Topic 8: Critiques of The New-Keynesian Phillips Curve

Last week, we discussed the New-Keynesian Phillips curve (NKPC). This model has a lot to be said in its favour. It formally describes how nominal rigidity, an idea central to Keynesian economics since the *General Theory*, can lead to an intuitive relationship between inflation and output. The model features rational expectations, and so is not subject to the criticisms of earlier Phillips curves about *ad hoc* treatment of expectations or to the Lucas critique of econometric accelerationist Phillips curves. It should also be noted that the NKPC model has profoundly different implications for the conduct of monetary policy relative to the less formal accelerationist Phillips curve.

Particularly in light of its important policy implications, the NKPC should probably not be accepted just on the basis of its attractive theoretical properties, but should also be subjected to empirical tests. In this context, it turns out that attitudes towards the NKPC theory in the profession are currently somewhat mixed with some (such as your lecturer) expressing doubts about the ability of this approach to match the data or serve as a basis for recommendations about monetary policy. In this final set of notes, we will first extend our discussion of how monetary policy operates in the NKPC framework, and then discuss some of the empirical tests of the NKPC's predictions for the behaviour of inflation.

Introducing Monetary Policy

Last week, we derived the NKPC relationship between inflation and the output gap

$$\pi_t = \beta E_t \pi_{t+1} + \gamma y_t. \tag{1}$$

and this allowed us to discuss some implications for monetary policy in an indirect fashion, to the extent that we could assume that monetary policy exerted some control over the output gap, y_t. A more formal way of modelling the implications of the NKPC for monetary policy, inflation, and output, however, requires some specification of how monetary policy affects output. We will adopt a standard modelling trick and determine the output gap as

$$y_t = m_t - p_t \tag{2}$$

In other words, we equate output with the real money supply. There are a number of possible justifications for this. For example, in the IS-LM model, an increase in the real money supply will shift the LM curve upwards leading to a short-run increase in output. This increase is usually assumed to be offset over time as the higher output leads to higher

prices and thus a reduction in the real money supply. This mechanism will be evident in this model also.

With this assumption about output, we can re-write the NKPC as

$$p_t - p_{t-1} = \beta E_t p_{t+1} - \beta p_t + \gamma m_t - \gamma p_t, \tag{3}$$

This can be re-written as

$$\beta E_t p_{t+1} - (1 + \beta + \gamma) p_t + p_{t-1} = -\gamma m_t. \tag{4}$$

Note that this is a second-order difference equation in the price level. It can be solved using the same methods that we used to solve the capital stock problem in Topic 6. Having already shown how to solve such problems, I won't work through all the steps (and won't be asking you to do so in the exam either). Suffice to say, the format of the solution is exactly as it was for the capital stock. The price level depends on two factors: Its own lagged value and a discounted sum of expected future money supplies. Specifically, the solution is of the form

$$p_t = \lambda p_{t-1} + (1 - \lambda)(1 - \lambda\beta) \sum_{k=0}^{\infty} (\lambda\beta)^k E_t m_{t+k} \tag{5}$$

where λ is the root between zero and one that solves the quadratic equation

$$\lambda^2 - \frac{1 + \beta + \gamma}{\beta}\lambda + \frac{1}{\beta} = 0. \tag{6}$$

An Example: Random Walk Money Supply

As an example of how monetary policy can have positive short-run effects on output in the NKPC model, consider the case in which the money supply follows a random walk. In other words,

$$m_t = m_{t-1} + \epsilon_t \tag{7}$$

where ϵ_t is a zero-mean unforecastable "shock" term. As in our consumption example in Topic 5, the random walk assumption implies

$$E_t m_{t+k} = m_t \tag{8}$$

To see what this implies for output, first plug this assumption into the formula for the price level, to get

$$p_t = \lambda p_{t-1} + \left[(1 - \lambda)(1 - \lambda\beta) \sum_{k=0}^{\infty} (\lambda\beta)^k \right] m_t \tag{9}$$

