Chapter 10

Classical Business Cycle Analysis: Market-Clearing Macroeconomics
Chapter Outline

• Business Cycles in the Classical Model
• Money in the Classical Model
• The Misperceptions Theory and the Nonneutrality of Money
Business Cycles in the Classical Model

• The real business cycle theory
  – Two key questions about business cycles
    • What are the underlying economic causes?
    • What should government policymakers do about them?
  – Any business cycle theory has two components
    • A description of the types of shocks believed to affect the economy the most
    • A model that describes how key macroeconomic variables respond to economic shocks
Business Cycles in the Classical Model

- Real business cycle (RBC) theory (Kydland and Prescott)
  - Real shocks to the economy are the primary cause of business cycles
Business Cycles in the Classical Model

• Real business cycle (RBC) theory (Kydland and Prescott)
  – Examples of real shocks:
    • Shocks to the production function
    • Shocks to the size of the labor force
    • Shocks to the real quantity of government purchases
    • Shocks to the spending and saving decisions of consumers (affecting the IS curve or the FE line)
  – Nominal shocks are shocks to money supply or demand (affecting the LM curve)
RBC Theory

• The largest role is played by shocks to the production function, which the text has called supply shocks, and RBC theorists call *productivity shocks*
RBC Theory

• Examples of productivity shocks
  – Development of new products or production techniques
  – Introduction of new management techniques
  – Changes in the quality of capital or labor
  – Changes in the availability of raw materials or energy
  – Unusually good or bad weather
  – Changes in government regulations affecting production
RBC Theory

- Most economic booms result from beneficial productivity shocks; most recessions are caused by adverse productivity shocks
RBC Theory

• The recessionary impact of an adverse productivity shock
  – Results from Chapter 3: Real wage, employment, output, consumption, and investment decline, while the real interest rate and price level rise
  – So an adverse productivity shock causes a recession (output declines), whereas a beneficial productivity shock causes a boom (output increases); but output always equals full-employment output
RBC Theory

• Real business cycle theory and the business cycle facts
  – The RBC theory is consistent with many business cycle facts
    • If the economy is continuously buffeted by productivity shocks, the theory predicts recurrent fluctuations in aggregate output, which we observe
    • The theory correctly predicts procyclical employment and real wages
    • The theory correctly predicts procyclical average labor productivity
      – If booms weren't due to productivity shocks, we would expect average labor productivity to be countercyclical because of diminishing marginal productivity of labor
RBC Theory

- Real business cycle theory and the business cycle facts
  - The theory predicts countercyclical movements of the price level, which seems to be inconsistent with the data
  - But Kydland and Prescott, when using some newer statistical techniques for calculating the trends in inflation and output, find evidence that the price level is countercyclical.
  - Though the Great Depression appears to have been caused by a sequence of large, adverse aggregate demand shocks, Kydland and Prescott argue that since World War II, large adverse supply shocks have caused the price level to rise while output fell
  - The surge in inflation during the recessions associated with the oil price shocks of 1973–1974 and 1979–1980 is consistent with RBC theory
RBC Theory

• Application: Calibrating the business cycle
  – A major element of RBC theory is that it attempts to make quantitative, not just qualitative, predictions about the business cycle
  – RBC theorists use the method of calibration to work out a detailed numerical example of the theory
    • First they write down specific functions explaining the behavior of people in the economy; for example, they might choose as the production function for the economy,
      \[ Y = AK^a N^{1-a} \]
RBC Theory

• Application: Calibrating the business cycle
  • Then they use existing studies of the economy to choose numbers for parameters like $a$ in the production function; for example, $a = 0.3$
  • Next they simulate what happens when the economy is hit by various shocks to different sectors of the economy
  • Prescott's computer simulations (Figs. 10.1 and 10.2) match post–World War II data fairly well
Figure 10.1 Actual versus simulated volatilities of key macroeconomic variables
Figure 10.2 Actual versus simulated correlations of key macroeconomic variables with GNP
RBC Theory

