Inflation in the Great Recession and Gradual Recovery

Robert G. King

Boston University

Inflation modeling circa 2007

- Standard “New Keynedian” model in textbooks, policy models.
- Incorporated long-standing view that inflation lagged real activity (Conference Board) and estimation of price-wage sectors
- Incorporated view that optimizing price-setting is forward-looking when there are adjustment frictions

2007 Specification

$$\pi_t = fE_t\pi_{t+1} + l\pi_{t-1} + cs_t + gx_t$$

- Rationalized by exogenous adjustment opportunities (Calvo) or quadratic adjustment costs (Rotemberg)
- Lurking in background: changing frequency of price adjustment

Questions on specification circa 2007

- Why is *l* not zero?
- How big is *f* relative to *l*?
- Do these sum to 1 or close to it?
- How to measure expectations? Surveys or RE approaches?
- What x's are important?
- If x is real and *f*+*l*=1, then what determines long-run inflation? (monetary policy, but how?)

2007 Specification: strategies on “s”

- Strategy #1: s is marginal cost or desired price measure, in which wages and productivity enter.
  - Inflation equation is one part of wage-price block, so additional modeling required.
  - Employed in many DSGE models (e.g., Smets-Wouters) and larger central bank policy models (e.g., FRB-US)
- Strategy #2: s is a macro slack measure skipping process of wage determination
  - Focus on finding best slack measure (e.g., output gap versus unemployment)
  - Develop model more immediately useful for linking inflation and real activity

Historical experience and research since 2007 and topics of project

- Topic 1: Recent accounts of inflation since 2008 using diverse methods (Watson, Yellen) use a very different framework, which emphasizes long-run inflation expectations: a "trend inflation view" that views expectations as anchored during 2008-16. How satisfactory is this account and how different would it be if shorter term expectations were employed?
- Approach: Use survey expectations measures as in Roberts (1995) and more recent work by Fuhrer (2011, 2012, …) and calculation in "off the shelf" models.
- Motivation: period since 2008 historically unusual and RE methods might be misleading

Topics (continued)

- Topic 2: Since 2007, there has been a large research program started by Bils and Klenow (2004) that measures size and frequency of micro price adjustments. How does this work inform our understanding of the inflation process over 2008-2016?
- Approach: constrained by access to micro data, use summary measures from Klenow and Kryvstov (2008) and Nakamura and Steinsson (2008) to frame issue. Use summary data from Berger and Vavra (2015) to explore 2008-2011.
- Motivations: Does evidence resolve historical puzzles identified in first topic? What are implications for modeling? What types of public access series would be usefully produced?

Topics (cont'd)

- Topic 3 (not included, as not settled): Many modelers circa 2007 followed Gali and Gertler (1999) and Sbordone (2002) in using real unit labor cost (labor's share) within strategy #1
- Approach: rework using alternative measures of cost and productivity
- Motivation: Behavior of labor's share since 2000 meant that this RULC approach has gone badly off target, as King and Watson (2012) stress.

More general inflation model

- Add long-run inflation expectation τ (expectation about trend inflation) .

$$\pi_t = m\tau_t + fE_t\pi_{t+1} + l\pi_{t-1} + cs_t + gx_t$$

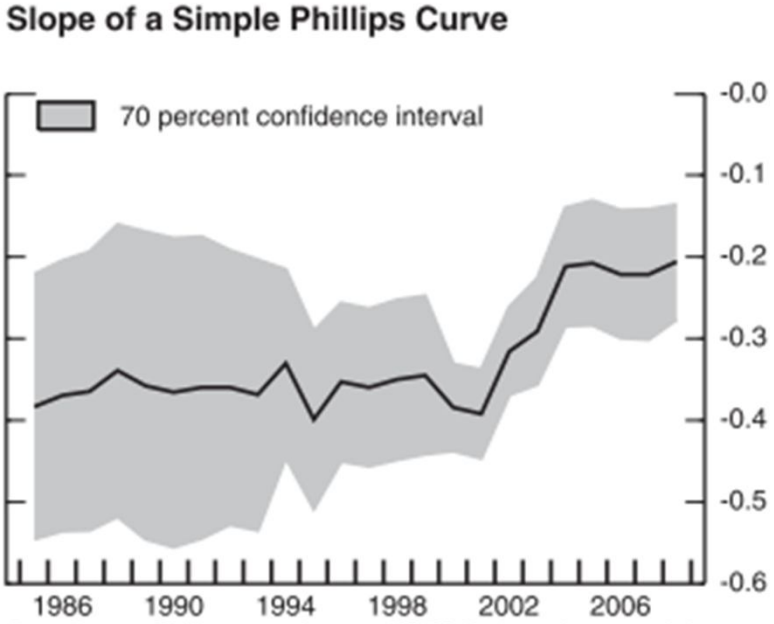
- Some cases (x real)
  - Accelerationist model (*f*=m=0, *l*=1)
  - Trend inflation model (*f*=0, *m*+*l*=1)
  - Standard NK model 2007 (*m*=0, *f*+*l* close to 1)
    - Purely forward-looking *l*=0, *f* close to 1
    - Representative (Fuhrer-Moore *f*=*l*=1/2)

Making issues concrete: looking back at FOMC in June 2009

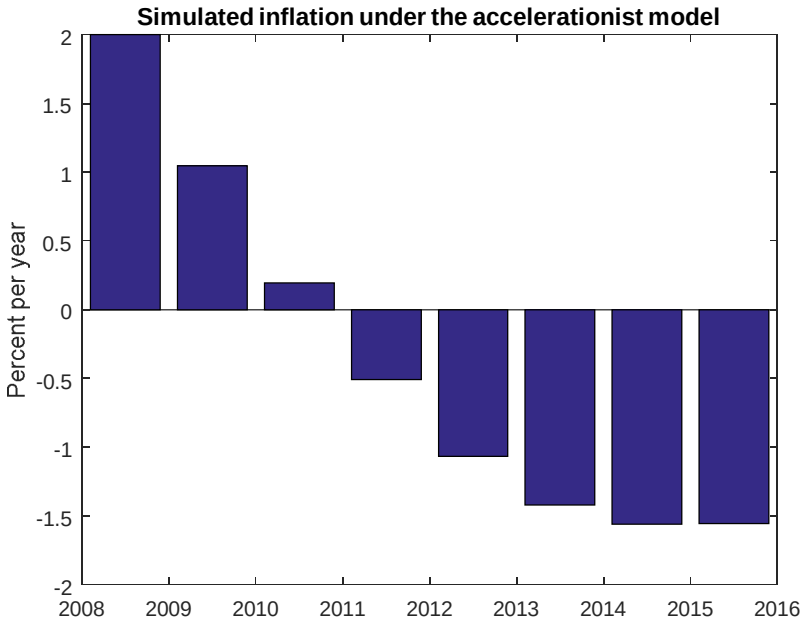
- Economy starting to turn around.
- Unemployment close to 10% and forecasted to remain high for an extended period
- Inflation had fallen dramatically in late 2008 and early 2009 (by more than was understood at the time).
- What would future inflation look like? Concern that a deflationary spiral might occur
- Battery of models to illustrate range of possible outcomes:
  - Simple accelerationist-style OLS estimate;
  - FRBUS-based forecast with FFR at ZLB through end of 2012
  - DSGE model featuring difference between types of goods

An estimate and implicit threat

- Accelerationist slope estimated by 20 year rolling regressions
- Annual inflation with actual unemployment
  (June to June, from 2 percent in 2008 and 2009H1)

