Japanese money demand: Evidence from regional monthly data

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6 February, 1998

Abstract

This study estimates the Japanese money demand function by household using seasonally adjusted panel data following Fujiki and Mulligan (1996a, b). The most plausible estimates of the income elasticity of money demand are in the range from 1.28 to 1.35 for the period from 1990 to 1995. These results are robust with respect to the choice of scale variables, and consistent with the estimates based on seasonally unadjusted monthly data and annual data. The stable relationship obtained from regional panel data provides useful information with which to judge the stability of the money demand function for the central bankers.

Key Words: Panel Data, Demand for Money
JEL Classification: E41, E52

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This paper benefits from joint works with Casey B. Mulligan, and the author thanks him for his helpful comments. The author also thanks Shigenori Shiratsuka, Toshitaka Sekine, and seminar participants at Hitotsubashi University, Kansai Economic Research Center, and Biwako Conference, for their helpful comments on the earlier version of this paper. Ms. Toshiko Kodera provided excellent research assistance.

1. Introduction

The stability of the money demand function is an important subject for investigation. For policy makers, the stable income elasticity of money demand is a key condition for the success of monetary policy based on monetary targets. For academic researchers, the quantification of the long run relationship between money and nominal income through the newly developed time series econometric techniques has been one of the most challenging fields of study. Although there are many studies on the Japanese money demand function, Sekine (1997) concludes that the the stability of Japanese M2+CDs demand function is still an open question. For example, Miyao (1996) shows that the stability of the money demand function is not supported by econometric estimates based on the idea of cointegration. However, it is not easy to classify Japanese macro-economic variables including M2+CDs and real GDP into I(0) variables and I(1) variables. This is because most Japanese macro-economic variables have structural breaks in the early 1970s as Soejima (1995, 1996) has shown. In addition, practically, it is difficult to make a good seasonal adjustment for recent data, simply because we lack information about the seasonality in the most recent year. Those considerations suggest that it would be valuable to have some other ways to judge the stability of the money demand function.

Following Fujiki and Mulligan (1996b), this study uses regional monthly data from consumption and deposit surveys performed by major Japanese banks to estimate the income elasticity of demand for money by households through cross-sectional regression. While restricting our attention to the demand for money by households, the cross-sectional money demand function can be estimated *every month.* It is interesting to check the stability of the cross-sectional monthly money demand function over time, since the stability of the aggregate money demand function is still an open question.

Estimates of the income elasticity of money demand obtained from regional monthly data are in the range from 1.28 to 1.35 during the period from 1990 to 1995. These results are robust with respect to the choice of scale variables for the money demand function. Moreover, these results are broadly consistent with the results using seasonally unadjusted data and annual data. Thus, the stable relationship obtained from the panel of monthly cross-sectional data might provide useful information with which to judge the stability of the money demand function. Note that the results reported in this paper are based on household data. Therefore, further investigation based on data obtained from firms will be necessary.

The organization of this paper is as follows. Section 2 briefly summarizes the model proposed by Fujiki and Mulligan (1996a) and discusses why cross-sectional data is useful in the estimation of the money demand function. Readers can find a literature review on the Japanese money demand function in Sekine (1997). Section 3 explains the data set. Section 4 reports the results of regression analysis. Section 5 concludes the paper.

2. Theoretical model

Fujiki and Mulligan (1996a) show that a parametric model for production by households leads to a conventional log linear money demand function which depends on real income, the interest rate and some prices. Specifically, they suppose that a household 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 other Greek letters are the parameters of a CES production function, subscript i means household i, and subscript *t* means time t. 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 other Greek letters are parameters of the production function. Household *i*'s choice of *m*, x_1, and x_3 for period *t* will be determined by minimizing the rental cost of producing output *y* subject to production functions (1) and (2), where the rental cost *r* is:

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

q_1 and q_3 represent the rental cost of x_1 and x_3, and *R* is the opportunity cost of money.

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. However, the derived demand for money obtained in this way is not useful for the sake of empirical analysis because household production, *y*, is unobservable. Therefore, we first plug the derived demand functions for *m*, x_1 and x_3 into the right hand side of equation (3) to express rental cost *r* as a function of *y*, *R*, q_1 and q_3. By inverting this cost function, we can express output *y* as a function of *r*, *R*, q_1 and q_3. Using this relationship, we can eliminate output *y* from the derived demand for money. With an additional assumption that the cost (i.e., expenditure) of a household is equal to the income of a household, we obtain the money demand function of a household as a function of income and the prices of inputs, but independent of *y*:

$$\log(m_{it}) \approx \beta \log(I_{it}) - \gamma \log(R_t) + \pi_\phi(\psi_\phi - \gamma)\log\left(\frac{q_{3,it}}{R_t}\right) + (\gamma - \beta)\log(q_{1,it}) - (1-\gamma)\log A_{it} + constant, \quad (4)$$

where I_{it} is the household income, which is assumed to be equal to r_{it}.

Suppose further that the input prices and the transaction technology follow the log normal distribution such that:

$$\begin{aligned} &\log(I_{it}) \sim N[\mu_{I,t}(h), \sigma^2_{It}(h)], \\ &\log(q_{j,it}) \sim N[\mu_{j,t}(h), \sigma^2_{jt}(h)],\ j = 1,\ 3,\ \text{and} \\ &\log(A_{it}) \sim N[\mu_{A,t}(h), \sigma^2_{At}(h)], \end{aligned} \quad (5)$$

and let $N_t(h)$ be the number of households, $I_t(h)$ be the mean income of households, and $m_t(h)$ be the average real money demand. Under those assumptions, the aggregate household demand for money takes on the following log linear form, whose income and interest rate elasticities are the same as its micro counterpart, equation (4) :

$$\begin{aligned} \log(m_t(h)) = {} & \beta \log(I_t(h)) - \gamma \log(R_t) + \\ & \pi_\phi(\psi_\phi - \gamma)\log\left(\frac{q_{3,t}(h)}{R_t}\right) + (\gamma - \beta)\log(q_{1,t}(h)) - (1-\gamma)\log A_t(h) \\ & + \frac{1}{2}\beta(\beta - 1)\sigma^2_{It}(h) + \frac{1}{2}\pi_\phi(\psi_\phi - \gamma)[\pi_\phi(\psi_\phi - \gamma) - 1]\sigma^2_{3t}(h) \\ & + \frac{1}{2}(1-\gamma)(2-\gamma)\sigma^2_{At}(h) + \frac{1}{2}\pi_\phi(\gamma - \beta)(\gamma - \beta - 1)\sigma^2_{1t}(h) \\ & + \text{covariances} + \text{constant}. \end{aligned} \quad (6)$$

In summary, under the parametric production function model, the income and interest rate elasticities of the money demand function are equal to the structural parameters of the household production function. Moreover, the income and interest rate elasticities of the money demand function obtained from individual relationships are invariant to aggregation over households.

