

## Business Cycles II: Theories

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In the previous lecture we have explored at length the main features of the fluctuations in economic activity known as business cycles. However the most interesting questions in business cycles research is what drives business cycles fluctuations and what are their consequences for welfare. This note provides some answers to these questions. We will review this question in the next note as well, in which we will also explicitly consider the impact of money and monetary policy on business cycles.

### Causes of Business Cycles

To start it is convenient to rewrite once again the basic national income accounting equation

$$Y = AF(K, L) = C + I + G + NX$$

This equation highlights two possible (non mutually exclusive) determinants of business cycles.

### Supply Shocks

These are shocks either to  $A$ ,  $L$  or  $K$ . By definition they affect  $Y$  and so they cause fluctuations in GDP. Example of this shocks are productivity increases (the US Economy in the late 1990s), large investment plans that increase  $K$  (The Marshall plan in Europe after the war), increases in employment (the increase in female labor market participation). Neoclassical economists (among which Finn Kydland and Edward Prescott which were awarded the 2004 Nobel Prize in Economics) believe that the shocks to supply are the key drivers of business cycle fluctuations. In particular they argue that aggregate demand (i.e.  $C$ ,  $I$ ,  $G$  and  $NX$ ) will simply respond to aggregate supply. Their key idea is that the business cycle of a nation is not very different from the business cycle of farmer Joe. Suppose that farmer Joe expects a few years of high productivity (say because he expects good weather). In order to take advantage of

the high productivity he's going to work hard (high  $L$ ) and invest in a new tractor. But now farmer Joe is also richer and he will want to buy new clothes and eat well (high  $C$ ). If Joe is counting on a lot of future good harvests, consumption and investment expenditures will probably exceed current income but Joe will not hesitate to borrow (negative  $NX$ ). Note that demand of farmer Joe moves exactly like aggregate demand over the cycle but obviously the key driver is not demand. His consumption and investment and are high because of the good harvest and it is not that he has a good harvest because he consumes and invest a lot. Kydland and Prescott argue that the modern market economies can be described as a collection of farmer Joes all hit by shocks to their productivity and these shocks generate business cycles. Their conclusion is that understanding business cycles is not very different from understanding growth, i.e. everything boils down to understanding TFP. In growth we were interested in understanding the long run movement of TFP, in business cycles we are more interested in understanding its short run fluctuations. For example Prescott argues that if you want to understand the 90's in Japan (the so called lost decade) you need to understand what caused the substantial drop in Japanese firms productivity. One test of their theory is to see what a model of the economy with only productivity shocks predicts for business cycles. Figure 5 shows actual business cycle in Japan and the predictions for Business Cycles coming out of standard RBC model. The figure shows that the RBC model does a decent job in capturing Japan's GDP (the same is true for US or for other variables such as investment or consumption). The challenge is then to understand what causes fluctuations in TFP: Prescott argues that, beside fluctuations in the rate of increase of technological progress, changes in rules and regulations, changes in competition and incentives, barriers to reallocations of factors, can cause substantial fluctuations in TFP.

### The RBC model

The model of farmer Joe outlined above is formally known as the Real Business Cycle model (RBC). Here we briefly describe a simplified version of the RBC model.

The first assumption of the RBC model is the existence of a representative agent, i.e. of a single agent (farmer Joe) who represents the entire economy. This is clearly a simplifying assumption but it's useful as it allow us to describe the entire economy using the behavior of a single agent. We also assume that in the economy there is no money and that there is a single good which is used for consumption, investment and saving. We assume that in every period Joe is endowed with 1 unit of time that he can use for leisure or for working. Preferences of farmer Joe, which are assumed equal to

$$\sum_{t=0}^{\infty} u(c_t, T - l_t)$$

where  $u(c, 1 - l)$  is a utility function which is increasing and concave in consumption  $c$  and leisure  $T - l$  (note that  $l$  is labor and  $T$  is total time available to Joe), capturing

