liquidity trap

A liquidity trap is defined as a situation in which the short-term nominal interest rate is zero. The old Keynesian literature emphasized that increasing money supply has no effect in a liquidity trap so that monetary policy is ineffective. The modern literature, in contrast, emphasizes that, even if increasing the current money supply has no effect, monetary policy is far from ineffective at zero interest rates. What is important, however, is not the current money supply but managing expectations about the future money supply in states of the world in which interest rates are positive.

A liquidity trap is defined as a situation in which the short-term nominal interest rate is zero. In this case, many argue, increasing money in circulation has no effect on either output or prices. The liquidity trap is originally a Keynesian idea and was contrasted with the quantity theory of money, which maintains that prices and output are, roughly speaking, proportional to the money supply.

According to the Keynesian theory, money supply has its effects on prices and output through the nominal interest rate. Increasing money supply reduces the interest rate through a money demand equation. Lower interest rates stimulate output and spending. The short-term nominal interest rate, however, cannot be less than zero, based on a basic arbitrage argument: no one will lend 100 dollars unless she gets at least 100 dollars back. This is often referred to as the 'zero bound' on the short-term nominal interest rate. Hence, the Keynesian argument goes, once the money supply has been increased to a level where the short-term interest rate is zero, there will be no further effect on either output or prices, no matter by how much money supply is increased.

The ideas that underlie the liquidity trap were conceived during the Great Depression. In that period the short-term nominal interest rate was close to zero. At the beginning of 1933, for example, the short-term nominal interest rate in the United States – as measured by three-month Treasuries – was only 0.05 per cent. As the memory of the Great Depression faded and several authors challenged the liquidity trap, many economists begun to regard it as a theoretical curiosity.

The liquidity trap received much more attention again in the late 1990s with the arrival of new data. The short-term nominal interest rate in Japan collapsed to zero in the second half of the 1990s. Furthermore, the Bank of Japan (BoJ) more than doubled the monetary base through traditional and non-traditional measures to increase prices and stimulate demand. The BoJ policy of 'quantitative easing' from 2001 to 2006, for example, increased the monetary base by over 70 per cent in that period. By most accounts, however, the effect on prices was sluggish at best. (As long as five years after the beginning of quantitative easing, the changes in the CPI and the GDP deflator were still only starting to approach positive territory.)

The modern view of the liquidity trap

The modern view of the liquidity trap is more subtle than the traditional Keynesian one. It relies on an intertemporal stochastic general equilibrium model whereby aggregate demand depends on current and expected future real interest rates rather than simply the current rate as in the old Keynesian models. In the modern framework, the liquidity trap arises when the zero bound on the short-term nominal interest rate prevents the central bank from fully accommodating sufficiently large deflationary shocks by interest rate cuts.

The aggregate demand relationship that underlies the model is usually expressed by a consumption Euler equation, derived from the maximization problem of a representative household. On the assumption that all output is consumed, that equation can be approximated as:

$$Y_t = E_t Y_{t+1} - \sigma(i_t - E_t \pi_{t+1} - r_t^e) \qquad (1)$$

where Y_t is the deviation of output from steady state, i_t is the short-term nominal interest rate, π_t is inflation, E_t is an expectation operator and r_t^e is an exogenous shock process (which can be due to host of factors). This equation says that current demand depends on expectations of future output (because spending depends on expected future income) and the real interest rate which is the difference between the nominal interest rate and expected future inflation (because lower real interest rates make spending today relatively cheaper than future spending). This equation can be forwarded to yield

$$Y_t = E_t Y_{T+1} - \sigma \sum_{s=t}^{T} E_t (i_s - \pi_{s+1} - r_s^e)$$

which illustrates that demand depends not only on the current short-term interest rate but on the entire expected path for future interest rates and expected inflation.

