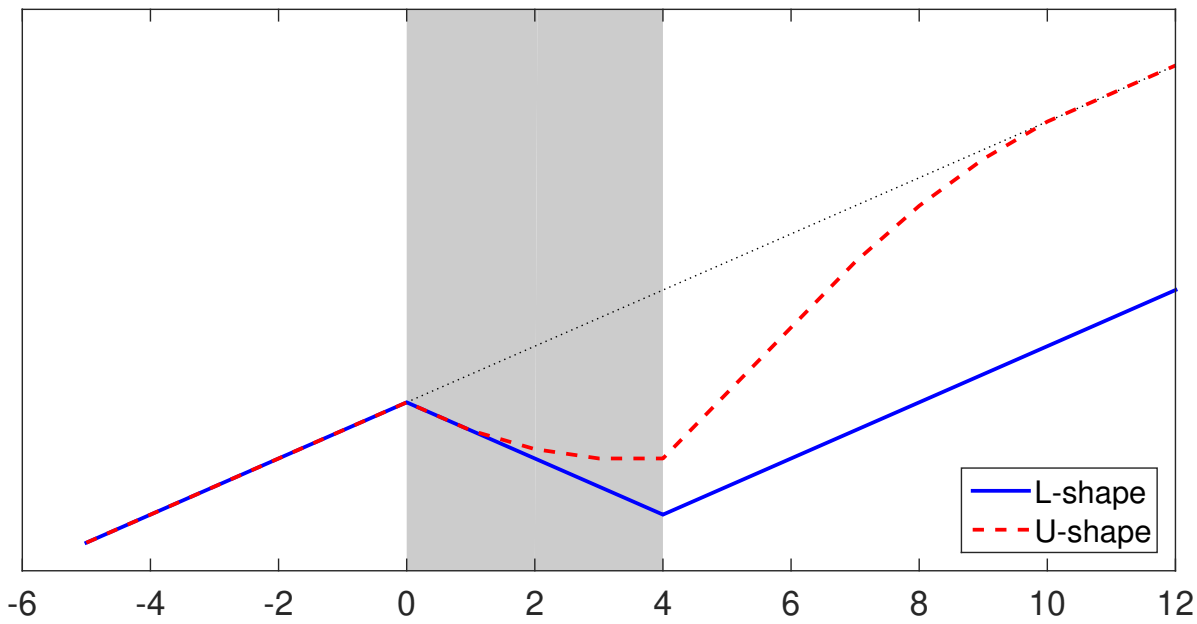
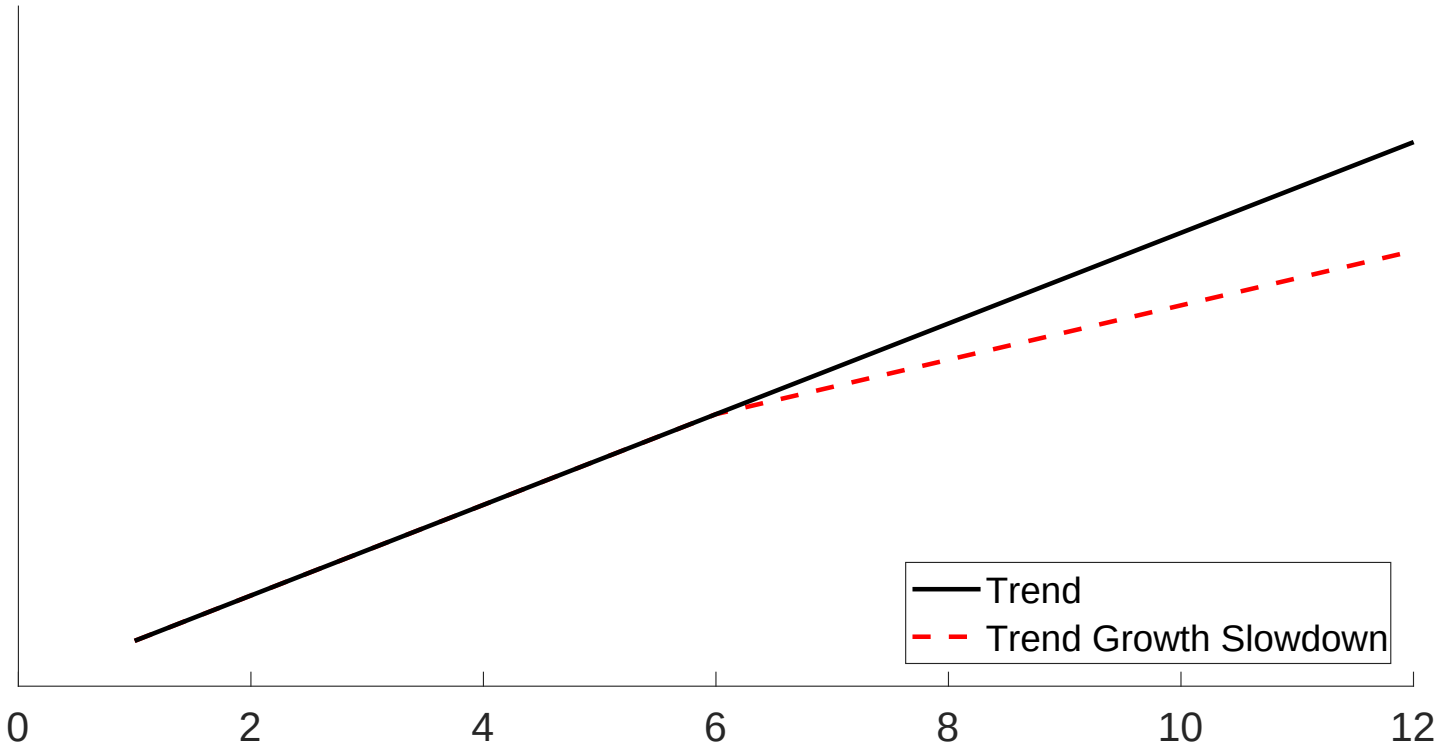


