1 Historical introduction

• Modern business cycle theory really got started with Great Depression

• Keynes: “The General Theory of Employment, Interest and Money”

• Keynesian economics and the study of aggregate demand

• You may have seen something like an Aggregate Demand / Aggregate Supply model in ECON 1B

• Dissatisfaction with the Keynesian model
  – Practical: “stagflation” of the 1970s
  – Theoretical: where are the “microfoundations”?
  – Theoretical: are the model predictions robust to policy changes (the Lucas critique)?
  – Theoretical: model not so useful for normative questions since there are no utility functions

• “Real business cycle model” tried to remedy these deficiencies, especially in terms of “microfoundations”

• “New-Keynesian” models blend some of the logic of the Keynesian model with the from-first-principles approach of the RBC

• We’ll study New Keynesian model later in the course

Key questions

• Positive: what causes economic fluctuations?

• Normative: what should we do about it?
2 The RBC model

• RBC = Neoclassical model plus “shocks”

• Are market economies fundamentally unstable?
  
  – RBC approach: no, the internal mechanisms are stable but there are exogenous disturbances (“shocks”) that move things around
  
  – Maybe the existence of shocks is a fundamental feature of a market economy?
  
  – Do we lose understanding if we model the shocks as exogenous?

• RBC is a “Real” model as opposed to “nominal”: no role for money or nominal variables

• Since RBC is a version of the Neoclassical model, First Welfare Theorem holds. What should we do about business cycles?

A two-period RBC model

• Special case of the neoclassical “general equilibrium” model that we have studied but with just two periods:
  
  – \( t = 0 \) represents the present
  
  – \( t = 1 \) represents the future

• Pros and cons of doing 2 periods instead of \( \infty \):
  
  – Pro: easier to solve and interpret
  
  – Con: we need to adjust the model a little bit for the fact that the world ends after \( t = 1 \), eg. capital fully depreciates after \( t = 1 \).
  
  – If we want to put numbers of the model we need to be careful: \( 2 \neq \infty \! \)

• Households

\[
\max_{c_0, l_0, c_1, l_1} u(c_0) + v(l_0) + \beta [u(c_1) + v(l_1)]
\]

s.t.

\[
a_1 = w_0 (1 - l_0) - c_0 + (1 + r_0) a_0
\]

\[
c_1 = w_1 (1 - l_1) + (1 + r_1) a_1
\]

\( a_0 \) given
• FOC: Euler equation and consumption-leisure equation

\[ u'(c_0) = \beta (1 + r_1) u'(c_1) \]  
\[ v'(l_t) = w_t u'(c_t) \]

• Firms (static problem)

\[ r^K_t = F_K(K_t, L_t) \]
\[ w_t = F_L(K_t, L_t) \]

• Arbitrage between lending and holding capital

\[ r_0 = r^K_0 - \delta \]
\[ r_1 = r^K_1 - 1 \] (because the world ends after \( t = 1 \))

• Market clearing

\[ L_t = 1 - l_t \]
\[ K_1 = a_1 \]

• Equilibrium conditions:

\[ u'(c_0) = \beta F_K(K_1, L_1) u'(c_1) \]
\[ v'(l_t) = F_L(K_t, L_t) u'(c_t) \] (for both \( t = 0 \) and \( t = 1 \))
\[ K_1 = Y_0 - c_0 + (1 - \delta) K_0 \]
\[ c_1 = Y_1 \] (because the world ends after \( t = 1 \))
\[ L_t = 1 - l_t \] (for both \( t = 0 \) and \( t = 1 \))

• Now we have 7 equations in 7 unknowns: \( c_0, c_1, l_0, l_1, K_1, L_0 \) and \( L_1 \)

