Preliminary

Central bank balance sheets and the liquidity trap

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Abstract

The effectiveness of policy in a liquidity trap is considered in a simple model. The model illustrates the interaction between fiscal and monetary policy. It highlights how traditional policy responses, such as expansionary open-market operations or bond-financed tax cuts, have no stimulative value, but non-traditional fiscal/monetary actions, such as money-financed tax cuts or non-Ricardian tax cuts, are stimulative. The fiscal theory of the price level is crucial in a liquidity trap, as money loses its special character once the nominal interest rate hits zero. Finally, the analysis highlights two results of practical relevance regarding central bank losses and the exchange rate effects of policies in a liquidity trap. With regard to the former, the model illustrates that any monetary action that lifts the economy from the liquidity trap must involve a deterioration of the central bank's balance sheet; hence, an institutional framework that forbids such losses hinders an escape from a liquidity trap. With regard to the latter, monetary actions that succeed in lifting the economy from a liquidity trap generate a real currency appreciation, reflecting the fiscal nature of the monetary action; hence, such actions cannot be criticized on "beggar-thy-neighbor" grounds.

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1. Introduction

Previously relegated to the dustbin of history, the liquidity trap is back – in modern Japan and on the research agenda.[1] The appropriate policy response has proven controversial. Suggestions include an inflation target (Krugman (1998)), fiscal expansion (Posen (1998)), a price-level target (Wolman (1998), Lilico (2002)), monetary expansion (Meltzer (1999)), a tax on currency holdings (Buiter and Panigirtzoglou (1999)), currency depreciation (McCallum (1999), Coenen and Wieland (2003)), and a combination of a currency depreciation and price-level target (Svensson (2001)). Most of these proposals are at least implicitly discussed below, as the effects of different monetary and fiscal actions are examined. Unfortunately these proposals may have limited effectiveness, at least to the extent that a baseline general equilibrium model with monetary frictions provides a reasonable guide for policy.

The model developed herein is a two-period, deterministic open-economy model with an optimizing representative consumer and flexible prices. In the model, expectations (or, more precisely given perfect foresight, future values) are very important (for consumption decisions, asset prices, and hence for the liquidity trap). The results demonstrate that the monetary authority, through open-market operations, cannot engineer inflation, price-level targets or currency depreciation once the economy enters the liquidity trap. This suggests that Svensson's (2001) foolproof policy cannot lift the economy from a liquidity trap without fiscal or balance sheet effects as has been claimed (a point developed more below).[2] This result is standard for the type of model analyzed, but highlights that suggestions for such policies must either involve monetary actions other than security purchases or imperfections not included in the model, such as imperfect substitutability between different assets that generates portfolio balance effects. Such imperfections may not allow for very powerful effects of monetary policy in a liquidity trap.[3]

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[1] Krugman (1998) gets credit for the snappy phrasing and an early return to the topic.

[2] Some readers may immediately object before turning to the analysis that Svensson (2001) does not rely on portfolio balance effects. However, a careful reading of his appendix 2 suggests otherwise.

[3] Lebow (1993) presents a cogent discussion of the limited role "non-traditional" monetary channels, such as portfolio balance or credit channels, may have in a liquidity trap, even if such channels are powerful outside a liquidity trap.

Traditional fiscal policy may also be relatively impotent for several reasons. First, when fiscal policy is pursued in a Ricardian fashion (as defined by Woodford (2001) or Cochrane (1998)), the aggregate demand effects of deficit-financed tax cuts is nil (or very limited) because of Ricardian equivalence (Barro (1974)). In addition, government consumption and investment may be (good) substitutes for private spending, implying that increases in government spending may have little effect on aggregate demand (i.e., a small government spending multiplier (Krugman (1999))). Both these reasons may explain part of the apparently weak aggregate demand effects of fiscal stimulus in Japan in the late 1990s (OECD (2000)). Another limit of fiscal policy may be the ability of the fiscal authority to pursue expansionary measures given the long-run fiscal outlook and the feasibility of raising future revenues or cutting future expenditures. This concern may have been more important in limiting the degree of fiscal expansion pursued by Japan recently (as the ratio of government debt to GDP exceeded 120 percent in 2000 and implicit public pension liabilities are large).

Given the impotence of securities purchases or bond-financed tax cuts when facing a liquidity trap, innovative monetary and fiscal policy actions are examined in the model. Monetary actions to relax the government's budget constraint or non-Ricardian fiscal policy can lift the economy from the liquidity trap. The appeal to the fiscal theory of the price level is crucial, as money loses its special character (i.e., a necessary but dominated asset class) once the nominal interest rate hits zero. The monetary and fiscal authorities must commit to inflating away (loosely, monetizing) some portion of outstanding nominal liabilities. In essence, the effects of monetary actions represent some pleasant monetarist arithmetic – the boosting of inflation through the fiscal effects of monetary policy emphasized by Sargent and Wallace (1981). It should be noted that relaxation of the government's budget constraint through monetary expansion is often mentioned as a possibility (e.g., Clouse et al (2000), and Bernanke (2000)), but typically is frowned upon as inappropriate. Such reasoning is difficult to comprehend, as money and bonds are perfect substitutes in a liquidity trap; since consumers are willing to increase their holdings of money in a liquidity trap and the government can lower tax

burdens by increasing the supply of money without resource costs, it would seem appropriate for the government to issue more money and cut taxes.[4]

Two practical issues arise from the analysis. First, the monetary actions suggested have negative effects on the central bank's balance sheet, reflecting the monetization of government liabilities. Providing money to the treasury without an accompanying increase in assets on the central bank's balance sheet implies that the outstanding stock of money exceeds the assets held by the central bank. Of course, such a balance sheet deterioration is not economically important; a central bank could always simply print more money whenever anyone wished to exchange their money for an asset (more money), without any change in the stock of money held by the public. However, such losses are prevented in certain institutional setups, most notably in Japan, where the Bank of Japan is a private entity that must remain solvent. Since only monetary actions with negative consequences for the central bank's balance sheet allow an escape from the liquidity trap, such institutional frameworks limit the potential of monetary policy.