• Application: Calibrating the business cycle
• The work on calibration has led to a major scientific debate within the economics profession about how to do empirical work
• Economists working on RBC models, led by Prescott, believe strongly in calibration as the only way to do empirical work in macroeconomics
• Others disagree, just as vehemently
RBC Theory

• Are productivity shocks the only source of recessions?
  – Critics of the RBC theory suggest that except for the oil price shocks of 1973, 1979, and 1990, there are no productivity shocks that one can easily identify that caused recessions
  – One RBC response is that it doesn't have to be a big shock; instead, the cumulation of many small shocks can cause a business cycle (Fig. 10.3)
Figure 10.3 Small shocks and large cycles

SIMULATED LEVEL OF AGGREGATE OUTPUT

SIMULATED PRODUCTIVITY SHOCKS

Time (months)
RBC Theory

- Does the Solow residual measure technology shocks?
  - *RBC* theorists measure productivity shocks as the *Solow residual*
    - Named after Robert Solow, the originator of modern growth theory
    - Given a Cobb-Douglas production function and data on $Y$, $K$, and $N$, the Solow residual is
      \[ A = \frac{Y}{K^a N^{1-a}} \]  
      (10.1)
    - It's called a residual because it can't be measured directly
RBC Theory

• Does the Solow residual measure technology shocks?
  – The Solow residual is strongly procyclical in U.S. data
    • This accords with RBC theory, which says the cycle is driven by productivity shocks
  – But should the Solow residual be interpreted as a measure of technology?
    • If it's a measure of technology, it should not be related to factors that don't directly affect scientific and technological progress, like government purchases or monetary policy
    • But statistical studies show a correlation between these
RBC Theory

• Does the Solow residual measure technology shocks?
  – Measured productivity can vary even if the actual technology doesn't change
    • Capital and labor are used more intensively at times
    • More intensive use of inputs leads to higher output
    • Define the utilization rate of capital $u_K$ and the utilization rate of labor $u_N$
    • Define capital services as $u_K \times K$ and labor services as $u_N \times N$
RBC Theory

• Does the Solow residual measure technology shocks?
  – Rewrite the production function as
    \[ Y = AF(u_K \times K, u_N \times N) = A(u_K \times K)^a(u_N \times N)^{1-a} \quad (10.2) \]
  – Use this to substitute for \( Y \) in Eq. (10.1) to get
  – Solow residual = \( A u_K^{a} u_N^{1-a} \) \quad (10.3)
  – So the Solow residual isn't just \( A \), but depends on \( u_K \) and \( u_N \)
RBC Theory

• Does the Solow residual measure technology shocks?
  – Utilization is procyclical, so the measured Solow residual is more procyclical than is the true productivity term $A$
    • Labor hoarding: firms keep workers in recessions to avoid incurring hiring and firing costs
    • Hoarded labor doesn't work as hard, or performs maintenance
    • The lower productivity of hoarded labor doesn't reflect technological change, just the rate of utilization
  – Conclusion: Changes in the measured Solow residual don't necessarily reflect changes in technology
RBC Theory

- Does the Solow residual measure technology shocks?
  - Technology shocks may not lead to procyclical productivity
    - Research shows that technology shocks are not closely related to cyclical movements in output
    - Shocks to technology are followed by a transition period in which resources are reallocated
    - Initially, less capital and labor are needed to produce the same amount of output
    - Later, resources are adjusted and output increases
RBC Theory

• Critics of RBC theory suggest that shocks other than productivity shocks, such as wars and military buildups, have caused business cycles
• Models allowing for other shocks are DSGE models (dynamic, stochastic, general equilibrium models)
Business Cycles in the Classical Model