Illustration of Slower Trend Growth

Similar to the idea of Fernald, Hall, Stock, and Watson (2017)



What We Do

- Characterize the Great Recession and its Recovery
  - (i) Permanent recession effect: L-shape (level shift)
    or
  - (ii) Large and persistent negative output gap: U-shape (transitory effect)
    or
  - (iii) Structural Break in trend growth (slope change)
    or
  - combination of (i), (ii), (iii)
- Develop a new Markov-switching model that allows a given recession and its recovery to be either L-shaped or U-shaped

Literature

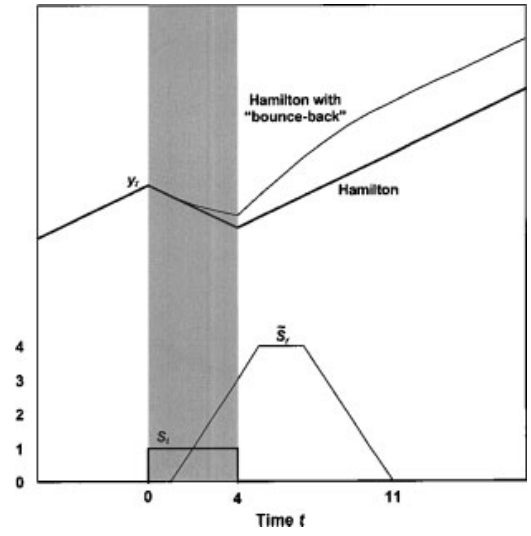
- Empirical Findings
  - Secular stagnation: Summers (2014, 2015), Eggertsson, Mehrotra, and Summers (2016), and many others.
  - Output Trend reduction in 2006: Luo and Startz (2014), Fernald, Hall, Stock, and Watson (2017), Kamber, Morley and Wong (2017)
  - Different shapes of recessions: Eo and Kim (2015)
- Methodology
  - Bounce-back effect: Kim, Morley, Piger (2005)
  - L-U shapes: Huang, Luo and Startz (2016)

Main Findings

The Great Recession and its recovery can be characterized as (maybe surprisingly)

- Lower level and growth of output were driven by a reduction in trend growth that began in 2006:Q1 (prior to the Great Recession, 2007:Q4-2009:Q2)
- Unrelated to the Great Recession
- U-shaped Recession (large, persistent negative output gap)
- Fully recovered by 2014

Model: Bounce-back Effect



- S_t is a latent Markov-switching state variable

$$\Delta y_t = \mu_0 + \mu_1 \mathbf{1}(S_t = 1) + \underbrace{\lambda \sum_{k=1}^{m} \mathbf{1}(S_{t-k} = 1)}_{\text{bounce-back effect}} + e_t$$

- $\mu_0 > 0$ and $\mu_1 < 0$, $\tilde{S}_t = \sum_{k=1}^{6} \mathbf{1}(S_{t-k} = 1)$
- if the economy in time t is in the recession, following m periods (t+1, t+2, ..., t+m) are subject to the bounce-back effect λ

A New Markov-Switching Model

Use a parsimonious Three state Markov-switching model that allows a given recession and its recovery to be either L-shaped or U-shaped

$$
\begin{aligned}
\Delta y_t &= \mu_0 + \delta \mathbf{1}(t > T_b) && \text{(expansion regime)} \\
&+ \mu_L \mathbf{1}(S_t = L) + \lambda_L \sum_{k=1}^{m} \mathbf{1}(S_{t-k} = L) && \text{(L-shaped contraction)} \\
&+ \mu_U \mathbf{1}(S_t = U) + \underbrace{\lambda_U \sum_{k=1}^{m} \mathbf{1}(S_{t-k} = U)}_{\text{bounce-back effect}} && \text{(U-shaped contraction)} \\
&+ e_t,
\end{aligned}
$$

- We impose TWO restrictions to identify two different shapes of recessions

Two Restrictions for the Three State Markov-Switching Model

- **R1**. U-shaped Recession: the bounce-back effect $m \cdot \lambda_U$ exactly cancels out the contractionary effect μ_U in level

$$\mu_U + m \cdot \lambda_U = 0$$

  and no restriction on λ_L for L-shaped recession (but expect that $\mu_L + m \cdot \lambda_L < 0$)
- **R2.** Does not switch between L-shaped and U-shaped regimes without going through an expansionary regime first

$$Pr[S_t = U | S_{t-1} = L] = 0$$

$$Pr[S_t = L | S_{t-1} = U] = 0$$

the regime transition matrix is given by

$$\Pi = \begin{bmatrix} 1 - p_{0L} - q_{0U} & 1 - p_{LL} & 1 - p_{UU} \\ p_{0L} & p_{LL} & 0 \\ p_{0U} & 0 & p_{UU} \end{bmatrix}. \tag{1}$$

