INTERNATIONAL EVIDENCE ON THE DEMAND FOR MONEY

Ray C. Fair*

Abstract—One of the current questions in the literature on the demand for money is whether the adjustment of actual to desired money holdings is in nominal or real terms. This paper describes a simple procedure that can be used to test the nominal against the real hypothesis. The test is carried out for 27 countries. The paper also tests the structural stability of the demand for money equations and the correctness of the dynamic specification.

The results are strongly in favor of the nominal adjustment hypothesis. There is, however, some evidence of moderate structural instability before and after 1973. The instability does not affect the conclusion that the nominal adjustment hypothesis dominates the real adjustment hypothesis.

I. Introduction

One of the current questions in the literature on the demand for money is whether the adjustment of actual to desired money holdings is in nominal or real terms. This paper describes a simple procedure that can be used to test the nominal against the real hypothesis. The test is carried out for 27 countries. The paper also tests the structural stability of the demand for money equations and the correctness of the dynamic specification.

II. The Model and Test

The typical demand for money model begins by postulating that the long-run desired level of real money balances ($M^*/P$) is a function of real income ($y$) and a short-term interest rate ($r$). The equation is usually specified in log form. The functional form used here is

$$\log(M^*/P) = \alpha + \beta \log y + \gamma r. \quad (1)$$

The log form has been used except for the interest rate. Interest rates can at times be quite low, and it may not be sensible to take the interest rate variable to be in log form. If, for example, the interest rate rises from 0.02 to 0.03, the log of the interest rate rises from 2.63 to 2.69, which is a change of 0.06. If, on the other hand, the interest rate rises from 0.10 to 0.11, the log of the rate rises from 2.30 to 2.21, which is only a change of 0.09. One does not necessarily expect a one percentage point rise in the interest rate to have four times the effect on the log of desired money holdings when the change is from a base of 0.02 than when it is from a base of 0.10. It may be a better approximation simply to use the level of the interest rate in an equation like (1) instead of the log of the rate, and this has been done here. Results are, however, presented below for both the level and log specifications.

If the adjustment of actual to desired money holdings is in real terms, the adjustment equation is

$$\log(M/P) - \log(M_{t-1}/P_{t-1}) = \lambda \log(M^*/P) - \log(M_{t-1}/P_{t-1}) + \epsilon_t. \quad (2)$$

If the adjustment is in nominal terms, the adjustment equation is

$$\log(M_t) - \log(M_{t-1}) = \lambda (\log(M^*/P) - \log(M_{t-1})) + \mu_r. \quad (3)$$

Combining (1) and (2) yields

$$\log(M_t/P) = \lambda \alpha + \lambda \beta \log y + \lambda \gamma r_t + (1 - \lambda) \log(M_{t-1}/P_{t-1}) + \epsilon_t. \quad (4)$$

Combining (1) and (3) yields

$$\log(M_t/P) = \lambda \alpha + \lambda \beta \log y + \lambda \gamma r_t + (1 - \lambda) \log(M_{t-1}/P_{t-1}) + \mu_r. \quad (5)$$

Equations (4) and (5) differ in the lagged money term. In (4), which is the real adjustment specification, $M_{t-1}$ is divided by $P_{t-1}$, whereas in (5),
which is the nominal adjustment specification, \( M_{t-1} \) is divided by \( P_t \).

A test of the two hypotheses is simply to put both lagged money variables in the equation and see which one dominates. If the real adjustment specification is correct, \( \log(M_{t-1}/P_{t-1}) \) should be significant and \( \log(M_{t-1}/P_t) \) should not, and vice versa if the nominal adjustment specification is correct. This test may, of course, be inconclusive in that both terms may be significant or insignificant. In the present case, however, as will be seen, the test is rarely inconclusive.

One must be concerned in the estimation of (4) and (5) about the possible endogeneity of \( y_t \), \( r_t \), and \( P_t \). Because of this, the equations have been estimated by two stage least squares (2SLS). The first stage regressors that were used are mentioned in the next section. This estimation work is based on the assumption that \( M_t \) is an endogenous variable. If \( M_t \) were set exogenously by the monetary authority, then the demand for money equation should not be estimated by 2SLS with \( M_t \) on the left hand side. In this case \( r_t \) should be on the left hand side, with only \( y_t \) and \( P_t \) as endogenous explanatory variables.