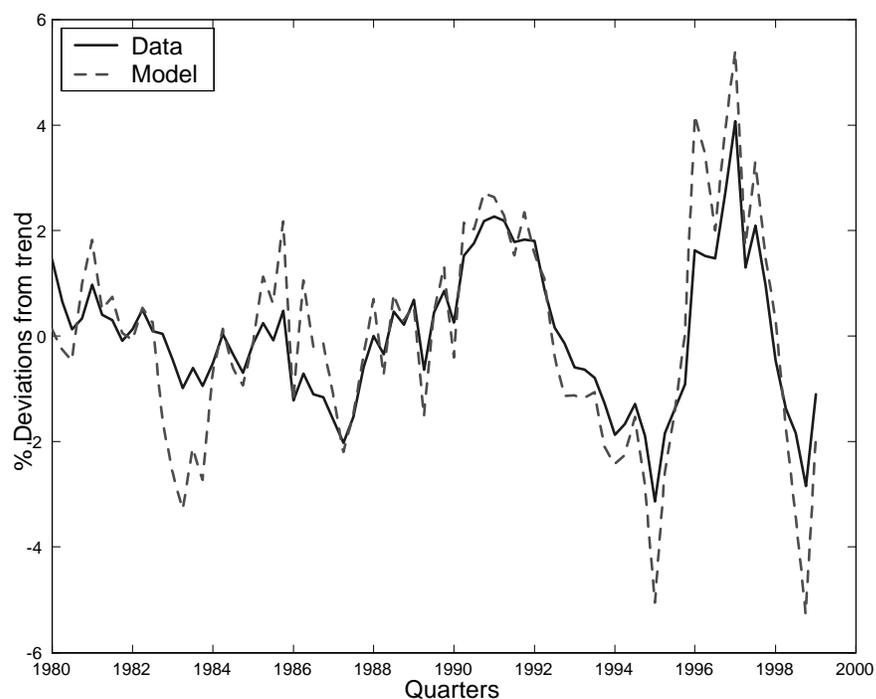


Figure 1: BUSINESS CYCLES IN JAPAN

that Joe likes to consume and likes free time but the marginal utility he enjoys from consumption and leisure are decreasing. It is assumed that the farming technology is given by the following relation

$$y_t = z_t F(k_t, l_t)$$

where  $y_t$  is farming output (say grain),  $z_t$  is a productivity shock (think about bad/good weather),  $k_t$  is the capital owned by Joe (think about his land and tractor) and  $l_t$  is the time spent working. As usual it is assumed that  $F$  is increasing in both  $k$  and  $l$ , but it displays diminishing returns in both.

Finally we have to write farmer Joe budget constraint. To do so we assume that he can save in two assets, capital  $k_t$  and a Swiss bank accounts  $b_t$  which pays an interest of  $r$ . The budget constraints in every period read as

$$z_t F(k_t, l_t) + b_t(1 + r) + (1 - \delta)k_t = k_{t+1} + b_{t+1} + c_t$$

To understand it better think of the following: at the end of each period Joe puts together all his resources: the grain produced in the period,  $y_t = z_t F(k_t, l_t)$ , the Swiss bank account plus interests  $b_t(1 + r)$ , the capital he started the period with  $k_t$ , a fraction  $\delta$  of which has depreciated in production. These resources (which are all