Therefore, we can directly compare the empirical estimates obtained from individual data with those obtained from aggregate data. This means that the study using micro data can provide some macro-economic policy implication for policy makers.

The obvious problem in estimating equation (4) is that we do not have good proxies for A, q_1 or q_3. However, suppose that in Japan, all households have fairly equal access to financial technology following Fujiki and Mulligan (1996b). At least we may safely assume that A, q_1, q_3 and R are constant in a cross section of regions. Therefore, by regressing the real money balance on a constant term and real income cross sectionally, we can estimate the income elasticity of money demand even though we do not have good proxies for A, q_1, or q_3, because those variables are absorbed into the constant term. Thus, the results obtained from cross-sectional monthly data will arguably provide useful information for the conduct of monetary policy.

3. Data

3.1. Regional data for personal deposit

Data on outstanding individual deposits at the end of each month in "all banks" by prefecture are available from *Monthly Economic Statistics* of the Bank of Japan.[1] Ten time series of regional money stock for individuals, hereafter called MMFP, were computed for the period from January

[1] The classification "all banks" includes commercial banks, long term credit banks, and trust banks. The commercial banks include city banks, regional banks, and foreign banks resident in Japan. Note that regional data on the amount of currency held by individuals are not available.

1985 to December 1995 by aggregating the prefecture data.[2] For the sake of comparison, all figures are deflated by the regional consumer price index (1990 average = 100) from the *Annual Report on the Consumer Price Index* and the *Time Series Report on the Consumer Price Index Linked with 1990-base Figures*, compiled by Statistics Bureau, Management and Coordination Agency Japan, and divided by the population in each region to obtain the per-capita real money balance.

There are several considerations to be made about MMFP data. First, MMFP data does not allow us to distinguish demand deposits from savings deposits if we focus on individual deposit data. Second, MMFP data includes the deposits of small businesses for the sake of business operations as long as the deposits are made in the name of an individual. Third, due to the extension of the coverage of "all banks" in April 1989, MMFP data show an unusual increase in April 1989. Finally, MMFP data covers the deposits in "all banks" but does not include the deposits in the Japanese post office and the Japanese agriculture and forestry cooperation. As can be seen in Table 1, while MMFP data always explains about forty percent of total individual deposits during the period from 1985 to 1995, a substantial percentage of individual deposits exist in the post office and agricultural cooperatives. Nonetheless, the proportion of deposits in the major financial institutions is stable throughout the sample period. Note also that the demand deposits and time deposits held by individuals explain about 53-59% of total M2+CDs during the period from 1985 to 1995, as the bottom row of Table 1 shows.[3] Therefore, MMFP data covers

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[2] The regional classification of prefectures is based on the classification by the *Annual Report on the Family Income and Expenditure Survey*.

[3] The financial institutions used to compile M1 and M2+CDs are "all banks," the community banks, the Norinchukin bank, and the Shokochukin bank. M2+CDs does not include deposits in the post offices, the agricultural and fishery cooperatives, the credit cooperatives, or the labor credit associations.

a fairly stable proportion of national monetary aggregates. The income elasticity of money demand by households will not be seriously biased because we can predict about 40% of individuals deposits using MMFP data.[4]

3.2 Scale variables

The Annual Report on the Family Income and Expenditure Survey compiled by the Statistics Bureau, Management and Coordination Agency of Japan provides data on the nominal consumption and disposable income of worker households in each region. Using the number of household members reported and the regional consumer price index, we can obtain constant-price-per-capita values of consumption and disposable income.[5] Consumption is also a relevant scale variable since we have derived equation (4) under the assumption that income equals expenditure, however, this assumption may not hold. Moreover, since we will use data on the sum of demand deposits and time deposits held by the individual, one might think that wealth is the relevant scale variable. Since the *Annual Report on the Family Income and Expenditure Survey* only reports the changes in the financial wealth rather than the stock of financial wealth held by families, we might regard consumption as a proxy for wealth based on the permanent income hypothesis.

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[4] Monthly regional data on the amount of deposit in the post office are unavailable.

[5] *The Annual Report on the Family Income and Expenditure Survey* also reports the pre-tax income of households. For 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. Hence it seems to be more natural to regard the disposable income as a relevant scale variable.

3.3. Conditioning variables

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). Population changes only gradually, but picks up some important information about the degree of urbanization. Hence we expect that PD will be useful to capture the differences in the financial technology and prices of inputs. We also introduce data on the number of branches of all banks per capita in each region (hereafter Branch). Remember, we are using data collected from "all banks" which used to have been allowed to open branches intensively in urban areas by the Japanese Ministry of Finance. It is possible that such banks have better financial technology than the local financial institutions. Therefore, the Branch variable might be a good proxy for the level of financial technology in each region.[6]

3.4. Seasonal adjustment

It is well known that Japanese monthly household disposable income and consumption show strong seasonal fluctuation in June and December due to "bonus" payments. Therefore, before moving on to the regression analysis, we compute seasonally adjusted series of regional CPI, nominal income, nominal consumption, and MMFP via the X-12-ARIMA procedure. We use the

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[6] Population statistics are reported once a year, on October 1. We transform the annual data into monthly data using a linear extrapolation formula to interpolate the missing observations other than October. We add up the monthly population of each prefecture to construct monthly regional population data. We apply the same procedure to

"Final trend component of seasonally adjusted data" computed by the X-12-ARIMA procedure, which takes out of irregular component of seasonally adjusted series.[7]

4. Results of regression

4.1. Cross-sectional regression

Figure 1 summarizes the results of cross-sectional regression of log(MMFP per capita/CPI) on a constant term and log(nominal disposable income per capita/CPI). The horizontal axis shows the sample period used for the regression, and the solid line shows the estimates of income elasticities in each month. Two dashed lines represent the upper and lower bounds of the income elasticities, which are constructed by adding or subtracting two times the standard error of the estimated income elasticity in each month computed by the method of White (1980). The estimates of income elasticities are gradually increasing in 1989, falling in early 1990, and become somewhat stable after 1991, with an average of 1.1078. However, the standard errors of the estimated income elasticities are so large that before 1988 and during 1990, we cannot reject the null hypothesis that the income elasticities are zero.

