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Abstract

Using Japanese regional data, we have obtained estimates of the income elasticity of demand deposits that are positive, have values that are close to one, and are statistically significantly different from zero, not only during the period of the low interest rate policy implemented after 1995 but also during the period of the "zero interest rate policy." The stable relationship obtained from regional data could provide useful information by which to judge the stability of the money demand function.

Keywords: Zero interest rate policy; Demand for Money.
JEL classification code: E41, E52.

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I. Introduction

Since inflation is a monetary phenomenon, it is necessary to maintain money supply growth at a level sufficiently high to fight off deflationary pressures. This statement must be correct in almost all models of monetary economics, and therefore it is natural that many academic economists stress this point when considering the conduct of Japanese monetary policy under the zero interest rate policy.

However, there are other views regarding the relationship between money, price level and output (or income) under the period of low nominal interest rates. For example, Cole and Kocherlakota (1988) theoretically show that the behavior of money supplies does not determine the price level if the nominal interest rate is zero. Nakajima and Saito (2000) found that it was difficult to find a stable relationship between M1 and the industrial production index using Japanese time series data after 1995, when the low interest rate policy was introduced. Their results are consistent with their theoretical model in suggesting that the low interest rate policy itself creates nominal rigidity in the Japanese economy, so that the quantity theory of money does not work.

It is interesting to discover whether or not we can observe stable relationships between these three variables, using Japanese data from February 1999 to August 2000, during the period of implementation of the zero interest rate policy. Moreover, it would be nice if we could compare the changes in the relationship between money, price level and income before and after the introduction of the low interest rate policy.

It is difficult to distinguish a long-run statistical relationship from a short-run statistical relationship among those variables based on standard time series econometric methods because we have only a limited number of observations during the low interest rate policy period. Nonetheless, it is possible to estimate the long-run relationship between real money balances and real income given the level of interest rate cross-sectionally. From our point of view, the cross-sectional estimator and also the between estimator, which uses individual time series average data for cross-sectional regression, would both be promising statistical methods. The between estimator is expected to pick up long-run properties of statistical relationships (Baltagi (1995), and a famous example is Feldstein and Horioka (1980)). Moreover, the between estimator is robust to measurement errors in explanatory variables, specification errors in the statistical model, and non-stationarity of data series, if it is based on long-term data (Peasaran and Smith (1995), Phillips and Moon (2000)). Armed with cross-sectional estimators and between estimators, we may well consider the long-run relationship between money, price level and income. We restrict our attention to the estimation of demand deposits, which correspond to national M1 minus cash. We also restrict our sample period to the period after the year 1985, following Nakajima and Saito (2000).

One may wonder if cross-sectional estimates of the income elasticity of money demand could adequately be used for macroeconomic analysis. However, Fujiki and Mulligan (1996a) provide an example of a structural model that makes this method theoretically valid. In addition, Fujiki and Mulligan (1996b) and Fujiki (1999) show that this approach may be useful in the case of the Japanese regional panel data. Therefore, in this study we use regional monthly data on disposable income obtained from the *Family Income and Expenditure Survey* and monthly data on deposits at major Japanese banks in order to estimate the income elasticity of demand for money by households and firms cross-sectionally.

We find that the between estimator of the income elasticity of demand deposit are positive and are statistically significantly different from zero during the period of the low interest rate policy. The stable relationship obtained from regional cross-sectional data could potentially provide useful information with which to judge the stability of the money demand function.

The organization of this paper is as follows. Section 2 summarizes the theoretical model proposed by Fujiki and Mulligan (1996a). Section 3 explains the empirical model and data set. Section 4 reports the results of empirical analysis and discusses their policy implications. Section 5 concludes the paper.

II. Theoretical model [1]

Fujiki and Mulligan (1996a) show that a parametric model for production by households and firms leads to a conventional log linear money demand function, which depends on real income, nominal interest rate and the prices of production inputs . Specifically, they suppose that a household or firm *i* produces output *y* using input x_1 and transaction service *T* according to the production function shown in equation (1):

$$y_{it} = [(1-\lambda_f)x_{1,it}{}^{(\gamma-\beta)/\gamma} + \lambda_f(\frac{\gamma-\beta}{\gamma-1})T_{it}{}^{(\gamma-1)/\gamma}]^{\gamma/(\gamma-\beta)}, \quad (1)$$

$$\lambda_f \in (0,\ 1),\ \beta > 0,\ \gamma \in (0,\ \ \min(1,\ \beta)),$$

where λ_f and the other Greek letters are the parameters of a CES production function, subscript *i* means household i, and subscript *t* means time t.[2] Transaction service *T* is produced according to the following production function:

$$T_{it} = A_{it}[(1-\lambda_\phi)m_{it}{}^{(\psi_\phi-1)/\psi_\phi} + \lambda_\phi x_{3,it}{}^{(\psi_\phi-1)/\psi_\phi}]^{\psi_\phi/(\psi_\phi-1)}, \quad (2)$$

where *m* is the real money balance, x_3 is an input into the production of transaction service, *A* shows the level of technology, and the other Greek letters are parameters of the production function.

Agent *i*'s choice of *m*, x_1, and x_3 for period *t* will be determined by minimizing the rental cost *r* to produce output *y* subject to production functions (1) and (2), where *r* is :

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[1] This section depends heavily on Fujiki (1999) and Fujiki and Mulligan (1996b).

[2] It will be shown that β is a scale elasticity of money demand later. Equation (1) is homogenous degree one in x_1 and *T* if β=1.

$$r_{it} = q_{1,t}x_{1,it} + q_{3,t}x_{3,it} + R_t m_{it}\,, \qquad \textbf{(3)}$$

q_1 and q_3 represent the rental cost of x_1 and x_3, and *R* is the nominal interest rate. Minimizing equation (3) subject to equations (1) and (2) will yield the derived demand for money *m*, inputs x_1 and x_3 as a function of *y*, *R*, q_1 and q_3 for agent i.

