Output Gaps

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July 6. 2010
The Questions

- What is the output gap?
- How do different concepts provide policy-relevant information?; and
- Is a DSGE model useful for output gap estimation? Why? How do such estimates compare to those from other approaches/policy institutions?
Discuss definitions – how do economists define the output gap?

Sketch-out a DSGE model – EDO.
  - Emphasize features relevant for output gap estimation.
  - Discuss how relevant features depend on the definition of the output gap being used.

Show estimates of output gaps from EDO, and discuss similarities/differences across concepts.

Compare model estimates to those from CBO or the FRB/US model.
  - Note: FRB/US model estimates of the gap are not the staff, or “Greenbook”, estimates of the output gap.

Sum up.
I present three estimates/definitions – the gap between output

- And its long-run stochastic trend (the “Beveridge-Nelson cycle”, Beveridge and Nelson (1981));
- And the level consistent with steady-state utilization (i.e., the “production-function approach”);
- And a “flexible-price” level.

It is important to consider the question at hand before deciding on a given output gap concept, as each provides different information.
Definition 1: Beveridge-Nelson Cycle (Detrended Output)

- According to this definition, the output gap is the deviation of output from the level expected to prevail in the long run.
- This definition has several advantages
  - It is not model-specific: Any approach capable of capturing the reduced-form time-series characteristics of output can provide an estimate.
  - This approach provides information related to a very specific forecasting problem – an estimate of how much economic growth will deviate from its average level going forward.
  - This method often provides estimates of the output gap that correspond to widely held views on what is “reasonable”.
Definition 2: Production-Function Approach

- In this approach, the output gap is defined as the deviation of output from the level that would occur if capital and labor input were utilized at “normal” rates, given current technology.
- Widely used in policy circles (CBO, FRB/US model)
- But the theoretical motivation for this approach is lacking (in some sense)
Definition 3: Flex-Price or Natural-rate Approach

- In this approach, the output gap is defined as the deviation of the actual level of output from the level of output that would prevail in the absence of price and wage rigidities.
- A model-specific measure.
- Related to welfare under some assumptions – but not always.
There are two sectors, with stochastic trends in both aggregate and investment-specific technology
- This implies the model has a rich Beveridge-Nelson permanent component
- Data on output, consumption, investment, inflation, hours, real wages, etc. inform estimates of the trend and exploit economic theory (as suggested in King, Plosser, Stock, and Watson (1991), for example)

Variable utilization and imperfect competition imply a rich production function approach

Both sectors have nominal rigidities in prices and wages and markup shocks
- As a result, stabilization of output at the “natural” rate level does not stabilize inflation.
Shocks that affect the risk-premia attached to investment in (real) assets are important:

- These shocks create wedges between the (real) policy rate and the expected return to investment in (real assets).
- These shocks are exogenous; act like external finance premia in financial accelerator models and can be endogenized.

Nominal rigidities:

- Sticky prices and sticky wages, with indexation.

Real rigidities:

- Habit formation in consumption;
- Adjustment costs to investment;
- Adjustment costs to cross-sectoral factor movements; and,
- Variable utilization of non-residential capital.
The model is estimated with Bayesian techniques using 11 data series:

**Real variables**
- GDP
- NDS (ex. housing) consumption
- Durables consumption
- Residential investment
- Non-residential investment
- Hours in the NFB sector

**Wages and prices**
- Real comp. per hour in the NFB sector
- PCE deflator
- Core PCE deflator
- PCE durables deflator

**Monetary policy**
- Federal funds rate

All other (latent) model variables are estimated as part of the Kalman-filter routine.

The estimation period 1984q4 to 2008q4.
The model assumes 11 exogenous structural shocks

Technology shocks
- Sector-neutral TFP
- Sector-specific TFP

Mark-up shocks
- Slow sector prices over m.c.
- Fast sector prices over m.c.
- Wage markup over m.r.s.

Risk Premia shocks
- Economywide
- Non-residential investment
- Residential investment
- Consumer durables

Demand shock
- Exog. public, net-foreign demand

Monetary policy shock
- Federal funds rate

These shocks can be grouped in categories that affect the Beveridge-Nelson trend or the flex-price/natural rates of output and those that do not.
The EDO estimate of the Beveridge-Nelson cycle
  - Captures NBER cycles
  - Showed “jobless” nature of recoveries following recent recessions
  - Has a volatile quarter-to-quarter permanent component to GDP – much more so than CBO, for example
The EDO production function gap should share elements of the Beveridge-Nelson cycle.

