No. 434

Statistical Inference of the Japanese M1 and M2 Money Demand Functions

Tsunemasa Shiba

June 1990

---

[1] I am grateful to Hiroki Tsurumi and Kazuo Sato for their helpful comments. Earlier versions of this paper were presented at the 1989 Far Eastern Meeting of the Econometric Society, June 11, 1989, Doshisha University, and at a workshop on Money Demand, January, 1990, Bank of Japan, sponsored by the Tokyo Center for Economic Research. I appreciate comments made by Koichi Hamada, Hiromi Katoh, and the participants of the two meetings. Grants from the Japan Securities Scholarship Foundation, and from the Nihonkai Keizai Kenkyusho, University of Toyama, are gratefully appreciated.

1 Introduction

I investigate Japanese M1 and M2 plus CD (M2CD hereafter) money demand functions for the sample period, 1955 to 1988 in this paper. M1 is the most basic definition of money, and many prominent money demand theories such as the Baumol-Tobin money demand theory, have been built around it. Besides, practically all empirical money demand studies in the U.S. deal with M1. M1 has been important in empirical studies in the U.S. [1] because the FED has targeted it until late in the 70's. While in Japan, as the Bank of Japan started to announce its forecasts in 1978 [see Hamada and Hayashi (1985,p.99)] M2CD is the most watched monetary targets. Tsutsui and Hatanaka (1982), Ishida (1985), Komura (1985), Shinkai (1985), Hamada and Hayashi (1985), Furukawa (1985), Kama (1986), Ueda (1988), Baba (1989), and Yoshida (1989), among others have *mainly* dealt with M2CD money demand functions for various different sample periods. Both M1 and M2CD demand functions are dealt with in this paper.

Evidently, a single money demand function may not be capable of explaining the Japanese money demand from the high growth rate era of the 60's to the present. In this paper, I find several regime shifts in the Japanese money demand, since early 60's to the present in both M1 and M2CD. In this paper, structural changes are identified by combining: what historical facts indicate, what descriptive statistics of economic variables imply, and which hypothesis various test statistics for structural change support. I combine these factors to identify join points, since if I used statistical hypothesis testing methods such as the Chow test, in an isolated manner then I would have ended up with dispensing prior information in the form of historical facts. Moreover, if I keep in mind of dates of major financial institutional changes and policy shifts, it seems that I could draw more concrete results out of descriptive data analysis of the variables used in this paper. Accounting for structural changes, I find the real partial adjustment model *a la* Goldfeld (1973) with appropriate interest rate variable, to be solid in terms of sign conditions, significance of estimated coefficients and tests of misspecifications. Estimated money demand function displays a remarkably solid forecasting ability in the 80's. In particular, the M2CD function for

---

[1] In his study of income velocity, Poole (1988) uses M1 saying that M1 and M2 growth rates of one subperiod to another are quite similar. He acknowledges that the two series have different secular trends, however. This view may suggest that M2 money demand functions also should be entertained in the U.S., where most money demand studies use M1.

the 80's in this paper, tracks the rapid growth of Marshallian K_2 after 1986.

Detection of structural change(s) is the main issue of this paper. In conjunction with examination of historical facts and descriptive data analysis,I will be concerned with such tests of significance as heteroskedasticity, autocorrelation, non-normality of residuals, since these are clearly signs of misspecification. Other than these tests of residuals, I use tests in simultaneous equations context. This is needed because it is possible that demand for and suppy of money constitute a simultaneous system of equations [see Cooley and LeRoy (1981) for a pessimistic view on identifiability of money demand function]. If so, then I ought to select an appropriate estimation procedure to deal with possible simultaneous bias, and at the same time try to exclude just enough number of exogenous variables from the equation of interest, i.e., try not to overidentify the equation. Finally, there is an issue of whether the partial adjustment process is in real terms or in nominal terms? Nonnested tests are suitable tests to investigate this issue. Nonnested tests may also be used to select an interest rate variable. In each test in this paragraph, I may use more than one statistic, since each has different maintained hypothesis in general.

The conventional partial adjustment model specification is used in this paper, since it seems that there have not been many theoretical developments[2] that offer explanatory variables other than income and interest rates. In the partial equilibrium setting, a model by Akerlof and Milbourne (1980) that uses the s-S inventory model approach, is of particular interest to those who

---

[2] Romer (1986) extends the Baumol-Tobin model in a general equilibrium continuous time model. His money demand model implies "a rather conventional demand for money" [Blanchard and Fischer (1989, p.176)], however. Lucas (1988), also derives a money demand relationship that has short term interest rate and the permanent income in a discrete finite horizon program with an utility function that is constant relative risk aversion of degree one in terms of consumption. These and other theoretical works [see Fischer (1988)] employ the Clower or cash-in-advance constraint so that a riskless asset such as money end up being held as a result of optimization process. The cash-in-advance constraint implies an unitary velocity. Svensson (1985) relaxed unitary velocity aspect of the cash-in-advance constraint by introducing uncertainty in individual's spending. A totally different approach for money demand in a general equilibrium setting would be to introduce real balance as an argument in the utility function. Blanchard and Fischer (1989, p.192), however, pointed out that we may not know what restrictions to impose on the utility function in such setting. Finally, McCallum and Goodfriend (1988) obtained a money demand function with the income and interest rate as two arguments, by not using the cash-in-advance constraint but by introducing the variable s, shopping time, which is related to leisure, l, as $s=1-l$, where total available time for an individual is normalized to be one.

investigate money demand empirically. They supply possible reasons why short run income elasticity of money demand may be "quite small" [Akerlof and Milbourne (1980, p.157)]. In addition, within the context of the partial adjustment model, distinction between the real partial adjustment process (RPAM) and the nominal partial adjustment process (NPAM) may be important as recently demonstrated by Fair (1988)[3] who obtained estimation results mostly in favor of the NPAM using time series data of 29 countries. In this paper I present nonnested test results to see which of the two processes is supported by data. Finally, it should be noted that a partial adjustment process is one of the many dynamic linear regression (DLR) models [Spanos (1986, p.552)]. Among the many models of DLR is the error correction model (ECM). I would regard the ECM as an appropriate specification when the following two conditions are satisfied: (1) all the underlying variables have at least one unit root, and (2) they are co-integrated. I have carried out tests for (1) and (2) using the variables used in this paper, and it turned out that the ECM is not called for, i.e., tests did not support unit root and co-integration.[4]

The plan of this paper is as follows: in section 2, I present descriptive

---

[3] Fair's result supports the RPAM for Japan, however. Goldfeld and Sichel (1987) and Spencer (1985), among others, discuss the issue of the RPAM versus NPAM. The partial adjustment process (PAM) has come under heavy criticisms. Pagan (1985), after giving a brief survey of the issue, points out that the PAM is particularly suspicious when the economic variable under consideration is growing at a constant rate. As a solution to a certain quadratic cost minimization problem he obtains an adjustment process [Pagan (1985, equation (5)], which involves the PAM as a special case. Starting with a similar adjustment process I may nest both the RPAM and the NPAM in one expression: $M_t - M_{t-1} = \gamma(M_t^* - M_{t-1}) + \eta\Delta P$, where $M_t =$ logarithm of money balance at time t, $M_t^* =$ desired M_t, $P =$ logarithm of price level at time t, and γ and η are parameters. This process yields the NPAM if $\eta = 0$, the RPAM if $\eta = 1 - \gamma$, and a process Goldfeld (1988, equation (8)) suggested if $\gamma = 1$, hence it may seem to be useful for discriminating the three processes. Upon solving for m_t assuming that the desired $m_t^* \equiv M_t^* - P$ follows $m_t^* = X\beta$, where X is a vector of exogenous variables and β is an appropriately dimensioned coefficient vector, however, it becomes apparent that the reduced form m_t is now an amalgam of the three processes and does not in itself have any economic content.The reduced form is given by $m_t = X\beta + \delta_1 M_{t-1} + \delta_2 P_t + \delta_3 P_{t-1}$, where δ_i's are coefficients. This is the expression Spencer (1985) used to discriminate the RPAM and NPAM. I do not use Spencer's approach since if I estimated the above equation and suppose that all δ_i's (i=1,2,3) turned out to be significant, I feel uncomfortable for not being able to identify underlying adjustment process.

[4] Baba (1989) and Yoshida (1989) present evidence in favor of the unit root and present the ECM money demand functions. Recently, Rasche (1987) and Miller (1989), among others have transformed variables in first difference form. The ECM formulation is apparently to be preferred over such *ad hoc* procedures.

