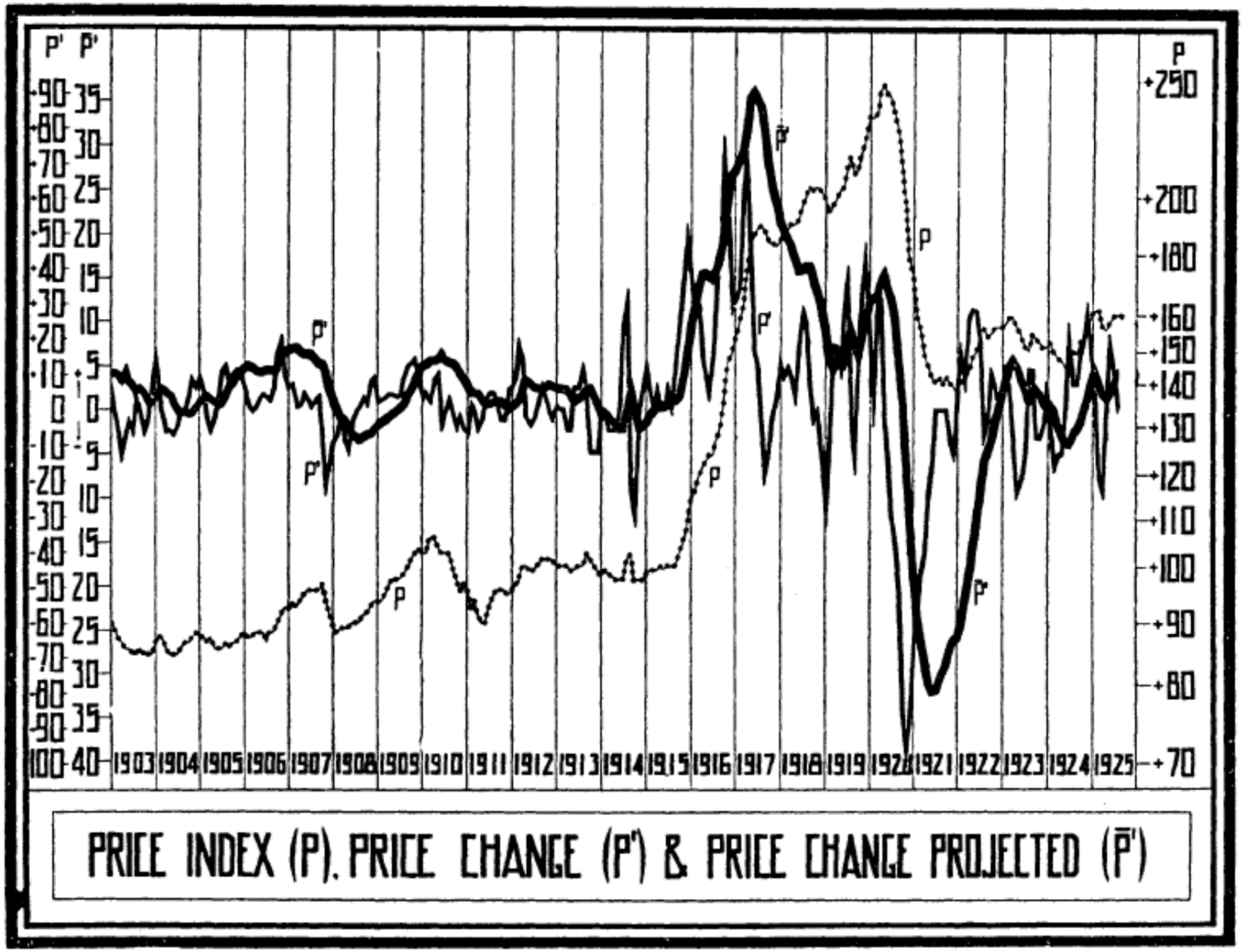
Inflation

A. The Phillips Curve
B. Forecasting inflation
C. Frequency of price changes
D. Microfoundations

A. Phillips Curve

Irving Fisher (1926) found negative correlation 1903-25 between U.S. unemployment and change in overall price level



A.W. Phillips (1958) documented relation between unemployment and rate of change of wages in U.K., 1861-1948

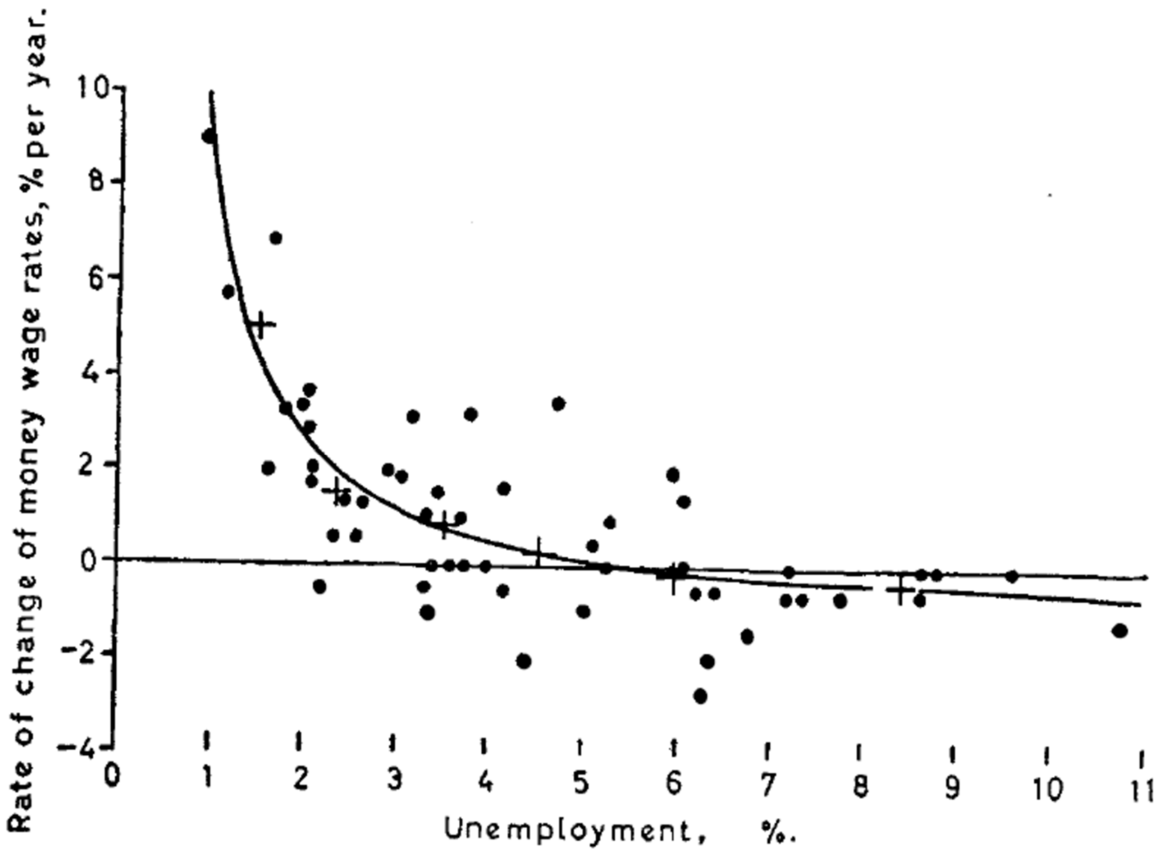


Fig.1. 1861 – 1913

- Early literature sometimes interpreted this as wages rise when there is excess demand and fall with excess supply
- But neoclassical theory does not require excess demand in order for prices to change
- Example: in long-run equilibrium inflation = rate of growth of money with full employment

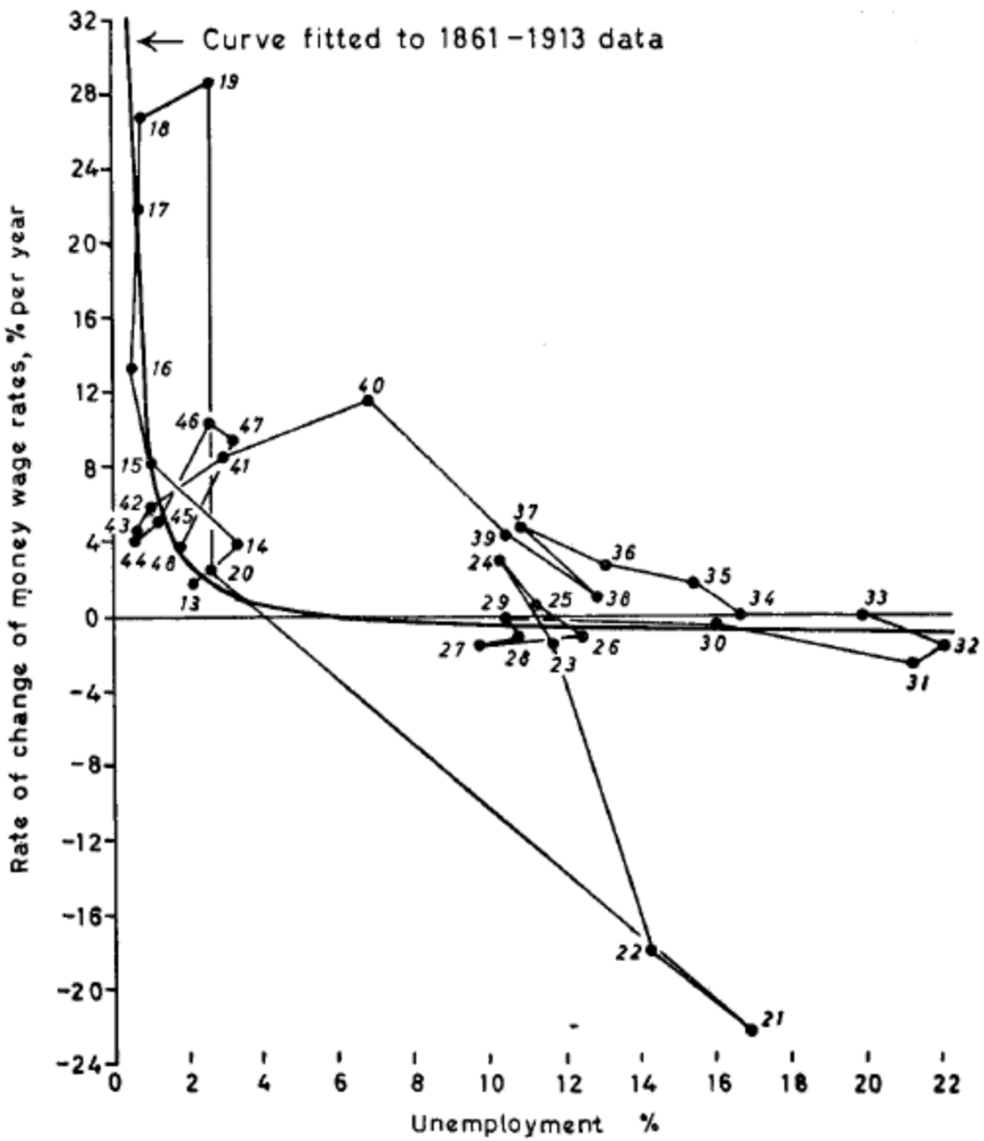
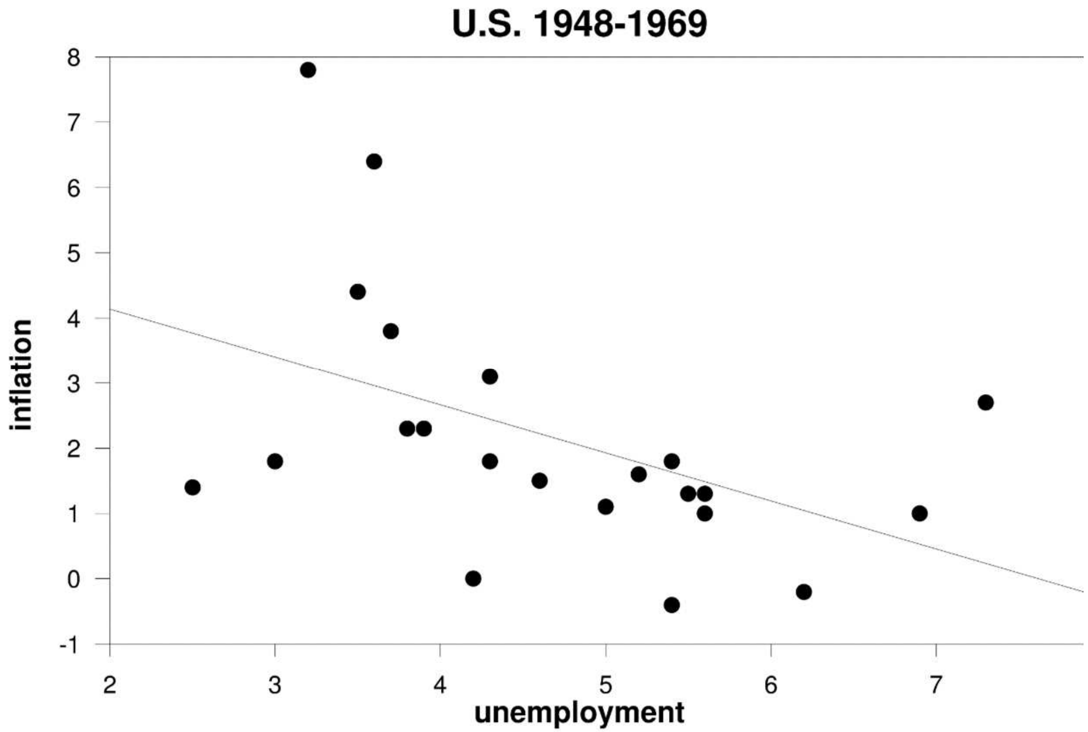
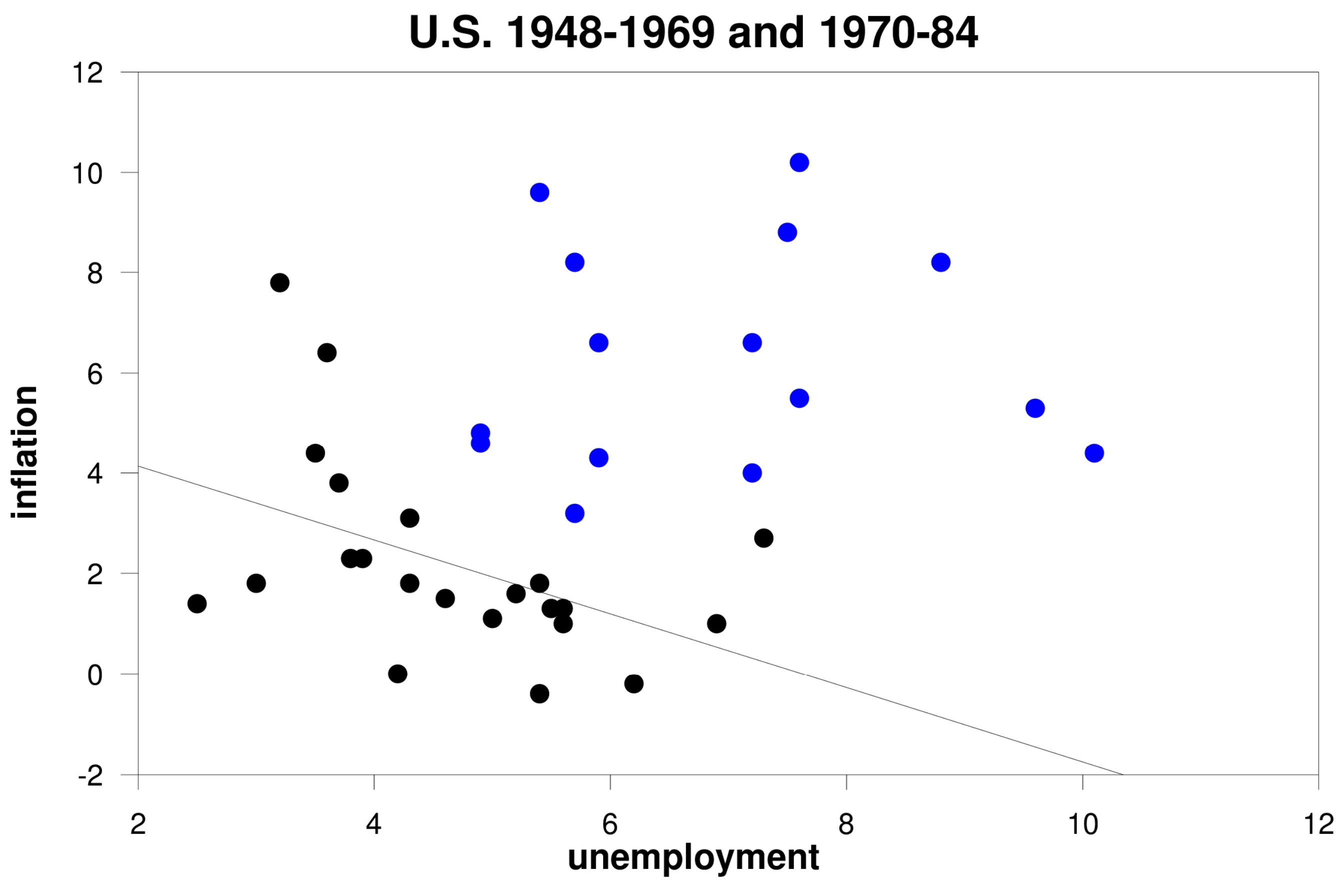


