Using consumer theory to test competing business cycle models

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In brief

- Is procyclical tfp due to genuine technology shocks, variable capacity utilisation, or increasing returns?
- A lot at stake!
- Measurement of technology shocks: inference about model based on observed responses to them; sunspots

In brief (2)

- Strategy:
  - Examine paths of tfp across consumer goods industries
  - Note that durables and luxuries should respond more to aggregate (relative tfp-neutral) shocks
  - Construct predicted path for relative outputs based on independent measure of durability and luxuriousness
  - Check correlation of this object with observed relative tfp and relative prices

Households' problem

$$E_0\left\{\sum_{t=0}^{\infty}\beta^t\sum_{i=1}^{M}\left\{\frac{c_t(i)^{1-[1/\sigma(i)]}}{1-[1/\sigma(i)]}\right\}-\lambda n_t(i)s_t(i)^{\phi}\right\}$$

$$c_t(i)=[1-\delta(i)]c_{t-1}(i)+x_t(i)$$

Households' problem

$$K_t = \sum_{i=1}^{M} k_t(i) + k_t$$

$$K_{t+1} = (1 - \delta_k) K_t + I_t$$

Firms' problem

$$p_t(i)y_t(i,j) - w_t[s_t(i,j)]n_t(i,j) - r_t(i)k_t(i,j)$$

$$y_t(i,j) = A_t(i)n_t(i,j)^{\gamma\alpha}[s_t(i,j)k_t(i,j)]^{\gamma(1-\alpha)}$$
$$- \mu s_t(i,j)k_t(i,j)$$

Productivity

$$\Delta \ln A_t(i) = \eta(i) a_t + \varepsilon_t(i)$$

$$E[a_t . \varepsilon_t(i)] = 0, \forall i;$$

The shift premium, utility and technology

$$E_0\left\{\sum_{t=0}^{\infty}\beta^t\sum_{i=1}^{M}\left\{\frac{c_t\left(i\right)^{1-[1/\sigma(i)]}}{1-[1/\sigma(i)]}\right\}-\lambda n_t(i)s_t(i)^{\phi}\right\}$$

$$y_t(i,j)=A_t(i)n_t(i,j)^{\gamma\alpha}[s_t(i,j)k_t(i,j)]^{\gamma(1-\alpha)}$$
$$-\mu s_t(i,j)k_t(i,j)$$

The shift premium, utility and production (Lucas, 1970)

$$\lambda n \; s^{\phi} = \tilde{\lambda} \int_{\tau=0}^{s} n_{\tau} \tau^{\phi} d\tau$$

$$y = \tilde{A} \int_{\tau=0}^{s} n_{\tau}^{\alpha} k^{1-\alpha} d\tau - \mu s k$$

The shift premium, utility and technology

$$n = \int_{\tau=0}^{s} n_\tau d\tau$$

$$\lambda = \tilde{\lambda} \frac{1-\alpha-\phi}{1-\alpha-\alpha\phi}$$

$$A = \tilde{A} \frac{1-\alpha-\phi}{1-\alpha-\alpha\phi} \left(\frac{1-\alpha-\phi}{1-\alpha} \right)^{\alpha}$$

Optimal shift premium

- Just like conventional labour supply, drops out of interaction of household and firm optimization.

$$s_t(i) = \left\{ \frac{A_t(i)[1-(1-\phi)\alpha]}{\mu} \right\}^{1/\alpha} \frac{n_t(i)}{k_t(i)}$$

CVU, IR and observed TFP

$$\Delta \ln(A_t(i))^o = \Delta \ln(y_t(i)) \; - \alpha \Delta \ln(n_t(i)) - (1-\alpha)\Delta \ln k_t(i)$$

$$\Delta \ln A_t(i) \; = \Delta \ln y_t(i) \; - \alpha\gamma\Delta \ln n_t(i) - [\gamma(1-\alpha)-1]\Delta \ln k_t(i)$$
$$-[\gamma(1-\alpha)-1]\Delta \ln s_t(i)$$

$$\Delta \ln A_t(i)^o = \Delta \ln A_t(i) + G_t(i)$$

$$G_t(i) = \alpha(\gamma-1)\Delta \ln n_t(i) + [\gamma(1-\alpha)+\alpha-2]\Delta \ln k_t(i)$$
$$+[\gamma(1-\alpha)-1]\Delta \ln s_t(i)$$

