Chapter 5

Sticky wages and prices

5.1 Motivation

The previous lectures have highlighted the apparent inability of monetary RBC models to replicate key features of the data. Simply adding a monetary sector to a standard model does not give a very realistic model of the business cycle and so is inappropriate for serious monetary policy analysis. In this lecture we introduce an additional propagation mechanism in the economy by allowing for stickiness in wages and prices. Such models begin to be more Keynesian in spirit but still remain some way from being useful.

5.2 Key readings

Cooley and Hansen (1994) "Money and the Business Cycle", in Cooley (ed) (1994) "Frontiers of Business Cycle Research". Especially Sections 5 and 6.

5.3 Related reading

Calvo (1983) "Staggered Prices in a Utility-Maximising Framework", *Journal of Monetary Economics*, 12, 383-398

Fischer (1977) "Long-Term Contracts, Rational Expectations, and the Optimal Money Supply Rule", *Journal of Political Economy*, 85, 191-206

Gray (1976) "Wage Indexation: A Macroeconomic Approach", *Journal of Monetary Economics*, 2, 221-235

Taylor (1980) "Aggregate Dynamics and Staggered Contracts", *Journal of Political Economy*, 88, 1-24

Yun (1996) "Nominal Price Rigidity, Money Supply Endogeneity and Business Cycles", *Journal of Monetary Economics*, 37, 175-391.

5.4   Fixed wage contracts

In their chapter in the Cooley volume, Cooley and Hansen suggest that it may be worth investigating what the effects of fixed wage contracts are in monetary RBC models. They consider a very simple example. Imagine that, for whatever reason, the nominal wage has to be set one period in advance using the expectations of both firms and workers. During the period in which the preset wage holds, firms are then free to determine their employment level such that marginal product of labour equals the preset nominal wage. The wage that is set one period in advance is based on rational expectations of next period's inflation and productivity. However, if the money supply is unexpectedly high next period the nominal wage will have been set too low and so inflation will be higher than expected and the real wage will have fallen. Because the real wage will have fallen, firms recruit more labour and so produce more output. Therefore positive money supply shocks are associated with higher output. However, because of rational expectations it is only *unexpected* money supply shocks which have this effect on output. Essentially, a price has been fixed in advance and cannot adjust within the period so that money can affect real variables. However, after the period has elapsed wages are reset at the appropriate new inflation level. Therefore the real wage rises to its "true" value and employment declines. In other words, this model generates little persistence as money supply shocks only have a positive effect while wages cannot be adjusted, which in this case is one year. If wages are set for several periods in advance, however, money can be non-neutral for longer periods. This idea that fixed nominal contracts may explain business cycle features is an old ideas and was the initial Keynesian response to the policy ineffectiveness claims of Rational Expectations, see Gray (1976), Fischer (1977) and Taylor (1980).

Variable	SD%	Cross-correlation of output with:							Correlation with M0 growth
		t-3	t-2	t-1	t	t+1	t+2	t+3	
Output	2.37	0.098	0.202	0.320	1.000	0.320	0.202	0.098	0.61
Consumption	0.49	0.363	0.392	0.346	0.261	0.304	0.131	-0.004	-0.42
Investment	9.00	0.047	0.154	0.289	0.986	0.298	0.198	0.108	0.67
Hours	3.10	0.001	0.066	0.142	0.937	0.189	0.128	0.070	0.77
Prices	1.79	0.053	0.055	0.041	-0.011	-0.361	-0.266	-0.191	0.42
Inflation	1.15	-0.003	0.022	0.078	0.561	-0.145	-0.117	-0.093	0.92
Nominal interest rate	1.04	-0.019	0.012	0.079	0.475	-0.069	-0.053	-0.039	0.71
ΔMoney	0.87	-0.015	0.064	0.236	0.608	-0.091	-0.076	-0.069	1.00
Velocity	2.39	0.022	0.122	0.254	0.975	0.254	0.172	0.097	0.74

Table 5.1: Simulated Monetary Economy with Nominal Contracts

(from Cooley and Hansen (ed) "Frontiers of Business Cycle Research")

There are a number of problems with this approach. Firstly, it requires a strong justification of why nominal wages may be fixed for several periods in advance and why they cannot be altered when the state of the world is revealed (i.e. why can they not be indexed?). Secondly, to explain the fact that the money supply one or two years ago predicts current output we need to assume that wages are fixed for long periods of time. In reality, wage contracts do not last this long. Thirdly, even if we make these assumptions we can still not explain some of the features we observe in the data. Table 5.1 from Cooley and Hansen (1994) (in Cooley (ed)) shows some simulation results from a CIA-RBC model with one period ahead fixed nominal wages. An important failing of this model (aside from the short lead time money has over output, which could be corrected by assuming longer contracts) is that high (low) interest rates do not predict low (high) future output. This is a very strong feature of the data and one which most monetary economists feel is a defining feature of the transmission mechanism of monetary policy. In the next section we turn to constructing models which try and explain this correlation in the data.