Because long-term interest rates depend on expectations about current and future short-term rates, this equation can also be interpreted as saying that demand depends on long-term interest rates. Monetary policy works through the short-term nominal interest rate in the model, and is constrained by the fact that it cannot be set below zero,

$$i_t \geq 0. \tag{2}$$

In contrast to the static Keynesian framework, monetary policy can still be effective in this model even when the current short-term nominal interest rate is zero. In order to be effective, however, expansionary monetary policy must change the public's expectations about future interest rates at the point in time when the zero bound will no longer be binding. For example, this may be the period in which the deflationary shocks are expected to subside. Thus, successful monetary easing in a liquidity trap involves committing to maintaining lower future nominal interest rates for any given price level in the future once deflationary pressures have subsided (see, for example, Reifschneider and Williams, 2000; Jung, Teranishi and Watanabe, 2005; Eggertsson and Woodford, 2003; Adam and Billi, 2006).

This was the rationale for the BoJ's announcement in the autumn of 2003 that it promised keep the interest rate low until deflationary pressures had subsided and CPI inflation was projected to be in positive territory. It also underlay the logic of the Federal Reserve announcement in mid-2003 that it would keep interest rates low for a 'considerable period'. At that time, there was some fear of deflation in the United States (the short-term interest rates reached one per cent in the spring of 2003, its lowest level since the Great Depression, and some analysts voiced fears of deflation).

There is a direct correspondence between the nominal interest rate and the money supply in the model reviewed above. There is an underlying demand equation for real money balances derived from a representative household maximization problem (like the consumption Euler equation 1). This demand equation can be expressed as a relationship between the nominal interest rate and money supply

$$\frac{M_t}{P_t} \geq L(Y_t, i_t) \tag{3}$$

where M_t is the nominal stock of money and P_t is a price level. On the assumption that both consumption and liquidity services are normal goods, this inequality says that the demand for money increases with lower interest rates and higher output. As the interest rate declines to zero, however, the demand for money is indeterminate because at that point households do not care whether they hold money or one-period riskless government bonds. The two are perfect substitutes: a government liability that has nominal value but pays no interest rate. Another way of stating the result discussed above is that a successful monetary easing (committing to lower *future* nominal interest rate for a given price level) involves committing to higher money supply *in the future* once interest rates have become positive again (see, for example, Eggertsson, 2006a).

Irrelevance results

According to the modern view outlined above, monetary policy will increase demand at zero interest rates only if it changes expectations about the future money supply or, equivalently, the path of future interest rates. The Keynesian liquidity trap is therefore only a true trap if the central bank cannot to stir expectations. There are several interesting conditions under which this is the case, so that monetary easing is ineffective. These ‘irrelevance’ results help explain why BoJ’s increase in the monetary base in Japan through ‘quantitative easing’ in 2001–6 may have had a somewhat more limited effect on inflation and inflation expectations in that period than some proponents of the quantity theory of money expected.

Krugman (1998), for example, shows that at zero interest rates if the public expects the money supply in the future to revert to some constant value as soon as the interest rate is positive, quantitative easing will be ineffective. Any increase in the money supply in this case is expected to be reversed, and output and prices are unchanged.

Eggertsson and Woodford (2003) show that the same result applies if the public expects the central bank to follow a ‘Taylor rule’, which may indeed summarize behaviour of a number of central banks in industrial countries. A central bank following a Taylor rule raises interest rates in response to above-target inflation and above-trend output. Conversely, unless the zero bound is binding, the central bank reduces the interest rate if inflation is below target or output is below trend (an output gap). If the public expects the central bank to follow the Taylor rule, it anticipates an interest rate hike as soon as there are inflationary pressures in excess of the implicit inflation target. If the target is perceived to be price stability, this implies that quantitative easing has no effect, because a commitment to the Taylor rule implies that any increase in the monetary base is reversed as soon as deflationary pressures subside.

Eggertsson (2006a) demonstrates that, if a central bank is discretionary, that is, unable to commit to future policy, and minimizes a standard loss function that depends on inflation and the output gap, it will also be unable to increase inflationary expectations at the zero bound, because it will always have an incentive to renege on an inflation promise or extended ‘quantitative easing’ in order to achieve low *ex post* inflation. This deflation bias has the same implication as the previous two irrelevance propositions, namely, that the public will expect any increase in the monetary base to be reversed as soon as deflationary pressures subside. The deflation bias can be illustrated by the aid of a few additional equations, as illustrated in the next section.

