Taylor-Type Rules and Permanent Shifts in Productivity Growth

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Disclaimer

• Not official opinion of either the Board of Governors of the Federal Reserve System or the Federal Reserve Bank of St. Louis
Outline of Talk

• The issue
• New Keynesian model
• Interest rate rules
  – Optimal policy
  – Taylor rule
  – Taylor rule with output growth target
  – Price level path target
  – Combination rule
Strategy

• Add money to an RBC model.
• Add permanent (exogenous) growth shocks.
• Add frictions that make money matter (Calvo pricing).
• Compute optimal policy
• Compute feasible policies
The Model

- Infinitely lived households
- Shopping time specification for money demand
- Capital accumulation with adjustment costs for investment
- A continuum of monopolistically competitive firms
- Calvo specification for sticky prices
- Interest rate rule for monetary policy


**Policy Rules**

\[
\ln\left(\frac{R_t}{\bar{R}}\right) = (1 + \theta_\pi)(\pi_t - \bar{\pi}) + \theta_y \ln\left(\frac{y_t}{\bar{y}}\right) \\
+ \theta_{dy} (d \ln y_t - d \ln \bar{y}) + \theta_p \ln\left(\frac{p_t}{\bar{p}_t}\right)
\]

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Policy Rules

\[ \ln \left( \frac{R_t}{\bar{R}} \right) = (1 + \theta_{\pi})(\pi_t - \bar{\pi}) \]
Responses to a permanent 0.1% real growth shock with optimal policy ($\theta_\pi = \infty$)

- **Capital Stock Growth**
- **Real Wage Growth**
- **Interest Rate**
  - Under Optimal Policy the real and nominal rates move by the same amount.

- **Output Growth**
- **Consumption Growth**
- **Investment Growth**
Policy Rules

\[ \ln \left( \frac{R_t}{R} \right) = (1 + \theta_\pi)(\pi_t - \bar{\pi}) \]

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Responses to a permanent 0.1% real growth shock with $\theta_{\pi} = 0.5$
• In our model with log utility, change in output growth = change in real rate in the long run.

• Easy to show that policy rule

  => inflation equation in the long run:

  \[ \hat{\pi} = \hat{r} \]

• So “long-run” inflation effects of the growth shock are determined by size of \( \theta_{\pi} \)
The Taylor Rule

\[
\ln\left( \frac{R_t}{\bar{R}} \right) = (1 + \theta_{\pi})(\pi_t - \bar{\pi}) + \theta_y \ln\left( \frac{y_t}{\bar{y}} \right)
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The Taylor Rule

Note the negative correlation between productivity growth and inflation.
Taylor rule “long-run” inflation equation

\[ \hat{\pi} = \frac{\hat{r}}{\theta_\pi} - \frac{\theta_y}{\theta_\pi} \hat{y} < 0 \]
The Output Growth Rule

\[
\ln \left( \frac{R_t}{\bar{R}} \right) = (1 + \theta_\pi)(\pi_t - \bar{\pi}) + \theta_{dy} (d \ln y_t - d \ln \bar{y})
\]
Rule with output gap in growth rather than levels
Output growth rule long-run inflation equation

\[ \hat{\pi} = \frac{\hat{r}}{\theta_\pi} - \frac{d\hat{y}}{\theta_\pi} \Rightarrow 0 \]
Why Below Trend Inflation?

• We have set up a policy for the long run. Because output rises slowly in the beginning, the nominal rate rises less than the real rate, inflation adjusts to clear the bond market, so we get a slightly below trend inflation during the transition to the long run (which reinforces a lower nominal interest rate).

• Note that this will appear to be higher output putting downward pressure on prices, but that way of thinking comes from thinking about models with money supply rules.

• This is not really the mechanism at work with an interest rate rule (money is jumping to satisfy money demand).
Price Level Path Targets

• Svensson (JMCB 1999)
• The price level path automatically ‘undoes’ the inflation induced by shocks-observed or unobserved.
The Price Path Rule

\[ \ln\left(\frac{R_t}{\bar{R}}\right) = (1 + \theta_\pi)(\pi_t - \pi) + \theta_p \ln\left(\frac{p_t}{\bar{p}_t}\right) \]

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Rule with Price Level Path Target
Price level path rule long-run inflation equation

\[ \hat{\pi} = \frac{\hat{r}}{\theta_p} - \hat{p} \Rightarrow 0 \]

Note that there will be a bias in achieving the price target, but it will be constant so long run average inflation goes to zero.
What about a Combination?

- The output gap growth rule does not anchor the price level, also does not deliver enough inflation initially.
- The price level path rule anchors the price level in the long-run but allows some inflation in the short run (until the policymaker recognizes the shift in the output growth trend).
The Combination Rule

\[ \ln \left( \frac{R_t}{R} \right) = \left( 1 + \theta_{\pi} \right) (\pi_t - \pi) \]

\[ + \theta_{dy} (d \ln y_t - d \ln \bar{y}) + \theta_p \ln \left( \frac{p_t}{\bar{p}_t} \right) \]

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The Combination Rule
Combination rule long-run inflation equation

\[
\hat{\pi} = \frac{\hat{r}}{\theta_P} - \frac{d\hat{y}}{\theta_\pi} - \hat{p} \Rightarrow 0
\]

Note that the output growth term picks up the error caused by mismeasurement of the real interest rate and eliminates the price level bias.
Welfare Consequences of Growth Shocks under Alternative Policy Rules

• The intuition is simple: The macro welfare losses occur when the price level deviates from the steady state—the optimal policy is to keep the price level along the steady state path.

• Optimal policy is not feasible: neither information nor central bank control are perfect.

• In this model, the welfare loss is a function of the deviation of output from the optimal path. Traditionally, macroeconomists look at a weighted average of inflation and output deviations.

• We also report expected deviations up to five years ahead.
Root Mean Squared Deviations of Output from the Optimal Path
Root Mean Squared Deviations of Inflation from the Optimal Path
Conclusions

• Rules that target the price level and/or the growth rate of output approach the optimal policy in *the standard New Keynesian model*.

• *Taylor rule induces instability in both output and inflation* if there are unobserved shifts in technology growth trends.
  
  – Taylor targets the level of output and the rate of price change.
  
  – Should target the level of prices and the rate of output growth.
Conclusions

• An upward shift in the growth trend leads to temporary declines in the capital stock and hours worked in standard one-sector growth models.

• The nominal dynamics (correlations with real variables and relative volatility) are driven by the monetary policy rule in general equilibrium models.

• With interest rate rules, inflation adjusts to clear the bond market.
  – What happens if the central bank announces that it will keep the interest rate at zero for an extended period?