In addition, the type of monetary expansion described may lead to a real currency appreciation in the short run (rather than the real depreciation predicted by portfolio balance channels), reflecting the fiscal nature of the monetary action. Hence, such policy actions cannot be criticized on the "beggar-thy-neighbor" grounds of calls for currency depreciation (e.g., Stevens (2001), the discussion in Svensson (2001) and Coenen and Wieland (2003)). This theoretical prediction has not been previously discussed, and suggests even more strongly the potential desirability of the policy for Japan in the years following 2001, when world aggregate demand appears to be faltering and beggar-thy-neighbor actions may aggravate adverse developments elsewhere in Asia or in the United States (*The Economist* (2001)).

2. A simple economy

The model is of a small, open economy, consisting of a representative consumer and a government (which can be broken down into a central bank and treasury if such a

[4] Outside of the liquidity trap, increases in the money supply boost the nominal interest rate (by increasing inflation) and hence create distortions. However, such distortions are absent in the liquidity trap, where the nominal interest rate is zero.

breakdown is desired). The economy consists of two periods, period 1 and period 2. Domestic output is exogenous, and the price level is perfectly flexible. Hence, the liquidity trap is a situation where the monetary authority cannot influence the price level through open-market operations, rather than a situation where the monetary authority cannot influence output. As in Krugman (1998), adding sticky prices and demand-determined output levels would transform the liquidity trap to a situation where the central bank's attempts to influence output are thwarted, thereby injecting a Keynesian flavor into the analysis. However, such a modification adds no insight and hence is ignored for simplicity.

2.1 The representative consumer

The representative consumers preferences over consumption of the domestically produced good (c(j), j= 1 or 2) and the foreign good (g(j), j = 1 or 2) are given by

Eq. 1 $$a\ln[c(1)] + (1-a)\ln[g(1)] + D\{a\ln(c(2) + (1-a)\ln[g(2)]\},$$

where "a" is a parameter (equal to the expenditure share of domestic goods in total consumption expenditure) and D is the discount rate. (Note that in what follows, variables denoted with a lower-case letter refer to real variables, such as consumption, while variables denoted with upper-case letters are nominal values, such as the price level).

The consumer's choices are constrained by a budget constraint and a transaction technology. The consumer is endowed with an income in each period (y), an initial stock of domestic assets (bonds, B(1)) and an initial stock of foreign assets (F(1)). The budget constraints in period 1 and 2 are

Eq. 2 $$M + QB(2) + \frac{Q^f F(2)}{E(1)} + P(1)c(1) + \frac{g(1)}{E(1)} = B(1) + \frac{F(1)}{E(1)} + P(1)y - P(1)ty,$$

Eq. 3 $$P(2)c(2) + \frac{g(2)}{E(2)} = M + B(2) + \frac{F(2)}{E(2)} + P(2)y - P(2)ty,$$

where M, B(2), and F(2) are the consumer's choices of money, domestic bond, and foreign bond holdings to be carried into period 2, Q and Q^f are the purchase price of domestic and foreign bonds in their own currency (and their inverses are the gross nominal return on these bonds), P(j) is the price of domestic goods in period j, E(j) is the

nominal exchange rate in period j (i.e., the value of foreign currency in terms of domestic currency, so an increase in E(j) is a nominal appreciation), and t is tax rate on the household's endowment (which is identical in each period for simplicity). For convenience, the foreign price level has been normalized to one and is assumed to be time-invariant, implying that the domestic price of foreign consumption goods is the inverse of the nominal exchange rate.

Transactions in period 2 are subject to a cash-in-advance constraint; no such constraint exists in period 1. The transaction technology is

Eq. 4 $$P(2)c(2) + \frac{g(2)}{E(2)} \leq M \, .$$

2.2 The government

The government issues bonds and money and collects taxes; as a convenient simplification, government spending is ignored. Government spending could be added to the model without changing the results discussed; however, such an addition would provide an avenue to analyze the effects of government spending on the equilibrium, and in particular on an escape from the liquidity trap. The details of such effects would likely depend on the substitutability of government consumption for private consumption and the financing of additional spending (i.e., whether distortionary taxes were needed or not). As a practical matter, calls for further increases in government consumption, at least in Japan, have not been popular, as productive opportunities for such spending appear limited, and hence such spending is not analyzed.

The notation for the domestic stocks of government-issued bonds and money, and for tax collections, has already been introduced. The government's choices regarding M and t are exogenous (and B(1), which has been determined in some earlier period, is also exogenous). Moreover, the specification assumes that tax collections are exogenous in real terms, not nominal terms, as this best reflects actual practice – where tax collections are typically a fraction of income, and hence rise and fall with the price level. The only remaining aspect of the government is its sequence of budget constraints, or more appropriately the valuation equations for government debt, which are given by

Eq. 5 $M + QB(2) = B(1) - P(1)ty$

Eq. 6 $B(2) = P(2)ty - M$.