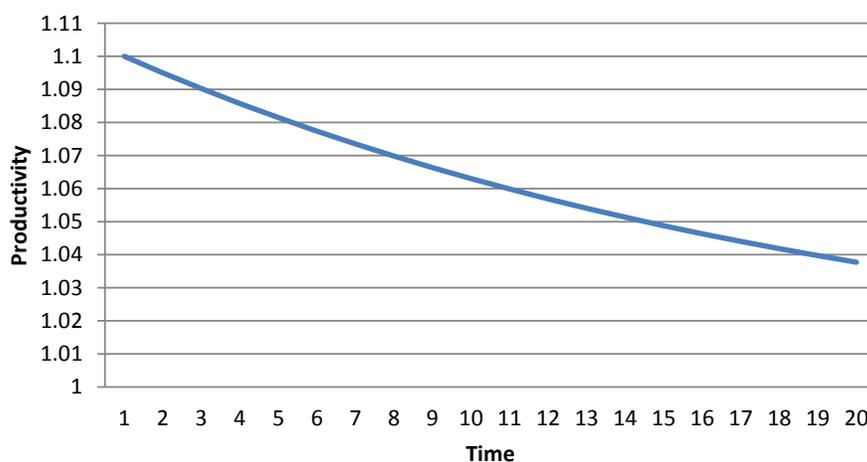


Figure 2: PRODUCTIVITY PATH FOLLOWING A GOOD SHOCK

denominated in the single consumption good) are split between three uses:  $k_{t+1}$  i.e. new capital which will be used for production next period,  $b_{t+1}$  i.e. new deposits in the bank account and current consumption  $c_t$ .

The final piece of the model regards our description of the process for the productivity shock  $z_t$  (i.e. the weather). It is usually assumed that the log of  $z_t$  follows an autoregressive process i.e.

$$\log z_{t+1} = \rho \log z_t + \varepsilon_t$$

where  $\rho$  is a fixed number bigger than 0 and less or equal to 1 and  $\varepsilon_t$  is a normal random variable with mean 0 and standard deviation  $\sigma$ . This process implies that the average log of  $z$  is 0 (i.e. the average  $z$  is 1) and that there are periods in which  $z$  is larger than 1 (above its mean) and periods in which  $z$  is below 1 (below its mean). If, for example, current  $z$  is above its mean, Joe expects it to follow the pattern described in figure 2 below.

The solution of this model requires fairly advanced techniques which are beyond the scope of the class. The idea is that Joe chooses labor, investment (in capital and in the bank account) and consumption to maximize his lifetime expected utility, subject to budget constraints in each period. Once a solution is obtained we can describe how Joe reacts to a productivity shock, i.e. to a positive (or negative) shock to  $z$ . Figure 3 below shows how the key variables in the model respond (in percentage change) to the positive shock depicted in figure 2. What are the key forces at work here?

The first force is the so called inter-temporal substitution. To understand it simply observe figure 2 and note that the pattern of productivity implies that current productivity is higher than future productivity and hence now it is a better time to work hard and invest. This is why labor and investment in capital are high today relative

to tomorrow: in other words working hard today is more efficient and this why Joe would inter-temporally substitute future work and investment for current work and investment. To make it very concrete think about studying, which is at the same time working and investment. Would you want study evenly or study very hard before the exam and lightly (or not at all) after the exam? The optimal solution is work hard before the exam, because before the exam is when your studying has the highest return. An interesting issue is why the model implies that investment (in percentage terms) jumps much more than labor. The reason is that investment, as we discussed earlier, is just a small fraction of capital. In particular remember assume that

$$z_t F(k_t, l_t) = z_t k_t^\alpha l_t^{1-\alpha}$$

and assume that  $z_t$  is 1% above its long term mean. this implies that Joe will want to set both  $k$  and  $l$  above their mean; say for simplicity he wants to increase them by 1%. But remember that

$$k_{t+1} = (1 - \delta)k_t + i_t$$

and that  $\delta \simeq 0.1$  (if a period is one year) so that investment is (on average) 10% of capital. This implies that if Joe wants to increase capital by 1% it has to increase investment by 10%, hence the large volatility of investment. The second force is the so called consumption smoothing (or permanent income hypothesis). This force implies that when Joe faces an increase in income (see figure 3) he also increases his consumption but he does so in a way that the increase in consumption is even across all future periods. This implies that currently Joe will increase its consumption less than income but in the future the increase in consumption will be higher than income.