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construct the Branch variable.

[7] The X-12-ARIMA first applies a SARIMA model to the original series and estimates an adjusted series that takes away level shifts and outliers in the original series, if there are any. For the sake of SARIMA estimation, the AUTOMDL command of the X-12-ARIMA package selects the best model from SARIMA (011) (011), SARIMA (012) (011), SARIMA (210) (011), and SARIMA (212) (011) with the criterion of forecast performance and serial correlation of error terms in those models. Next, the X-12-ARIMA applies the standard X-11 procedure to the adjusted series obtained in the first stage. For more details, see the *X-12-ARIMA Reference Manual, Beta Version 1.0*, September 12, 1995, Time Series Staff, Statistical Research Division, Bureau of the Census.

Figure 2 shows the cross-sectional estimates of the income elasticities of money demand after adding PD as an additional explanatory variable. As can be seen from Figure 2, the estimates of income elasticities are somewhat larger than those shown in Figure 1, (the mean of the income elasticities shown in Figure 2 is 1.2286), and they are significantly larger than zero for most of the periods. Figure 3 shows the estimates of PD elasticities of money demand, which are positive and significantly different from zero. Their average between January 1985 and December 1995 is 0.2545. While we find a jump in April 1989 due to the changes in the definition of "all banks" in prefecture deposit statistics, the estimates of PD elasticities are pretty stable except for this jump.[8]

What explains the increase in the estimates of income elasticities during the period 1985-1989 shown in Figure 2? One answer may be financial innovation. The gradual liberalization of interest rates and the lower limit for large time deposits starting in 1985 enabled "all banks" to attract larger amount of time deposits from individuals. If richer individuals in richer regions deposit larger amounts of money compared with the other regions, it is possible that we will find an increase in the cross-sectional income elasticity of money demand. The other plausible answer is that the increase in the price of land in urban areas leads to the increase in deposits in those areas, whose rate of increase is faster than that of current income. The unstable estimates of income elasticities during the period from 1989 to 1991 could be a statistical artifact, since deposits in the Shikoku region increased substantially due to the changes in the coverage of all banks in March 1989. On the other hand, the income in the Shikoku region in this period shows an unusual

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[8] One might wonder if the results here might be a statistical artifact because the author is constructing the PD variable by transforming annual data of population into monthly data by a linear interpolation formula. Even if we use the PD variables holding the population within a year constant (hereafter call this variable PD2), the difference between the estimates of income elasticities using PD and those using PD2 is only 0.00392 on average. The difference between the estimates of PD elasticities using PD and those using PD2 is 0.000879 on average.

decline in the middle of a boom. Somewhat unstable estimates of income elasticities during 1993 could be explained by unusual increases in incomes in the Shikoku, Okinawa, and Hokuriku regions, for which we do not have a good explanation.

We conjectured that some movement of income elasticities could be explained by the changes in the regional distribution of “all banks.” Therefore, it may be possible to obtain more stable estimates of the income elasticity of money demand if we add the Branch variable into the set of conditioning variables. Figure 4 compares the income elasticities obtained using the cross-sectional estimation with PD as the conditioning variable with those including both PD and Branch. By adding the Branch variable, we obtain slightly larger income elasticities compared with the estimates conditioned only on PD during the periods from 1989 to 1990, and they are significantly different from zero as conjectured.

4.2. Pooling estimation

Next we test the robustness of the income elasticities estimates using panel data. We pool all of the data available, add aggregate time dummies, and then make the sample periods shorter. We do not intend to conduct an analysis based on the dynamic model of money demand shown in Fujiki and Mulligan (1996a).

Table 2 shows the estimates of income elasticities and PD elasticities using various sample periods, although the estimates of time dummies are not reported. Observe that the income elasticities are pretty stable around the range from 1.19 to 1.35. We test whether the restrictions of holding both income elasticities and PD elasticities constant over the sample period are justified using the F-test. As can be seen in the fifth column in Table 2, based on post-1989 data, we could not reject the null hypothesis that both income elasticities and PD elasticities are constant over time, and we may safely conclude that the income elasticities take values between 1.27 and 1.35. The results are consistent with the results obtained by Fujiki and Mulligan (1996b), which find that the plausible range of the income elasticity of money demand is 1.2-1.4 based on cross-sectional estimation using annual prefecture data which are close to M2 minus currency. Table 3 reports the results of pooling regressions holding PD and Branch constant, and as expected, the estimates of income elasticities take values between 1.33 and 1.45. However, the p-values of the F-test show that pooling estimation is valid only after 1992.

Now let us include R instead of aggregate time dummies as an additional explanatory variable in equation (4). We originally included time dummies hoping that they would capture the effect of A, q_1, q_3 and R altogether in equation (4). Once we include R (here we use the overnight call rate, collateralized), it is impossible to add time dummies simultaneously. However, if R, q_1, and q_3 are not correlated and both q_1 and q_3 are constant, then the choice of R and the time dummies should not affect the results of estimation so much. Note that we also add a dummy variable that takes the value of one after April 1989 for each region to take care of the effect of exogenous changes in the MMFP statistics due to the changes in the definition of "all banks". Table 4 reports the results of pooling regression. Observe that after 1990, the results reported in Table 4 and Table 2 are almost identical with respect to the estimates of income elasticities and PD elasticities of money demand. The results strongly support our view that cross-sectional data can be used to estimate the income elasticity of money demand.

