Micro and Macro Evidence on Inflation and Monetary Policy

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How Does Monetary Policy Work?

- Consensus in mainstream media that effects are large

How Does Monetary Policy Work?

- Consensus in mainstream media that effects are large
- Sometimes we forget this is surprising!
- Monetary policy is fundamentally all about units!
  - Surprising it does anything at all

The Importance of Units

- Suppose I double the money supply
  - If price level doubles...
- Suppose I double the nominal interest rate
  - If inflation rises by the same amount...
- Suppose exchange rate devalues
  - If P_{US}/P_{For} adjusts by same amount...

...Then nothing "real" changes

Milton Friedman: Daylight Savings Time

- March 13 2022: Clocks roll forward by one hour
  - Intended to optimize meeting times vs. daylight
- If meeting times were set optimally already, DST wouldn't matter
  - Apparently it does
  - More heart attacks on March 14

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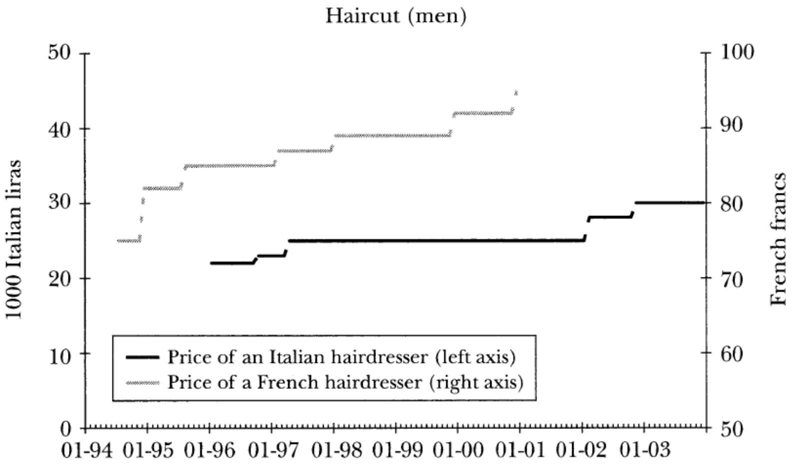
"Obvious" reasons:

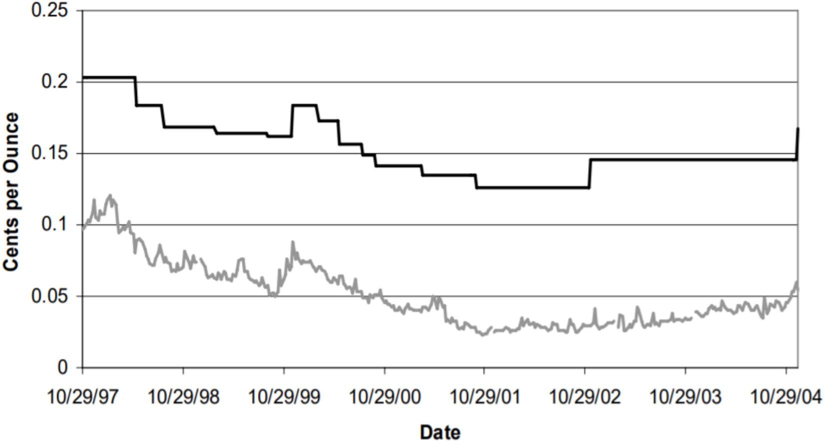
- Coordination, simplicity, etc.
- Similar arguments for prices

1. **Micro evidence**
   - Haircuts, washing machines, saltine crackers...
   - “Price rigidity”
2. Macro evidence
   - Discontinuity/ Heteroskedasticity-based identification
   - Regional data
   - “Phillips curves”



Source: Dhyne et al. (2006)

Coffee Wholesale and Commodity Prices



Source: Nakamura and Zerom (2010)

Measuring Price Rigidity: Harder than You Think

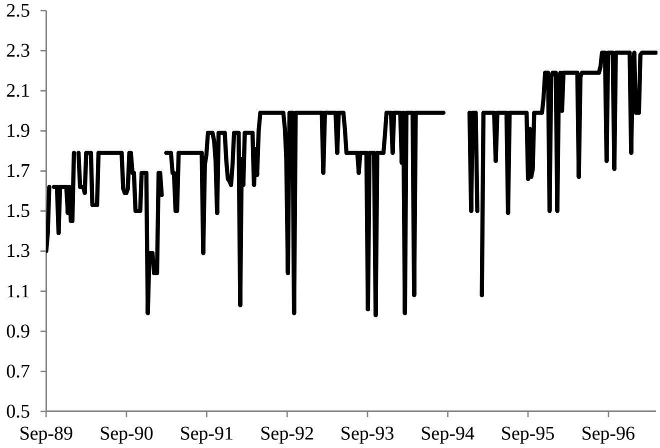
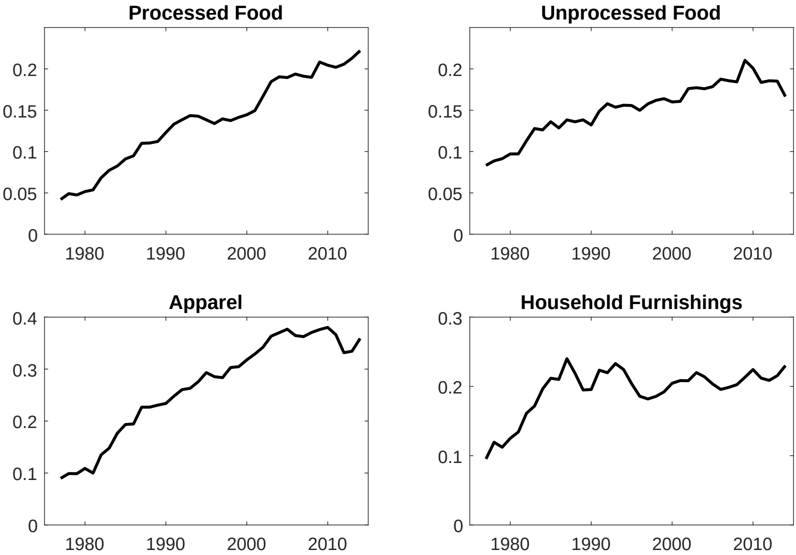