It may also be the case that the error terms are serially correlated, and, as discussed in the next section, this has been taken into account in the estimation. The equations have been estimated in per capita terms, which means that \( M_t \) has been divided by \( POP_t \), and \( M_{t-1} \) has been divided by \( POP_{t-1} \), where \( POP \) is the population of the country.

**III. The Data and Results**

The data that have been used are part of my multicountry model (Fair (1984)). The data are quarterly. Money demand equations have been estimated for 27 countries. The non U.S. data are from the International Financial Statistics of the IMF except for the data on GNP for the OECD countries, which are data from the OECD. For each country except the United States the variables are as follows. \( M \) is the money supply, seasonally adjusted when available. \( r \) is a short-term interest rate. The interest rate that seemed to correspond most closely to short-run money market conditions was chosen for each country. In a few cases the only short-term interest rate available was the discount rate, and so this rate had to be used. \( y \) is real GNP, and \( P \) is the GNP deflator. In some cases quarterly GNP data were not available, and in these cases quarterly data were constructed by interpolation. The industrial production index was typically used as the quarterly interpolation variable. \( POP \) is the population of each country. The data on population are annual, and quarterly data were constructed by assuming that the change in population in each of the four quarters of the year is the same.\(^2\)

The money demand equations for the United States are part of my U.S. model (also in Fair (1984)). There are three relevant equations: an equation explaining the demand for money by households, an equation explaining the demand for money by firms, and an equation explaining the demand for currency. (Money includes demand deposits and currency.) The data on demand deposits and currency are from the Flow of Funds Accounts. They are end-of-quarter data. \( y \) for the household equation is real disposable income, and \( y \) for the firm and currency equations is the real level of sales. \( r \) for the equations is the after-tax three-month Treasury bill rate.

All equations include a constant term. The non U.S. equations also include three seasonal dummy variables. Most of the GNP data are not seasonally adjusted for countries other than the United States, and some of the money data are also not seasonally adjusted. The seasonal dummy variables are meant to pick up unaccounted for seasonal effects.

The first set of results is presented in table 1. Except for four countries, the equations have been estimated by 2SLS.\(^3\) The first stage regressors used for each country are the main predetermined variables in my multicountry model for that country. About 18 first stage regressors per country were used. Each equation was first estimated under the

\(^2\) See Fair (1984), appendix B, for a complete description of the data. The data have been updated for purposes of this paper. The sample period listed in table 1 below for each country shows the period over which the data were collected for that country. The sample periods begin four quarters after the quarter for which data on all relevant variables are available. They end at the latest available data. In Fair (1984) all the GNP data were taken from the IMF. For this paper, as noted above, the GNP data for the OECD countries have been taken from the OECD.

