

## Inflation

After the static aggregate demand and supply analysis of the equilibrium price level ( $P$ ) and output ( $Y$ ) developed in Chapter 6 and applied in Chapters 7 and 8, Gordon's Chapter 9 extends this to the dynamic short-run Phillips (SP) curve analysis of the equilibrium inflation rate ( $p$ ) and output. The schedule relating unemployment to the inflation rate achievable given a fixed expected rate of inflation is the *short-run Phillips curve*<sup>1</sup>. This is done in two steps:

1. The short-run Phillips curve is derived directly from explicit introduction of inflation and the role of inflationary expectations into the AD–SAS model; and
2. the definitional relationship between nominal GDP growth ( $x$ ), real GDP growth ( $y$ ), and the inflation rate ( $p$ ):

$$y = x - p$$

with the short-run Phillips curve.

---

1. A.W. Phillips was a Kiwi engineer-turned-economist who found evidence of a fairly stable long-run trade-off between inflation and unemployment: the higher one, the lower the other. The supply shocks of the '70s and the realisation that *stagflation* could occur mean that we now distinguish between short-run and long-run Phillips curves.

This model is then capable of determining not only the short-run and long-run rate of inflation, but also the specific dynamic path by which the economy arrives at the long-run equilibrium.

This is followed by a discussion of the choices of policy-makers in altering this adjustment to long-run equilibrium.

## 1. Real GDP and the Inflation Rate

The earlier AD–SAS model determined the effect of changes in aggregate demand and supply on the price *level*, so that in order to convert this model into a dynamic setting, we need to analyse the effect of *continuous* changes in aggregate demand (and supply) on the *rate of change* of prices, aka the inflation rate ( $p$ ), as seen in Gordon's Figure 9.1.

The position of the SAS curve depends on the nominal wage rate ( $W$ ), and thus the driving force that restored the economy to its long-run equilibrium following an expansion in aggregate demand was the increase in nominal wages which shifted the SAS curve and restored the actual real wage ( $W/P$ ) to its equilibrium level. The short-run expansion of output in the meantime was due to the failure of workers to anticipate inflation.

The central idea behind the SP curve is that because workers are constantly renegotiating current nominal wage rate contracts based on last period's actual price level ( $P$ ), an output level above the natural level ( $Y^N$ ) can only be sustained if there is a continuous rather than a one-shot increase in aggregate demand.

The simultaneous shifts in AD and SAS which maintain the above-natural level of GDP result in a continuous increase in the price level (or inflation). This is precisely why the SP curve slopes upwards at any fixed, expected rate of inflation ( $p^e$ ).

While the initial increase in nominal GDP growth ( $x$ ) can originate from an expansionary fiscal policy — or any other source of planned autonomous spending — sustained inflation can come only from a continuous increase in the nominal money supply ( $M^s$ ). *In the long run, inflation is a monetary phenomenon.*

## 2. Expectations

In the short run, actual inflation may be higher or lower than expected, and real GDP ( $Y$ ) can differ from long-run equilibrium natural real GDP ( $Y^N$ ). An acceleration of nominal GDP growth ( $x$ ) in the short run goes partly into an acceleration of inflation ( $p$ ), but also partly into an acceleration in growth in real GDP ( $y$ ). But when expectations of inflation ( $p^e$ ) catch up to actual inflation ( $p$ ), the economy will return to its level of natural real GDP.

The short-term Phillips curve has shifted up by exactly the amount that people have raised their expectations of inflation, and  $SP_1(p^e)$  now passes through the vertical line with real GDP equal to  $Y^N$  at actual equals expected inflation ( $p = p^e$ ). This vertical line is the LP or long-run Phillips curve, and shows all possible positions of long-run equilibrium where expectations of inflation are correct.

Two reasons for the upward shift in SP as inflationary expectations are incorporated into nominal wage ( $W$ ) contracts:

- a greater rate of inflation ( $p$ ) resulting from a larger continuous increase in aggregate demand is necessary to sustain any given level of output ( $Y$ ), and
- the same level of inflation resulting from the same continuous expansion of aggregate demand sustains a lower level of output, and this lower level of output will be the natural level of output if inflationary expectations are

totally accurate (a movement from  $E_1$  to  $E_3$  in Gordon Figure 9-2).