Figure 2
Price of Nabisco Premium Saltines 16 oz. at a Dominick's Finer Foods Store in Chicago

Frequency of Sales



Source: Nakamura-Steinsson-Sun-Villar (2018)

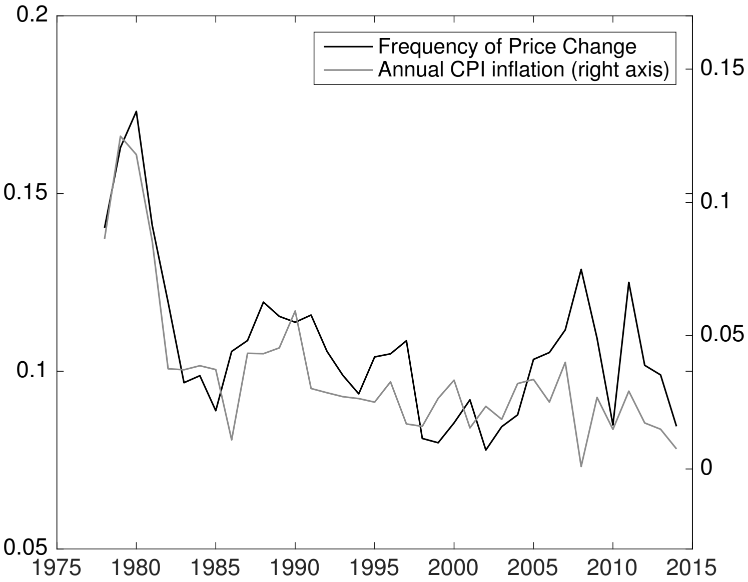


Figure 12: Frequency of Price Changes in U.S. Data

Source: Nakamura-Steinsson-Sun-Villar (2018)

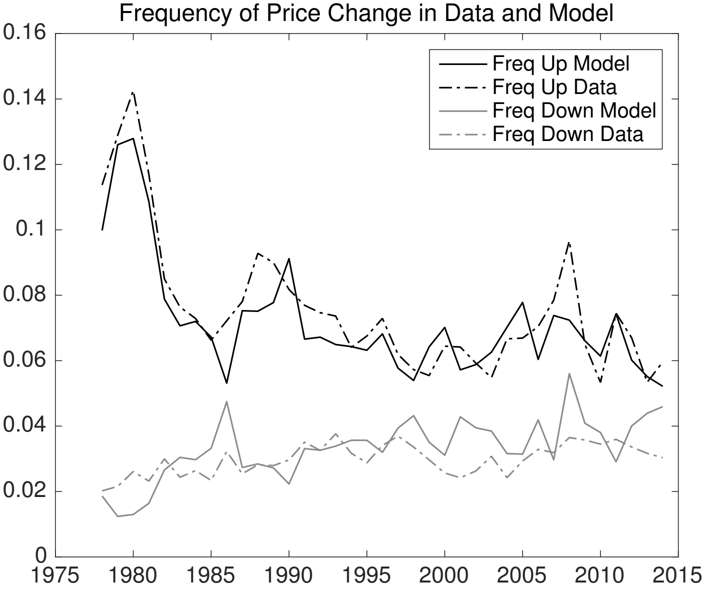


Figure 14: Predicted and Actual Frequency of Price Changes

Source: Nakamura-Steinsson-Sun-Villar (2018)

How this Affects the Real Interest Rate

Consider a shock that causes households and firms to deleverage...

- Sharp increase in desire to save $\rightarrow$
- Drop in "natural" rate of interest
- Nominal rates are at ZLB
- Need inflation to make real rates fall
- In frictionless model: prices *jump* down and rise
- But will this really happen?
- If prices adjust more sluggishly, real rate may rise rather than fall!

Great Depression

1931: Economy in freefall

- Major banking crisis, US on Gold Standard
- Prices fell $\approx$ 30% peak-trough
- Inflation massively negative
- Led to *elevated* real interest rates

- Huge turnaround when Roosevelt comes into office and goes off gold

More Generally

Inflation (and real interest rates) matter for modeling response to all shocks:

- Stock/house prices
- Optimism / “Animal Spirits”
- Tax rebates, etc.