Fujiki and Mulligan (1996a) show that firms' aggregate money demand is log linear in output (or, firm sales) *y* and nominal interest rate *R*, whose income elasticity is β, and interest rate elasticity is γ. This result is obtained under the assumption that sales, rental rates q_1 and q_3, and technology *A* are log normally distributed across firms: $\log y_{it} \sim N[\mu_{y,t}(f), \sigma^2_{yt}(f)]$, $\log q_{j,it} \sim N[\mu_{j,t}(f), \sigma^2_{jt}(f)]$, *j* =1,3, and $\log A_{it} \sim N[\mu_{A,t}(f), \sigma^2_{At}(f)]$.

Fujiki and Mulligan (1996a) also shows that households' aggregate money demand function becomes a log linear function of income I_{it} and the nominal interest rate, whose income elasticity is β and interest rate elasticity is γ, and the prices of inputs q_{it}. This result is also obtained under the assumptions that the expenditures of households are equal to their incomes, and that the household income, input prices, and the transaction technology follow lognormal distribution: $\log(I_{it}) \sim N[\mu_{i,t}(h), \sigma^2_{It}(h)]$, $\log(q_{j,it}) \sim N[\mu_{j,t}(h), \sigma^2_{jt}(h)]$, *j*= 1,3, and $\log(A_{it}) \sim N[\mu_{A,t}(h), \sigma^2_{At}(h)]$.

Let $N_t(f)$ be the number of firms, $y_t(f)$ be average firm sales, $m_t(f)$ be the real money balances of firms, N_t(h) be the number of households, I_t(h) be average household income, and m_t(h) be the average real money demand at date t. Define N_t as the size of the population at date t, and let $\eta_t(f)=N_t(f)/N_t$ and $\eta_t(h)=N_t(h)/N_t$ denote the number of firms and households per capita respectively. Finally, let ν_t be aggregate sales as a fraction of aggregate household income: $\nu_t=[N_t(f)/N_t(h)][y_t(f)/I_t(h)]$. Then, by adding firms' aggregate money demand and households' aggregate money demand, we obtain an expression (4) that approximates real money balances per capita:

$$
\begin{aligned}
\log(\frac{M_t}{P_t N_t}) &= \beta \log y_t(h) - \gamma \log R_t \\
&+ \pi_\phi(\psi_\phi - \gamma)[\omega \log \frac{q_{3,t}(f)}{R} + (1-\omega)\log \frac{q_{3,t}(h)}{R_t}] \\
&+ \omega\gamma \log q_{1,t}(f) + (1\text{-}\omega)(\gamma - \beta)\log q_{1,t}(h) \\
&- (1-\gamma)[\omega \log A_t(f) + (1\text{-}\omega)\log A_t(h)] \\
&+ [\omega \log \eta_r(f) + (1\text{-}\omega)\log \eta_t(h)] + \beta\omega[\log v_t + \log \frac{\eta_t(h)}{\eta_t(f)}] \\
&+ \frac{1}{2}\beta(\beta - 1)[\omega\sigma_{yt}^2(f) + (1-\omega)\sigma_{It}^2(h)] \\
&+ other\ \text{covariances weighted by } \omega, 1\text{-}\omega.
\end{aligned} \tag{4}
$$

Equation (4) shows that both the income elasticity of the money demand function, β, and the interest rate elasticity of the money demand function, γ, are equal to the structural parameters of the household and firm production functions. In other words, both the income and interest rate elasticities of the money demand obtained from households and firms are invariant to aggregation. Therefore, we can directly compare our empirical estimates obtained from cross-sectional data with those obtained from aggregate data. In practice, we do not have good proxies for A, q_1 or q_3 in estimating equation (4). However, given the relatively homogeneous and stable Japanese banking industry, we may safely assume that A, q_1, q_3 and R are constant in a cross section of regions. Therefore, by regressing real money balance on a constant term and real income cross-sectionally, we can estimate an income elasticity of money demand, β, even though we do not have good proxies for A, q_1, or q_3, because those variables are absorbed into the constant term.

However, we should be careful about the results obtained from cross-sectional approach. For example, the discussion above assumes that a regional specific shock that would shift money demand in a particular region is not correlated with the cross-sectional variation of income. However, this assumption may not be always satisfied. For example, regionally specific financial distress might induce households and firms to remove their deposits towards financial institutions located in a high-income area. In such a case, a cross-sectional approach might overstate the income elasticity of money demand.

III. Data and Statistical Model

We are now ready to estimate the income elasticity of money demand using panels of cross-sectional data. We have both annual data and monthly data series on regional employee income and money. We prefer to use annual data series because they include more reliable employee income statistics. However, annual series are published with a substantial time lag, and we have series only up to the 1998 fiscal year. Therefore, we present the results using monthly data and annual data simultaneously.

First, the *Annual Report on the Family Income and Expenditure Survey* compiled by the Statistics Bureau and Statistics Center, Ministry of Public Management, Home Affairs, Posts and Telecommunications of Japan provides monthly data on the nominal disposable income of worker households in each prefecture. Using the number of household members reported and the regional consumer price index, we can obtain constant-price-per-capita values of disposable income.[3] Unfortunately, the monthly prefecture data series of the *Family Income and Expenditure Survey* are very noisy. Therefore, in order to avoid transitory shocks and the difficulty of seasonal adjustment, we will use yearly average data. In addition, we think it is necessary to make regional aggregation for monthly disposable income data, instead of using prefectural disposable income series because these data series are subject to small sample bias. For example, the monthly disposable income of worker households in Kanagawa prefecture is reported to be higher than that in Tokyo, which is presumably the richest prefecture in Japan. This could be a result of sampling bias, which happens to pick up rich households in Kanagawa

[3] *The Annual Report on the Family Income and Expenditure Survey* also reports the pre-tax income of households. In the case of worker households, it is common that the taxes on wage earnings, which make up the majority of their earnings, are deducted before payment. Therefore, it seems to be more natural to regard disposable income as the relevant scale variable.

prefecture.