Estimation

- Postwar (quarterly) U.S. real GDP growth: $100 \cdot \ln(Y_t/Y_{t-1})$
- Sample period: 1947:Q2 to 2017:Q2
- Benchmark: trend growth break in 2006:Q1 by MLE (e.g. Fernald, Hall, Stock, and Watson, 2017)
- The length of the post-recession bounce-back is set to $m = 6$ (e.g. Kim, Morley, Piger, 2005)
- Hamilton filer: keeping track of 3^{m+1} states (2187 for m=6)
- Maximum likelihood estimation

Benchmark Model: Parameter Estimates

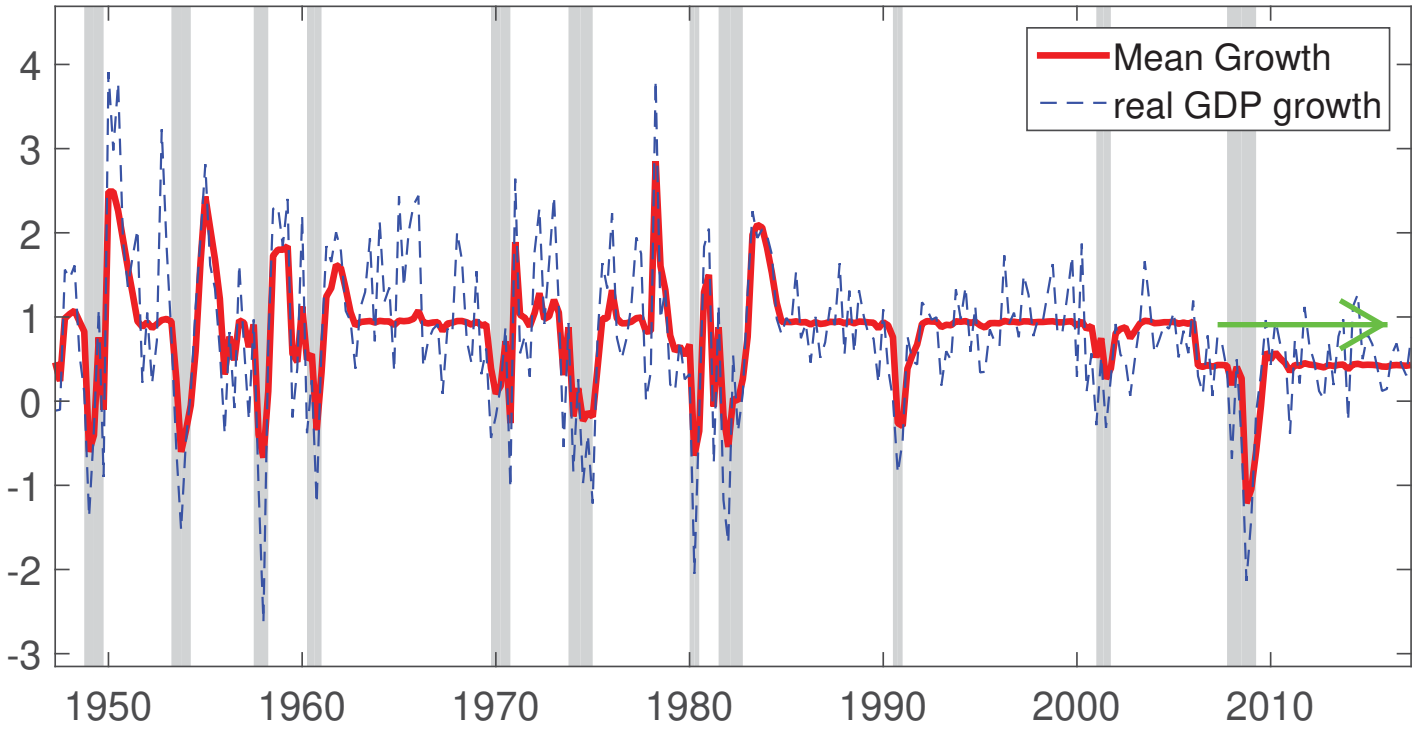
Benchmark: Trend growth break in 2006:Q1

- $\hat{\lambda}_L \approx 0$: near strict L-shape (i.e. Hamilton model)
- trend growth slowdown $\hat{\delta} = -0.52 \Rightarrow$ long-run growth $0.44 = \hat{\mu}_0 + \hat{\delta}$ (e.g. FOMC 2017 Dec. projection: $0.45 = 1.8/4$)
- $p_{00} = 1 - p_{0L} - p_{0U} > p_{LL}$ or p_{UU}: expansion regime is more persistent

Parameter	Estimate	S.E.
p_{0L}	0.0285	(0.0224)
p_{0U}	0.0334	(0.0174)
p_{LL}	0.7354	(0.1289)
p_{UU}	0.8020	(0.0851)
σ^2	0.4370	(0.0500)
μ_0	0.9570	(0.0755)
μ_L	-1.1038	(0.4219)
λ_L	-0.0170	(0.0948)
μ_U	-1.9554	(0.1864)
δ	-0.5197	(0.1361)
log-lik	-342.47	