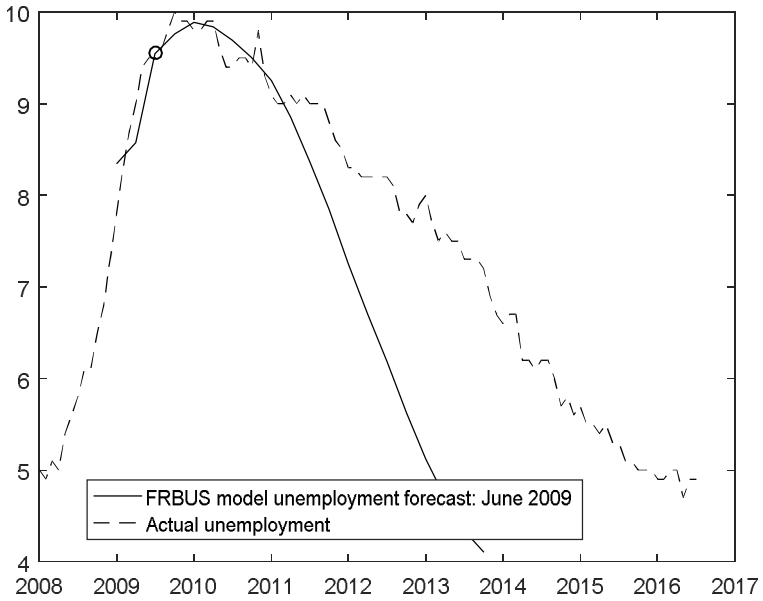


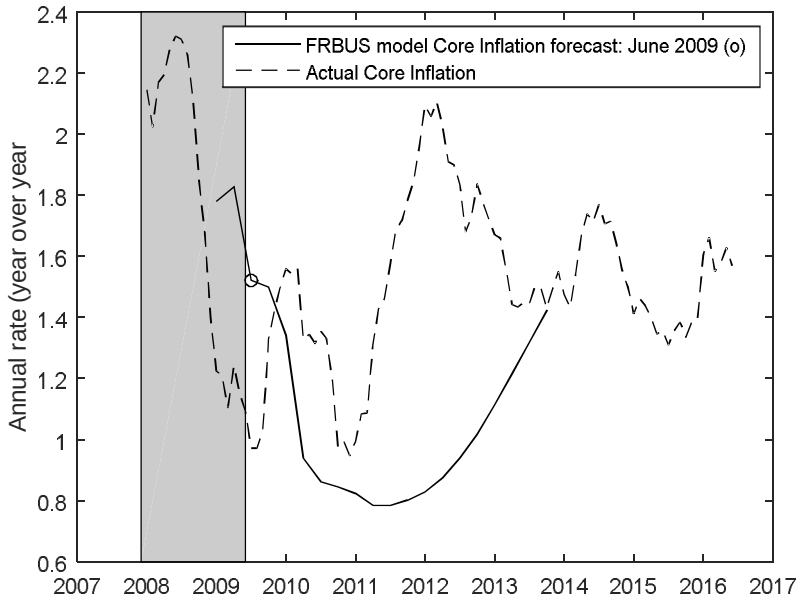
Note: From a Phillips curve for core PCE inflation using annual data and 20-year rolling estimation samples.



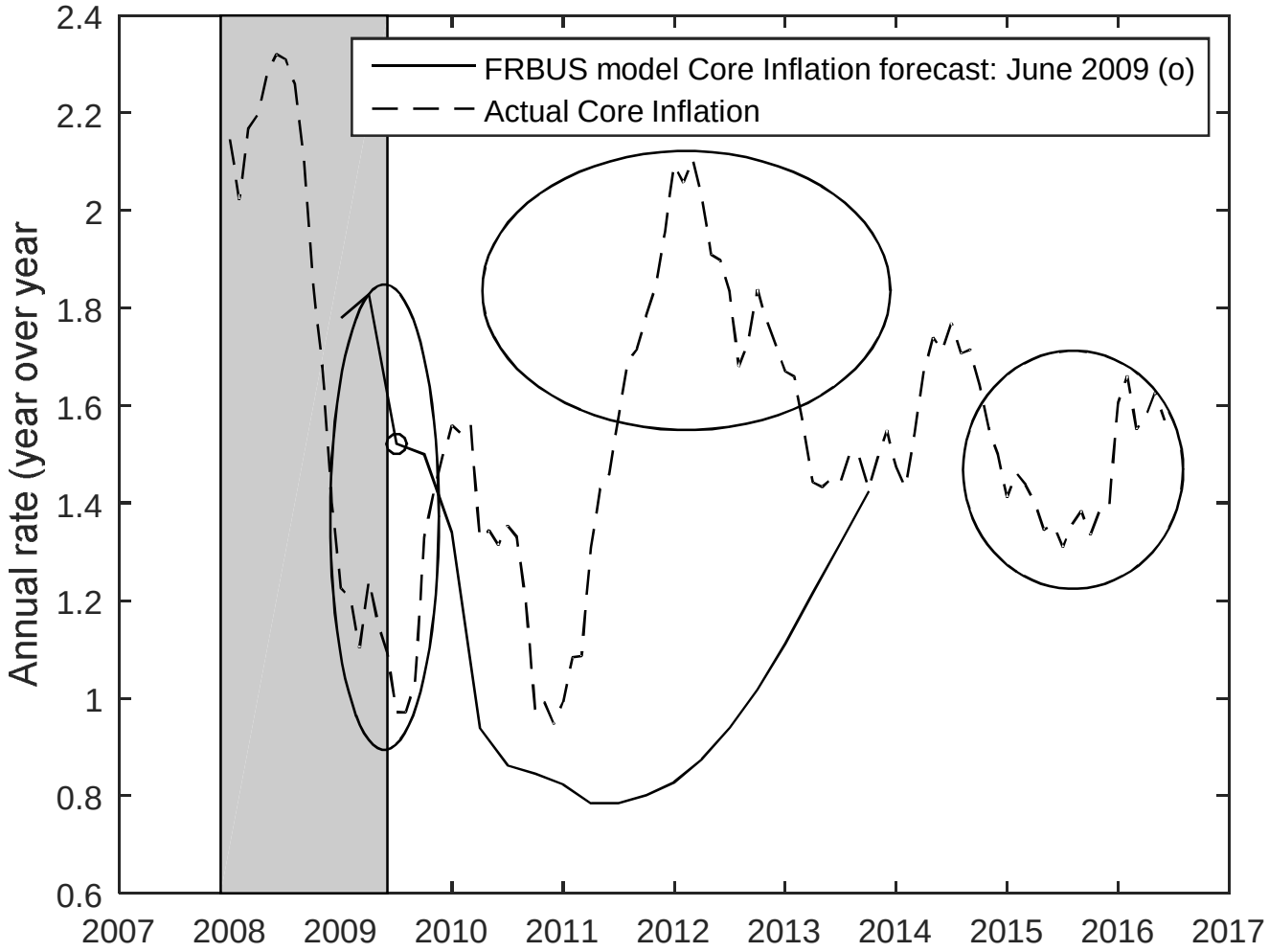
Forecasted and actual unemployment and inflation

- Unemployment forecasted to be persistently high
- Inflation more sluggish than unemployment but to ultimately return to 2%





Inflation surprises



Topic 1: Trend inflation and inflation dynamics

- Watson (2014) and Yellen (2015) study the behavior of inflation over lengthy samples using unemployment gaps as measure of slack, assuming with $m+l=1$ and with $f=0$.

$$\pi_t = m\tau_t + l\pi_{t-1} + cs_t + gx_t$$

- In Yellen (2015)
  - Two lags rather than one
  - SPF measure of 10 year Core PCE inflation forecasts, but relatively constant over 2008-2016
  - Constraint imposed m=.4 and sum of *l* coefficients=.6
  - Estimated c=-.08
  - Relative import price inflation as x variable