Regarding annual data, prefectural employee income statistics compiled by the Economic Planning Agency of Japan for each fiscal year provide a good counterpart to our monthly disposable income figures. We use employee income deflated by the gross prefecture expenditure deflator during the period from fiscal year 1985 to fiscal year 1998. Since we are using annual data, prefectural data are available and we increase the number of cross-sectional units to 47.

Second, data on demand deposits held by individuals and firms at domestically licensed banks by prefecture (end of month outstanding) are available from the *Monthly Economic Statistics* of the Bank of Japan (hereafter, MMF1 data).[4] MMF1 were computed for the period from January 1985 to August 2000. Due to the extension of the coverage of banks included in this statistics in April 1989 and occasional consolidations of banks, MMF1 data sometimes show an unusual increase, particularly in April 1989[5].

The caveats about MMF1 data are as follows. First, MMF1 data do not include cash[6]. Second, they do not have a breakdown by individuals and firms. Third, they do not include demand deposits at the community banks, the Norinchukin bank, and the Shokochukin bank, which are included in the computation of M1 statistics. However, Table 1 shows that MMF1 data are always about 70 percent of M1 during the period from 1985 to 1988, about 80 percent from 1989 to 1991, and about 70 percent from 1992 to 1999. Therefore, if we are careful about the sample periods, MMF1 is an almost a constant proportion of M1. All figures are deflated

[4] Domestically licensed banks include city banks, regional banks, regional II banks, trust banks and long-term credit banks. Note that regional data on the amount of currency held by individuals are not available.

[5] The data before March 1989 do not cover deposits at the regional II banks.

[6] In 1998, average M1 outstanding was 1,927 billion Japanese yen, while the average outstanding of banknotes in circulation was 482 billion Japanese yen.

by the regional consumer price index[7] and divided by the population in each region to obtain the per-capita real money balance.

Our empirical models are as follows. For monthly data series, we estimate a *between estimator* (hereafter $\hat{\beta}_{betw}$), which is an OLS estimator of equation (5),

$$\begin{aligned}\ln \overline{(Demand\ Deposit)}_j &= \alpha_{betw} + \beta 1_{betw}(\mathrm{j}) \ln \overline{(Disposable\ Income)}_j \\ &+ \beta 2_{betw}(\mathrm{j})\, \overline{(Population\ Density)}_j + u_j, \\ &\mathrm{j} = 1,\ldots,10, \quad T \text{ given}, \quad \overline{(X)}_j = (1/T)\textstyle\sum_1^T X_{jt}.\end{aligned} \tag{5}$$

where subscript *j* means region j, and subscript *t* means time t. Remember that it is important to control for the level of financial technology and the price of inputs in each region when estimating equation (4). To this end, we introduce population density (hereafter PD) as a conditioning variable following Fujiki and Mulligan (1996b)[8]. We set T to be 12 months, from April to March of a year later. Standard errors are computed by the method of White (1980).

For annual data series, we obtain a *cross-sectional estimator*, hereafter $\hat{\beta}_{cs}(t)$, which is an OLS estimator of equation (6),

$$\begin{aligned}\ln(Demand\ Deposit)_{it} &= \alpha_{cs}(t) + \beta 1_{cs}(\mathrm{t}) \ln(Employee\ Income)_{it} \\ &+ \beta 2_{cs}(\mathrm{t})\,(PD)_{it} + u_{it}, \\ &i = 1,\ldots,47, \quad t \text{ given}.\end{aligned} \tag{6}$$

where subscript *i* means prefecture and subscript *t* means fiscal year t (t = 1985,...1998). Standard errors are computed by the method of White (1980).

One may well consider using a fixed-effects model if we may safely assume that relevant long-run factors are fixed. It is well known that fixed-effects estimators tend to pick up short-run dynamics. Since we are mainly interested in the long-run income elasticity of money

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[7] The regional consumer price index (1995 average = 100) figures are taken from *the Annual Report on the Consumer Price Index* and the *Time Series Report on the Consumer Price Index Linked with 1995-base Figures*, compiled by Statistics Bureau and Statistics Center, Ministry of Public Management, Home Affairs, Posts and Telecommunications of Japan.

[8] Population statistics are available only once a year, on October 1. We transform the annual data into monthly data using a linear extrapolation formula. We use the fiscal year average of this monthly series as our PD variable. So

demand, we do not employ fixed-effects estimation and leave it for a future study.

IV. Results of regression and application

In this section, we report the estimates of the long-run income elasticity of the money demand using panels of cross-sectional data, and an application to the analysis of interest rate elasticity of money demand.

A. Results of cross-sectional estimation and between estimation

The second, third, fourth and fifth column of Table 2 show the between estimators of $\beta 1_{betw}$ and $\beta 2_{betw}$ of equation (5). All estimates are positive and their standard errors are small enough to reject the null hypothesis that those parameters are zero. The sixth column of the Table 2 shows the cross-sectional estimates of the income elasticities of money demand, i.e., $\beta 1_{cs}$, obtained in equation (6). Again, the cross-sectional estimates of income elasticity of money demand are positive and take reasonable values.

As Figure 1 shows, between estimators of income elasticity of money demand take the lower values than those of the cross-sectional estimators do except for the years 1985 and 1998. However, their sizes are not so different.

Why did the size of the cross-sectional estimator of income elasticities of money demand, $\beta 1_{cs}$ in equation (6), increase during the period from 1985 to 1989 and then decrease afterwards, as can be seen in Figure 1? First, one should be careful about the changes in the definition of the banks surveyed in the deposit statistics in 1989, which could have increased the deposits in local areas and may also have tended to bias downwards the income elasticities of money demand. Second, the increase in the income elasticities of money demand in 1990

far, I do not have a better alternative for the PD variable.

could reflect higher stock prices and the boom in the Japanese real estate market. Third, Japanese firms and individuals could employ sophisticated cash management technology owing to financial deregulation in those days. New financial technology might have reduced the amount of necessary demand deposits for the sake of transactions, and it might have reduced the value of the income elasticity of money demand after 1990.