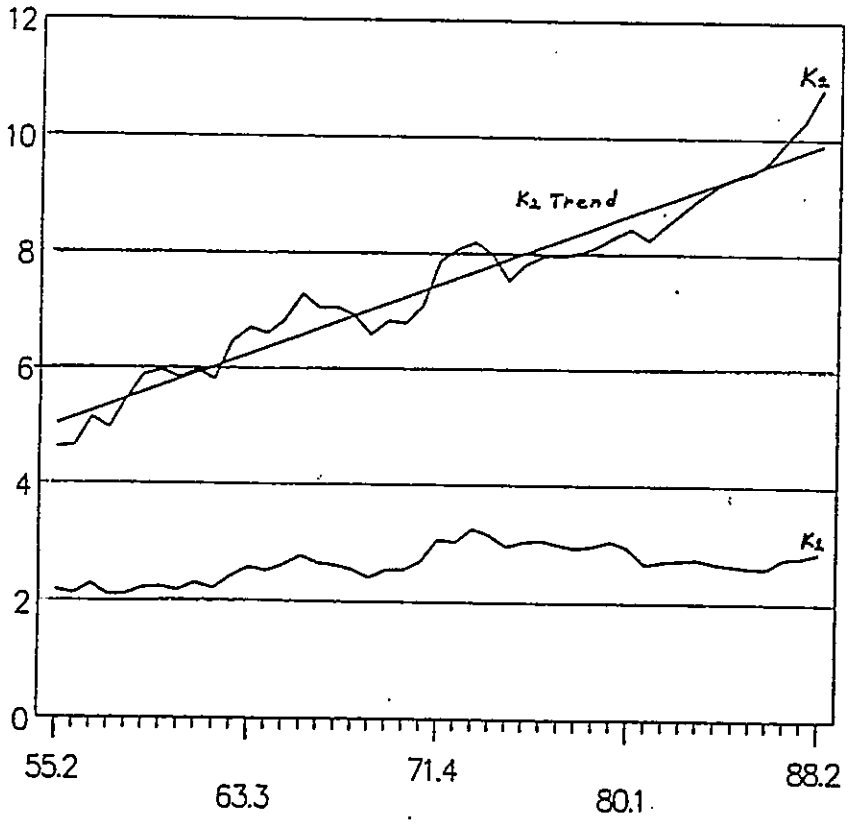

Figure 1: K1 and K2 with a Trend Line (1955.2 to 1988.3)

Notes: $K_i = M_i/PY$ for $i = 1, 2$, PY = nominal GNP, and
M_1 and M_2 are seasonally adjusted M1 and M2+CD, respectively.
Data source: Bank of Japan

data analysis of Marshallian K_1 and K_2 using graphs and descriptive statistic measures. Relating descriptive data analysis results to historical facts, I come up with possible break points in my entire sample period. I discuss all of the test statistics used in this paper briefly in section 3. Section 4 presents estimation results of, first M2CD and then M1. Concluding remarks are given in section 5.

2 Descriptive Data Analysis of Marshallian K

For the sample period 1955.2 to 1988.3, graphs of Marshallian $K_i's$, $i = 1, 2$, are presented in Figure 1 and 2[5]. Figure 1 presents K_1, and K_2 with its

---

[5] All data in this paper are seasonally adjusted quarterly series. In particular, the X11 method has been used on the monthly M2CD series to obtain its quarterly series. Money stock data are end-of-the-period observations. LM1 and LM2 denote log of M1

Table 1: Descriptive Statistics of K_1 and K_2

From To	1956.2 1988.3		1956.2 1969.4		1970.1 1979.4		1980.1 1988.3	
	mean	std.	mean	std.	mean	std.	mean	std.
K_1	2.66	0.29	2.40	0.19	2.97	0.18	2.72	0.09
K_2	7.57	1.41	6.26	0.69	7.83	0.45	9.31	0.75

Notes: mean= $\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$,and
std.= $\sqrt{\frac{1}{n-1}\sum_{i=1}^{n}(x_i - \bar{x})^2}$
for variable x.
1980.1 = first quarter of year 1980.

trend line together in one graph. K_2 has a persistent upward trend, which is also evident in the descriptive measures of Table 1, while K_1 is seen to have slightly increased to the '70s but somewhat declined into the 80's. Sato (1990) is not surprised with an upward trend in K_2 and no trend in K_1. He argues that M_1 represents transactions balance, and thus, when divided by nominal income, it becomes relatively constant. He notes that the household sector has been increasing its wealth-income ratio, resulting in an increase in K_2, while firms' M_2 represents transactions balance therefore K_2 for firms is constant. See next to the final footnote of this paper for more on this issue.

Among the possible explanations for K_2's strong upward trend since the middle of the 70's, is commercial banks' issuance of CD's (certificate of deposits). Commercial banks have been allowed to issue large denomination CD's starting 1979. Another likely reason for K_2's upward trend is the large scale issuance of government bond that started in 1975 fiscal year. In what ways the large scale issuance of government bonds to finance budgetary deficit, affected the money demand in Japan, is not certain. It may have increased money demand, since people needed liquidity to purchase bonds, but at the same time it might have been a shift from one form of asset to another, thus decreased money demand. In Figure 1, K_2 is seen to have departed upwards from its trend line [6] three times in the sample period:1962.2

---

and M2CD, respectively. Log of real GNP is LY. Two interest rate variables used in this paper are: LR=log of yield on the interest-bearing Nippon Telephone and Telegraph's bond and LC=log of call rate. Interest rate variables are not seasonally adjusted.

[6] Ordinary least squares (OLS) estimation of K_2 on time for 1955.3 to 1988.3 is used

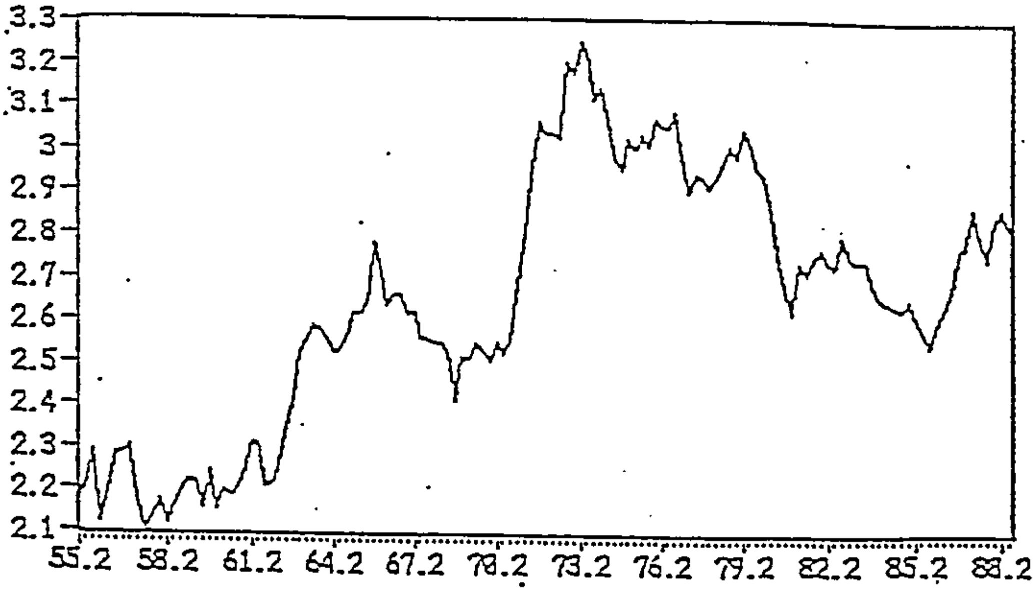

Figure 2: K1 (1955.2 to 1988.3)

to 1967.4, 1971.2 to 1974.2, and since 1985.4 to the present. The most recent departure, i.e., that of 1985.4 to the present, is large, [7] however, the one in the middle of the 60's is also persistent. One may attribute defensive policy measures taken to cope with the shock due to the breakdown of the Bretton-Woods fixed exchange rate system, to the second departure. Clear-cut answers to the reasons for the upward departures of K_2 from its trend line in the recent and in the 60's, do not seem to exist.

Figure 2 shows K_1 separately from K_2, and K_1 seem to possess roughly three distinct phases since 1955: 1955 to the early 70's upward trend, high

---

to draw the trend line in Figure 1.

[7] Ueda (1988) and Baba (1989) among others, are concerned with this most recent upward departure of K2 from its trend line since 1985. Both of these authors successfully explain the recent rise of K2. Ueda (1988) adds yield and risk premiums of other assets. More on the issue of asset variables in money demand is found in the *Concluding Remarks* of this paper. Baba (1989), on the other hand, based on an econometric modelling principle advocated by Hendry (1987), uses conventional set of variables and allows more dynamics. The econometric methodology that Baba (1989) and Yoshida (1989) follow is the "general-to-specific" approach. See Gilbert (1986) for a comprehensive comparison of this and more traditional econometric methodology. Recently Muscatelli (1989) applied this principle to the U.K. M1.

plateau of the 70's to the very early 80's, and distinctly lower plateau in the 80's. I may, therefore, divide the entire sample period into three sub- sample periods for both M1 and M2CD. Note that I have not decided whether to actually sub-divide the sample period at all, or about the precise period of the possible join point. I will leave these to the examination of the sequential Chow test and so on, in the next section.

3 On the Test Statistics Used

Before I examine money demand function estimation results, however, some words on each of these specification error tests are in order.[8]

3.1 Autocorrelation, Heteroskedasticity, ARCH, RESET and Normality

Since the partial adjustment formulation in this paper contains lagged dependent variable in the right hand side, I use Durbin's t statistic [Durbin (1970)] to detect autocorrelation in the disturbance terms. It is asymptotically equivalent to Durbin's h statistic, and is distributed as t_{n-5} for the present paper, under the null hypothesis. White's test and ARCH_i test for i=1,. . . ,4, test heteroskedasticity of residuals [see White (1980) and Engle (1982), respectively]. In the present paper, White's statistic is distributed as chi-square(6) under the null hypothesis of homoskedasticity, where "6" refers to the number of variables in the test's auxiliary regression. ARCH_i tests if the residual variances follow what Engle calls, "autoregressive conditional heteroskedasticity," process or not, and the Lagrange multiplier statistic under the null hypothesis of no ARCH is distributed as $\chi^2(i)$, where i is the lag length in the ARCH_i process. I have not tested for higher order serial correlation in the error terms, since I have used seasonally adjusted data. For the ARCH tests, however, I did carry out tests up to four lags.

---

[8] Most of the test statistics in this paper are justified on the asymptotic grounds. Kiviet (1986) criticized the use of asymptotically justified test statistics that are not corrected for finite sample biases. In particular, he took up tests of serial correlation and structural change, when a lagged dependent variable appears as a regressor. His Monte Carlo results are not convincing to me, however. For instance, the number of replications in Kiviet (1986) is a mere 500. As he ackowledges [Kiviet (1986, p.250)], one needs about 10,000 replications to have a ±1 percent width with 95 percent confidence level, and 400 replications are needed for a ±5 percent width with the same confidence level. Kiviet's remarks do seem to warrant the use of some finite sample correction factors but at the same time, it seems that more careful experimental design is needed.

