1 Facts

Before we can talk about the features of the business cycle, we have to define what it is.

2 The Kydland–Prescott model

Modern business cycle theory uses a version of the growth model—one that is ceaselessly being hit by imperfectly predictable shocks. The first generation of models were hit by shocks only to productivity. The reason for that was that Kydland and Prescott (1982) wanted to measure what fraction of output fluctuations could be accounted for by “real” shocks as opposed to “monetary” shocks.

Given the then prevailing views about the importance of monetary shocks, Kydland and Prescott were surprised to find that a model hit only by shocks to productivity—of a magnitude and nature that we can more or less observe—also generates aggregate time series whose properties very much resemble actual business cycles and where most (85 percent) of the variance of the cyclical component of output is accounted for.

An honest exposition of the model involves decision-making under uncertainty and several other technicalities, so we will settle here for intuitive considerations.
Output in the Kydland-Prescott economy is produced according to

\[ Y_t = K_t^\theta (z_t H_t)^{1-\theta} \]

where \( H \) is hours worked and the crucial assumption is that \( z_t \) jumps around in an imperfectly predictable way. The neat thing about this is that \( z_t \) can be measured, provided we have data on the capital stock, output and hours worked. \( z_t \) is the celebrated Solow residual although apparently Solow himself is outraged at the way it was used by Kydland and Prescott. Solow thought of it as a measure of our ignorance; for Kydland and Prescott it is the ultimate cause of business cycles and growth.

So far we just have a growth model. We can introduce fluctuations—and distinguish them from long–run growth—by assuming that \( z_t \) consists of two components, a trend and a cycle. More specifically, suppose

\[ z_t = A_t \tilde{z}_t \]

and let \( A_t \) grow deterministically via

\[ A_{t+1} = (1 + \gamma) A_t \]

but let \( z_t \) jump around in an unpredictable way. Specifically, suppose

\[ \ln \tilde{z}_{t+1} = \rho \ln \tilde{z}_t + \varepsilon_{t+1}, \]

where \( \varepsilon_t \) be a sequence of random variables that are independent across time. Suppose \( \mathbb{E}[\varepsilon_t] = 0 \) and \( \mathbb{E}[\varepsilon_t^2] = \sigma^2 \). Meanwhile, \( 0 < \rho < 1 \) is a parameter measuring persistence.

As \( z_t \) jumps around, so does \( Y_t \), in a mechanical way. But \( K \) and \( H \) jump around too. Especially \( H \). To explain exactly why would take us too far afield. But the basic idea is simple: construct a description of people’s preferences so that they find it in their interest to work hard when the wage is (temporarily) high and take a break when it is (temporarily) low. Thus the theory is based on intertemporal substitution of leisure. Through this mechanism, the theory is able to account for fluctuations in hours worked.

Capital plays a role, too. Through it, people are able to smooth consumption by saving in good times and running down the capital stock in bad times. This leads to the prediction that investment is more volatile than output and that consumption is smoother than output—which is exactly what we observe.


3 Lucas’ money surprise model

This model is often called the “monetary misperceptions” model: it is based on the idea that producers are imperfectly informed about the general price level so that they misinterpret changes in the demand price for their good as a rise in its relative price. This misinterpretation is not the result of irrationality—just imperfect information.

Roughly speaking, the idea in Lucas (1972) is that the world consists of many households consisting of a shopper and a shopkeeper. Each household produces a distinct good, but every household consumes a basket consisting of all goods.

Every morning each household sends out one member to go shopping. When shoppers arrive, the shopkeeping member of each household observes the price it can get for its good. On that basis, a decision is made on how much to produce.

A household faces two distinct sources of uncertainty. One is that its good fluctuates in popularity, so that its relative price fluctuates. The other is monetary policy. Every morning, the central bank injects or withdraws cash into the economy. These injections and withdrawals are picked up by shoppers and they cause fluctuations in the demand price for every good and hence cause fluctuations in the general price level.

It seems like a fair assumption that a shopkeeper would like to respond to a temporary increase in the relative price in the good by producing a bit more. This argument is in the same spirit as the intertemporal substitution argument in the real business cycle mode. “Make hay while the sun shines.”

On the other hand, if a temporarily high demand price is entirely due to a monetary injection, then it is optimal not to respond at all, since it doesn’t affect the amount that every unit of output today will buy tomorrow.

Formally, suppose a firm would like to respond in the following way to an increase in the relative demand price.

$$\ln y^* = \ln p.$$  

Meanwhile, the observed log price is the sum of the relative price and the general price level $P$. Thus the firm observes, when making its production decision, only the sum

$$\ln \hat{p} = \ln P + \ln p.$$
To motivate this little formula, think of $p$ as the price of your good in terms of potatoes and $P$ as the money price of potatoes. Then $\hat{p} = Pp$ is the money price of your good.