Fig. 9 1913-1948

- There is also a negative correlation over 1948-69 between U.S. unemployment rate and inflation rate (measured by year-over-year % change in PCE deflator)
- Newey-West tstat = -1.9



Correlation seemed to break down in subsequent data



But allowing different intercepts over different subsamples seems to salvage the relationship

Traditional interpretation:

π_t = inflation rate

π_t^* = expected inflation rate

u_t = unemployment rate

u_t^n = natural unemployment rate

$$\pi_t = \pi_t^* + \gamma(u_t - u_t^n)$$

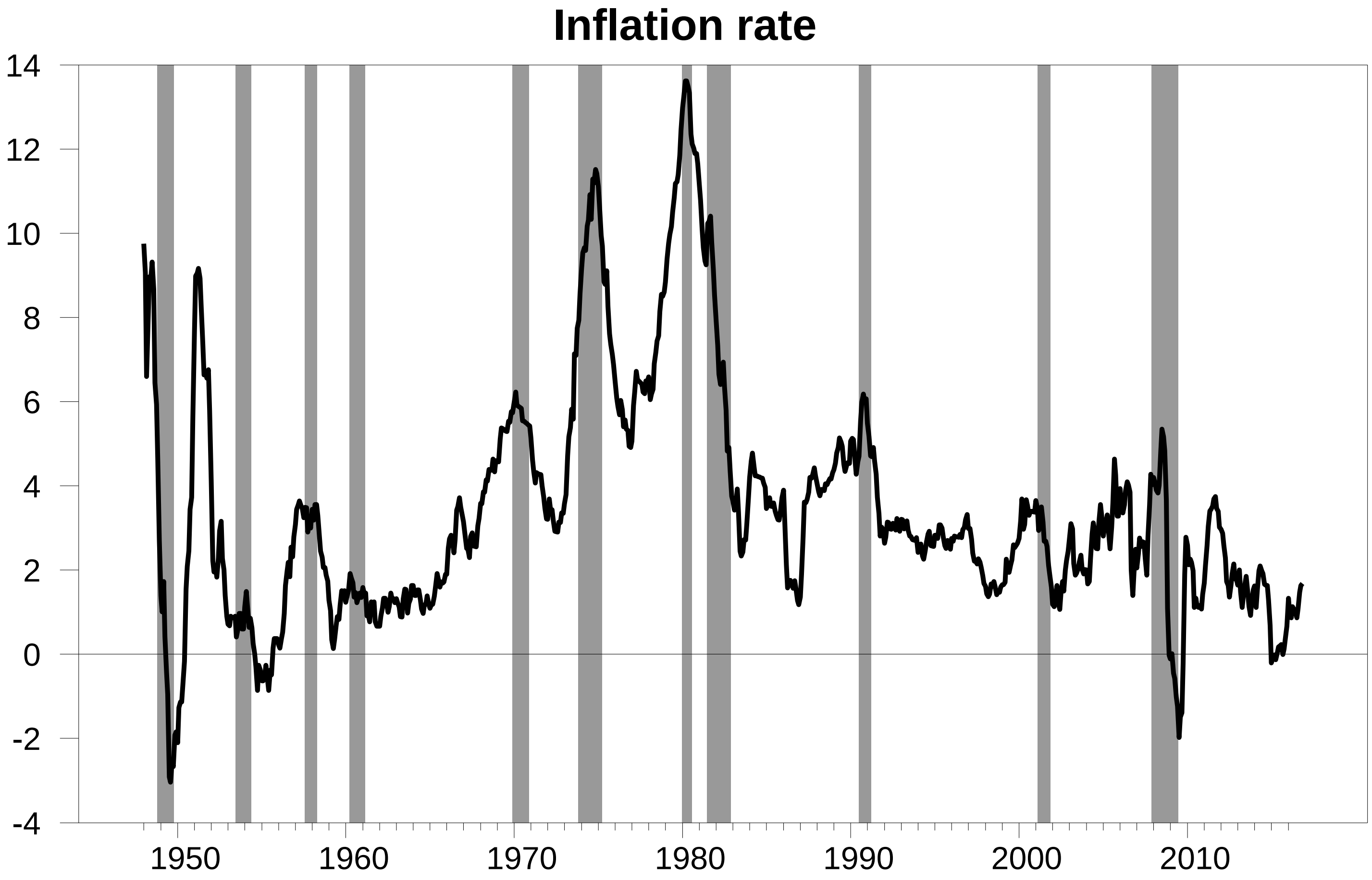
Consistent with long-run equilibrium

$\pi_t = \pi_t^* = \log(M_{t+1}/M_t)$ when $u_t = u_t^n$

$$\pi_t = \pi_t^* + \gamma(u_t - u_t^n)$$

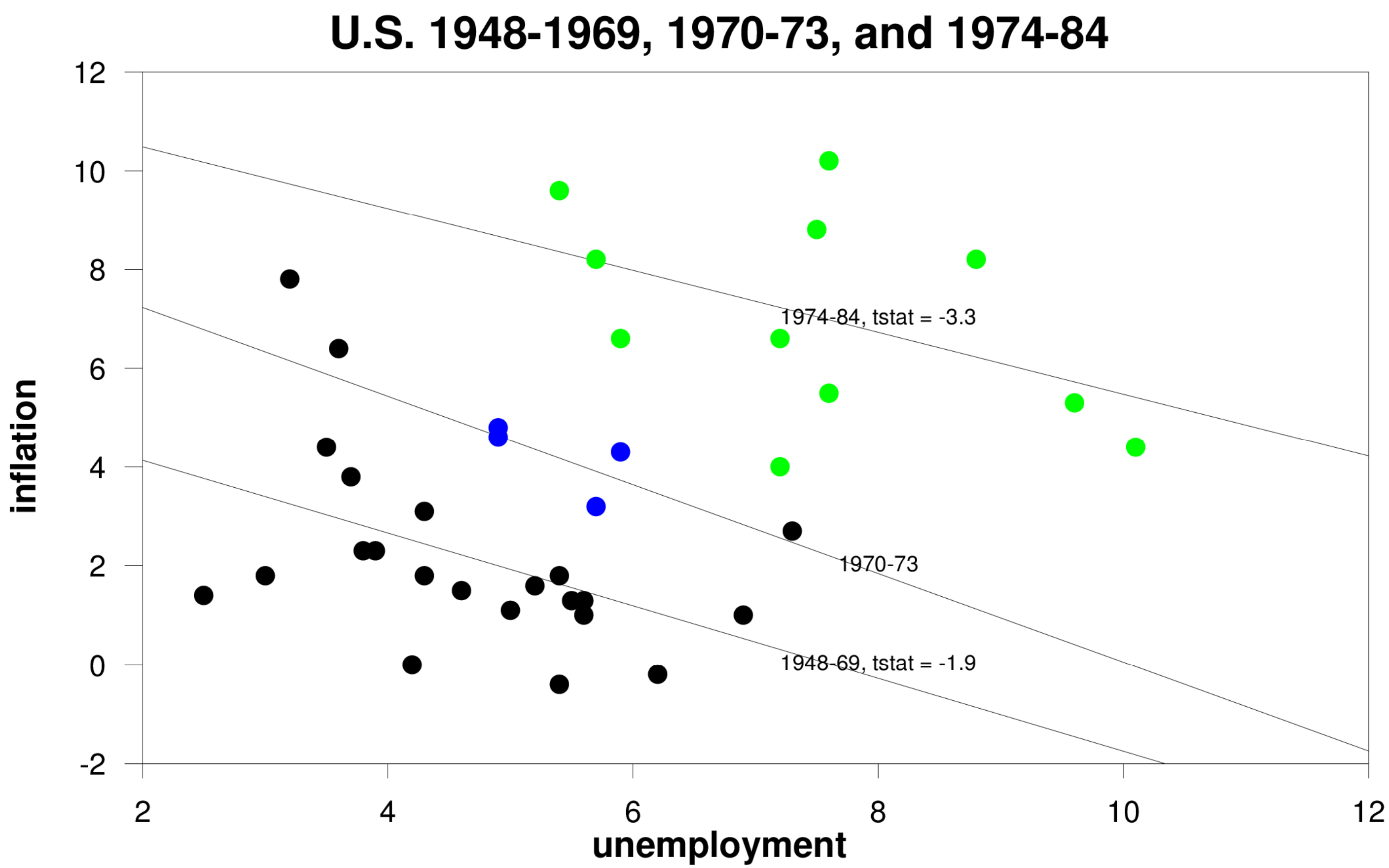
Interpretation:

$\pi_t^* \uparrow$ in response to rising π_t in late 1960s



Percent change in consumer price index from value preceding year, 1948:M1-2016:M11

Rising inflation expectations could account for upward shift in PC



Interpretation based on Calvo sticky prices (example of New Keynesian PC)

A fraction $1-\alpha$ of firms is allowed to set optimal price p_t^* in period t, remaining α keep fixed from $t-1$

$$\log P_t = \alpha \log P_{t-1} + (1-\alpha)\log p_t^*$$

If those setting price were allowed to change price every period, would choose

$$\log \tilde{p}_t^* - \log P_t = \zeta(\log Y_t - \log Y_t^n)$$

Y_t = aggregate real output

Y_t^n = natural level of output

(what Y_t would be if all prices flexible)

ζ = function of elasticity of MC with respect to production (measure of “real rigidities”)

If instead period t price setters realize they will be Calvo frozen in future periods with prob α (and discount future at rate β) then

$$\log p_t^* - \log P_t = (1-\alpha\beta)\zeta(\log Y_t - \log Y_t^n)$$
$$+\alpha\beta E_t(\pi_{t+1} + \log p_{t+1}^* - \log P_{t+1})$$

which turns out to imply

$$\pi_t = \kappa\zeta(\log Y_t - \log Y_t^n) + \beta E_t \pi_{t+1}$$

$\kappa = \frac{(1-\alpha)(1-\alpha\beta)}{\alpha}$ measures “nominal rigidities”

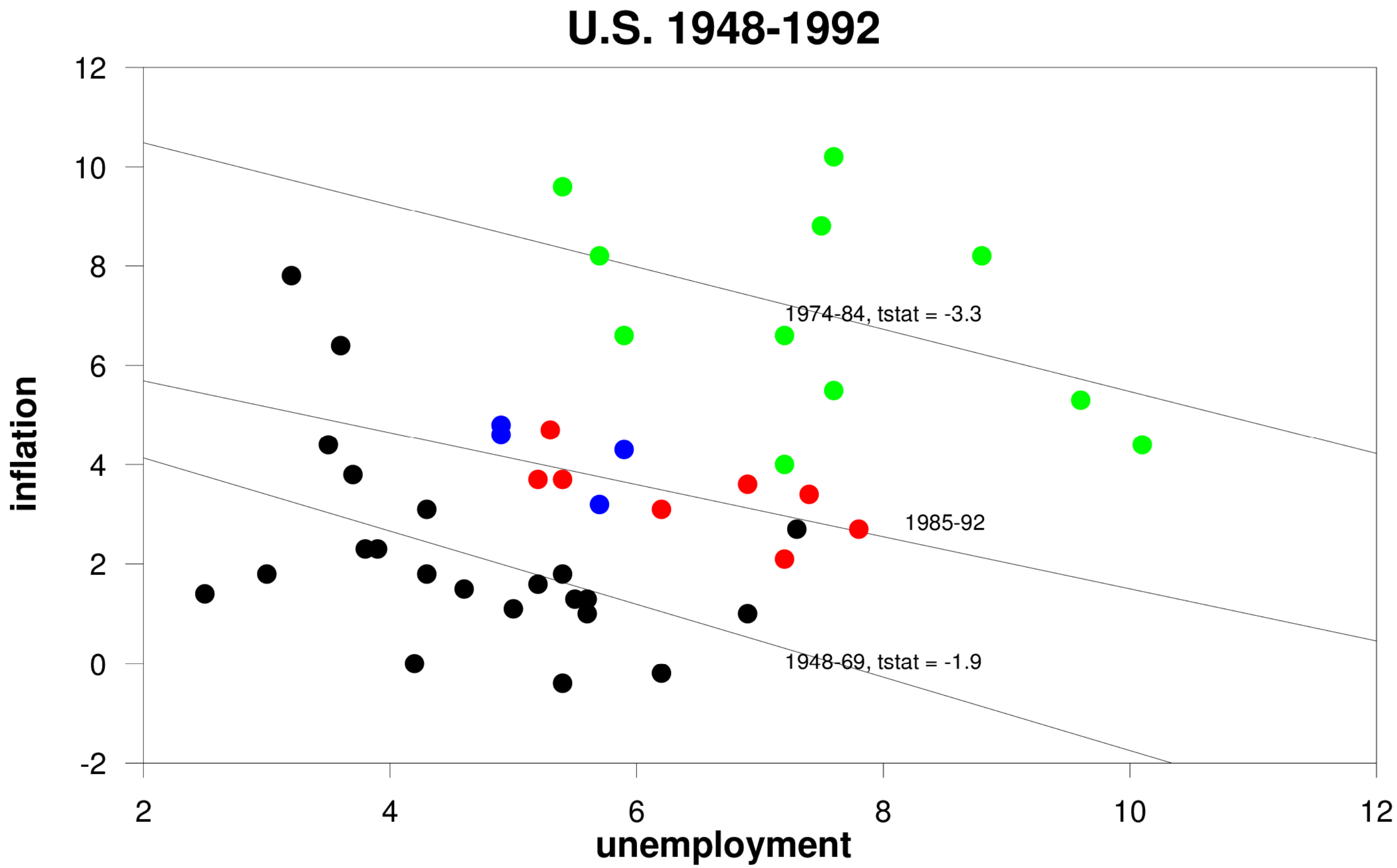
Okun's Law

$$u_t - u_t^n = \theta(\log Y_t - \log Y_t^n)$$

$$\theta \simeq -0.5$$

Phillips Curve refers to broad class of relations between inflation or wage inflation and unemployment or real output.

Lower inflation after 1984 brought expected inflation and Phillips Curve back down



Return to traditional formulation:

$$\pi_t = \pi_t^* + \gamma(u_t - u_t^n)$$

$$\pi_t^* = E_{t-1}\pi_t$$

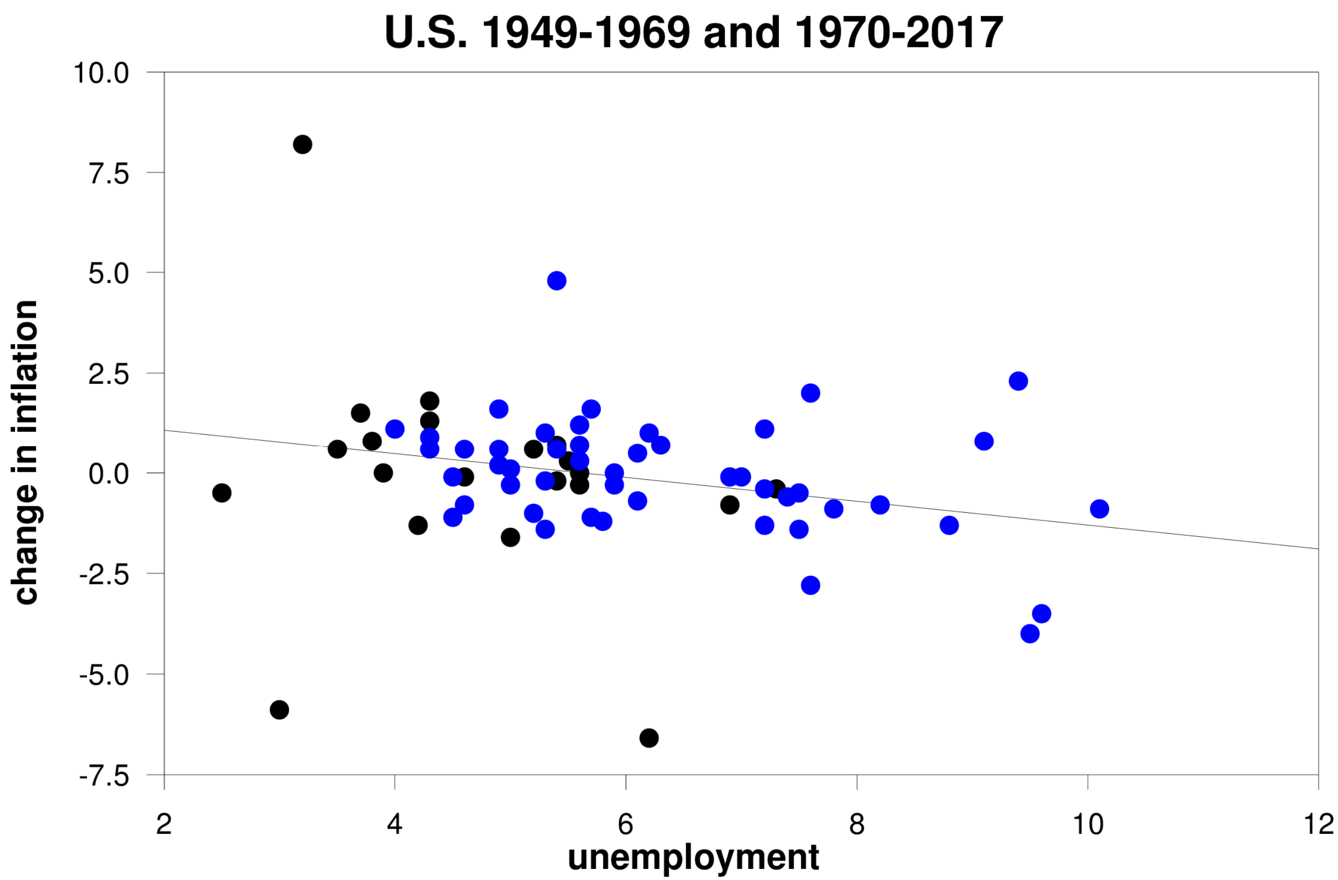
How measure π_t^*?

Suppose $\pi_t^* = \pi_{t-1}$

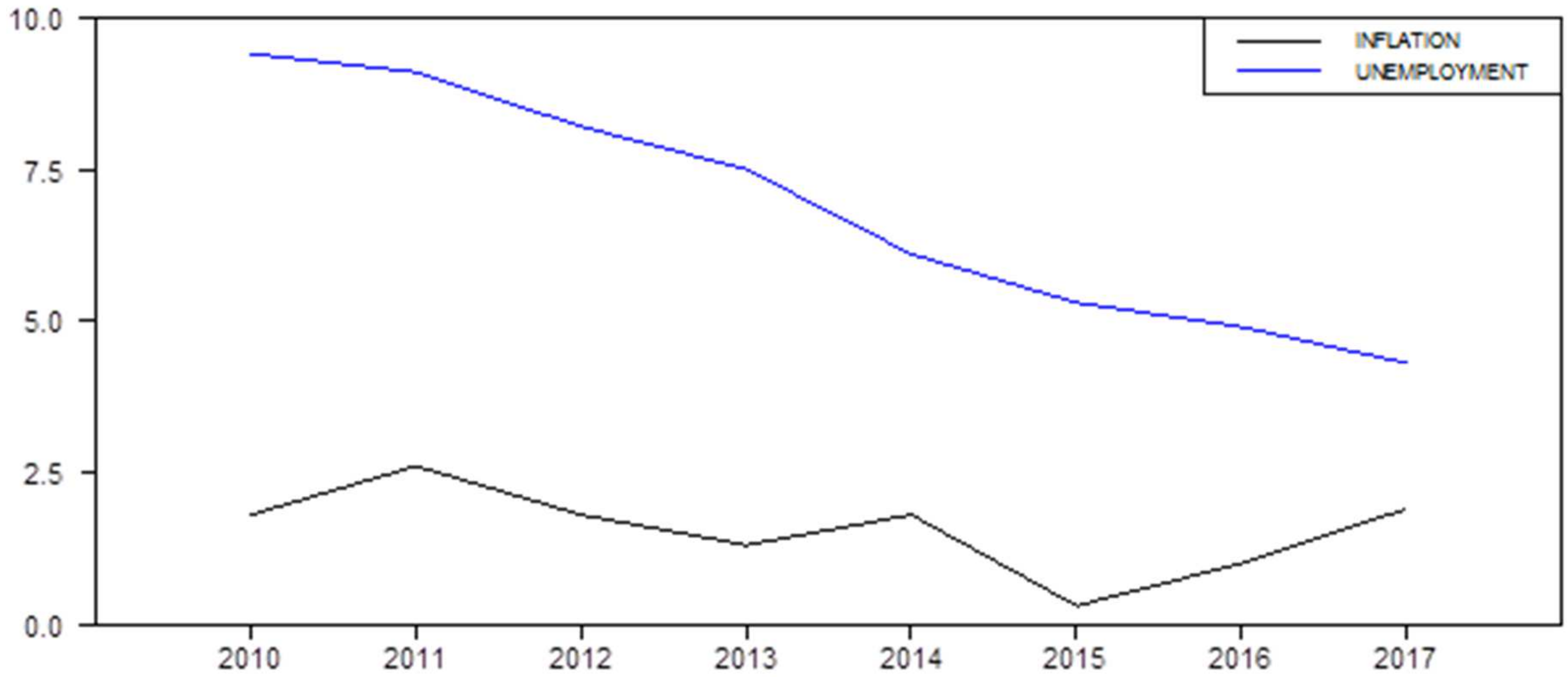
$$\pi_t - \pi_{t-1} = \gamma(u_t - u_t^n)$$

Plot change in inflation, not level of inflation, on vertical axis.