Ramsey's (1969) RESET$_p$, for p=2 to 4, may also be regarded as tests of heteroskedasticity but usually regarded as general tests for detection of missing explanatory variable(s), where p is the maximum power of dependent variable in the original regression, raised in the auxiliary regression [see Thursby and Schmidt (1977)]. RESET$_p$ statistic under the null hypothesis of no missing explanatory variables is distributed as $F_{p,n-4-p}$, where n=number of observations and "4" refers to the number of regressors in the money demand equation in this paper. The Jarque-Bera (JB) statistic [see Jarque and Bera (1980)] tests if the residuals are distributed as normal. Its null hypothesis, H_0, is given by H_0: residuals' measure of symmetry and kurtosis is that of the normal distribution, versus the alternative H_1: residuals' distribution belongs to the Pearson family. The statistic is distributed as $\chi^2(2)$ under H_0.

3.2 Tests in Simultaneous Equations Framework

I employed two sets of statistics in a simultaneous equations context . They are tests of overidentification and tests of independence. It should be noted first that to identify the coefficients in the money demand function, enough number of exogenous variables need to be excluded [see for example Laidler (1977) on this point]. Taking the null hypothesis H_0 as the just- identified model, i.e., the number of explanatory variables appearing in the specification under consideration is just enough so that the specification is correct in this respect, and the alternative hypothesis H_1 as excluding too many variables, i.e., the current model is misspecified, tests of overidentification have been proposed first by Anderson and Rubin (1949) in the context of limited information maximum likelihood estimator. Tsurumi and Shiba (1983) proposed an alternative test, which is easy to implement and has a decent power conditioned on sufficient statistics. I use the above two tests to examine if too many number of variables are excluded from the specification in a simultaneous equations context [9]. The Anderson-Rubin test is distributed

---

[9] Note that the most fundamental question is: whether the parameters in the demand function are identified when money demand and supply are regarded as one system? See Cooley and LeRoy (1981) for a very pessimistic view on this issue. This question, unfortunately, cannot be answered by a statistical hypothesis testing, since there is no test that sets underidentified model in the null or in the alternative model. I shall, however, maintain that parameters of the standard partial adjustment money demand function, are identified. Consider the following system: $m^D = \alpha + \beta r + \gamma y + \delta m^D_{-1} + \epsilon$, $m^S = \theta + h$, and $m^D = m^S = m$, where m^D =money demand, m^D_{-1} =lagged money demand, m^S =money supply, r =interest rate, y=income variable, θ =money multiplier, h =high powered

as χ^2 with the degrees of overidentification as its degrees of freedom. Letting K to be the number of predetermined variables in the system, under H_0 this statistic is distributed as χ^2_{K-4}. Tsurumi and Shiba's statistic is distributed as $F_{K-4,n-K-1}$ under H_0. Lagged income variable and log of price level are used as the predetermined variables that are excluded from the structural equation.

The tests of independence examine if the basic specification when estimated by the OLS, suffers from simultaneous bias or not. I set the null hypothesis H_0 as the interest rate variable is independent of the structural error term assuming normality of the error terms. Several well known tests of independence, e.g., Wu (1973) and Hausman (1978), Revankar (1978), Revankar and Hartley (1975), are available. Let me denote them as WHT, RT and RHT, respectively. They differ because of the way they treat the identifiability condition [see Tsurumi and Shiba (1983) on this issue]. For the present paper, under H_0, the WHT is distributed as $F_{1,n-5}$, the RHT is distributed as $F_{K-3,n-K-1}$, and the RT is distributed as $F_{1,n-K-1}$.

3.3 Tests to Determine Join Points

In this paper, given a sample period, I usually have multiple of possible break points. Hence, a test statistic such as the Chow test [Chow (1960)], when used as a formal test statistic to detect a single possible join point, might give misleading results. Thus, given a sample period, I decided to use sequence of Chow tests [SCT hereafter] as a descriptive statistics measure, to detect a break point(s). There are several other ways[10] of detecting break

---

money, and these are in logarithms. The parameters of the money demand equation in this system, are identified whether r, the interest rate, is included in m^S or not. If I drop h in the m^S equation as Cooley and LeRoy (1981, p.841) do, however, the parameters in the m^D equation become unidentified. Related to the issue of identifiability, is the question, "what variable should be put in the left hand side?" This is the normalization problem. Obviously, if an equation is just-identified as in the above m^D, I may estimate the reduced form equation of r, the interest rate, to recover the structural parameters of m^D. An alternative to the present paper's approach is to estimate an interest rate equation. Equally and probably more fundamental is the list of predetermined variables in the system. Without such a list, one cannot perform any test in simultaneous equations framework. Hence, whether one has a simple IS-LM type world in his mind or some other model, crucially affects the outcome of tests in simultaneous equations framework. Therefore, results of tests of overidentification and independence in this paper should be interpreted with caution.

[10] For instance, Quandt (1958) proposed a sequence of likelihood ratios, and from a Bayesian point of view Ferreira (1975) computed a posterior probability density function

points given a sample.

Among them are Brown, Durbin and Evans' (1975) Cusum [CuSum] and Cusum-of- squares [CuSSQ] methods. These methods are frequently used to detect parameter shifts or drifts, and hence these may give clues to my selection of sub- samples. Their methods are based on normalized 1-period ahead recursive residuals sequence at time r, w_{1r}, and it is defined in a footnote below[11]. While the CuSum test is intended to catch systematic movements of parameter vector, the CuSSQ test is designed to detect haphazard types of movements [see Brown *et al.* (1975, p.154)]. After some experiments on these statistics, I decided to use the CuSum and CuSSQ as descriptive diagnostic check tool and not to carry out formal tests of significance with them[12].

3.4 Nonnested Tests

The Cox-Pesaran nonnested test [Cox (1961) and Pesaran (1974)] and the J test [Davidson and Mackinnon (1981)] are used in this paper to decide (1)

[pdf] of a join point given non-informative priors. Quandt's likelihood ratios has the same information content as the Chow statistic: sum of squared residuals [SSR] fitted for pre-break point period, post-break point period, and the entire sample period. The kernel of Ferreira's join point posterior pdf is the inverse of the sum of pre- and post-break point SSR's, and thus it also has the same information content as the Chow test. Moreover, when his posterior pdf is plotted with a SCT in the same plane, it becomes apparent that they constitute a pair of mirror images. Therefore we present only the SCT results. Chow tests may be applied in a sequential statistics manner, that is to select break points by sequentially selecting smaller subset of sample periods within a given sample period [Ninomiya (1977) and Riddell (1978)]. I am not taking that avenue of approach since I want to combine (1) results from descriptive statistics, and (2) statistical evidence from OLS's, and (3) my prior knowledge as to what happened in the Japanese macroeconomy.

[11] $w_{jr} = (y_r - x_r' b_{r-j})/\sqrt{1 + x_r'(X_{r-j}' X_{r-j}) x_r}$ for $r = k+j, \ldots, n$, where y =dependent variable at time r; x_r =kx1 vector of explanatory variables at time r and k is the number of regressors; X_r = rxk matrix with each row consisting of $x_1', \ldots, x_r'$; b_r = OLS estimate of kx1 population parameters that use data up to time r; j is set to 1 for w_{1r}.

[12] Such view of the CuSum and CuSSQ tests can be found, for example, in Harvey (1981, p.154). Brown *et al.* (1975) provide critical values for different significance levels of the CuSum test, while that of the CuSSQ test can be found in Durbin (1969). After some numerical experiments, I found that the CuSum, CuSSQ and w_{1r}, all are somewhat unreliable as to detecting break points after the first break point when there are multiple break points. That is, when a break occurs, then the behavior of w_{1r} is affected by it, and hence it may become almost impossible to sort out if a certain turn is due to the real break or is an effect of the previous break.

whether interest rate variable is better proxied by LC (the call rate)[13] or LR (yield on the NTT bond), and (2) whether the partial adjustment process is real (RPAM) or nominal (NPAM). Under the null model H_0, both the Cox-Pesaran statistic and the J statistic are asymptotically distributed as the standard normal.

---

[13] I may cite a couple of nonstatistical reasons why the call rate is not an appropriate variable in the money demand function. First, it is the interbank rate. Then the question arises if the call rate as such is relevant in the portfolio choice? In addition, the call rate has been used as a policy variable by the Bank of Japan to change the cost structure of commercial banks particularly in the decade after 1965. In view of this, one may regard that the call rate is the variable that influences the supply of money, and not the demand for money.

Table 2: M2CD with LR as Interest Rate

Estimation period	1962.1 1988.3	1962.1 1970.4	1971.1 1976.3	1976.4 1988.3
constant term	0.290	0.716	-0.250	-0.432
(t-value)	(6.1)	(2.6)	(-0.6)	(-1.3)
LR	-0.051	-0.061	-0.105	-0.028
(t-value)	(-6.9)	(-1.6)	(-8.5)	(-3.3)
LY: income	0.113	0.252	0.487	0.191
(t-value)	(3.5)	(2.1)	(4.9)	(1.8)
lagged dep.	0.892	0.742	0.619	0.872
(t-value)	(34.1)	(6.5)	(9.9)	(12.4)
R^2	0.9996	0.999	0.992	0.999
St.E.	0.012	0.010	0.009	0.008
D.W.	1.179	1.756	2.364	2.302
Durbin's t	4.616	0.576	-1.082	-0.918
Tests of Heteroskedasticity				
White	24.270	7.129	3.839	3.037
$ARCH_1$	8.464	0.459	0.026	1.053
$ARCH_2$	10.138	1.677	2.888	3.794
$ARCH_3$	11.450	0.326	2.564	5.885
$ARCH_4$	8.754	1.203	3.380	5.945
$RESET_2$	14.614	0.233	1.531	0.038
$RESET_3$	9.943	0.116	0.911	0.058
$RESET_4$	6.566	0.252	0.574	0.116
Jarque-Bera	2.420	3.270	1.018	0.552
Tests of Independence				
Wu-Hausman	0.971	0.330	2.659	0.197
Revankar-Hartley	0.497	4.790	1.267	0.336
Revankar	0.961	0.319	2.519	0.193
Tests of Overidentification				
Anderson-Rubin	0.033	13.593	0.015	0.529
Tsurumi-Shiba	0.032	12.781	0.014	0.473
Nonnested Tests of Interest Rates				
Cox-Pesaran H_1 : LC	-2.462	-2.917	-4.689	1.118
J-Test H_1 : LC	2.137	1.226	3.480	-1.011
Cox-Pesaran H_1 : LR	-2.287	-1.542	0.908	-4.840
J-Test H_1 : LR	2.006	0.896	-0.526	3.430
Nonnested Tests of RePAM and NoPAM				
Cox-Pesaran H_1 : Re	-11.67	-8.234	-4.899	-6.313
J-Test H_1 : Re	9.327	5.621	3.646	5.259
Cox-Pesaran H_1 : No	-2.280	-0.027	-0.013	1.115
J-Test H_1 : No	2.222	0.417	0.374	-0.913