\(^3\) The four countries are Turkey, Colombia, India, and Pakistan. The sample periods seemed too short for these countries for the use of 2SLS to make much sense. The equations for these countries were estimated by ordinary least squares.
<table>
<thead>
<tr>
<th>Country</th>
<th>First $\hat{\beta}$</th>
<th>Second $\hat{\beta}$</th>
<th>$\log(y_t/POP_t)$</th>
<th>$\tau$</th>
<th>Real Adj.</th>
<th>Nominal Adj.</th>
<th>DW</th>
<th>SE</th>
<th>$R^2$</th>
<th>Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canada</td>
<td>-0.157</td>
<td>0</td>
<td>0.071</td>
<td>-0.0038</td>
<td>-0.72</td>
<td>1.66</td>
<td>2.26</td>
<td>.0282</td>
<td>.957</td>
<td>621-854</td>
</tr>
<tr>
<td>Japan</td>
<td>0.000</td>
<td>0</td>
<td>0.084</td>
<td>-0.0050</td>
<td>1.19</td>
<td>-0.29</td>
<td>1.93</td>
<td>.0230</td>
<td>.993</td>
<td>661-854</td>
</tr>
<tr>
<td>Austria b</td>
<td>0.237</td>
<td>0</td>
<td>-0.007</td>
<td>0.004</td>
<td>-0.29</td>
<td>1.26</td>
<td>1.60</td>
<td>.0223</td>
<td>.956</td>
<td>651-861</td>
</tr>
<tr>
<td>Belgium</td>
<td>-0.266</td>
<td>-0.226</td>
<td>0.057</td>
<td>0.0048</td>
<td>0.54</td>
<td>0.33</td>
<td>2.05</td>
<td>.0187</td>
<td>.904</td>
<td>611-844</td>
</tr>
<tr>
<td>Denmark</td>
<td>-0.274</td>
<td>0</td>
<td>0.270</td>
<td>-0.0031</td>
<td>0.33</td>
<td>0.52</td>
<td>2.34</td>
<td>.0376</td>
<td>.874</td>
<td>691-844</td>
</tr>
<tr>
<td>France</td>
<td>-0.164</td>
<td>0</td>
<td>0.094</td>
<td>-0.0022</td>
<td>0.24</td>
<td>0.49</td>
<td>2.20</td>
<td>.0215</td>
<td>.868</td>
<td>641-854</td>
</tr>
<tr>
<td>Germany</td>
<td>0.114</td>
<td>0</td>
<td>0.343</td>
<td>-0.0053</td>
<td>-0.03</td>
<td>0.74</td>
<td>1.77</td>
<td>.0129</td>
<td>.992</td>
<td>691-854</td>
</tr>
<tr>
<td>Italy</td>
<td>0.008</td>
<td>0</td>
<td>0.130</td>
<td>-0.0035</td>
<td>0.13</td>
<td>0.79</td>
<td>1.99</td>
<td>.0185</td>
<td>.934</td>
<td>711-853</td>
</tr>
<tr>
<td>Netherlands</td>
<td>-0.063</td>
<td>0</td>
<td>0.392</td>
<td>-0.0083</td>
<td>-0.34</td>
<td>0.79</td>
<td>2.03</td>
<td>.0176</td>
<td>.978</td>
<td>611-844</td>
</tr>
<tr>
<td>Norway</td>
<td>-0.727</td>
<td>-0.727</td>
<td>0.087</td>
<td>-0.0024</td>
<td>0.19</td>
<td>0.76</td>
<td>1.97</td>
<td>.0347</td>
<td>.962</td>
<td>611-844</td>
</tr>
<tr>
<td>Sweden</td>
<td>0.527</td>
<td>0.527</td>
<td>1.213</td>
<td>0.0076</td>
<td>-1.29</td>
<td>1.05</td>
<td>2.13</td>
<td>.0227</td>
<td>.943</td>
<td>711-824</td>
</tr>
<tr>
<td>Switzerland</td>
<td>-0.116</td>
<td>0</td>
<td>0.050</td>
<td>-0.0097</td>
<td>1.45</td>
<td>-0.57</td>
<td>2.16</td>
<td>.0312</td>
<td>.881</td>
<td>611-843</td>
</tr>
<tr>
<td>U.K.</td>
<td>-0.377</td>
<td>-0.377</td>
<td>0.118</td>
<td>-0.0048</td>
<td>0.25</td>
<td>0.69</td>
<td>1.87</td>
<td>.0225</td>
<td>.927</td>
<td>581-861</td>
</tr>
<tr>
<td>Finland</td>
<td>-0.108</td>
<td>0</td>
<td>0.651</td>
<td>-0.0082</td>
<td>0.26</td>
<td>0.26</td>
<td>2.09</td>
<td>.0415</td>
<td>.912</td>
<td>711-854</td>
</tr>
<tr>
<td>Greece b</td>
<td>-0.490</td>
<td>-0.490</td>
<td>0.169</td>
<td>-0.0011</td>
<td>-0.12</td>
<td>0.99</td>
<td>2.00</td>
<td>.0391</td>
<td>.988</td>
<td>611-844</td>
</tr>
<tr>
<td>Ireland</td>
<td>-0.280</td>
<td>-0.280</td>
<td>0.068</td>
<td>-0.0045</td>
<td>0.15</td>
<td>0.80</td>
<td>1.97</td>
<td>.0307</td>
<td>.927</td>
<td>611-844</td>
</tr>
<tr>
<td>Portugal b</td>
<td>-0.080</td>
<td>0</td>
<td>0.194</td>
<td>-0.0061</td>
<td>0.26</td>
<td>0.51</td>
<td>1.98</td>
<td>.0332</td>
<td>.960</td>
<td>611-834</td>
</tr>
<tr>
<td>Turkey a,b</td>
<td>-0.426</td>
<td>-0.426</td>
<td>0.184</td>
<td>-0.0026</td>
<td>0.10</td>
<td>0.77</td>
<td>2.09</td>
<td>.0503</td>
<td>.941</td>
<td>701-844</td>
</tr>
<tr>
<td>Australia</td>
<td>0.163</td>
<td>0</td>
<td>0.104</td>
<td>-0.0058</td>
<td>0.21</td>
<td>0.69</td>
<td>1.74</td>
<td>.0226</td>
<td>.938</td>
<td>703-854</td>
</tr>
<tr>
<td>New Zealand b</td>
<td>0.013</td>
<td>0</td>
<td>0.041</td>
<td>-0.0078</td>
<td>-0.030</td>
<td>1.19</td>
<td>1.97</td>
<td>.0339</td>
<td>.977</td>
<td>611-851</td>
</tr>
<tr>
<td>South Africa</td>
<td>0.077</td>
<td>0</td>
<td>0.070</td>
<td>0.0022</td>
<td>-0.26</td>
<td>1.17</td>
<td>1.82</td>
<td>.0353</td>
<td>.923</td>
<td>621-853</td>
</tr>
</tbody>
</table>