The final consideration regards the bank account: why does Joe reduces his bank account? The reason is the following. Intertemporal substitution implies, in response to a good productivity shock, Joe wants to increase investment, and consumption smoothing implies that Joe wants to increase consumption. In general Joe does not have enough resources to finance both increases with current output, and hence he needs to use resources from the bank account, which declines. Notice that if you consider Joe to representative of a country as a whole, this is consistent with the fact that in good times countries tend to run current account deficits, i.e. to reduce their assets abroad (i.e. their bank accounts).

The next question is how the model's predictions line up with what happens during an actual business cycle. On some dimension the model does well, in particular when times are bad investment in capital is the variable that fall the most and consumption is the variable that jumps the least, labor, consumption and output are all above the mean, and current account (the change in the swiss bank account in the model) decline. On the other hand the model has a hard time explaining some aspects of business cycles as for example the period immediately following the recession of 2007-2009, as shown in the picture below.

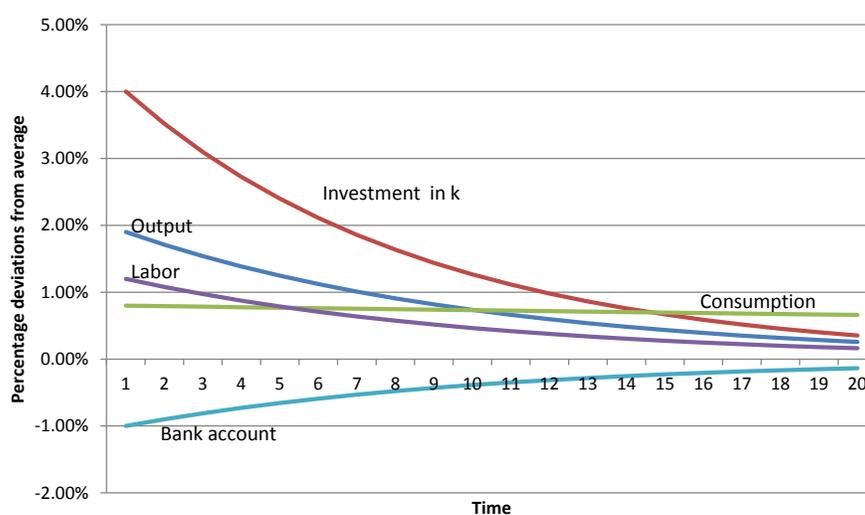


Figure 3: RESPONSES OF MACRO VARIABLES FOLLOWING A POSITIVE SHOCK

the picture show that at the onset of the recession productivity indeed declined but afyter the first few months of recession productivity recovered fairly quickly, yet both GDP and employment stayed well below their mean. So why were firms not hiring, even if productivity was back on trend. many economists believe that other types of shocks were hitting the economy.

## Demand Shocks

Demand shocks are shocks in either  $C$ ,  $I$ ,  $G$  or  $NX$  which are, initially, independent from supply. To continue with farmer Joe example a demand shock would be the local village administration unexpectedly buying a lot more apples than Joe expected. What would Joe do? well that depends on what is currently doing and on how he expects the local administration to pay for the apples. If Joe was not working very hard, now facing the additional demand he will probably work harder and try to be more efficient, so that the shock in demand will cause an increase in output (GDP) and probably TFP. In this case a demand shock can cause a business cycle expansion. But if Joe was already working at full capacity it is unlikely that the additional demand will cause any change production and it will rather be met by an increase in the price of apples. Also suppose that the Joe expects that the administration will raise taxes in the future to pay for the additional apple purchases. In this case Joe will probably will want to reduce his consumption in order to save to pay for the higher taxes and thus the increase in public demand will be offset by a decline in private demand and the overall effect on GDP can be small.

