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The Liquidity Trap: Evidence from Japan

by
Isabelle Weberpals

Bank of Canada



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Isabelle Weberpals

International Department
Bank of Canada

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Abstract

Japanese economic activity has been stagnant since the collapse of the speculative asset-price bubble in 1990, despite highly expansionary monetary policy which has brought interest rates down to record low levels. Although several reasons have been put forward to explain the sustained weakness of the Japanese economy, none is more intriguing from the viewpoint of a central bank than the possibility that monetary policy had been largely ineffective because the Japanese economy entered a Keynesian “liquidity trap.” According to Keynes, the monetary authority would be unable to reduce interest rates below a non-zero positive interest rate floor if market participants believed that interest rates had reached bottom. Any subsequent monetary expansion, then, would lead investors to increase their holdings of idle cash balances and to become net sellers of government bonds.

This paper provides evidence on whether the Japanese economy entered a “liquidity trap” in the recent period, based on a money-demand framework. A Markov regime-switching approach is also used to determine whether the more recent response of money demand to interest rates can be characterized as a separate regime. In general, we do not find any support for the liquidity trap hypothesis. Moreover, we cannot conclude that the response of the demand for money to changes in interest rates was significantly different than in the past. However, we do find that through history the magnitude of the response of money demand to changes in interest rates has been relatively smaller in Japan, suggesting that traditional money demand relationships may not hold.

Résumé

L'activité économique piétine au Japon depuis l'éclatement de la bulle spéculative survenu sur les marchés financiers en 1990, en dépit d'une politique monétaire fortement expansionniste qui a fait baisser les taux d'intérêt à des niveaux records. Plusieurs raisons ont été avancées pour expliquer la faiblesse persistante de l'économie nippone, mais la plus curieuse du point de vue d'une banque centrale est la possibilité que la politique monétaire se soit largement avérée inefficace parce que l'économie était tombée dans une «trappe à liquidité» de type keynésien. Selon Keynes, l'autorité monétaire serait incapable de réduire les taux d'intérêt en deçà d'un niveau positif minimum si les participants aux marchés sont convaincus que les taux d'intérêt ont touché un plancher. Dans ce cas, toute augmentation ultérieure de la masse monétaire amènerait les investisseurs à accroître leurs encaisses oisives et à se défaire des titres émis par les administrations publiques.

L'auteure de l'étude cherche à déterminer, au moyen d'une analyse de la demande de monnaie, si l'économie nippone est tombée récemment dans une trappe à liquidité. Elle utilise aussi un modèle de Markov à changement de régime en vue d'établir si la réaction récente de la demande de monnaie aux taux d'intérêt peut être interprétée comme un régime distinct. De façon générale, l'auteure ne trouve aucun indice étayant l'existence d'une trappe à liquidité ni de preuve lui permettant de conclure que la réaction de la demande de monnaie aux variations de taux d'intérêt se soit nettement modifiée. Elle constate toutefois que la sensibilité de la demande de monnaie à ces variations a jusqu'ici été plus faible au Japon qu'ailleurs, ce qui donne à penser que la relation traditionnellement établie entre la demande de monnaie et les taux d'intérêt ne s'y vérifie peut-être pas.

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The Liquidity Trap: Evidence from Japan

“The rate of interest is a highly psychological phenomenon.”

- John Maynard Keynes

Introduction and Motivation

Since mid-1991, the Bank of Japan (BOJ) has used open-market operations to guide official short-term money market rates down from cyclical highs, reversing the earlier sharp increase in interest rates aimed at bursting the speculative asset-price bubble of the late 1980s. In particular, the uncollateralized overnight call loan rate, the primary day-to-day monetary policy instrument of the BOJ, has declined from the cyclical peak of just above 8 per cent in 1991 to a record low of 0.4 per cent in September 1995. Since then, the BOJ has allowed the call loan rate to remain, on average, below the official discount rate (which also reached a historic low of 0.5 per cent last September). This kept market interest rates at low levels while allowing the possibility of further easing through official interest rates. More recently, the BOJ has also utilized more specialized tactics, such as an increase in outright purchases of certificates of deposit and Japanese government bonds from financial institutions, aimed at reinforcing interest rate reductions and increasing liquidity in Japan’s fragile banking sector.¹ In addition, the BOJ has intervened heavily in foreign exchange markets, reportedly purchasing as much as \$60 billion in U.S. dollars in 1995, a large part of which is rumoured to have been unsterilized. The use of foreign exchange intervention was mainly aimed at countering the significant appreciation of the yen, which on a G-10 nominal effective basis appreciated by about 40 per cent between mid-1991 and September 1995, leading to a tightening of nominal monetary conditions of more than 1000 basis points over this period.

Despite the BOJ initiatives, which were supplemented by aggressive fiscal measures,² domestic economic activity in Japan was uncharacteristically weak over most of the recovery. Indeed, from late-1994 to mid-1995, annual real output growth averaged just 0.3 per cent, well below the average 3-4 per cent growth observed over past recoveries. While the latest recession

1. Jacob and Weberpals (1995) discuss these tactics in more detail.

2. Of note on the fiscal side, the government has implemented seven economic stimulus packages since August 1992; the direct contribution of these measures has totalled nearly 8 per cent of nominal GDP.

would have most likely been deeper without these measures, it would appear that aggregate output responded to traditional fiscal and monetary policy measures with considerably longer lags and less intensity than in the past. Although several explanations have been offered for this, none is more intriguing from the viewpoint of a central bank than the possibility that monetary policy had been largely ineffective because the Japanese economy had entered a “liquidity trap.”³

This paper provides some evidence on the question of whether the Japanese economy entered a liquidity trap in the recent period. The paper is divided into five sections. Section 1 provides background on the liquidity trap from the literature. Section 2 develops the money-demand function used to test for the presence of a liquidity trap and discusses the properties of the data used in testing, while Section 3 presents the empirical results. Section 4 applies a Markov regime-switching framework to the original model in order to determine whether the more recent response of money demand to interest rates can be characterized as a separate regime. Section 5 provides some concluding remarks and discusses avenues for further research.

