The Calvo Model and the New Keynesian Phillips Curve

The traditional ('old Keynesian') Phillips curve is of the form

$$\pi_t = \pi_{t-1} + \phi y_t \tag{1.1}$$

where π is inflation, y is some measure of excess demand, and ϕ is a parameter. If we ignore discounting[1], the simplest New Keynesian Phillips curve has the form

$$\pi_t = E[\pi_{t+1} \mid I_t] + \phi y_t \tag{1.2}$$

One of the most popular ways of deriving this is to use a set up due to Calvo, which is now known as *Calvo contracts*[2]. In its most concise version, this assumes that wage setters change their wages with some fixed probability α each period. When they do change their wage, it may be in force for some time, so this 'contract wage' (x when logged) will depend on future prices and excess demand in the following way

$$x_t = (1-\alpha)\sum_{i=t}^{\infty} E[(p_i + \beta y_i) \mid I_t]\alpha^{i-t} \tag{1.3}$$

where p is the logged price level, and y is again some measure of excess demand. Here α is effectively a discount rate on future variables. (You can check that, in steady state, this reduces to $x=p+\beta y$.)

We can rewrite this in the form

$$x_t = \alpha E[x_{t+1} \mid I_t] + (1-\alpha)(p_t + \beta y_t) \tag{1.4}$$

assuming that current variables are known. Suppose for simplicity that prices are simply set equal to actual wages, which in turn will be a weighted average of current and past contract wages i.e.

$$p_t = (1-\alpha)\sum_{i=-\infty}^{t} x_i \alpha^{t-i} \tag{1.5}$$

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[1] With discounting, a discount factor multiplies the term in expected inflation. Such an equation would no longer imply a long run vertical Phillips curve. More complex, microfounded versions would also replace output by marginal costs, which are proportional to output only under rather restrictive assumptions.

[2] Actually you can get something quite close to (1.2) from the two period contract model. Suppose $p_t = \beta(p_{t-1} + E_t[p_{t+1}]) + (1-\beta)E_t[M_t]$. This is a little simpler than the two period model, as we only have one term in money. If we transform the expected nominal money term into a real balance term by subtracting $(1-\beta)p_t$ from each side, then we get $\pi_t = E_t[\pi_{t+1}] + \frac{1-\beta}{\beta} E_t[M_t - p_t]$.

Again ‘quasi-differencing’ gives

$$p_t = \alpha p_{t-1} + (1-\alpha)x_t \qquad (1.6)$$

Using (1.6) to eliminate x from (1.4) gives

$$p_t - \alpha p_{t-1} = \alpha(E[p_{t+1} \mid I_t] - \alpha p_t) + (1-\alpha)^2(p_t + \beta y_t) \qquad (1.7)$$

This can then be rewritten as

$$p_t - p_{t-1} = E[p_{t+1} - p_t \mid I_t] + \frac{(1-\alpha)^2}{\alpha}\beta y_t \qquad (1.8)$$

As $\pi_t = p_t - p_{t-1}$, then this is (1.2). Note that the parameter on excess demand in (1.2) involves α as well as β.

The Calvo model involves a neat way of extending the effects of contracts beyond a fixed number of periods. From a theoretical point of view, its main weakness is that α is treated as fixed, rather than the result of an optimisation decision.