### 3. Nominal GDP Growth ( $x$ ) and Inflation

Given the expectation of inflation ( $p^e$ ) when the contracts were negotiated, where will the economy be along the current SP curve? The SP curve gives combinations of output  $Y$  and inflation  $p$  consistent with equilibrium in the AD-SAS model, but we need to know the rate of growth of nominal GDP  $x$ . The model's short-term equilibrium must be a combination of output and inflation consistent with both SP and  $x = p + y$ .

#### 4. Acceleration in Nominal GDP Growth ( $x$ )

Since an increase in nominal GDP growth ( $x$ ) must be divided between a rise in inflation ( $p$ ) and real GDP growth ( $y$ ), the short-run equilibrium must move up along the given SP. But the economy is no longer in equilibrium (where  $y=0$ ,  $p = x$ , and the economy is on LP). Inflationary expectations adjust with shifts in SP until the economy does reach long-run equilibrium.

The response of inflation ( $p$ ) to an acceleration in demand growth depends on the slope of the short-run Phillips curve (SP) and the speed with which expectations of inflation respond to changes in the actual inflation rate. The flatter the slope of the SP curve, the slower the rate of adjustment of expectations ( $p^e$ ), and the longer the response of inflation ( $p$ ) to higher nominal GDP growth ( $x$ ), and the longer the temporary expansion of real GDP ( $Y$ ).

Real GDP must grow (the growth rate of GDP is positive  $y > 0$ ), whenever nominal GDP growth exceeds the inflation rate ( $x > p$ ).

## 5. Expectations Adjustments

How quickly will inflationary expectations adjust to higher inflation? Or: how high can real GDP be pushed by the acceleration in nominal GDP growth? There are two forms of expectations:

- *rational or forwards-looking expectations* attempt to predict the future behaviour of prices by combining all relevant current and past information with a theory about inflation. New classical theory assumes rational expectations. Under this assumption, the economy immediately adjusts to long-run equilibrium following an anticipated rise in nominal GDP growth ( $x$ ): from  $E_0$  to  $E_3$  in Gordon's Figure 9-4.
- *adaptive or backwards-looking expectations* assume that individuals form expectations on the basis of past information only. Adaptive expectations are consistent with staggered and overlapping long-term contracts discussed in Gordon's Chapter 8. Adaptive expectations usually lead to overshooting.

With the simple rule that this period's expected inflation rate equals last period's actual inflation rate, Gordon's Figure 9-4 shows the effect on inflation and real GDP of an acceleration of demand growth as adjustment occurs to LP.

## 6. Cures for Inflation

A permanent end to inflation requires that nominal GDP growth ( $\dot{x}$ ) drop to the growth rate of the natural real GDP ( $\dot{Y}^N / Y^N$ ). But this drop will cause a temporary recession in actual real GDP ( $Y$ ), the length and intensity of which will depend on the slope of the SP curve and the speed of adjustment of expectations.

The speed of adjustment of the economy to long-run equilibrium depends on three factors:

- the speed with which nominal GDP growth ( $\dot{x}$ ) is reduced,
- the speed with which inflationary expectations ( $p^e$ ) adjust, and
- the slope of the SP curve.

Gordon Figure 9-8 contrasts sudden versus gradual policy, and compares the costs of the two in terms of output forgone as measured by the sacrifice ratio.

## 7. Supply Disturbances

Fluctuations in nominal GDP growth ( $x$ ) and aggregate demand can explain the *demand* inflation of the '60s and the '80s, but they cannot explain the great volatility of unemployment and inflation rates of the '70s: *supply inflation*.

Supply inflation stems from sharp changes in business costs that are not related to prior changes in nominal GDP growth. Examples are oil price rises, wage rate increases, droughts and crop failures. Supply shocks can be beneficial as well as harmful: the fall in oil prices of early 1986.

Gordon's Figure 9-10 relates nominal and real oil prices and nominal GDP growth to the post-1970 inflation rate of the USA. Supply shocks help explain three puzzles:

- why unemployment has been so high and variable,
- why the inflation rate has been so high and variable, and
- why productivity has grown so slowly.