Phillips Curve as relation between unemployment and change in inflation (tstat = -2.4)



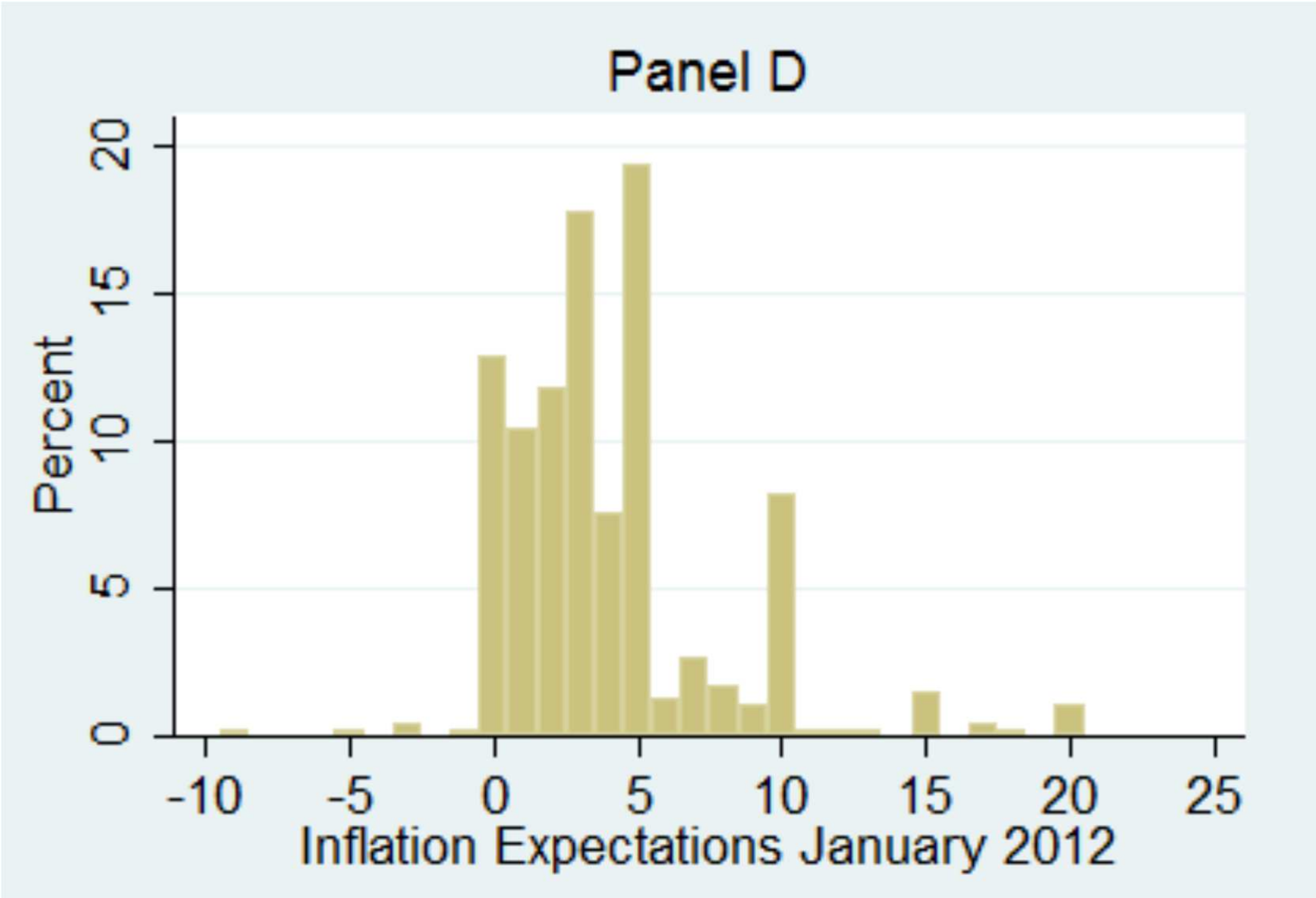
But R^2 = 0.06 and inflation was very steady despite huge drop in unemployment over last ten years



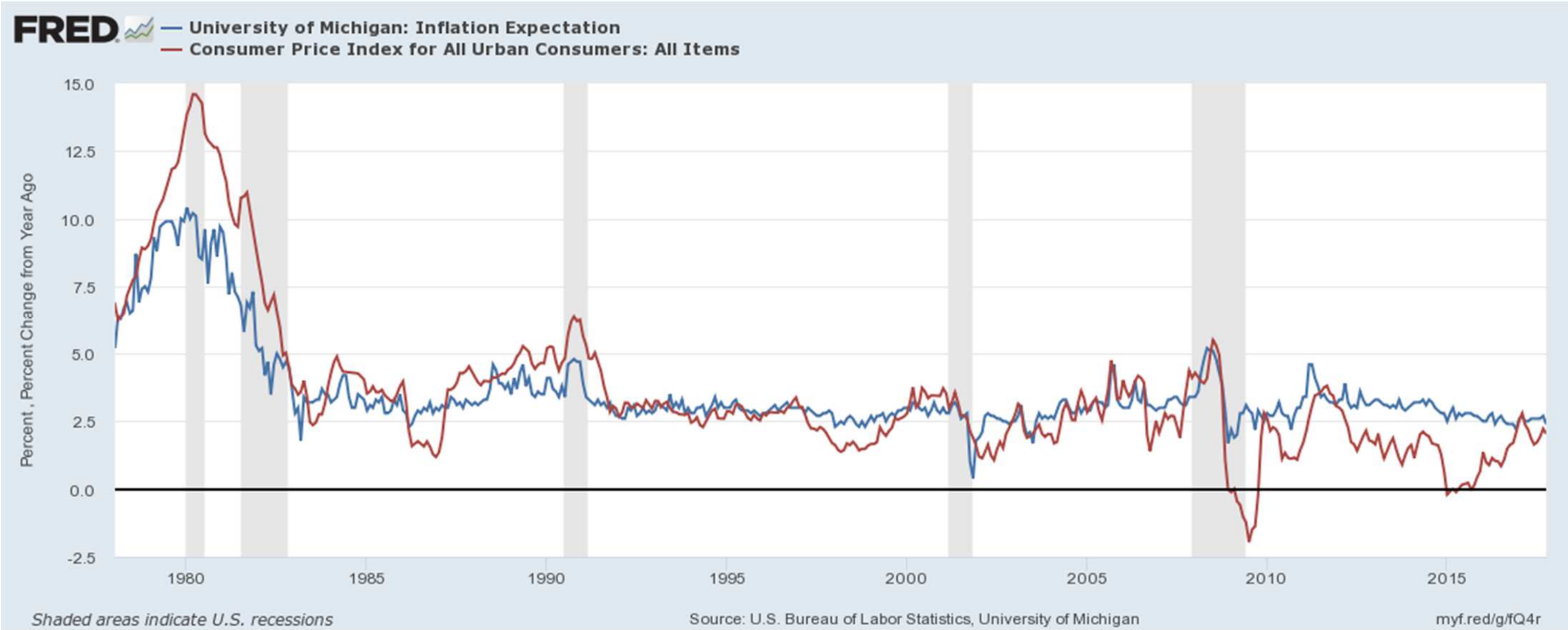
Another way to measure π_t^*: ask people directly.

Michigan Survey of Consumers:

"By about what percent do you expect prices to go (up/down) on the average, during the next 12 months?"

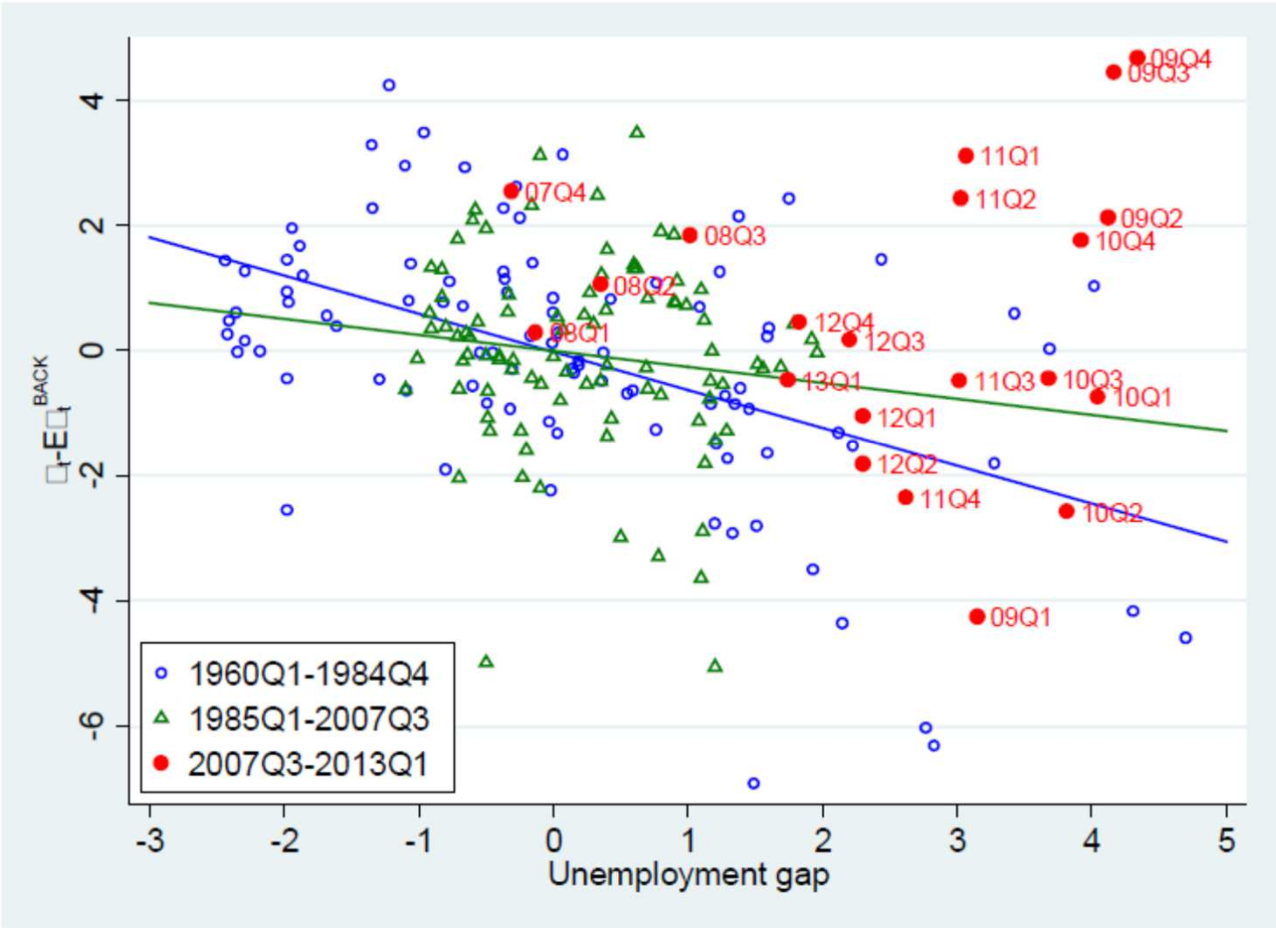


Source: Carola Binder, JME, June 2017


FRED
University of Michigan: Inflation Expectation
Consumer Price Index for All Urban Consumers: All Items
15.0
12.5
10.0
7.5
5.0
2.5
0.0
-2.5
Percent , Percent Change from Year Ago
1980
1985
1990
1995
2000
2005
2010
2015
Shaded areas indicate U.S. recessions
Source: U.S. Bureau of Labor Statistics, University of Michigan
myf.red/g/fQ4r

PC with $\pi_t^* = \pi_{t-1}$ estimated over 1960-84 or 1985-2007 significantly underestimates inflation 2007-2018