Using the geometric sum formula

$$\sum_{k=0}^{\infty} (\lambda\beta)^k = \frac{1}{1-\lambda\beta} \tag{10}$$

this simplifies to

$$p_t = \lambda p_{t-1} + (1-\lambda)\, m_t \tag{11}$$

So, output is

$$\begin{aligned} y_t &= m_t - \lambda p_{t-1} - (1-\lambda)\, m_t \\ &= \lambda m_t - \lambda p_{t-1} \\ &= \lambda m_t - \lambda m_{t-1} + \lambda m_{t-1} - \lambda p_{t-1} \\ &= \lambda y_{t-1} + \lambda \Delta m_t \\ &= \lambda y_{t-1} + \lambda \epsilon_t \end{aligned} \tag{12}$$

Output depends positively on its own lagged values and also on the current value of the money growth "shock" term. In this example, monetary policy can generate a "business cycle" of sorts, with output being correlated with its own past values. However, the output gap will average out to zero in the long run in this example.

Disinflationary Booms!

This last set of calculations appear to be a good example of what New-Keynesian economics is trying to achieve: A micro-founded model in which expansionary monetary shocks can have a positive effect, at least in the short-run. However, all is not as good as it seems. In a well-known paper, Laurence Ball (*AER*, 1994) showed that these models had what appeared to be a very counterfactual prediction: A central bank could reduce inflation and produce a boom at the same time. Ball used a sticky-price model that was a little different from the Calvo model we've been working with, but one can see this property for our model quite easily.

Imagine an economy in which the central bank has been running a simple monetary policy holding the money stock fixed at m^* and the public has expected it to continue running this policy. In other words, $m_t = m_{t-1} = m_{t-2} .... = m^*$. One can show that this economy will settle down with $p_t = m_t = m^*$. Output in this economy can also be written as

$$y_t = m_t - \lambda p_{t-1} - (1-\lambda)(1-\lambda\beta) \sum_{k=0}^{\infty} (\lambda\beta)^k E_t m_{t+k} \tag{13}$$

This can be simplified as

$$y_t = (1-\lambda)\left(m^* - (1-\lambda\beta)\sum_{k=0}^{\infty}(\lambda\beta)^k E_t m_{t+k}\right) \tag{14}$$

Now suppose the central bank announces that it is breaking with its m^* monetary policy and planning to have a lower level of the money supply *at some point in the future*. What happens? Prices fall and output increases. The economy goes through a disinflationary boom.

What is going on here? Well, price-setters in the Calvo model are forward-looking. So, while price rigidities prevent the price level from jumping around too much, it does still respond to news about the future. So, the monetary policy announcement means firms expect lower levels of the money stock in the future, this leads to lower prices today, boosts today's real money supply and so boosts output. Our example was obviously stylized but the overall result is quite general: As long as the central bank disinflates in a smooth enough manner, it can produce a short-run boom as well as a decline in inflation.[1]

Disinflationary Booms: Two Views

The disinflationary boom result seems very much at odds with the real world. In reality, most countries that have introduced programs to reduce inflation rates have done so only at the cost of significant output losses over the adjustment period. There have been two main reactions to Ball's results.

The first reaction is to argue that the NKPC model is still a good description of reality and the reason we do not see disinflationary booms in practise is because of *credibility* problems on the part of the central bank. Ball himself has pursued this line of reasoning in a follow-up paper.[2] According to this argument, the central bank's statements that it will slow money growth not now but later, may not be credible. This argument is likely to be more relevant if the economy has been going through high inflation. In this case the central bank's commitment to low inflation may be doubted, and this type of statement, ("we'll slow money growth later, not today") would be unlikely to change the public's mind.

That central banks should do their best to make their commitment to low inflation

[1] See the Rudd-Whelan paper "Inflation Targets, Credibility, and Persistence In a Simple Sticky-Price Framework," on the reading list for a more detailed discussion of the disinflationary boom results.