The left-hand side of equation 5 is the nominal value of government liabilities issued in period 1, which equals the difference between debt payments and tax revenues that period. Equation 6 equates nominal liabilities to tax collections in period 2. Note that these two equations can be combined to equate the initial stock of government nominal liabilities (B(1)) to the present discounted value of tax and seignorage revenue

$$B(1) = P(1)ty + QP(2)ty + (1-Q)M \quad .$$

Seignorage revenue is non-zero when the nominal interest rate exceeds zero (i.e., when Q<1). The sequence of budget constraints implies that the value of government liabilities equals the resources taken from the economy to pay for the liabilities. As discussed in Cochrane (1998) or Woodford (2001), the equality between the nominal value of government debt and the present the resources used to repay that debt is an equilibrium condition that ensures that an investor is willing to hold government debt, not a constraint on the feasible set of government policies, at least under certain conditions.

2.3 The foreign sector

The economy is a small open economy that takes the world interest rate ($1/Q^f$-1) as given. The rest-of-the-world interacts with the domestic economy solely in providing imports of the foreign good (elastically at the nominal exchange rate) and foreign bonds as assets; it does not demand any exports from the domestic economy, again a convenient simplification.

Given this, the only constraints imposed on the domestic economy by the foreign sector are balance of payments constraints. These equate the initial stock of the economy's foreign assets to the present discounted value of imports (at the world real interest rate, which equals the nominal rate as the world price level is fixed) and are given by

Eq. 7 $F(1) = Q^f F(2) + g(1)$

Eq. 8 $F(2) = g(2)$.

As purchases of foreign goods can only occur if the initial stock of foreign assets is positive and positive purchases are necessary for utility to be bounded, the exogenous initial stock of foreign assets is restricted to be greater than zero.

2.4 Equilibrium

The equilibrium is characterized by the values of consumption (domestic and foreign), prices, and domestic interest rates (c(j), g(j), P(j), E(j), and Q for j = 1 and 2) that maximize the value of the representative consumer's preferences (eq. 1) subject to the budget constraints and transaction technology (eqs. 2 to 4) and that are consistent with the resource constraint, government debt valuation equations and balance of payments constraints (eqs. 5 through 8) given the exogenous values for output, government debt and taxes, the money supply, foreign assets, and the world real interest rate (y, B(1), t, M, F(1), and Q^f). The equilibrium can be characterized analytically, as shown in an appendix. Such an analytical characterization is particularly valuable when examining the liquidity trap, which occurs when the nominal interest rate equals zero and hence the cash-in-advance constraint (eq. 4) does not bind. It is often difficult to analytically characterize equilibrium at such corner solutions in more complicated or many-period models, and hence more transparent results are found in the simple setup herein.

2.4 The central bank and the treasury

The discussion so far has ignored any distinction between the central bank and the treasury, as only the consolidated government position affects equilibrium – given government policies on the money supply, taxes and the initial supply of government debt. However, a distinction between the central bank and treasury is useful when considering the set of policies consistent with institutional constraints on the central bank. In particular, it is common for a legal requirement to exist that limits the outstanding supply of money (M) – the liability of the central bank – to be less than or equal to the central bank's asset holdings, and for any surplus income (seignorage) to be returned to the treasury. Assuming that the central bank's open market operations involve the sale

and purchase of government debt (B(cb)) and that this constraint is binding, such policies imply the following conditions

Eq. 9 $M = B(cb)$

Eq. 10 $Seignorage = B(cb) - QB(cb) = (1-Q)M$.

The effect of these constraints on the treasury has already been incorporated in the government budget constraints (equations 5 and 6). One important implication of these constraints is that the central bank can only affect the government's budget position outside a liquidity trap (when Q<1). This implies that money-financed tax cuts (or purchases of goods) are inadmissible, as the money supply so created would not be backed by government debt.

3. The liquidity trap

The factors influencing the likelihood of a liquidity trap and the nature of the economy's response to changes in government policies are simple to describe; the descriptions are provided as a set of properties. Proofs of the properties are relegated to an appendix.

First, a definition: a *liquidity trap* occurs when the nominal interest rate equals zero (or Q equals one). The forces determining whether such trap will occur and the behavior of the economy are summarized by five properties. The first property is a special feature of the model that contributes to its tractability:

> **Property 1:** Inflation is entirely determined by time preference (P(2)/P(1) equals D).

As this result implies a fixed constant of proportionality between the first and second period price levels, the remainder of the discussion simply refers to the price level.

The next two properties focus on the impact of monetary and fiscal actions on the price level and nominal interest rates.

> **Property 2:** The nominal interest rate is decreasing in the money supply (M), decreasing in the tax rate (t) and increasing in the initial stock of debt (B(1)) outside the liquidity trap.

Each of these effects is standard from undergraduate treatments – loose monetary policy lowers nominal interest rates, as does a tight fiscal policy. However, in the present case

these effects arise through the interaction of fiscal and monetary policy on the valuation of government debt. The government's budget constraint implies

Eq. 11 $B(1) = P(1)ty + QP(2)ty + (1-Q)M$.