The EDO production function trend may differ substantially from CBO (no “smoothing” is assumed; but smoothing can occur because of cyclical utilization).

In the event:
- Similar to Beveridge-Nelson cycle.
Production-Function Gap

Gap, Percent deviation from permanent component (Beveridge-Nelson, dashed)

Permanent component, percent change from four-quarters earlier (Beveridge-Nelson, dashed)

Permanent component, percent change from previous quarter, annual rate (Beveridge-Nelson, dashed)
The flexible-price or natural-rate of output differ from “efficient” output in notable ways, reflecting
- The effect of markup shocks under price flexibility (as in Justiniano and Primiceri (2008))
- The differential effects of sectoral risk premia shocks on natural and efficient output
Flexible-price or Natural-rate Gap

Gap (percent deviation), Natural-rate gap - solid (right axis), Beveridge-Nelson - dashed (left axis)

Gap (change from four-quarters earlier), Natural-rate gap - solid (right axis), Beveridge-Nelson - dashed (left axis)

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Output Gaps
Two issues arise in any practical use of the flexible-price/natural-rate approach:

First, the natural rate of output provides a point-in-time estimate, but the natural rate follows a complicated time series process – not a simple trend.

Second, the natural rate of output gap does not provide “Taylor” rule relevant information without also considering the natural rate of interest.
The growth of the Beveridge-Nelson trend going forward is a constant (a bit above 2 3/4 percent per year in EDO)

All other concepts of “equilibrium” output must converge to the Beveridge-Nelson trend at some far horizon

In contrast, projections of the natural rate of output will tend to fluctuate significantly over time.

As a result, discussions of the economic outlook or the potential policy implications of alternative measures of “equilibrium” output must take into account both gaps and forecasts for trends.
The natural rate in interest-rate rules

The role of the output gap plays a central role in a Taylor rule.

Consider a simple benchmark rule, in which the nominal interest rate \( r_t \) is a function of its natural rate \( r^n_t \), inflation \( \pi_t \), and a measure of the output gap \( \text{gap}_t \)

\[
\begin{align*}
    r_t &= \phi_r r^n_t + \phi_\pi \pi_t + \phi_{\text{gap}} \text{gap}_t.
\end{align*}
\]

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Approach 1 (Taylor?): Ignore natural rate and consider traditional gap – yielding very low policy rate in 2009

Approach 2 (Woodford?): Vary policy rate with natural rate of interest – also yielding very low policy rate in 2009
Natural rate of interest

Rate of interest (quarterly rate, red, dashed)

Gap, Percent deviation from permanent component (black, solid)
Comparing Gaps from EDO to Other Estimates

- CBO and FRB/US model gaps are both highly correlated with the Beveridge-Nelson cycle from the EDO model.
- EDO has a much more variable “potential” growth rate.
  - Similar cycles but different potential growth rates imply different covariances of gaps and potential.
  - In general, gaps and potential growth rates are related in non-trivial ways – and intuition gained from one approach does not carry over to other approaches.
  - Smooth potential growth (e.g., CBO) yields smooth cycles;
    But EDO gives smooth cycles with variable potential growth;
    Variances and covariances matter.
Comparing BN Gap from EDO to CBO

Gap (percent deviation), CBO - solid (right axis), Beveridge-Nelson - dashed (left axis)

Percent change in trend, CBO - solid (right axis), Beveridge-Nelson - dashed (left axis)
Comparing BN Gap from EDO to FRB/US

Gap (percent deviation): FRB/US model - solid (right axis), Beveridge-Nelson - dashed (left axis)

Percent change in trend, FRB/US model - solid (right axis), Beveridge-Nelson - dashed (left axis)
My analysis suggests

- The Beveridge-Nelson concept from our DSGE model yields gaps like the CBO or FRB/US.
- The flexible-price/natural-rate gaps are dependent on modeling assumptions, and its use in policy applications or forecasting requires a deep understanding of a specific model’s structure. They do not fit simply in Taylor rules.
- “Equilibrium” or trend expected growth is highly variable in the flex-price/natural-rate case.
- The preferred gap depends on the question – What is the growth outlook? What is happening to unemployment? What are price pressures? What is efficient, and how does that depend on model assumptions?