Chapter 8

The liquidity effect

8.1 Motivation

In all the models we have examined so far there has been a very strong positive correlation between money supply shocks and the nominal rate of interest. This is a major failing of the models since in the data there is a negative correlation - in other words money supply shocks should reduce the nominal interest rate but in our models they increases it. What is missing in the models is a liquidity effect. Positive money supply shocks increase liquidity and so should reduce the price of money (the nominal interest rate). In this lecture we show how the basic cash-in-advance model can be amended to generate a liquidity effect.

8.2 Key readings

On the liquidity effect the best reference is Christiano "Modelling the Liquidity Effect of a Monetary Shock" which is printed in Miller (ed) "The Rational Expectations Revolution" and also Christiano and Eichenbaum (1992) *American Economic Review Papers and Proceedings*. Fuerst (1992) "Liquidity, Loanable Funds and Real Activity" *Journal of Monetary Economics*, should be readable enough in places to be worth a look. Once again Lucas (1990) "Liquidity and Interest Rates" *Journal of Economic Theory* is the seminal reference but it is a difficult read for those unfamiliar with dynamic programming.

8.3 Related reading

Alvarez, Atkenson and Kehoe (1999) "Money and Interest Rates with Endogeneously Segmented Markets", *NBER Working Paper*, No. 7060

Cogley and Nason (1995) "Output Dynamics in Real-Business-Cycle Models", *American Economic Review*, 85, 492-511

Strongin (1995) "The Identification of Monetary Policy Disturbances: Explaining the Liquidity Puzzle", *Journal of Monetary Economics*, 35, 463-497

8.4 Introduction

Before we can develop a model which explains how monetary policy affects the real economy we obviously need empirical evidence on whether monetary policy is important and if so through which channels it operates. Not surprisingly this is a long and controversial literature. Some more recent references have been given in the key readings sections and the enthusiast can follow up those references from earlier literature. For our purposes we shall assume that the results of Strongin (1995) are broadly correct: money supply innovations (correctly measured) are important and account for a large proportion of output fluctuations, a positive money supply shock tends to lower nominal interest rates and then lead to higher output.

The crucial thing here is the way in which positive money supply shocks lower the nominal interest rate. If we can explain how that happens then we can explain relatively easily how interest rates then affect output. However, explaining why the **nominal** interest rate falls is not a trivial exercise. In a neoclassical model the standard way of viewing nominal interest rates is through the Fisher hypothesis. This says that the nominal interest rate equals the real interest rate plus the expected inflation rate. In other words, the nominal interest rate must compensate depositors not just with the real interest rate but also for any purchasing power they are expected to lose during the period arising from inflation. An increase in the money supply can have two effects: (i) it can reduce the real interest rate (this is called the "liquidity effect", more money, i.e. more liquidity, tends to lower the price of money which is equivalent to lowering the interest rate) (ii) it forecasts higher future inflation (called the expected inflation or Fisher effect). Therefore to generate a falling nominal interest rate in response to a positive money supply shock we require the liquidity effect to outweigh the Fisher effect. However, in neoclassical models money does not influence real variables such as the real interest rate. Therefore increases in the money supply just forecast higher inflation and so the nominal interest rate rises as there is no liquidity effect only a Fisher effect (higher expected inflation). Therefore to generate the liquidity effect (lower nominal interest rates for higher money supply) we require enough non-neutralities that inflation expectations do not outweigh the liquidity effect.

Examining the stylised facts seen in previous lectures we can see that this was not the case for the basic CIA models. In these models nominal interest rates have little predictive power for output. This is because increases in the nominal interest rate are entirely due to the Fisher effect. In the CIA model when agents have higher expectations of inflation the nominal interest rate rises accordingly and there is no liquidity effect. We therefore need to amend the CIA model if we are to explain the liquidity effect.