Notes to Table 1:
LR = log of yield on the NTT bond, LY = log of real GNP, lagged dep. = lagged dependent variable, i.e., log of real money balance, R^2 = multiple coefficient of determination, St.E. = standard error of regression, D.W. = Durbin-Watson statistic, Durbin's t = Durbin's (1970) statistic for detecting serial correlation in the error terms, when a lagged dependent variable is included in the right hand side. This is distrubuted as t_{n-k+1}, where n=number of observations, k=number of regressors, under the null hypothesis. White = White's (1980) LM statistic for detecting heteroskedasticity. This is distributed as χ^2_p, where p=number of regressors in the auxiliary regression. ARCH$_i$ = Engle's (1982) statistic for i-th order ARCH process, and this is distributed as χ^2_p, where p is the maximum lag length considered. RESET$_i$ = Ramsey's (1969) statistic that includes up to i-th power of an explanatory variable, and this is distributed as $F_{i-1,n-k-i+1}$. Jarque-Bera = Jarque and Bera's (1980) test for nonnormality and this is distributed as χ^2_2. Wu-Hausman = Wu (1973) and Hausman's (1978) test and this is distributed as $F_{m_1,n-k_1-2m_1}$, where m_1 =number of included right hand side endogenous variables and k_1 =number of included exogenous variables. Revankar-Hartley = Revankar and Hartley's (1973) test, and it is distributed as $F_{k_2,n-m_1-k}$, where k_2 =number of excluded exogenous variables. Revankar = Revankar's (1978) test is distributed as $F_{m_1,n-m_1-k}$. Anderson-Rubin = Anderson and Rubin's (1949) test of overidentifiability is distributed as $\chi^2_{k-m_1-k_1}$. Tsurumi- Shiba = Tsurumi and Shiba's (1983) test is distributed as $F_{k_2-m_1,n-m_1-k}$. Cox-Pesaran = Cox's (1961) statistic modified by Pesaran (1974) for regression framework, is distributed as N(0,1) under the H_0 model. J-Test = a nonnested test by Davidson and Mackinnon (1981), is also distributed as N(0,1) under the H_0 model.

4 Money Demand Function Estimated

4.1 Estimation Results of M2CD

Table 2 presents estimation results for M2CD when RT, yield on interest-bearing Nippon Telephone and Telegraph bonds, is used. The column on the most left hand side is the estimation result for the entire sample period,

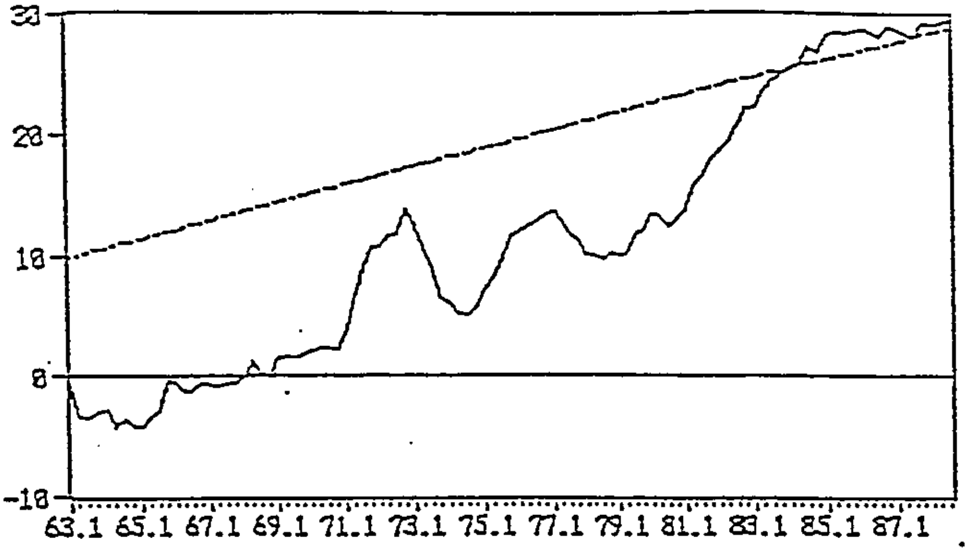

Figure 3: CuSum of M2 with LR (1963.1 to 1988.3)

i.e., 1962.1 to 1988.3 [14]. The sign conditions are met and the t-statistics are significant at the 5 percent level. If I look into the results of the various specification error test results, however, misspecification is apparent. Durbin's t, White's heteroskedasticity test, ARCH(2) and ARCH(4), and all RESET tests, are significant at the one percent level. These facts lead me to examine the CuSum, CuSSQ and SCT given in Figures 3, 4 and 5, respectively. I need to keep in mind, however, that these tests, based on a wrong specification, may lead to misleading conclusions on determination of join points. What I ought to do, then, is to carefully combine historical facts with indications from these test statistics to draw my own conclusion.

Figure 3 presents the CuSum graph for the period, 1963.1 to 1988.3. Except for the period after 1984, it stays below the upper 5 percent bound. The CuSSQ graph is given in Figure 4. This graph never exceeds the upper 5 percent line, however, it touches the bound at 1975.3. As I discussed in the previous section, these two graphs convey different types of parameter instability. Additional information on parameter instability is given in the

---

[14] The entire sample period when LC, log of the call rate, is used becomes 1955.3 to 1988.3. When LR is used in place of LC, however, it becomes 1962.1 to 1988.3, due to the data inavailability of LR prior to 1962.1.

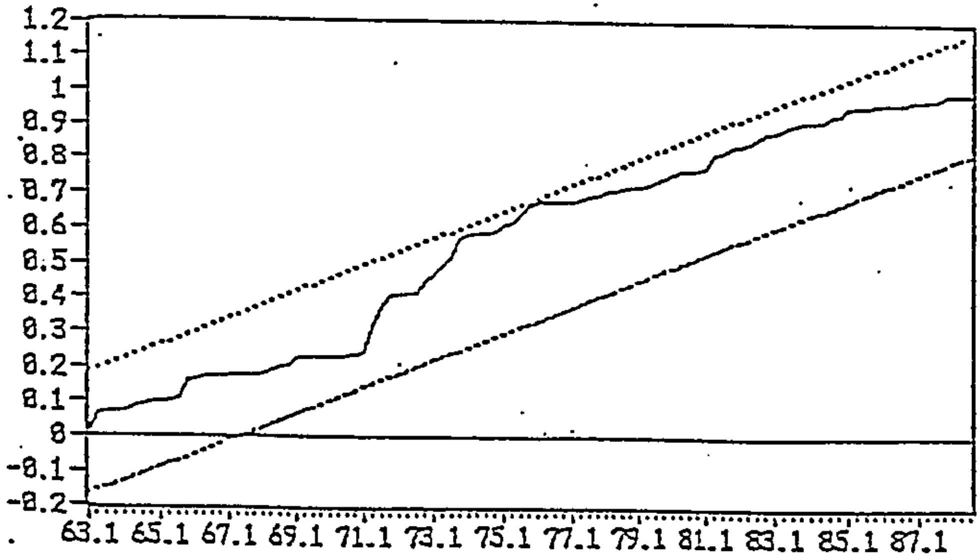

Figure 4: CuSSQ of M2 with LR (1963.1 to 1988.3)

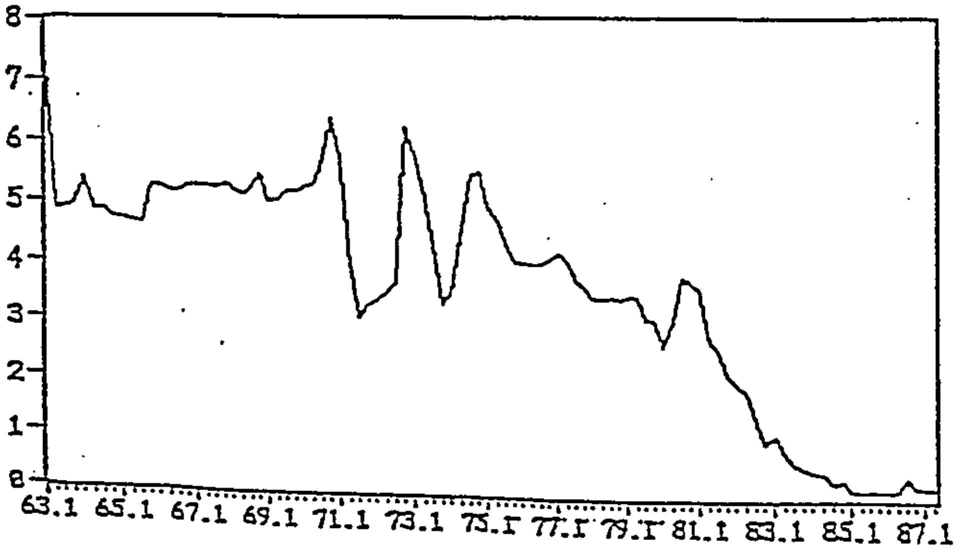

Figure 5: SCT of M2 with LR (1963.1 to 1987.2)

SCT of Figure 5. It shows outstanding peaks at 1970, late 1972 and 1974. Other minor peaks and plateaus are not easily interpreted. In summary, there seem to be two possible break points in the 70's: one in the early part, i.e., 1970 to 1972, and the other in the middle, i.e., late 1974 to possibly 1976. The first one can be easily associated with the transition from the fixed exchange rate system to the floating. During 1970 to 1972, the exchange rate system was not fully in float. The second one may be associated with the start of large scale issuance of government bond at the 1975 fiscal year. One should keep in mind, however, that the government kept on issuing bonds in large scale after 1975 too.

