THE FORMATION OF EXPECTATIONS, INFLATION
AND THE PHILLIPS CURVE

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HOW DO AGENTS FORM THEIR EXPECTATIONS?

- One of the most fundamental questions in macroeconomics, finance, and other fields in economics.
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- Inflation expectations play a central role in almost all key economic decisions

  - Prices and wages (Phillips curve): \( \pi_t = E_t \pi_{t+1} + \gamma \cdot \text{gap}_t \)

  - Consumption decisions (Euler eqtn): \( c_t = E_t c_{t+1} - \sigma [i_t - E_t \pi_{t+1}] \)

  - Investment decisions (Tobin’s \( Q \)): \( Q_t = MP_K / [i_t - E_t \pi_{t+1} + \delta] \)

  - Asset prices: \( p^{stock}_t = E_t D_{t+1} / (i_t - E_t \pi_{t+1}) + E_t p^{stock}_{t+1} \)

  - Central bank decisions (Taylor rule): \( i_t = \varphi_{\pi} E_t \pi_{t+h} + \varphi_x E_t x_{t+h} \)
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- Inflation expectations is a key object for central banks:
  - Alan Greenspan, “I am not saying what [inflation expectations] is a function of. We know it’s a very difficult issue, but that is the key variable. It’s important, but just because we can’t make a judgment as to what these driving forces are in an econometric sense doesn’t mean that it’s not real.”
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  - Ben Bernanke (2007): “How should we measure inflation expectations, and how should we use that information for forecasting and controlling inflation? I certainly do not have complete answers to those questions, but I believe that they are of great practical importance. … Information on the price expectations of businesses--who are, after all, the price setters in the first instance--… is particularly scarce.”
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  - Janet Yellen (2016): “Perhaps most importantly, we need to know more about the manner in which inflation expectations are formed and how monetary policy influences them.”
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- **Frameworks:**
  - Full-information rational expectations (FIRE)
  - Sticky-information
  - Noisy information
  - Bounded rationality
  - Learning
  - Non-rational expectations (adaptive)

  Rational Expectations models subject to frictions/costs.

  Rationality but no knowledge of the economy structure.
LET THERE BE FIRE

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  - Lucas critique (abandon “old” Keynesian economic models in favor of equilibrium models characterized by agents with rational expectations)
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- Phillips curve:
  - Old style: Phillips (1958), Samuelson and Solow (1960)
  - New Keynesian Phillips Curve = dominant framework
    - Micro-founded
    - FIRE-based
    - Forward-looking
MEASURING INFLATION EXPECTATIONS

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- Pushback to Prescott (Zarnowitz, Lovell, Manski, etc.): one should not discount data even if it’s inconsistent with a beautiful theory.
ALTERNATIVES TO FIRE

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• Learning
  ➢ Least-squares regressions to find relationships in the data
  ➢ Pick the model with the best fit from a menu of models

Rational Expectations models subject to frictions/costs.
PHILLIPS CURVE WITH FIRE

NKPC: $\pi_t = \beta E_t \pi_{t+1} + \kappa X_t + shock_t$
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  - **Missing disinflation**
MISSING DISINFLATION

![Graph showing missing disinflation trend]
Hall (2013): the Phillips curve is dead.
PHILLIPS CURVE WITH SURVEY MEASURES OF EXPECTATIONS

Challenges for the Phillips curve with FIRE

- Ad-hoc lags, instability and structural breaks
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- **Missing disinflation**
  - If we use household expectations, there is no puzzle
MISSING DISINFLATION

![Graph showing the relationship between unemployment gap and inflation gap.

- The graph plots the unemployment gap (x-axis) against the inflation gap (y-axis).
- Data points for different quarters are differentiated by color and shape: 1960Q1-1984Q4 (blue circles), 1985Q1-2007Q3 (green triangles), and 2007Q3-2013Q1 (red dots).
- A trend line is drawn to illustrate the relationship over time.

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Note: The graph visually represents the concept of missing disinflation, where the unemployment gap and inflation gap are not perfectly aligned as expected in a standard disinflation scenario.
## NKPC WITH AND WITHOUT FIRE

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No need to radically depart from the standard empirical specification of the Phillips curve.
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How is this possible?