In general, we do not find any support for the existence of liquidity trap in Japan during the 1991-95 period. Moreover, we cannot conclude that the response of the demand for money to changes in interest rates was significantly different than in the past. However, we do find that through history the magnitude of the response of money demand to changes in interest rates has been relatively smaller in Japan, suggesting that traditional money-demand relationships may not hold. We also caution that the results may be biased by the impact of past financial regulation and ongoing financial deregulation on money growth and domestic interest rates.

1.0 The Liquidity Trap: Some Background

The possibility that a liquidity trap may exist under certain conditions was first postulated by Keynes (1936). The idea has led to much debate in the literature, particularly after the *General Theory of Employment, Interest and Money* was first published and then again in the 1970s, two periods characterized by stagnant growth. In his two-asset world of cash and government bonds (the latter that proxy a typical government security for which the central bank can influence the rate of interest), Keynes argues that a liquidity trap would arise if market participants believed that

3. Other explanations include the possibility that the authorities should have been more aggressive earlier in the cycle. Also, Weberpals (1995) suggests that many of the “special” factors at play in the Japanese economy following the collapse of the speculative bubble in 1990 (of which the difficulties in the financial sector, balance sheet adjustments, widespread deflationary pressures, and historically high levels of unemployment are most significant), as well as the January 1995 Kansai earthquake and sarin gas attacks, may have combined to depress confidence levels to such an extent that consumers and investors chose to replenish savings and forego expenditures.

interest rates had bottomed out at a “critical” interest rate level,⁴ and that rates should subsequently rise, leading to capital losses on bond holdings. The inelasticity of interest rate expectations at a critical rate would imply that the demand for money would become highly or perfectly elastic (implying both a horizontal money-demand function and LM curve) at this point. The monetary authority, then, would not be able to reduce interest rates below the critical rate, as any subsequent monetary expansion would lead investors to increase their demand for liquidity and become net sellers of government bonds. Money-demand growth, then, should accelerate when interest rates reach the critical level. The short-run impact of a monetary expansion in the presence of a liquidity trap and under normal conditions is illustrated in Appendix 1.

The demand for real money balances (M_d/P), then, is a function of real aggregate income (Y) and the *spread* between the nominal interest rate (r) and the critical rate (\bar{r}), as shown in Equation 1. As such, money balances depend on how far away the nominal interest rate is away from the liquidity floor, rather than uniquely on the level of the nominal interest rate. This non-linear relationship would imply that, in the presence of a liquidity trap, as the nominal interest rate approaches the interest rate floor (i.e., $r - \bar{r}$ approaches 0), the interest rate elasticity would be greater than at higher interest rate levels. This is a generalization of a standard money-demand function, where \bar{r} equals zero.

Equation 1:
$$\frac{M_d}{P} = f(Y, r - \bar{r})$$

Interestingly, a large part of the research in this area focusses not on an empirical investigation of the possible existence of a liquidity trap, but rather on attempts to justify or refute the hypothesis that interest rates can be bounded from below at a positive level from a purely logical standpoint. For example, Patinkin (1974) doubts that Keynes believed that a liquidity trap could actually occur. Instead, he suggests that Keynes was really arguing that monetary policy could fail to stimulate economic activity if interest rates declined too slowly (i.e., more slowly than the reduction in the marginal efficiency of capital), especially if the interest rate elasticity of investment was low. In contrast, Grandmont and Laroque (1976) use a microeconomic general-equilibrium model to show that (in theory at least) a liquidity trap could arise. They contend that as interest rates fall to zero, the central bank must create increasing amounts of money through open-market operations to bring the bond market into equilibrium after consumers become net

4. Keynes believed that the economy could enter a liquidity trap when long-term bond rates reached 2 per cent.

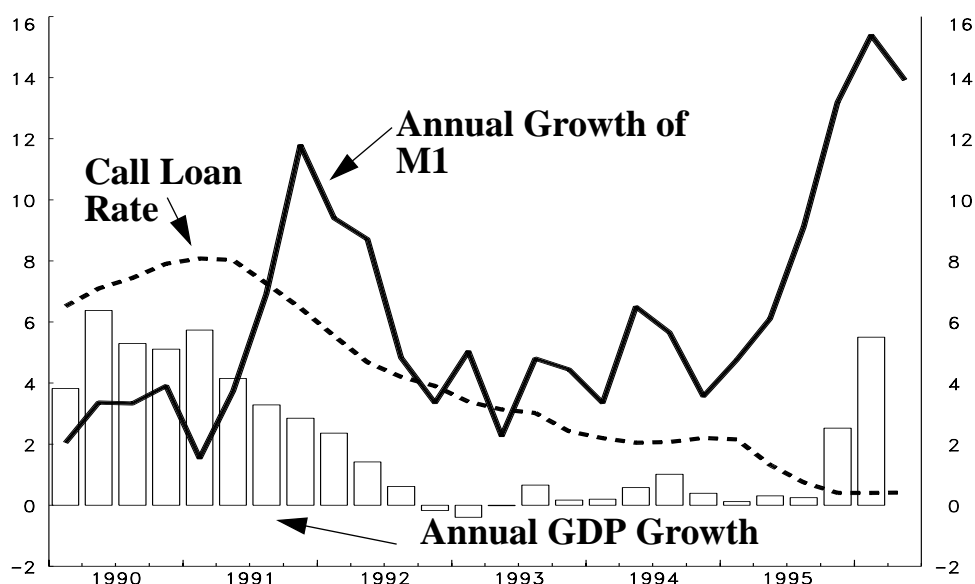
sellers of bonds.