Some readers might wonder why we do not report results obtained from a fixed-effects model. Indeed, Mulligan and Sala-i-Martin (1992) argue that if there are differences in the financial sophistication of banks, and the structure of banking industries and the levels of prices among regions are persistent, fixed regional effects should adequately reflect the difference. Since the structure of the Japanese banking industry has been fairly stable due to regulation by the Ministry of Finance, the use of a fixed-effects model might make sense. However, note that it is well known that fixed-effects estimators tend to pick up short run dynamics of the data. Moreover, we are using aggregate data on deposits on the one hand and the household survey for income on the other, hence, strictly speaking, income is not correctly measured. In the presence of measurement errors in the explanatory variables, a fixed-effects estimator will bias the estimator downward as Mairesse (1990) has shown.[9] Therefore, we would like to put aside the fixed-effects model since we are more interested in the long run behavior of money demand for the sake of policy recommendations.[10]

4.3. Choice of scale variables

Consumption might be a relevant scale variable in equation (4) if the assumption that income equals expenditure does not hold, or if the wealth effect is important as Sekine (1997) has stressed and consumption is a better proxy of permanent income than current income.[11] Figure 5 reports the results of cross-sectional regression using log(nominal consumption per capita/CPI) instead of log(nominal disposable income per capita/CPI) together with PD. The thick solid line shows the

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[9] We obtain *negative* estimates of the income elasticity of money demand when we include the set of fixed regional effects as an additional explanatory variable.

[10] Using the sample periods of 1990-1995, the consistent estimator with respect to the random measurement error suggested by Gliliches and Hausman (1984) yields an estimate of income elasticity of 0.277 (s.e. = 0.023).

[11] From the theoretical viewpoint, Lucas (1988) shows that money demand is a function of consumption in a cash-in-advance economy. Empirically, Mankiw and Summers (1986) point out that consumption is a better scale

estimates of consumption elasticities of money demand, and the thin solid line shows the estimates of income elasticities of money demand shown in Figure 2. The two dashed lines in the figure are upper and lower bounds on estimates of the consumption elasticities of money demand. Those two series of estimates are almost identical. Table 5 reports the pooling estimates of consumption elasticities and PD elasticities using various sample periods, although the estimates of time effects are not reported. Observe that the consumption elasticities are fairly stable around the range from 1.15 to 1.41. We test whether the restriction of holding consumption elasticities and PD elasticities over the sample period constant are justified or not by with a standard F-test. As can be seen in the fifth column in Table 5, we find that based on post-1989 data, we could not reject the null hypothesis that consumption elasticities and PD elasticities are constant. The results suggest that we do not have to worry about the validity of assumptions that income equals expenditure in order to derive equation (4), because the results obtained using two scale variables are almost identical.

4.4. Consistency based on seasonally unadjusted data

So far we have conducted our research using seasonally adjusted data. However, if we are interested in cross-sectional variation alone, we do not have to use seasonally adjusted data. Moreover, one may be skeptical about the X-12-ARIMA procedure. In this section we use seasonally unadjusted data and see to what extent our original results are sensitive to the seasonal adjustment.

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variable because it reflects permanent income more accurately than income does using U.S. time-series data.

Figure 6 compares the estimates of income elasticities of money demand holding PD constant using seasonally adjusted data with those using seasonally unadjusted data. As can be seen from Figure 6, the estimates using seasonally adjusted data smoothly pass through the estimates using seasonally unadjusted data. Table 6 shows the average elasticities in each month during the period from January 1985 to December 1995. We find that income elasticities in July and December are relatively smaller, and the constant terms in those two months are apparently larger.

We compute the trend components of seasonally adjusted series of income elasticities obtained from regressions using the seasonally unadjusted data shown in Figure 6 by the X-12-ARIMA procedure. Figure 7 compares this series (solid line) with the estimates of income elasticities obtained from the seasonally adjusted series (dashed line). Surprisingly, those two series are quite similar except for a few cases. This implies that if a policy maker is interested in the trend components of the income elasticity of money demand, he or she should estimate the cross-sectional money demand function using seasonally unadjusted data and compute seasonally adjusted series of income elasticity obtained from that series. He or she should not worry about obtaining accurate seasonally adjusted series of income, money and CPI for each region anymore. The results are potentially very good news for policy makers since they will substantially reduce the burden of the estimating money demand function.

4.5. Consistency based on annual data

In order to check the robustness of our results, we compare them with results obtained from annual data. Prefecture employee income statistics compiled by the Economic Planning Agency of Japan for each fiscal year provide a good counterpart to our monthly scale variable, i.e., disposable income, because we have analyzed worker households so far. We use employee income deflated by the gross prefecture expenditure deflator during the period from fiscal year 1985 to fiscal year 1993 along with PD and prefecture money data on individual deposits deflated by the gross prefecture expenditure deflator during the period from the end of fiscal year 1985 to fiscal year 1993. For the sake of comparison, we wish to make the analysis using the sample period of 1985-1995. However, the most recent data for prefecture income statistics is for fiscal year 1993. Since we are using annual data, prefecture data is available and we increase the number of cross-sectional units to 47. The results of estimation are reported in Table 7. The sixth column of Table 7 shows the average of cross-sectional estimates of the income elasticities of money demand obtained from monthly data during each fiscal year. Except for fiscal years 1986, 1987 and 1991, the magnitude of income elasticities obtained from annual data are close to their monthly counterpart. The PD variable is not a statistically significant explanatory variable in this case. However, we may safely conclude that the results obtained from monthly data are not away from the results obtained from annual data, thus our results obtained from the monthly data provide useful and timely information to guide the conduct of monetary policy, which presumably focuses on the long run properties of economic data.

5. Conclusion

The motivation for this study is to estimate some structural parameters of the money demand function from cross-sectional monthly data. Our monthly cross-sectional data yield fairly stable estimates of the income elasticities of money demand after 1991. The results are broadly consistent with the results obtained from annual data, and very similar to those obtained from the analysis using consumption as a scale variable. Regarding the results obtained from seasonally unadjusted data, we do observe seasonal fluctuation in the money demand functions in each month, but the seasonal cycles seem to be clear. We admit that the standard errors of the cross-sectional estimates of income elasticities are so large that it is hard to argue that those income elasticities are useful for the sake of forecasting. However, those results suggest that cross-sectional data can be used to judge trends of the income elasticity of money demand by households. The obvious drawback of this study is that we use household data. We need to study the demand for money by firms in Japan further, as Mulligan (1997) did in the U.S.