8.5 Modelling the liquidity effect

Lucas (1992) sketched out a way this could be achieved by subtly altering the structure of CIA models and this idea was developed more fully in Fuerst (1992). Accessible treatments are to be found in Christiano and Eichenbaum (1992) (which has the merit of being very short) and Christiano which is in Miller (ed) "The Rational Expectations Revolution". The trick in these models is not dissimilar to some we have seen earlier, and it essentially involves altering the information at agents' disposal. Agents are to be thought

of as a family who at the beginning of each period split up into (i) a worker (ii) a shopper (iii) a firm (iv) a financial intermediary. What is crucial to the model is that before the household separates at the beginning of the period they have to decide how much cash to hold for consumption purposes (equals $m_t - n_t$ where m denotes the money holdings inherited from last period and n is cash deposited with the financial intermediary). All consumption goods have to be purchased with cash so that $m - n > pc$. Only after a decision has been made on n does the household separate and at this point the state of the world is revealed, e.g. the current productivity shock and money supply shock. After separating at the beginning of the period, agents cannot come into touch with each other again and have to respond to shocks subsequently in an uncoordinated way. Once they have separated the worker in the household decides how many hours to work (l), the member of the household who acts as a firm hires h hours of work at the wage rate w (we ignore capital for the moment) and produces $f(h)$ which sells at price p. However, the wage bill has to be paid in advance and to finance this wage bill (wh) the firm borrows the amount b, where $b \geq wh$, on which it has to pay the nominal interest rate R. At the end of the period the new level of money balances equals what was inherited from last period, interest earned on n this period plus wage income less consumption plus the profits made by the household firm. We can, using Lagrange multipliers, outline the consumer's maximisation problem as

$$\max \left\{ E_0 \sum_{t=0}^{\infty} \left[\begin{array}{c} \beta^t u(c_t, l_t) + \lambda_{1t}\beta^t(m_t - n_t - p_t c_t) + \lambda_{2t}\beta^t(b_t - w_t h_t) \\ + \lambda_{3t}\beta^t(m_{t+1} - m_t - n_t R_t - w_t l_t + p_t c_t - p_t f(h_t) + w_t h_t + b_t R_t) \end{array} \right] \right\}$$

The consumer has to maximise lifetime utility by choosing for each period n (savings), m (money holdings), c (consumption), h (labour demand), l (labour supply) and b (borrowing). This maximisation has three constraints (i) the first reflects the cash in advance constraint faced by the consumer (ii) the second reflects the cash in advance constraint faced by the firm and (iii) the final way defines how money grows over time. For a given choice of n, made in the absence of any knowledge on the current productivity shock or money supply shock, the household's first order conditions are:

$$
\begin{array}{cl}
c_t & \beta^t u'_{ct} - \lambda_{1t}\beta^t p_t + \lambda_{3t}\beta^t p_t = 0 \\
m_t & \lambda_{1t}\beta^t - \lambda_{3t}\beta^t + \lambda_{3t-1}\beta^{t-1} = 0 \\
h_t & -\lambda_{2t}\beta^t w_t - \lambda_{3t}\beta^t p_t f'(h_t) + \lambda_{3t}\beta^t w_t = 0 \\
b_t & \lambda_{2t}\beta^t + \lambda_{3t}\beta^t R_t = 0
\end{array}
$$

Using the first order conditions for c and m we have that

$$
\begin{aligned}
\frac{u'_{ct}}{p_t} &= \lambda_{1t} - \lambda_{3t} \\
\beta E_t \frac{u'_{ct+1}}{p_{t+1}} &= -\lambda_{3t}
\end{aligned}
$$

and using the first order condition for b we have that

$$\beta E_t \frac{u'_{ct+1}}{p_{t+1}} R_t = \lambda_{2t}$$

and combining them all together we have

$$[1 + R_t] = \frac{\Lambda_t + u'_{ct}/p_t}{\beta E_t[u'_{ct+1}/p_{t+1}]}$$

where $\Lambda_t = \lambda_{2t} - \lambda_{1t}$

Consider first the case when $\Lambda = 0$. In this case the equation collapses to the standard Euler equation for consumption except that now we make an allowance for inflation. This equation simply says that the nominal interest rate equals the real interest rate (the ratio of the marginal utility of consumption) times a term reflecting inflation in the goods market. In other words we have the standard Fisherian equation that the nominal interest rate equals the real interest rate plus the inflation rate.

However, if $\Lambda < 0$, which implies $\lambda_1 > \lambda_2$, then the nominal interest rate is less than the standard Fisherian formula. What does this mean? If $\Lambda < 0$ then the value of the multiplier attached to the firm's cash in advance constraint is worth less than that attached to the consumer. In other words, the firm has more cash available than the consumer. Ideally, the household would want to switch these excess funds from the firm to the consumer. However, the structure of the model is that consumers cannot rapidly change their consumption and savings decisions, only firms can alter their borrowing/saving in response to current shocks. Therefore when cash is more readily available to the firm than the household then $\Lambda < 0$ and the nominal interest rate is low. Exactly the opposite reason suggests that when cash is scarce amongst firms then $\Lambda > 0$ and the nominal interest rate will rise.