Nevertheless, the limited body of empirical research has failed to provide any strong evidence that monetary policy may be ineffective in the short run if interest rates fall too low. Indeed, many of the earlier studies in this area (which deal exclusively with U.S. data), such as Bronfenbrenner and Mayer (1960), Pifer (1969), Barth, Kraft and Kraft (1976), firmly refute the existence of a critical interest rate and find no evidence that the interest rate elasticity of money increases as interest rates decline. On the other hand, other studies, such as Kostas and Khouja (1969), Eisner (1971), and Spitzer (1976) find evidence that a minimum rate does exist that is reasonably close to Keynes' (1936) original conjecture of 2 per cent, although Laidler (1985) suggests that this may be largely the result of a demand/supply identification problem. To the best of our knowledge, the Japanese case has not been considered.

1.1 The Liquidity Trap: Prima Facie Evidence from Japan

Recent trends in interest rates, the monetary aggregates and economic activity all appear to, prima facie, lend support to the liquidity-trap hypothesis in the Japanese economy. As shown in Graph 1, short-term interest rates (measured by the call loan rate) declined to record low levels in late-1995. At the same time, however, the growth in the narrow M1 monetary aggregate accelerated steadily, increasing from a low of about 2 per cent in 1993 to nearly 18 per cent after the call loan rate fell close to zero.

Graph 1: Recent Trends in Money, Interest Rates and Output



2.0 A Model for Money Demand in Japan

In the presence of a liquidity trap, the money-demand function should exhibit two important characteristics. First, the interest rate elasticity of money demand should be negatively correlated to the level of interest rates. In other words, as interest rates decline, the interest rate elasticity of demand should rise as the money-demand function becomes perfectly elastic. In the case of Japan, then, we should expect, a priori, to observe a relatively high interest rate elasticity (i.e., a large negative number) since interest rates are currently at 0.5 per cent. Second, the money-demand function should show evidence of a liquidity floor that is both positive and significant. Referring again to Appendix 1, we are, in effect, looking for evidence that the money-demand function has become horizontal at \bar{r} . These characteristics are our criteria for rejecting or accepting the liquidity trap hypothesis.

As a basis for testing, we construct a simple money-demand equation of the general form specified in Equation 1. Previous work has suggested that results can differ according to the monetary aggregate used (i.e., narrow or broad). We would have liked to apply the methodology to several monetary aggregates (specifically M1, M2+CDs, and broad liquidity in the Japanese case). However, we were severely constrained in our choice by the high degree of financial regulation in the Japanese economy until the mid- to late-1980s.⁵ Financial regulation appears to have most affected the financial instruments contained in the broader aggregates (term deposits and other administered-rate products, government bonds, etc.), so that the use of a broader aggregate in our analysis might further contaminate the results. As a result, we attempt to model only the narrow M1 money aggregate as a function of real output (as measured by real GDP) and the uncollateralized call loan rate, since among the domestic short-term interest rates available, this was found to be one of the least regulated interest rates over the full sample period.⁶ From a theoretical perspective, this is ideal, since we are trying to quantify the direct impact of monetary policy, which should be most evident from the overnight rate and a narrow monetary aggregate. Moreover, the liquidity trap hypothesis argues that there should exist a trade-off between bonds and cash (or zero-interest bearing demand deposits), and again this would be most evident from a narrow monetary aggregate.

5. A model of M2+CDs, for example, would have required the use of call loan rate *and* the M2+CD “own interest rate,” such as term deposit rate. Term deposits, however, were not introduced until 1979 and were not completely liberalized until 1989.

6. An alternative would be the 3-month *gensaki* or “repo” rate. However, data is only available from February 1977. A comparison of the *gensaki* rate with the call loan rate shows that the two rates are nearly identical and the use of the *gensaki* rate in the estimation of the M1 money-demand equation yields similar results.

Nevertheless, it could be argued that the high degree of regulation in other parts of the financial market and the extensive use of window “guidance” by the Bank of Japan until 1982 could have indirectly affected the relationship of M1 to the call loan rate. As such, all results should be interpreted with caution.

Unit-root tests—the Augmented-Dickey Fuller (ADF) test and the $MZ\alpha$ test, a modified version of the Phillips-Perron $Z\alpha$ test proposed by Stock (1991)—suggest that real M1 and real GDP are non-stationary in levels, but are found to be stationary in first differences, that is I(1). The call loan rate, on the other hand, is found to be stationary in levels, that is I(0), based on the $MZ\alpha$ test. The ADF test, however, finds the call loan rate to be I(1). Since Schwert (1986) shows that the ADF test has limited finite-sample power, the call loan rate is treated as I(0) for our purposes. The results of these tests are shown in Appendix 2. As such, we are constrained to examining the short-run dynamics of money, output, and interest rates. This does not pose a problem since the liquidity trap is a short-run property of the money-demand function. Thus, the model of real money balances to be used in testing is Equation 2.

Equation 2:

$$\Delta \log\left(\frac{M1_t}{P_t}\right) = \beta_0 + \sum_{i=1}^m \left(\beta_i \Delta \log \frac{M1_{t-i}}{P_{t-i}}\right) + \sum_{i=0}^n (\alpha_i \Delta \log Y_{t-i}) + \sum_{i=0}^p \gamma_i \log(r_{t-i} - \bar{r}) + \mu_t$$

Notice that Equation 2 is a log-log specification, where all variables, including the interest rate, are in logs. We acknowledge that this may introduce a bias towards finding a low interest rate elasticity, since most of the observations for the call loan rate would be concentrated around the steeper portion of the money-demand function. As an alternative, we estimated Equation 2 using a semi-log specification (i.e., using the level of the call loan rate). We found that the parameter estimates were not significantly different than the log-log specification. However, the estimate for \bar{r} was found to be unsatisfactory. For this reason, our results are based on a log-log specification, but we acknowledge that the results may potentially be biased against finding evidence of liquidity trap. The results from the Markov regime-switching model described in Section 4 and the kinked money-demand function estimated by Weberpals (1995) should take account of this problem.