Some readers may consider that larger firms would like to concentrate their funds in banks located in financial centers. Moreover, workers working in the downtown Tokyo area might use banks nearby their offices, although they live in nearby prefectures such as Kanagawa prefecture. If this conjecture is true, then the amount of deposits in Tokyo area is overvalued, and the income elasticity of money demand might be biased upwards. To check the robustness of our results, we drop Tokyo and Kanagawa prefectures, which are very rich prefectures, from the sample. Cross sectional estimators of the income elasticity of money demand, obtained from equation (6), both with and without those two prefectures, are plotted in Figure 2. We find the positive evidence regarding the hypothesis that the inclusion of richer prefectures would bias upwards the income elasticity of money demand. However, the two series of estimates of income elasticity of money demand seem to follow the same trend. Moreover, even after dropping two wealthy prefectures, the income elasticity of money demand is still statistically significantly different from zero[9].

Although the sizes of standard errors in the parameters are not so small, it may be said that the income elasticities obtained from between estimator $\beta 1_{betw}$ of equation (5) are stable except for fiscal 1995, as shown in Figure 1. Cross-sectional regressions based on a single year or just a few years of observations may not yield unbiased or consistent estimators. However, a cross-sectional estimator, when based on long time averages, i.e. a between estimator, is known

[9] The result of the between regression using the average sample from Fiscal 1985 to Fiscal 1998 yields the income

to provide a consistent estimator for long-run relationships (Peasran and Smith (1995)). It is interesting to see what are the results of a between regression using long-term averages of our data.

For example, the between estimator using the whole sample is 0.8735 (s.e. 0.099), as can be seen in the bottom panel of the second column in Table 2. The between estimator using the average sample from September 1995 to August 2000 yields an estimates of $\beta 1_{betw}$ as equal to 0.9498, as can be seen in Table 2. Therefore, even if we restrict our sample period to the period after the introduction of the low interest rate policy in the year 1995, $\beta 1_{betw}$ is stable and statistically significantly different from zero.

In February 1999, the Bank of Japan adopted the zero interest rate policy to "flexibly provide ample funds and encourage the uncollateralized overnight call rate to move as low as possible." In April 1999, the Bank of Japan declared that it was committed to a zero interest rate policy "until deflationary concerns are dispelled." From then on, the uncollateralized overnight call rate was stable at around virtually zero percent. On August 11, 2000, the Bank of Japan determined to end the zero interest rate policy to "encourage the uncollateralized overnight call rate to move on average around 0.25%."

It is interesting to see whether there are any substantial changes in the between estimates of income elasticity of money demand using the sample period from May 1999 to August 2000. The result of the between regression using the average sample from September 1999 to August 2000 yields an income elasticity of money demand of 1.209, as can be seen in the second column in the bottom panel of Table 2[10].

The income elasticity of money demand greater than one is consistent with the increase in

elasticity of money demand 0.976 (s.e.=0.194).

[10] Remember we are using seasonally unadjusted data. Therefore, we drop the sample from May 1999 to August

the demand for money in a situation where the risks are expressed by the variance of firm income and individual income because if $\beta > 1$, the expression of $\beta(\beta - 1)[\omega\sigma_{yt}^2(f) + (1-\omega)\sigma_{It}^2(h)]/2$ in equation (4) are positively correlated with $\sigma_{yt}^2(f)$ and $\sigma_{It}^2(h)$. Those factors might also explain the increase in the demand for money over time.

B. Application to the estimation of the interest rate elasticity of money demand

If one believes that a plausible estimate of the income elasticity of money demand could be obtained from between regressions, it is interesting to use the estimates to obtain the interest rate elasticity of money demand from time series data.

Let us suppose the average income elasticity of money demand to be 0.874. This value corresponds to the income elasticity of money demand obtained from the between estimator using time series average monthly data from March 1985 to August 2000, which is shown in Table 2. Now consider an application of this income elasticity of money demand towards time series data. More specifically, consider a relationship between {log (M1 per capita <seasonally adjusted monthly >/ CPI <seasonally adjusted monthly national average>) - 0.874*log (national average disposable income per capita[11]/CPI<seasonally adjusted monthly national average>)} and the uncollateralized overnight call rate (percentage)[12], which is plotted in Figure 3.

Figure 3 suggests a negative relationship between those two variables. For example, the ordinary least square estimates of log (M1 per capita/CPI)-0.874*log (Disposable income per capita/CPI) on log (Uncollateralized overnight call rate) yields an interest rate elasticity of -

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1999.

[11] The data is obtained from *the Family Income and Expenditure Survey*. We use national average data for worker households, seasonally adjusted by the X-11 procedure.

[12] For the year 1985, we use the collateralized call rate.

0.1084[13], that is, the estimate of γ in equation (4) is 0.1084.

According to Nakajima and Saito (2000), after the introduction of the low interest rate policy in 1995, the interest rate elasticity of M1 increased substantially. To check the robustness of our interest rate elasticity of money demand, I divide our sample period of data from January 1985 to November 2000 into two periods, and estimate the interest rate elasticity of money demand for each sample period.

The horizontal axis in Figure 4 corresponds to break points of the sample. The thin solid line in Figure 4 shows our estimates of interest rate elasticity of money demand obtained from the data before the break points (the first sample), and the thick solid line shows the interest rate elasticity of money demand obtained from data after the break points (the second sample). The dotted lines show the upper and lower bounds of the interest rate elasticities, which are constructed by adding and subtracting two times the standard error of the estimated coefficients[14]. Figure 4 shows that if we restrict the sample period to recent data (the second sample), the size of the interest rate elasticity of money demand increases.[15] In contrast, the interest rate elasticity of money demand using the data from January 1985 onward (the first sample) takes small negative values even after 1990.

Our evidence suggests that the interest rate elasticity of money demand increased

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[13] Note that both log (M1 per capita/CPI)-0.874*log (Disposable income per capita/CPI) and log (Uncollateralized overnight call rate yields) have unit root (Test statistics are -1.70 (lag=1) and -2.70 (lag=10)). Moreover, those two series are cointegrated based on the residual-based ADF test (the test statistic is -2.10, while the 5% critical value is -1.99) without any deterministic trend or constant. The dynamic OLS method (in which the lag and lead lengths are both 2) yields the estimates of γ to be –0.1089 (s.e.=0.00064). Therefore, it may well be said that the interest rate elasticity is negative and statistically significant. Nonetheless, if one takes the view that the call rate is set exogenously by the Bank of Japan, the estimation made by OLS makes sense.