Lower levels of debt, higher tax rates and a larger money supply all imply less need for seignorage revenue, and hence increase Q (or lower the nominal interest rate) – until the nominal interest rate hits zero and the economy enters the liquidity trap. Figure 1 graphs the nominal interest rate against the money supply, illustrating the negative relationship. The dashed line in the figure illustrates the impact of a tax cut – which shifts out the locus summarizing the nominal interest rate/money supply relationship, increasing the nominal interest rate for a given money supply.

> **Property 3:** The price level is increasing in the money supply (M) outside the liquidity trap. Moreover, the money supply is the only variable under the government's control that influences the price level outside the liquidity trap, i.e. the price level is *money determined*.

Outside a liquidity trap, the cash-in-advance constraint (equation 4) is binding and the price level follows standard quantity theory logic, i.e., the price level is proportional to the money supply.

The interesting properties of the model arise in a liquidity trap.

> **Property 4:** Once the economy enters a liquidity trap, further increases in the money supply have no effect on any endogenous variable. The nominal interest rate can be lifted above zero by tax cuts. The price level remains strictly decreasing in tax rates within the liquidity trap, and is solely determined by fiscal variables (B(1) and t), i.e., the price level is *fiscally determined*.

The inability of further increases in the money supply to affect nominal interest rates or the price level are standard results once the zero bound on nominal interest rates are reached. This again reflects the influence of the government's budget constraint on equilibrium; once the nominal interest rate hits zero (Q equals 1), further increases in the money supply have no impact of government budget balance (equation 9) or household decisions (as money and bonds are perfect substitutes). The switch to a *fiscally determined* equilibrium is more interesting and appeals to the fiscal-theory of the price level (Cochrane (1998) and Woodford (2001)). Once money becomes irrelevant, the price

level is solely determined by requirements for fiscal balance. Tax cuts increase the price level (and tax increases lower the price level), as such movements are necessary to ensure that the nominal value of government liabilities equals nominal tax collections. Of course, the type of tax movements considered are *non-Ricardian*; tax cuts one period are not offset by tax cuts in the other period. Rather, a tax cut is financed by an increase in the price level, boosting nominal tax collections.

Figures 1 and 2 illustrate the effects of fiscal policy changes in a liquidity trap. Consider an initial equilibrium where the economy is in a liquidity trap, but only barely – so the money supply is just to the right of M*. At this point, any further increases in the money supply have no effect on the price level or nominal interest rates. A tax cut shifts the locus summarizing the nominal interest rate/money supply relationship to the right, boosting the nominal interest rate so long as the money supply is less than M**. Moreover, as shown in figure 2, a tax cut boosts the price level regardless of the position of the money supply by shifting up the price level/money supply locus over the liquidity trap region where the price level is *fiscally determined*. At lower levels of the money supply (outside the liquidity trap) – i.e., to the left of M* – fiscal policy has no impact on the price level, as the price level is *money determined*.

> **Corollary of property 4:** Conventional expansionary open market operations have no effect on the equilibrium once the economy is in a liquidity trap. Monetary actions with direct fiscal consequences, such as money-financed tax cuts, can lift the economy from the liquidity trap and raise the price level, but involve creation of money in excess of the assets on the central bank's balance sheet and hence are legally prohibited by regimes with constraints like equation 9.

This result stem directly from property 3 and the conventional constraint (9) that money is injected through open market operations (either purchasing government bonds or other assets that in the current model are perfect substitutes for government bonds in a liquidity trap). In particular, the increase in the money supply necessary to finance a tax cut will leave the economy between M* and M** in the model (because the increase in the money supply needed is less than the increase to M**), implying a positive nominal interest rate and higher price level. Additional increases in the money supply, above the

level required for the tax cut, would raise the price level further until the money supply exceeds M**.

The final property presented discusses the impact of money supply and fiscal policy movements on the nominal and real exchange rate.

> **Property 5:** 1. Outside a liquidity trap, increases in the money supply cause a nominal exchange rate depreciation (in the initial period, i.e., lower E(1)). 2. The nominal exchange rate in period one is decreasing in the tax rate and increasing in the initial stock of foreign debt, i.e., tighter fiscal policy leads to a real and nominal depreciation in period 1. 3. Uncovered interest parity holds, implying that the degree of nominal exchange rate depreciation between periods one and two is higher the higher is the nominal interest rate – and hence the tighter is monetary policy (lower M) and the looser is fiscal policy (higher B(1) and lower t). 4. In a liquidity trap, increases in the money supply have no effect on the nominal or real exchange rate. 5. In a liquidity trap, a money-financed tax cut (or non-Ricardian tax cut) generates a real exchange rate appreciation (or unchanged real exchange rate) in period one.

For the most part, these results reflect standard forces and operate through uncovered interest parity. However, the last result – that a money-financed tax cut generates a real exchange rate appreciation – is not often emphasized. In particular, this result stems from the fiscal aspect of the monetary expansion (the tax cut), as the monetary aspect is absent when the cash-in-advance constraint is not binding and the price level and nominal interest rate are *fiscally determined*.