The reduction in natural real GDP ( $Y^N$ ) is the direct effect of an adverse supply shock. It is unavoidable. The aggravation of inflation and unemployment are indirect effects of an adverse supply shock. The government can choose a trade-off: less inflation and more unemployment, or vice versa, as described by the short-term Phillips curve (SP) above.

Because adverse supply shocks increase the rate of inflation at every level of the output ratio ( $Y/Y^N$ ), the SP curve will shift upwards. There are two factors here:

- changes in inflationary expectations, and
- supply shocks.

The direct effects of a supply shock are its effects on the output ratio and inflation. The indirect effects depend on how the government responds to the supply shock by altering the level of nominal GDP growth. There are three alternative policies (Gordon Figure 9-11):

- *accommodating*, in which nominal GDP growth is raised so as to maintain the original output ratio;
- *neutral*, in which nominal GDP growth is maintained so as to allow a decline in the output ratio equal to the increase in the rate of inflation;
- *extinguishing*, in which nominal GDP growth is reduced so as to maintain the original inflation rate. The extra inflation is extinguished.

SP will remain at its new position only if the supply shock lasts and if the expected rate of inflation remains fixed at its pre-supply-shock level.

If nominal wages are increased immediately, then even a temporary supply shock can lead to permanent inflation if it is not extinguished through a deep recession, with possibly severe loss of output.

## Indicators

### 1. Layton's Australian Indicators (Package, 35)

#### *1.1 Leading indicators*

Several indicators foreshadow a turning point in the business cycle: in the early stages of a recession, fewer new firms are founded, orders for machinery and equipment wane, and the sharemarket, in anticipation of lower profits, often falls. Households, too, reduce their spending on consumer durables, including cars and housing. Residential construction permits and housing starts, with especially long lead times, slow down.

Factory overtime (hours)  
 New telephone services (net demand)  
 Private non-residential building (value of approvals)  
 Total new residential building (approvals)  
 Change in price index of materials used in manufacturing  
 ASX "all ordinaries" share price index  
 Gross operating surplus (constant \$)  
 Implicit price deflator / unit labour cost ratio  
 Overdraft limits outstanding (constant \$)

#### *1.2 Roughly coincident indicators*

Household income (constant \$)  
 Gross non-farm product (constant \$)  
 Quantity of factory production  
 Retail sales (excluding motor vehicles)  
 Total employed civilian labour force  
 Unemployed rate, inverted

## 2. Stock's Experimental Indexes (Package 36)

### 2.1 *Leading Index*

New private housing authorisations
Manufacturers' unfilled orders in durable goods industries
A trade-weighted index of exchange rates (USD v. ¥, £, DM, Fr, L)
Part-time work in non-agricultural industries
Change in the 10-year bond rate
Risk premium on high-grade, short-run private paper (the spread between the 6-month commercial paper rate and the 6-month Treasury bill rate)
Slope of the yield curve (the spread between 10-year and 1-year Treasuries)

Note that this is multivariate: the indicators are used together in a single index, not separately.

### 2.2 *Coincident Index*

Industrial production
Real personal income (less transfers)
Real manufacturing and trade sales
Employee-hours at non-agricultural establishments

Note that this is multivariate: the indicators are used together in one index, not separately.

## Westpac-Melbourne Institute Indices of Economic Activity

There are four indices:

- the leading index
- the coincident index
- the lagging index
- the leading index of inflation

The components of *the leading index* are:

Overtime worked
Private non-residential building approved
Total number of dwelling units approved
Change in manufacturing materials prices
Australian share price index
Gross operating surplus of trading enterprises
Ratio of implicit price deflator to male labour cost
Money supply M3
Demand for new telephones

Layton suggests Outstanding overdraft limits instead of Money supply M3. Stock's indicators are somewhat different.

The components of *the coincident index* are:

Household Income Gross non-farm product Index of Industrial Gross Product Retail trade Total employed civilian labour force Unemployment Rate (inverted)
---

Layton suggests Quantity of factory production instead of Index of Industrial Gross Product, which the Westpac-Melbourne Institute index has only recently adopted. Stock's indicators are somewhat different.