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Table 1: Proportion of individual deposits in each financial institution

(Units: Percent of Total Individual Deposits)

Year	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
MMFP (All Banks)	39.0	38.9	39.1	39.7	39.7	40.6	41.9	40.7	39.4	39.2	38.6
Community Banks	11.7	11.6	11.6	11.6	11.7	11.9	12.1	11.7	11.7	11.6	11.5
Credit Cooeratives	3.1	3.0	3.0	2.9	3.0	3.0	3.1	3.1	3.1	3.1	3.0
Agriculature and Fishery Cooperatives	12.6	12.4	12.2	12.0	12.0	11.9	12.1	12.0	12.0	11.9	11.5
Labor Credit Associations	1.4	1.5	1.5	1.5	1.5	1.4	1.4	1.4	1.4	1.5	1.5
Post Office	31.9	32.3	32.4	32.0	31.9	30.9	29.1	30.7	32.2	33.3	33.6
Percent of Individual Deposits in M2+CDs	56.3	56.2	55.7	54.1	52.9	53.2	54.8	56.6	57.3	58.4	59.8

Note: Data are as of the end of March of each year.
Sources: Prefecture Economic Statistics, The Bank of Japan.

Table 2: Results of pooling regression constraining income elasticity and PD elasticity to be constant.

Sample period	ln(nydpc/cpi) (S.E.)	ln(PD) (S.E.)	Adj. R-bar (S.E.)	F-value p-value
1985 Jan	1.1980	0.2530	0.8673	2.1985
1995 Dec	(0.0268)	(0.0032)	(0.1381)	1.0000
1986 Jan	1.2420	0.2517	0.8549	1.9169
1995 Dec	(0.0255)	(0.0034)	(0.1383)	1.0000
1987 Jan	1.2776	0.2468	0.8331	1.6399
1995 Dec	(0.0247)	(0.0037)	(0.1399)	1.0000
1988 Jan	1.3044	0.2400	0.8023	1.3555
1995 Dec	(0.0243)	(0.0039)	(0.1407)	0.9991
1989 Jan	1.3019	0.2303	0.7389	0.8523
1995 Dec	(0.0247)	(0.0043)	(0.1425)	0.0718
1990 Jan	1.2897	0.2265	0.7030	0.7057
1995 Dec	(0.0263)	(0.0046)	(0.1425)	0.0017
1991 Jan	1.3467	0.2232	0.7291	0.3751
1995 Dec	(0.0213)	(0.0046)	(0.1346)	0.0000
1992 Jan	1.3409	0.2250	0.7290	0.4208
1995 Dec	(0.0222)	(0.0053)	(0.1348)	0.0000
1993 Jan	1.3579	0.2312	0.7271	0.3718
1995 Dec	(0.0272)	(0.0061)	(0.1356)	0.0000

Note: The F-value tests the null hypothesis that the income elasticity and PD elasticity are constant over time. The p-value shows the probability that the null hypothesis is rejected.

Table 3: Results of pooling regression constraining income, Branch, and PD elasticities to be constant.

Sample period	ln(nydpc/cpi) (S.E.)	ln(Branch) (S.E.)	ln(PD) (S.E.)	Adj. R-bar (S.E.)	F-value p-value
1985 Jan	1.3336	0.2398	0.2425	0.8855	3.1464
1995 Dec	(0.0245)	(0.0174)	(0.0040)	(0.1282)	1.0000
1986 Jan	1.3701	0.2384	0.2423	0.8749	2.9131
1995 Dec	(0.0234)	(0.0185)	(0.0042)	(0.1284)	1.0000
1987 Jan	1.4005	0.2406	0.2383	0.8562	2.7286
1995 Dec	(0.0232)	(0.0199)	(0.0044)	(0.1299)	1.0000
1988 Jan	1.4299	0.2535	0.2329	0.8326	2.3910
1995 Dec	(0.0236)	(0.0212)	(0.0044)	(0.1295)	1.0000
1989 Jan	1.4276	0.2696	0.2246	0.7835	1.6965
1995 Dec	(0.0245)	(0.0229)	(0.0046)	(0.1297)	1.0000
1990 Jan	1.4153	0.2806	0.2215	0.7580	1.3449
1995 Dec	(0.0262)	(0.0247)	(0.0048)	(0.1287)	0.9972
1991 Jan	1.4394	0.2619	0.2182	0.7786	1.3270
1995 Dec	(0.0250)	(0.0250)	(0.0050)	(0.1217)	0.9921
1992 Jan	1.4437	0.2958	0.2197	0.7910	1.0902
1995 Dec	(0.0255)	(0.0276)	(0.0055)	(0.1183)	0.7459
1993 Jan	1.4699	0.3227	0.2265	0.7999	0.8711
1995 Dec	(0.0302)	(0.0319)	0.0060	(0.1161)	0.1888

Note: The F-value tests null hypothesis that the income elasticity, Branch elasticity and PD elasticity are constant over time. The p-value shows the probability that the null hypothesis is rejected.

Table 4: Results of pooling regression constraining income, call rate and PD elasticity to be constant.

Sample period	ln(nydpc/cpi) (S.E.)	Call Rate (S.E.)	ln(PD) (S.E.)	Adj. R-bar (S.E.)
1985 Jan 1995 Dec	1.0422 (0.0289)	-0.0113 (0.0009)	0.2952 (0.0055)	0.9490 (0.0856)
1986 Jan 1995 Dec	1.0922 (0.0287)	-0.0099 (0.0008)	0.3024 (0.0063)	0.9506 (0.0807)
1987 Jan 1995 Dec	1.1140 (0.0322)	-0.0093 (0.0008)	0.3037 (0.0078)	0.9492 (0.0772)
1988 Jan 1995 Dec	1.1183 (0.0421)	-0.0093 (0.0008)	0.3035 (0.0098)	0.9502 (0.0706)
1989 Jan 1995 Dec	0.9202 (0.0682)	-0.0112 (0.0009)	0.2898 (0.0237)	0.9518 (0.0612)
1990 Jan 1995 Dec	1.2953 (0.0281)	-0.0065 (0.0020)	0.2266 (0.0047)	0.7268 (0.1367)
1991 Jan 1995 Dec	1.3474 (0.0237)	-0.0044 (0.0023)	0.2233 (0.0047)	0.7516 (0.1289)
1992 Jan 1995 Dec	1.3402 (0.0245)	-0.0101 (0.0042)	0.2250 (0.0053)	0.7515 (0.1290)
1993 Jan 1995 Dec	1.3575 (0.0294)	-0.0225 (0.0081)	0.2312 0.0061	0.7511 (0.1295)

Note: For samples that began before April of 1989, we added a dummy variable that equals one for observation after that month.