[14] For most of the sub-sample periods of more than 36 months, both log (M1 per capita/CPI)-0.874*log (Disposable income per capita/CPI) and log (Uncollateralized overnight call rate yields) have unit root according to the ADF t-statistics. In the first sample, the two series after the division points between 1992 and 1997 are cointegrated, therefore the discussion here is for the sake of exposition only.

[15] The qualitative nature of this result is not sensitive to small changes in the value of income elasticity, for example

substantially after the introduction of the low interest rate policy around 1995. However, there are many caveats to taking those results at face value. First, we have not yet provided one of the most important variables to be included in the regression, i.e. the level of financial technology. Second, as Figure 3 shows, the changes in the uncollateralized overnight call rate are very small. This factor could contribute to the instability of estimates of interest rate elasticity, which could be far larger than the standard errors shown in Figure 4. Third, even if the use of *the Family Income and Expenditure Survey* data is acceptable, it is well known that the time series estimates and cross-sectional estimates may not agree with each other, depending on the nature of the variables under study (Mirrases (1990)). Fourth, the model introduced in this paper does not take into account of the nominal rigidity or zero bound of the nominal interest rate.

With those reservations, our results support stable long-run income elasticities of money demand even after 1995, but the choice of a particular value of income elasticity of money demand is not essential for the increase in the interest rate elasticity of money demand observed after 1995. The results are broadly consistent with the finding made by Nakajima and Saito (2000), which reports that the relationship between the index of national industrial production (IIP) and M1 is unclear after the year 1995 but that the interest rate elasticity of money demand increased substantially using a time series method.

C. Possible interpretations and policy implications

Although our results are very preliminary, it is tempting to speculate on the reasons why the value of the interest rate elasticity of money demand might have increased after 1995.

One answer is nominal rigidity created by the low interest rate policy, as argued by Nakajima and Saito (2000). Another possibility is that the economic slump and financial

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using 1.086 or 0.950 instead of 0.874.

panics[16] in those periods changed the attitude of firms and households regarding the demand for liquidity. We have some statistical data that support this view.

First, regarding the behavior of households, according to national aggregate M1 data, the proportion of deposits made by individuals increased substantially especially from the middle of 1995 to 1996 onward (Figure 5). According to the *Public Opinion Survey on Household Savings and Consumption*[17], the proportion of households who regard safety (or, low risk) and liquidity, rather than profitability, as the most important factors to be considered when selecting financial products for their savings increased after 1995 (Figure 6). Therefore, some of the increase in the demand for money could reflect the demand for safe and liquid assets under the low interest rate policy.

One may wonder why Japanese households do not try to hold more risky assets, say, stocks or foreign assets, and why they accept low returns from domestic assets. Regarding this point, the *Public Opinion Survey on Household Savings and Consumption* shows that from 1996 to 2000 only 15 percent of household answered that they increased the holdings of high return, presumably risky, assets, recognising that they were living in a period of low interest rates. This finding may reflect the situation in which the appreciation of yen up to 79.75 yen/dollar on April 19, 1995 and declining stock prices in the first half of 1995 induced Japanese households to refrain from investing in stocks or foreign bonds. In addition, according to the *Public Opinion Survey on Household Savings and Consumption,* Japanese households mainly save to prepare for their spending after retirement, children's education, and to provide a buffer stock in case of illness or accidents. Therefore, Japanese households may

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[16] The failure of credit cooperatives and the non-performing loans accumulated in the Specified Housing Loan Companies in 1995, the collapse of Sanyo Securities, Yamaichi Security, and Hokkaido Takusyoku Bank in November 1997, and so forth.

[17] The Central Council of Saving Information conducts this survey once a year for Savings Information. It covers

well have every reason to keep increasing the demand for money, even though the rate of return is so small.

Second, regarding the behavior of firms, according to national aggregate M1 data, the proportion of deposits made by firms has been on a downward trend since 1985, but after 1998 the demand deposits of firms increased substantially (Figure 5). Looking at the diffusion index of Lending Attitudes of Financial Institutions and Financial Positions (All Industries, Major Firms, Diffusion Index (%)) of the "Tankan" complied by the Bank of Japan, in Figure 7, firms do feel that the banks' lending attitudes became extremely severe from the fourth quarter of 1997 onward, and that firms' financial positions did not deteriorate quickly. The evidence suggests the possibility that even under the low interest rate policy, the perceptions of firms regarding the adequate level of liquidity might have changed dramatically after 1997. One might say that γ might be an increasing function of firms' perceptions regarding banks' lending attitudes, which could change over time.

This evidence suggests the following policy implications. The funds supplied under a low interest rate policy may be absorbed by the increase in the demand for liquidity at a constant level of income, reflecting the preference for safe assets by firms and households. If this conjecture is correct, one should be careful about overstating the long-run effects of quantitative easing in the short run during a low interest rate period, such as the increase in the demand for more risky assets, and the increase in the broad money supply, stock prices, spending and the future price level. Those considerations suggest that there are risks in applying the standard argument of quantitative easing, which is based on the indisputable long-run supply side properties of monetary economics, to the debate of short-run economic policy discussion. We should be more careful about the distinction between the short-run

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approximately 4,000 Japanese households.

demand for money and the long-run demand for money by households and firms.

V. Conclusion

Our monthly cross-sectional data yield stable estimates of the income elasticities of money demand using a between estimator except for the year 1995. Those results are broadly consistent with the evidence based on the cross-sectional estimators using annual data. The between estimates of the income elasticity of demand deposit are positive and statistically significantly different from zero during the period of the low interest rate policy. We do not obtain a stable interest rate elasticity of money demand even if we control for the size of income elasticity of money demand. In particular, the absolute size of interest rate elasticity tends to take on a large value using the sample of data after 1995.