Benchmark Model: Time-Varying Mean

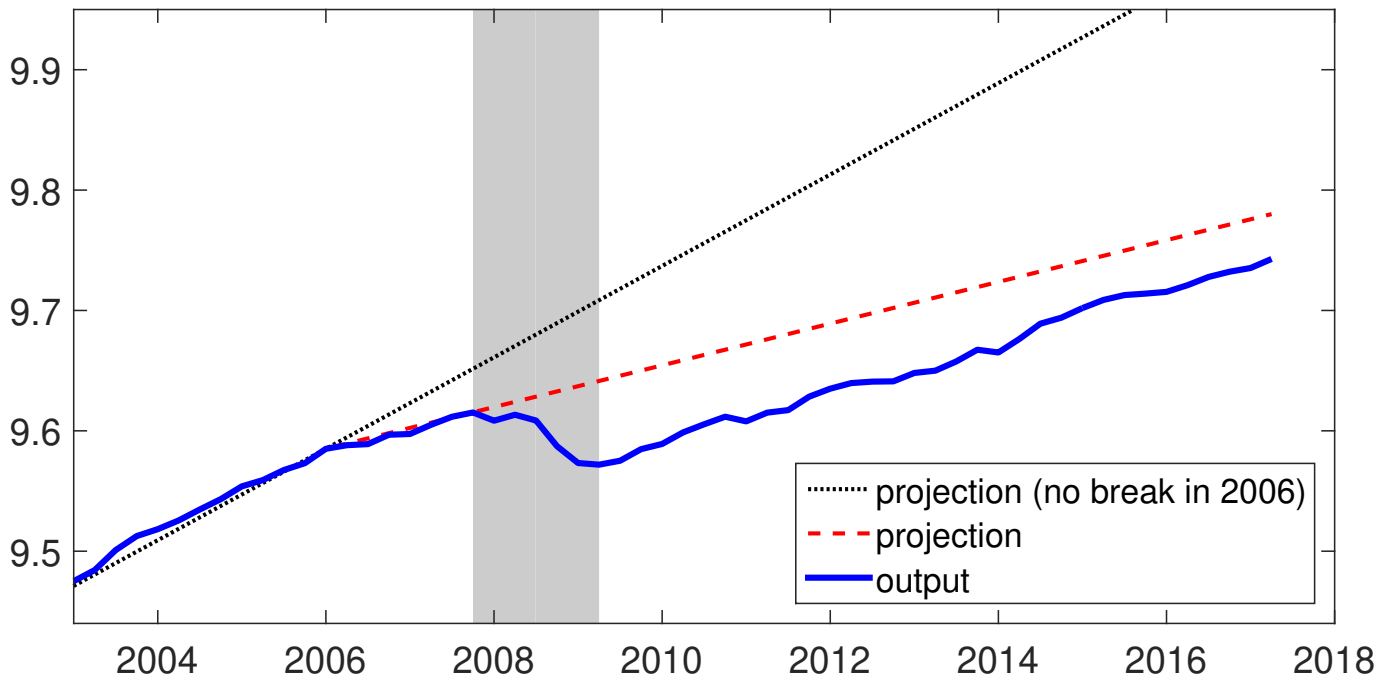
- Time-varying mean: $E[\bar{\mu}_t | I_t]$ where $\bar{\mu}_t = \Delta y_t - e_t$



Note: The shaded areas denote NBER recession dates.

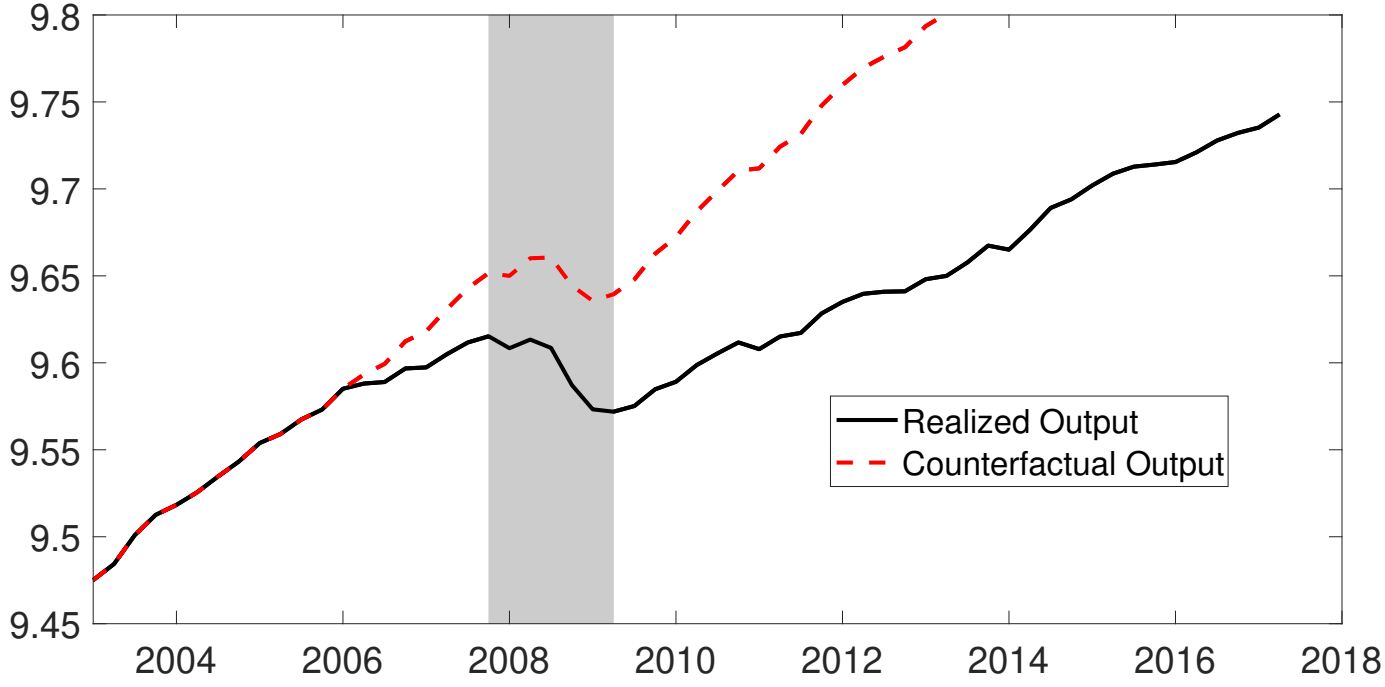
Projected Trends in 2006:Q1 and Realized Output