[2] Laurence Ball, "Disinflation with Imperfect Credibility," *Journal of Monetary Economics*, February 1995, pages 5-23.

appear as credible as possible, and that doing so may reduce the costs of disinflation, has been a general theme of rational expectations macroeconomics. However, it is not clear that the evidence runs in favour of this view. Since the early 1980s, central banks have increasingly taken steps to boost their anti-inflationary credibility. Many central banks now have official low inflation targets and most are independent of political control. Despite these steps, it still appears that inflation can only reduced at the cost of significant losses in output. So, the second reaction to this result is that perhaps there is something wrong with the NKPC model.

Testing the New-Keynesian Phillips Curve

One way to assess whether the NKPC model seems to be explaining the relationship between inflation and output is to examine whether the pure forward-looking relationship

$$\pi_t = \gamma \sum_{k=0}^{\infty} \beta^k E_t y_{t+k} \tag{15}$$

seems to fit the data. A number of empirical studies have found that it does not. For instance, look at the upper panel of Figure 2: This figure is from the Rudd-Whelan paper on the reading list called (for reasons that will become apparent in a minute) "Does the Labor Share of Income Drive Inflation?"[3] The solid line in this figure is actual US inflation. The dashed line is an estimate of the present discounted value of output gaps generated using an econometric forecasting model.[4] The figure reveals a shockingly bad performance for the NKPC model. The present value of output gaps turns out to be *negatively correlated* with inflation. So, not only does inflation not appear to equal this present value, it does not even have the correctly-signed correlation.

One simple way to explain the model's failure is in terms of leading indicators. According to the model, inflation should be a positive leading indicator of future values of the output gap. In fact, high inflation tends to be a negative leading indicator for output.

[3]This paper can be downloaded at www.federalreserve.gov/pubs/feds/2002/200230/200230abs.html and can also be found in the April 2005 edition of the *J*ournal of Money, Credit, and Banking.

[4]To be precise, it is an estimate generated using a so-called Vector Autoregressive (VAR) econometric model, in which the output gap and a set of other variables, are each regressed on all their own lagged values.

The Labour Share Approach

Recall from last week's handout that the true "driving variable" in the NKPC is actually the ratio of marginal cost to the price level, or real marginal cost as we called it. The output gap version of the model was introduced because we don't observe a time series for real marginal cost but presume that it is procyclical. Galí and Gertler (1999) suggest that the problem here may be that "potential output" is hard to measure so empirical proxies for the output gap, based on detrended actual output, may be poor proxies for the real output gap. They suggest an alternative approach based on trying to construct a more direct proxy for real marginal cost. Specifically, this approach tries to measure real marginal cost directly by assuming that it can be proxied with real average variable cost, where it is also assumed that labour is the only variable factor of production. In this case, average nominal variable cost is $\frac{wL}{Y}$ where w is the wage rate and L is labour input. So this proxy for *real* marginal cost is $\frac{wL}{pY}$, which is also the labour share of national income.

Galí and Gertler argue that this produces a more sensible version of the NKPC, and show that the leading indictor argument works better in this case: Inflation turns out to be a positive leading indicator for the labour share. However, not everyone is a big fan of this approach. The Rudd-Whelan paper puts forward two critiques:

- Average and marginal cost are not the same thing and are quite likely to have different cyclical properties. Indeed, it may often be the case that the two are moving in the opposite direction. For example, employed labour is often underutilized in recessions. This can lead to an increase in average costs of production: This shows up in the data as spikes in the labour share of income during recessions (see the attached Figure 1 from Rudd-Whelan for US evidence on this). However, real marginal cost almost surely falls in recessions because elements such as overtime payments decline.

- The present value of labour shares is usually positively correlated with inflation, but the fits—which vary with the specific forecasting VAR—are generally very poor. For example, see the lower panel of Figure 2: It shows that the present value of labour shares generated from a VAR that fits the data well has an R^2 of only one percent.