5.5 Sticky prices

Yun (1996) investigates how the assumption of sticky prices impacts on the ability of RBC monetary models to explain the cyclical behaviour of inflation. He uses a cash in advance RBC model and shows that by introducing sticky prices he can substantially improve the model's ability to

(a) explain procyclical inflation

(b) explain why output and inflation rise in response to temporary shocks.

To introduce sticky prices into the analysis it is necessary to introduce market power - if firms do not have some monopoly power then prices cannot be different across competitors. Yun uses standard assumptions regarding preferences to derive the demand for good i as

$$D_t(i) = \left(\frac{P_t(i)}{P_t}\right)^{-\epsilon} D_t$$

where D_t is aggregate demand, $P_t(i)/P_t$ is the relative price for good i and ϵ denotes the elasticity of demand. To model price stickiness he follows the formulation of Calvo (1983). This formulation assumes that each period a fraction of firms, $1 - \alpha$, charges a new price and the remaining fraction α simply index their price in line with inflation. Under these assumptions firms expect to keep their prices unchanged for $1/\alpha$ periods. However, note this is an expectation - some firms will be changing prices frequently whilst others will go for long periods before changing their prices. We should stress that this is done for analytical convenience rather than empirical plausibility.

Table 5.2a shows the correlation of inflation (at various leads and lags) with the changes in US GNP along with the correlation of inflation with the components of US GNP due to permanent productivity shocks and temporary monetary disturbances. Tables 5.2b - 5.2e show the same set of numbers but for different assumptions about price flexibility. Comparing Tables 5.2a and 5.2b shows that assuming flexible prices e.g. $\alpha = 0$ means that the model cannot explain why inflation responds in a strong way to temporary money supply shocks. However, notice that only by assuming $\alpha = 0.75$, that is that only 25% of firms

change their prices each period, can we replicate findings based on US data. This then begs the question what can justify such large and important price rigidites and whether this value of $\alpha = 0.75$ is plausible. The second thing to note about the Yun paper is that it *only* focuses on the inflation-output correlation. In particular, it does not try to focus on other problematic correlations - namely money-output-interest rates.

j	-3	-2	-1	0	1	2	3
π_{t+j} and output growth at t	-0.200	-0.104	-0.048	-0.025	0.026	0.014	-0.028
π_{t+j} and Δtrend output at t	0	0	0	-0.451	-0.177	-0.151	-0.169
π_{t+j} and transitory output at t	0.744	0.814	0.850	0.867	0.649	0.550	0.469

Table 5.2a: Inflation and Output Correlations for US data

j	-3	-2	-1	0	1	2	3
π_{t+j} and output growth at t	-0.019	-0.020	-0.031	-0.378	0.035	0.034	-0.033
π_{t+j} and Δtrend output at t	0	0	0	-0.378	-0.033	-0.035	-0.024
π_{t+j} and transitory output at t	0.172	0.179	0.187	0.199	0.098	0.094	0.091

Table 5.2b: Inflation and Output Correlations for Flexible Price Model

j	-3	-2	-1	0	1	2	3
π_{t+j} and output growth at t	-0.042	-0.076	-0.168	-0.209	0.012	0.021	-0.026
π_{t+j} and Δtrend output at t	0	0	0	-0.371	-0.025	-0.025	-0.0.025
π_{t+j} and transitory output at t	0.187	0.212	0.288	0.289	0.122	0.109	0.104

Table 5.2c: Inflation and Output Correlations for $\alpha = 0.25$

j	-3	-2	-1	0	1	2	3
π_{t+j} and output growth at t	-0.091	-0.187	-0.477	-0.306	0.053	0.021	-0.001
π_{t+j} and Δtrend output at t	0	0	0	-0.374	-0.025	-0.026	-0.026
π_{t+j} and transitory output at t	0.220	0.256	0.363	0.522	0.184	0.148	0.125

Table 5.2d: Inflation and Output Correlations for $\alpha = 0.5$

j	-3	-2	-1	0	1	2	3
π_{t+j} and output growth at t	-0.088	-0.196	-0.553	-0.601	0.093	0.055	-0.031
π_{t+j} and Δtrend output at t	0	0	0	-0.370	-0.025	-0.032	-0.033
π_{t+j} and transitory output at t	0.243	0.308	0.455	0.867	0.305	0.228	0.177

Table 5.2e: Inflation and Output Correlations for $\alpha = 0.75$