Given the presence of the critical interest rate, \bar{r} , in Equation 2, we cannot use ordinary least squares (OLS) to estimate the parameters β_0 , β_i , α_i , γ_i , and \bar{r} simultaneously because of an

identification problem. Instead, we use a maximum-likelihood estimation in a two-step approach proposed by Pifer (1969). In Step 1, starting point values for β_0 , β_i , α_i , and γ_i are determined by OLS estimation with \bar{r} arbitrarily set to a positive interest rate floor that does not exceed the minimum interest rate observed over history (0.8 per cent in our sample) such that $\bar{r} < r_{\min}$.⁷ In Step 2, we use these starting point values in a maximum-likelihood estimation to simultaneously determine all parameter estimates. Estimates are determined by maximizing the value of the log-likelihood function or equivalently minimizing the variance of the residuals. Steps 1 and 2 are repeated for different starting point values based on a range of values for the arbitrary interest rate floor, not violating the condition that $\bar{r} < r$. In other words, we scan through the range $0 \leq \bar{r} < 0.8$ in ten-basis-point increments. Note that \bar{r} must be less than r for the logarithm of $r - \bar{r}$ to be defined.

3.0 Empirical Results

Based on the model and the methodology described above, two alternative models were found to maximize the value of the log-likelihood function (relative to other models of varying lag length). These results along with selected residual diagnostic test statistics are presented in Appendix 3.⁸ Both models are estimated without BASE and with RMIN, a variable for a critical interest rate. However, the two models (referred to as Model 1 and Model 2), give two very different estimates of the interest rate floor (\bar{r}), thus highlighting the fact that the results are sensitive to model specification. The results for both models are also found to be very sensitive to the sample size used, most likely a result of model instability. Bearing in mind that the results are not entirely robust, we can make the following observations.

Consider first Model 1 for the BASE case.⁹ When the model is estimated without an interest rate floor, M1 growth is found to be largely determined by lagged money growth and contemporaneous and lagged real GDP growth. The parameter estimate of the log of the interest rate (contemporaneous value only), although significantly different from zero,¹⁰ is found to be

7. We use a sample that ends before interest rates were lowered to record lows in order to search over a larger set of arbitrary values that *includes* the record low interest rate of 0.5.

8. This was done with the Bank of Canada's residual diagnostic test procedures. See Amano and van Norden (1991).

9. The residuals from the BASE and RMIN cases for Model 1 appear to be well behaved, except for some evidence of skewness. The residual tests used include the Lagrange-Multiplier test for serial correlation (of orders 1 to 4), the Engle test for autoregressive conditional heteroskedasticity (ARCH) (of orders 1 to 12), the Jarque-Bera test for normality, tests for skewness and kurtosis, and the RESET test for the omission of explanatory variables and misspecified functional form. In addition, sequential Chow tests admit some evidence of instability. These results are shown in Appendix 5.

10. All parameter estimates, and residual diagnostic and parameter stability test statistics are significant at the 10 per cent level.

extremely small (-0.009), suggesting that a significant reduction in interest rates is required to stimulate M1 growth. Conversely, this also implies that a relatively small change in M1 growth would result in significant changes in short-term interest rates. Based on this model, the reduction in interest rates from 8 per cent to 0.5 per cent would lead to an acceleration in M1 growth of only 3.5 per cent. When \bar{r} is introduced into the model, the maximum-likelihood estimates do not change markedly. However, only lagged money growth is found to be significantly different from zero. Moreover, while the model shows evidence that a positive interest rate floor exists (approximately 0.6 per cent), it is not found to be significantly different from zero. This is broadly consistent with similar work using U.S. data (for example, Pifer 1969 and Eisner 1971), where a positive interest rate floor was also found but was determined to be insignificant. As noted above, the second characteristic of a liquidity trap is that the interest rate elasticity of money demand should increase (in absolute terms) as the interest rate falls to zero. Based on Model 1, we calculate the interest rate elasticity through time in a series of rolling regressions. As shown in Appendix 4, the interest rate elasticity in Model 1 is found to have *decreased* since 1986, approaching zero.

In sum, although we find some evidence of a positive interest rate floor, Model 1 does not convincingly support the existence of a liquidity trap given that (1) the estimate of the interest rate floor is insignificant, (2) the interest rate elasticity of money demand has decreased as interest rates have approached zero, and (3) the interest rate elasticity of money demand is near zero, implying the money-demand function is nearly vertical instead of horizontal.

As an alternative, consider the results of Model 2, which are also shown in Appendix 2. Model 2 simply adds one lag of the log of the interest rate to Model 1, while dropping the contemporaneous growth rates of real GDP. This simple modification results in a somewhat higher value of the log-likelihood function, and also increases the significance of the explanatory variables in the model, implying that Model 2 is statistically superior to Model 1.¹¹

While at first glance these modifications appear to be minor, they help illustrate a very important point. When the interest rate floor is introduced into Model 2, the value of \bar{r} that maximizes the value of the log-likelihood function is estimated to be *negative* (-0.7),¹² implying that interest rates would have to fall below zero before monetary policy becomes ineffective. This

11. Note that the coefficient of the contemporaneous value of the interest rate increases markedly relative to Model 1, but that the first lag of the interest rate has a positive coefficient, implying different short-run dynamics than Model 1. The interest rate elasticity is fairly similar across both models.

12. We obtain this result for every starting value of the interest rate floor used in Step 1.

has little intuitive appeal since depositors would prefer to hold their interest-bearing deposits as cash (at an interest rate of zero) instead of receiving a negative interest payment.¹³ As such, these results can be interpreted to mean that a positive and statistically significant interest rate floor is not found, illustrating that a simple modification to Model 1 significantly changes the value of the estimated critical interest rate. This casts some doubt on the robustness of the estimation approach. Model 2 also shows that the interest rate elasticity of money demand is negatively correlated with interest rates over the most recent period.¹⁴

4.0 Markov Regime-Switching Model of Money Demand in Japan

The maximum-likelihood parameter estimates of a single money-demand equation (as specified by Model 1 and Model 2) show evidence of instability, thus leaving us unable to reject the liquidity-trap hypothesis with certainty. This result is hardly surprising, given that since the early 1970s a large number of structural changes have occurred in the Japanese economy, many of them related to the gradual deregulation of Japanese financial markets.¹⁵ In addition, the sharp appreciation of the yen and the deregulation of import markets have contributed to the current deflationary environment. Thus, it appears reasonable to suppose that the money-demand relationship may indeed be characterized by several regimes rather than by a single equation.