Key common implication

- Yellen slope and lag estimates: $c/(1-l)=-.20$
- Watson estimates

$$\pi_t = \tau_t + \beta(L)s_t + \gamma(L)x_t$$

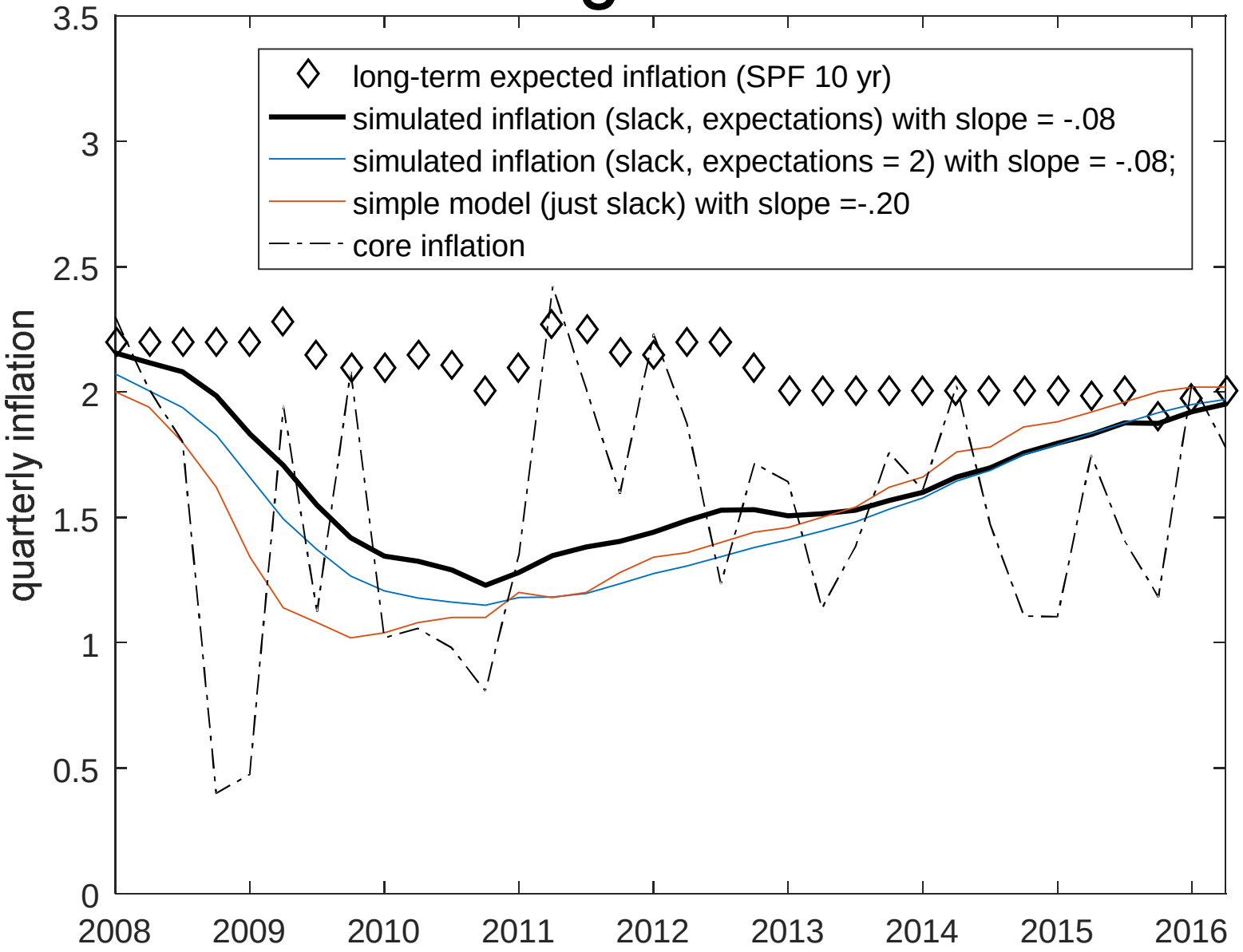
- Coefficient sum $\beta(1)$ is -.20 over 1960-2013, -.21 over 1960-83 and -.19 over 1984-2013.
- With trend at 2% and a 5% normal unemployment rate, persistent change implies

$$\pi_t \simeq 2 - .2*(u_t - 5)$$

Simulating Yellen model

- Initial condition: actual inflation 2008 Q1 & Q2
- No import shocks (but think not important for recent core inflation in Yellen or Watson)
- Slack is actual unemployment path minus 5%
- SPF 10 year as measure of trend inflation, but conduct an alternative with trend at 2%
- Compare to simple model just discussed
- Prediction is for quarter-to quarter inflation, while prior chart had year-over year.