The components of *the lagging index* are:

Credit to the private sector by financial institutions Long-term unemployment rate (13 weeks or over) 90-day commercial bill rate
---

The components of *the leading inflation index* are:

Ratio of Employment/Civilian Population Weekly award rates of pay for full-time adult Credit to the private sector by financial institutions Price Index of home-produced material used in manufacturing Price Index of imported material used in manufacturing Survey of expected change in selling price
---

# Macroeconomics and Game Theory

## 1. The failure of Keynesian demand management

In many countries, from the 1950s onwards, fine-tuning of economies has failed, as unemployment and inflation drifted up together until the end of the 1970s. Successive cyclical peaks have grown higher and fluctuations bigger. The phenomenon is too persistent and widespread to be explained by temporary supply-side or political shocks.

Milton Friedman, with his natural rate hypothesis, had been arguing that demand management was actually doing more harm than good, that it could certainly not achieve a permanent reduction in unemployment, and that it was probably destabilising prices and possibly employment as well.

Hence his argument for using a money-supply rule which limited money-supply growth to  $k\%$  per annum, where  $k$  is the target inflation rate plus the growth rate of the natural real level of GDP. His broad view of the economy is now widely accepted: that unexpected inflation ( $p$ ) can temporarily increase real output ( $Y$ ) and employment ( $N$ ), but that anticipated inflation is unlikely to have real effects.

## **2. Why?**

Why have governments around the world allowed inflation to drift upwards continuously, while being unable to do anything much about unemployment ( $U$ )?

### 3. Policy as a Game Between the Private Sector and Government

The government chooses the money supply ( $M^S$ ). Firms and households make decisions about nominal wage rates ( $W$ ). The government can adjust its monetary policy continuously, and cannot in fact precommit itself to a particular money supply in advance. We model this by having the private sector announce its wage outcome (“high” or “low”) before the government sets the money supply, (also “high” or “low”).

Low  $W$  is consistent with zero expected inflation ( $p^e=0$ ); high  $W$  is consistent with high expected inflation. Low  $M^S$  is non-inflationary; High  $M^S$  is inflationary;

The decisions taken in a large decentralised economy are assumed to be taken non-cooperatively: each player takes the decision which best achieves his or her own objectives, assuming all other players have done the same: a Nash equilibrium.

#### 3.1 Objectives and outcomes

Suppose the government has a target of zero for the inflation rate ( $p$ ), but always prefers higher real GDP ( $Y$ ) to less (and conversely lower unemployment to higher). Suppose the private sector set money wages ( $W$ ) so that, at the price level ( $P^e$ ) expected to rule in the economy over the period for which the wage bargains or contracts are in force employment ( $N$ ) is at an equilibrium level (associated with  $Y^N$ ).

Since the government chooses the money supply taking wage decisions as given, it does so recognising that higher money supply partly raises prices and partly raises aggregate demand and output. So it will choose a money supply where the marginal benefit of higher output is just matched by the marginal cost of higher inflation.

The private sector takes this behaviour by the government into account and bases its nominal wage decision on the price level expected to emerge, in such a way to generate the preferred level of employment, with the GDP at the real natural level ( $Y^N$ ), and inflation ( $p$ ) at some positive rate.