Consequently, we attempt to characterize a Japanese money-demand equation by a Markov regime-switching model, first proposed by Goldfeld and Quandt (1973), in order to identify two separate regimes given by:

Regime 1:

$$\Delta \log \left(\frac{M1_t}{P_t} \right) = \beta_{1,0} + \sum_{i=1}^m \left(\beta_{1,i} \Delta \log \frac{M1_{t-i}}{P_{t-i}} \right) + \sum_{i=0}^n (\alpha_{1,i} \Delta \log Y_{t-i}) + \sum_{i=0}^p \gamma_{1,i} \log(r_{t-i} - \bar{r}) + \mu_{1,i}$$

where $\mu_{1,i} \sim N(0, \sigma_{1,i})$;

Regime 2:

$$\Delta \log \left(\frac{M1_t}{P_t} \right) = \beta_{2,0} + \sum_{j=1}^m \left(\beta_{2,j} \Delta \log \frac{M1_{t-j}}{P_{t-j}} \right) + \sum_{j=0}^n (\alpha_{2,j} \Delta \log Y_{t-j}) + \sum_{j=0}^p \gamma_{2,j} \log(r_{t-j} - \bar{r}) + \mu_{2,j}$$

13. However, Black (1995) suggests that if short-term instruments are viewed as options, then nominal interest rates can be negative.

14. The residuals from Model 2 also appear to be non-normal and serially correlated, and parameter estimates are found to be unstable.

15. This is in addition to significant financial innovations that have occurred in international financial markets, contributing to unstable money-demand relationships in other countries.

where $\mu_{2,i} \sim N(0, \sigma_{2,i})$

For each regime, a maximum-likelihood method as detailed in Hamilton (1989), which uses a set of Gauss procedures developed by van Norden and Vigfusson (1996), is used to estimate the parameters (β , α , γ , and \bar{r}), given an unobserved state variable. Ultimately, we would like to find evidence of two interest rate regimes: a high- and a low-interest rate regime. The transition probabilities (or the conditional probabilities of switching from between the two regimes) are also estimated and are assumed to follow a first-order Markov process.¹⁶ For simplicity, we use the same model specification in each regime.¹⁷ The results of the maximum-likelihood estimation (based on approximately 100 estimation attempts with different starting point values) for the BASE and RMIN cases are shown in Appendix 6. Note that the specification is found to be best characterized by Model 1, described in Section 2.

In the BASE case, two regimes are identified. In Regime 1, parameter estimates are broadly similar to those obtained for Model 1, although real output growth appears to be more important. In Regime 2, the coefficients on both contemporaneous and lagged real output growth are negative. Although this may appear inconsistent with our priors, an examination of the graph in Appendix 7, which plots the call loan rate against the smoothed probabilities of being in Regime 1, we see several episodes where the probability of being in Regime 1 is very small: namely, the early 1960s, early- and mid-1970s, and briefly during each of the recessions in the 1980s and the 1990s. Each of these episodes is characterized by extreme volatility, where the expected relationship between money and output does not hold. Simple correlation coefficients over these periods confirm that the relationship is indeed negative. The regime-switching model, then, has grouped these periods as one regime, so we are left with another regime (Regime 2) which should, in effect, result in parameter estimates that are “uncontaminated” by these special episodes. Using this argument, the application of a regime-switching framework has already provided an interesting insight. Notice that the interest rate elasticity of money demand remains small (although significant) in both regimes, and that the move to a low interest rate environment during the 1990s does not affect the probability of being in Regime 1. In other words, the reduction in the call loan rate to 0.5 per cent has not contributed to a change in the relationship between money demand and interest rates.¹⁸

16. See van Norden and H. Schaller (1993) for a more detailed explanation of a Markov regime-switching model.

17. If the results appear promising, it may be beneficial to explore the possibility that the model specification varies in each regime.

18. Notice that we obtain this result prior to introducing \bar{r} in the model.

When \bar{r} is introduced into the model (RMIN in Appendix 6), the parameter estimates are virtually unchanged, suggesting that if a liquidity trap does exist, its impact on the model dynamics are insignificant.¹⁹ Based on a log-likelihood-ratio test statistic of 0.3 (which is chi-square-distributed with one degree of freedom), however, the restricted model with \bar{r} is clearly not rejected. The values of \bar{r} that maximize the value of log-likelihood function are both negative, and positive values for \bar{r} were found to result in the lowest values for the log likelihood function. We interpret this finding to mean that a positive critical interest rate cannot be found.²⁰

4.0 Concluding Remarks

Based on a traditional M1 money-demand function and a Markov regime-switching model of M1 money demand, both modified to allow for the possibility of an interest rate floor, we do not find any firm evidence that the Japanese economy has entered a Keynesian liquidity trap.²¹ In particular, we do not find evidence that (1) a positive and significant interest rate floor exists, or that (2) the interest rate elasticity of money demand increases in absolute terms as the call loan rate declines to 0 per cent. Instead, we find that the interest rate elasticity of money demand is very small, implying that the money-demand function is nearly vertical, not horizontal as would be required by the liquidity trap hypothesis, and that this has not changed significantly over the sample period. This would imply that, in general, changes in interest rates can have only a limited impact on the growth of money demand (and ultimately on output growth).