Table 5: Results of pooling regression constraining consumption elasticity and PD elasticity to be constant.

Sample period	ln(ncpc/cpi) (S.E.)	ln(PD) (S.E.)	Adj. R-bar (S.E.)	F-value p-value
1985 Jan	1.1540	0.2512	0.8566	2.4408
1995 Dec	(0.0301)	(0.0032)	(0.1435)	1.0000
1986 Jan	1.2080	0.2483	0.8439	2.0761
1995 Dec	(0.0286)	(0.0034)	(0.1434)	1.0000
1987 Jan	1.2505	0.2428	0.8213	1.7539
1995 Dec	(0.0281)	(0.0037)	(0.1448)	1.0000
1988 Jan	1.2933	0.2360	0.7875	1.3701
1995 Dec	(0.0279)	(0.0041)	(0.1459)	0.9994
1989 Jan	1.3219	0.2247	0.7201	0.6974
1995 Dec	(0.0263)	(0.0046)	(0.1475)	0.0000
1990 Jan	1.3181	0.2199	0.6774	0.5335
1995 Dec	(0.0287)	(0.0050)	(0.1485)	0.0000
1991 Jan	1.3671	0.2157	0.6923	0.2959
1995 Dec	(0.0263)	(0.0054)	(0.1434)	0.0000
1992 Jan	1.3855	0.2156	0.6750	0.3097
1995 Dec	(0.0300)	(0.0064)	(0.1476)	0.0000
1993 Jan	1.4114	0.2193	0.6667	0.3179
1995 Dec	(0.0372)	(0.0078)	(0.1498)	0.0000

Note: The F-value tests the null hypothesis that the consumption elasticity and PD elasticity are constant over time. The p-value shows the probability that the null hypothesis is rejected.

Table 6: Monthly average of income elasticities obtained from seasonally unadjusted data

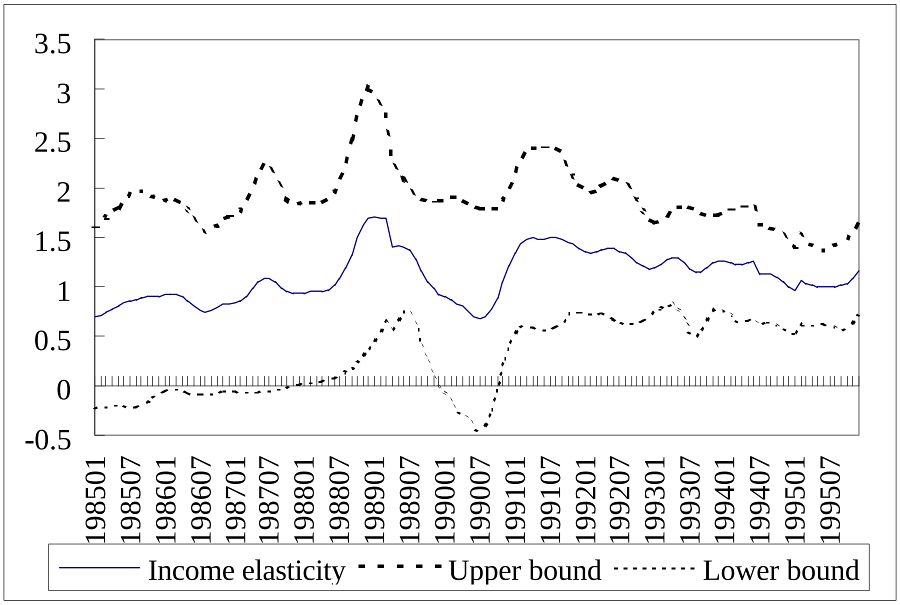
Month	Constant	ln(Real nydpci)	ln(PD)
January	-1.4041	1.3682	0.2374
February	-0.8603	1.3154	0.2525
March	-2.4846	1.4512	0.2895
April	-0.9383	1.3220	0.2332
May	-1.3440	1.3649	0.2249
June	-0.1728	1.2067	0.2741
July	5.8628	0.7029	0.1962
August	-1.8101	1.3939	0.3053
September	-0.6150	1.3025	0.2506
October	-0.6145	1.2967	0.2548
November	-0.8378	1.3164	0.2421
December	2.5988	0.9392	0.2739

Note: Average elasticities are computed using the sample from January 1985 to December 1995.

Table 7: Results of cross-sectional regression using annual data

Sample period	Constant (S.E.)	ln(Real nydpci) (S.E.)	ln(PD) (S.E.)	Adj. R-bar (S.E.)	Monthly Average
Fiscal 1985	5.5414	1.0065	0.0633	0.3630	0.9452
	(3.7794)	(0.4566)	(0.0529)	(0.2021)	
Fiscal 1986	4.1193	1.1818	0.0595	0.4280	0.9971
	(3.5797)	(0.4313)	(0.0525)	(0.1988)	
Fiscal 1987	4.6972	1.1173	0.0706	0.4406	1.1145
	(3.5775)	(0.4296)	(0.0537)	(0.2005)	
Fiscal 1988	4.4621	1.1489	0.0684	0.4399	1.5220
	(3.3981)	(0.4068)	(0.0511)	(0.2035)	
Fiscal 1989	4.9617	1.0966	0.0809	0.4500	1.1875
	(3.4075)	(0.4066)	(0.0504)	(0.2055)	
Fiscal 1990	4.3830	1.1716	0.0659	0.4408	1.0621
	(3.3881)	(0.4039)	(0.0471)	(0.2035)	
Fiscal 1991	4.6825	1.1364	0.0630	0.4395	1.4247
	(3.2250)	(0.3829)	(0.0464)	(0.2007)	
Fiscal 1992	4.0619	1.2092	0.0438	0.3931	1.3035
	(3.4126)	(0.4049)	(0.0475)	(0.2035)	
Fiscal 1993	3.2432	1.3090	0.0294	0.4106	1.4126
	(3.2060)	(0.3799)	0.0455	(0.1978)	