  Not just monetary shocks!

Simple macro models:

- r matters for intertemporal substitution (affects C, I)
- But is this the key mechanism?
- Role of banks may be crucial (e.g. credit constraints)
- Wealth effects of asset price responses

Digital Currencies

Suppose I invent the EmiDollar

- I have the "printing presses"

  (Can inject EmiDollars into your account, saved on my computer)
- I can make EmiFOMC announcements of interest rates on EmiDollars
- Does it matter?

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- I can make EmiFOMC announcements of interest rates on EmiDollars
- Does it matter?
  - No, but why?
  - No one sets prices in EmiDollars
  - Monetary actions will cause changes in EmiDollar ex. rate vs. USD$

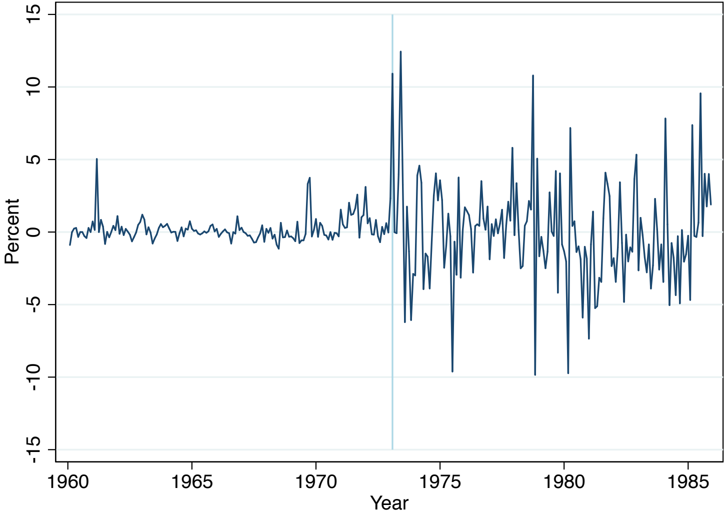
  Unit of account matters!

(Obvious analogy with Bitcoin)

Empirical Evidence on Inflation Dynamics

1. Micro evidence
   - Haircuts, washing machines, saltine crackers...
   - “Price rigidity”
2. **Macro evidence**
   - Discontinuity/ Heteroskedasticity-based identification
   - Regional data
   - “Phillips curves”

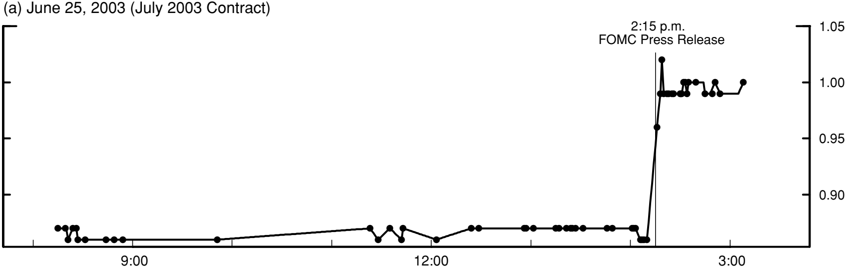
US/German Real Exchange Rate



Source: Nakamura and Steinsson (2018)

FOMC Announcements as Mini Experiments

Figure 1. Intraday Trading in Federal Funds Futures Contracts



Source: Gurkaynak-Sack-Swanson (2005)

Policy News Shock

Nakamura and Steinsson (2018):

- Simple summary statistic for Fed actions
- First principle component of changes in 5 interest rate futures
  - Fed Funds futures, Eurodollar futures
  - Span year after FOMC meeting

    (Similar to GSS 05 "path factor")
- Sample period 2000-2014

TABLE 1

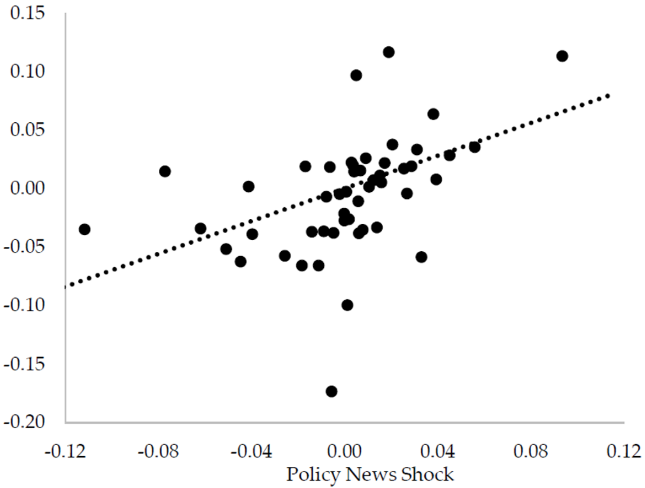
Response of Interest Rates and Inflation to the Policy News Shock

	Nominal	Real	Inflation
2Y Treasury Yield	1.10	1.06	0.04
	(0.33)	(0.24)	(0.18)
5Y Treasury Yield	0.73	0.64	0.09
	(0.20)	(0.15)	(0.11)
10Y Treasury Yield	0.38	0.44	-0.06
	(0.17)	(0.13)	(0.08)
2Y Treasury Inst. Forward Rate	1.14	0.99	0.15
	(0.46)	(0.29)	(0.23)
3Y Treasury Inst. Forward Rate	0.82	0.88	-0.06
	(0.43)	(0.32)	(0.15)
5Y Treasury Inst. Forward Rate	0.26	0.47	-0.21
	(0.19)	(0.17)	(0.08)
10Y Treasury Inst. Forward Rate	-0.08	0.12	-0.20
	(0.18)	(0.12)	(0.09)

Source: Nakamura-Steinsson (2018). Window: 30-minutes.