I would therefore divide the sample period, 1962.1 to 1988.3, into three sub-sample periods: [1]': 1962.1 to the early 1970's, [2]': early to the middle of 1970's, [3]': middle of 1970's to 1988.3. I then computed the OLS for boundary periods to determine exact sub-sample periods for [1]' to [3]'. The criteria I used to select them are: (a) sign conditions, (b) significance of t statistics, and (c) insignificance of Durbin's t statistic. As a result I came up with the following: [1]: 1962.1 to 1970.4, [2]: 1971.1 to 1976.3, and [3]: 1976.4 to 1988.3. Estimation results along with various specification error test results of these sub-sample periods are given after the second column in Table 2. Except for the tests of overidentification for period [1], all test statistics are insignificant, and thus do not indicate any specification error.

In order to check if the division of the entire sample period into [1] to [3] as above, is justified or not, I have estimated the LR specification for two combined periods: [1+2] combines [1] and [2], and [2+3] combines [2] and [3]. For the period [1+2], SCT and CuSSQ graphs are presented in Figures 6 and 7, respectively. Note that the SCT graph has a unique peak at 1971, and thus supports the division that I made in the above. The CuSSQ graph, on the other hand, is so stable that it does not give any clue of parameter change around 1970 to 1972. Next, SCT and CuSum graphs are computed for [2+3], and they are Figures 8 and 9, respectively. Again the SCT graph shows a high degree of instability from late 1974 to 1976, while the CuSum graph does not show that. The CuSum graph, rather, suggests an instability around 1985.

Nonnested tests results of the RPAM versus NPAM are strongly in favor of the RPAM for all sub-sample periods in Table 2. On the choice of interest rate variable, LC versus LR, LC is favored for periods [1] and [2], while LR is favored for period [3]. Note that these results do not necessarily imply that LC is the better choice than LR for [1] and [2]. I will have strong support for LC only after I examine the criteria that I laid out in the above (a) to

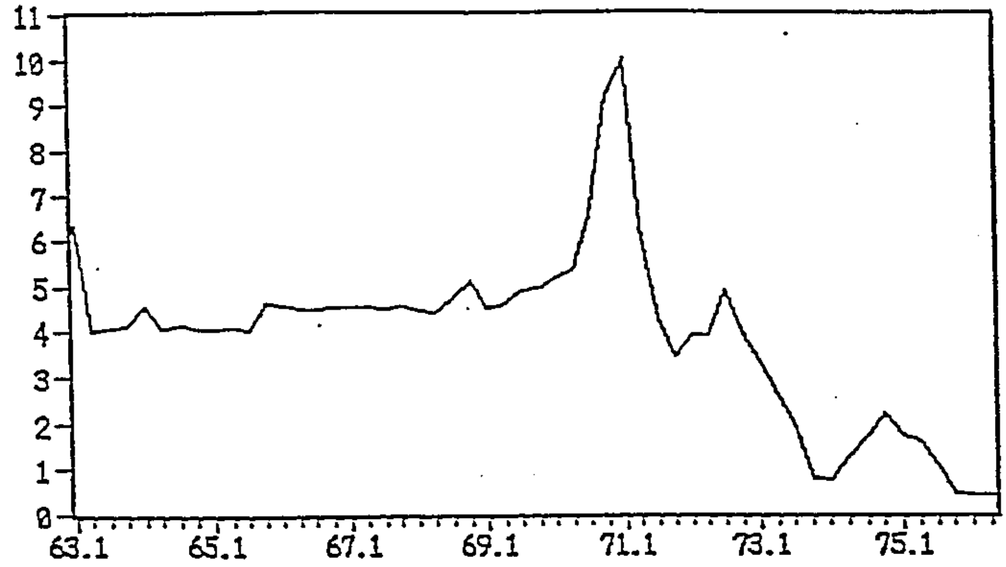

Figure 6: SCT of M2 with LR (1963.1 to 1976.2)

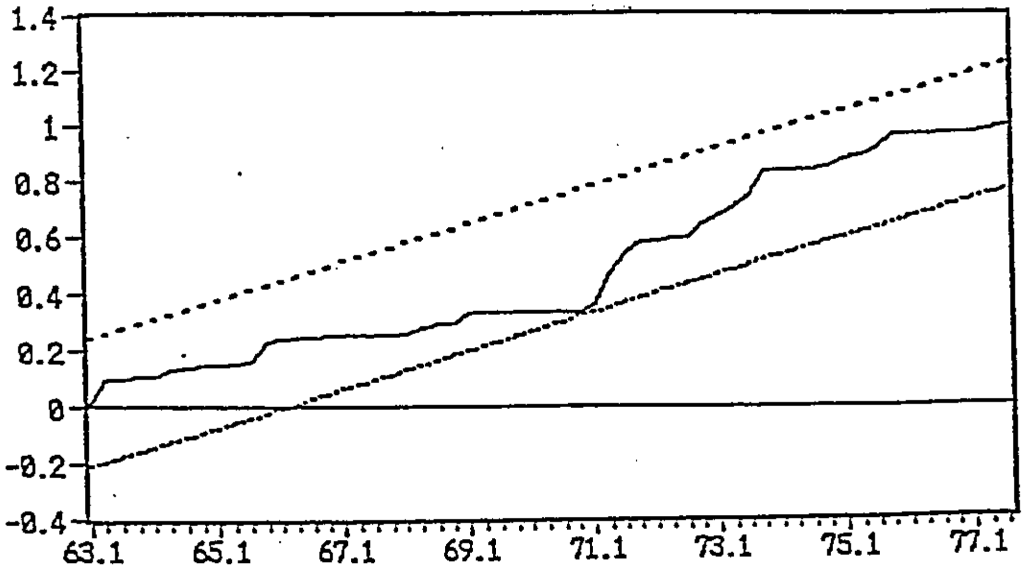

Figure 7: CuSSQ of M2 with LR (1963.1 to 1977.3)

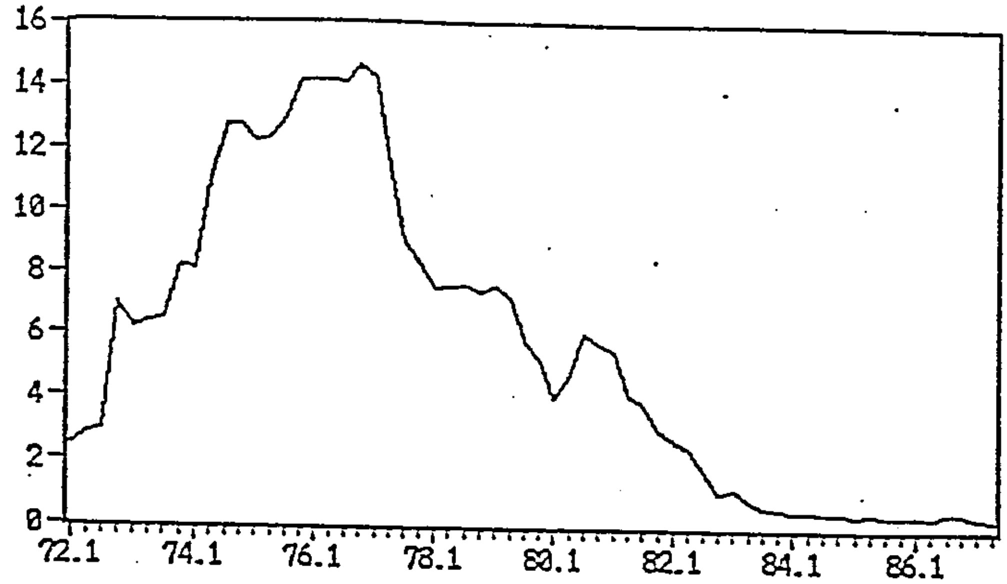

Figure 8: SCT of M2 with LR (1972.1 to 1987.2)

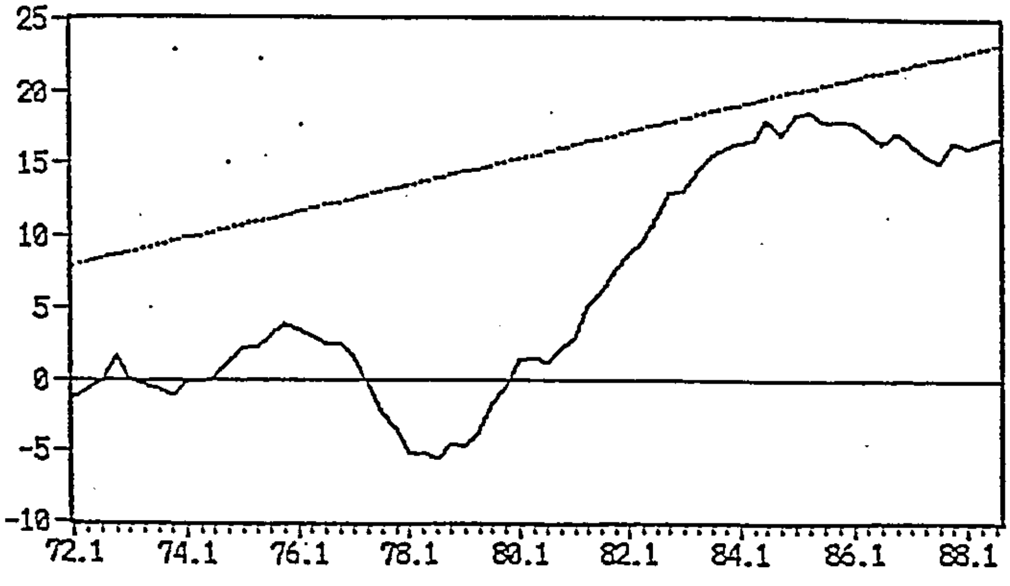

Figure 9: CuSum of M2 with LR (1972.1 to 1988.3)

(c). It would be nice if a nonnested test that incorporates these (a) to (c) were developed. Let me now examine the LC specification. Its results are given in Table 3.