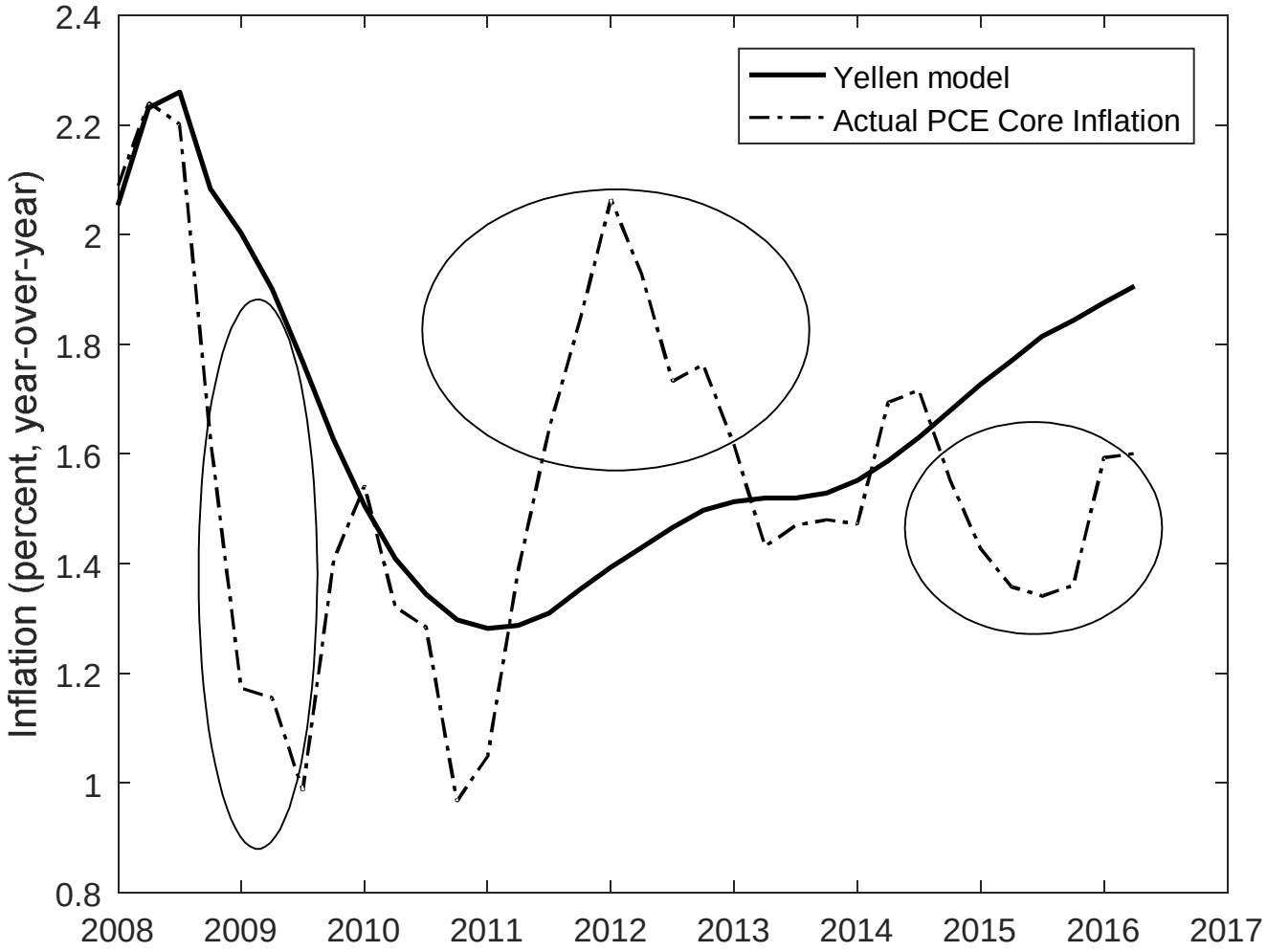
Accounting for inflation



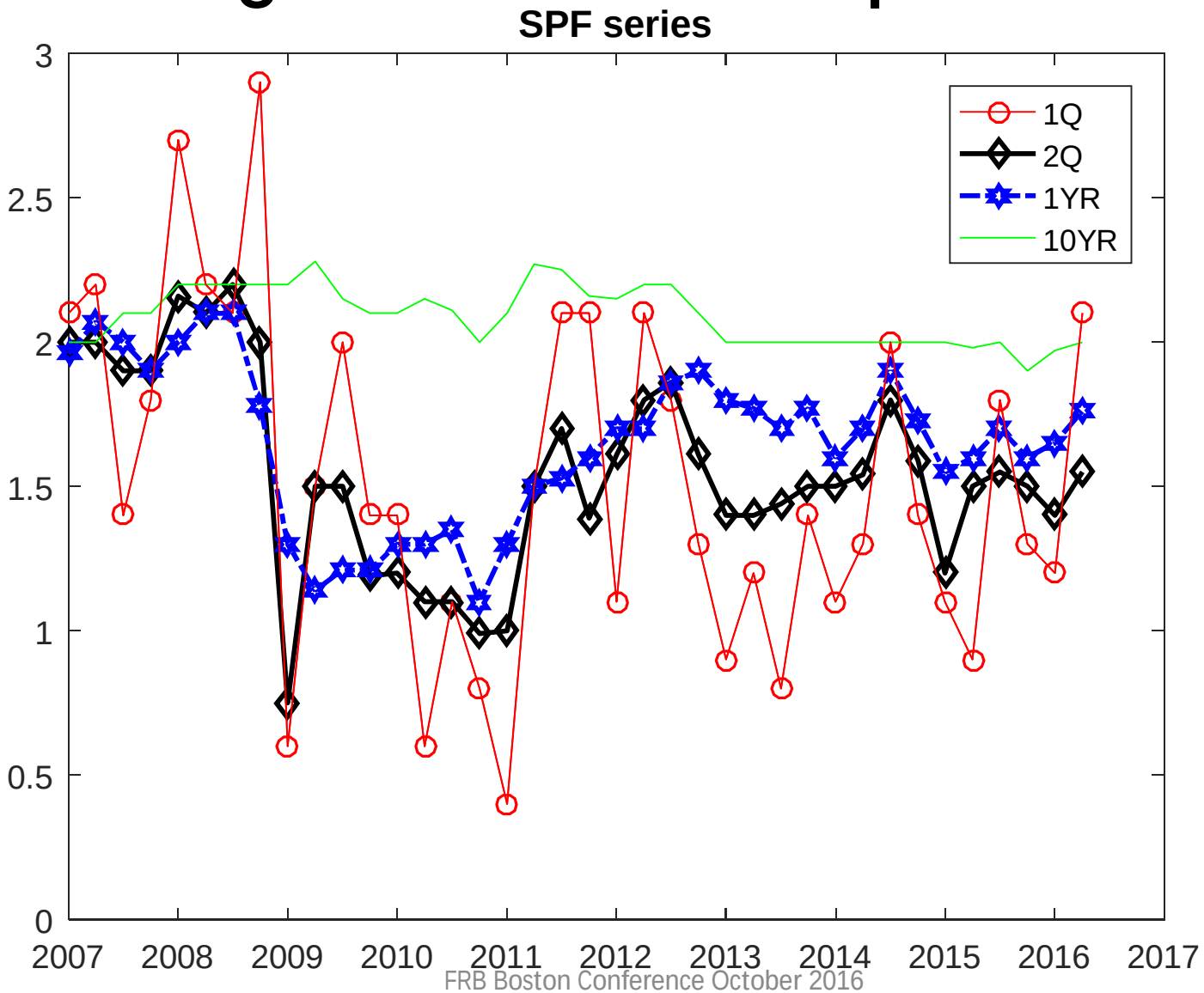
Comments and interpretation

- Inflation is sluggish relative to slack (recall **Simple model** is “just slack”)
- Differences between simulations based on **SPF10year** and **constant trend** (2%) are small (echoes results in Fuhrer (2011,2012)
- Surprises above are puzzles vis-a-vis this model:
  - Rapid inflation decline in 2009
  - Inflation around 2011 is too high
  - Recent inflation is too low

Version with annual inflation



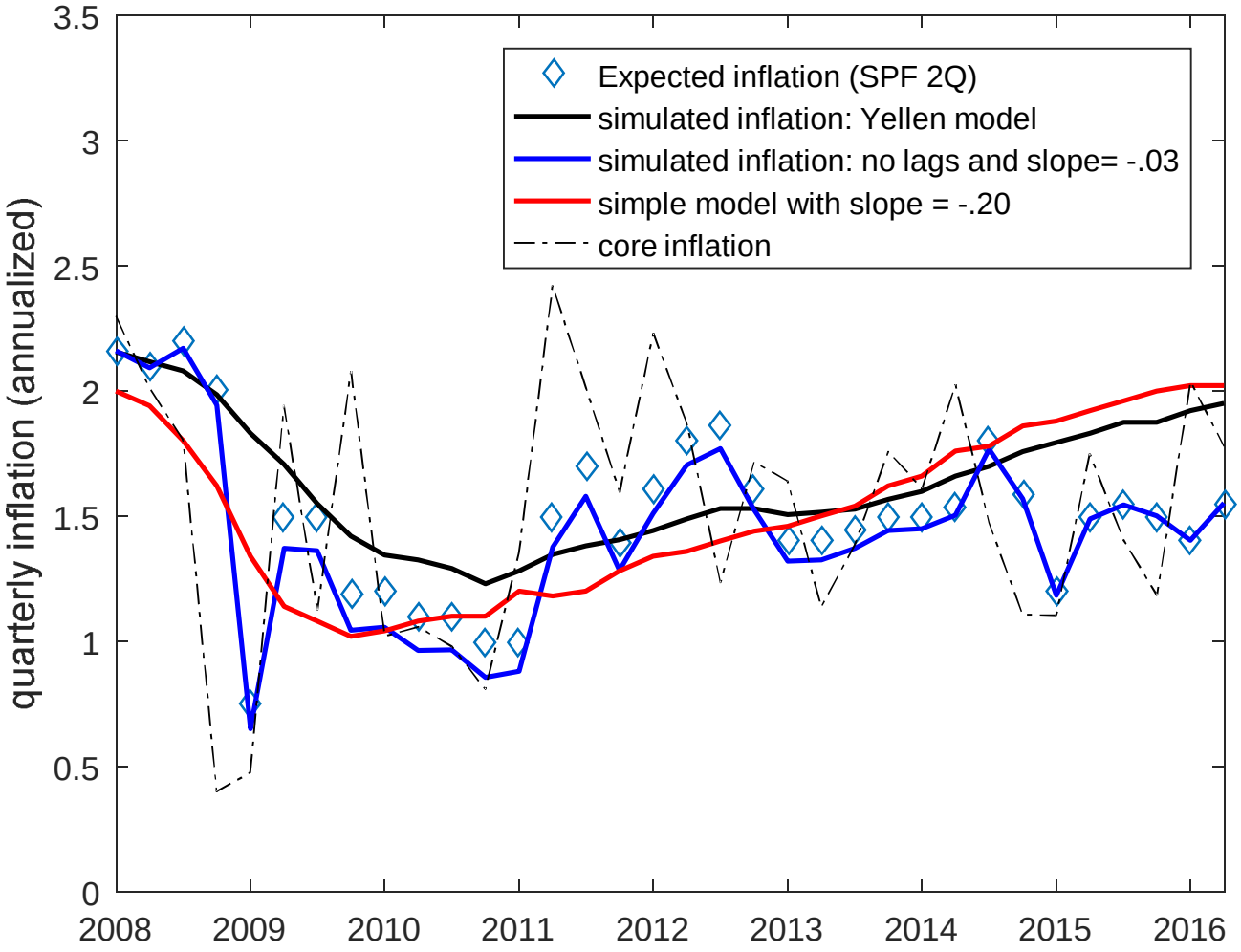
Missing short-term expectations?