Adam and Padula (2011): Without full-information, inflation

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\pi_t = (1 - \theta)(1 - \theta \beta) \sum_{j=0}^{\infty} (\theta \beta)^j F_tX_{t+j} + (1 - \theta) \sum_{j=0}^{\infty} (\theta \beta)^j F_t \pi_{t+j}
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where \( F_t Y_{t+j} \) denotes date-t forecast for variable \( Y \) at time \( t + j \).
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Test:  \( \pi_t = \beta \bar{F}_t[\pi_{t+1}] + b_1 X_t + a_2 \bar{F}_t[\pi_{t+2}] + a_3 \bar{F}_t[\pi_{t+3}] + \cdots + b_2 \bar{F}_t[X_{t+1}] + \cdots \)
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Outcome: we can’t reject the null of $a_2 = a_3 = \cdots = b_1 = \cdots = 0$
CHALLENGES IN USING SURVEY EXPECTATIONS

- Do we have expectations of the right agents?
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- Truth telling?
  - Career concerns? Herding? Act upon expectations?
- Do respondents understand what inflation is?
  - People use different notions of general prices
  - Percent change is hard for some respondents
PHILLIPS CURVE WITH SURVEY INFLATION EXPECTATIONS

\[ \pi_t = a_0 + a_1 E_t \pi_{t+1} + b_1 (UE_t - UE_t^N) + \text{error} \]

where

\( \pi_t \) = the actual q-o-q inflation rate (CPI, annualized),

\( E_t \pi_{t+1} \) = one-year ahead inflation forecast (CPI),

\( UE_t \) = the unemployment rate,

\( UE_t^N \) = the natural rate of unemployment (CBO’s NAIRU).
## Test #1: Stability

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### Michigan Survey of Consumers, 78Q1:14Q3

- $UEGap_t$: $-0.230^{**}$, $-0.240$, $-0.261$, $-0.234^{**}$
  - (0.098), (0.149), (0.287), (0.118)
- $E_t\pi_{t+1}$: $1.440^{***}$, $1.515^{***}$, $1.469^{***}$, $0.898^{***}$
  - (0.075), (0.094), (0.400), (0.224)

R-squared: 0.697, 0.787, 0.463, 0.159
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<td><strong>Survey of Professional Forecasters, 81Q3:14Q3</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>$UEGap_t$</td>
<td>-0.175</td>
<td>-0.374**</td>
<td>-0.538**</td>
<td>-0.167</td>
</tr>
<tr>
<td></td>
<td>(0.110)</td>
<td>(0.146)</td>
<td>(0.239)</td>
<td>(0.208)</td>
</tr>
<tr>
<td>$E_t\pi_{t+1}$</td>
<td>0.714***</td>
<td>1.179***</td>
<td>1.863***</td>
<td>0.603</td>
</tr>
<tr>
<td></td>
<td>(0.134)</td>
<td>(0.269)</td>
<td>(0.364)</td>
<td>(1.227)</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.192</td>
<td>0.269</td>
<td>0.482</td>
<td>0.042</td>
</tr>
<tr>
<td><strong>Financial markets (Cleveland Fed), 82Q1:14Q3</strong></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>$UEGap_t$</td>
<td>-0.140</td>
<td>-0.449***</td>
<td>-0.105</td>
<td>-0.078</td>
</tr>
<tr>
<td></td>
<td>(0.104)</td>
<td>(0.150)</td>
<td>(0.227)</td>
<td>(0.206)</td>
</tr>
<tr>
<td>$E_t\pi_{t+1}$</td>
<td>0.562***</td>
<td>0.976***</td>
<td>1.719***</td>
<td>0.630</td>
</tr>
<tr>
<td></td>
<td>(0.122)</td>
<td>(0.315)</td>
<td>(0.365)</td>
<td>(0.500)</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.131</td>
<td>0.138</td>
<td>0.411</td>
<td>0.054</td>
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</table>
**TEST #2: WHICH EXPECTATIONS?**