In Table 3, period [1] starts at 1953.3 rather than 1962.1 because LC is available for a longer period than LR. This is why the nonnested tests of LC versus LR is not computed in the first two columns. Period [1]'s result has LC and LY insignificant, and tests of independence are all highly significant. Period [2] satisfies sign conditions and has significant enough t statistics, however, its RESET(2) and RESET(4) statistics are significant at 5 percent level. Period [3] has a high Durbin's t statistic, but all other statistics are insignificant. I may, thus, conclude that for M2CD, LR is the better choice than LC.

I shall now conduct within sample forecasting exercises with the M2CD money demand functions using LR. The first money demand function has a sample period of 1976.4 to 1988.3 and it is dynamically simulated for 1985.1 to 1988.3, while the second has a sample period of 1962.1 to 1988.3 and simulated for the same 1985.1 to 1988.3 period. Let me call them 'Forec.(a)' and 'Forec.(b),' respectively. The simulation results are given in Figure 10 along with the actual level of real M2CD. Forec.(b) is generated from an equation estimated for a sample period that probably involves several structural changes [see earlier arguments in this subsection]. Forec.(a) has a RMS percent error[15] of 17.9 percent while Forec.(b) has 33.7 percent. As seen in Figure 10, Forec.(b) consistently underestimates the actual. The largest underestimation by Forec.(b) occurs in 1986.4, when the percentage difference between Forec.(b) and the actual is 2.2 percent. This translates into an underestimation of about 7 trillion yen in nominal terms assuming that 1986 M2CD was about 321 trillion yen. Forec.(a), on the other hand, tracks rapid rise in K2 after 1986, and it does not make a huge underestimation as Forec.(b) does. In all but one period, 1986.3, its percentage error was less than 1.5 percent [in 1986.3 it was 2.1 percent]. This may compare with the *static* simulation exercise by Yoshida (1989, p.138), who used an error correction model and obtained an excellent simulation result.

---

[15] RMS (root mean squared) percent error is defined by $\sqrt{\frac{1}{T}\sum_{t=1}^{T}(\frac{Y_t^s - Y_t^a}{Y_t^a})^2}$, where T =number of periods simulated, Y_t^a =actual value of variable Y at time t, and Y_t^s =simulated value of Y at time t.

Table 3: M2CD with LC as Interest Rate

Estimation period	1955.3 1988.3	1955.3 1970.4	1971.1 1976.3	1976.4 1988.3
constant term	0.184	0.127	-0.020	-0.707
(t-value)	(4.7)	(2.1)	(-.01)	(-2.4)
LC	-0.025	-0.005	-0.050	-0.021
(t-value)	(-5.9)	(-0.5)	(-6.1)	(-4.9)
LY: income	0.041	0.005	0.464	0.229
(t-value)	(1.5)	(0.1)	(3.6)	(2.5)
lagged dep.	0.956	0.989	0.613	0.857
(t-value)	(43.3)	(35.5)	(7.5)	(14.6)
R^2	0.9998	0.9995	0.987	0.999
St.E.	0.013	0.013	0.012	0.007
D.W.	1.339	1.855	1.730	2.635
Durbin's t	4.003	0.546	0.435	-2.242
Tests of Heteroskedasticity				
White	17.529	9.759	3.306	2.956
$ARCH_1$	5.007	0.119	1.668	0.176
$ARCH_2$	15.256	4.621	2.113	0.288
$ARCH_3$	17.509	4.790	3.189	0.602
$ARCH_4$	18.353	5.925	3.176	0.666
$RESET_2$	0.773	2.486	5.895	0.017
$RESET_3$	7.185	1.232	2.787	0.096
$RESET_4$	4.978	0.811	N.A.	N.A.
Jarque-Beara	7.304	1.454	0.517	1.909
Tests of Independence				
Wu-Hausman	0.015	31.597	0.154	0.012
Revankar-Hartley	2.735	15.969	0.077	1.060
Revankar	0.015	31.052	0.145	0.011
Tests of Overidentification				
Anderson-Rubin	5.869	0.018	0.011	2.468
Tsurumi-Shiba	5.653	0.884	0.009	2.166
Nonnested Tests of Interest Rates				
Cox-Pesaran H_1 : LC	N.A.	N.A.	-4.689	1.118
J-Test H_1 : LC	N.A.	N.A.	3.480	-1.011
Cox-Pesaran H_1 : LR	N.A.	N.A.	0.907	-4.840
J-Test H_1 : LR	N.A.	N.A.	-0.526	3.430
Nonnested Tests of RePAM and NoPAM				
Cox-Pesaran H_1 : Re	-13.55	-11.49	-8.152	-5.280
J-Test H_1 : Re	10.838	9.175	6.041	4.360
Cox-Pesaran H_1 : No	-3.354	-1.144	1.321	0.185
J-Test H_1 : No	3.128	1.349	-0.729	0.018

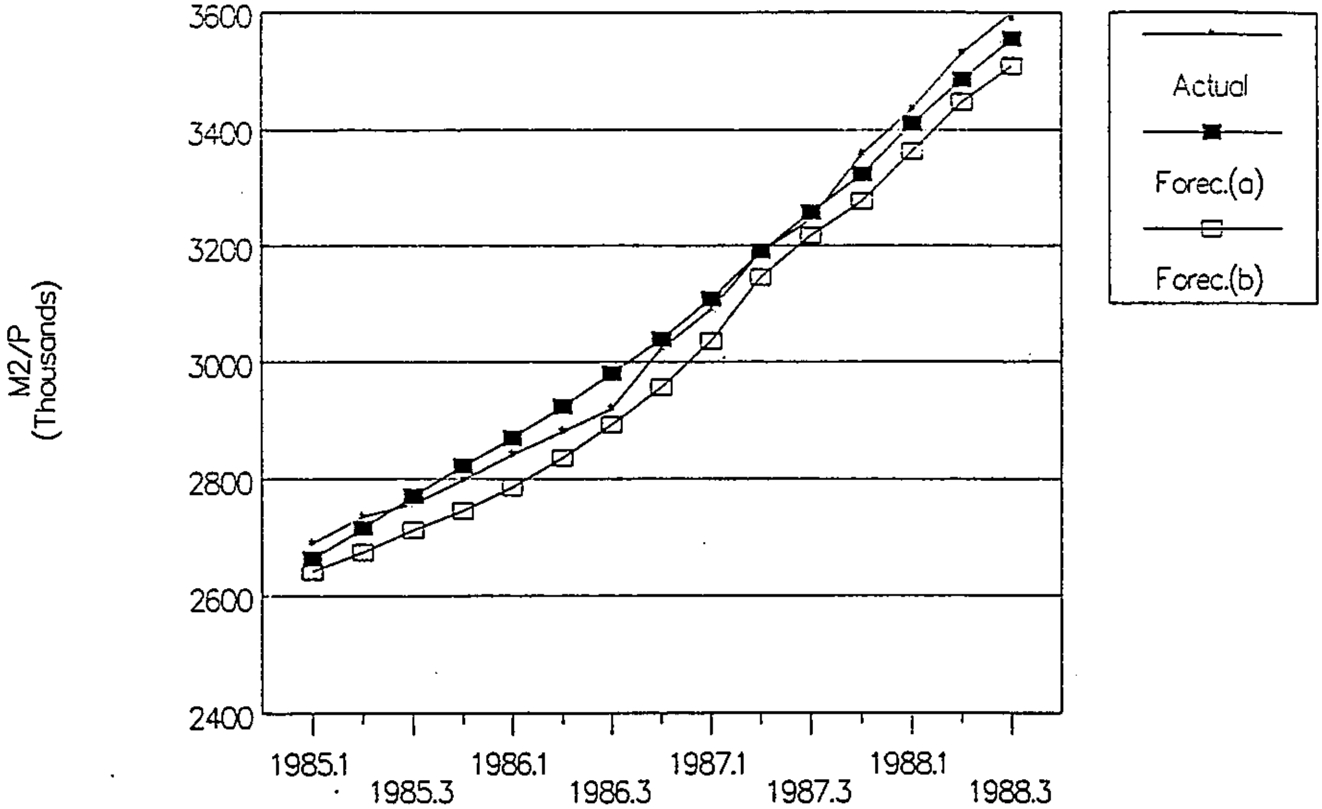

Figure 10: M2CD Forecasted for 1985.1 to 1988.3

4.2 M1 Money Demand Function

I have divided the entire sample period in the same way as in section 4.1, and arrived at the following sub-sample periods. For the specification that uses LC,{1}: 1955.3 to 1971.3, {2}: 1971.4 to 1980.4, {3}: 1981.1 to 1988.3. When LR is used in place of LC, "1955.3" is replaced by "1962.1", and so on. Results with LC and LR are given, respectively, in Tables 4 and 5. Let me first discuss Table 5. The first four columns of the Table give insignificant t statistics for LY, the income variable. The only reasonable estimation results is in the last column, period {2+3}, i.e., two periods {2} and {3} integrated to one period. All misspecification tests are insiginificant for {2+3}. Its nonnested tests of LC versus LR seem to be in favor of LC, however. Let me turn to Table 4 now. In this Table, periods {1}, {3} and {2+3} have significant enough income coefficient t statistics. Period {1} has only slightly significant t statistic for LY and its result is marred with significant RESET_4 and the Jarque-Bera statistic.