Figure 1: Results of cross-sectional univariate regression



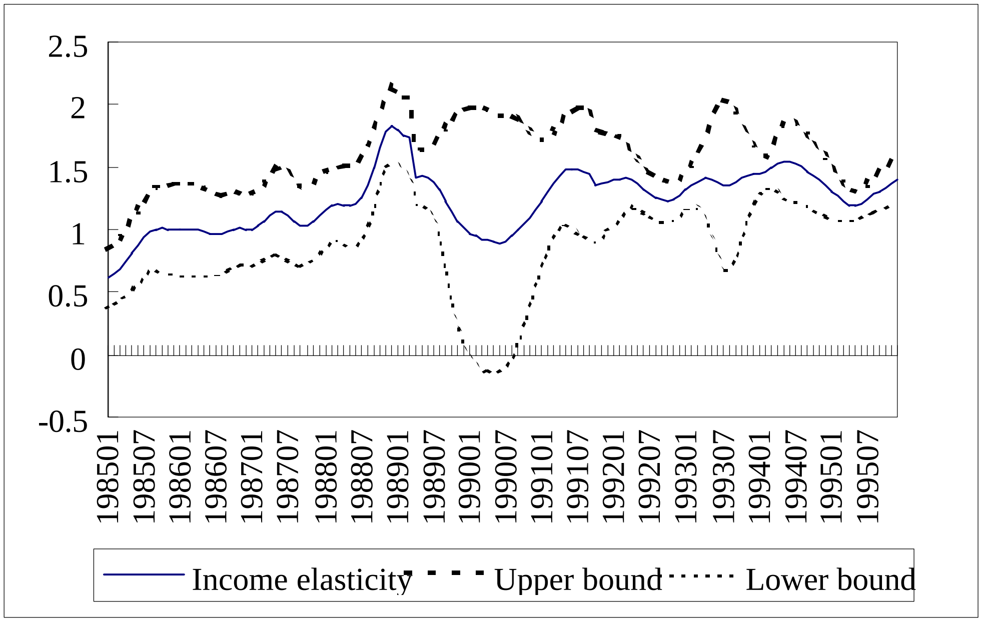
Note: Upper bound = Income elasticity + 2 (Standard error of Income elasticity)

Lower bound = Income elasticity - 2 (Standard error of Income elasticity)

The estimation method is OLS using cross-sectional data for each sample period.

Standard errors are computed by the method of White (1980).

Figure 2: Results of cross-sectional regression holding PD constant



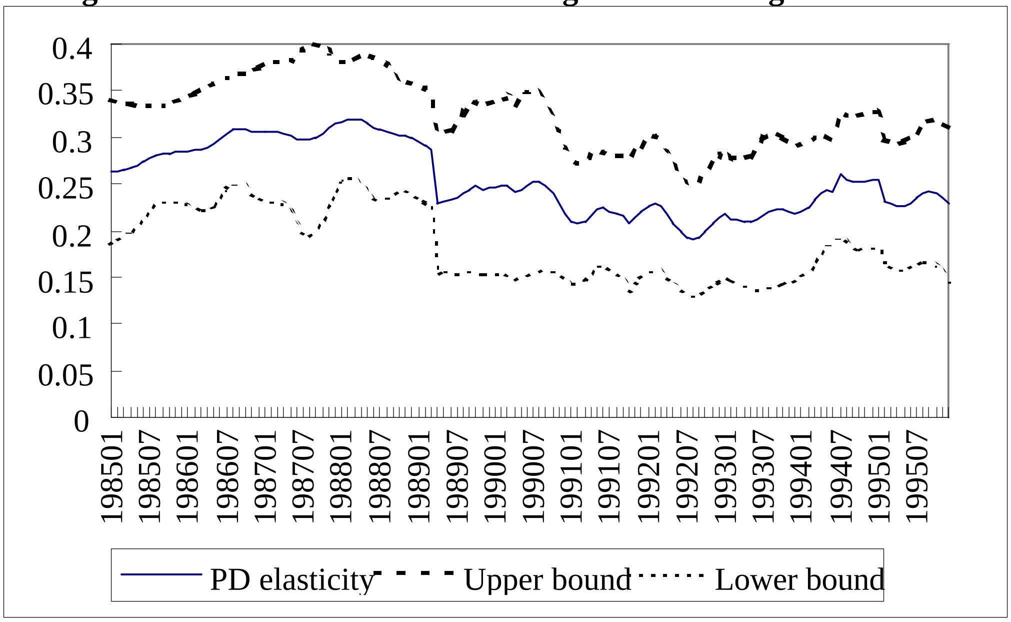
Note: Upper bound = Income elasticity + 2 (Standard error of Income elasticity)

Lower bound = Income elasticity - 2 (Standard error of Income elasticity)

The estimation method is OLS using cross-sectional data for each sample period.

Standard errors are computed by the method of White (1980).

Figure 3: Results of cross-sectional regression holding PD constant



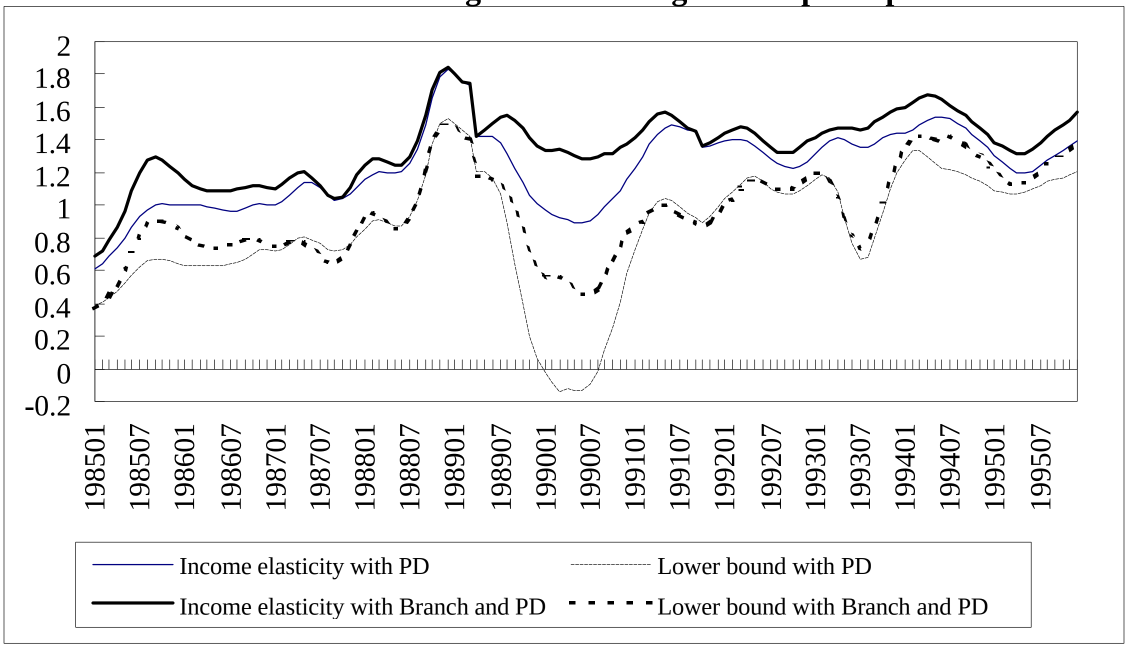
Note: Upper bound = PD elasticity + 2 (Standard error of PD elasticity)

