monetary business cycle models (sticky prices and wages)

Since the earliest analysis of the monetary transmission mechanism by pre-eminent classical economists of the 18th and early 19th century, sticky prices and wages have been identified as playing a central role (Humphrey, 2004). The classical economists believed that prices adjusted gradually to a change in the nominal money stock, so that monetary changes could exert substantial short-run effects on output. Nominal wages were regarded as particularly slow to change, and thus helped account for gradual price adjustment by mitigating short-run pressures on factor costs.

The classical economists and their successors used this framework both to guide recommendations about policy and to evaluate alternative monetary regimes. For example, the belief that prices would respond slowly to a monetary contraction led Thornton and Ricardo to recommend a gradualist approach to deflation.

Early Keynesian models, and some critiques

A major contribution of Keynes (1936) and prominent successors such as Hicks to understanding the monetary transmission mechanism consisted in developing an explicit theoretical framework expressed in terms of equilibrium conditions in goods and asset markets. This IS–LM framework was of great value in illuminating the channels through which monetary shocks affected interest rates and output. However, the assumption of fixed prices and wages was a major shortcoming. It was eventually supplanted by the famous ‘Phillips curve’ relation linking nominal wage inflation to the unemployment rate, or variants relating price inflation to the output gap:

\[ p(t) - C_0 p(t-1) = b \cdot (y(t) - y(t^*)) b > 0 \]  

where \( p(t) \) is (the log of) the price level, \( y(t) \) output, \( y(t^*) \) potential output, and \( b \) is a parameter. The Phillips curve filled a missing link in earlier ‘fixed price’ IS–LM analysis by making it feasible to trace the dynamic effects of a monetary shock on prices and output. Thus, an initial rise in output following a monetary expansion boosts prices via (1), which in turn causes real balances and output to revert gradually to pre-shock levels. However, the Phillips curve had weak theoretical underpinnings, so that there was little economic rationale for what determined the sensitivity of prices to the output gap (that is, ‘\( b \)’ in (1)), for the activity variable(s) driving price dynamics, and for how inflation might be influenced by expectations.

A series of remarkable critiques beginning with the analysis of Friedman (1968) and Phelps (1968) provided impetus for developing more theoretically coherent models of price and wage dynamics. These authors argued that the Phillips curve should be augmented so that actual inflation depended directly on inflation expectations in addition to real activity. In this framework, output could be pushed above potential...
only through surprising private agents by keeping inflation above the level that they had forecast in previous periods. Since such surprises could not continue indefinitely, there could be no long-run trade-off between inflation and output: expansionary monetary policy would eventually raise expected inflation, resulting in higher inflation with no output stimulus.

Shortly thereafter, Lucas (1972) derived an ‘expectations-augmented’ Phillips curve in a clearly specified rational expectations model. Lucas adopted a signal extraction framework in which agents partly misinterpreted aggregate nominal shocks as shocks to the relative price of their own output good (due to limited information), and responded by adjusting their supply. Consistent with Friedman and Phelps, Lucas’s model implied that aggregate output varied positively with the unanticipated component of inflation (with anticipated inflation exerting no real effects). But because unanticipated inflation was linked explicitly to a ‘rational expectations’ forecast error in Lucas’s model – which would be expected to die away quickly as agents learned about the nature of underlying shocks – monetary shocks could exert only transient effects on output. This posed a serious challenge to traditional Keynesian models by suggesting that their ability to derive persistent effects in response to a monetary injection relied on ad hoc assumptions about price dynamics or expectations formation. Moreover, because only unanticipated changes in inflation affected output, Lucas’s supply relation implied that any predictable policy was as good as any other (the ‘policy ineffectiveness’ proposition). This point, emphasized by Sargent and Wallace (1975), contrasted sharply with the activist policy stance that emerged from typical Keynesian models.

**Monetary transmission in optimization-based MBC models**

Since the mid-1990s a new generation of optimization-based MBC models has emerged that can generate ‘traditional’ Keynesian implications, but in a framework consistent with rational expectations and rigorous microfoundations. Roughly speaking, these new MBC models graft features that can induce sluggish price and/or wage adjustment onto an underlying real business cycle (RBC) model. (Blanchard, 2000, and Taylor, 1999, provide comprehensive surveys of the foundations of modern optimization-based MBC models, which were laid in a series of important contributions spanning several decades.)

To highlight salient features of the modern approach, it is helpful to examine a specific characterization of price-setting that has been utilized extensively in the literature. This relation, often called the ‘New Keynesian Phillips curve (NKPC)’, takes the form

\[
p(t) - p(t - 1) = B * E(t) \left[ p(t + 1) - p(t) \right] + b * (y(t) - y(t)^*)
\]

(2)

where \( E(t) \) is the conditional expectation operator, and \( B \) is the discount factor.

Following Calvo (1983) and Yun (1996), the NKPC can be derived in a framework consistent with intertemporal optimization. Firms are assumed to behave as