Effect of Monetary Shocks on Real Rates

Figure 1: Binned Scatter Plot for 5-Year Real-Yield Regression



Source: Nakamura-Steinsson (2016)

Price Rigidity and Coordination Failure

How long can price rigidity persist?

- Nominal price stickiness not the whole story!
  - Staggered price setting
  - Strategic complementarity among price setters
    (firm A's optimal price increasing in firm B's price)
- These features can potentially interact to create a lot of sluggishness
  - Pass-through regressions

Empirical Evidence on Inflation Dynamics

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2. Macro evidence
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   - **Regional data**
   - **“Phillips curves”**

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Reference: “The Slope of the Phillips Curve: Evidence from U.S. States” with Jonathon Hazell, Juan Herreno, Jon Steinsson

Phillips Curve

Classic literature attempts to estimate:

$$\pi_t = -\kappa(u_t - u_t^n) + \beta E_t \pi_{t+1} + \nu_t$$

- First term: Response to unemp. gap $u_t - u_t^n$
  - Measure of aggregate demand
  - κ is "slope" of Phillips curve
  - "Old Keynesian" Phillips curve
- Second term: Expected inflation $E_t \pi_{t+1}$
- Third term: supply shocks: ν_t

Phillips Curve: Identification

How to estimate?

$$\pi_t = -\kappa(u_t - u_t^n) + \beta E_t \pi_{t+1} + \nu_t$$

Challenge:

- π_t, u_t, and $E_t \pi_{t+1}$ are endogenous variables!

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Challenge:

- π_t, u_t, and $E_t \pi_{t+1}$ are endogenous variables!
    - *Very* challenging identification problem
    - OLS won't work
    - Similar to demand curve estimation

      (but with some added twists)
    - Not impossible!
    - But need careful identification approaches / instruments

Phillips Curve: Solved Forward

Can "solve forward" previous equation to get:

$$\pi_t = -\kappa E_t \sum_{j=0}^{\infty} \beta^j \tilde{u}_{t+j} + E_t \pi_{t+\infty} + \omega_t$$

Notes:

- $\tilde{u}_{t+j}$ is cyclical unemployment
- First term reflects Phillips curve slope

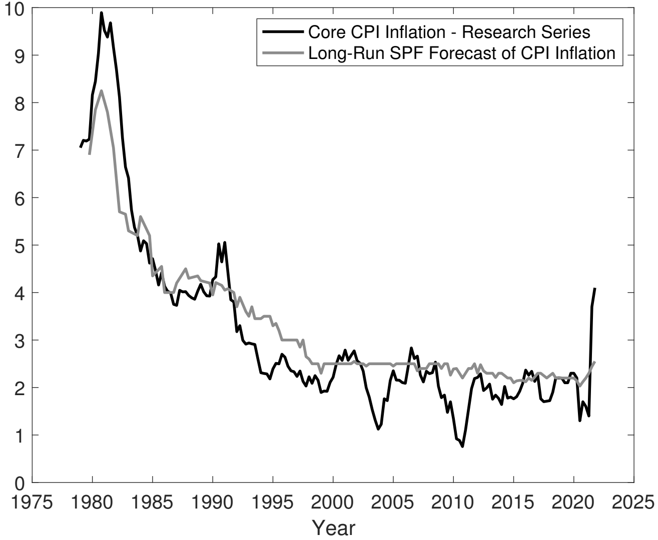
  discounted present value $\rightarrow$ persistence matters
- Second term is long run inflation expectations $E_t \pi_{t+\infty}$

The Role of the Long-Run Inflation Target

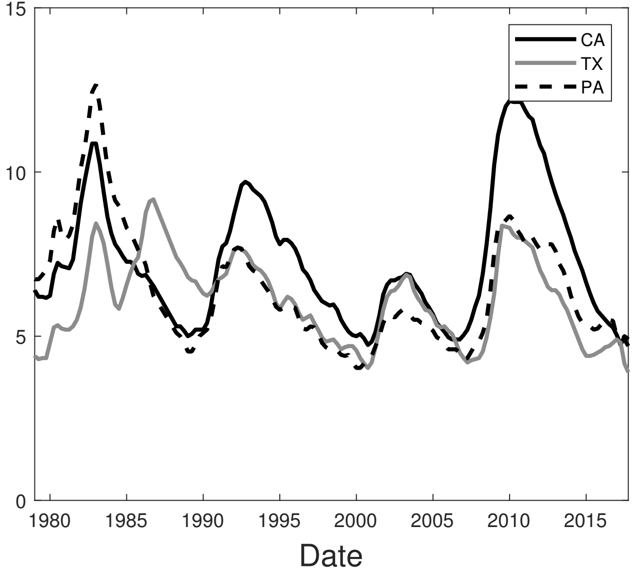
$$\pi_t = -\kappa E_t \sum_{j=0}^{\infty} \beta^j \tilde{u}_{t+j} + E_t \pi_{t+\infty} + \omega_t$$