• Replacing \( L_t = 1 - l_t \), we have 5 equations in 5 unknowns: \( c_0, c_1, l_0, l_1, K_1 \):

\[ u'(c_0) = \beta F_K(K_1, L_1) u'(c_1) \]
\[ v'(1 - L_0) = F_L(K_0, L_0) u'(c_0) \]
\[ v'(1 - L_1) = F_L(K_1, L_1) u'(c_1) \]
\[ K_1 = Y_0 - c_0 + (1 - \delta) K_0 \]
\[ c_1 = Y_1 \]
• The Williamson textbook (ch. 10) tries to do a graphical version of this system of equations, which I find hard to follow

Using the model to talk about business cycles

• Exogenous variables in the model

1. The production function.
   For instance, if
   \[ F(K_t, L_t) = A_t K_t^\alpha L_t^{1-\alpha} \]
   the parameter \( A_t \) is exogenous
   Also, if the production function is
   \[ F(K_t, L_t) = A_t K_t^\alpha L_t^{1-\alpha} + e_t \]
   (i.e. it has an endowment component), then \( e_t \) is exogenous.

2. Intertemporal preferences, measured by \( \beta \)

3. Preferences for consumption/leisure. For instance, if
   \[ v(l) = \frac{\theta \epsilon}{1 + \epsilon} l^{1+\epsilon} \]
   the parameter \( \theta \) is exogenous

4. The initial capital stock \( K_0 \)

• Steps in using the model to think of business cycles:

1. Define some basic values for the exogenous variables and call that “normal” (e.g.: middle of the business cycle)

2. Compute the values for the endogenous variables: \( c_0, c_1, l_0, l_1, K_1 \)

3. Suppose an exogenous “shock” moves one or more of the exogenous variables

4. Compute the values for the endogenous variables: \( c_0, c_1, l_0, l_1, K_1 \) in response to the shock

5. Ask: does this look like what we see in business cycles?

• In particular, we should check whether in the model it’s true that output, employment, consumption, investment and productivity more or less move in the same direction when there is a shock.
3 Productivity shocks

- Consider a shock to $A_0$ in the production function

$$F(K_0, L_0) = A_0 K_0^\alpha L_0^{1-\alpha}$$

- An improvement in technology, that lasts only for today.

- In the equations:

$$u'(c_0) = \beta F_K(K_1, L_1) u'(c_1)$$
$$v'(1 - L_0) = \uparrow F_L(K_0, L_0) u'(c_0)$$
$$v'(1 - L_1) = F_L(K_1, L_1) u'(c_1)$$

$$K_1 = \uparrow Y_0 - c_0 + (1 - \delta) K_0$$
$$c_1 = Y_1$$

- Shock improves the marginal product of labour, which raise wages (other things being equal)

- Graphically, you can see this as an increase is labour demand (but remember that other things change as well)

- Adjust by $\uparrow c_0$, $\uparrow L_0$, or both

- Economically, higher wages induce:
  - income effect - why?
  - substitution effect - why?

- Does it matter if the shock is temporary or permanent?

- Suppose:
  - Shock is temporary
  - Income effect exists but is small
  - Substitution effect is strong

- Under these assumptions
  - $c_0$ goes up a little bit
  - $L_0$ goes up quite a lot
- $Y_1$ goes up for two reasons: direct effect of shock on productivity and additional labour input
- $K_1$ goes up (you can see this from resource constraint) - households smooth consumption by building capital for tomorrow

**Interpretation and implications**

- Success! The model gives you a simultaneous rise in
  - output
  - productivity
  - hours worked
  - consumption
  - investment

- Booms are times when households choose to work more in response to temporarily high wages

- Symmetrically, recessions are times when households choose to work less in response to temporarily low wages

- The model can “explain” a large fraction of the fluctuations in GDP
  1. Construct an infinite-horizon version of the RBC model
  2. Do a growth accounting exercise with data from the US economy and find the Solow residuals for each period (usually one quarter)

\[
\text{Solow Residual } \equiv g_Y - \alpha g_K + (1 - \alpha) g_L
\]

3. Assume that the Solow residuals are an accurate measure of a series of exogenous technological shocks

4. Simulate the response of the model when you ask it to respond to the shocks you estimated from the data

5. Compare GDP, etc. in the model to the same variables in the data

- Result: the model generates (explains?) about $\frac{2}{3}$ of the fluctuations in GDP that we observe in the data.
Implications for policy

