NEW KEYNSIAN PHILLIPS CURVE

FISCHER MODEL PHILLIPS CURVE

Recall Fischer model with assumption that firms set price path based on information from $(t-1)$:

$$\underline{p_t^1 \quad p_{t+1}^1} \qquad \text{based on info from } (t-1)$$

$$\underline{p_{t-1}^2 \quad p_t^2} \qquad \text{based on info from } (t-2)$$

price level at time t is $\frac{1}{2}(p_t^1 + p_t^2)$

and $y_t = m_t - p_t$ and $p_t^* = p_t + \phi y_t$

Result: $$p_t = E_{t-2}[m_t] + \frac{\phi}{1+\phi}\left(E_{t-1}[m_t] - E_{t-2}[m_t]\right)$$

$$y_t = \frac{1}{1+\phi}\left(E_{t-1}[m_t] - E_{t-2}[m_t]\right) + \left(m_t - E_{t-1}[m_t]\right)$$

What kind of Phillips curve would this generate?

To make results more comparable with NKPC discussion, assume firms set price path with information from t:

$$\underline{p_t^1 \quad p_{t+1}^1} \qquad \text{based on info from } t$$

$$\underline{p_{t-1}^2 \quad p_t^2} \qquad \text{based on info from } t-1$$

means $$p_t^1 = p_t^* = p_t + \phi y_t$$

$$p_t^2 = {}_{t-1}p_t^* = {}_{t-1}p_t^e + \phi\, {}_{t-1}y_t^e$$

New Keynseian Phillips Curve

Fischer Model Phillips Curve (cont.)

$$p_t = \tfrac{1}{2}(\phi y_t + p_t) + \tfrac{1}{2}(\phi\, {}_{t-1}y_t^e + {}_{t-1}p_t^e)$$

solve for p_t

$$p_t = \phi y_t + \phi\, {}_{t-1}y_t^e + {}_{t-1}p_t^e$$

subtract p_{t-1} from both sides

$$p_t - p_{t-1} = \text{-----}\ {}_{t-1}p_t^e - p_{t-1}$$

$$\pi_t = \phi(y_t + {}_{t-1}y_t^e) + {}_{t-1}\pi_t$$

$$= \phi y_t + \underbrace{E_{t-1}[\phi y_t + \pi_t]}_{\text{past beliefs about current conditions}}$$

$$E_{t-1}[\pi_t] = \phi(E_{t-1}[y_t] + {}_{t-1}y_t^e) + E_{t-1}[{}_{t-1}\pi_t^e]$$

If expectations rational,

$$E_{t-1}[\pi_t] = {}_{t-1}\pi_t^e$$

$$E_{t-1}[{}_{t-1}\pi_t^e] = {}_{t-1}\pi_t^e$$

$$E_{t-1}[y_t] = {}_{t-1}y_t^e$$

hence

$${}_{t-1}\pi_t = \phi\,\underbrace{({}_{t-1}y_t^e + {}_{t-1}y_t^e)}_{\text{must be zero}} + {}_{t-1}\pi_t$$

hence....

NEW KEYNESIAN PHILLIPS CURVE

FISCHER MODEL PHILLIPS CURVE (cont.)

$\pi_t = \phi y_t + {}_{t-1}\pi_t$ Same as LSF, Friedman-Phelps Phillips curve!

Means $y_t > 0$ does not forecast future $\pi \downarrow$. Good.

But $E_t[y_{t+1}] = 0$ always. Bad.

? What if we combine Fischer model assumption that pricesetters predetermine path for p_i, not necessarily fixed i,

with Calvo assumption that a pricesetter resets with fixed probability each period, not at predetermined intervals?

Result: Mankiw-Reis "Sticky Information,"

But why call it "Sticky Information"?

Friday, March 29, 2013.max

STICKY INFORMATION (MANKIW & REIS, 2002)

Like Fischer, pricesetter sets a path for future p's instead of fixing p

Like Calvo, reset at random time

Motivation/interpretation of reset time: when pricesetter gets new info & updates forecast about economy, current & future p_i^*'s.

Two questions:

1) Phillips curve?

2) Can we get persistent recessions/booms from m shocks? (Recall in LSF, answer was <u>no</u>.

Also no for "sticky info" with annual updating.

STICKY INFO (cont.)

Assumptions using Romer notation

$y_t = m_t - p_t$ & monetary policy sets a path for m.

M&R's "λ"

α ← reset probability

M&R's "α"

$p_{it}^* = (1-\phi)p_t + \phi m_t$

hence expected future p_i^*'s depend on expected future m's & p's ← behavior of other pricesetters

A firm that updates info at time t sets

$$p_{it+j} = E_t\, p_{t+j}^* = (1-\phi)E_t p_{t+j} + \phi E_t m_{t+j}$$

Rational expectations.