The producer would like to set $\ln y = \ln p$. But this is not feasible, since he doesn’t observe $\ln p$. So suppose output is set according to

$$\ln y = b \ln \hat{p}$$

This is at least feasible. Suppose also that the producer would like to minimize the expected squared regret, i.e. $E(\ln y - \ln y^*)^2$. The minimization problem then becomes

$$\min_b E [b \ln P + (b - 1) \ln p]^2$$

Now suppose that $\ln P$ and $\ln p$ are independent, that $E[\ln p] = 0$ and that $E[\ln P] = 0$. This amounts to assuming that the average relative price is one, that the long-run average absolute price level is one (no long–run inflation) and that there is no association between monetary shocks and real demand shocks.

Our problem then reduces to

$$\min_b \left\{ b^2 \sigma_{\ln P}^2 + b^2 \sigma_{\ln p}^2 - 2b \sigma_{\ln p}^2 \right\}$$

where $\sigma_{\ln p}^2 = E[(\ln p)^2]$ and $\sigma_{\ln P}^2 = E[(\ln P)^2]$ The solution is

$$b = \frac{\sigma_{\ln p}^2}{\sigma_{\ln p}^2 + \sigma_{\ln P}^2}$$

Thus the more uncertainty is associated with monetary policy, the less an optimizing producer will respond to a given demand price shock—she will suspect that it is mostly due to a monetary injection or withdrawal, not a change in the relative price.

In this economy, what is the relationship between output and the money supply/general price level (the two are assumed to be the same)? Well, producers set prices according to

$$\ln y = \frac{\sigma_{\ln p}^2}{\sigma_{\ln p}^2 + \sigma_{\ln P}^2} (\ln P + \ln p).$$

By the law of large numbers, or perhaps by the definition of relative prices, average (log) output will be, if we normalize $M/P = 1$,

$$\ln Y = \frac{\sigma_{\ln p}^2}{\sigma_{\ln p}^2 + \sigma_{\ln P}^2} \ln P = \frac{\sigma_{\ln p}^2}{\sigma_{\ln p}^2 + \sigma_{\ln P}^2} \ln M.$$
This model is supposed to be dynamic (although all the interesting action is within a period) so we may write

$$\ln Y_t = \frac{\sigma_{\ln p}^2}{\sigma_{\ln p}^2 + \sigma_{\ln M}^2} \ln P_t = \frac{\sigma_{\ln p}^2}{\sigma_{\ln p}^2 + \sigma_{\ln M}^2} \ln M_t.$$  \hspace{1cm} (1)

The beauty of this model is that any \textbf{expected} change in the money supply has \textbf{no} effect on output. Output responds only to \textbf{surprise} changes in the money supply.

This is why (1) is often called the Lucas surprise supply function. It can, incidentally, be motivated in many different ways apart from the way in which Lucas did it. One way is to say that unions and employers write wage contracts based on inflationary expectations, fixing nominal wages. Then an inflationary surprise (but not an expected increase in inflation) leads to a fall in the real wage, inducing employers to take on more labour and increase production. (It is an open question, however, why anyone would agree to work more at this lower real wage.)

Notice that, in this model, fluctuations in aggregate output are entirely due to unexpected fluctuations in monetary policy. If the central bank were to behave predictably, aggregate output would be constant.

\section*{4 Empirical evaluation of the two business cycle theories}

Difficulty in testing the money surprise model: how do we measure surprises? Williamson rightly points out that the empirical fact that prices are countercyclical are a problem for the money surprise model and (perhaps) a success for the RBC model. But this doesn’t really settle the issue. Is any deviation from “trend” really a surprise?

Another angle on this is to consider the correlation between the real wage (or labour productivity) and hours. The RBC model predicts a correlation close to +1. The money surprise model, when motivated in the second (non–Lucasian) way, predicts a negative correlation. What does the evidence say? About zero.

This is a serious problem for the RBC model—but one that can easily be solved by introducing other shocks, e.g. fluctuating government expenditure or taxes. This gives rise to fluctuations in labour supply, not just labour demand.
On the whole, the RBC framework has proven itself to be an excellent framework for understanding business cycles, with new refinements arriving all the time. A recent contribution is Restuccia and da Rocha (2002). They note that output fluctuations are larger, and employment fluctuations smaller, in countries and regions where agriculture is important. This matches the fact reported in the Williamson text that business cycle fluctuations seems to have dampened over time, as reported by Romer (1999).

But what about the relationship between money, prices and output? What about the Phillips curve? There is a burgeoning literature on this, well funded by central banks across the world. Perhaps surprisingly, it has proved very difficult to come up with an expectations–augmented Phillips–style relationship that fits the data. Perhaps the fundamental problem is that surprises really are what matters and that they can’t be measured.

References


“The main cause of the business cycle, and a sufficient cause, seems to be the fact that technical and commercial progress cannot by its very nature give rise to a series which proceeds as evenly as the growth in our time of human needs ... but is now accelerated and now retarded.”

—Knut Wicksell (1851-1926)