- The government *shouldn’t* do anything about the business cycle
- By the 1st Welfare Theorem, the allocation is *efficient*
- If people aren’t working because there is a recession, this is an *efficient* response to the fact that productivity is low today: people take time off when productivity is low and work harder when productivity is high
- This is an *assumption* of the model, not a conclusion
- To be precise: competitive markets are an assumption of the model and whenever we have competitive markets the FWT holds
- BUT the model does say that it is possible to observe fluctuations in GDP, etc. in a world where there is nothing “wrong” (i.e. no inefficiency)
- Observing fluctuations does not *prove* that there is something wrong that should be fixed
- (But it’s also possible that this is the wrong model and in the right model business cycles are indeed inefficient)
- The only thing the government should do about a recession is to try to improve productivity
  - Encourage competition
  - Lower transaction costs
  - Promote innovation
  - All of these things are desirable anyway, not just when there is a recession

Criticisms and limitations

- Where are the technology shocks?
- Moreover, where are the *negative* technology shock?
- Elasticity of labour supply
  - Remember we talked about this being a very important number when we talked about the effects of taxes
  - A high elasticity of labour supply is an important ingredient of BOTH:
    * the argument that taxes have large effects
* the RBC model
* (which are views often held by the same people)

- Cyclicality of wages. In general, the model does better on quantities than on prices.
- No unemployment?
- Measurement of TFP with unobserved capacity utilization
- Measured productivity has become less cyclical than it used to be

4 Other shocks

Impatience shocks: sudden decreases in $\beta$

- Has some appeal because it means households want goods now rather than later, an effect that is important in Keynesian models, as we’ll see later

- In the equations:

\[
\begin{align*}
  u'(c_0) &= \downarrow \beta F_K(K_1, L_1) u'(c_1) \\
  v'(1 - L_0) &= F_L(K_0, L_0) u'(c_0) \\
  v'(1 - L_1) &= F_L(K_1, L_1) u'(c_1) \\
  K_1 &= Y_0 - c_0 + (1 - \delta) K_0 \\
  c_1 &= Y_1
\end{align*}
\]

- Adjust by $\uparrow c_0, \downarrow c_1 \uparrow F_K$ (which means lower investment), or all at the same time
- If $\uparrow c_0$, this implies $\downarrow L_0$!
- Consumption increases but people work less!
- Therefore output must fall
- If consumption increases and output falls, it means investment goes down
- This shock DOES NOT produce the “co-movement” of business cycles: consumption goes up but output, investment and hours of work go down!
Laziness shocks

- Suppose households temporarily don’t want to work, i.e. the marginal utility of leisure goes up
- (You could also think of the opposite: households temporarily don’t mind working)
- In the equations:

\[
\begin{align*}
    u'(c_0) &= \beta F_K(K_1, L_1) u'(c_1) \\
    \uparrow u'(1 - L_0) &= F_L(K_0, L_0) u'(c_0) \\
    v'(1 - L_1) &= F_L(K_1, L_1) u'(c_1) \\
    K_1 &= Y_0 - c_0 + (1 - \delta) K_0 \\
    c_1 &= Y_1
\end{align*}
\]

- Adjust by $\downarrow L_0$
- $Y_0$ goes down because $L_0$ goes down
- If $r_1$ didn’t change, households would $\downarrow c_0$ and $\downarrow c_1$ to smooth consumption
- In order to smooth consumption, households save less so $\downarrow K_1$ goes down
- Output, consumption, investment and hours worked all go down together
- This shock DOES produce the “co-movement” of business cycles
- But do we really want a theory based on waves of laziness?
- Maybe other things that “look” like laziness: disruption in labour markets, prices not adjusting...