Putting SPF measures into Yellen model

- The measures are much more volatile
- The measures co-vary with actual inflation
- With fixed slope, these can have deflationary implications just as in accelerationist model
- Empirical studies have found much smaller slopes (Fuhrer)
- Rather than estimate slope, I just use a smaller slope of -.03 to illustrate effect

Completely forward-looking model



Key dimensions related to puzzles

- All measures fall sharply in late 2008 and early 2009 but perhaps too late
- All measures rise during middle of period, but not enough
- All measures remain low in recent years

- Maybe we need shorter-term expectations to understand inflation since 2008

Topic 2: Micro Price Dynamics

- Since 2007, there has been a large literature devoted to studying micro price dynamics using the data underlying the construction of the CPI and, to a lesser extent, the PPI.
- Some of this literature can be interpreted (as I did at a FRB Boston conference in 2007) as suggesting that the standard NK model based on Calvo price frictions focuses on exactly the wrong margin.
- That is, I suggrested that we would be better off with a model of fixed size of individual price adjustments and a varying fraction of prices adjusted in this manner.

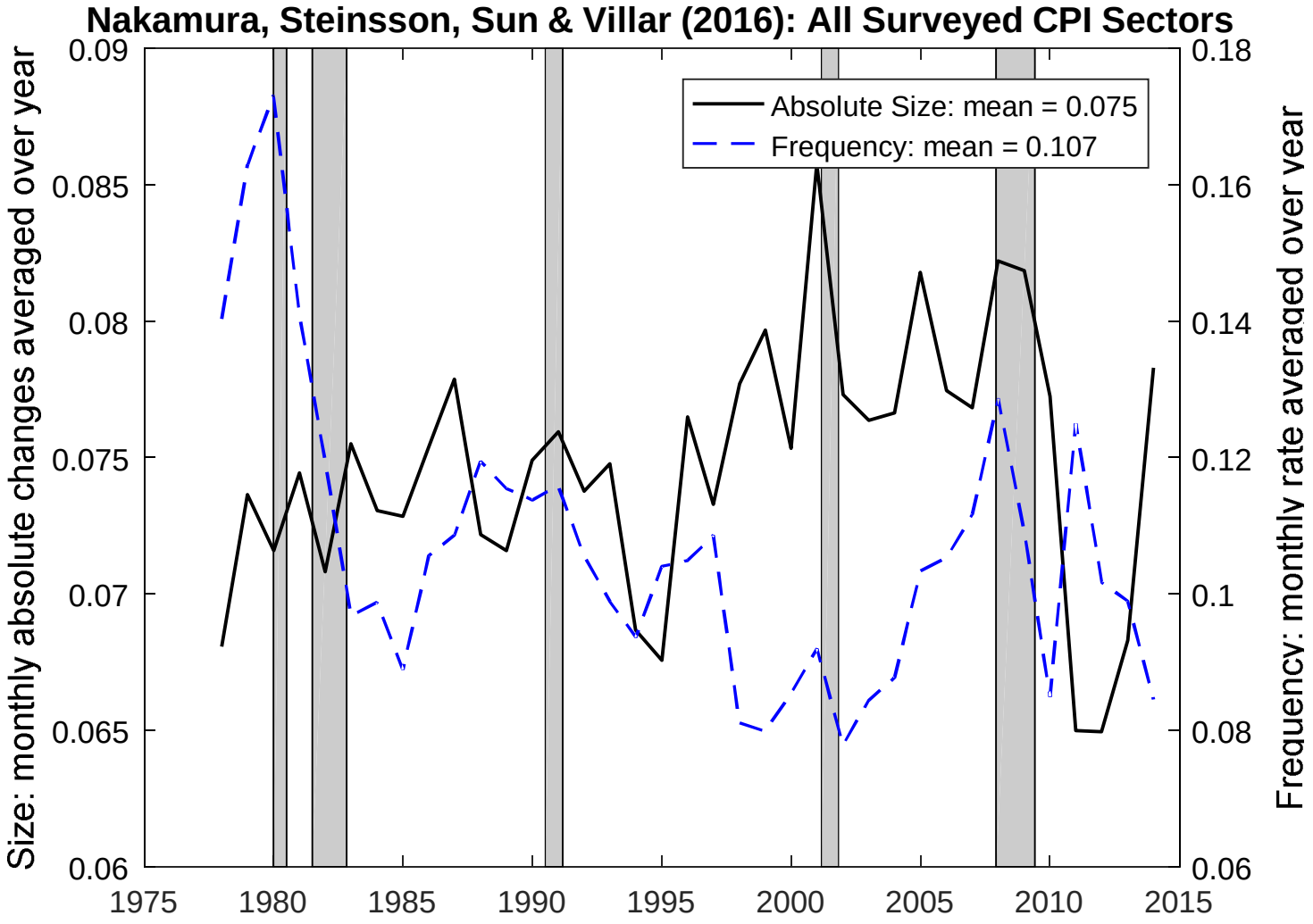
Conflicting evidence

- Nakamura-Steinsson:
  - Absolute size of price decreases larger than increases
  - Little change over time in size measures or the frequency of price decreases
  - Frequency of price increases moves with inflation
- Klenow and coauthors (Kryvstov, Malin)
  - Fraction of price changes in a period explains little of changes in inflation

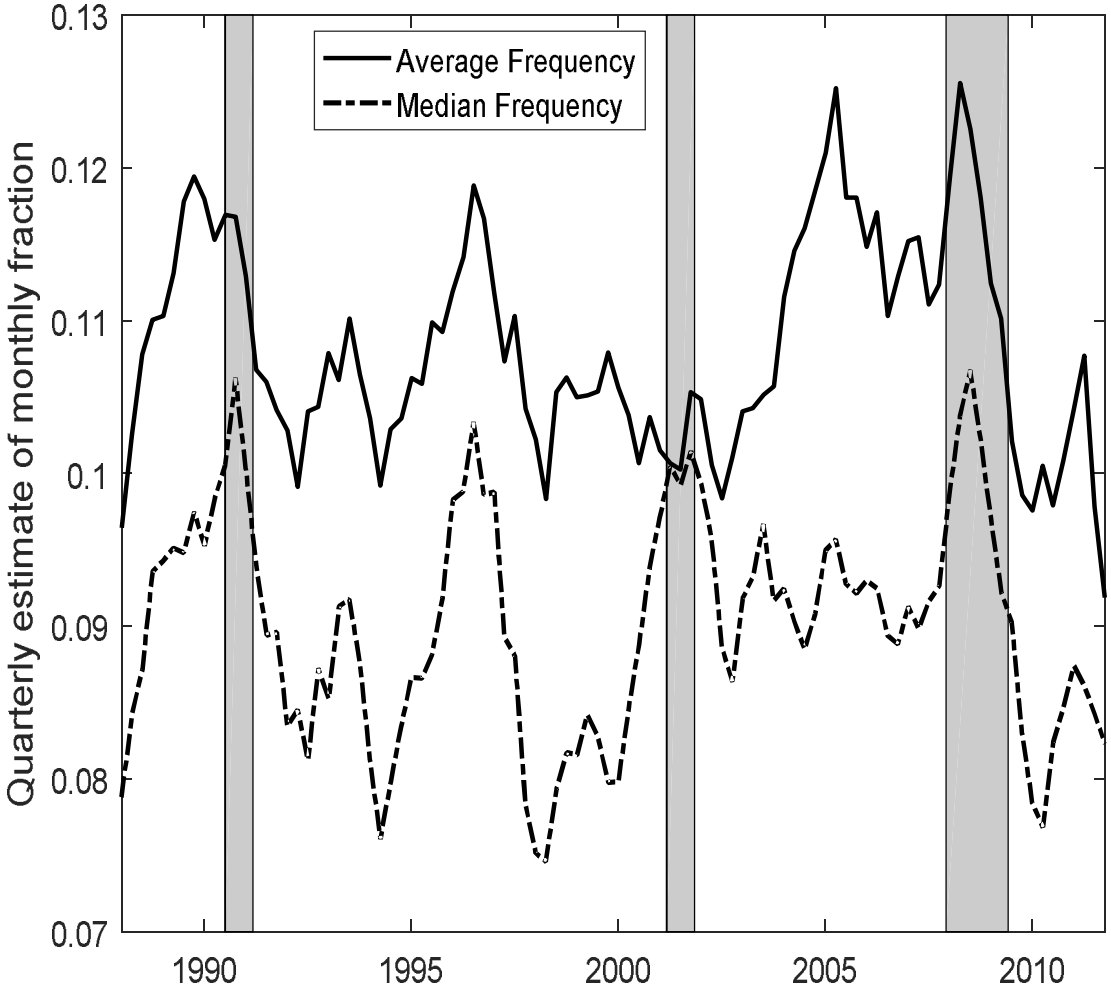
Questions

- What does more recent evidence produced by Berger and Vavra (2015) indicate? [disclaimer]
- In particular, what happened during Great Recession and Gradual Recovery?
- Can changing frequency help understand puzzling aspects of inflation?
  - Answer in a purely accounting sense
  - Vavra (2015) connects changing frequency to slope of Phillips curve, with greater flexibility in recessions, but do not explore that linkage here