Demand side economists (or Keynesian economists) argue that shocks to demand are

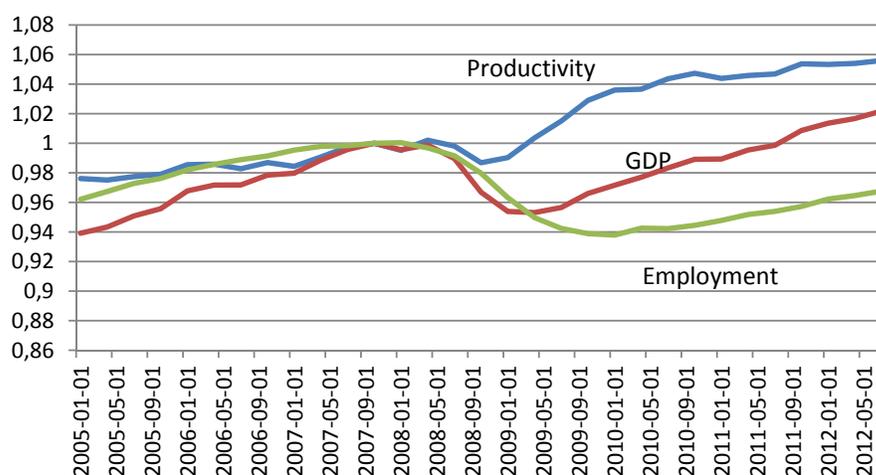


Figure 4: LABOR PRODUCTIVITY, LABOR AND GDP IN US, 2007-2009 RECESSION

very important for fluctuations in GDP. They argue that the supply will adjust to the new (post-shock) level of demand and implicitly they argue that at any point in time there are a lot of idle resources in the economy, so that the additional demand mobilize these resources and translate in additional output.

**The Keynesian cross** The Keynesian cross is the simplest model of how a demand shock can affect the level of economic activity and hence business cycles. The first assumption is that there are idle resources in the economy and hence higher demand will translate, in general, in higher level of economic activity. But how is economic activity exactly determined? The second assumption regards the composition of aggregate demand

$$AD = C + G + I$$

The Keynesian cross treats government spending  $G$  and investment as fixed (more precisely independent on the level of economic activity) and assume that aggregate consumption can be represented by

$$C = C_f + cY \quad (1)$$

i.e. a fixed component  $C_f$  plus a component that is proportional to income, where  $c$  is a constant, usually called the marginal propensity to consume. Substituting (1) into the expression for aggregate demand yields

$$AD = C_f + G + I + cY$$

that is plotted below.

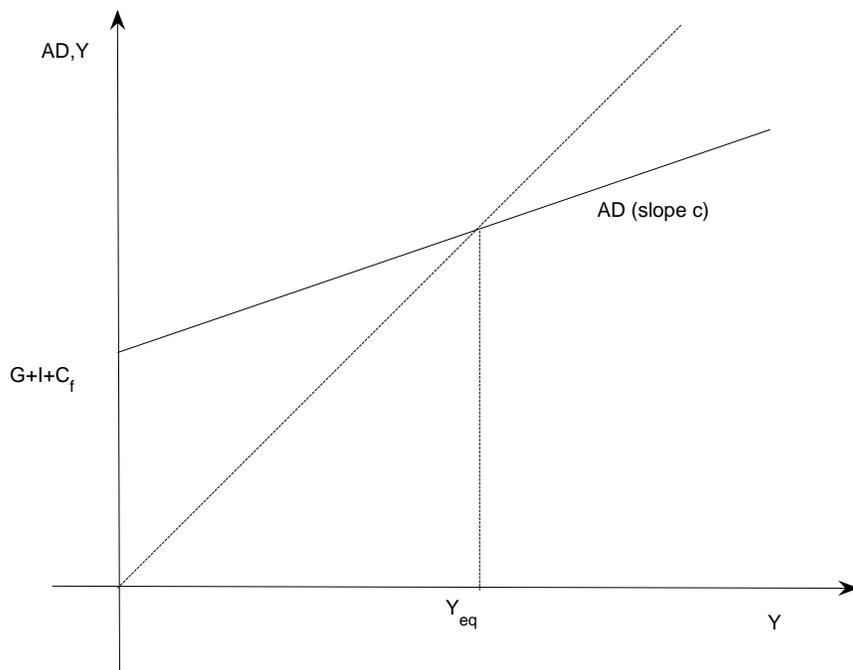


Figure 5: THE KEYNESIAN CROSS

In the graph you can see how equilibrium level of economic activity ( $Y_{eq}$ ) is determined as the level of GDP where aggregate demand is equal to aggregate supply ( $Y$ ). Algebraically equating  $AD$  and  $Y$  yields