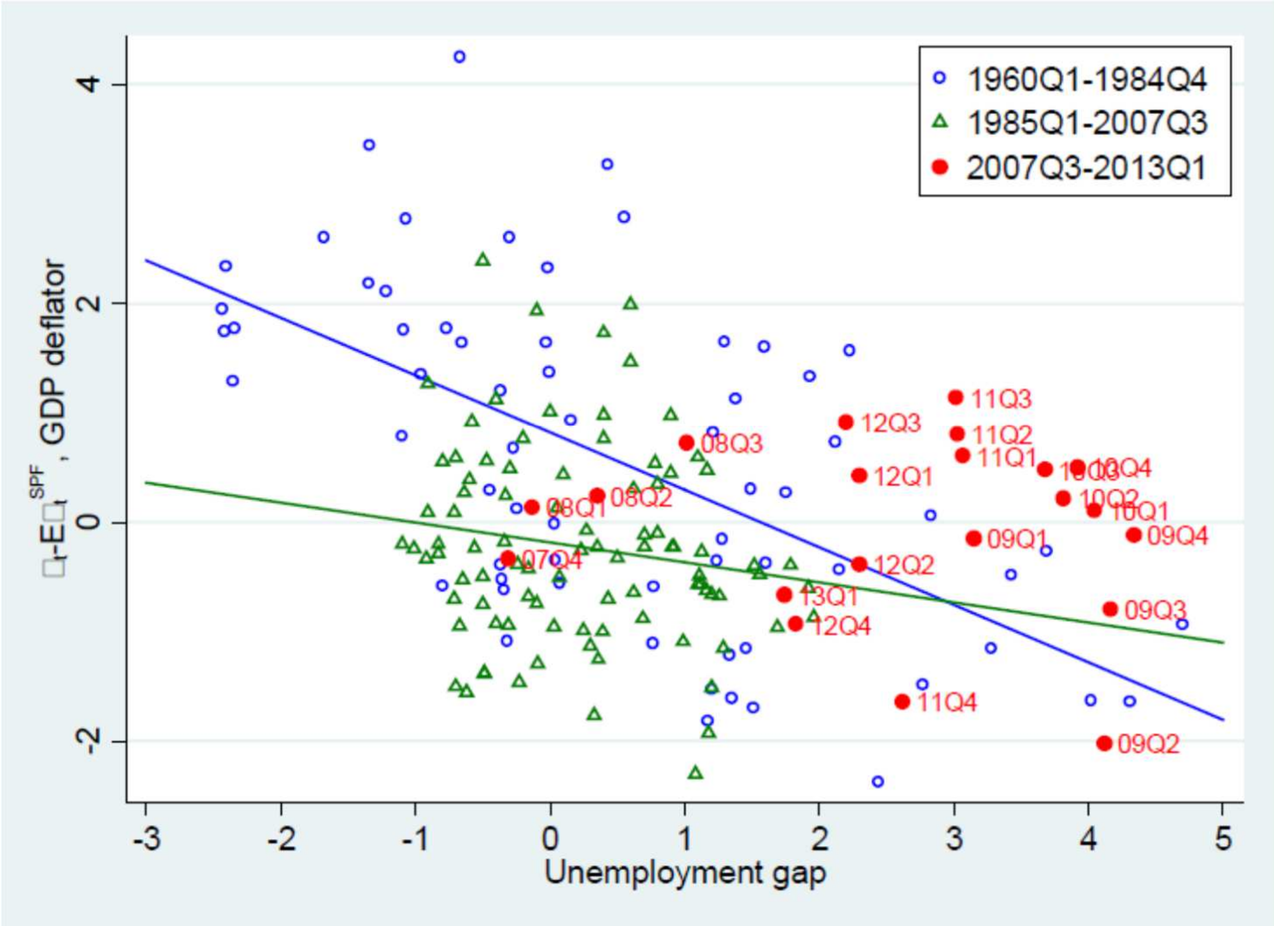
Panel A. Phillips Curve with Naïve Expectations



Source: Coibion, Gorodnichenko and Kamdar (JELit, forthcoming)

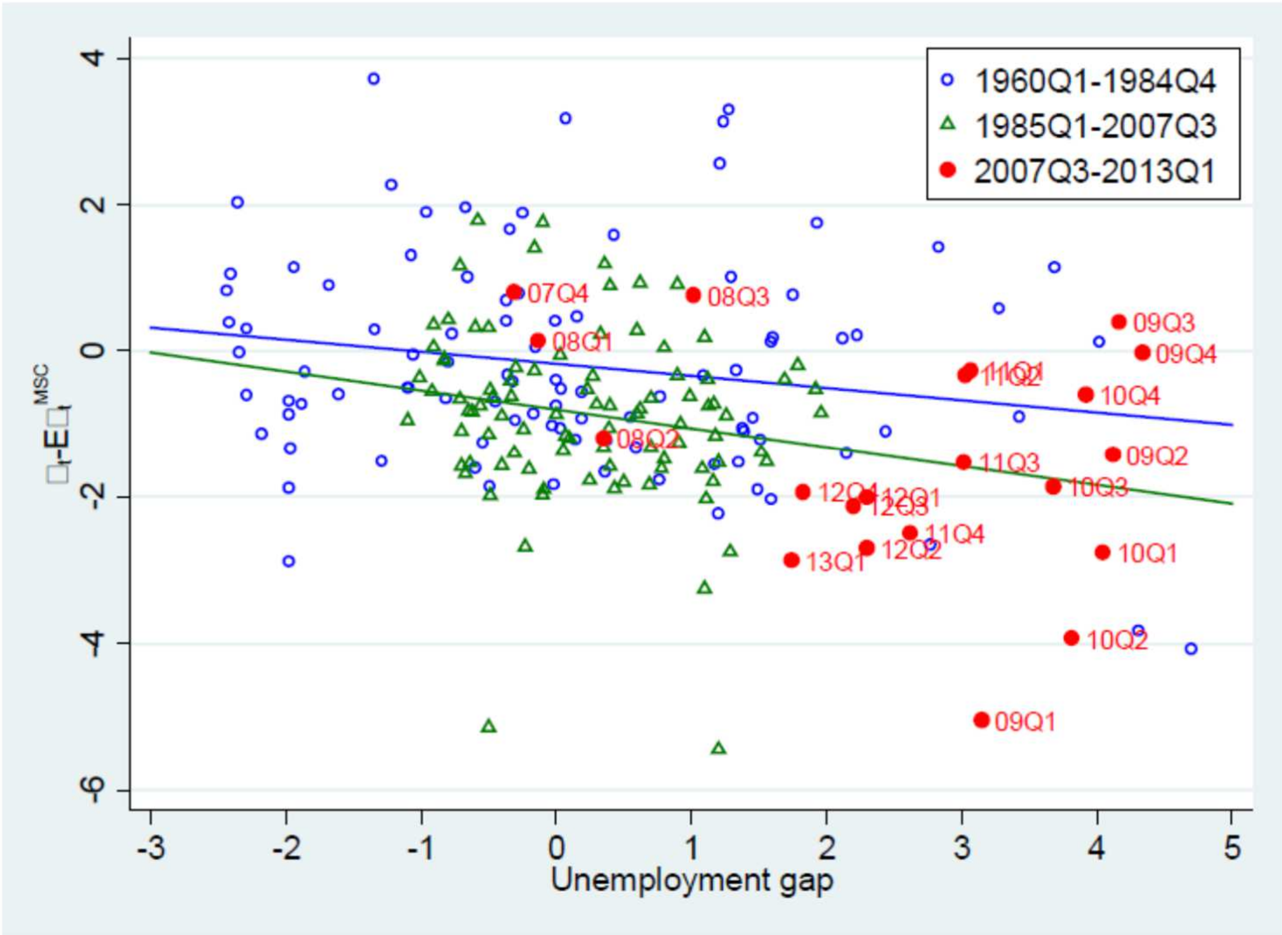
PC with π_t^* the average forecast from Survey of Professional Forecasters does not do any better

Panel B. Phillips Curve with SPF Expectations



But PC with inflation expectations from Michigan Survey accounts for much of “missing inflation”

C. Phillips Curve with Household Inflation Expectations



Inflation

A. The Phillips Curve
B. Forecasting inflation

Question: if our goal is to forecast inflation, should we pay any attention to unemployment rate?

Stock-Watson (1999)

π_t = inflation rate in month t (at annual rate)

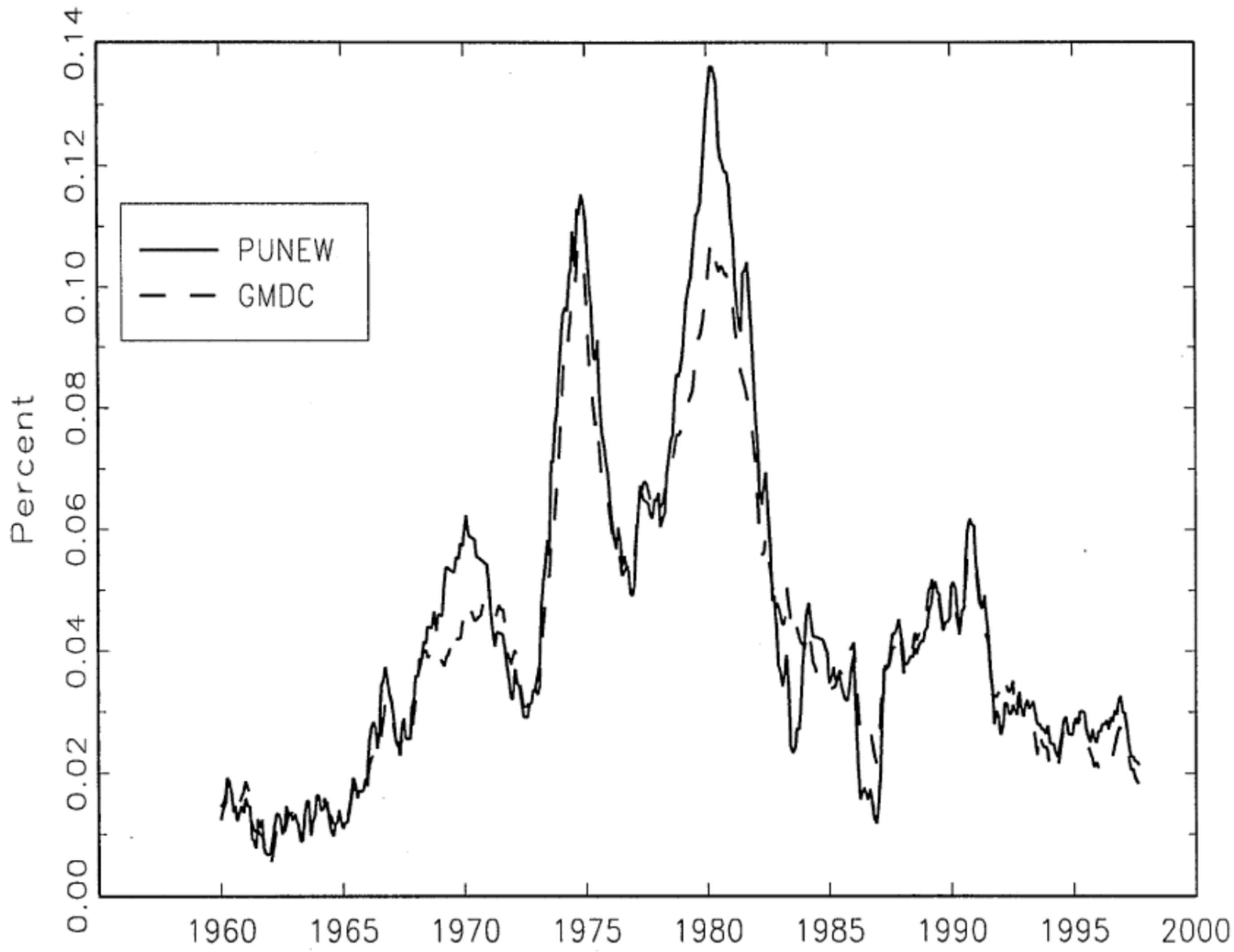
$$= 1200(\log P_t - \log P_{t-1})$$

π_t^{12} = average inflation rate over past year

$$= (1/12)(\pi_t + \pi_{t-1} + \cdots + \pi_{t-11})$$

π_t measured from either CPI or PCE (better)

t = 1959:M1 to 1999:M7


PUNEW
GMDC
Percent
0.00
0.02
0.04
0.06
0.08
0.10
0.12
0.14
1960
1965
1970
1975
1980
1985
1990
1995
2000

$$\pi_t^{12} - \pi_t = \phi + \sum_{j=1}^{p} \beta_j u_{t-j} + \sum_{j=1}^{p} \gamma_j(\pi_{t-j} - \pi_{t-j-1}) + \varepsilon_t$$

Question 1: are coefficients stable?