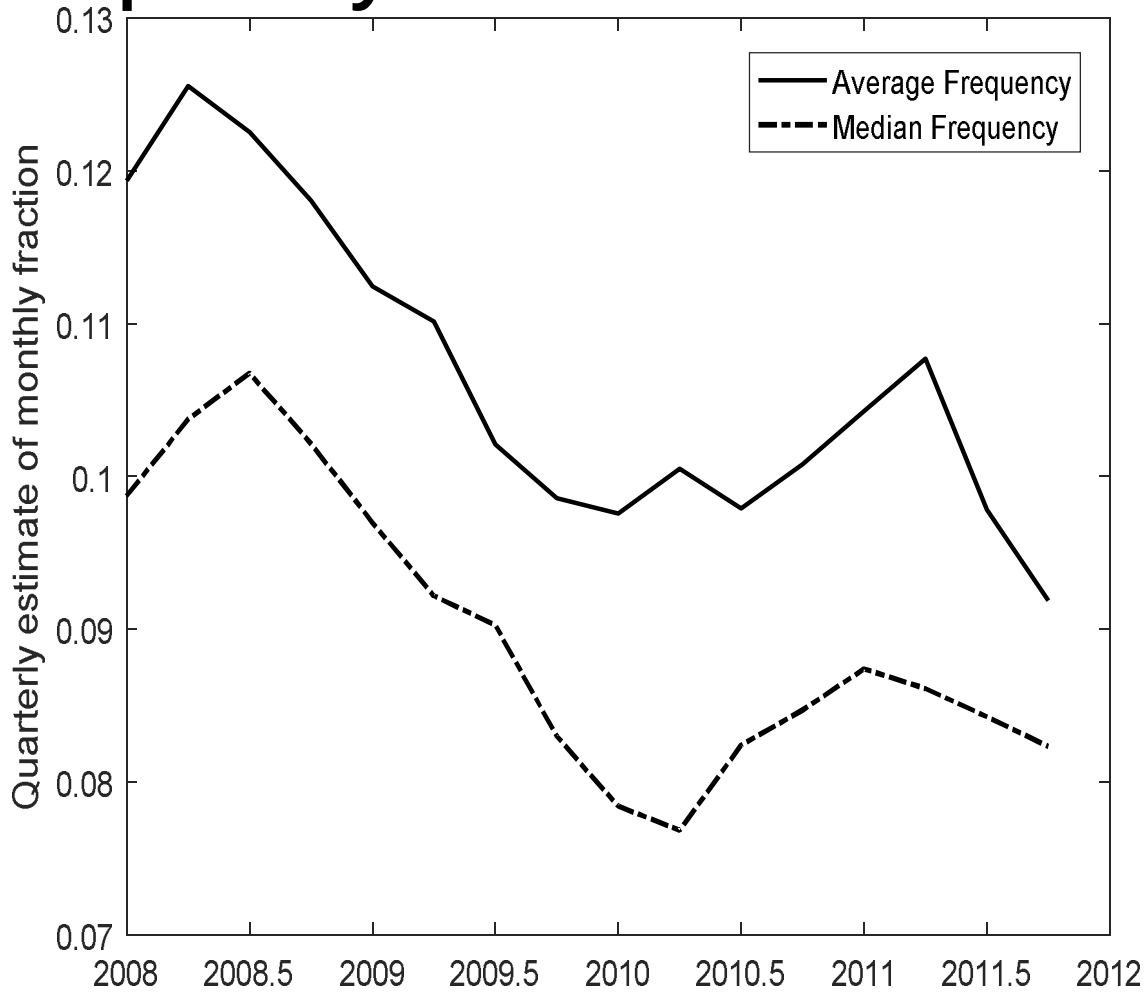
Long-term perspective on changing frequency



Frequency measures from Berger-Vavra: Average frequency like Klenow and coauthors, Median frequency (across sectors) like Nakamura and Steinsson



Looking more closely at BV frequency measures over 2008-11



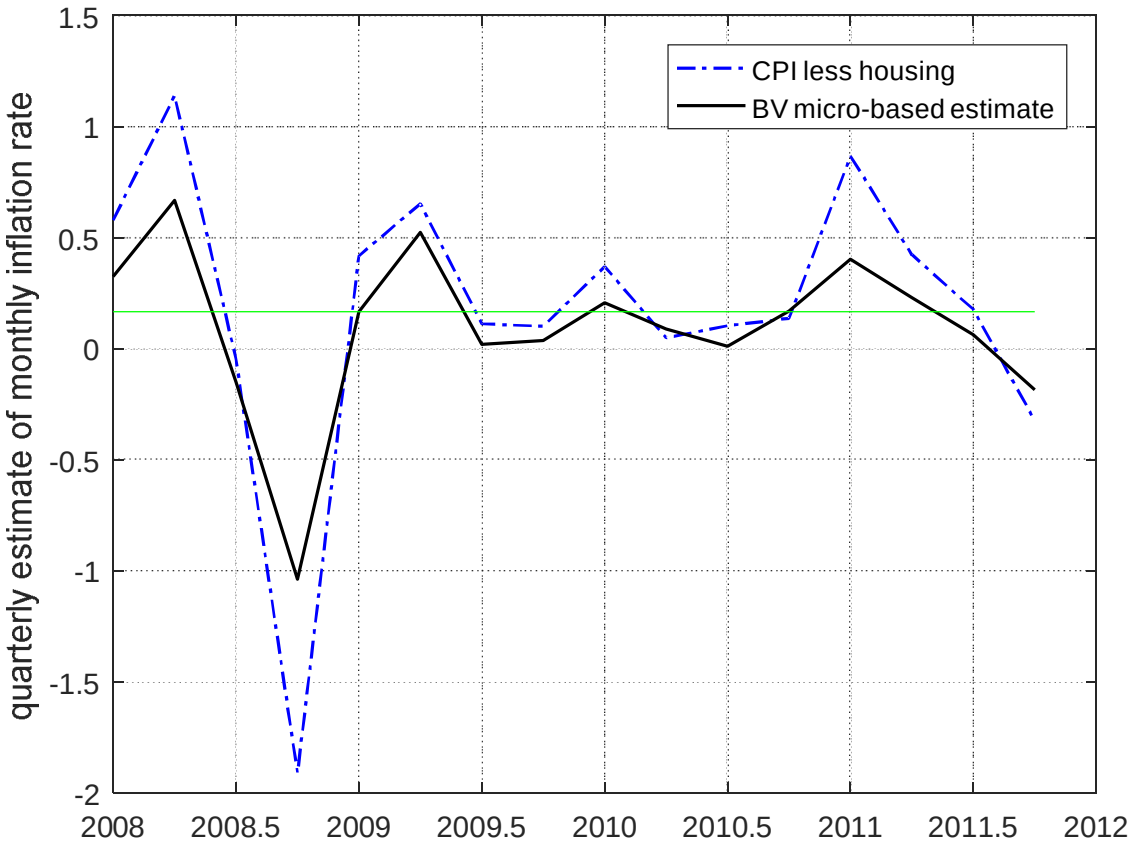
Breaking inflation into frequency and size

- Micro-based studies also concern only part of CPI, since shelter and used vehicles components are estimated in other ways
- Many micro-based studies define price adjustment as changes in “regular prices” which exclude sales and substitutions
- Micro-based inflation measures are thus smoother than published BLS indices

Caveat on results to follow

- Would ideally like to study micro-based CPI excluding food and energy
- But only have access (via Berger and Vavra) to summary data on measures including these components.