What is happening here? At the beginning of the period consumers make their decisions regarding consumption and savings and they cannot change these decisions. Once they have made their decision the state of the world is revealed. Let us assume that there is unexpectedly high money supply growth. Banks therefore have more cash than they need and as long as $R > 0$ they will want to lend this money out. However, because consumers have made their decisions the only part of the household that can respond and increase their borrowing is the firm sector. However, to encourage the firm to borrow more the nominal interest rate must fall. Returning to the consumer's first order condition we can see that it is possible for an increase in the money supply to have the desired liquidity effect, i.e. for R to fall. However, this will not always occur as it requires Λ to change by more than inflation expectations. Otherwise the Fisher effect dominates and there is no liquidity effect. Fuerst shows that under some parameter values the liquidity effect dominates and the effect of an increase in the money supply is to lower interest rates and increase output (although see Christiano for some sceptical comments on this).

How does the fall in nominal interest rates increase output? Using the first order conditions for b and h it can be shown that

$$\frac{f'(h)}{1 + R_t} = \frac{w_t}{p_t}$$

so that the marginal product of labour divided by the nominal interest rate equals the real wage rate. The reason the nominal interest rate enters into the labour demand condition is that labour is a cash in advance good, and so a borrowing cost is incurred for every person hired. Therefore when the nominal interest rate falls, hiring costs decline and so the firm is prepared to recruit more workers, i.e. the labour demand curve shifts to the right. If instead nominal interest rates rise then the labour demand curve shifts left, lowering employment, wages and output.

Therefore this extended version of CIA has the capacity to explain the liquidity effect (i.e. falling nominal interest rates in response to an increase in the money supply). It does so by combining the standard inflation tax that CIA models involve with an additional non-neutrality. This additional non-neutrality is essentially to assume that there are not complete markets. Ideally the consumer would like to be able to take out an insurance policy such that if the money supply were unexpectedly high more cash would be given to the consumer and if the money supply were low then cash would be taken away from the consumer. If such an insurance policy existed it could be used to ensure that the value of cash was the same for both the shopper and the firm in the household, i.e. $\Lambda = 0$. However, in the absence of such an insurance scheme the household has to precommit to a given level of cash holdings to purchase consumption goods with. Notice however that because of Rational Expectations the household on average chooses the correct amount of cash. In other words, we have the standard result that it is only unexpected money supply shocks that lead to the liquidity effect, not anticipated money. The household always chooses its cash so that on average it expects the value of cash to be the same for both firm and shopper. This leads to a similar problem that we encountered for the fixed nominal contracts model. As we discussed (see the reference to Cogley and Nason), the standard RBC model does not generate much persistence via capital accumulation. Therefore, even though money supply shocks affect output this period they have little effect on output in future periods. What happens in the Fuerst model is that next period households realise there is more money in the economy and reallocate it accordingly between shopper and firm. The rebalancing of the portfolio means that on average both shopper and firm will value money the same and real interest rates return to their previous level. In other words, the Fuerst model only generates the liquidity effect for as long as it takes consumers to rebalance their portfolio in the optimal way. In the Fuerst model this only takes one period and so even though this model can explain the liquidity effect it cannot explain why in the data it operates with a one to two year lead time over output. Christiano and Eichenbaum (1992) show that by assuming costs of adjustment we can get more persistent liquidity effects but it seems unlikely that they can explain a liquidity effect over a two year period.

8.6   Conclusion

We have outlined in the lectures a number of variants of cash in advance models. Whilst each variant gets closer to explaining certain observed facts it is clear that they are still someway from having a convincing

and fully articulated model of how money affects output over the business cycle. The shopping time technology approach may hold some hope for the neoclassical monetary economists as it allows for greater flexibility on the part of the consumer than the CIA model. However, it will still prove difficult in that model to explain why the liquidity effect operates with such a long lead time. However, these notes suggest that the appropriate model will have to involve greater complexity than simply assuming certain prices are fixed. Such an approach clearly does not account for several features of the data. It is worth noting here that considerable interest has recently been placed, invariably by Keynesian economists, in the role of credit rather than money in determining business cycle fluctuations. However, it is still undecided whether credit or money will hold the key to understanding why nominal variables affect the economy.