- Projection without the break using the pre-break expansionary mean growth rate of $\hat{\mu}_0 = 0.96$ diverges markedly with realized output even before the Great Recession
- Projection with the break strongly supports the idea that the trend growth reduction began in 2006 prior to the Great Recession



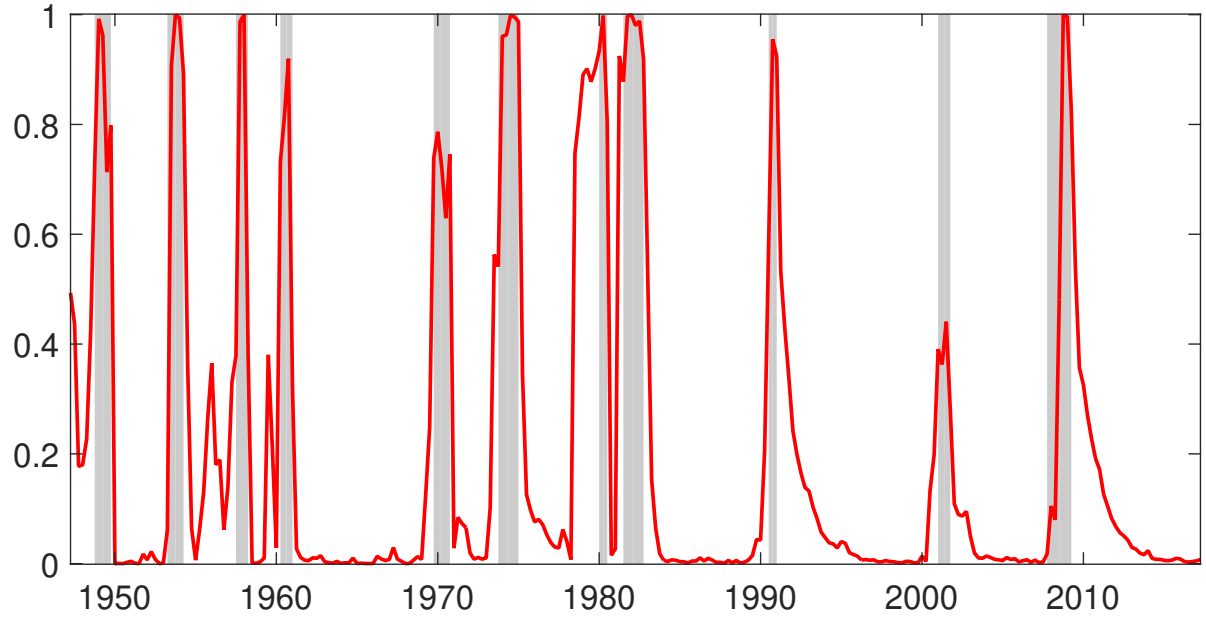
Counterfactual Output and Realized Output

- What if there was no trend slowdown in 2006?



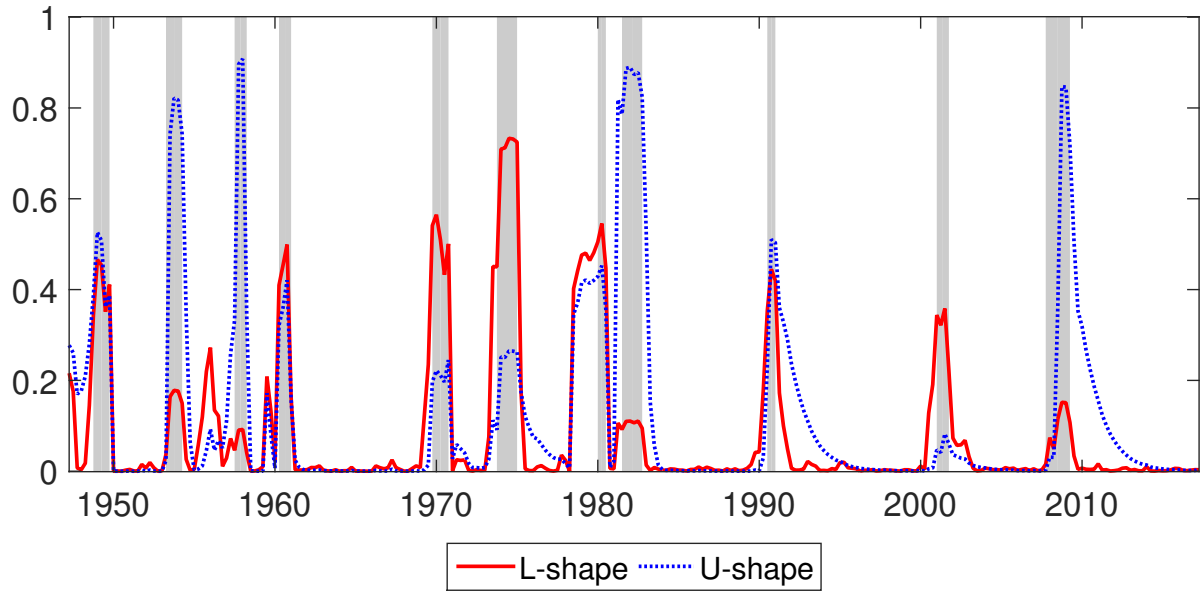
Probability of the Contractionary Regime