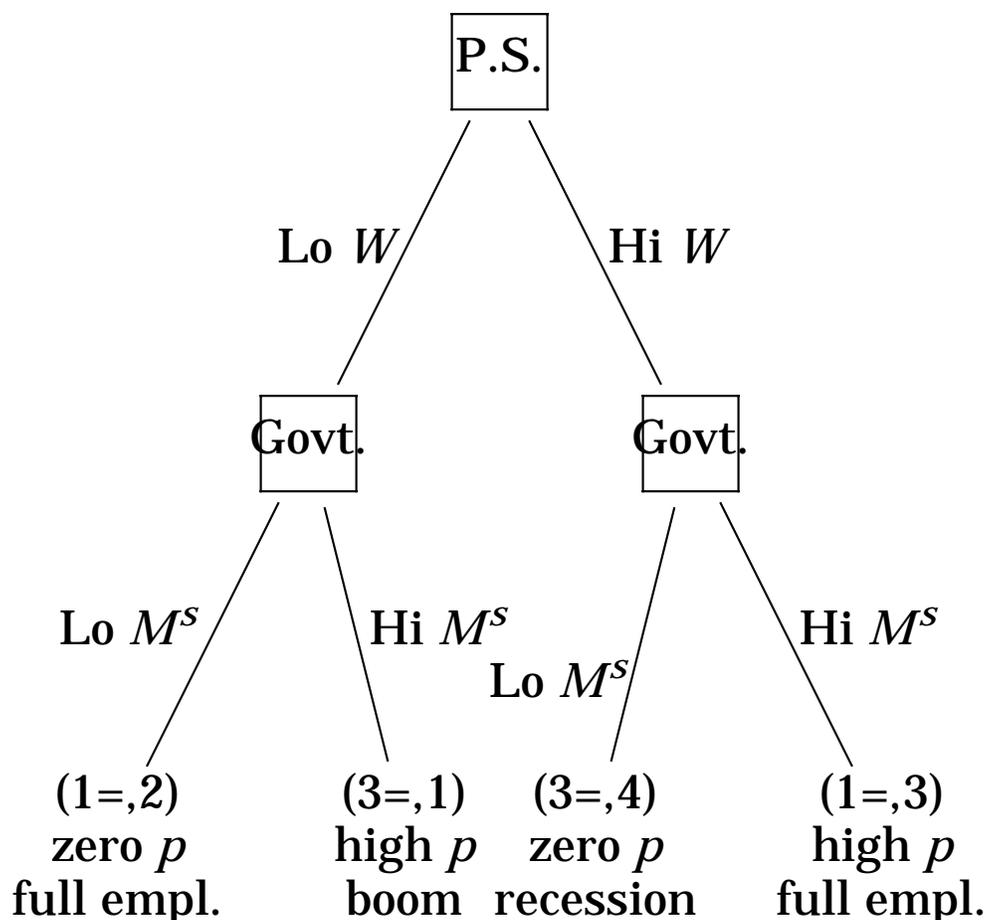
### *3.2 Extensive form of this game*

The following extensive-form game tree describes the game.

There are four possible outcomes. The tree shows the inflation and employment associated with each, and how the two players rank the outcomes.

For a given wage level ( $W$ ), the government always prefers to stimulate the economy with a high money supply, but it prefers lower nominal wages to higher nominal wages.

The private-sector firms and workers behave as though they prefer the outcomes that give full employment: the boom is bad because the high prices ( $P$ ) have eroded their real wages ( $W/P$ ), and the recession is bad because the employment level is too low.



As second mover, the government will choose the high-inflation money supply no matter what the private sector has chosen. (For the government, high money supply dominates low money supply.) Anticipating this, the private sector will set high nominal wages.

The high-inflation/full-employment outcome is generated. (This is the unique sub-game perfect equilibrium of the game. It takes account of the fact that the government cannot commit. It rules out non-credible threats.)

The government ends up with its third-ranked outcome. But it could do better: if, before the game, the government announced that in any

event it would not allow a high money supply — that it would follow a non-accommodating monetary policy, then so long as they believed it the firms and workers of the private sector would go for low wages.

But such an announcement is not credible: once nominal wages are set, there is no benefit to the government in keeping to its low-inflation policy. It is better off increasing the money supply and producing a boom.

Could the government precommit to a non-inflationary money supply? Perhaps by appointing an independent body to control the money supply. To what extent is the central bank independent of the government? In this framework, the answer to such a question has real consequences.

Barro and D. Gordon used this kind of analysis to provide a positive model of inflation and monetary policy. For instance: if the government became keener on high real GDP, then the effect would be to produce higher inflation, but no extra output. If the equilibrium unemployment rate rose, the inflation rate would rise, and so would the actual unemployment rate.

This simple model can thus be used to explain two things:

1. the greater inflation-proneness of left-wing (or unemployment-averse) governments, and
2. the stagflation of the 1970s, when governments continued to attempt to achieve low target unemployment rates which

became less and less sustainable, as the equilibrium unemployment rate rose and rose, with the effects that their demand stimulation led to inflation, and had no beneficial effects on employment.

### *3.3 Reputation and Repeated Interactions*

## **4. Coordination or Rivalry Among Governments?**

Internal policy coordination is a Prisoner's Dilemma.

e.g. rival exchange-rate appreciation to squeeze out inflationary momentum  
→ spillover effects as the inflation is “exported”

e.g. rival exchange rate depreciation to stimulate exports (as in the 1930s)  
→ spillover effects as unemployment is “exported”

## **5. Political Business Cycles**