• Fiscal policy shocks in the classical model
  – The effects of a temporary increase in government expenditures (Fig. 10.4)
    • The current or future taxes needed to pay for the government expenditures effectively reduce people's wealth, causing an income effect on labor supply
    • The increased labor supply leads to a fall in the real wage and a rise in employment
    • The rise in employment increases output, so the $FE$ line shifts to the right
    • The temporary rise in government purchases shifts the $IS$ curve up and to the right as national saving declines
Figure 10.4 Effects of a temporary increase in government purchases

(a) Labor market

(b) General equilibrium
Business Cycles in the Classical Model

• Fiscal policy shocks in the classical model
  – The effects of a temporary increase in government expenditures (Fig. 10.4)
    • It's reasonable to assume that the shift of the IS curve is bigger than the shift of the FE line, so prices must rise to shift the LM curve up and to the left to restore equilibrium
    • Since employment rises, average labor productivity declines; this helps match the data better, since without fiscal policy the RBC model shows a correlation between output and average labor productivity that is too high
    • So adding fiscal policy shocks to the model increases its ability to match the actual behavior of the economy
Business Cycles in the Classical Model

- Fiscal policy shocks in the classical model
  - Should fiscal policy be used to dampen the cycle?
    - Classical economists oppose attempts to dampen the cycle, since prices and wages adjust quickly to restore equilibrium
    - Besides, fiscal policy increases output by making workers worse off, since they face higher taxes
    - Instead, government spending should be determined by cost-benefit analysis
Business Cycles in the Classical Model

• Fiscal policy shocks in the classical model
  – Should fiscal policy be used to dampen the cycle?
    • Also, there may be lags in enacting the correct policy and in implementing it
      – So choosing the right policy today depends on where you think the economy will be in the future
      – This creates problems, because forecasts of the future state of the economy are imperfect
    • It's also not clear how much to change fiscal policy to get the desired effect on employment and output
Business Cycles in the Classical Model

- Unemployment in the classical model
  - In the classical model there is no unemployment; people who aren't working are voluntarily not in the labor force
  - In reality measured unemployment is never zero, and it is the problem of unemployment in recessions that concerns policymakers the most
Business Cycles in the Classical Model

- Unemployment in the classical model
  - Classical economists have a more sophisticated version of the model to account for unemployment
  - Workers and jobs have different requirements, so there is a matching problem
  - It takes time to match workers to jobs, so there is always some unemployment
Business Cycles in the Classical Model

- Unemployment in the classical model
  - Unemployment rises in recessions because productivity shocks cause increased mismatches between workers and jobs
  - A shock that increases mismatching raises frictional unemployment and may also cause structural unemployment if the types of skills needed by employers change
  - So the shock causes the natural rate of unemployment to rise; there's still no cyclical unemployment in the classical model
Business Cycles in the Classical Model

• Unemployment in the classical model
  – Davis and Haltiwanger show that there is a tremendous amount of churning of jobs both within and across industries
  – But this worker match theory can't explain all unemployment
    • Many workers are laid off temporarily; there's no mismatch, just a change in the timing of work
    • If recessions were times of increased mismatch, there should be a rise in help-wanted ads in recessions, but in fact they fall
Figure 10.5 Rates of job creation and job destruction in U.S. manufacturing, 1973-1998
Business Cycles in the Classical Model

• Unemployment in the classical model
  – So can the government use fiscal policy to reduce unemployment?
    • Doing so doesn't improve the mismatch problem
    • A better approach is to eliminate barriers to labor-market adjustment by reducing burdensome regulations on businesses or by getting rid of the minimum wage
Business Cycles in the Classical Model

- Household production
  - The RBC model matches U.S. data better if the model accounts explicitly for output produced at home
  - Household production is not counted in GDP but it represents output
  - Rogerson and Wright used a model with household production to show that such a model yields a higher standard deviation of (market) output than a standard RBC model, thus more closely matching the data
  - Parente, Rogerson, and Wright showed that after household production is accounted for, income differences across countries are not as large as the GDP data show
Business Cycles in the Classical Model