Lower bound = PD elasticity - 2 (Standard error of PD elasticity)

The estimation method is OLS using cross-sectional data for each sample period.

Standard errors are computed by the method of White (1980).

Figure 4: Results of cross-sectional regression holding branch per capita and PD constant



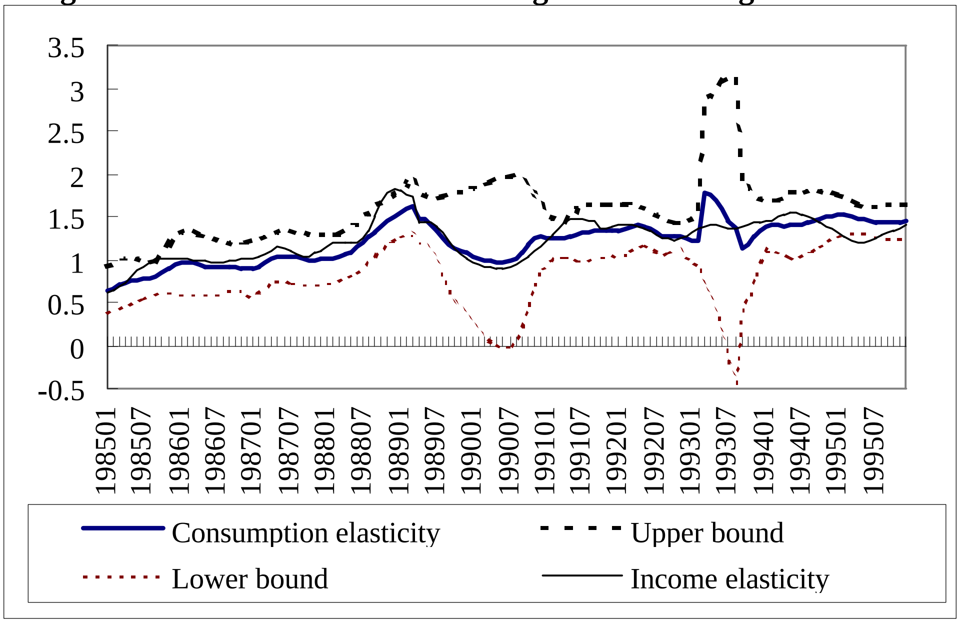
Note: Upper bound = Income elasticity + 2 (Standard error of Income elasticity)

Lower bound = Income elasticity - 2 (Standard error of Income elasticity)

The estimation method is OLS using cross-sectional data for each sample period.

Standard errors are computed by the method of White (1980).

Figure 5:Results of cross-sectional regression holding PD constant



Note: Upper bound = Consumption elasticity + 2 (Standard error of Consumption elasticity)

Lower bound = Consumption elasticity + 2 (Standard error of Consumption elasticity)

The estimation method is OLS using cross-sectional data for each sample period.

Standard errors are computed by the method of White (1980).

Figure 6: Cross-sectional income elasticities of money demand holding PD constant

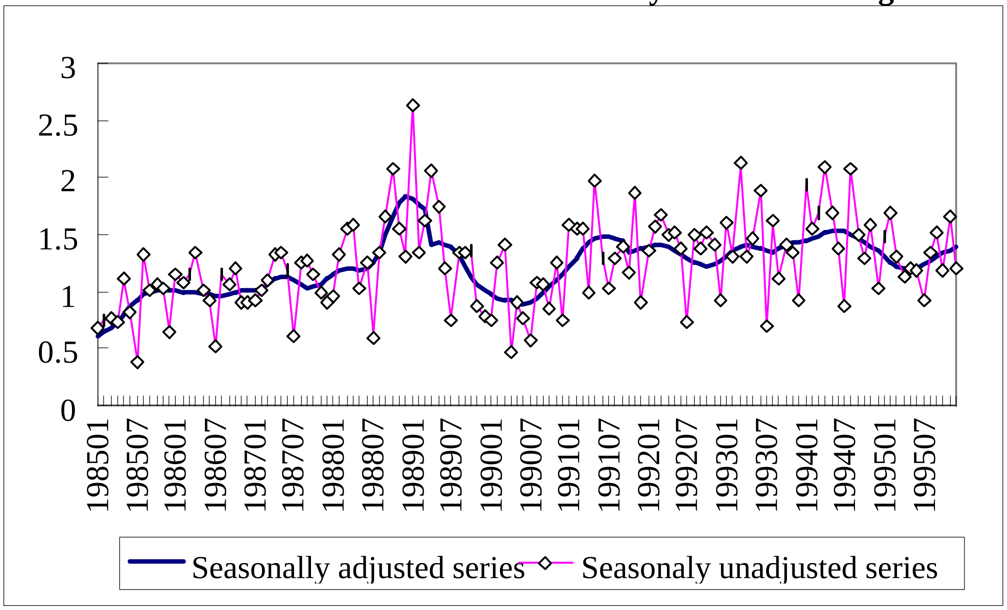


Figure 7: Estimates of income elasticities obtained from cross-sectional regression