The deflation bias and the optimal commitment

The deflation bias can be illustrated by completing the model that gave rise to (1), (2) and (3). In the model prices are not flexible because firms reset their price at random intervals. This gives rise to an aggregate supply equation which is often referred to as the ‘New Keynesian’ Phillips curve. It can be derived from the Euler equation of the firm’s maximization problem (see, for example, Woodford, 2003)

$$\pi_t = \kappa(Y_t - Y_t^n) + \beta E_t \pi_{t+1} \qquad (4)$$

where Y_t^n is the natural rate of output (in deviation from steady state), which is the ‘hypothetical’ output produced if prices were perfectly flexible, β is the discount factor of the household in the model and the parameter $\kappa > 0$ is a function of preferences and technology parameters. This equation implies that inflation can increase output above its natural level because not all firms reset their prices instantaneously.

If the government’s objective is to maximize the utility of the representative household, it can be approximated by

$$\sum_{t=0}^{\infty} \beta^t \{\pi_t^2 + \lambda_y (Y_t - Y_t^e)^2\} \qquad (5)$$

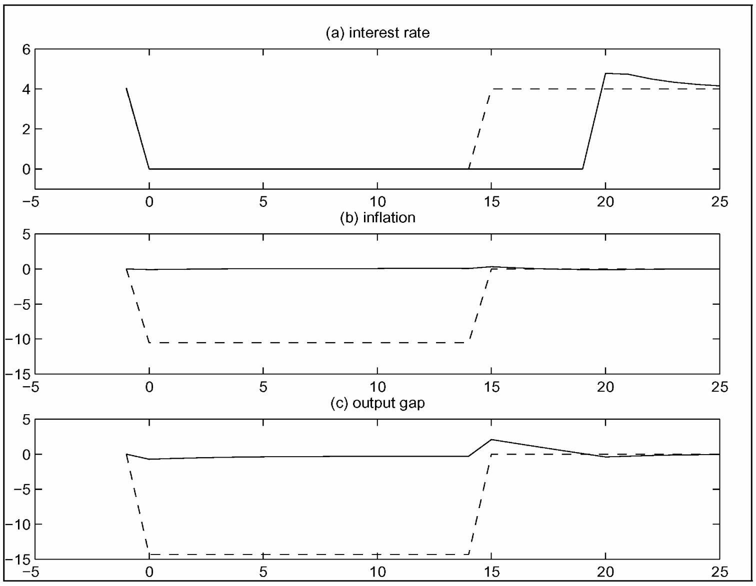
where the term Y_t^e is the target level of output. It is also referred to as the ‘efficient level’ or ‘first-best level’ of output. The standard ‘inflation bias’ first illustrated by Kydland and Prescott (1977) arises when the natural level of output is lower than the efficient level of output, that is, $Y_t^n < Y_t^e$.

Eggertsson (2006a) shows that there is also a deflation bias under certain circumstances. While the inflation bias is a steady state phenomenon, the deflation bias arises to temporary shocks. Consider the implied solution for the nominal interest rate when there is an inflation bias of $\bar{\pi}$. It is

$$i_t = \bar{\pi} + r_t^e.$$

This equation cannot be satisfied in the presence of sufficiently large deflationary shocks, that is, a negative r_t^e. In particular if $r_t^e < -\bar{\pi}$ this solution would imply a negative nominal interest rate. It can be shown (Eggertsson, 2006a) that a discretionary policymaker will in this case set the nominal interest rate to zero but set inflation equal to the 'inflation bias' solution $\bar{\pi}$ as soon as the deflationary pressures have subsided (that is, when the shock is $r_t^e \geq -\bar{\pi}_t$). If the disturbance r_t^e is low enough, the zero bound frustrates the central bank's ability to achieve its 'inflation target' $\bar{\pi}$ which can in turn lead to excessive deflation. (While deflation and zero interest rates are due to real shocks in the literature discussed above, an alternative way of modelling the liquidity trap is that it is the result of self-fulfilling deflationary expectations; see, for example, Benhabib, Schmitt-Grohe and Uribe, 2001.)