Answer: no

(1) Instability seems to be in γ_j not ϕ or β_j

Panel A: One-month ahead regressions ($h = 1$)

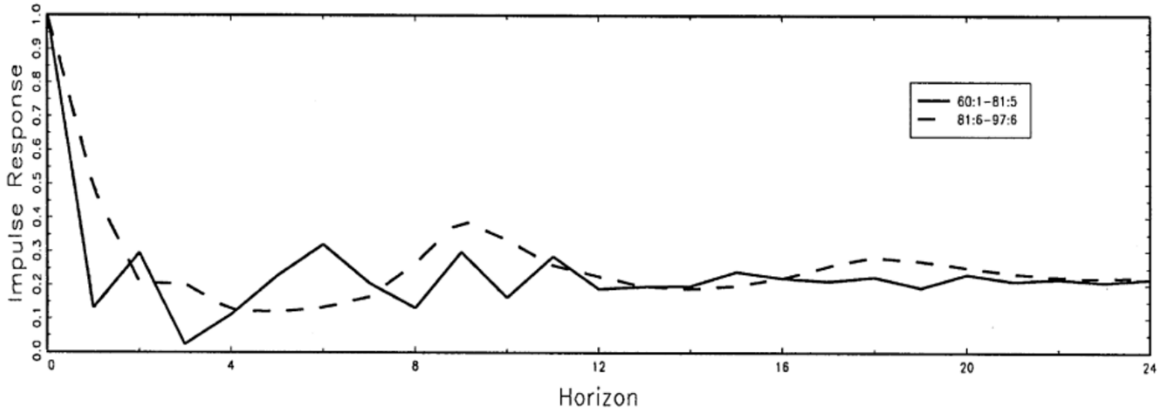
Price index	Unemp. rate	QLR_{all}	$QLR_{\phi,\beta}$	QLR_{γ}
		P-values for QLR test statistics		
Punew	Lhur	0.00	0.58	0.01
	Lhmu25	0.00	0.62	0.02
GMDC	Lhur	0.13	0.99	0.05
	Lhmu25	0.12	0.94	0.05
Puxhs	Lhur	0.00	0.68	0.00
	Lhmu25	0.00	0.85	0.00

Panel B: One-year ahead regressions ($h = 12$)

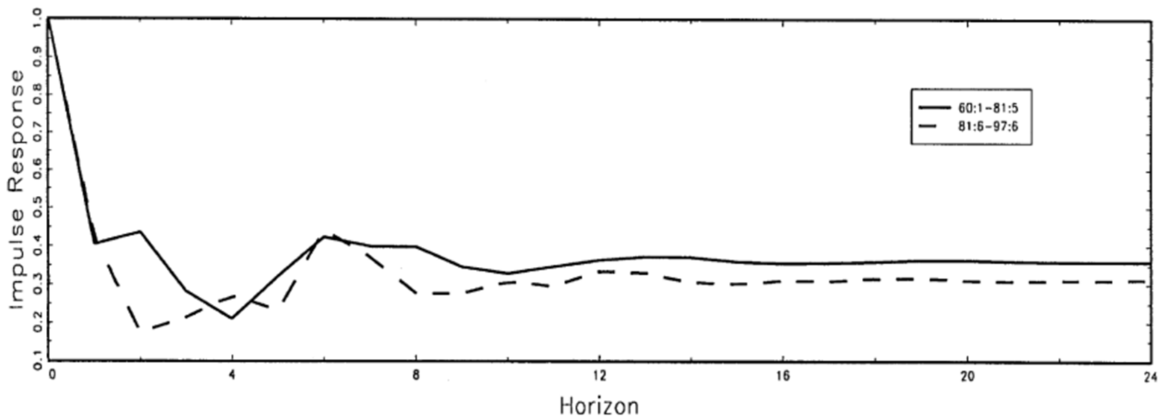
Punew	Lhur	0.00	0.00	0.00
	Lhmu25	0.00	0.01	0.00
GMDC	Lhur	0.01	0.09	0.07
	Lhmu25	0.03	0.37	0.03
Puxhs	Lhur	0.00	0.03	0.00
	Lhmu25	0.00	0.19	0.00

Lhmu25 = unemployment rate for males 25-54

(2) IRF seems not to change much over samples



(b) GMDC



(3) Will assess usefulness for forecasting separately on different subsamples

$$\pi_t^{12} - \pi_t = \phi + \sum_{j=1}^{p} \beta_j u_{t-j} + \sum_{j=1}^{p} \gamma_j(\pi_{t-j} - \pi_{t-j-1}) + \varepsilon_t$$

Estimate (and choose p) using data through date T , look at forecast of π_{T+12}^{12}.

Compare root mean squared error of this forecast to that of model without u_t or with some alternative measure x_t.

$\lambda =$ weight for x_t for best forecast combining u_t and x_t.

		PUNEW				GMDC			
		1970–1983		1984–1996		1970–1983		1984–1996	
Variable	Trans	Re1. MSE	λ	Re1. MSE	λ	Re1. MSE	λ	Re1. MSE	λ
No change		1.90	0.11	2.44	0.06	1.30	0.30	2.78	– 0.05
		(0.59)	(0.07)	(1.59)	(0.08)	(0.18)	(0.15)	(1.31)	(0.05)
Univariate	–	1.26	– 0.13	0.98	0.53	1.00	0.50	1.06	0.27
		(0.19)	(0.25)	(0.15)	(0.33)	(0.15)	(0.38)	(0.09)	(0.29)

- Other measures of real activity sometimes better than unemployment
  - capacity utilization
  - manufacturing and trade sales
  - first PC of activity measures (now called Chicago Fed National Activity Index).
- Non-output measures systematically forecast worse
  - other inflation data
  - yield curve
  - monetary aggregates
  - exchange rates

Variables	Trans	PUNEW				GMDC			
		1970–1983		1984–1996		1970–1983		1984–1996	
		Rel. MSE	λ	Rel. MSE	λ	Rel. MSE	λ	Rel. MSE	λ
Univariate	–	1.26	– 0.13	0.98	0.53	1.00	0.50	1.06	0.27
		(0.19)	(0.25)	(0.15)	(0.33)	(0.15)	(0.38)	(0.09)	(0.29)
Interest rates									
fyff	DLV	1.34	0.05	1.02	0.44	1.07	0.37	1.06	0.25
		(0.33)	(0.16)	(0.15)	(0.33)	(0.20)	(0.35)	(0.08)	(0.29)
fycp	DLV	1.25	0.06	1.04	0.42	1.03	0.42	1.07	0.23
		(0.18)	(0.17)	(0.16)	(0.33)	(0.16)	(0.38)	(0.08)	(0.30)
fygm3	DLV	1.27	0.06	1.01	0.47	1.09	0.31	1.06	0.25
		(0.24)	(0.20)	(0.15)	(0.31)	(0.19)	(0.38)	(0.08)	(0.29)
fygm6	DLV	1.25	0.03	1.04	0.42	1.02	0.46	1.06	0.24
		(0.21)	(0.22)	(0.15)	(0.31)	(0.16)	(0.43)	(0.08)	(0.29)
fygt1	DLV	1.21	0.08	1.03	0.42	1.02	0.45	1.06	0.25
		(0.17)	(0.22)	(0.15)	(0.32)	(0.15)	(0.40)	(0.08)	(0.30)
fygt5	DLV	1.24	– 0.03	1.13	0.37	1.01	0.48	1.06	0.27
		(0.18)	(0.24)	(0.24)	(0.21)	(0.16)	(0.38)	(0.09)	(0.29)
fygt10	DLV	1.23	0.19	1.11	0.41	1.02	0.45	1.06	0.26
		(0.21)	(0.25)	(0.25)	(0.19)	(0.15)	(0.36)	(0.09)	(0.29)

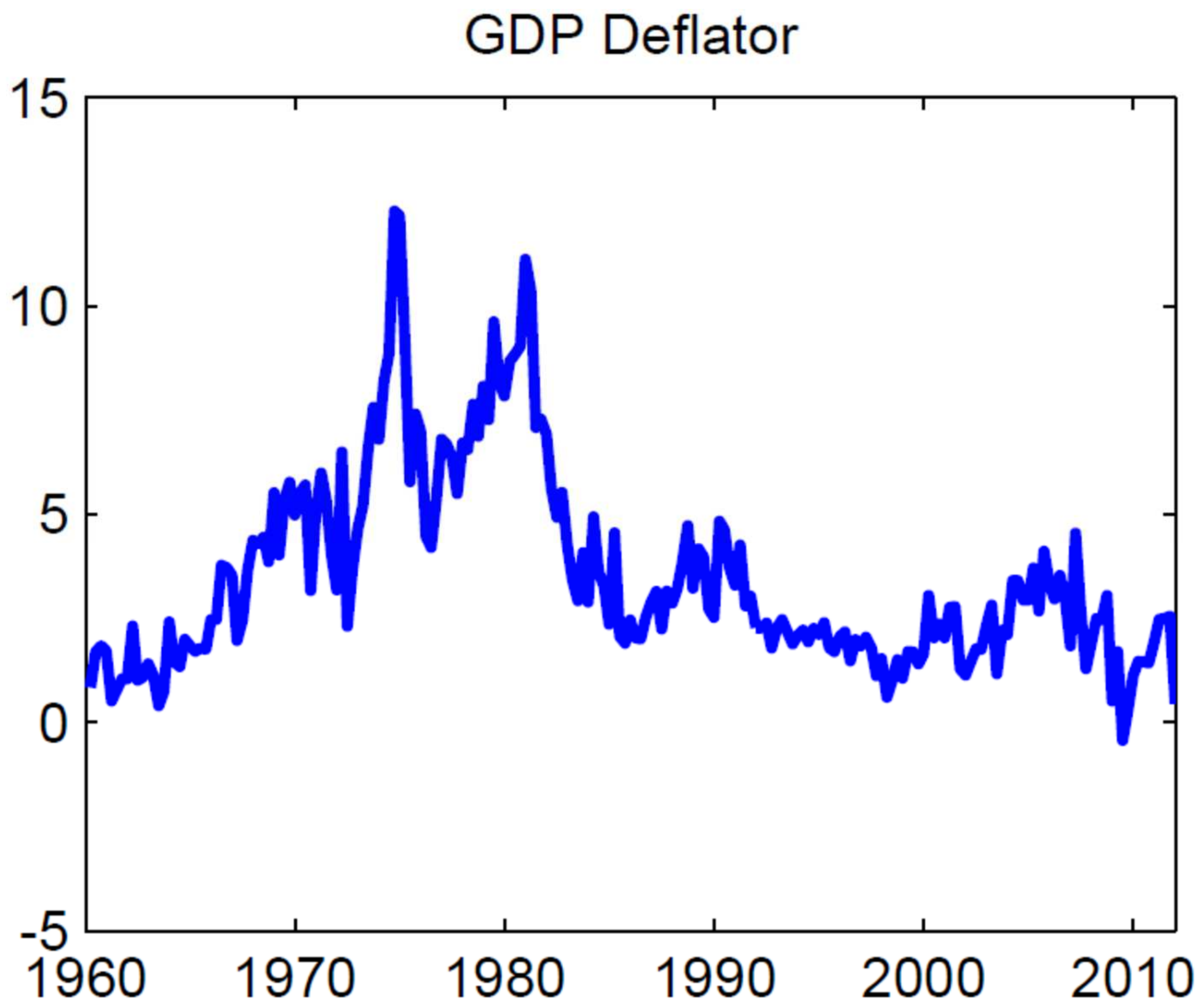
Variables	Trans	PUNEW				GMDC			
		1970–1983		1984–1996		1970–1983		1984–1996	
		Rel. MSE	λ	Rel. MSE	λ	Rel. MSE	λ	Rel. MSE	λ
Nominal money									
fm1	DLN	1.25	0.11	1.08	0.42	1.06	0.38	1.05	0.37
		(0.19)	(0.20)	(0.26)	(0.23)	(0.17)	(0.32)	(0.10)	(0.24)
fm2	DLN	1.29	− 0.01	0.97	0.53	1.05	0.39	0.98	0.54
		(0.19)	(0.23)	(0.13)	(0.17)	(0.16)	(0.34)	(0.08)	(0.21)
fm3	DLN	1.27	− 0.07	1.00	0.50	1.03	0.43	1.01	0.49
		(0.20)	(0.25)	(0.12)	(0.17)	(0.15)	(0.35)	(0.08)	(0.19)
fml	DLN	1.28	0.05	1.12	0.35	1.06	0.38	1.06	0.37
		(0.26)	(0.26)	(0.14)	(0.14)	(0.18)	(0.35)	(0.09)	(0.19)
fmfba	DLN	1.27	− 0.03	1.11	0.33	1.04	0.43	1.13	0.12
		(0.21)	(0.26)	(0.27)	(0.35)	(0.18)	(0.35)	(0.16)	(0.36)
fmbase	DLN	1.36	− 0.18	1.05	0.42	1.11	0.29	1.08	0.23
		(0.23)	(0.23)	(0.19)	(0.31)	(0.18)	(0.33)	(0.11)	(0.30)
fmrra	DLN	1.28	− 0.14	0.99	0.51	1.00	0.51	1.06	0.31
		(0.18)	(0.26)	(0.17)	(0.27)	(0.16)	(0.39)	(0.10)	(0.27)
fmrnba	DLN	1.26	− 0.11	1.07	0.37	1.01	0.47	1.07	0.24