$$Y_{eq} = \frac{C_f + G + I}{(1 - c)}$$

suggesting that increases in  $G, I, C_f$  or increases in the marginal propensity of consume  $c$  cause increases in equilibrium level of economic activity. Sometimes the term  $\frac{1}{1-c}$  is referred to as the Keynesian multiplier as it summarizes the impact of 1 extra dollar of aggregate demand on the level of economic activity. If, for example,  $c = 0.8$  then the multiplier is around 5. Why is that? when the first dollar is spent it increases  $Y$  by 1. This increase in  $Y$  causes in turn, through (1), an increase in consumption expenditure by 0.8 and thus a further increase in  $Y$  by 0.8. This in causes a further increase in consumption and output by  $0.8 * 0.8$  and so forth the final effect is given by

$$1 + 0.8 + 0.8^2 + 0.8^3 + .. = \sum_{t=0}^{\infty} 0.8^t = \frac{1}{1 - 0.8}$$

As a simple application of the Keynesian consider the so called Haavelmo result, which states that an increase in the government spending, fully financed by taxes, has an expansionary effect. To see this consider a slightly modified version of the Keynesian cross above:

$$C = C_f + c(Y - T)$$

where  $T$  represents taxes, and assume that the government uses taxes to finance public spending, i.e.  $T = G$ . In this case we have

$$AD = C_f + G + I + c(Y - T) = C_f + G + I + c(Y - G)$$

and it is easy to derive

$$Y_{eq} = \frac{C_f + I}{(1 - c)} + G$$

showing that each dollar of increased government spending, fully financed by taxes, raises equilibrium output by one dollar and thus leaves private consumption unchanged. The idea here is that the government, by taking away income from private consumers through taxes and using it for spending, increases aggregate demand, as the government has a higher propensity to consume than private agents. Obviously this cannot be always true (otherwise the government could raise output to infinity), but it is meant to represent a possibility of raising output in periods of low demand and idle resources.

A more sophisticated view of the role of demand shock comes from the study of the so called “coordination failures”. Suppose that there are two farmers Joe and Jim.

Joe sells apples to Jim and Jim sells beans to Joe. Suppose that Joe expects that Jim will not work very hard, not make much money and so he will not buy much apples. Suppose that Jim expects the same from Joe. It's easy to see that in such equilibrium none of them will work very hard because they expect the demand for their products to be low and thus output will be low. In this case if the administration goes out and buy a lot of apples and beans it can get the economy out of the low demand/low production equilibrium.

### **Policy implications**

In the '60s the prevalent view was that demand shocks were the main determinant of business cycles. Keynes in particular argued that private business men were driven by "animal spirits" and that these spirits lead to repeated coordination failures like the one describes above. This view lead to the idea that the government had to stabilize the economy by adjusting government purchases or money supply to compensate for the variation in private demand. The smooth run of many economies in the '60s lead many to believe that this type of stabilization was very effective and that business cycles were dead. More recently a majority of economists believe that demand fluctuations, although important, cause fluctuations in productions that are short lived, while supply shocks cause more sustained fluctuations and so that an effective stabilization policy should focus more on the production side, removing inefficiencies and distortions and facilitating production. This change in view has been caused mainly by the episodes of the 1970s, or by the recent Japanese experience in which demand management policies have not lead to very effective stabilizations.