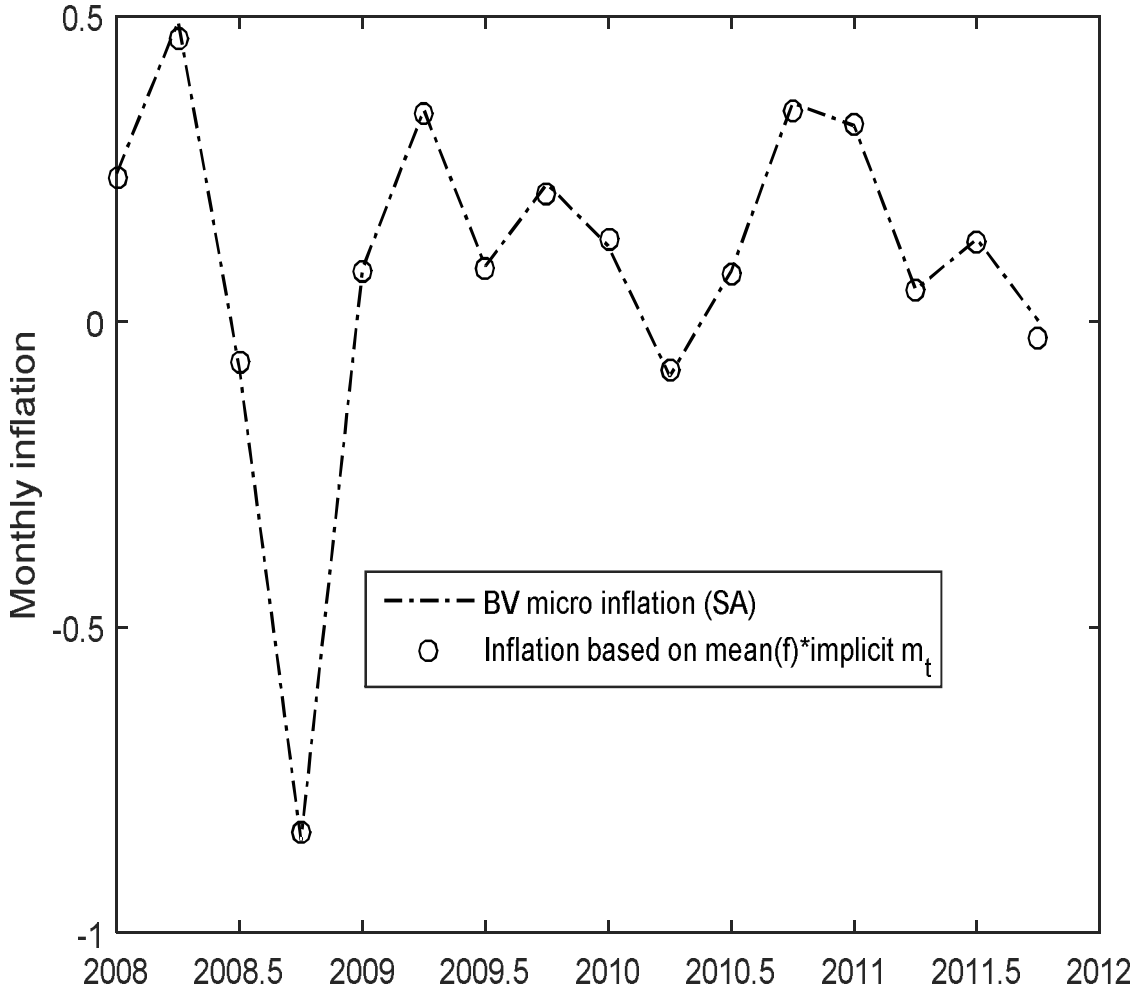
Behavior of inflation
(0.5% per month is 6% per year)



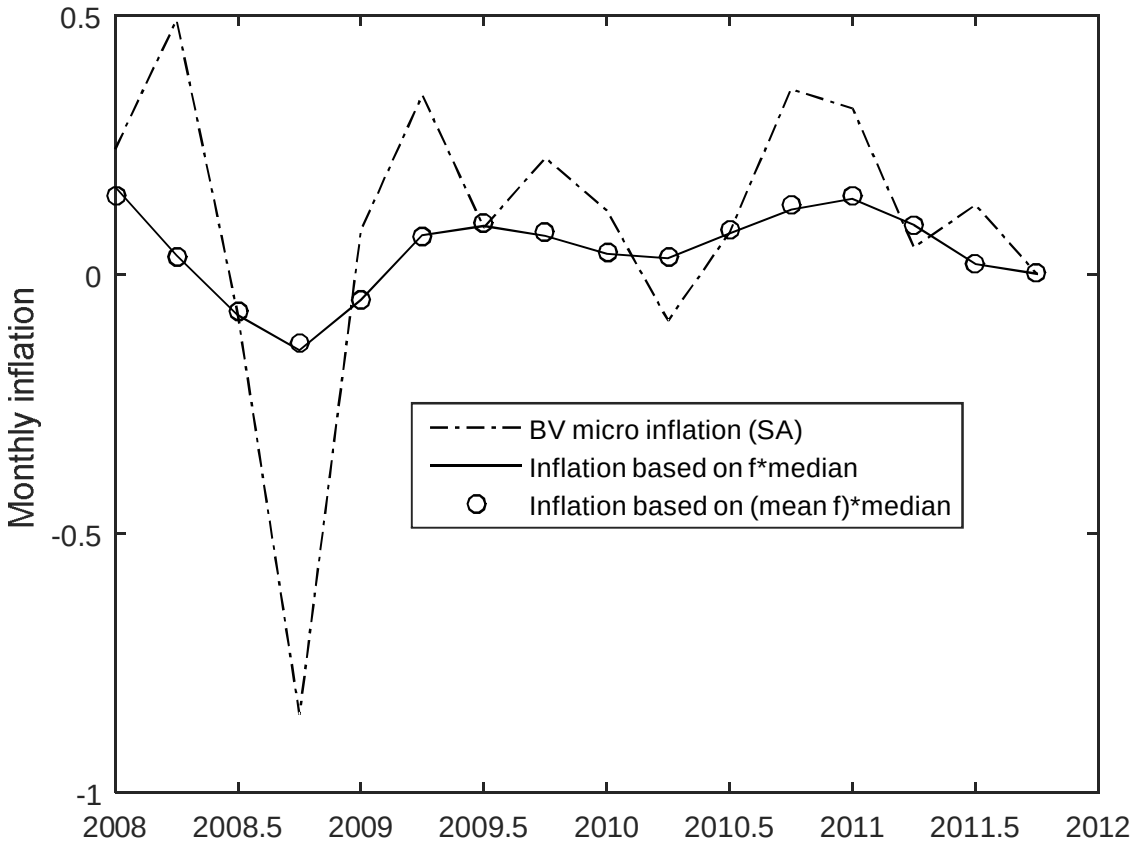
Decomposing inflation

- Klenow-Kryvstov: inflation is the product of the frequency of price change and the average size of price adjustment ($\pi_t=f_t*m_t$)
- Calculate implicit m as $m_t=\pi_t/f_t$
- BV provide data on median size of price adjustment, so employ this as alternative to implicit m.
- Question: what does inflation look like if frequency is fixed? Construct inflation with mean frequency, $\pi_t=f*m_t$

Constructed inflation with implicit mean



Actual inflation, median-based inflation with fixed and varying frequency



Interpretation

- For micro-based CPI including food and energy, variations in frequency are irrelevant over 2008-2011.
- Cannot help explain puzzling rapid drop in inflation in late 2008 or rise in inflation around 2011 (both of which are present in micro-based inflation estimate)