Although these results are obtained from money-demand functions that are somewhat unstable over time and are based on data that may be influenced by government financial controls, this result still has important implications for the conduct of monetary policy. These results suggest that monetary policy, in general, has a limited impact in Japan, a finding that presents a major challenge for the Bank of Japan. While this result is consistent with the recent Japanese experience, and may indeed explain why the significant reduction in interest rates failed to

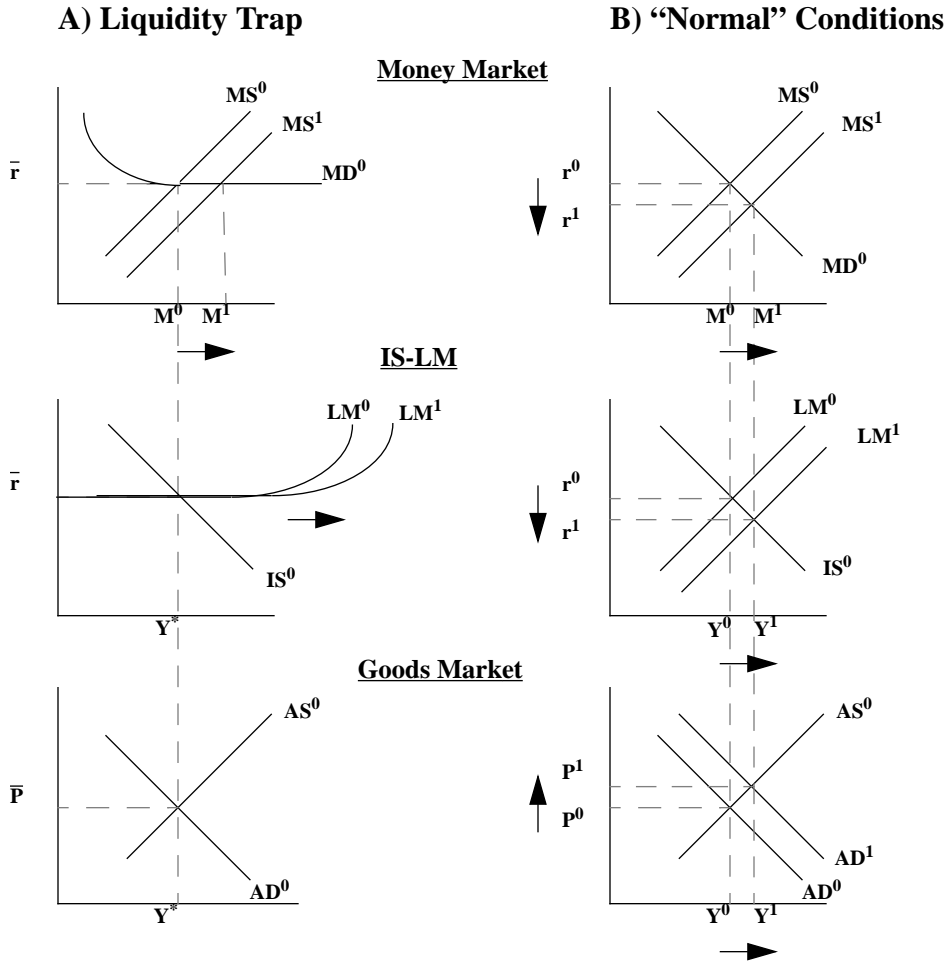
19. Because of the difficulty in estimating \bar{r} and the other coefficient estimates simultaneously in Gauss, \bar{r} was selected using a grid search over a range of possible values for \bar{r} in both regimes, where possible values were determined according to results obtained in Section 2. Negative values were therefore considered.

20. Note that a test for higher-order Markov effects suggests that the transition probabilities for Regime 2 may be better characterized by higher-order effects. As Vigfusson (1996) notes, estimation would become significantly more difficult. The value added from altering our assumptions is questionable, given that higher-order effects appear significant only for the regime with the lowest frequency.

21. Indeed, recent revisions to real GDP growth in the second part of 1995 and a surge in growth in the first quarter of 1996 may provide some further evidence that a liquidity trap does not exist in Japan, since output appears to be expanding at current low interest rates. However, it is difficult to separate the precise impact of expansionary fiscal and monetary policy on growth in Q1.

stimulate aggregate demand, it nevertheless appears inconsistent with other experiences where the monetary policy stance was an important determinant of aggregate output. This suggests that the characteristics of the most recent episode are unique. Indeed, the collapse of the speculative asset-price bubble had a significant adverse impact on the balance sheets, and subsequently on the confidence, of consumers, firms and financial institutions. At the same time, corporate restructuring and the ongoing yen appreciation contributed to important employment and wage adjustments, further depressing confidence and encouraging savings. Together, these factors may have outweighed the benefits of stimulative monetary and fiscal policy. Alternatively, the sluggish response of output to changes in interest rates may also imply that policy lags have become longer than in the past. Even though the data do not support the liquidity trap hypothesis, these possibilities are worth pursuing, since there appears to have been some shift in the way output responds to changes in monetary policy.

Appendix 1: Short-Run Impact of a Monetary Expansion in the Presence of a Liquidity Trap



Appendix 2: Unit-Root Test Results

Table 1: Unit-Root Test Results^a (1962Q1 to 1995Q3)

Ho: $y_t = \rho y_{t-1}$, for $\rho = 1$

	Log Levels				First Difference (logs)			
	k	trend	ADF	MZ α	k	trend	ADF	MZ α
M1/P	1	yes	-2.858 (-3.150)	-4.720 (-17.500)	1	no	-5.065 (-2.580)	-83.380 (-11.000)
Y	3	yes	-2.097 (-3.150)	-1.617 (-17.500)	2	no	-2.960 (-2.580)	-102.730 (-11.000)
r	1	no	-0.549 (-2.580)	-14.787 (-11.000)	-		-	-