Figure 1 Response of the nominal interest rate, inflation and the output gap to a shocks that lasts for 15 quarters



Note: The horizontal axis measures time in terms of quarters and the vertical axis shows annual percentages. The dashed line shows the solution under policy discretion, the solid line the solution under the optimal policy commitment.

To illustrate this consider the following experiment. Suppose the term r_t^e is unexpectedly negative in period 0 $(r_t^e = r_L < 0)$ and then reverts back to its steady state value $\bar{r} > 0$ with a fixed probability α in every period. For simplicity assume that $\bar{\pi} = 0$. Then it is easy to verify from eqs. (1), (4), the behaviour of the central bank described above and the assumed process for r_t^e that that the solution for output and inflation is given by (see Eggertsson, 2006a, for details)

$$\pi_t = \frac{1}{\alpha(1-\beta(1-\alpha)) - \sigma\kappa(1-\alpha)} \kappa\sigma r_L^e \text{ if } r_t^e = r_L^e \text{ and} \qquad (6)$$
$$\pi_t = 0 \text{ otherwise}$$

$$Y_t = \frac{1-\beta(1-\alpha)}{\alpha(1-\beta(1-\alpha)) - \sigma\kappa(1-\alpha)} \sigma r_L^e \text{ if } r_t^e = r_L^e \text{ and} \qquad (7)$$
$$Y_t = 0 \text{ otherwise}$$

Figure 1 shows the solution in a calibrated example for numerical values of the model taken from Eggertsson and Woodford (2003). (Under this calibration $\alpha = 0.1$, $\kappa = 0.02$, $\beta = 0.99$ and $r_L = -\frac{0.02}{4}$ but the model is calibrated in quarterly frequencies.) The dashed line shows the solution under the contingency that the natural rate of interest reverts to positive level in 15 periods. The inability of the central bank to set negative nominal interest rate results in a 14 per cent output collapse and 10 per cent annual deflation. The fact that in each quarter there is a 90 per cent chance of the exogenous disturbance to remain negative for the next quarter creates the expectation of future deflation and a continued output depression, which creates even further depression and deflation. Even if the central bank lowers the short-term nominal interest rate to zero, the real rate of interest is positive, because the private sector expects deflation. The same results applies when there is an inflation bias, that is, $\bar{\pi} > 0$, but in this case the disturbance r_t^e needs to be correspondingly more negative to lead to an output collapse.

The solution illustrated in Figure 1 is what Eggertsson (2006a) calls the deflation bias of monetary policy under discretion. The reason why this solution indicates a deflation bias is that the deflation and depression can largely be avoided by the correct *commitment* to optimal policy. The solid line shows the solution in the case that the central bank can commit to optimal future policy. In this case the deflation and the output contraction are largely avoided. In the optimal solution the central bank commits to keeping the nominal interest at zero for a considerable period beyond what is implied by the discretionary solution; that is, interest rates are kept at zero even if the deflationary shock r_t^e has subsided. Similarly, the central bank allows for an output boom once the deflationary shock subsides and accommodates mild inflation. Such commitment stimulates demand and reduces deflation through several channels. The expectation of future inflation lowers the real interest rate, even if the nominal interest rate cannot be reduced further, thus stimulating spending. Similarly, a commitment to lower future nominal interest rate (once the deflationary pressures have subsided) stimulates demand for the same reason. Finally, the expectation of higher future income, as manifested by the expected output boom, stimulates current spending, in accordance with the permanent income hypothesis (see Eggertsson and Woodford, 2003, for the derivation underlying this figures. The optimal commitment is also derived in Jung, Teranishi and Watanabe, 2005, and Adam and Billi, 2006, for alternative processes for the deflationary disturbance).

The discretionary solution indicates that this optimal commitment, however desirable, is not feasible if the central bank cannot commit to future policy. The discretionary policymaker is cursed by the deflation bias. To understand the logic of this curse, observe that the government's objective (5) involves minimizing deviations of inflation and output from their targets. Both these targets can be achieved at time $t = 15$ when the optimal commitment implies targeting positive inflation and generating an output boom. Hence the central bank has an incentive to renege on its previous commitment and achieve zero inflation and keep output at its optimal target. The private sector anticipates this, so that the solution under discretion is the one given in (6) and (7); this is the deflation bias of discretionary policy.

