5. The Lucas Critique and Monetary Policy

John B. Taylor, May 6, 2013
Econometric Policy Evaluation: A Critique

• Highly influential (Nobel Prize)
• Adds to the case for policy rules
• Shows difficulties of econometric policy evaluation when forward-looking expectations are introduced
• But it left an impression of a “mission impossible” for monetary economists
  – Tended to draw researchers away from monetary policy research to real business cycle models
• Nevertheless it was constructive
  – An alternative approach suggested through three examples:
    • One focused on monetary policy
      – inflation-unemployment tradeoff
    • The other two focused on fiscal policy
      – consumption and investment
• Worth studying in the original
First Derive the Inflation-Output Tradeoff

Derive "aggregate supply" function:

Supply $y_{it}$ in market $i$ at time $t$ is given by

$$y_{it} = y_{it}^p + y_{it}^c$$

where

$y_{it}^p$ is "permanent" or "normal" supply

$y_{it}^c$ is "cyclical" supply

$$y_{it}^c = \beta(p_{it} - p_{it}^e)$$

$p_{it}$ is the log of the actual price in market $i$ at time $t$

$p_{it}^e$ is the perceived (in market $i$) general price level in the economy at time $t$
Find conditional expectation of general price level

\[ p_{it} = p_t + z_{it} \]

\( p_t \) is distributed normally with mean \( \bar{p}_t \) and variance \( \sigma^2 \)

\( z_{it} \) is distributed normally with mean 0 and variance \( \tau^2 \)

Thus

\[
\begin{pmatrix} p_t \\ p_{it} \end{pmatrix} \text{ is distributed N} \left[ \begin{pmatrix} \bar{p}_t \\ \bar{p}_t \end{pmatrix} \begin{pmatrix} \sigma^2 & \sigma^2 \\ \sigma^2 & \sigma^2 + \tau^2 \end{pmatrix} \right]
\]

\[ p_{it}^e = E(p_t | p_{it}, I_{t-1}) = \bar{p}_t + [\sigma^2 / (\sigma^2 + \tau^2)](p_{it} - \bar{p}_t) \]

\[ = (1 - \theta)p_{it} + \theta \bar{p}_t \]

where \( \theta = \tau^2 / (\sigma^2 + \tau^2) \)

Covariance divided by the variance
Now, substitute the conditional expectation
\[ p_{it}^e = (1 - \theta) p_{it} + \theta \bar{p}_t \]
into the market supply function
\[ y_{it}^c = \beta (p_{it} - p_{it}^e) \]
to get
\[ y_{it}^c = \beta [p_{it} - ((1 - \theta) p_{it} + \theta \bar{p}_t)] \]
\[ = \theta \beta (p_{it} - \bar{p}_t) \]
Aggregating and adding in normal level we get:
\[ y_t^c = \theta \beta (p_t - \bar{p}_t) \]
\[ y_t = \theta \beta (p_t - \bar{p}_t) + y_{pt} \]
Sometimes called “Lucas Supply Function”
Consider a policy intervention and the critique

Now suppose inflation follows

\[ p_t = p_{t-1} + \varepsilon_t \]

where

\( \varepsilon_t \) has a mean \( \pi \) and variance \( \sigma^2 \)

Then the aggregate supply equation becomes

\[ y_t = \theta \beta (p_t - p_{t-1}) - \theta \beta \pi + y_{pt} \]

If estimated by regressing the output gap \( (y_t - y_{pt}) \)
on inflation \( (p_t - p_{t-1}) \) and a constant, the regression equationwould appear to show that monetary policy could bring
\( y_t \) above \( y_{pt} \) permanently by raising inflation.

But that would be a seriously mistaken conclusion because thecoefficient \( \pi \) would change and therefore the constant in theestimated equation would change. But a constructive critique? How?
Other examples: consumption

\[ c_t = ky_{pt} + u_t \]

\[ y_{pt} = (1 - \beta) \sum_{i=0}^{\infty} \beta^i E(y_{t+i}|I_t) \]

if actual income follows the stochastic process

\[ y_t = a + w_t + v_t \]

where \( w_t \) is a random walk and \( v_t \) is serially uncorrelated, then

\[ E(y_{t+i}|I_t) = (1 - \lambda) \sum_{j=0}^{\infty} \lambda^j y_{t-j}, \text{ for } i > 0 \quad (\lambda \text{ depends on variances of } w, v) \]

Thus, the consumption function is

\[ c_t = k(1 - \beta)y_t + k\beta(1 - \lambda) \sum_{j=0}^{\infty} \lambda^j y_{t-j} + u_t \]

and the coefficients on income can be estimated.
Now consider a policy intervention in the Lucas consumption example

Suppose we cut taxes by $x$ permanently at time 0.

- Then income will rise by $x$ permanently
  - Then $E(y_{0+i}|I_0)$ up by $x$ for all $i \geq 0$.
  - Permanent income $y_{p0}$ will rise by $x$.
- According to the theory, consumption $c_0$ will rise by $kx$
- However, the estimated econometric model implies that consumption $c_0$ increases by $k(1-\beta\lambda)x$ which is much less than $kx$. Only over time would $c_t$ rise up to $kx$. 
Application: Temporary Fiscal Stimulus in 2008

Graph showing billions of dollars for disposable personal income and personal consumption expenditures from January 2007 to July 2008. The graph highlights the effect of a rebate on disposable personal income, with a peak in income around July 2008.
### Consumption Regressions

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient 1</th>
<th>Coefficient 2</th>
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</thead>
<tbody>
<tr>
<td>Lagged PCE</td>
<td>.794</td>
<td>.832</td>
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<tr>
<td></td>
<td>(.057)</td>
<td>(.056)</td>
</tr>
<tr>
<td>Rebate payments</td>
<td>.048</td>
<td>.081</td>
</tr>
<tr>
<td></td>
<td>(.055)</td>
<td>(.054)</td>
</tr>
<tr>
<td>Disp. Pers. Income</td>
<td>.206</td>
<td>.188</td>
</tr>
<tr>
<td>(w/o rebate)</td>
<td>(.056)</td>
<td>(.055)</td>
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<tr>
<td>Oil Price ($/bbl)</td>
<td>-----</td>
<td>-1.007</td>
</tr>
<tr>
<td>lagged 3 months</td>
<td></td>
<td>(.325)</td>
</tr>
<tr>
<td>( R^2 )</td>
<td>.999</td>
<td>.999</td>
</tr>
</tbody>
</table>

Dependent variable = PCE

Oil price = West Texas Intermediate.

Sample period is January 2000 to October 2008.

Standard errors in parentheses.
General Formulation of the Critique

Using a framework
\[ y_{t+1} = F(y_t, x_t, \theta, \varepsilon_t) \]
to evaluate policy (changes in \( x_t \))
will in general lead to mistakes,
because \( \theta \) will change when \( x_t \) changes.

The alternative framework is to specify a policy rule
for the instrument (money growth, interest rate)
\[ x_t = G(y_t, \lambda, \eta_t) \]
which implies that
\[ y_{t+1} = F(y_t, x_t, \theta(\lambda), \varepsilon_t) \]
A policy change is thus a change in \( \lambda \) which affects \( \theta \)
and thereby the stochastic process for \( y_t \).