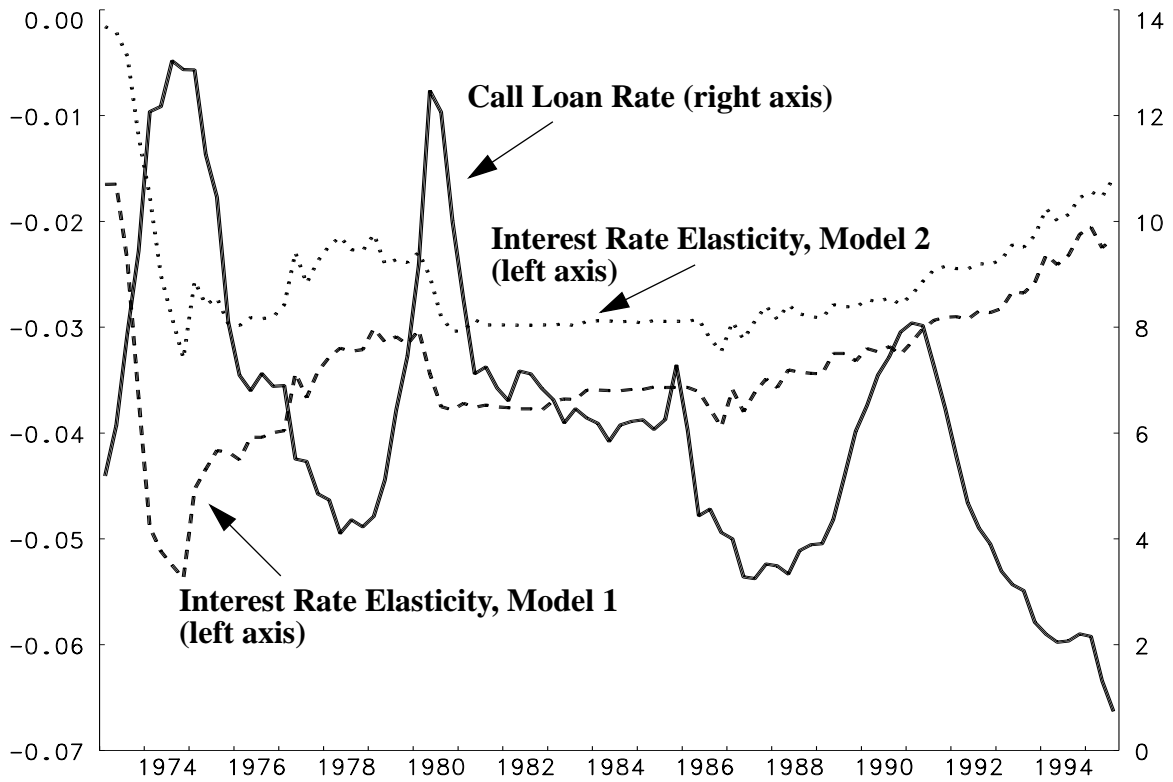
a. All tests use a constant term. Critical values at the 10 per cent significance level are in parentheses.

Appendix 3: Parameter Estimates and Summary Statistics¹

	Model 1		Model 2	
	BASE	RMIN	BASE	RMIN
Constant	0.020 (2.793)	0.016 (0.910)	0.008 (1.117)	0.001 (0.820)
M1D {1}	0.278 (3.235)	0.274 (3.594)	0.303 (3.884)	0.308 (4.432)
GDPD {0}	0.233 (1.424)	0.288 (1.471)	-	-
GDPD {1}	0.324 (2.030)	0.316 (1.745)	0.478 (3.222)	0.484 (2.808)
INT {0}	-0.009 (-2.301)	-0.007 (-0.997)	-0.055 (-4.136)	-0.064 (-2.035)
INT{1}	-	-	0.052 (3.681)	0.060 (2.100)
\bar{r}	-	0.545 (0.200)	-	-0.691 (-0.269)
MAXLIK VALUE	469.598	469.764	471.477	474.993
LM(4)	3.042 (0.551)	3.021 (0.554)	12.061 (0.017)	11.731 (0.020)
ARCH(4)	2.403 (0.662)	2.416 (0.660)	3.662 (0.454)	3.849 (0.427)
ARCH(12)	5.599 (0.935)	5.612 (0.934)	7.306 (0.837)	7.426 (0.828)
Skewness	0.438 (0.039)	0.444 (0.036)	0.414 (0.050)	0.401 (0.058)
Kurtosis	0.247 (0.565)	0.255 (0.553)	0.613 (0.153)	0.619 (0.150)
Jarque-Bera	4.498 (0.105)	4.629 (0.099)	5.547 (0.062)	5.327 (0.070)
RESET(2-4)	0.318 (0.813)	0.361 (0.781)	0.414 (0.743)	0.134 (0.940)

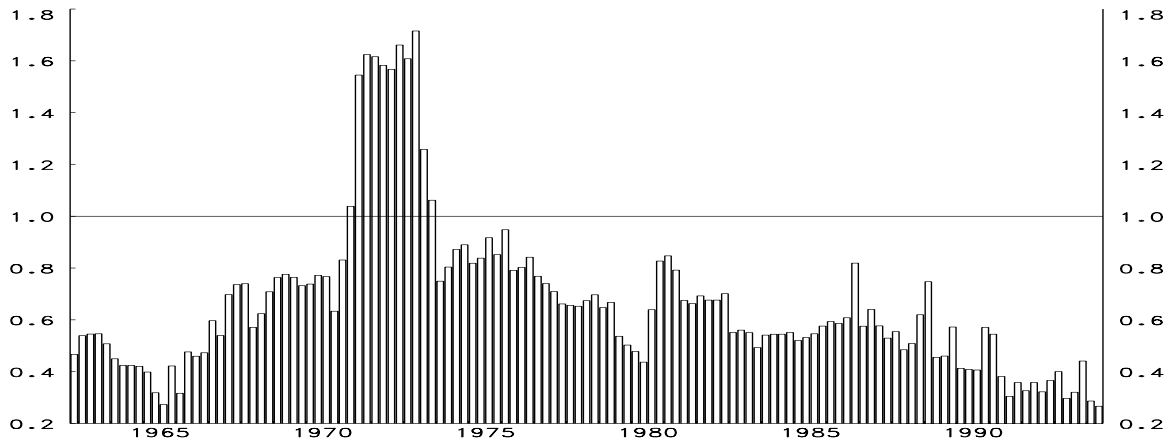
-
1. Parameter estimates are accompanied by t-statistics. Selected summary statistics and residual diagnostic test statistics are also presented, accompanied by significance levels. Parameter estimates and test statistics *not* significant at the 10 per cent level are highlighted.