• Heterogeneous-Agent Models
  – Most macroeconomic models (including the IS–LM and AD–AS models), key variables are economy-wide averages of income, the wage rate, wealth, money holdings, etc.
  – But some issues in macroeconomics are better addressed in models in which agents in the model act in different ways or face different wages or have differing amounts of wealth; such models are heterogeneous-agent models
  – For example, to understand how the unemployment rate changes over time, a model of the demographics of the labor force (the number of workers of different ages, different levels of experience, and different levels of education) is useful
  – In recent years, more macroeconomists have begun building heterogeneous-agent models
Business Cycles in the Classical Model

• Heterogeneous-Agent Models
  – Some researchers have used heterogeneous-agent models to study the costs of business cycles, in terms of the reduced well-being of the agents
  – In recessions, people who do not lose their jobs are not affected as much as people who lose their jobs; heterogeneous-agent models can account for the differential impact on the well-being of different people
  – In addition, people who lose their jobs may not be able to borrow, so their consumption spending declines, making them worse off
  – Research shows that when people cannot borrow, the costs of business cycles are significantly larger than if people were able to borrow whenever they lose their jobs, and thus not have to reduce their spending
Business Cycles in the Classical Model

• Heterogeneous-Agent Models
  – Researchers have also used heterogeneous-agent models to see if they can calibrate the real interest rate better than in other models
  – The real interest rate generated by RBC models is often several percentage points higher than is true in the data
  – But in RBC models with heterogeneous agents in which people face risk, such as the risk of becoming unemployed, and cannot borrow if they become unemployed, then the real interest rate is somewhat lower than in other RBC models without heterogeneous agents
  – The risk in such models also leads people to save more than they would if there were no such risk
• So, RBC models with heterogeneous agents are able to match certain aspects of the economic data better than standard RBC models
Money in the Classical Model

• Monetary policy and the economy
  – Money is neutral in both the short run and the long run in the classical model, because prices adjust rapidly to restore equilibrium
  – Monetary nonneutrality and reverse causation
    • If money is neutral, why does the data show that money is a leading, procyclical variable?
      – Increases in the money supply are often followed by increases in output
      – Reductions in the money supply are often followed by recessions
Money in the Classical Model

• If money is neutral, why does the data show that money is a leading, procyclical variable?
  – The classical answer: Reverse causation
    • Just because changes in money growth precede changes in output doesn't mean that the money changes cause the output changes
    • Example: People put storm windows on their houses before winter, but it's the coming winter that causes the storm windows to go on, the storm windows don't cause winter
    • Reverse causation means money growth is higher because people expect higher output in the future; the higher money growth doesn't cause the higher future output
    • If so, money can be procyclical and leading even though money is neutral
Money in the Classical Model

• Why would higher future output cause people to increase money demand?
  – Firms, anticipating higher sales, would need more money for transactions to pay for materials and workers
  – The Fed would respond to the higher demand for money by increasing money supply; otherwise, the price level would decline
Money in the Classical Model

• The early theoretical RBC models did not include a monetary sector at all—they assumed that money was unimportant for the business cycle
• More recently, RBC theorists have been trying to incorporate money into their models
• The focus so far has been trying to get the models to produce a liquidity effect, in which an increase in the money supply temporarily reduces nominal interest rates
Money in the Classical Model

• The nonneutrality of money: Additional evidence
  – Friedman and Schwartz have extensively documented that often monetary changes have had an independent origin; they weren't just a reflection of changes or future changes in economic activity
    • These independent changes in money supply were followed by changes in income and prices
    • The independent origins of money changes include such things as gold discoveries, changes in monetary institutions, and changes in the leadership of the Fed
Money in the Classical Model

• The nonneutrality of money: Additional evidence
  – More recently, Romer and Romer documented additional episodes of monetary nonneutrality since 1960
    • One example is the Fed's tight money policy begun in 1979 that was followed by a minor recession in 1980 and a deeper one in 1981
    • That was followed by monetary expansion in 1982 that led to an economic boom
  – So money does not appear to be neutral
  – There is a version of the classical model in which money isn't neutral—the misperceptions theory discussed next
The Misperceptions Theory and the Nonneutrality of Money