- Long-run inflation target major determinant of current inflation
  - Has a coefficient of one
  - Current inflation moves one-for-one with beliefs about long-run inflation target
- Inflation can vary without **any** variation in output gap, purely due to $E_t \pi_{t+\infty}$
  - Potentially a source of severe omitted variables bias when estimating κ

Long-Run Inflation Expectations



Regional Business Cycles



Regional Phillips Curves?

Regional Variation:

- Texas goes into boom but Illinois does not

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Could we use diff-in-diff approach?

- How much does inflation rise in Texas *relative* to Illinois?

Regional Phillips Curves?

Regional Variation:

- Texas goes into boom but Illinois does not

Could we use diff-in-diff approach?

- How much does inflation rise in Texas *relative* to Illinois?
- Panel data has many advantages
  - More datapoints, more options for identification

Regional Phillips Curves: Critiques

- Not obvious we can use slope of *relative* Phillips curve to learn about slope of *aggregate* Phillips curve
- Regional analysis is about "relative" prices
(not aggregate inflation)
- Fundamentally different experiments

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Problem of external validity

Regional Phillips Curve: Simple model

- Simple structural model implies:

$$\pi_{Ht}^{N} = -\kappa E_t \sum_{j=0}^{\infty} \beta^j \tilde{u}_{H,t+j} - \lambda E_t \sum_{j=0}^{\infty} \beta^j \hat{p}_{H,t+j}^{N} + E_t \pi_{t+\infty} + \omega_{Ht}^{N},$$

- Long-run inflation expectations are constant across regions and can be replaced with time fixed effects:

$$\pi_{Ht}^{N} = -\kappa E_t \sum_{j=0}^{\infty} \beta^j \tilde{u}_{H,t+j} - \lambda E_t \sum_{j=0}^{\infty} \beta^j \hat{p}_{H,t+j}^{N} + \gamma_t + \omega_{Ht}^{N},$$

Even beyond this exact equivalence, may still be informative about κ (Nakamura and Steinsson, 2018; Andrews, Gentzkow and Shapiro, 2020)

AN ASIDE: WHAT IS κ?

- Neoclassical model: Very large κ
  - Prices respond efficiently
- Keynesian model: Small κ
  - Is this all about price rigidity?
  - No!
  - Price rigidity easiest to measure
  - But κ small largely due to "real rigidities"
  - Lack of full response conditional on price change
  - e.g., Wage rigidities, strategic complementarities in pricing, monopsony power, decreasing returns etc. (much harder to measure)

Regional Phillips Curve: Identification

Can leverage panel structure for identification

$$\text{Tradable Demand}_{i,t} = \sum_{x \in T} \bar{S}_{x,i} \times \Delta \log S_{-i,x,t}$$

- $\bar{S}_{x,i}$: Average employment share of industry x in state i over time
- $\log S_{-i,x,t}$: National employment share of industry x at time t
- Identifying assumption: supply shocks not simultaneously correlated with **both** shifts $\Delta \log S_{-i,x,t}$ **and** shares $\bar{S}_{x,i}$
- Intuition:
  - Oil boom increases labor demand and wages in Texas
  - "Demand shock" for Texan restaurants
  - Oil boom does not differentially affect production technology for restaurants in Texas

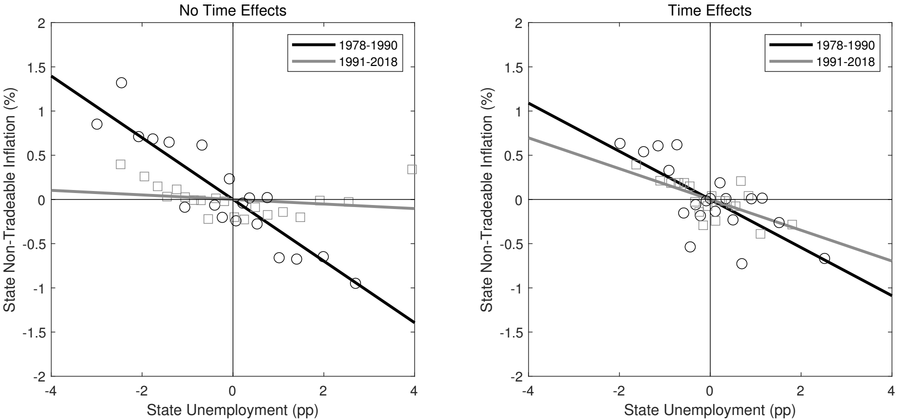


FIGURE: Scatterplots—Non-Tradeable Inflation and Unemployment

Regional identification (RHS) yields more stable Phillips curve; Much less flattening

Volcker Disinflation: Interpretation

- Volcker disinflation: Inflation fell *mostly* due to lower long-run inflation expectations (regime change)
  - Only $\approx$ 2% due to higher unemployment
  - Need supply shocks (oil shocks) to explain high inflation in early 80s

Volcker Disinflation: Interpretation

- Volcker disinflation: Inflation fell *mostly* due to lower long-run inflation expectations (regime change)
  - Only $\approx$ 2% due to higher unemployment
  - Need supply shocks (oil shocks) to explain high inflation in early 80s
- Underscores importance of long-run beliefs about inflation!
  - But how does the monetary authority change (keep control over) $E_t \pi_{t+\infty}$
  - Fundamentally hard!!
  - Sometimes beliefs do change rapidly

    (e.g., Volcker disinflation, ends of hyperinflations)
  - How does the Fed convince people that it is “serious” about inflation?