Figure 3 illustrates these points. Outside the liquidity trap (to the left of M*), the real exchange rate P(1)E(1) is decreasing in the money supply. This occurs because at higher levels of the money supply, the nominal interest rate is lower, reducing the tax on consumption of foreign goods in the second period (g(2)) that arises from the cash-in-advance constraint. The decrease in this tax lowers demand for the foreign good in period one, exerting downward pressure on the real exchange rate. The dashed-line illustrates the effect of a fiscal expansion (tax cut) financed through money creation. This shifts the real exchange rate/money supply locus upward, as the resulting higher nominal interest rate increases the tax on consumption of the foreign good in period 2 through the cash-in-

advance constraint and hence increases period-one demand for the foreign good, exerting upward pressure on the real exchange rate. The higher nominal interest rate follows from the corollary to property 4, i.e., that the additional money necessary to finance a tax cut leaves the economy below M**.

3. Discussion and caveats

The model emphasizes the importance of fiscal effects of monetary policy. In this respect the analysis echoes less formal discussions (i.e., outside an explicit, optimizing model) of the liquidity trap. The results stem from the fact that seignorage revenues on the outstanding stock of money are zero in a liquidity trap, reflecting the zero nominal interest rate. In this situation, any transfer to the treasury – or any fiscal effects of monetary actions – involve a worsening of the central bank's balance sheet. Some observers have noted that, in practice, it may therefore make sense to allow a central bank to have negative net worth. This is suggested in Bernanke (2000) and currently is not allowed in most countries where monetary expansions must occur through purchases of assets for the central bank's balance sheet, e.g. the United States (Clouse et al. (2000)) and Japan (Oda and Okina (2000)).

One recent contribution with a similar flavor is that of Eggertson (2001), who emphasizes the need for an coordinated fiscal/monetary expansion. One notable difference is the inclusion of the central bank's balance sheet in the analysis: In order to pursue an expansionary fiscal/monetary mix in a liquidity trap, the central bank must create unbacked money. Eggertson does not consider whether this constraint operates in his model, ignoring an important institutional feature.

The analysis also sheds light on the foolproof escape method of Svensson (2001), which consists of an initial currency depreciation accompanied by a price-level target. Svensson does not formally consider whether such a policy is implementable through open-market operations, but suggests in an appendix that such a constraint on central bank behavior is unimportant. By explicitly modeling the interaction of fiscal and monetary policy in an optimizing model, the current analysis indicates that the "foolproof way" may not be so foolproof, as it is not implementable in the current model. It is also interesting to note that a money-financed tax cut leads to a real exchange rate

appreciation in the model, not a depreciation. This theoretical prediction suggests even more strongly the potential desirability of the policy for Japan in the years following 2001, when world aggregate demand appears to be faltering and beggar-thy-neighbor actions may aggravate adverse developments elsewhere in Asia or in the United States (see Stevens (2001), the other comments on Svensson (2001), *The Economist* (2001) or Coenen and Wieland (2003)).

Of course, one strong limitation of the current analysis is the two-period framework, which severely limits the dynamic aspects of the model (as shown in property one, where inflation is entirely driven by the discount rate). However, the results are more general than they appear. Consider an infinite-horizon model, and suppose that government debt consists solely of one-period nominal debt. In period t, the value of such debt (payments to the public) is B(t). The stock of money held by the public at the beginning of period t, issued in the previous period, equals M(t). Further, in period t, the amount of debt carried into the next period is chosen by the treasury (B(t+1)), and the price of such debt in period t is Q(t) (and is determined in the bond market). Denote nominal tax collections in period t by T(t) and nominal government purchases by G(t). The valuation equation for the government's nominal debt, reflecting the consolidation of treasury and central bank accounts, is

Eq. 12 $$Q(t)B(t+1) = B(t) + G(t) - T(t) - M(t+1) + M(t).$$

Iterating equation 12 forward (and imposing the necessary condition that the real presented-discounted value of government debt not diverge in either direction, i.e., a transversality condition) yields

Eq. 13 $$B(t) + M(t) = \sum_{j=0}^{\infty} \prod_{k=0}^{j} Q(t+k)\{T(t+j) - G(t+j) + (1 - Q(t+k+1))M(t+j+1)\}$$

Now consider different types of monetary actions in a liquidity trap where the nominal interest rate is (expected to be) equal to zero over the indefinite horizon. It is clear from equation 13 that no sequence of monetary actions has any impact on the equilibrium, as the government's budget constraint is unaffected (and bonds and money are perfect substitutes in households' balance sheets).

The importance of fiscal effects of monetary policy can be extended to consider the effects of alternative monetary actions. For example, consider the purchase of

privately-issued securities via money creation. Such purchases are often suggested as one route out of a liquidity trap (e.g., Clouse et al (2000)). Of course, in a baseline model with one interest rate, private securities are perfect substitutes for government securities, and such open-market operations have no effects. Imperfect substitutability, or a portfolio balance channel, is one way in which such purchases could have real effects. However, absent such effects, which are often considered to be quite small (Lebow (1993)), fiscal effects of monetary policy actions are critical to escaping the liquidity trap via money creation.

Both Krugman (1998) and Auerbach and Obstfeld (2003) emphasize the importance of creating expectations of future expansion in the money supply. Their intuition flows from equation 13. In particular, if short-term nominal interest rates are expected to be positive at some point in the future, an increase in the money supply at that point relaxes the government's budget constraint and hence can influence the current equilibrium. Aside from the difficulties in engendering such expectations, it is important to note that even such policies could result in adverse consequences for a central bank's balance sheet and hence may not be pursued in practice. For example, suppose that long-term interest rates imply some expectation that short-term nominal interest rates will be positive at some date t+k in the future. In addition, suppose that the central bank's assets consist of some medium-term government bonds (horizon less than k). Expectations of a monetary action in the future can affect today's equilibrium via equation 13. If such effects lift the economy from the liquidity trap in the medium term, i.e., raise expected short-term rates at a horizon less than k, this will lower the value of government securities on the central bank's balance sheet (as the value of the bonds today is decreasing in their expected yield for a given face value). Such adverse movements in the value of central bank assets would require a monetary contraction to maintain a positive net-worth position. This may make it very difficult (in practice) to create expectations of a monetary expansion.