Optimism / news about the future

- Keynes had this idea about “animal spirits”: businessmen become very confident about the future and things start to go well
- Strict interpretation: news.
  - The economy reacts to what people think about the future
  - (and then what people expect actually happens, at least on average)
- Less strict interpretation: optimism
– The economy reacts to what people think about the future
– (and maybe they are completely wrong, but we still care about how their expectations affect things)

• Good news about future wealth:

\[ Y_1 = F (K_1, L_1) + e_1 \]

and we ask what happens if \( e_1 \) changes

• In the equations:

\[ u'(c_0) = \beta F_K (K_1, L_1) \uparrow u'(c_1) \]
\[ v'(1 - L_0) = F_L (K_0, L_0) u'(c_0) \]
\[ v'(1 - L_1) = F_L (K_1, L_1) \downarrow u'(c_1) \]

\[ K_1 = Y_0 - c_0 + (1 - \delta) K_0 \]
\[ c_1 = Y_1 \]

• Adjust by \( \uparrow c_0 \)

• Therefore \( \downarrow L_0 \) and \( \downarrow K_1 \)

• Future wealth makes households consume more, but also work less and invest less, so it DOES NOT produce the “co-movement” we observe in business cycles.

• Good news about future productivity:

\[ Y_1 = A_1 K_1^\alpha L_1^{1-\alpha} \]

and we ask what happens if \( A_1 \) changes

\[ u'(c_0) = \beta \uparrow F_K (K_1, L_1) u'(c_1) \]
\[ v'(1 - L_0) = F_L (K_0, L_0) u'(c_0) \]
\[ v'(1 - L_1) = \uparrow F_L (K_1, L_1) u'(c_1) \]

\[ K_1 = Y_0 - c_0 + (1 - \delta) K_0 \]
\[ c_1 = Y_1 \]

• Effect on current consumption depends on income vs. substitution effects

• If \( \uparrow c_0 \), then \( \downarrow L_0 \) (and vice-versa)
• Either way, the shock DOES NOT produce the “co-movement” we see in business cycles.

Uncertainty

• Uncertainty is also about how people think about the future

• Instead of pessimism (“the future will be bad”), uncertainty is about (“I don’t know what the future will look like”)

• A simple way to model uncertainty is to say

\[ Y_1 = F(K_1, L_1) + e_1 \]

and \( e_1 \), instead of a known number, is a random variable

• Under standard preferences, uncertainty will lead to higher expected marginal utility of consumption, i.e.: \( \mathbb{E}[u'(c_1)] \) rises.\(^1\)

\[
\begin{align*}
  u'(c_0) &= \beta F_K(K_1, L_1) + \mathbb{E}[u'(c_1)] \\
  u'(1 - L_0) &= F_L(K_0, L_0) u'(c_0) \\
  u'(1 - L_1) &= F_L(K_1, L_1) u'(c_1) \\
  K_1 &= Y_0 - c_0 + (1 - \delta) K_0 \\
  c_1 &= Y_1
\end{align*}
\]

• Adjust by \( \downarrow c_0 \) (precautionary savings)

• But then \( \uparrow L_0 \) and \( \uparrow Y_0 \) and \( \uparrow K_1 \)

• Again, no “co-movement”

5 Conclusion

• Productivity shocks and laziness shocks could, in principle, generate “business cycle” co-movement

• Disagreement about how reasonable they are as theories

• Evidence is somewhat mixed

• Other types of shocks tend to generate the wrong co-movement

\(^1\)Mathematically, this depends on whether \( u'''(c) > 0 \), i.e. on the third derivative of the utility function. Most evidence suggests that the reasonable case is that it is positive.
• The key is in the equation

\[ v'(1 - L_0) = F_L(K_0, L_0) u'(c_0) \]

Unless something happens to \( v \) or \( F_L \), consumption and hours of work will move in opposite directions! Consumption and leisure are normal goods.

• The alternative explanation is that there are some market imperfections missing from our model

• Other shocks combined with market imperfections could be part of the story.

• In particular, we have to look for market imperfections such that

\[ v'(1 - L_0) = F_L(K_0, L_0) u'(c_0) \]

does NOT hold.