The results show that if the Bank of Japan considers the future changes in the nominal interest rate, it may be better to have many estimates of both income elasticity and of the interest rate elasticity of money demand based on various statistical methods. The cross-sectional approach pursued in this paper could be one of the ways to enhance the robustness of its understanding regarding the transmission mechanism under conditions of low interest rates.

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Table 1: Proportion of deposits to monetary aggregates

Fiscal Year	MMF1/M1
1985	0.7027
1986	0.7039
1987	0.6995
1988	0.6965
1989	0.8034
1990	0.8112
1991	0.7729
1992	0.732
1993	0.7165
1994	0.7023
1995	0.7017
1996	0.6993
1997	0.6979
1998	0.6835
1999	0.6805
2000 April-June	0.655

Source: Bank of Japan.

Note: The Japanese fiscal year 1995 corresponds to the period from April 1995 to March 1996. The M1 figure is based on the fiscal year average of monthly outstanding data. The MMF1 figure is computed from the average of end-of-month outstanding data.

Table 2: Estimates of employee income /disposable income elasticity and population density (PD) elasticity

	Between Estimator Equation (5) Monthly Household Survey Data				Cross Sectional Estimator Equation (6) Annual Data			
	Income	s.e.	PD	s.e.	Income	s.e.	PD	s.e.
Fiscal 1985	0.99450	0.14340	0.00136	0.00005	0.76079	0.30539	0.00030	0.00005
Fiscal 1986	0.88780	0.22420	0.00137	0.00009	0.99132	0.29051	0.00028	0.00005
Fiscal 1987	0.77520	0.21410	0.00134	0.00009	1.12522	0.24893	0.00027	0.00005
Fiscal 1988	0.89090	0.30900	0.00134	0.00011	1.25849	0.28729	0.00025	0.00005
Fiscal 1989	0.68980	0.23680	0.00105	0.00009	1.22457	0.23525	0.00021	0.00004
Fiscal 1990	0.84460	0.23060	0.00108	0.00008	1.32475	0.22695	0.00020	0.00004
Fiscal 1991	0.82120	0.23210	0.00098	0.00008	1.10974	0.20341	0.00020	0.00005
Fiscal 1992	0.75670	0.15320	0.00093	0.00006	1.02935	0.22167	0.00019	0.00005
Fiscal 1993	0.79870	0.20040	0.00086	0.00007	0.99420	0.23099	0.00018	0.00004
Fiscal 1994	0.77740	0.12930	0.00083	0.00005	0.87606	0.21581	0.00018	0.00004
Fiscal 1995	0.63890	0.17290	0.00077	0.00007	0.93815	0.21487	0.00017	0.00004
Fiscal 1996	0.77950	0.19830	0.00079	0.00007	0.93957	0.20038	0.00016	0.00004
Fiscal 1997	0.89090	0.22340	0.00078	0.00008	0.97909	0.19854	0.00016	0.00004
Fiscal 1998	1.03270	0.23140	0.00080	0.00008	0.78868	0.27128	0.00017	0.00004
Fiscal 1999	1.12890	0.30710	0.00094	0.00010				
All sample	0.87350	0.09960	0.00101	0.00005	1.07132*	0.216217*	0.000195*	0.000043*
Sep.95- Aug. 2000	0.94980	0.17170	0.00082	0.00004				
Sep. 99-Aug. 2000	1.20927	0.25290	0.00091	0.00005				

Note: The estimation method is OLS. * shows the results of between estimation using annual data time series mean from the 1985 fiscal year to the 1997 fiscal year. Standard errors are computed by the method of White (1980). The estimations include a constant term as the set of explanatory variables. Equation (5) has ten observations for each fiscal year, and equation (6) has forty-seven observations for each fiscal year.

Figure 1: Income elasticity of money demand

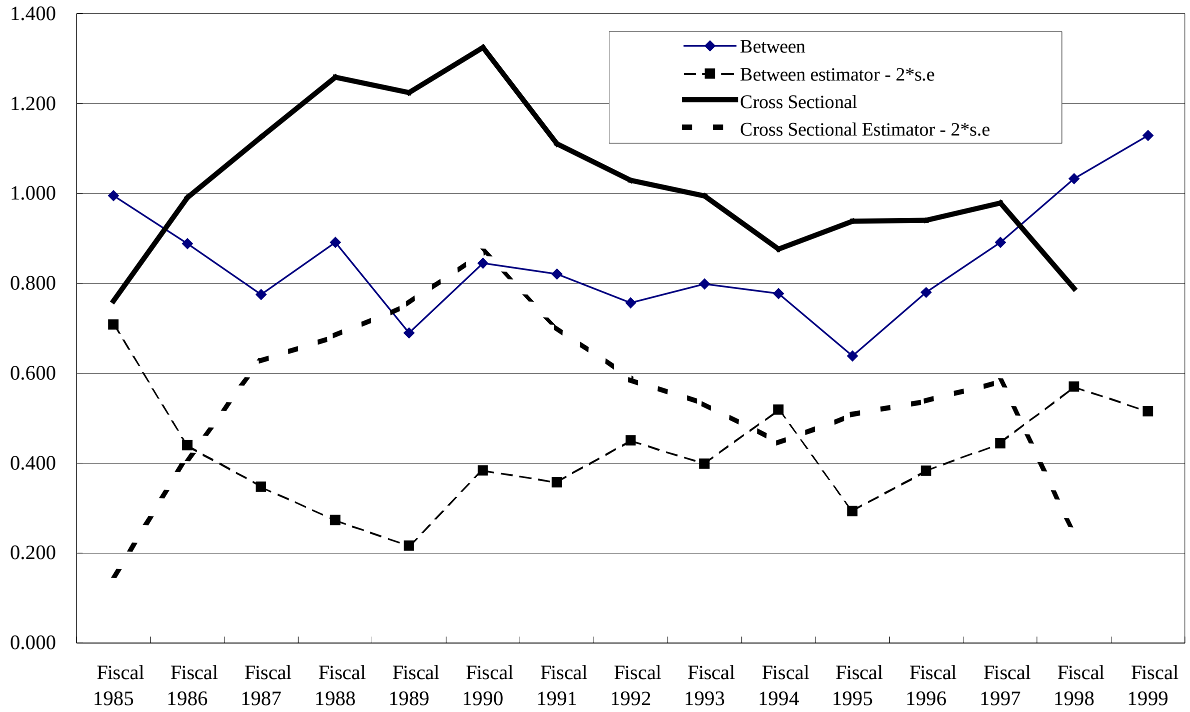


Figure 2: Income Elasticity of Money Demand obtained from the cross sectional estimator and those obtained by dropping Tokyo and Kanagawa prefectures