5. Summary

A liquidity trap is a problem for conventional stabilization policies: Open market operations are impotent, and Ricardian equivalence and the long-run sustainability of

fiscal policy limit the impact of traditional fiscal policy. Because of these problems, there has been a call for the use of all emergency measures – purchase of private securities, intervention in foreign exchange markets, implementation of inflation targets – in the hope that something will work (Svensson (1999)).

The analysis herein provides a simple description of policy options and their theoretical effects. The model illustrates the interaction between fiscal and monetary policy. It highlights how traditional policy responses, such as expansionary open-market operations or bond-financed tax cuts, have no stimulative value, but non-traditional fiscal/monetary actions, such as money-financed tax cuts or non-Ricardian tax cuts, are stimulative. The fiscal theory of the price level is crucial in a liquidity trap, as money loses its special character once the nominal interest rate hits zero. Finally, the analysis highlights two results of practical relevance regarding central bank losses and the exchange rate effects of policies in a liquidity trap. With regard to the former, the model illustrates that any monetary action that lifts the economy from the liquidity trap must involve a deterioration of the central bank's balance sheet; hence, an institutional framework that forbids such losses hinders an escape from a liquidity trap. With regard to the latter, monetary actions that succeed in lifting the economy from a liquidity trap generate a real currency appreciation, reflecting the fiscal nature of the monetary action; hence, such actions cannot be criticized on the "beggar-thy-neighbor" grounds.

In emphasizing fiscal effects, portfolio balance channels need not be quantitatively important. With that said, the independence of most central banks in modern economies suggests that such policies may be difficult to implement without coordination with fiscal authorities. Such legal and practical issues have already begun attracting research (see Clouse et al (2000) for a discussion of legal issues in the United States, and Eggertsson (2001) for an analysis of the time-consistency of fiscal/monetary coordination).

Appendix

Denoting the Lagrange multipliers on constraints 2, 3 and 4 facing the household by w(1), w(2) and w(3), respectively, and taking derivatives yields the following first-order conditions for the households choice variables (c(j), g(j), M, B(2), F(2), j=1,2)

A 1 $$\frac{a}{c(1)} = P(1)w(1)$$

A 2 $$D\frac{a}{c(2)} = P(2)(w(2)+w(3))$$

A 3 $$\frac{1-a}{g(1)} = \frac{w(1)}{E(1)}$$

A 4 $$D\frac{1-a}{g(2)} = \frac{w(2)+w(3)}{E(2)}$$

A 5 $$w(1) = w(2)+w(3)$$

A 6 $$Qw(1) = w(2)$$

A 7 $$\frac{Q^f w(1)}{E(1)} = \frac{w(2)}{E(2)} \ .$$

Combining these expressions with the resource constraints (c(1)=c(2)=y), the government budget constraints (equation 5 and 6), the balance of payments constraints (equation 7 and 8) and the cash-in-advance constraint (equation 4, with appropriate complementary slack condition, so that this constraint binds when w(3) is greater than zero) yields the equilibrium expressions for price levels, the nominal discount factor (and nominal interest rate) and exchange rates

A 8 $$P(1) = \min[\frac{a}{D}\frac{M}{y}, \frac{B(1)}{t(1+D)}]$$

A 9 $$P(2) = \min[a\frac{M}{y}, \frac{DB(1)}{t(1+D)}]$$

A 10 $$Q = \max[1, \frac{1-\frac{B(1)}{M}+\frac{a}{D}t}{1-at}]$$

A 11 $$E(1)P(1) = \frac{a}{1-a}\frac{1}{1+DQ}\frac{F(1)}{y}$$

A 12 $$E(2)P(2) = \frac{Q}{Q^f}\frac{P(2)}{P(1)}E(1)P(1)\ .$$

The properties discussed in the text follow directly from these expressions. Note that A 12 is an uncovered interest parity condition, and the first parts of A 8 and A 9 reflect the quantity equation reasoning that derives from the binding cash-in-advance constraint.

References

Auerbach, Alan and Maurice Obstfeld (2003) The Case for Open-Market Purchases in a Liquidity Trap. Mimeo, University of California at Berkeley, February.

Barro, Robert J. (1974) Are Government Bonds Net Wealth? *Journal of Political Economy* 81:1095-1117.

Bernanke, Ben S. (2000) Japanese Monetary Policy: A Case of Self-Induced Paralysis? In Posen, Adam and Ryoichi Mikitani, *Japan's Financial Crisis and Its Parallels to US Experience.* Institute for International Economics, Washington, DC, 149-166.

Buiter, Willem H. and Nikolaos Panigirtzoglou (1999) Liquidity Traps: How to Avoid Them and How to Escape Them. *NBER Working Paper 7245*.

Clouse, James et al. (2000) Monetary Policy When the Nominal Short-Term Interest Rate Is Zero. Federal Reserve Board, *Federal Reserve Board Finance and Economics Discussion Paper* 2000-51.