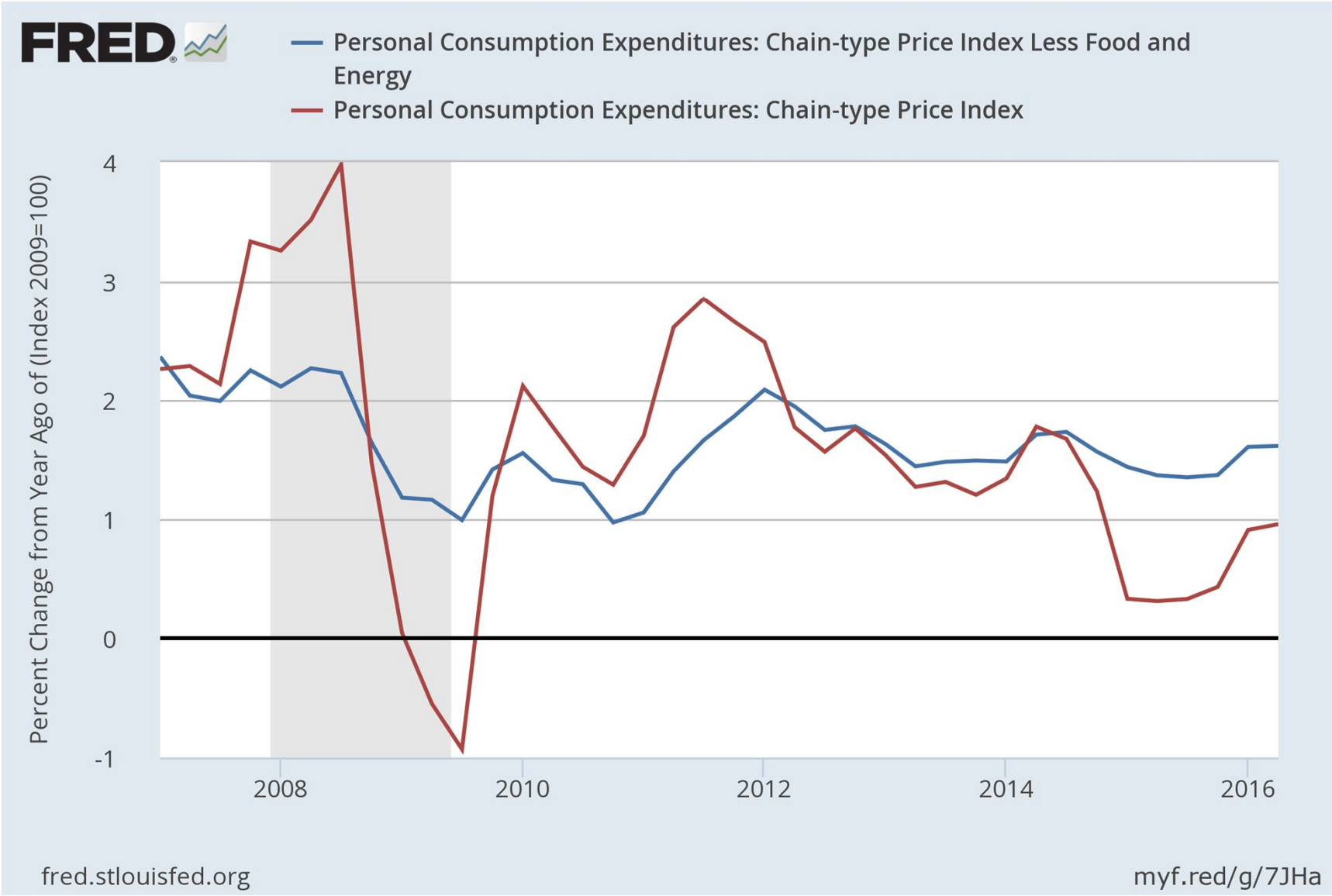
Comments on BLS research output

- BLS regularly produces some public access data of a "research series" form, for example "Labor force and employment smoothed for population control adjustments"
- It would be useful for academics working on micro pricing to help BLS create new pricing research series
- What I'd like to have had: micro-based components of CPI series plus breakdown into services, nondurables and durables with estimates of π_t, f_t and m_t

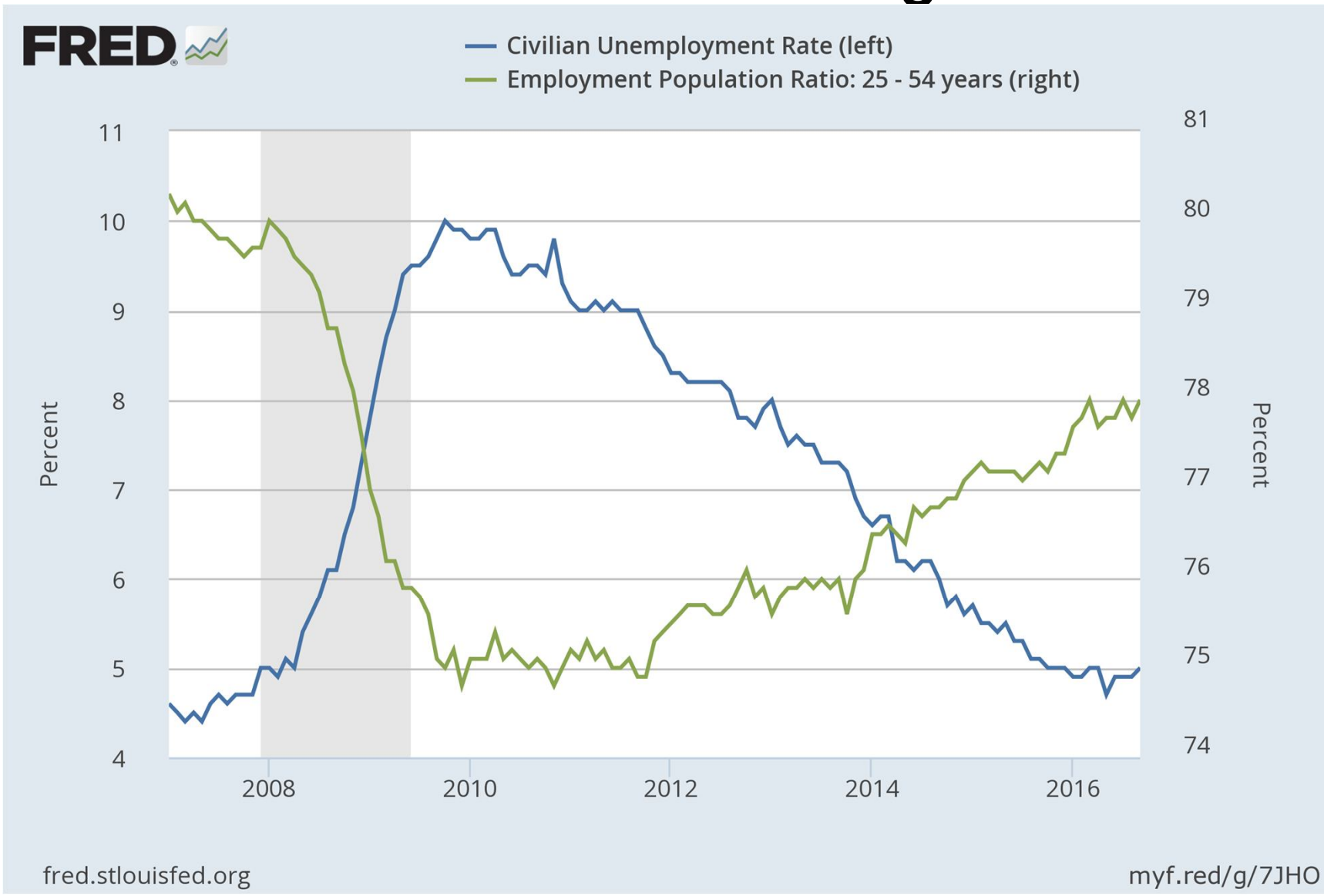
Summing Up

- Identified three aspects of core PCE inflation during the “Great Recession and Gradual Recovery” which are surprising vis-à-vis forecasts in June 2009 and puzzling vis-à-vis “anchored long-term expectations” model of Yellen
- Suggested that shorter-term inflation expectations may be omitted factor
- Explored possibility that changes in price adjustment frequency could help, but found no evidence (from CPI data imperfectly matched to task) that this was so.

Not core enough



Not slack enough



RULC, its components, inflation