Information intake changes expectations of future:

$E_{t-1} m_t - E_{t-2} m_t$ Effect of info arriving in $(t-1)$ on forecast of m_t

$m_t - E_{t-1} m_t$ Error in time t's forecast

$$m_t = m_t - E_{t-1} m_t + \underbrace{(E_{t-1} m_t - E_{t-2} m_t)}_{\text{info arriving in } t-1} + \underbrace{(E_{t-2} m_t - E_{t-3} m_t)}_{\text{info arriving in } t-2} + \ldots$$

STICKY INFO (cont.)

Solution (Following Romer)

Conjecture form of soln.:

1) y_t & p_t depend only on m_t & previous periods' forecasts of m_t (only exogenous variable)

2) If m_t is exactly what everyone forecast at all points in the past, $y_t = 0$ (no surprises)

3) Soln. is loglinear (y is loglinear fn. of m's)

1) means

$$p_t = a_0(m_t - E_{t-1} m_t) + a_1 \underbrace{(E_{t-1} m_t - E_{t-2} m_t)}_{\text{effect on } p_t \text{ of info arriving in period } (t-1)} + a_2 (E_{t-2} m_t - \ldots)$$

("fraction... passed into the aggregate price level")

$$y_t = m_t - p_t$$

$$= m_t - E_{t-1} m_t + (E_{t-1} m_t - E_{t-2} m_t) + \ldots \leftarrow (m_t)$$

$$- a_0 (m_t - E_{t-1} m_t) - a_1 (E_{t-1} m_t - E_{t-2} m_t) - \ldots \leftarrow (p_t)$$

$$= \sum_{i=0}^{\infty} (1 - a_i)(E_{t-i} m_t - E_{t-i-1} m_t)$$

So, what are values for a_i's?

STICKY INFO

Soln. (cont.)

What are a_i's?

a_i is effect on p_t of $(E_{t-i}\, m_t - E_{t-i-1}\, m_t)$

Firms that have updated info in $(t-i)$ or later have adjusted p_{it} in response to that info. Firms that last updated prior to $(t-i)$ haven't adjusted p_{it} to that info.

Figure out:

1) For a firm that has updated since $(t-i)$, what's effect of that info on p_{it}?

2) What fraction of firms has updated since $(t-i)$?

1) & 2) together give effect of $(E_{t-i}\, m_t - E_{t-i-1}\, m_t)$ on p_t, which is a_i.

STICKY INFO

Soln.

What is a_i?

1) For a Firm that has updated, effect of info

When a firm updates,

$$\Delta p_{it} = \Delta E p_{it}^* = \Delta E((1-\phi)p_t + \phi m_t)$$

$$= (1-\phi)\Delta E p_t + \phi \Delta E m_t$$

Individual Firm takes a_i as given, so response to $(E_{t-i} m_t - E_{t-i-1} m_t)$ is

$$\Delta p_{it} = (1-\phi) a_i (E_{t-i} m_t - E_{t-i-1} m_t) + \phi (E_{t-i} m_t - E_{t-i-1} m_t)$$

$$= [(1-\phi) a_i + \phi](E_{t-i} m_t - E_{t-i-1} m_t)$$

Effect on price level is

$$\Delta p_t = \lambda_i [(1-\phi) a_i + \phi](\ldots\ldots)$$

Fraction of firms that have updated since i

and $a_i = \lambda_i [(1-\phi) a_i + \phi]$

STICKY INFO

Soln.

What is a_i?

2) What is λ_i?

$(1-\alpha)$ Prob. firm has <u>not</u> updated since $t-1$

$(1-\alpha)(1-\alpha)$ " " " " " " $t-2$
$= (1-\alpha)^2$

$(1-\alpha)^{i+1}$ Prob. firm has not updated since $(i-1)$

$\lambda_i = 1 - (1-\alpha)^{i+1}$ Prob. firm <u>has</u> updated in period i or <u>after</u> period i

So $a_i = \lambda_i [(1-\phi)a_i + \phi]$

solve for a_i!

$$a_i = \frac{\phi\left[1-(1-\alpha)^{i+1}\right]}{1-(1-\phi)\left[1-(1-\alpha)^{i+1}\right]} \qquad (7.81)$$

see: as $i\uparrow$, $(1-\alpha)^{i+1}\downarrow$, $a_i\uparrow$

Info about m_t that arrived long ago has big effect on p_t. Almost all firms have had a chance to update & change p_{it} plan.