Digression: War Against the US Great Inflation

- Many (unsuccessful) attempts to curb inflation in 70's
  - Nixon 1971: Wage and price controls
  - Ford 1974: Inflation "public enemy number one"

WIN: Whip inflation now

COURTESY: GERALD R. FORD PRESIDENTIAL MUSEUM

- Carter:
  - "Persistent high inflation threatens the economic security of our country"
  - Oct 1979: Appoints Paul Volcker Chairman of Fed

How Does One Change Long-Run Beliefs?

- In 1979/80 the newly appointed chairman of the U.S. Federal Reserve, Paul Volcker
  - Sets as a goal to bring inflation below 4%
  - Dramatically raises interest rates
  - Fed funds rate reached record high of 20% in 1980!
- Volcker tightened policy dramatically
  - Caused massive recession
  - Didn't get fired
- Perhaps this was crucial in changing beliefs about long-run monetary regime

Lessons from the Past

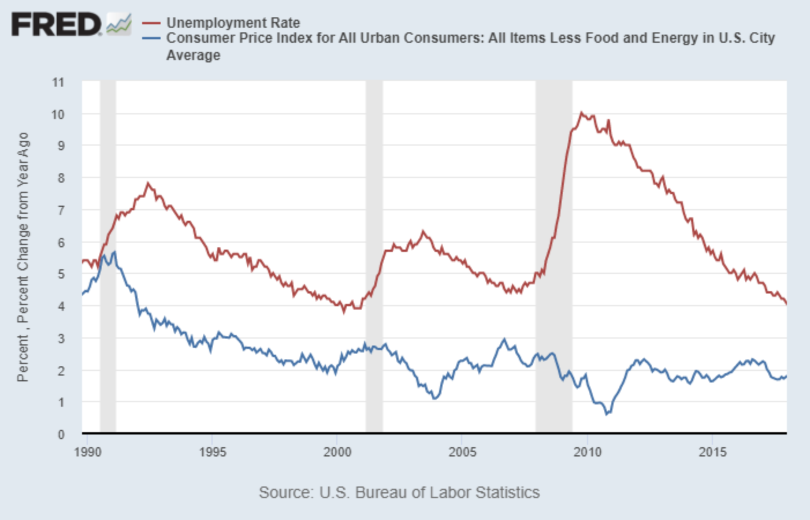
1. Long-run inflation expectations key driver of inflation
2. Demand-driven inflation:

   1% increase in unemp. $\rightarrow 1/3\%$ increase in inflation
   (Regional estimates)

   - Assumes stable inflation expectations
   - Normal shock persistence
3. Shelter/rent has highest κ
4. Hard to explain experience of 1970s/80s without supply shocks

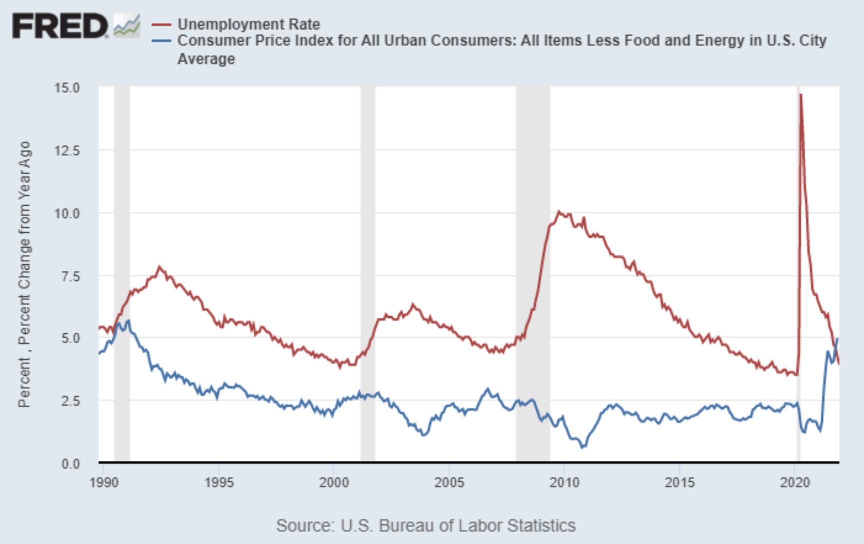
Core CPI and Unemployment: Pre-COVID, Post-1990

Pre-COVID:



Core CPI and Unemployment: 1990-2021

Including COVID:



The Current Situation

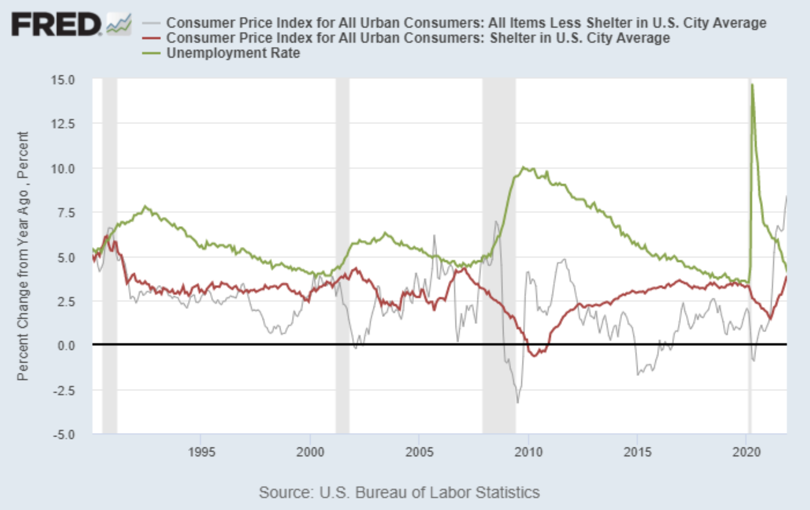
Initial Shock

- Unemployment spiked to historic levels
- Inflation fell by *much less* than $1/3\%$ for each 1% inc. in unemployment
- Why?
  1. Shock much less persistent: integral matters
     - Recall: $\kappa E_t \sum_{j=0}^{\infty} \beta^j \tilde{u}_{t+j}$
  2. Supply shocks
     - Sick workers, caring for sick workers, new safety regulations, etc. etc.

CPI: Shelter vs. Non-shelter

Green line: Unemployment

Red Line: CPI shelter   Grey Line: CPI Non-shelter



Last 9 Months

- Big spike in inflation
- Even though unemployment higher than pre-COVID

- Unemployment imperfect measure of labor market tightness
  - Vacancies very high
  - Unprecedented decline in labor force participation
  - Sectoral shifts in labor market
  - Unprecedented speed of recovery

Supply shocks are back!

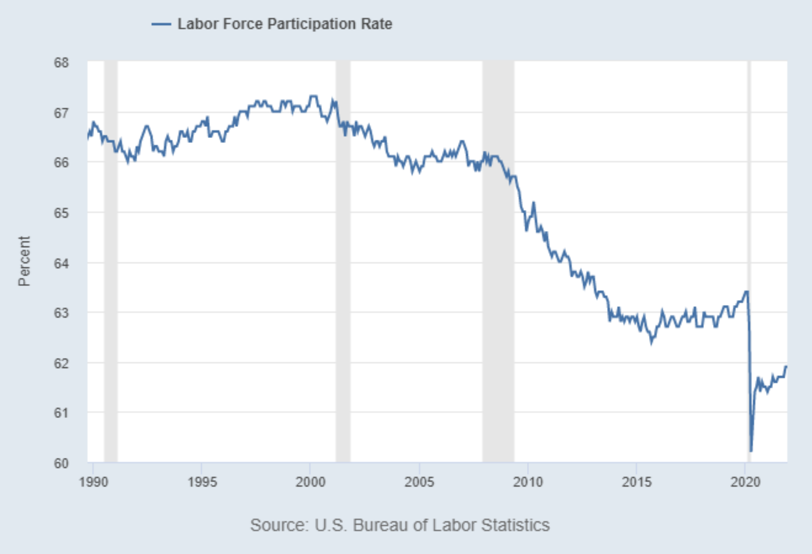
- Declining labor force participation
- Direct costs of COVID for firms
  (sick days, safety precautions etc.)

Also, relative price shocks

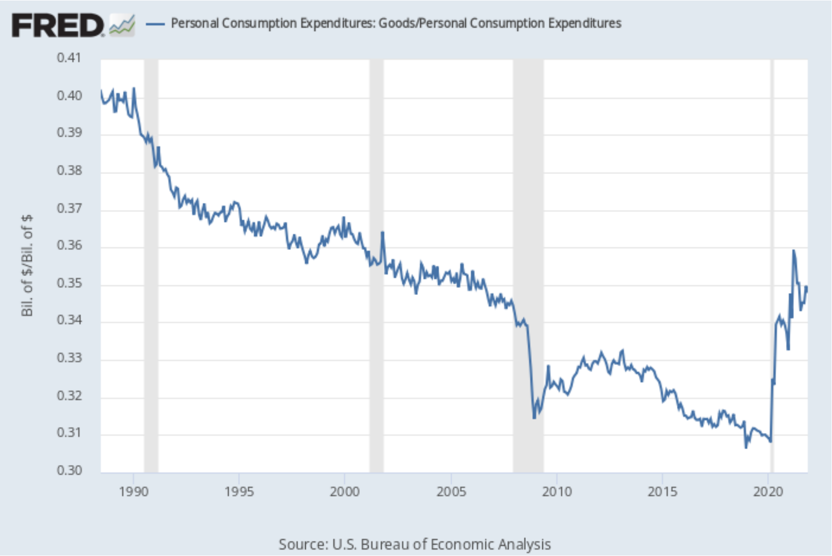
- Massive structural shift from services to goods
- "Looks like" supply shock in a model