Cochrane, John (1998) A Frictionless View of Inflation. *NBER Macroeconomics Annual* 323-384.

Coenen, Gunter and Volker Wieland (2003) The Zero-Interest-Rate Bound and the Role of the Exchange Rate for Monetary Policy in Japan. Mimeo, Goethe University of Frankfurt, March.

Eggertsson, Gauti (2001) Committing to Being Irresponsible: Deficit Spending to Escape a Liquidity Trap. Mimeo, Princeton University.

Krugman, Paul R. (1998) It's Baaack! Japan's Slump and the Return of the Liquidity Trap. *Brookings Papers on Economic Activity* 2.

Krugman, Paul R. (1999) Time on the Cross; Can Fiscal Policy Save Japan? Mimeo.

Lebow, David E. (1993) Monetary Policy at Near-Zero Interest Rates. Federal Reserve Board *Economic Activity Working Paper Series Number 136.*

Lilico, Andrew (2002) The Liquidity Trap and Price-Level Targeting. *Economic Affairs* 22:47-52.

McCallum, Bennett T. (1999) Theoretical Analysis Regarding a Zero Lower Bound on Nominal Interest Rates. Mimeo, Carnegie Mellon University.

Meltzer, Allan H. (1999) Commentary: How Should Monetary Policy Be Conducted in an Era of Prices Stability? In *New Challenges in Monetary Policy*, Federal Reserve Bank of Kansas City Symposium.

Oda, Nobuyuki and Kunio Okina (2000) Further Monetary Easing Policies Under the Non-negativity Constraints of Nominal Interest Rates: Summary of the Discussion Based on Japan's Experience. Institute for Monetary and Economic Studies, Bank of Japan, *IMES Discussion Paper Series* 2000-E-24.

OECD (Organisation for Economic Cooperation and Development) (2000) *Economic Survey of Japan 1999/2000.* Paris.

Posen, Adam S. (1998) *Restoring Japan's Economic Growth*. Institute for International Economics, Washington, DC.

Sargent, Thomas J. and Neil Wallace (1981) Some Unpleasant Monetarist Arithmetic. *Federal Reserve Bank of Minneapolis Quarterly Review* 5(3).

Stevens, Glenn (2001) Comment on Svensson (2001). *Monetary and Economic Studies* 19(S-1):313-316.

Svensson, Lars E.O. (1999) Commentary: How Should Monetary Policy Be Conducted in an Era of Prices Stability? In *New Challenges in Monetary Policy*, Federal Reserve Bank of Kansas City Symposium.

Svensson, Lars E.O. (2001) The Zero Bound in an Open-Economy: A Foolproof Way of Escaping from a Liquidity Trap. *Monetary and Economic Studies* 19(S-1):277-312.

The Economist (2001) Deflation. November 17, 82-83.

Woodford, Michael (2001) Fiscal Requirements for Price Stability. *NBER Working Paper 8072.*