Figure 3: Log (M1/CPI)-0.874*log (Disposable income/CPI) and call rate

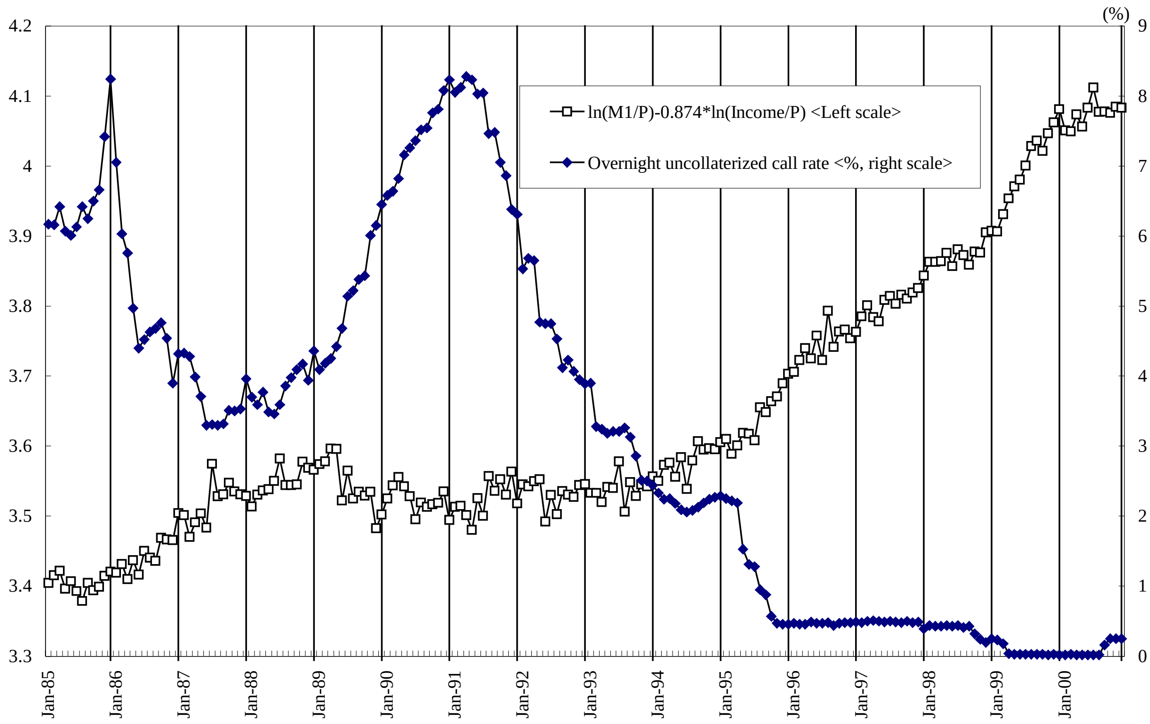


Figure 4: Interest rate elasticity of money demand

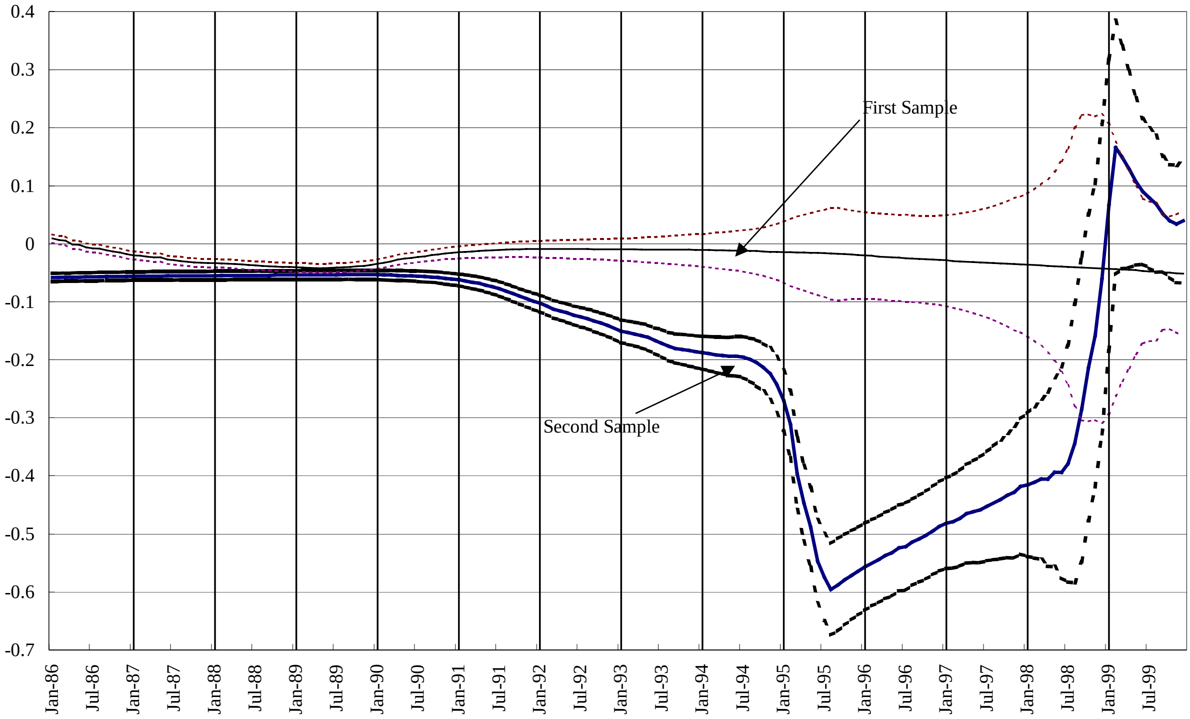


Figure 5: Annual percent changes in M1 components

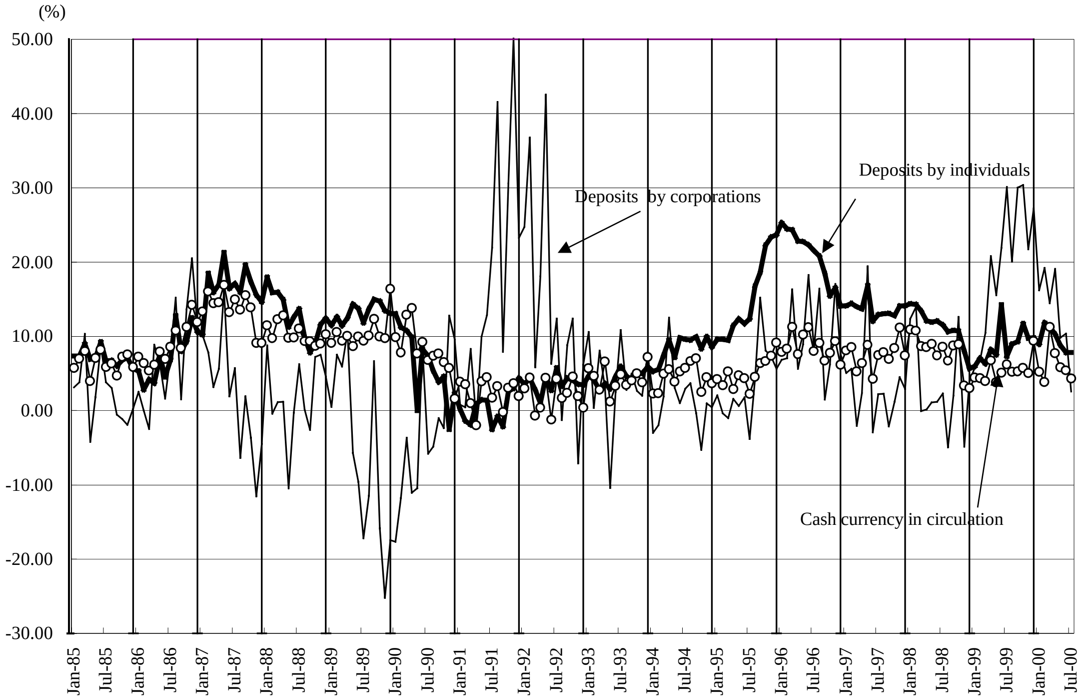
