Lecture 3
King and Rebelo: Resuscitating Real Business Cycles

The effects of a positive productivity shock:

\( A_t \uparrow \Rightarrow \)
Marg return capital \( \uparrow \Rightarrow \) investment \( \uparrow \), interest rate \( \uparrow \)
Marg return labour \( \uparrow \Rightarrow \) real wage rate \( \uparrow \)

\( \Rightarrow \)
- wealth effect (income effect), higher wages will lead to higher income \( \Rightarrow \) consump. \( \uparrow \), leisure \( \uparrow \)
- wage effect (substitution effect) \( \Rightarrow \) work more \( \uparrow \)
- interest rate effect \( \Rightarrow \) work more
  \( \Rightarrow \) consume less

Kydland & Prescott (1991):
- Technology shocks account for 70 percent of US business cycle fluctuations
- Basic RBC model said to “explain” business cycle volatility in the US.

However:
- Consumption and labour input (work hours) less volatile than in data
- Real wages and real interest rates procyclical, in contrast to data

Why?
High volatility of productivity leads to higher output, and higher real wage and higher interest rate

Higher real wage and higher interest rate raise labour input, but wealth effect goes the other way.
Diminishing returns to labour also dampens volatility in labour input.

Increase in productivity raises consumption via wealth effect, but higher real interest rate dampens the effect.

While RBC proponents claimed success, critics argued:
1) Parameter values are unreasonable (in particular, labour supply is less elastic than assumed)
2) Real wage rates are not procyclical
3) Productivity shocks implausible, and are badly measured by Solow residual

On 1) – labour supply elasticity
- Assumed labour supply elasticity is much higher than micro data estimates indicate
- In model, there is a representative worker – only variation in hours (intensive margin), no movement from between employment and nonemployment (extensive margin)
- In contrast to data, where most of the variation is due to the variation in employment

One solution: indivisible labour (Hansen, 1985):
- Fixed costs of going to work
- Lottery about who goes to work
- Complete insurance, i.e. all individuals share income and consumption equally
- Ensures that aggregate labour supply much more elastic than individual labour supply
**One problem** – unemployed are better off than the employed, because of same consumption and more leisure

**Response:** non-separable preferences between consumption and leisure, where the marginal utility of consumption is decreasing in leisure => employed individuals obtain higher consumption

**Possible interpretation:** Unemployed may work outside the market, e.g. in household, and have less need for market consumption.

**However:** Model does not explain the behaviour of the unemployed well. Furthermore, voluntary unemployed due to costs of going to work does not seem plausible. Unreasonable to assume that labour demand affect labour supply only via real wage rate.

**On 2) Procyclical real wages**

a) Incorporate labour contracts with wage smoothing. Optimal if workers are risk averse and firms risk neutral.

Note that these wage contracts have no allocative effects, i.e. that firms do not set labour input according to current real wage. Labour input depends on average wage over time.

b) In downturns, the less productive workers leave employment. As less productive workers have lower wages, this implies that aggregate wages become less cyclical.
3) On productivity shocks

- hard to identify such large shocks (why don’t we read about them in New York Times?)
- Negative productivity shocks not plausible
- Solow residual is endogenous
  - Depend on capital utilization and labour hoarding
  - Depend on e.g. military purchases, which suggests a role for demand
  - => bad proxy for productivity shocks

Productivity shocks must be large, because there is little amplification of the shocks in the model
  - One percent productivity shock leads to not more than two percent increase in output (caused by increase in labour input)
  - key amplification mechanism is intertemporal substitution of labour

Productivity shocks must be persistent because there is little internal persistence or propagation within the model

\[ A_t \uparrow \Rightarrow \]
Marg return capital \( \uparrow \Rightarrow \) investment \( \uparrow \), interest rate \( \uparrow \)
Marg return labour \( \uparrow \Rightarrow \) real wage rate \( \uparrow \)

The increase in investment leads to a larger capital stock, which dampens the marginal return to capital.

If the productivity shock is temporary, the capital stock might soon be higher than “necessary”, implying lower investment than steady state. This will make the boom less persistent.
Permanent productivity shocks?

Not implausible.

Will have smaller effect on labour input than temporary shocks have, because temporary shocks have smaller wealth effects, and temporary high real wages and high interest rates

Extension of RBC model:

Variable capacity utilization

• Assume that depreciation of capital is an increasing function of the capital utilization rate (electricity use as proxy for capacity utilization)

• Firms choose the utilization rate of capital so as to maximize profits

Key parameter: the elasticity of the depreciation with respect to the utilization rate.

• If optimal with considerable variation in the utilization rate to reduce depreciation, the model becomes closer to “linear in labour” (as capital utilization move in proportion with labour input)

• Variable capital utilization is plausible, but does the firm voluntary produce less than capacity, even when it would be able to sell more output, to reduce depreciation?
Business cycles in high substitution economy

Key elements:

- Indivisible labour –
  - makes labour supply highly elastic
- Variable capacity utilization
  - makes model “almost linear in labour”

- Less procyclical real wages
- RBC model with substantial amplification of productivity shocks.
- Implying that small variation in productivity can have large effects on macroeconomic activity
- Low probability of technological regress


- Gali (AER, 1999) explore effect of technology shocks on employment.
- Find that a positive technology shock has negative impact on the use of labour input, while GDP increases.
- Reject a key prediction of standard RBC models, in which technology shocks leads to a positive comovement of output, employment and productivity.
- Implies that technology shocks cannot be a dominant source of observed business cycles, as these are characterized by strong positive comovement of output and labour input measures.
- Alternative explanation proposed by Gali: sticky price model
Suppose the following aggregate production function

\[ Y = F(K, AN) \]  
A is labour augmenting technical progress

If \( F \) is homogeneous of degree one (i.e. constant returns to scale), we can write

\[ \frac{Y}{N} = AF(k,1), \quad \text{where} \quad k \equiv (K/AN) \]

\( k \) is the ratio of capital to labour, measured in efficiency units

\( Y/N \) is labour productivity, and we note that permanent shocks to \( A \) and \( k \) will have permanent effect on \( Y/N \)

**Empirical approach**

Use Structural VAR

VAR (vector autoregression) is a system of equations where each variable in the system is regressed on a set of its own lagged values, and lagged values of each of the other variables.

Early use of VAR typically put little or no structure or restrictions on the system. This implied that one could not use the VARs to make inference.

Structural VARs impose restrictions on the VAR, so as to make it possible test theories and explore relationships
Gali: simple version:
two variable VAR, with
- productivity (output per hours worked), and
- hours worked

Restriction: shocks that have permanent effect on productivity are assumed to be technology shocks

Hours worked enter in first differences, because hours worked is found to be non-stationary. (This assumption has been the cause for heated debate in the US, but it is less contentious for European data.)

Find that a positive shock to technology has a negative impact effect on hours worked.

Inconsistent with basic RBC model, where a positive technology shock will increase the marginal product of labour, leading to increased labour input.

Consistent with a sticky price model, where firms due to a sticky price are unable to sell more in the short run. When productivity increases, firms hence reduce their use of labour input.
Results caused by changes in capital taxes?
A capital tax will also affect the use of capital. Thus, permanent changes in the capital tax may have a permanent effect on productivity.

Along a balanced growth path, the optimal use of capital is typically determined by a condition like

\[(1 - \tau)F_k(k, 1) = \text{const.}\]

where the constant may reflect the time discount rate, etc.

However, Gali finds no evidence that changes in the capital income tax is correlated with permanent shocks in the VAR.