Variables	Trans	PUNEW				GMDC			
		1970–1983		1984–1996		1970–1983		1984–1996	
		Rel. MSE	λ	Rel. MSE	λ	Rel. MSE	λ	Rel. MSE	λ
exrsw	DLN	1.32	– 0.07	1.31	0.26	1.62	–0.12	1.39	0.03
		(0.22)	(0.22)	(0.50)	(0.27)	(0.71)	(0.21)	(0.39)	(0.28)
exrjan	DLN	1.42	0.30	1.49	0.30	1.49	0.26	1.14	0.19
		(0.33)	(0.08)	(0.50)	(0.15)	(0.34)	(0.09)	(0.16)	(0.26)
exruk	DLN	1.27	– 0.15	1.01	0.47	1.04	0.39	1.08	0.22
		(0.19)	(0.25)	(0.17)	(0.32)	(0.13)	(0.36)	(0.10)	(0.30)
exrcan	DLN	1.28	– 0.20	0.98	0.54	1.01	0.48	1.06	0.31
		(0.18)	(0.25)	(0.16)	(0.33)	(0.15)	(0.38)	(0.09)	(0.28)

The major conclusion of this study is that the Phillips curve, interpreted broadly as a relation between current real economic activity and future inflation, produced the most reliable and accurate short-run forecasts of US price inflation across all of the models that we considered over the 1970–1996 period. This conclusion will come as no surprise to applied macroeconomic forecasters in business and government, where the Phillips curve plays a central role in short-run inflation forecasting. The conclusion is also consistent with the recent academic literature on short-run inflation forecasting. For example, in a com-

Faust and Wright (2013)

- Sample 1960:Q1 to 2011:Q4
- More observations from recent low-inflation regime
- Any model that implies reversion over long horizons to the full-sample mean will badly miss recent observations


GDP Deflator
15
10
5
0
-5
1960
1970
1980
1990
2000
2010

- Estimate model through date T using unrevised data as reported at the time.
- Calculate forecast error for π_{T+h}.
- Repeat for each $T = 1985$:Q1 to 2011:Q4.
- Calculate ratio of RMSE to that of a baseline model.

Examples of models that do badly:

Direct: $\pi_{t+h} = \rho_0 + \sum_{j=1}^{p} \rho_j \pi_{t-j} + \varepsilon_{t+h}$

RAR: $\pi_t = \rho_0 + \sum_{j=1}^{p} \rho_j \pi_{t-j} + \varepsilon_t$

$\Rightarrow \hat{\pi}_{t+h|t-1}$ by recursion

PC: $\pi_{t+h} = \rho_0 + \sum_{j=1}^{p} \rho_j \pi_{t-j} + \lambda u_{t-1} + \varepsilon_{t+h}$

RW: $\hat{\pi}_{t+h} = \pi_{t-1}$

Table 2: RMSPE of Selected Inflation Forecasts

Horizon	0	1	2	3	4	8
			Panel A: GDP Deflator			
Direct	1.06**	1.00	0.96	1.04	1.09	1.34***
RAR	1.06**	1.02	1.01	1.17***	1.24***	1.53***
PC	1.07*	1.03	1.01	1.08	1.14*	1.41***
RW	1.19***	1.17**	1.09	1.04	1.06	1.25*

Model that beats all those (RMSE $=$ 1.00)

τ_t $=$ estimate of trend inflation at t

Blue-Chip forecast of 5-10 year inflation

$$g_t = \pi_t - \tau_t$$

$$g_t = \rho g_{t-1} + \varepsilon_t$$

$$\Rightarrow \hat{\pi}_{t+h|t-1} = \tau_{t-1} + \rho^{h+1}(\pi_{t-1} - \tau_{t-1})$$

$$\rho = 0.46$$

This also beats:

- Estimated AR for g_t
- PC for g_t instead of π_t

What beats it? Subjective forecasts

- Blue Chip forecast for horizon h
- Survey of Profession forecasters
- Fed's Green Book forecasts

Table 2: RMSPE of Selected Inflation Forecasts

Horizon	0	1	2	3	4	8
			Panel A: GDP Deflator			
Direct	1.06**	1.00	0.96	1.04	1.09	1.34***
RAR	1.06**	1.02	1.01	1.17***	1.24***	1.53***
PC	1.07*	1.03	1.01	1.08	1.14*	1.41***
RW	1.19***	1.17**	1.09	1.04	1.06	1.25*
RW-AO	0.95	0.90*	0.91	0.94	0.96	1.05
UCSV	0.98	0.96	0.91	0.91	0.94	1.07
AR-GAP	1.03	0.97	0.95*	1.01	1.05	1.18***
PC-GAP	1.04	1.02	1.03	1.10*	1.17**	1.33***
PCTVN-GAP	1.04	1.02	1.03	1.10*	1.17**	1.30***
Term Structure VAR	1.07**	1.12**	1.16***	1.25***	1.32***	1.50***
TVP-VAR	0.99	0.94	0.95	0.94	1.00	1.21
EWA	1.02	0.94*	0.91**	0.97	1.01	1.15***
BMA	1.00	0.91**	0.89***	0.97	1.09	1.19**
FAVAR	1.02	1.03	1.07	1.06	1.13**	1.26***
DSGE	1.06	1.02	1.06	1.08	1.08	1.16
DSGE-GAP	1.02	0.95	0.97	0.98	0.97	1.05
BC	0.81***	0.85***	0.87***	0.90***	0.94**	
SPF	0.82***	0.84***	0.86***	0.88***	0.91**	
GB	0.84*	0.83**	0.82**	0.81**	0.82**	
Fixed ρ + nowcast	0.81***	0.93***	0.97**	1.00	1.00	1.00

Subjective forecasts do better because they have better "nowcast" ($\hat{\pi}_{t-1|t-1}$).

Can improve fixed ρ forecast considerably by including Blue Chip nowcast

$$\hat{\pi}_{t+h|t-1} = \tau_{t-1} + \rho^{h+1}(\hat{\pi}^{BC}_{t-1|t-1} - \tau_{t-1})$$

Table 2: RMSPE of Selected Inflation Forecasts

Horizon	0	1	2	3	4	8
			Panel A: GDP Deflator			
Direct	1.06**	1.00	0.96	1.04	1.09	1.34***
RAR	1.06**	1.02	1.01	1.17***	1.24***	1.53***
PC	1.07*	1.03	1.01	1.08	1.14*	1.41***
RW	1.19***	1.17**	1.09	1.04	1.06	1.25*
RW-AO	0.95	0.90*	0.91	0.94	0.96	1.05
UCSV	0.98	0.96	0.91	0.91	0.94	1.07
AR-GAP	1.03	0.97	0.95*	1.01	1.05	1.18***
PC-GAP	1.04	1.02	1.03	1.10*	1.17**	1.33***
PCTVN-GAP	1.04	1.02	1.03	1.10*	1.17**	1.30***
Term Structure VAR	1.07**	1.12**	1.16***	1.25***	1.32***	1.50***
TVP-VAR	0.99	0.94	0.95	0.94	1.00	1.21
EWA	1.02	0.94*	0.91**	0.97	1.01	1.15***
BMA	1.00	0.91**	0.89***	0.97	1.09	1.19**
FAVAR	1.02	1.03	1.07	1.06	1.13**	1.26***
DSGE	1.06	1.02	1.06	1.08	1.08	1.16
DSGE-GAP	1.02	0.95	0.97	0.98	0.97	1.05
BC	0.81***	0.85***	0.87***	0.90***	0.94**	
SPF	0.82***	0.84***	0.86***	0.88***	0.91**	
GB	0.84*	0.83**	0.82**	0.81**	0.82**	
Fixed ρ + nowcast	0.81***	0.93***	0.97**	1.00	1.00	1.00

Does this mean nothing matters for inflation?

- Subjective forecasts may do optimal job at inferring implications of real output for π_{t-1}.
- Fed may do optimal job in exploiting PC to steer π_{t+h} to its target (τ_{t-1}) within a few quarters (no deviation from target is predictable).
- Parsimony is very helpful in real-time forecasting.

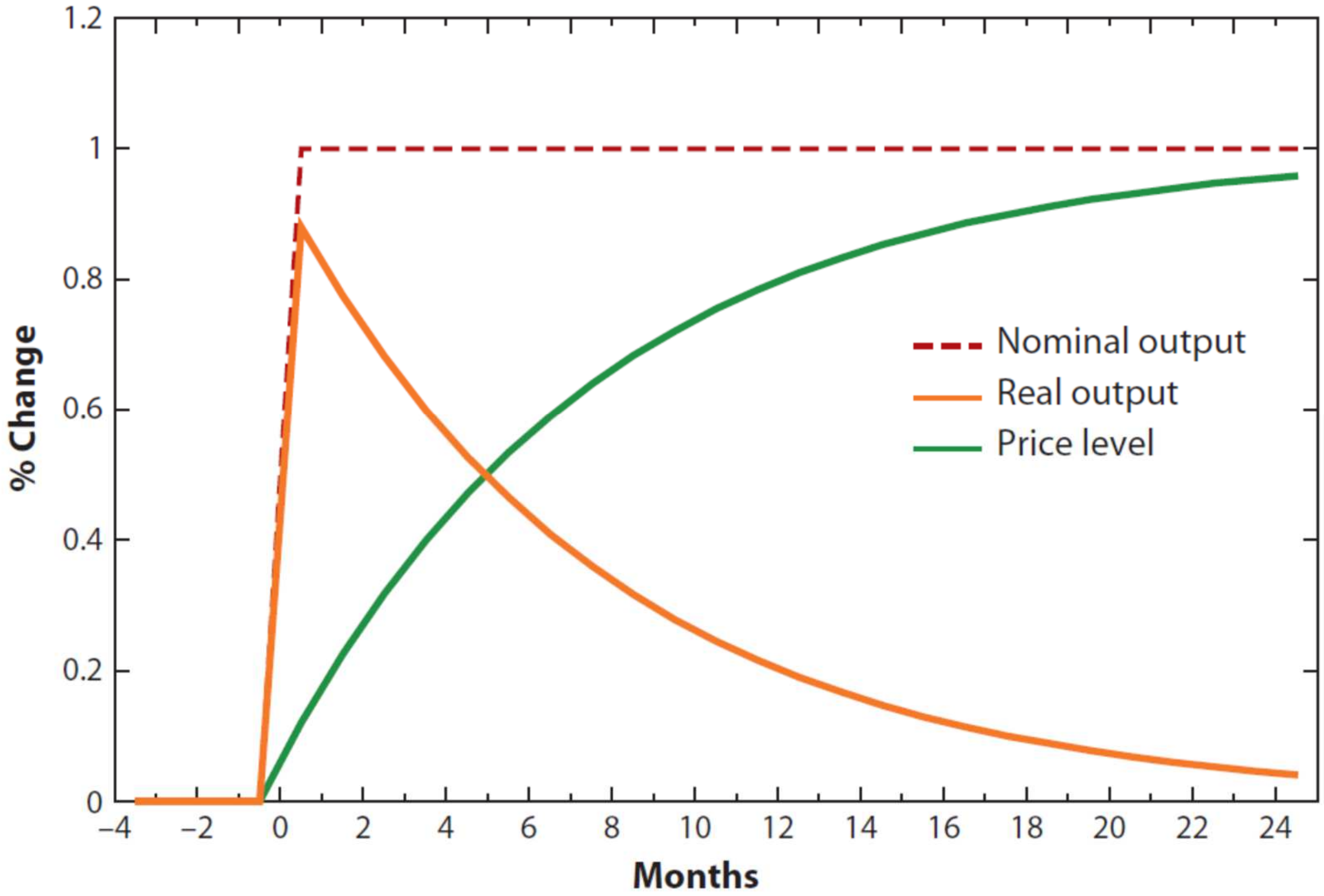
Inflation

A. The Phillips Curve
B. Forecasting inflation
C. Frequency of price changes

Bils and Klenow (2004) found 21% of individual prices that go into calculating CPI change each month.

Suggests Calvo fraction of firms keeping prices fixed is $\alpha = 0.79$ per month or $\alpha^3 = 0.49$ per quarter.

A shock that raises nominal demand 1% would raise real output 0.5% within the quarter but only 0.125% after 3 quarters.