$$E[S_t = contraction|I_T] = E[S_t = L|I_T] + E[S_t = U|I_T]$$



Smoothed Probabilities of L-shaped and U-shaped Recession Regimes

- U-shape: the 1953-54, 1957-58, 1981-82, and 2007-09 recessions
- L-shape: the 1969-70, 1973-75, and 2001 recessions

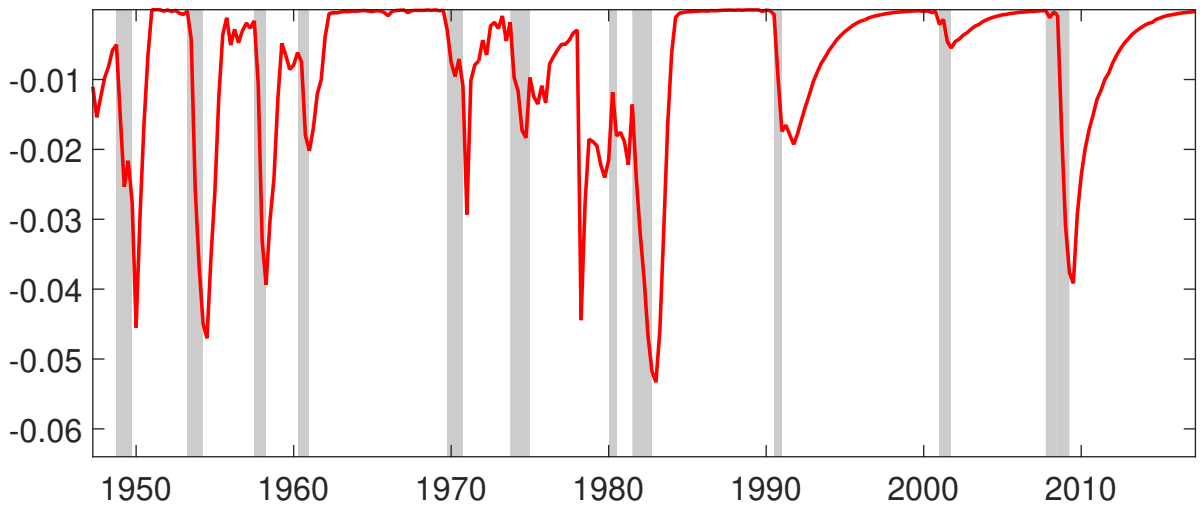


Estimated Output Gap

Beveridge-Nelson decomposition (Regime-switching version, Morley and Piger, 2008)

$$\begin{aligned} c_t &= y_t - \tau_t^{BN} \\ \hat{\tau}_t^{BN} &= \lim_{h \to \infty} \left\{ E^M \left[y_{t+h} | I_t \right] - h \cdot E^M \left[\Delta y_t \right] \right\}, \end{aligned}$$

where τ_t^{BN} is the long-horizon conditional forecast of the level of output minus any deterministic drift.



Output Growth Reduction in 2006?

Formally detect break dates: 1973 or 2006 or possibly any other dates

- Use Qu and Perron (2007) structural break test: unconditional mean and error variance jointly
- Calculate the long-run growth rate
- Estimate trend and the output gap
- Forecast inflation with the output gap estimates using a reduced form Phillips curve

Structural Break Tests for Output Growth

- Qu and Perron test finds two breaks: 1984:Q2 and 2006:Q1
- Related to the Great Moderation and our Markov-switching model, a larger variance before 1984:Q2 could potentially be related to a more frequent realization of recessions before the mid-1980s.
- 8 recessions for 37 years (1947-1984) vs 3 recessions for 33 years (1985-2017)

# of breaks	Estimated Break Dates	LR Test Stat	Critical Value (5%)
1	1984:Q2	66.19	12.09
2	1984:Q2, 2006:Q1	**22.82**	**13.39**
3	1960:Q4, 1984:Q2, 2006:Q1	9.14	14.28