STICKY INFO

Effect of m on output

Recall $y_t = \sum_{i=0}^{\infty} (1-a_i)(E_{t-i} m_t - E_{t-i-1} m_t)$

where $a_i = \dfrac{\phi\,[1-(1-\alpha)^{i+1}]}{1-(1-\phi)[1-(1-\alpha)^{i+1}]}$

Example: m is random walk

$m_t = m_{t-1} + \varepsilon_t$ means $(E_{t-i} m_t - E_{t-i-1} m_t) = \varepsilon_i$

1) As $i\uparrow$, so that shock ε_i is further back in time, bigger effect on p_t, smaller effect on y_t.

But old ε's are still affecting y_t

($(1-a_i)$ is close to zero, but positive)

so variations in y are persistent,

AD shocks have persistent effects on y.

2) Real rigidity. Small ϕ means small a_i, ε's have bigger effect on y.

STICKY INFO

Effect of m on output

Possible lag in effect of m on π

For small ϕ (lots of real rigidity)
& "plausible" value of α,
as time passes following an ε,
a_i rises fast at first, then more slowly
& effect on π is greatest many periods after
shock. Hence a downward m shock
"first produces a recession, then a fall
in inflation."

Sticky Information

Sticky-Information Phillips Curve (following M&R)

$p_t^* = p_t + \alpha y_t$ (Romer's ϕ)

λ Probability firm can adjust it's path for p (Romer's α)

x_t^j price for period t set by firm that last updated j periods ago

$$x_t^j = E_{t-j}\, p_t^*$$

$$p_t = \lambda p_t^* + \underbrace{(1-\lambda)\lambda E_{t-1} p_t^*}_{\text{firms that adjusted last period}} + \overbrace{(1-\lambda)(1-\lambda)\lambda E_{t-2} p_t^*}^{\text{firms that adjusted period before last}} + \cdots$$

M&R's (A3)

$$p_t = \lambda \sum_{j=0}^{\infty} (1-\lambda)^j E_{t-j}\, p_t^*$$

$$p_t = \lambda(p_t + \alpha y_t) + \lambda \sum_{j=0}^{\infty} (1-\lambda)^{j+1} E_{t-1-j}(p_t + \alpha y_t) \qquad (A4)$$

$$= \lambda(p_t + \alpha y_t) + \lambda \sum (1-\lambda)^j (1-\lambda) E_{t-1-j}(p_t + \alpha y_t)$$

$$= \lambda(p_t + \alpha y_t) + \lambda \sum (1-\lambda)^j E_{t-1-j}(\;) - \lambda^2 \sum (1-\lambda)^j E_{t-1-j}(\;)$$

From (A3), $p_{t-1} = \lambda \sum_{j=0}^{\infty} (1-\lambda)^j E_{t-1-j}(p_{t-1} + \alpha y_{t-1})$ (A5)

hence

$$\pi_t = p_t - p_{t-1} = \lambda(p_t + \alpha y_t) + \lambda \sum_{j=0}^{\infty} (1-\lambda)^j E_{t-1-j}\big(\overbrace{p_t - p_{t-1}}^{\pi_t} + \alpha \overbrace{(y_t - y_{t-1})}^{\Delta y_t}\big)$$

$$\underbrace{- \lambda^2 \sum_{j=0}^{\infty} (1-\lambda)^j E_{t-1-j}(p_t + \alpha y_t)}_{\text{what's this?}}$$

NKPC

STICKY INFORMATION

Sticky-information Phillips curve (cont.)

Recall $p_t = \lambda(p_t + \alpha y_t) + \lambda \sum_{j=0}^{\infty} (1-\lambda)^{j+1} E_{t-1-j}(p_t + \alpha y_t)$ (A4)

hence $p_t - \lambda p_t - \lambda\alpha y_t = \lambda \sum_{j=0}^{\infty} \ldots$

$(1-\lambda) p_t - \lambda \alpha y_t =$

note difference

Divide both sides by $(1-\lambda)$

$$p_t - \frac{\lambda\alpha}{(1-\lambda)} y_t = \lambda \underbrace{\sum_{j=0}^{\infty} (1-\lambda)^{j} E_{t-1-j}(p_t + \alpha y_t)}$$

funny thing at bottom of previous page, divided by λ. Substitute

$$\pi_t = \lambda(p_t + \alpha y_t) + \lambda \sum_{j=0}^{\infty} (1-\lambda)^j E_{t-1-j}(\pi_t + \alpha \Delta y_t)$$
$$- \lambda\left(p_t - \frac{\lambda\alpha}{1-\lambda} y_t\right)$$
$$= \frac{\alpha\lambda}{1-\lambda} y_t + \lambda \underbrace{\sum_{j=0}^{\infty} (1-\lambda)^j E_{t-1-j}(\pi_t + \alpha\Delta y_t)}$$

past expectations of current economic conditions, as in Fischer or Friedman-Phelps.