1970s: Led to inflation expectations to become unhinged, pulling up nominal anchor

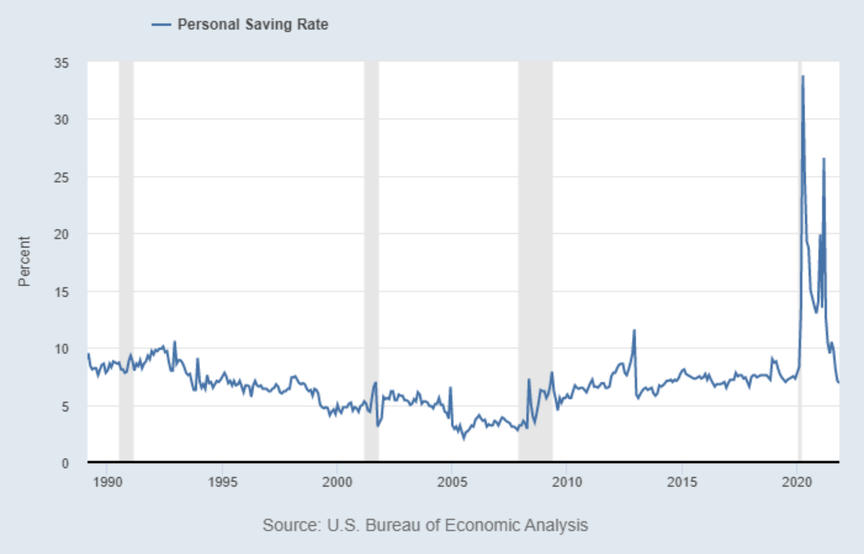
Labor Force Participation



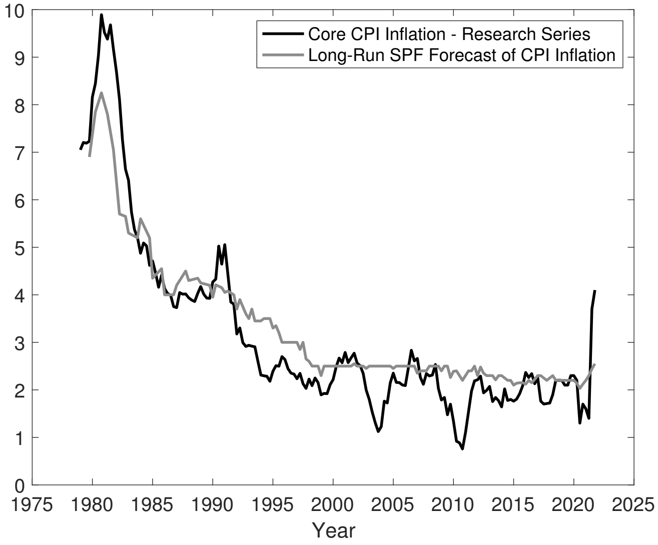
Goods Spending: Frac. Total Consumer Expenditures



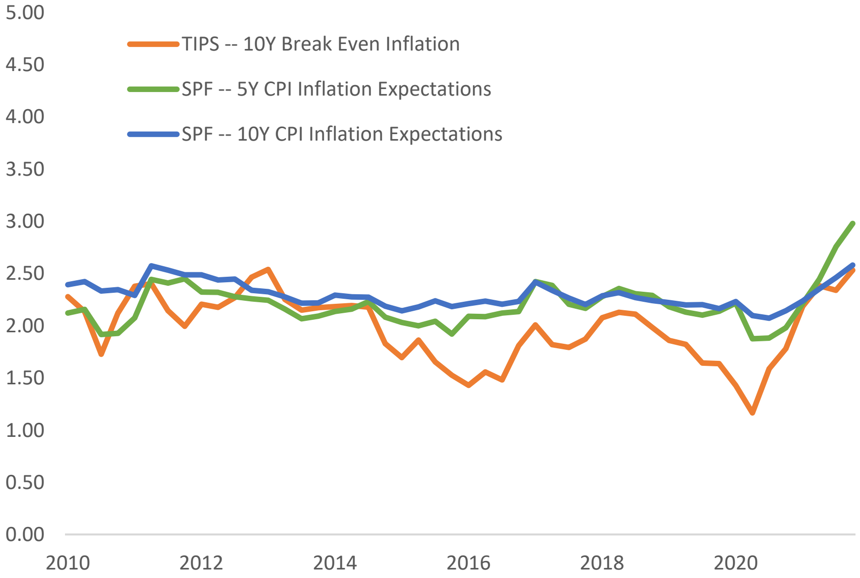
Personal Saving as Frac. Disp. Personal Income (BEA)



Long-Run Inflation Expectations



Alterative Measures: Long-Run Inflation Expectations



CONCLUSION

Understanding “unit of account” crucial in understanding many phenomena in economics and finance

- Inflation, real interest rate
- Monetary policy
- Digital currencies

Many approaches to studying have synergies

- Micro/granular data
- Natural experiments
- Discontinuity/based
- Structural modeling