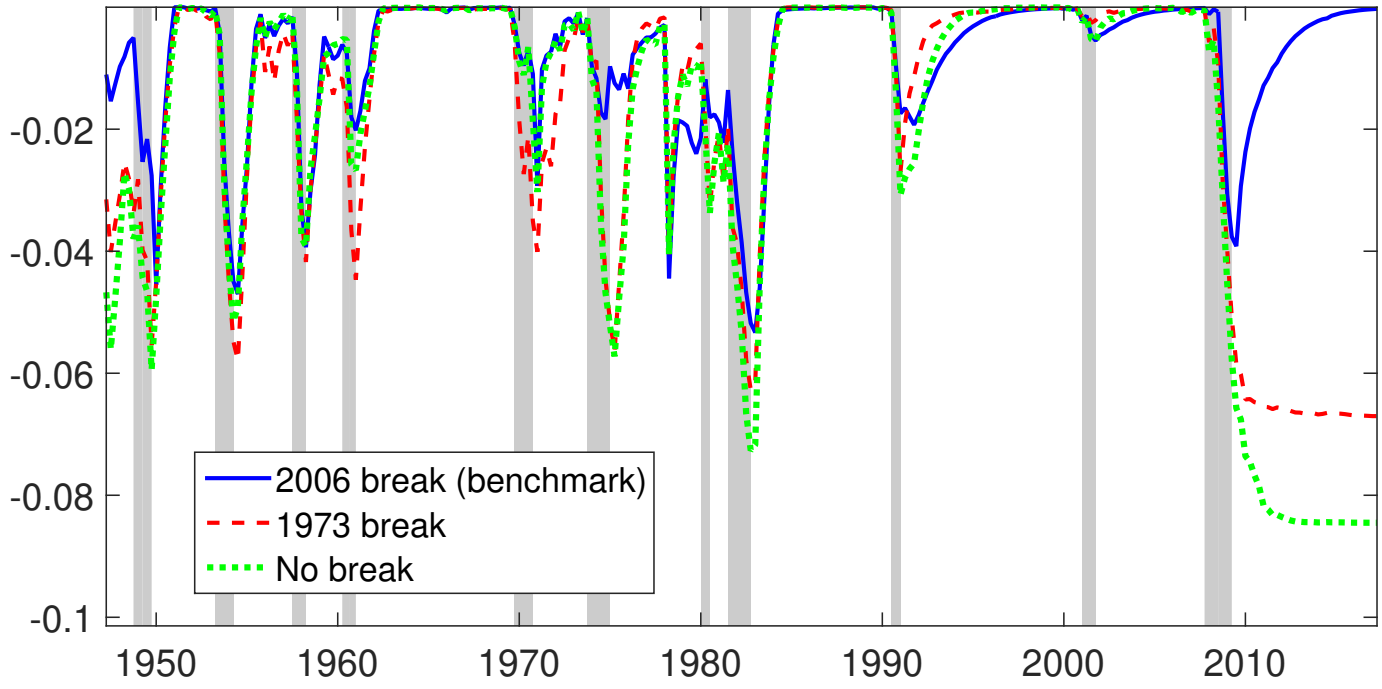
Structural Break Test Estimation

Estimates for Mean and Standard Deviation of Output Growth Allowing for Structural Breaks

Regime	Estimated Break Date	Mean	Std. Dev.	Confidence Set for Break Date
		(a) Unrestricted Model		
1		0.89	1.16	
2	1984:Q2	0.80	0.49	[1982:Q1,1987:Q1]
3	2006:Q1	0.35	0.62	[1994:Q4,2006:Q4]
		(b) Restricted Model		
1		0.82	1.17	
2	1984:Q2	0.82	0.49	[1982:Q1,1987:Q2][1991:Q1]
3	2006:Q1	0.35	0.62	[1994:Q4,2006:Q4]

Note: The restricted model reported in panel (b) allows a change in variance only for the first break.

Estimated Output Gaps for Different Structural Break Dates



Note: the 1973 break and no break models find that the U.S economy remains to be in the L-shaped recession until the end of sample (2017:Q2).

$$\underbrace{\mu_0}_{\text{Expansion before the Great Recession}} > \underbrace{\mu_0 + \mu_L + m \cdot \lambda_L}_{\text{Expansion since the Great Recession}} > \underbrace{\mu_0 + \mu_L}_{\text{L-shaped Recession without bounce-back effect}}$$