Appendix 4: Money-Demand Equations and Interest Rate Elasticities (Rolling Regressions)

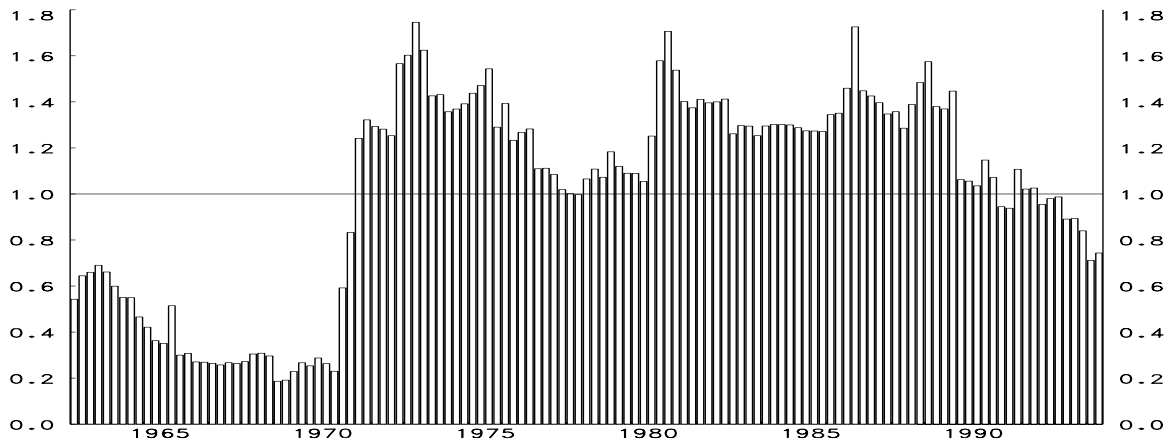


Appendix 5: Rolling Chow Test Statistics

MODEL 1



MODEL 2



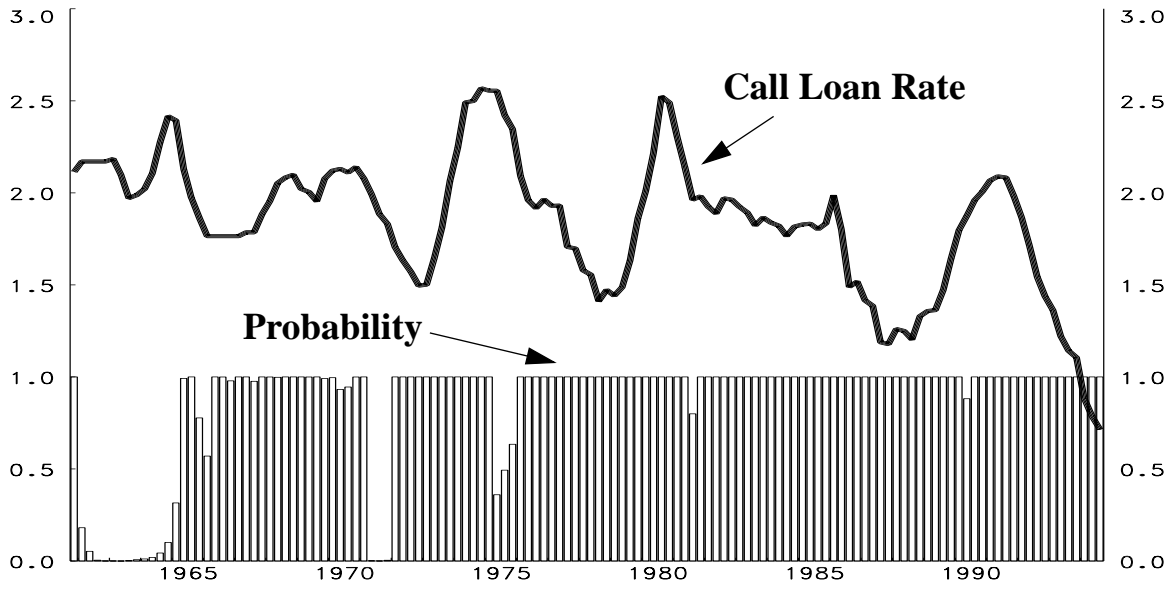
Appendix 6: Markov Regime-Switching Results

	BASE		RMIN	
	Regime 1	Regime 2	Regime 1	Regime 2
Constant	0.029 (3.830)	0.158 (7.587)	0.039 (3.823)	0.180 (7.297)
M1D {1}	0.074 (0.851)	0.417 (5.143)	0.070 (0.798)	0.412 (4.986)
GDPD {0}	0.486 (3.018)	-0.316 (-2.967)	0.485 (3.015)	-0.319 (-3.080)
GDPD {1}	0.352 (2.266)	-1.080 (-8.163)	0.347 (2.234)	-1.084 (-8.282)
INT {0}	-0.016 (-3.608)	-0.050 (-5.647)	-0.020 (-3.617)	-0.058 (-5.714)
Degree of Persistence	1.889 (5.857)	0.825 (2.028)	1.891 (6.035)	0.832 (2.082)
Standard Deviation	0.017 (13.711)	0.0044 (5.335)	0.017 (13.825)	0.0043 (5.378)
RMIN	-	-	-1.1	-0.2
MAXLIK VALUE	367.545		367.687	

White's Misspecification Tests

AR(1)	2.642 (0.104)	0.120 (0.729)	2.740 (0.098)	0.139 (0.709)
ARCH(1)	0.257 (0.612)	1.462 (0.227)	0.274 (0.601)	1.010 (0.315)
Higher-Order Markov Effects	0.316 (0.574)	4.554 (0.033)	0.308 (0.5794)	4.448 (0.034)

Appendix 7: Smoothed Probabilities of Being in Regime 1 and the Call Loan Rate



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