Shaping expectations

The lesson of the irrelevance results is that monetary policy is ineffective if it cannot stir expectations. The previous section illustrated, however, that shaping expectations in the correct way can be very important for minimizing the output contraction and deflation associated with deflationary shocks. This, however, may be difficult for a government that is expected to behave in a discretionary manner. How can the correct set of expectations be generated?

Perhaps the simplest solution is for the government to make clear *announcements* about its future policy through the appropriate ‘policy rule’. This was the lesson of the ‘rules vs. discretion’ literature started by Kydland and Prescott (1977) to solve the inflation bias, and the same logic applies here even if the nature of the ‘dynamic inconsistency’ that gives rise to the deflation bias is different from the standard one. To the extent that announcements about future policy are believed, they can have a very big effect. There is a large literature on the different policy rules that minimize the distortions associated with deflationary shocks. One example is found in both Eggertsson and Woodford (2003) and Wolman (2005). They show that, if the government follows a form of price level targeting, the optimal commitment solution can be closely or even completely replicated, depending on the sophistication of the targeting regime. Under the proposed policy rule the central bank commits to keep the interest rate at zero until a particular price level is hit, which happens well after the deflationary shocks have subsided.

If the central bank, and the government as a whole, has a very low level of credibility, a mere announcement of future policy intentions through a new ‘policy rule’ may not be sufficient. This is especially true in a deflationary environment, for at least three reasons. First, the deflation bias implies that the government has an incentive to promise to deliver future expansion and higher inflation, and then to renege on this promise. Second, the deflationary shocks that give rise to this commitment problem are rare, and it is therefore harder for a central bank to build up a reputation for dealing with them well. Third, this problem is even further aggravated at zero interest rates because then the central bank cannot take any direct actions (that is, cutting interest rate) to show its new commitment to reflation. This has led many authors to consider other policy options for the government as a whole that make a reflation credible, that is, make the optimal commitment described in the previous section ‘incentive compatible’.

Perhaps the most straightforward way to make a reflation credible is for the government to issue debt, for example by deficit spending. It is well known in the literature that government debt creates an inflationary incentive (see, for example, Calvo, 1978). Suppose the government promises future inflation and in addition prints one dollar of debt. If the government later reneges on its promised inflation, the real value of this one dollar of debt will increase by the same amount. Then the government will need to raise taxes to compensate for the increase in the real debt. To the extent that taxation is costly, it will no longer be in the interest of the government to renege on its promises to inflate the price level, even after deflationary pressures have subsided in the example above. This commitment device is explored in Eggertsson (2006a), which shows that this is an effective tool to battle deflation.

Jeanne and Svensson (2006) and Eggertsson (2006a) show that foreign exchange interventions also have this effect, for very similar reasons. The reason is that foreign exchange interventions change the balance sheet of the government so that a policy of reflation is incentive compatible. The reason is that, if the government prints nominal liabilities (such as government bonds or money) and purchases foreign exchange, it will incur balance-sheet losses if it reneges on an inflation promise because this would imply an exchange rate appreciation and thus a portfolio loss.

There are many other tools in the arsenal of the government to battle deflation. Real government spending, that is, government purchases of real goods and services, can also be effective to this end (Eggertsson, 2005). Perhaps the most surprising one is that policies that temporarily reduce the natural level of output, Y_t^n, can be shown to increase equilibrium output (Eggertsson, 2006b). The reason is that policies that suppress the natural level of output create actual and expected reflation in the price level and this effect is strong enough to generate recovery because of the impact on real interest rates.