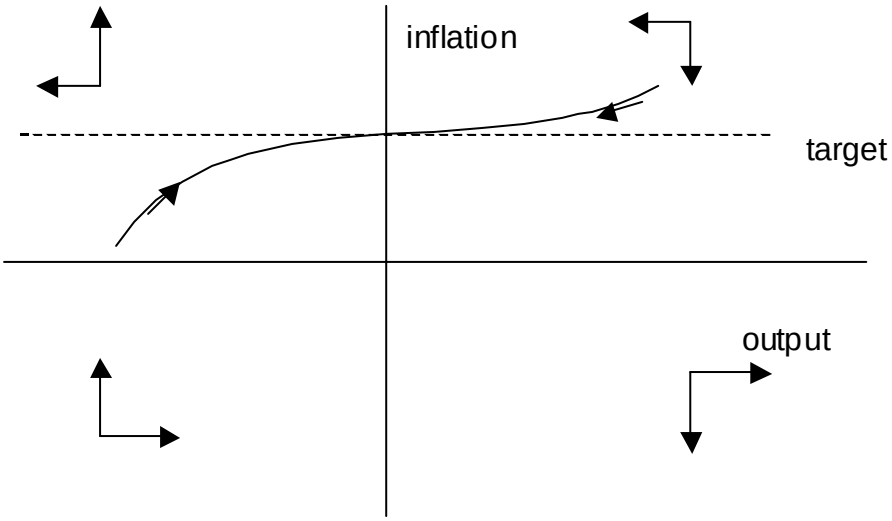
Inflation and excess demand

A key property of the New Keynesian Phillips curve is that, once a persistent shock has been anticipated, excess demand will be associated with falling inflation. We can see this directly from (1.2). A *persistent* positive shock to demand will lead to an initial positive jump in inflation, followed by a gradual decline while the shock lasts, until we return to equilibrium when the shock is over. This is standard saddle path dynamics.

To see this more clearly, suppose the central bank can manipulate excess demand (y) so that demand falls when inflation is above target i.e.

$$y_t = y_{t-1} - \gamma(\pi_t - \pi^*) \tag{1.9}$$

We can now draw the following phase diagram. Equation (1.2) gives us a constant inflation line at y=0. Equation (1.9) gives us a constant output line when inflation is equal to its target. When output is positive, (1.2) tells us that inflation must be falling, and vice versa. When inflation is above target, output is falling and vice versa.



We have a stable saddle path. A positive shock to excess demand leads to an immediate jump up in inflation, followed by a steady fall as excess demand returns to zero and inflation returns to target. This also illustrates price level determinacy – for any given shock the path of inflation is precisely defined, so the price level is also known.

Costless disinflation

Another feature of this New Keynesian Phillips curve is that it is costless to change the target inflation rate. Suppose the target falls when excess demand is zero. Inflation must immediately fall to the new target level – we do not require any period of negative excess demand to achieve this. This is exactly analogous to the impact of a permanent increase in taxes on consumption. In contrast, with a backward looking Phillips curve, current inflation is related to past inflation, so to reduce the inflation rate some period of negative excess demand is necessary.

Motivation

Calvo contracts are popular among macroeconomists because they lead to very simple aggregate inflation dynamics: the New Keynesian Phillips curve. However, as we noted above, the microfoundations are questionable. In addition, no actual firm will decide whether to change its price by throwing a dice! So what is going on here.

One answer is that Calvo contracts appear to mimic a more complicated world involving menu costs, where some firms change their price because the gain to profits exceeds the menu cost, and some firms do not because the profit gain is below the menu cost. As a result, menu costs are often given as a justification for assuming Calvo contracts. Ideally, we would work with a model which explicitly had menu costs in it, and where firms were heterogeneous in the sense that some happened to be near their profit maximising price, and some were not. However, such models appear to complex to work with, so Calvo contracts are seen as 'short cut' to incorporating menu costs.

Does the New Keynesian Phillips curve fit the data?

There are a number of empirical problems with this simple model:

1. In many if not most cases, excess demand appears to be associated with rising, not falling inflation
2. This model implies that inflation responds very quickly to anticipated demand shocks. Empirical evidence, on the other hand, tends to find that inflation follows demand rather than leads it.
3. Permanently reducing the inflation rate appears quite costly (in terms of lost output) in practice.

Partly as a result, many macroeconomists have worked with hybrid Phillips curves, which combine forward and backward looking elements. However, there is not as yet any generally accepted microeconomic story behind these hybrid equations, although there are a number of promising theories.