### **The costs of business cycles**

Although it should be pretty clear why having a 4% growth rate is better than 0% growth it is less obvious what is the cost of recurrent fluctuations around the long run growth. There are two main arguments against business cycles and one in favor. The first argument is that people dislike fluctuations in their consumption and their income. As a simple example of that think about comparing the following two eating patterns

- 1) Eat nothing for a week, Eat like a pig for a week, Eat nothing etc. etc.
- 2) Eat regularly every week

Clearly most people would prefer the second pattern. So since during recessions there are people losing their jobs and that are forced to low consumption business cycles induced undesired fluctuations in people's consumption and income patterns.

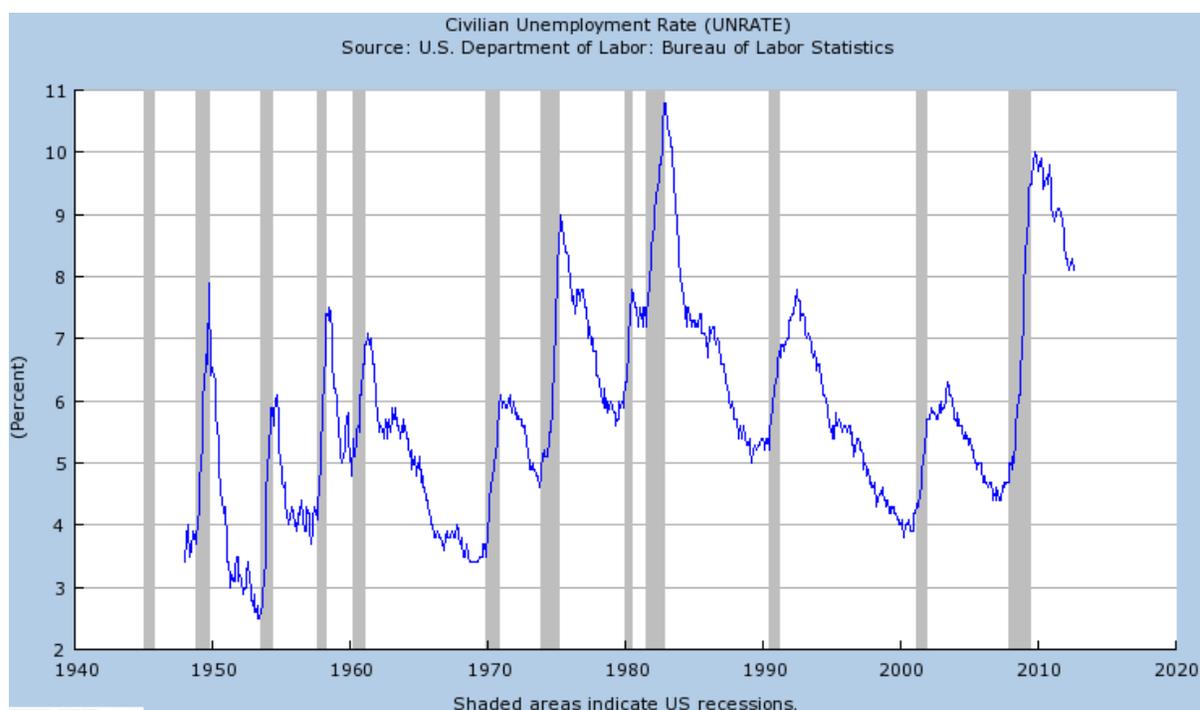


Figure 6: UNEMPLOYMENT IN RECESSIONS

Economist Robert Lucas has argued that **on average** in the US these costs are not very high. The main reason is that average business cycles fluctuations are fairly small (a typical recession involves a decline of income of less than 5%). The fact that average fluctuations are small though does not mean that the costs are small for everybody. In particular some fraction of the population might be affected very severely by the business cycles (for example people who lose their job and have not any savings, or MBAs which graduate in recession year). Figure 6 shows that the unemployment rate during recessions goes up substantially.