In summary, I have obtained satisfactory estimation result for M1 for the period 1971.4 to 1988.3. Among the two interest rate variables, LC is slightly favored over LR. In another set of nonnested tests, the NPAM

Table 4: M1 with LC as Interest Rate

Estimation period	1955.3 1988.3	1955.3 1971.3	1971.4 1980.4	1981.1 1988.3	1971.4 1988.3
constant term	0.222	-0.028	1.46	3.44	1.34
(t-value)	(5.0)	(-0.4)	(3.5)	(3.7)	(5.1)
LC	-0.026	-0.03	-0.03	-0.099	-0.04
(t-value)	(-4.4)	(-1.8)	(-4.5)	(-4.3)	(-6.5)
LY: income	0.032	0.095	0.094	0.22	0.13
(t-value)	(1.2)	(1.6)	(1.1)	(2.5)	(3.1)
lagged dep.	0.959	0.92	0.81	0.55	0.79
(t-value)	(41.5)	(17.3)	(8.7)	(5.0)	(15.2)
R^2	0.999	0.999	0.969	0.985	0.990
St.E.	0.019	0.018	0.017	0.013	0.016
D.W.	1.48	1.52	1.69	2.27	1.95
Durbin's t	3.07	1.59	0.89	-0.97	0.20
Tests of Heteroskedasticity					
White	5.68	11.8	3.99	9.09	6.55
ARCH$_1$	0.45	0.13	0.08	0.09	0.18
ARCH$_2$	0.47	0.84	0.17	0.08	0.17
ARCH$_3$	1.85	0.89	0.40	0.79	0.26
ARCH$_4$	4.73	6.04	0.60	0.99	1.07
RESET$_2$	24.436	0.017	0.027	1.771	0.956
RESET$_3$	13.707	2.826	1.825	1.245	0.684
RESET$_4$	9.547	7.045	N.A.	0.796	0.473
Jarque-Bera	20.349	7.493	1.284	2.113	3.609
Tests of Independence					
Wu-Hausman	1.12	0.01	0.30	1.89	0.30
Revankar-Hartley	10.51	4.00	0.19	0.93	0.24
Revankar	1.12	0.01	0.29	1.82	0.30
Tests of Overidentification					
Anderson-Rubin	4.06	3.34	0.10	0.01	0.20
Tsurumi-Shiba	23.38	9.05	0.08	0.04	0.18
Nonnested Tests of Interest Rates					
Cox-Pesaran H_1 : LC	N.A.	N.A.	-1.81	-3.23	-2.21
J-Test H_1 : LC	N.A.	N.A.	1.53	2.21	1.92
Cox-Pesaran H_1 : LR	N.A.	N.A.	0.08	-0.87	-1.05
J-Test H_1 : LR	N.A.	N.A.	0.02	0.89	1.01
Nonnested Tests of RePAM and NoPAM					
Cox-Pesaran H_1 : Re	-2.31	-2.86	-2.38	-1.56	-1.46
J-Test H_1 : Re	2.18	2.53	2.02	1.35	1.40
Cox-Pesaran H_1 : No	-4.63	-2.26	-1.41	0.64	-2.70
J-Test H_1 : No	4.13	2.06	1.31	-0.50	2.41

Table 5: M1 with LR as Interest Rate

Estimation period	1962.1 1988.3	62.1 1971.3	1971.4 1980.4	1981.1 1988.3	1971.4 1988.3
constant term	0.429	-0.101	1.500	3.605	1.731
(t-value)	(6.1)	(-0.4)	(3.5)	(3.1)	(5.7)
LR	-0.036	0.022	-0.070	-0.110	-0.064
(t-value)	(-3.9)	(0.5)	(-4.1)	(-3.5)	(-6.2)
LY: income	0.030	-0.034	0.028	0.108	0.114
(t-value)	(1.1)	(-0.3)	(0.3)	(1.1)	(2.8)
lagged dep.	0.946	1.039	0.873	0.650	0.776
(t-value)	(39.1)	(8.5)	(8.6)	(6.0)	(14.4)
$\bar{R}^2$	0.999	0.997	0.967	0.982	0.990
St.E.	0.018	0.017	0.017	0.014	0.016
D.W.	1.45	1.21	1.63	2.27	1.82
Durbin's t	2.96	2.14	1.09	-1.02	0.78
Tests of Heteroskedasticity					
White	4.52	15.28	3.97	10.39	5.96
ARCH$_1$	2.40	4.18	0.01	0.35	0.01
ARCH$_2$	2.41	7.47	0.18	1.8	0.26
ARCH$_3$	3.33	8.83	0.22	2.25	0.54
ARCH$_4$	3.71	8.60	0.67	2.09	1.58
RESET$_2$	4.655	25.788	0.088	2.236	0.225
RESET$_3$	15.288	14.810	0.643	1.107	0.644
RESET$_4$	11.035	9.818	N.A.	N.A.	N.A.
Jarque-Bera	14.931	2.805	1.049	4.469	3.068
Tests of Independence					
Wu-Hausman	2.00	2.65	0.01	0.81	0.0001
Revankar-Hartley	3.02	2.05	0.42	0.59	0.13
Revankar	1.98	2.58	0.01	0.78	0.0001
Tests of Overidentification					
Anderson-Rubin	3.64	1.37	0.98	0.31	0.29
Tsurumi-Shiba	4.19	1.55	0.82	0.39	0.26
Nonnested Tests of Interest Rates					
Cox-Pesaran H_1 : LC	N.A.	N.A.	-1.8	-3.22	-2.21
J-Test H_1 : LC	N.A.	N.A.	1.52	2.21	1.92
Cox-Pesaran H_1 : LR	N.A.	N.A.	0.06	0.87	-1.04
J-Test H_1 : LR	N.A.	N.A.	0.03	0.89	1.01
Nonnested Tests of RePAM and NoPAM					
Cox-Pesaran H_1 : Re	-2.83	-3.65	-2.39	-1.71	-1.73
J-Test H_1 : Re	2.61	2.93	2.03	1.49	1.62
Cox-Pesaran H_1 : No	-2.10	-0.71	-1.42	0.69	-2.35
J-Test H_1 : No	2.67	0.79	1.32	-0.55	2.13

seems to be preferred over the RPAM, and this is in contrast to M2CD, where RPAM is strongly preferred.

5 Concluding Remarks

In this paper I focused upon the conventional partial adjustment type money demand function specification for M2CD and M1. After data analyses of relevant variables, I identified three possible break points for each M2CD and M1 in the entire sample period of 1962 to 1988. I first estimated one money demand function using a particular interest rate variable for the entire period. The usual set of conditions, such as the sign and significance of the estimated regression, were satisfactory. Examination of its coefficients' stability by such methods as the CuSum, CuSSQ and sequential Chow tests, however, revealed that the entire sample period needed to be broken up. After a short search to determine the exact sub-sample periods, I estimated sub- sample regression and presented results in Tables 2 to 5. Various misspecification test results mostly did not show any sign of specification error for these sub-sample estimation results.

For M2CD, LR, log of yield on interest-bearing NTT bond, instead of the call rate, turned out to be the chosen interest rate variable. The two break points are 1971 and 1977. The first may be due to the exchange rate system change, and the second may be due to the large scale issuance of government bond. In all three sub-samples, estimated coefficient on the lagged dependent variable is lower compared to the studies cited earlier. I obtained .742, .619 and .872 in the first to last sub-sample period, respectively. This implies that the regression results are more realistic as partial adjustment models. Estimated coefficients for the middle period, 1971 to 1976, are different from that of the first and the last sub-sample periods. In particular, income coefficient decreased from .487 in the second sub-sample period to .191 in the last. Whether Akerlof and Milbourne (1980) type of explanation is applicable or not need to be examined. Interest rate elasticity declined in absolute terms in the same two sub-sample periods from .105 to .028. Forecasting ability of the estimated regression equation, particularly that of the last sub-sample period, was excellent. It fully tracked the rapid rise in Marshallian K_2 after 1986.

In summary, with the proper search of break points, the conventional money demand function is still capable of explaining Japanese money demand. Recently, however, deregulation and changes in the financial system have been rapid and far-reaching in Japan. Also many new savings instruments have been introduced [see Hamada and Hayashi (1985 p.92)]. New small denomination money market certificates is one of them. In view of these[16], and also of rapid price hike in land and stock market, it seems that empirical money demand functions can use the flow-of-funds data to disaggregate the total asset demand into sectors[17], and take into account of yields and risk premiums of various different assets[18].

References

[1] Akerlof, George A. and R.D.Milbourne, 1980, "The short run demand for money," *Economic Journal*, 90, 885-900.

[2] Anderson, T.W., and H. Rubin, 1949, "Estimation of the parameters of a single equation in a complete system of stochastic equations," *Annals of Mathematical Statistics*, 20, 46-63.

[3] Baba, Yoshihisa, 1989, "Japan M2 demand in the 1980's: an econometric approach," paper presented at 1989 *Far Eastern Econometric Society Meetings* at Doshisha University, Kyoto, Japan.

[4] Backus, David and Douglas Purvis, 1980, "An integrated model of household flow-of-funds allocations," *Journal of Money, Credit and Banking*, 12, 2, 400-421.

[5] Blanchard, Olivier J., and Stanley Fischer, 1989, *Lectures on macroeconomics* (MIT Press, Cambridge).

---

[16] Financial deregulation and introductions of new financial instruments, may make it more difficult to successfully estimate disaggregated money demand functions (see Goldfeld (1988, p.774).

[17] Importance of the wealth constraint that imposes a certain adding-up conditions,was emphasized by Brainard and Tobin (1968). Saito and Oshika (1979) followed Brainard and Tobin's approach on the Japanese household sector asset demand functions, and estimated a household money demand function along with other sectors' money demand. Backus and Purvis (1980) used the U.S. flow-of-funds data.