The Hybrid NKPC Model

What lies behind the poor empirical performance of the NKPC model? Rudd and Whelan show that the systematic mistake that the model makes is that it fails to account for the

fact that inflation seems to depend quite heavily on its own lagged values. In other words, irrespective of what is going on with the output gap or labour share, inflation tends not to change too much from quarter to quarter. Simple regressions of inflation on its own lags have much higher R^2 values than any of empirical versions of the NKPC, and you may recall that "accelerationist" Phillips curves featuring lagged inflation terms are still popular among forecasting and policy economists.

Though Galí and Gertler are more positive in their assessment of the NKPC than Rudd and Whelan (they view it as a "good first approximation"), they also agree that the model fails to fully incorporate the role played by lagged inflation. They suggest a patched-up or "hybrid" version of the NKPC model that features a fraction of firms that set prices according to a rule of thumb that depends on lagged inflation. This produces a specification of the form

$$\pi_t = \lambda_b \pi_{t-1} + \lambda_f E_t \pi_{t+1} + \gamma mc_t^r \tag{16}$$

This is another example of a second-order stochastic difference equation and it has solution

$$\pi_t = \delta_1 \pi_{t-1} + \mu \sum_{k=0}^{\infty} \delta_2^k E_t mc_{t+k}^r \tag{17}$$

where δ_1 and δ_2^{-1} are the roots of the polynomial equation

$$\lambda_f x^2 - x + \lambda_b = 0 \tag{18}$$

This approach is considered by many to be a good compromise between the pure rational expectations micro-based approach of the NKPC, and the more pragmatic accelerationist Phillips curves. And because it incorporates a lagged inflation term, it can fit the data for inflation quite well. However, for those of you who want to be skeptical, there are still some grounds for suspicion. First, equation (16) relies on the assumption that there are constant fractions of backward and forward-looking price-setters. But why should this be so? Who are these backward-looking price-setters and what motivates their behaviour? And should this fraction remain stable even across different monetary policy regimes? It seems quite possible that the hybrid model is itself subject to the Lucas critique, despite the fact that addressing this critique is a major focus of the research agenda behind this approach.

Second, a lot of the good fit of the hybrid model comes from the π_{t-1} term, and not much from the $\sum_{k=0}^{\infty} \delta_2^k E_t mc_{t+k}^r$ term, so it's not clear that the "rational expectations" element of the model is actually helping that much. Indeed, according to one set of calculations

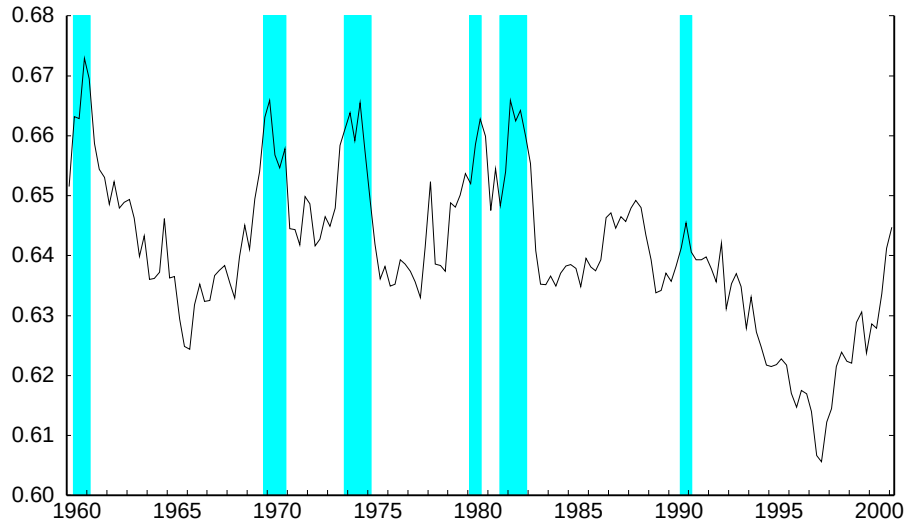
from a more recent Rudd-Whelan paper, one often cannot reject that the coefficient μ in equation (17) is statistically insignificant.[5]

Of course, though, always beware who you're buying you're conclusions from: Others out there are more positive about this approach than me. So, if you're interested in pursuing research in this area (or any other area of macroeconomics), its always best to get your hands dirty, download some data, and decide for yourself.