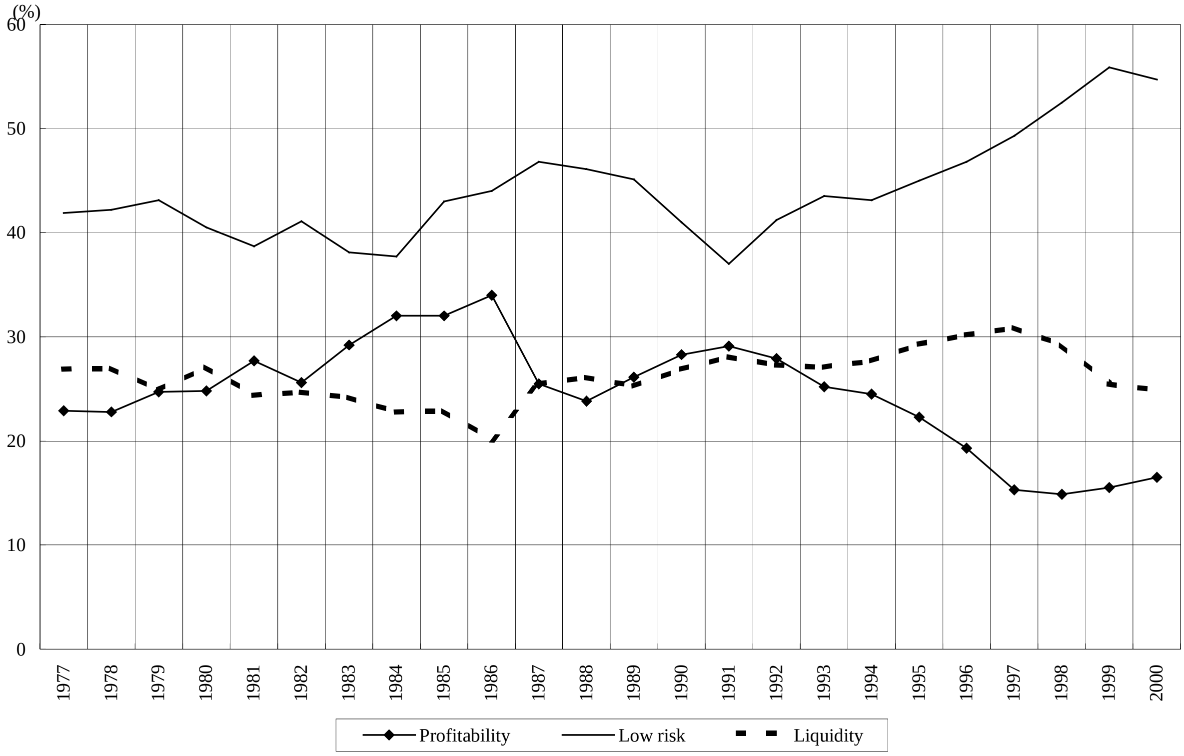


Figure 6: The most important factors determining the selection of financial products



Source: *Public Opinion Survey on Household Savings and Consumption*, the Central Council for Savings Information, various years.

Figure 7: Tankan diffusion index