Conclusion: the Great Depression and the liquidity trap

As mentioned in the introduction, the old literature on the liquidity trap was motivated by the Great Depression. The modern literature on the liquidity traps not only sheds light on recent events in Japan and the United States (as discussed above) but also provides new insights into the US recovery from the Great Depression. This article has reviewed theoretical results that indicate that a policy of reflation can induce a substantial increase in output when there are deflationary shocks (compare the solid line and the dashed line in Figure 1: moving from one equilibrium to the other implies a substantial increase in output). Interestingly, Franklin Delano Roosevelt (FDR) announced a policy of reflating the price level in 1933 to its pre-Depression level when he became President in 1933. To achieve reflation FDR not only announced an explicit objective of reflation but also implemented several policies which made this objective credible. These policies include all those reviewed in the previous section, such as massive deficit spending, higher real government spending, foreign exchange interventions, and even policies that reduced the natural level of output (the National Industrial Recovery Act and the Agricultural Adjustment Act: see Eggertsson, 2006b, for discussion). As discussed in Eggertsson (2005; 2006b) these policies may greatly have contributed to the end of the depression. Output increased by 39 per cent during 1933–7, with the turning point occurring immediately after FDR's inauguration, when he announced the policy objective of reflation. In 1937, however, the administration moved away from reflation and the stimulative policies that supported it – prematurely declaring victory over the depression – which helps explaining the downturn in 1937–8, when monthly industrial production fell by 30 per cent in less than a year. The recovery resumed once the administration recommitted to reflation (see Eggertsson and Puglsey, 2006). The modern analysis of the liquidity trap indicates that, while zero short-term interest rates made static changes in the money supply irrelevant during this period, expectations about the future evolution of the money supply and the interest rate were key factors determining aggregate demand. Thus, recent research indicates that monetary policy was far from being ineffective during the Great Depression, but it worked mainly through expectations.

Gauti B. Eggertsson

See also expectations; inflationary expectations; optimal fiscal and monetary policy (with commitment); optimal fiscal and monetary policy (without commitment)

Bibliography

Adam, K. and Billi, R. 2006. Optimal monetary policy under commitment with a zero bound on nominal interest rates. *Journal of Money, Credit and Banking* (forthcoming)

Benhabib, J., Schmitt–Grohe, S. and Uribe, M. 2001. Monetary policy and multiple equilibria. *American Economic Review* 91, 167–86.

Calvo, G. 1978. On the time consistency of optimal policy in a monetary economy. *Econometrica* 46, 1411–28.

Eggertsson, G. 2005. Great expectations and the end of the depression. Staff Report No. 234. Federal Reserve Bank of New York.

Eggertsson, G. 2006a. The deflation bias and committing to being irresponsible.

Journal of Money, Credit and Banking 38, 283–322.

Eggertsson, G. 2006b. Was the New Deal contractionary? Working paper, Federal Reserve Bank of New York.

Eggertsson, G. and Puglsey, B. 2006. The mistake of 1937: a general equilibrium analysis. *Monetary and Economic Studies* (forthcoming).

Eggertsson, G. and Woodford, M. 2003. The zero bound on interest rates and optimal monetary policy. *Brookings Papers on Economic Activity* 2003(1), 212–19.

Jeanne, O. and Svensson, L. 2006. Credible commitment to optimal escape from a liquidity trap: the role of the balance sheet of an independent central bank. *American Economic Review* (forthcoming).

Jung, T., Teranishi, Y. and Watanabe, T. 2005. Zero bound on nominal interest rates and optimal monetary policy. *Journal of Money, Credit and Banking* 37, 813–36

Krugman, P. 1998. It's baaack! Japan's slump and the return of the liquidity trap. *Brookings Papers on Economic Activity* 1998(2), 137–87.

Kydland, F. and Prescott, E. 1977. Rules rather than discretion: the inconsistency of optimal plans. *Journal of Political Economy* 85, 473–91.

Reifschneider, D. and Williams, J. 2000. Three lessons for monetary policy in a low inflation era. *Journal of Money, Credit and Banking* 32, 936–66.

Wolman, A. 2005. Real implications of the zero bound on nominal interest rates. *Journal of Money, Credit and Banking* 37, 273–96.

Woodford, M. 2003. *Interest and Prices: Foundations of a Theory of Monetary Policy*. Princeton: Princeton University Press.

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