<table>
<thead>
<tr>
<th>Dep. var.: $\pi_t$</th>
<th>(1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$UEGap_t$</td>
<td>-0.230**</td>
</tr>
<tr>
<td></td>
<td>(0.098)</td>
</tr>
</tbody>
</table>

Expected inflation, $E_t\pi_{t+1}$

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>MSC</td>
<td>1.440***</td>
</tr>
<tr>
<td></td>
<td>(0.075)</td>
</tr>
</tbody>
</table>

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>SPF</td>
<td></td>
</tr>
</tbody>
</table>

Financial markets

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Observations</td>
<td>146</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.697</td>
</tr>
<tr>
<td>Sample period</td>
<td>78Q1:14Q3</td>
</tr>
</tbody>
</table>
## Test #2: Which Expectations?

<table>
<thead>
<tr>
<th>Dep. var.: $\pi_t$</th>
<th>(1)</th>
<th>(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$UEGap_t$</td>
<td>-0.230**</td>
<td>-0.223**</td>
</tr>
<tr>
<td></td>
<td>(0.098)</td>
<td>(0.101)</td>
</tr>
</tbody>
</table>

Expected inflation, $E_t\pi_{t+1}$

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSC</td>
<td>1.440***</td>
<td>1.072***</td>
</tr>
<tr>
<td></td>
<td>(0.075)</td>
<td>(0.208)</td>
</tr>
<tr>
<td>SPF</td>
<td>0.178</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.164)</td>
<td></td>
</tr>
</tbody>
</table>

Financial markets

<table>
<thead>
<tr>
<th>Observations</th>
<th>146</th>
<th>132</th>
</tr>
</thead>
<tbody>
<tr>
<td>R-squared</td>
<td>0.697</td>
<td>0.296</td>
</tr>
<tr>
<td>Sample period</td>
<td>78Q1:14Q3</td>
<td>81Q3:14Q3</td>
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</tbody>
</table>
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<table>
<thead>
<tr>
<th>Dep. var.: $\pi_t$</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$UEGap_t$</td>
<td>-0.230**</td>
<td>-0.223**</td>
<td>-0.212**</td>
</tr>
<tr>
<td></td>
<td>(0.098)</td>
<td>(0.101)</td>
<td>(0.093)</td>
</tr>
</tbody>
</table>

Expected inflation, $E_t\pi_{t+1}$

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
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<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSC</td>
<td>1.440***</td>
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<td></td>
<td>(0.075)</td>
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</tr>
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<td></td>
<td>(0.164)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Financial markets</td>
<td></td>
<td></td>
<td>0.103</td>
</tr>
<tr>
<td></td>
<td></td>
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<td>(0.163)</td>
</tr>
</tbody>
</table>

- **Observations**: 146, 132, 130
- **R-squared**: 0.697, 0.296, 0.254
- **Sample period**: 78Q1:14Q3, 81Q3:14Q3, 82Q1:14Q3
**TEST #3: PREDICTIVE POWER**

- Step #1: fit a model on the data before the Great Recession
- Step #2: compute forecast errors during the Great Recession
TEST #3: PREDICTIVE POWER

• Step #1: fit a model on the data before the Great Recession
• Step #2: compute forecast errors during the Great Recession

<table>
<thead>
<tr>
<th>Source of inflation expectations</th>
<th>Mean (1)</th>
<th>Std. Dev. (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Michigan Survey of Consumers</td>
<td>-0.17</td>
<td>1.63</td>
</tr>
<tr>
<td>Survey of Professional Forecasters</td>
<td>1.02</td>
<td>1.61</td>
</tr>
<tr>
<td>Financial markets (Cleveland Fed)</td>
<td>0.94</td>
<td>1.60</td>
</tr>
</tbody>
</table>
CONCLUDING REMARKS

- FIRE is useful and the New Keynesian Phillips Curve is an epitome of FIRE success
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  - Current state: "theory ahead of business cycle measurement"
  - Few measures of real-time beliefs of firms and other price setters
  - How to rule out many alternative deviations from FIRE
    - Impose discipline on non-FIRE models
    - Derive testable implications and test them