[18] Friedman (1988), Hamburger (1977), Field (1984), and Ueda (1988) for Japanese data, among others introduced various stock market variables into their money demand functions. Friedman (1988, p. 223) argues that there are three possible reasons why hike in real stock price increases real money demand, and one reason, the substitution effect, to reduce it. The three reasons that he cites are the wealth effect, transactions effect, and increase in riskiness of stocks. Friedman says that the question which one of the above effects is dominant, is to be decided empirically.

[6] Brainard, William C., and James Tobin, 1968, "Pitfalls in financial model building," *American Economic Review, Papers and Proceedings*, 58, May, 99-122.

[7] Brown, R. L., J. Durbin, and J. M. Evans, 1975, "Techniques for testing the constancy of regression relationships over time," *Journal of the Royal Statistical Society*, Ser. B, 37, 149-192.

[8] Chow, Gregory, 1960, "Tests of the equality between two sets of coefficients in two linear regressions," *Econometrica*, 28, 561-605.

[9] Cooley, Thomas F. and Stephen F. LeRoy, 1981, "Identification and estimation of money demand," *American Economic Review*, 71, 5, 825-844.

[10] Cox, David R., 1961, "Tests of separate families of hypotheses," Proceedings of the Fourth *Berkeley Symposium on Mathematical Statistics and Probability*, 7, 105-123 (University of California Press, Berkeley).

[11] Davidson,Russel and James G. Mackinnon, 1981, "Several tests for model specification in the presence of alternative hypothesis," *Econometrica*, 49, 781-793.

[12] Durbin, James, 1969, "Tests for serial correlation in regression analysis based on periodogram of least squares residuals," *Biometrika*, 56, 1-15.

[13] Durbin, James, 1970, "Testing for serial correlation in least- squares regression when some of the regressors are lagged dependent variables," *Econometrica*, 38, 410-421.

[14] Engle, Robert F. 1982, "Autoregressive conditional heteroscedasticity with estimates of the variance of United Kingdom inflations," *Econometrica*, 50, 987-1007.

[15] Fair, Ray, 1987, "International evidence on the demand for money," *Review of Economics and Statistics*, 69, 3, 473-480.

[16] Ferreira, Pedro E., 1975, "A Bayesian analysis of a switching regression model: known number of regimes," *Journal of the American Statistical Association*, 70, 350, 370-374.

[17] Fischer, Stanley, 1988, "Recent developments in macroeconomics," *Economic Journal*, 98, 294-339.

[18] Field, Alexander J., 1984, "Asset exchanges and the transactions demand for money, 1919-29," *American Economic Review*, 74, 1, 43-59.

[19] Friedman, Milton, 1988, "Money and the stock market," *Journal of Political Economy*, 96, 2, 221-243.

[20] Furukawa, Akira, 1985, *Gendai nihon no kinyu bunseki* (Toyokeizai, Tokyo).

[21] Gilbert, Cristopher L., 1986, "Professor Hendry's econometric methodology," *Oxford Bulletin of Economics and Statistics*, 48, 283-307.

[22] Goldfeld, Stephen M., 1973, "The demand for money revisited," *Brookings Papers on Economic Activity*, 4, 577-638.

[23] Goldfeld, Stephen M. and D. Sichel, 1987, "Money demand: the effects of inflation and alternative adjustment mechanisms," *Review of Economics and Statistics*, 69, August, 511-515.

[24] Goldfeld, Stephen M., 1988, "Demand for money: empirical studies," in *The New Palgrave Dictionary of Economic Theory and Doctorine.*

[25] Hamada, Fumimasa, 1989,"Tsuuka bouchou no mekanizumu," *Nihon Keizai Shinbun*, December.

[26] Hamada, Koichi and Fumio Hayashi, 1985, "Monetary policy in postwar Japan," in pp.83-121 of *Monetary Policy in Our Times*, A. Ando, H. Eguchi, R. Farmer and Y. Suzuki eds. (MIT Press, Cambridge, MA).

[27] Hamburger, Michael J., 1977, "Behavior of the money stock," *Journal of Monetary Economics*, 3, 265-288.

[28] Harvey, Andrew C., 1981, *The econometric analysis of time series* (Philip Allan, Oxford).

[29] Hausman, Jerry A., 1978, "Specification tests in econometrics," *Econometrica*, 46, 1251-1271.

[30] Hendry, David F., 1987, "Econometric methodology: a personal perspective," in T.F. Bewley ed., *Advances in Econometrics Fifth World Congress* Volume II (Cambridge University Press, Cambridge).

[31] Ishida, Kazuhiko, 1984, "Divisia monetary aggregates ni tsuite," *Kinyuukenkyu* (Bank of Japan), 3,1,13-39.

[32] Jarque, Carlos M. and Anil K.Bera, 1980, "Efficient tests of normality, homoscedasticity and serial Independence of regression residuals," *Economics Letters*, 6, 255-259.

[33] Kama, Kunio, 1986, "Nihon ni okeru kahei jyuyou no anteisei ni tsuite," *Souka Keizai Ronshu*, 16, 1/2, 65-80.

[34] Kiviet, Jan F., 1986, "On the rigour of some misspecification tests for modelling dynamic relationships," *Review of Economic Studies*, 53, 241-261.

[35] Komura, Chikara, 1985, "The demand for money reconsidered: the case of Japan," *Seikeidaigaku Keizaigakubu Ronshu*, 16, 1, 48-57.

[36] Laidler, David, 1977, *The demand for money: theories and evidence* 2nd ed. (Harper & Row, New York).

[37] Lucas, Robert E., Jr., 1988, "Money demand in the United States: a quantitative review," *Carnegie-Rochester Conference Series on Public Policy*, 29, 137-168.

[38] McCallum, Bennett T., and Marvin S. Goodfriend, 1988, "Demand for money: theoretical studies," in *The New Palgrave Dictionary of Economic Theory and Doctorine.*

[39] Miller, Stephen M., 1989, "Money demand instability: has it ended?" *Economics Letters*, 30, 345-349.

[40] Muscatelli, V.A., 1989, "A comparison of the 'rational expectations' and 'general-to-specific' approaches to modelling the demand for M1," *Oxford Bulletin of Economics and Statistics*, 51, 4, 353-375.

[41] Ninomiya, Shoji, 1977, "Stepwise Chow test," *Economic Studies Quarterly*, 28, 50-60.

[42] Pagan, Adrian, 1985, "Time series behaviour and dynamic specification," *Oxford Bulletin of Economics and Statistics*, 47, 199-211.

[43] Pesaran, M. Hashem, 1974, "On the general problem of model selection," *Review of Economic Studies*, 41, 153-171.

[44] Poole, William, 1988, "Monetary lessons of recent inflation and disinflation," *Journal of Economic Perspectives*, 2, 3, 73-100.

[45] Quandt, Richard E., 1958, "The estimation of the parameters of a linear regression system obeying two separate regimes," *Journal of the American Statistical Association*, 53, 873-880.

[46] Ramsey, James B., 1969, "Tests for specification errors in classical linear least squares regression observations," *Journal of the Royal Statistical Society*, Ser. B, Pt. 2, 350-371.

[47] Rasche, Robert H., 1987, "M1-velocity and money demand functions: do stable relationships exist?" *Carnegie-Rochester Conference Series on Public Policy*, 27, 9-88.

[48] Revankar, Nagesh S., 1978, "Asymptotic relative efficiency analysis of certain tests of independence in structural systems," *International Economic Review*, 19, 165-179.

[49] Revankar, Nagesh S. and Michael J. Hartley, 1973, "An independence test and conditional unbiased predictions in the context of simultaneous equation systems," *International Economic Review*, 14, 625-631.

[50] Riddell, W. Craig, 1978, "The use of the stepwise Chow test," *Economic Studies Quarterly*, 29, 242-247.

[51] Romer, David, 1986, "A simple general equilibrium version of the Baumol-Tobin model," *Quarterly Journal of Economics*, 101, 4, 663-686.

[52] Sato, Kazuo, 1990, *Personal communication.*

[53] Saito, Mitsuo and Takashi Oshika, 1979, "Shisan sentaku no youin bunseki," *Keizai Bunseki*, 74, 23-60.

[54] Shinkai, Yoichi, 1984, "Nihon no kahei jyuyou ni tsuite," *Osakadaigaku Keizaigaku*, 34, 2/3, 36-44.

[55] Spanos, Aris, 1986, *Statistical foundations of econometric modelling* (Cambridge University Press, London).

[56] Spencer, David, 1985, "Money demand and the price level," *Review of Economics and Statistics*, 67, 490-496.

[57] Svensson, Lars E.O., 1985, "Money and asset prices in a cash-in- advance economy," *Journal of Political Economy*, 93, 5, 919-944.

[58] Thursby, Jerry G. and Peter Schmidt, 1977, "Some properties of tests for specification error in a linear regression model," *Journal of the American Statistical Association*, 72, 635-641.

[59] Tsurumi, Hiroki and Tsunemasa Shiba, 1983, "A new likelihood ratio test of identifiability and its relation to exogeneity tests in a simultaneous equation system," *mimeo.*

[60] Tsutsui, Yoshiro and Michio Hatanaka, 1982, "Nichibei ryoukoku ni okeru kaheijyuyouno anteisei ni tsuite," *Kikan Gendaikeizai* (Nihonkeizaishinbun, Tokyo), Autumn, 124-135.

[61] Ueda, Kazuo, 1988, "Financial deregulation and the demand for money in Japan," *Discussion Paper* 66, Osaka University.

[62] White, Halbert, 1980, "A heteroscedasticity-consistent covariance matrix estimator and a direct test for heteroscedasticity," *Econometrica*, 48, 817-838.

[63] Wu, De-Min, 1973, "Alternative tests of independence between stochastic regressors and disturbances," *Econometrica*, 41, 733-750.

[64] Yoshida, Tomoo, 1989, "Tsuuka jyuyou no anteisei wo megutte," *Kinyu Kenkyu*, 8, 3, 99-147.