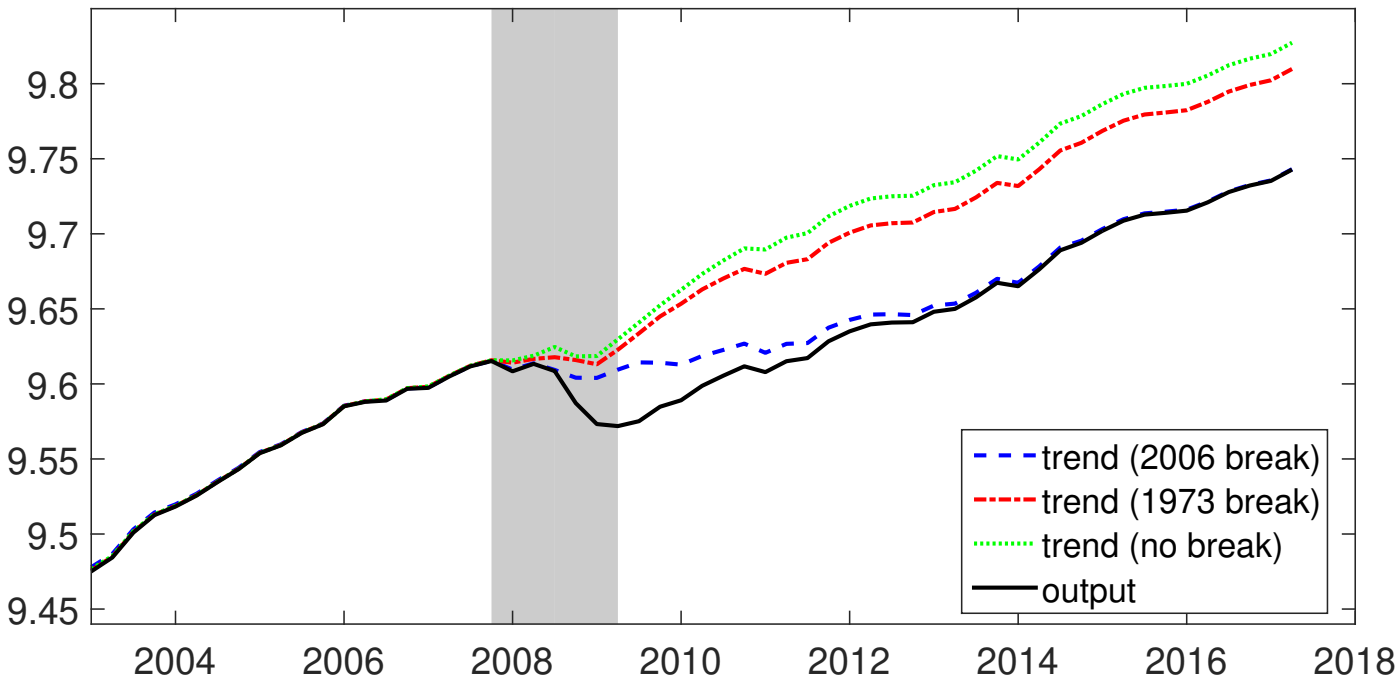
MLE under Alternative Structural Break Dates

$\mu_L + m \cdot \lambda_L \approx -0.2 \sim -0.3$

	1973 Break		No Break	
Parameter	Estimate	S.E.	Estimate	S.E.
p_{0L}	0.0038	(0.0043)	0.0069	(0.0067)
p_{0U}	0.0445	(0.0171)	0.0420	(0.0172)
p_{LL}	0.9906	(0.0150)	0.9896	(0.0141)
p_{UU}	0.6985	(0.1063)	0.6927	(0.1203)
σ^2	0.4744	(0.0468)	0.4931	(0.0487)
μ_0	0.9826	(0.0623)	0.8259	(0.0470)
μ_L	-2.0951	(0.4781)	-2.6951	(0.4634)
λ_L	0.3204	(0.0839)	0.4025	(0.0773)
μ_U	-1.8676	(0.1759)	-1.7743	(0.2291)
δ	-0.2599	(0.0854)		
log-lik	-343.88		-347.78	

Note: Benchmark: log-lik -342.47; LR growth 0.72

Output and Trend for different break dates



Forecasting Inflation: Model

- Specify an autoregressive distributed lag (ADL) forecasting model. (e.g. Clark and McCracken 2006, Stock and Watson 1999, 2009)
- For an h-period-ahead inflation forecast, the ADL model is given by

$$\pi_{t+h} - \pi_t = \alpha + \sum_{j=0}^{p-1} \phi_j \Delta\pi_{t-j} + \kappa \hat{c}_t + \epsilon_{t+h,t}, \tag{2}$$

  where π_t is inflation and $\hat{c}_t$ is the estimated output gap that depends on the structural break specification.
- PCE Headline and Core for the sample period of 1959:Q2 to 2017:Q2 (recovery period)
- $p = 2$ (headline) and $p = 1$ (core) by AIC
- Evaluation sample of 2009:Q3 to 2017:Q2

Forecasting Inflation: Results

	Headline PCE Inflation							
	h=1		h=2		h=3		h=4	
	RRMSE	DM	RRMSE	DM	RRMSE	DM	RRMSE	DM
1973 Break	1.15	0.08	1.30	0.04	1.24	0.09	1.32	0.11
No Break	1.23	0.03	1.47	0.02	1.41	0.04	1.61	0.06
	Core PCE Inflation							
	h=1		h=2		h=3		h=4	
	RRMSE	DM	RRMSE	DM	RRMSE	DM	RRMSE	DM
1973 Break	1.71	0.00	2.14	0.00	2.53	0.01	2.55	0.04
No Break	1.97	0.00	2.60	0.00	3.09	0.01	3.13	0.03

Note: (1) Ratio of RMSE (RRMSE) and (2) Diebold-Mario (DM) test p-values in comparison to the benchmark (2006 break).

Conclusion

- We find that the Great Recession wss U-shaped (i.e. a large, persistent negative output gap) so that it does not explain the stagnation of U.S. real GDP since it ended.
- The low level and growth of output since the Great Recession are due to a secular decline in trend growth that began in 2006, prior to the Great Recession. (slope effect)
- The trend growth reduction is supported by structural break test, the estimates of trend and the output gap, and good forecasting relationship with inflation.
- We propose a new parsimonious but flexible Markov-switching model that allows a given recession and its recovery to be either L-shaped or U-shaped.