• Introduction to the misperceptions theory
  – In the classical model, money is neutral since prices adjust quickly
    • In this case, the only relevant supply curve is the long-run aggregate supply curve
    • So movements in aggregate demand have no effect on output
The Misperceptions Theory and the Nonneutrality of Money

• Introduction to the misperceptions theory
  – But if producers misperceive the aggregate price level, then the relevant aggregate supply curve in the short run isn't vertical
    • This happens because producers have imperfect information about the general price level
    • As a result, they misinterpret changes in the general price level as changes in relative prices
    • This leads to a short-run aggregate supply curve that isn't vertical
    • But prices still adjust rapidly
The Misperceptions Theory and the Nonneutrality of Money

- The misperceptions theory is that the aggregate quantity of output supplied rises above the full-employment level when the aggregate price level $P$ is higher than expected
  - This makes the AS curve slope upward
The Misperceptions Theory and the Nonneutrality of Money

- Example: A bakery that makes bread
  - The price of bread is the baker's nominal wage; the price of bread relative to the general price level is the baker's real wage
  - If the relative price of bread rises, the baker may work more and produce more bread
  - If the baker can't observe the general price level as easily as the price of bread, he or she must estimate the relative price of bread
  - If the price of bread rises 5% and the baker thinks inflation is 5%, there's no change in the relative price of bread, so there's no change in the baker's labor supply
  - But suppose the baker expects the general price level to rise by 5%, but sees the price of bread rising by 8%; then the baker will work more in response to the wage increase
The Misperceptions Theory and the Nonneutrality of Money

• Generalizing this example, if everyone expects prices to increase 5% but they actually increase 8%, they'll work more
  – So an increase in the price level that is higher than expected induces people to work more and thus increases the economy's output
  – Similarly, an increase in the price level that is lower than expected reduces output
The Misperceptions Theory and the Nonneutrality of Money

• The equation

\[ Y = \bar{Y} + b(P - P^e) \]  \hspace{1cm} (10.4)

summarizes the misperceptions theory

– In the short run, the aggregate supply (SRAS) curve slopes upward and intersects the long-run aggregate supply (LRAS) curve at \( P = P^e \) (Fig. 10.6)
Figure 10.6 The aggregate supply curve in the misperceptions theory
The Misperceptions Theory and the Nonneutrality of Money

• Monetary policy and the misperceptions theory
  – Because of misperceptions, unanticipated monetary policy has real effects; but anticipated monetary policy has no real effects because there are no misperceptions
  – Unanticipated changes in the money supply (Fig. 10.7)
Figure 10.7 An unanticipated increase in the money supply
The Misperceptions Theory and the Nonneutrality of Money

- Monetary policy and the misperceptions theory
  - Initial equilibrium where $AD^1$ intersects $SRAS^1$ and $LRAS$
    - Unanticipated increase in money supply shifts $AD$ curve to $AD^2$
    - The price level rises to $P^2$ and output rises above its full-employment level, so money isn't neutral
    - As people get information about the true price level, their expectations change, and the $SRAS$ curve shifts left to $SRAS^2$, with output returning to its full-employment level
    - So unanticipated money isn't neutral in the short run, but it is neutral in the long run
The Misperceptions Theory and the Nonneutrality of Money

• Do the data support the misperceptions theory?
• Robert Barro found support for the misperceptions theory
  – His results suggested that output was affected only by unanticipated money growth
• But others challenged these results and found that both anticipated and unanticipated money growth seem to affect output
The Misperceptions Theory and the Nonneutrality of Money

• Monetary policy and the misperceptions theory
  – Anticipated changes in the money supply
    • If people anticipate the change in the money supply and thus in the price level, they aren't fooled, there are no misperceptions, and the SRAS curve shifts immediately to its higher level
    • So anticipated money is neutral in both the short run and the long run
Figure 10.8 An anticipated increase in the money supply