Source: Nakamura and Steinsson (2013)

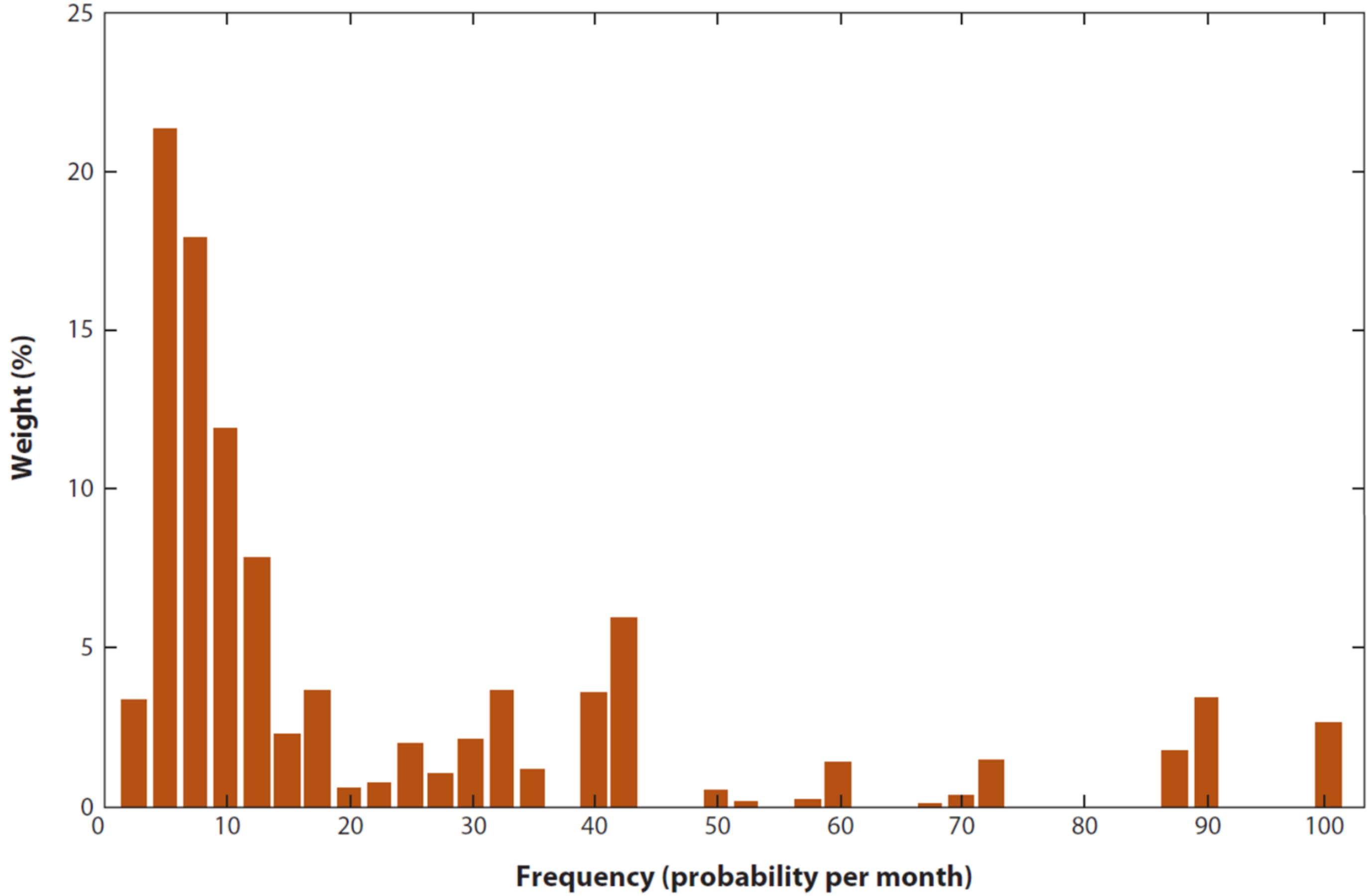
Weekly price of 18-ounce jar of Peter Pan Creamy Peanut Butter at a supermarket in NW Chicago

Source: Chevalier and Kashyap (2015)

- Many items are characterized by a temporary sale after which their price goes back to the old "reference price"
- Should we exclude these changes and think of α as fraction of products for which the price-setter is able to change the reference price?
- Nakamura and Steinsson (2008): avg frequency of change in posted prices = 27.7% per month
- Avg frequency of change in regular prices (excluding substitution) = 21.5% per month

- Different industries have very different frequencies of price change
- What matters for monetary nonneutrality is fraction who haven’t changed after n months

Expenditure-weighted distribution of frequency of regular price changes across different entry-level CPI items



Source: Nakamura and Steinsson (2013)

- However, Bils et al. (2003) find that relative prices in flexible-price sectors fall following an expansionary monetary shock
- Mackowiak et al. (2009) find little difference in speed of response of prices to monetary shock across sectors characterized as sticky price versus flexible price

Inflation

A. The Phillips Curve
B. Forecasting inflation
C. Frequency of price changes
D. Microfoundations

Why don’t firms change price more often?

(1) Menu cost

- Small cost of changing price
- Even though cost is of second-order importance for firm's profits), cost to economy could be first-order if there are distortions such as monopoly power (Akerlof & Yellen, 1985; Mankiw, 1985)
- But does not explain why inflation matters-- just speed up rate at which prices change (Caplin and Spulber, 1987)

(2) Sticky information (Mankiw and Reis, 2002)

- Firms update information infrequently (e.g., Calvo fairy arrives)

(3) Rational inattention (Sims, 2003)

- Processing information more accurately is more accurate
- Mackowiak et al. (2009) found firms change prices more quickly in response to sectoral shocks than to aggregate shocks

Carlsson and Skans (2012)

- Carlsson and Skans (AER, 2012) proposed to distinguish these explanations using matched firm-level data on product prices and unit labor costs in Sweden

Associated with firm f is a local labor market j, specific goods g produced by firm, and sector s

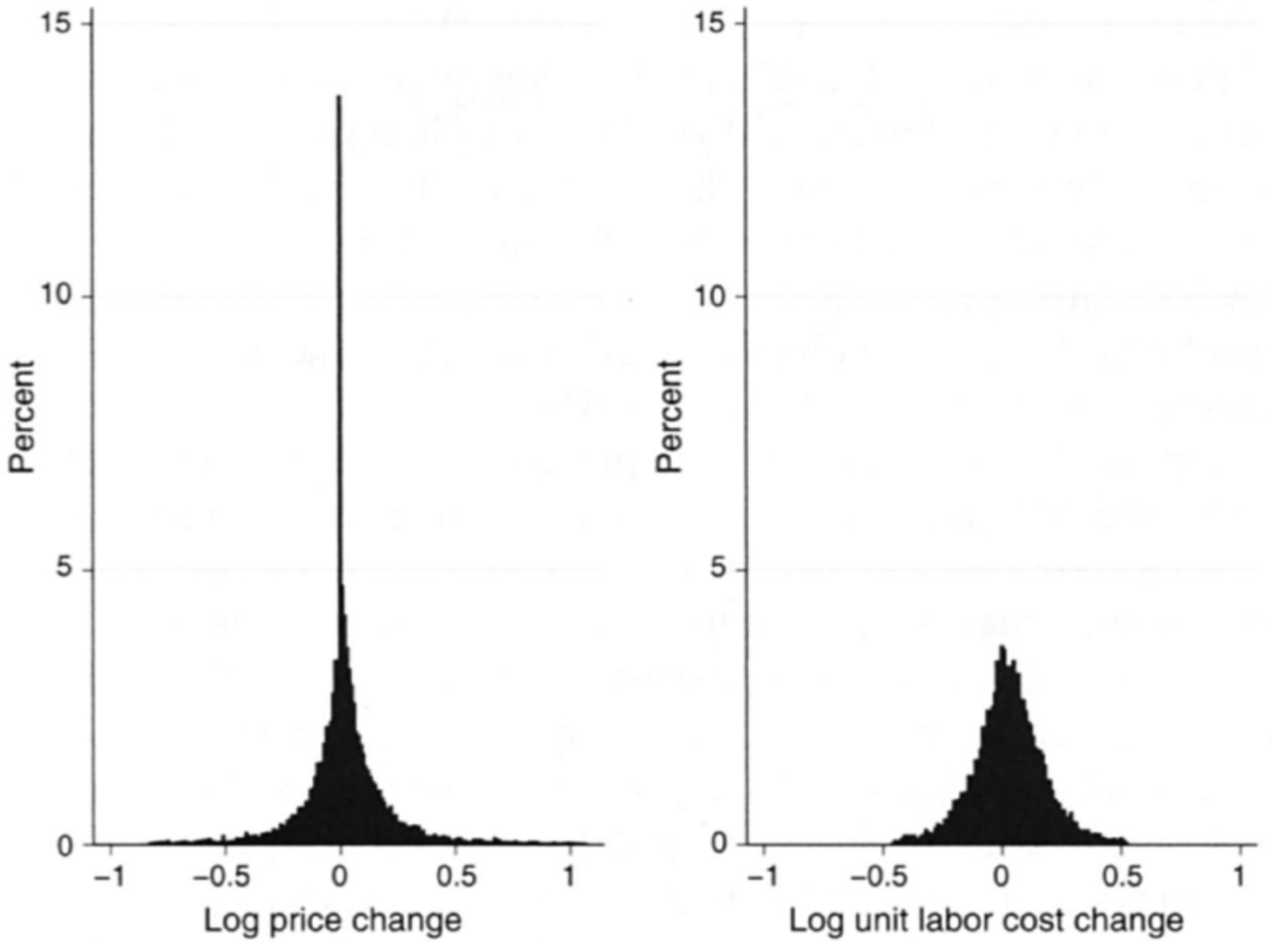
$\mathbf{w}_{jt}$ = vector of wages paid to different types of workers (age, gender, education,...) in local area j and year t

$\mathbf{L}_{ft}$ = vector of different types of labor hired by firm f

$\mathbf{w}'_{jt}\mathbf{L}_{ft}$ = wage bill

$\alpha\mathbf{w}'_{jt}\mathbf{L}_{ft}/Y_{ft}$ = marginal cost $= \alpha MC_{ft}$

P_{gt} = price of some good g sold by firm f


15
10
5
0
Percent
−1
−0.5
0
0.5
1
Log price change
15
10
5
0
Percent
−1
−0.5
0
0.5
1
Log unit labor cost change

$$\ln P_{gt} = \gamma_g + \alpha_{st} + \lambda \ln(\mathbf{w}'_{jt}\mathbf{L}_{ft}/Y_{ft}) + \varepsilon_{gt}$$

OLS: $\hat{\lambda} = 0.265$ with std error 0.019

IV: $\hat{\lambda} = 0.334$ with std error 0.055

instruments: $d_g, d_{st}, MC_{f,t-1}, MC_{f,t-2}, \widehat{MC}_{f,t}, \widehat{MC}_{f,t-1}$

$$\widehat{MC}_{f,t} = \mathbf{w}'_{jt}\mathbf{L}_{f,t-1}/Y_{f,t-1}$$

Caution: if there is endogeneity concern, typically not solved by lags (if explanatory variables serially correlated, error is likely also)

$\hat{\lambda} << 1 \Rightarrow$ some kind of stickiness

All variation in MC here comes from local conditions.

Also find no difference between firms facing high variance of local shocks and those with low.

Inconsistent with rational inattention.

Under sticky information, should find coefficient near unity for component predictable far in advance.

When instruments are lagged 4-9 years, coefficent rises to 0.516 with std error 0.154.

Calvo model implies price at t reflects expected future marginal costs

$$\ln P_{gt} = \gamma_g + \alpha_{st} + \lambda_1 \ln(\mathbf{w}'_{jt}\mathbf{L}_{ft}/Y_{ft}) + \lambda_2 \ln(\mathbf{w}'_{j,t+1}\mathbf{L}_{f,t+1}/Y_{f,t+1}) + \varepsilon_{gt}$$

Using date t instruments find

$\hat{\lambda}_2 = 0.364$ with std error 0.154

Zbaracki, et al. (2004)

- Zbaracki, et al. (REStat, 2004) studied billion-dollar firm that produces 8,000 products used to maintain machinery sold to other firms
- Goal: study details of what happens when price is changed
- Conclusion: firm spent $1.216 M in 1997 changing its prices

- Interview firm managers to ask how they make decisions
- Sit in on meetings where pricing decisions were made
- Study database of price changes

(1) Pricing season: company develops price plans for coming year beginning in August

- Low cost?
- High quality?
- Competitors?
- Spent $280,000 (23% of total) on this process

Communicating plans to customers

- Flights, meetings, phone calls $369,000
- Negotiation costs $524,000
- 73% of total

(3) Print and distribute price list in Nov

- Cost $43,000 (3.5% of total)

Other evidence on microfoundations

- Kashyap (QJE, 1995) studied prices in catalogs of Bean and Orvis and REI
- Found sometimes prices stayed same for years despite printing new catalog each 6 months
- When prices did change, sometimes changed very little

- Nakamura and Steinsson (2017) noted that Calvo-based models imply the cost of inflation is greater dispersion of relative prices
- Found no evidence there was more dispersion during the Great Inflation of 1970s

Conclusions

- Abundant evidence of price rigidities and monetary nonneutrality from multiple sources
- Tradeoff between tractable representation (Calvo) and detailed reconciliation with how decisions are actually made and implemented
- Need to exercise caution in taking implications of New Keynesian models (e.g., welfare costs of inflation) too literally