Also the fact that business cycle fluctuations are small is only true for post-war US. As we have seen in many emerging countries a typical recession can involve fall of average income of more than 30% and the same happened during the great depression. In this case even the cost of average fluctuations can be substantial.

The second argument against business cycles is that fluctuations can actually have negative effects on future growth. The logic behind this reasoning is that fluctuations affect the decision to invest. Suppose for example that you have just been hired in a company that might or might not be around next year. You will not invest a lot in training or education specific to that the company because there is a high probability that your investment will be wasted. On the other hand if you are hired by a company you know is going to be around for a long time you will be more willing to take the investment. So in an economy with less severe business cycles companies go out of

business less frequently and so there is more incentive for investment and investment affects future growth. Finally an argument in favor of business cycles is the so called “Cleansing effects of recessions”; according to this view recessions are a necessary part of economic transformation because they force marginal or unhealthy firms out of business and create room for new business to start.

## Review questions

### 1. A simple RBC model

Consider a farmer which lives for two seasons (fall and winter) and has utility function given by

$$\log(c_f) + \log(c_w)$$

where  $c_f$  and  $c_w$  are consumption in fall and winter. The farmer has a unit of time and can work either in the fall or in the winter (or in both). Her output in the fall is given  $2l_f$  and in the winter is given by  $l_w$  where  $l_f$  and  $l_w$  represent time worked in the two seasons. The farmer starts the fall with no resources but can store resources for the winter.

1. Write the fall and winter farmer budget constraint
2. Solve for optimal labor decision of the farmer
3. Solve for consumption of the farmer and storage policy.

## Answer

1. Fall b.c.  $c_f + s = 2l_f$  where  $s$  is storage. Winter b.c.  $c_w = s + (1 - l_f)$
2. Since productivity in the fall is always higher than the one in winter (returns to labor are constant), it is optimal for the farmer to concentrate all her work in the fall, so  $l_f = 1$  and  $l_w = 0$ .
3. Consider any unequal distribution of consumption between fall and winter. It implies that the marginal utility of consumption is higher in one season than in the other, so that the farmer can increase her utility by moving consumption from the season with higher consumption to the one with lower consumption. It follows that the optimal choice implies equal consumption across seasons. This result, together with the labor decisions, implies  $c_f = 1, c_w = 1$  and  $s = 1$ .

## 2. GDP and aggregate demand

Suppose that in a given economy aggregate demand  $AD$  is given by

$$\begin{aligned}AD &= C + G \\ C &= cY\end{aligned}$$

where  $C$  is aggregate private consumption and  $c$  tells you the fraction of  $GDP$  that is consumed by the private sector.  $G$  is government spending and is equal to 1.

1. For a given  $c$  (say  $c = 0.8$ ) plot aggregate demand as a function of  $GDP$ .
2. Assume that the economy has idle resources and that  $c$  is constant and equal to 0.8. Use the Keynesian cross framework to compute equilibrium  $GDP$ . Also compute the effect on  $GDP$  and on private aggregate consumption  $C$  of an increase in government spending from 1 to 1.2.
3. Assume instead that the economy has no idle resources and that  $Y$  is fixed and equal to 5. What happens to private consumption when government spending increases from 1 to 1.2?

### Answer

1. AD graph has  $Y$  on the x-axis and  $AD$  on the Y-axis. It is a line with intercept 1 and slope 0.8.  $AD = 1 + 0.8Y$
2.  $Y = \frac{1}{1-0.8} = 5$ , if  $G$  increases to 1.2 then  $Y = \frac{1.2}{1-0.8} = 6$ .
3. Since the economy is closed  $Y = C + G$ . If  $Y$  is fixed at 5 and  $G$  increases by 0.2 then  $C$  must fall by 0.2.

### Concepts you should know

1. Supply Shocks
2. The Real Business Cycle Model
3. Productivity Shock
4. Demand Shocks
5. Keynesian Cross
6. Government Spending Multipliers