Figure 1: The nominal interest rate i

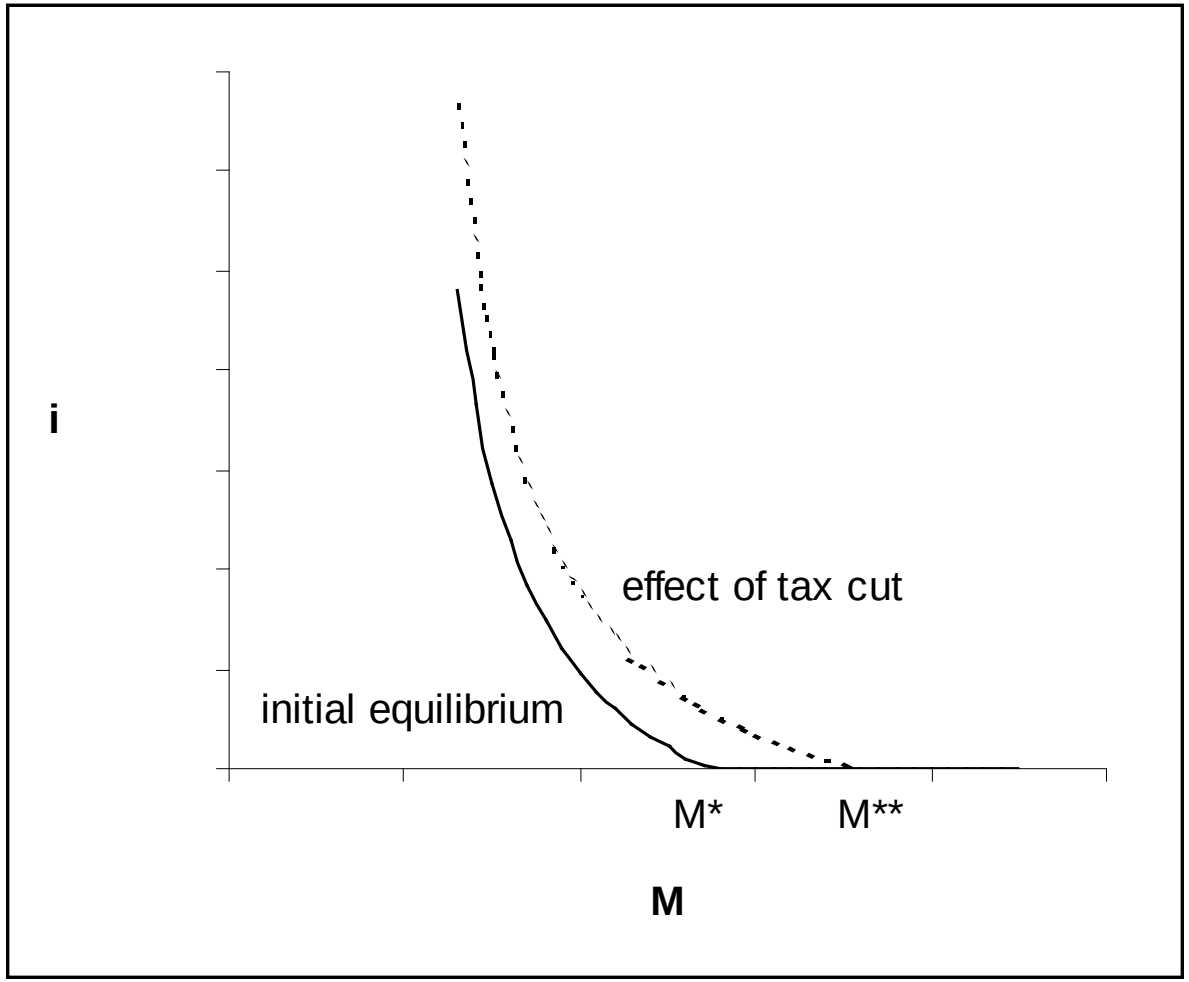

Figure 2: The price level P

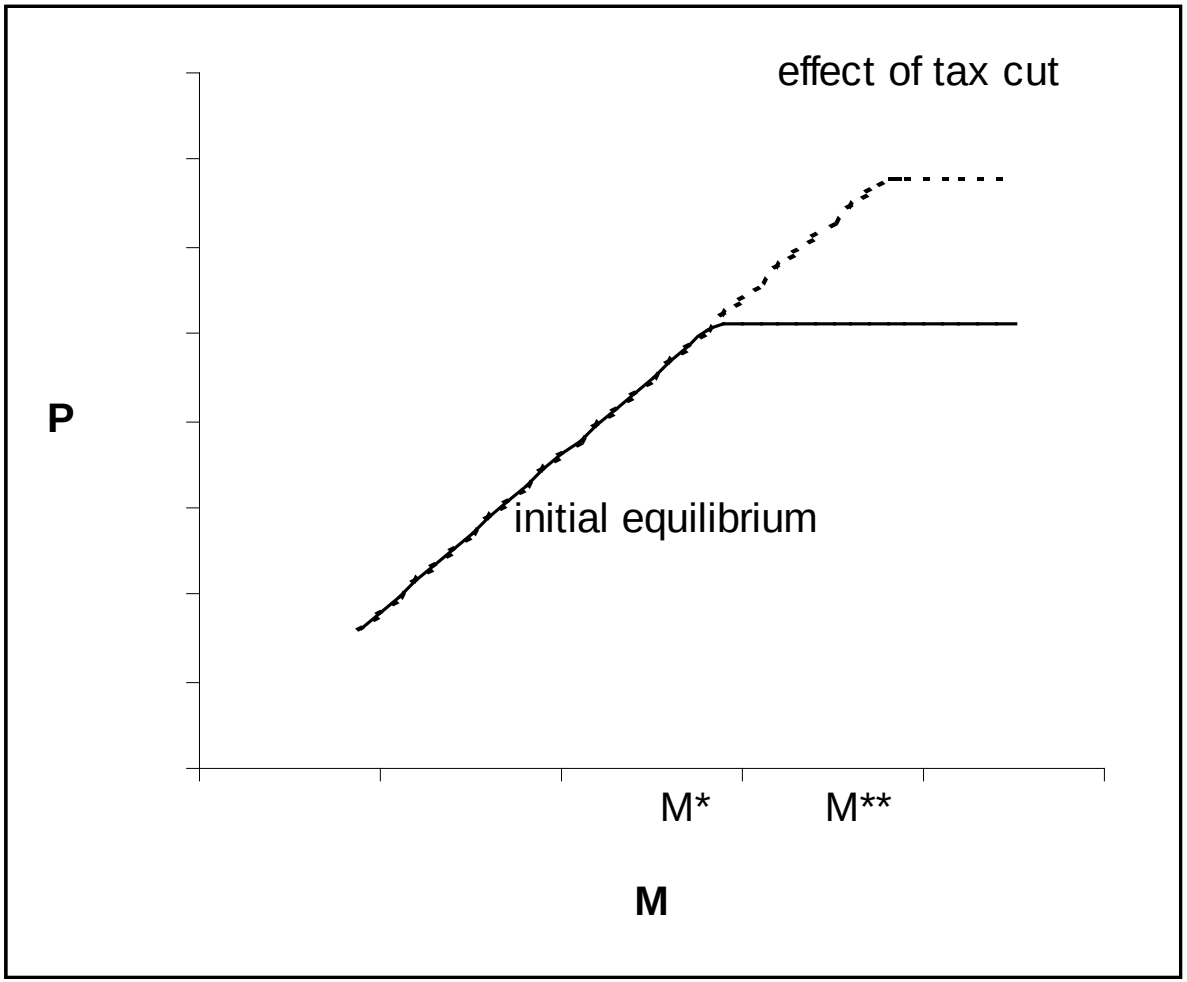

Figure 3: The real exchange rate E(1)P(1)