Estimating the Phillips Curve for the US

The Phillips curve formalises the intuition that, if the economy is booming (due to a rise in demand), workers will demand higher wages and, in response, firms will raise prices. A modern variant of the Phillips curve derived in this course is the well-known *New Keynesian Phillips curve*:

$$\pi_t = \bar{\pi} + \beta E_t \pi_{t+1} - \kappa(u_t - u_t^n) + \nu_t \tag{1}$$

This equation suggests that the rate of inflation π_t is determined by three factors: (i) expected future inflation $E_t\pi_{t+1}$; (ii) the output gap (measured here as the difference between unemployment u_t and the "*natural rate of unemployment*" u_t^n)[1]; and (iii) cost-push shocks ν_t (exogenous events - meaning not driven by demand - that influence prices). The slope of the Phillips curve κ indicates the sensitivity of inflation to fluctuation of unemployment around its *natural level* (i.e. the output gap or an increase in demand). $\bar{\pi}$ is an intercept.

For the following exercises use US data of quarterly frequency. You should be able to find data going back to at least the early 1980s. Think carefully about what data are the most meaningful to use for every question. At every step motivate your choice.

1.1) Let's start with the original Phillips curve relation and estimate the correlation between inflation and unemployment. That is, estimate the following variant of the regression equation in (1):

$$\pi_t = \bar{\pi} - \kappa u_t + \nu_t.$$

Use a scatter plot to plot the inflation rate against unemployment. Also, draw the line implied by your estimated parameters for $\bar{\pi}$ and κ through the cloud of points. Interpret the estimated slope: is the estimated relationship as steep/flat (resp. strong/weak) as you had expected?

1.2) If we set $\beta = 1$ and $E_t\pi_{t+1} = \pi_{t-1}$ (adapted expectations) in (1), we arrive – again ignoring u_t^n – at the variant of the (original) Phillips curve we have labelled as *accelerationist Phillips curve*:

$$\Delta\pi_t = \bar{\pi} - \kappa u_t + \nu_t.$$

[1] In class we have discussed *Okun's law*, describing the relationship between the deviation of unemployment from its *natural level* and the *output gap*. i.e. the deviation of output from its *natural level*.

Use a scatter plot to plot the change in the inflation rate against unemployment. Also, draw the line implied by your estimated parameters for $\bar{\pi}$ and κ through the cloud of points. Interpret the estimated slope: is the estimated relationship as steep/flat (resp. strong/weak) as you had expected? How do your findings compare to the results in 1.1)?

1.3) In the previous two exercises we have formalised the expectation formation as $E_t\pi_{t+1} = \beta\pi_{t-1}$. In 1.1) we set $\beta = 0$ and and in 1.2) $\beta = 1$. We have not yet explored which β would be "suggested" by the data. To that aim estimate the slope coefficient κ in the following regression (i.e. adding π_{t-1} as an additional regressor):

$$\pi_t = \bar{\pi} + \beta\pi_{t-1} - \kappa u_t + \nu_t.$$

What value of β do you obtain and how would you interpret your estimate? Does the estimated slope coefficient κ change in comparison to your previous results? If so (if not) why?

1.4) The *New Keynesian Phillips curve* in (1) relates inflation to the *natural rate of unemployment* and in order to estimate that equation we would need a time series for u_t^n. Suggest (or search for) a sensible measure for u_t^n. Use this measure to investigate how your estimate for κ would change if unemployment (u_t) in the Phillips curve is replaced by its deviation from the *natural rate*, i.e. $u_t - u_t^n$. Compare your results to what you found in 1.3). For this, estimate the following regression:

$$\pi_t = \bar{\pi} + \beta\pi_{t-1} - \kappa(u_t - u_t^n) + \nu_t.$$

1.5) One may argue that the inflation-unemployment relationship depends on the specific price index used to measure π_t. For example, the US Bureau of Economic Analysis (BEA) uses 16 third-tier components of consumption[2] to build their quarterly personal consumption expenditure (PCE) price index. Construct two alternative price indices based on (combinations of several) sub-components of the PCE index. Use the regression specification as in 1.3). Does the estimate of the slope coefficient κ change depending on *how* you measure inflation, i.e. what type of consumption you consider?

1.6) A big challenge in empirical macroeconomics, is to properly account for the role of

[2]Those consist of four components of durable goods, four of non-durable goods, seven of household services expenditures, and final consumption expenditures by nonprofit institutions serving households (NPISH) that pay for services then provide them to households without charge. The data can be found in NIPA Tables 2.3.4 and 2.3.5

expectations. Expectations can often not be (accurately) modelled and/or observed. This may cause a bias when estimating causal relationships where expectations are known to play a crucial role.

Surveys are often used to *proxy* inflation expectations. Several surveys measuring inflation expectations (consumer surveys, surveys of professional forecasters or economists, etc.) are freely available. Search for a time series of such survey-based expectations, call it x_t, to replace $E_t\pi_{t+1}$ in the Phillips curve. That is, estimate

$$\pi_t = \bar{\pi} + \beta x_t - \kappa u_t + \nu_t.^3$$

How does your estimate of β change and what is your conclusion about the inflation-unemployment relationship now?

1.7) You have investigated the relationship between inflation and unemployment (resp. the output gap) for a variety of specification of the Phillips curve. Summarise your different estimates for κ in a table. Do your estimates differ across specifications? What could be a reason for this? What is your overall assessment: is the Phillips curve "alive and well" or do you find evidence for the opposite?

[3] You can use the aggregate measure of inflation that you have used previously in 1.1-1.4.