Prices and wages, vcu, constant returns

$$\Delta \ln w_t(i) = \ln s_t(i)^{\phi} = \frac{\phi}{\alpha}\Delta \ln A_t(i) + \phi \Delta \ln \frac{n_t(i)}{k_t(i)}$$

$$\Delta \ln p_t(i) = -(1-\alpha\phi)\Delta \ln A_t(i) + \phi \Delta \ln \frac{n_t(i)}{k_t(i)}$$

Increasing returns and relative price response to an aggregate shock

$$\frac{w_t[s_t(i,j)]n_t(i,j) + r_t(i)k_t(i)}{A_t(i)n_t(i,j)^{\gamma\alpha}[s_t(i,j)k_t(i,j)]^{\gamma(1-\alpha)} - \mu s_t(i,j)k_t(i,j)}$$

Identification tool 1: luxuries are more procyclical

$$\frac{c_t(i)^{-1/\sigma(i)}}{c_t(l)^{-1/\sigma(l)}} = \frac{p_t(i)}{p_t(l)}$$

$$\sigma(bread) = 0.5, \sigma(caviar = 1)$$

$$\frac{c_t(caviar)^{-\frac{1}{1}}}{c_t(bread)^{-\frac{1}{0.5}}} = 1 = \frac{c_t(bread)^2}{c_t(caviar)}$$

Estimating degree of luxury

$$\frac{c_t(i)^{-1/\sigma(i)}}{c_t(l)^{-1/\sigma(l)}} = E_t\left\{\frac{p_t(i)}{p_t(l)} - \beta[1-\delta(i)]\frac{p_{t+1}(i)}{p_{t+1}(l)}\left(\frac{c_{t+1}(l)}{c_t(l)}\right)^{-1/\sigma(l)}\right\}$$

$$c_t(i) = (1-\delta(i))c_{t-1} + x_t(i)$$

Identification tool 2: durables expenditure is more procyclical

$$c_t(i) = [1 - \delta(i)]c_{t-1}(i) + x_t(i)$$

$$c(i) = \frac{x(i)}{\delta(i)}$$

Estimating durability

- Measure of durability: depreciation rates taken from those applied by insurance loss adjusters (in 1972!)

Identified relative technology neutral movements in relative output

$$z_t(i) = \left[\frac{\sigma(i)}{\sigma}, \ln \delta(i), \frac{\sigma(i)}{\sigma} . \ln \delta(i) \right] \otimes$$

$$\left[\Delta \ln c_{t-2}, \Delta \ln c_{t-1,} \Delta \ln c_t, \Delta \ln c_{t+1} \right]$$

$$\lim_{M \to \infty} \frac{\sum_{i=1}^{M} z_t(i)' [\Delta \ln A_t(i) - \Delta \ln A_t]}{M} = 0, \forall t$$

Testing: run some regressions

$$\Delta \ln tfp_t(i) = f(z_t(i))$$

$$\Delta \ln p_t(i) = f(z_t(i))$$

Results

- 1% increase in z leads to 0.23% increase in tfp
- 1% increase in z leads to 0.22% increase in relative prices
- Suggests vcu and/or weak ir

Recap

- We wanted to test whether observed tfp contained stuff that wasn’t pure technology
- Problem, we don’t observe technology
- Solution: construct an object that is the component of relative consumption growth due to aggregate shocks, i.e. uncorrelated with relative technology , using the theory that response to aggregate shocks is a function of durability and luxuriousness
- Show that this object is correlated with relative tfp across industries, and relative prices

Alternative strategies

- Basu (1996)
- Assume material inputs used in fixed proportions with capital (e.g. electricity), so variation in material inputs reveal variations in capital utilisation
- Hall (1988), Ramey (1991): see whether fluctuations in observed tfp correlate with (e.g.) defence spending, assumed to be uncorrelated with true technology shocks