1. Money supply increases
2. Expected price level rises
The Misperceptions Theory and the Nonneutrality of Money

• Rational expectations and the role of monetary policy
  – The only way the Fed can use monetary policy to affect output is to surprise people
  – But people realize that the Fed would want to increase the money supply in recessions and decrease it in booms, so they won't be fooled
  – The rational expectations hypothesis suggests that the public's forecasts of economic variables are well-reasoned and use all the available data
The Misperceptions Theory and the Nonneutrality of Money

• Rational expectations and the role of monetary policy
  – If the public has rational expectations, the Fed won't be able to surprise people in response to the business cycle; only random monetary policy has any effects
  – So even if smoothing the business cycle were desirable, the combination of misperceptions theory and rational expectations suggests that the Fed can't systematically use monetary policy to stabilize the economy
The Misperceptions Theory and the Nonneutrality of Money

• Propagating the effects of unanticipated changes in the money supply
  – It doesn't seem like people could be fooled for long, since money supply figures are reported weekly and inflation is reported monthly
  – Classical economists argue that *propagation mechanisms* allow short-lived shocks to have long-lived effects
The Misperceptions Theory and the Nonneutrality of Money

- Propagating the effects of unanticipated changes in the money supply
  - Example of propagation: The behavior of inventories
    - Firms hold a normal level of inventories against their normal level of sales
    - An unanticipated increase in the money supply increases sales
    - Since the firm can't produce many more goods immediately, it draws down its inventories
    - Even after the money supply change is known, the firm must produce more to restore its inventory level
    - Thus the short-term monetary shock has a long-lived effect on the economy
The Misperceptions Theory and the Nonneutrality of Money

• Though the text presents the theories in the reverse order, the misperceptions theory came first (being developed in the 1970s) and the RBC theory came later (in the 1980s)

• Many classical economists moved away from the misperceptions theory because they weren't convinced by its arguments for monetary non-neutrality; in particular, the information lag in observing money and prices didn't seem long enough to cause much effect
The Misperceptions Theory and the Nonneutrality of Money

- Are price forecasts rational?
  - Economists can test whether price forecasts are rational by looking at surveys of people's expectations
  - The forecast error of a forecast is the difference between the actual value of the variable and the forecast value
  - If people have rational expectations, forecast errors should be unpredictable random numbers; otherwise, people would be making systematic errors and thus not have rational expectations
The Misperceptions Theory and the Nonneutrality of Money

• Are price forecasts rational?
  – Many statistical studies suggest that people don't have rational expectations
    • But people who answer surveys may not have a lot at stake in making forecasts, so couldn't be expected to produce rational forecasts
    • Instead, professional forecasters are more likely to produce rational forecasts
    • Keane and Runkle, using a survey of professional forecasters, find evidence that these forecasters do have rational expectations
    • Croushore used inflation forecasts made by the general public, as well as economists, and found evidence broadly consistent with rational expectations, though expectations tend to lag reality when inflation changes sharply
The Misperceptions Theory and the Nonneutrality of Money

• Are price forecasts rational?
  – If you examine a survey of forecasters, like the Livingston Survey, you'll see that the forecasters made very bad forecasts of inflation around 1973 to 1974 and again around 1979 to 1980
  – Both time periods are associated with large rises in oil prices
  – Looking at data on interest rates, if you take nominal interest rates and subtract the expected inflation rate (using the Livingston Survey forecasts of inflation), the resulting real interest rates are nearly always positive
The Misperceptions Theory and the Nonneutrality of Money

- Are price forecasts rational?
  - But if you subtract actual inflation rates from nominal interest rates, you'll find negative realized real interest rates around the time of the oil price shocks.
  - In fact, the real interest rate was as low as negative 5 percent at one point.
  - So making bad inflation forecasts has expensive consequences in financial markets.
Key Diagram 8 The misperceptions version of the AD–AS model