[5] "Can Rational Expectations Sticky-Price Models Explain Inflation Dynamics?" by Jeremy Rudd and Karl Whelan, can be downloaded at www.federalreserve.gov/pubs/feds/2003/200346/200346abs.html

Figure 1
Output Gap Concepts, U.S. Nonfarm Business Sector
(NBER Recession Dates Shaded)

A. Labor Income Share



B. Quadratically Detrended Log GDP

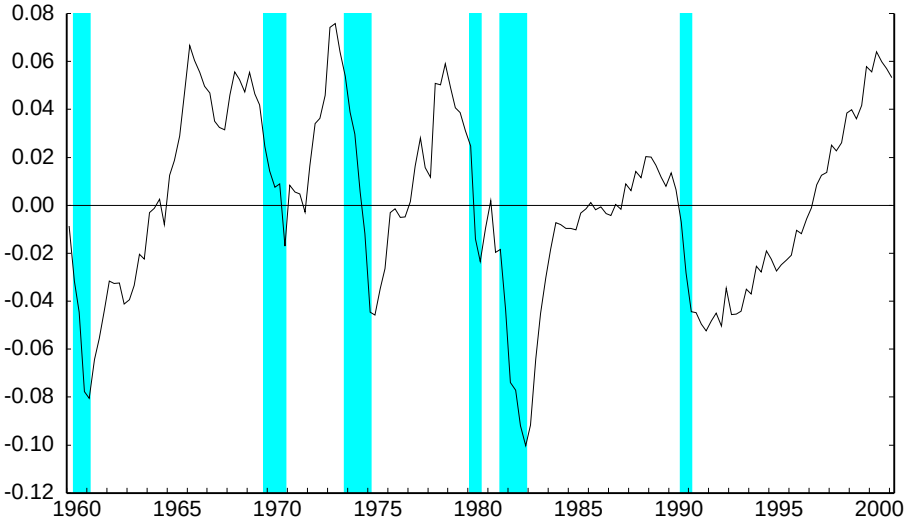
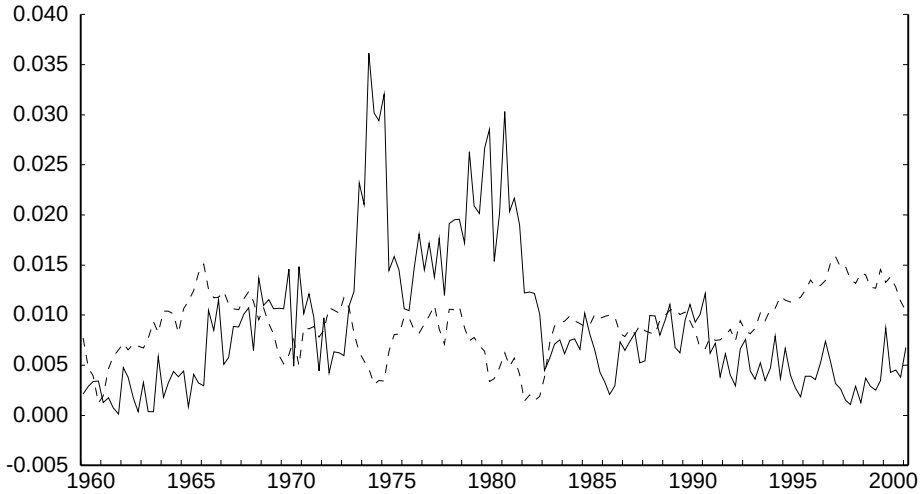


Figure 2
Actual and Predicted Inflation--Present-Value Method
(VAR models include GDP gap, labor's share, and unit labor cost growth)

A. Present Value of GDP Gaps from VAR System



B. Present Value of Labor Income Shares from VAR System