**Table 1.** Estimates of the Money Demand Equations with Both Lagged Money Variables

**Dependent Variable is log($M_t/(POP_t/P_t)$)**

International Evidence on the Demand for Money
The assumption of a first order autoregressive error term. If the $t$-statistic of the estimate of the autoregressive coefficient was less than two in absolute value, the equation was reestimated under the assumption of no autoregressive error term. The column in table 1 labelled "First $\hat{\rho}$" contains the estimate of the autoregressive coefficient from

<table>
<thead>
<tr>
<th>Country</th>
<th>First $\hat{\rho}$</th>
<th>Second $\hat{\rho}$</th>
<th>log($y_t/\text{POP}_t$)</th>
<th>$r_t$</th>
<th>Real Adj.</th>
<th>Nominal Adj.</th>
<th>DW</th>
<th>SE</th>
<th>$R^2$</th>
<th>Sample</th>
<th>log $r_t$</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colombia</td>
<td>-0.244 (1.64)</td>
<td>0</td>
<td>0.034 (0.21)</td>
<td>-0.0009 (0.37)</td>
<td>0.22 (0.78)</td>
<td>0.55 (1.95)</td>
<td>2.24 (0.0372)</td>
<td>.720</td>
<td>711-844</td>
<td>-0.024 (0.41)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peru</td>
<td>0.008 (0.05)</td>
<td>0</td>
<td>0.120 (0.78)</td>
<td>-0.0016 (1.04)</td>
<td>0.21 (0.97)</td>
<td>0.64 (3.05)</td>
<td>1.90 (0.0462)</td>
<td>.986</td>
<td>711-844</td>
<td>-0.079 (2.03)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>India</td>
<td>-0.078 (0.59)</td>
<td>0</td>
<td>0.125 (1.71)</td>
<td>0.0008 (0.50)</td>
<td>0.23 (1.35)</td>
<td>0.58 (3.33)</td>
<td>2.10 (0.0369)</td>
<td>.828</td>
<td>611-811</td>
<td>0.007 (0.58)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pakistan</td>
<td>-0.136 (0.91)</td>
<td>0</td>
<td>0.036 (0.47)</td>
<td>-0.0019 (0.51)</td>
<td>-0.34 (1.48)</td>
<td>1.28 (5.22)</td>
<td>2.19 (0.0298)</td>
<td>.968</td>
<td>731-842</td>
<td>-0.019 (0.59)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Philippines</td>
<td>0.198 (1.05)</td>
<td>0</td>
<td>0.057 (2.34)</td>
<td>0.0014 (0.68)</td>
<td>0.07 (1.48)</td>
<td>0.80 (2.96)</td>
<td>1.71 (0.0294)</td>
<td>.821</td>
<td>581-802</td>
<td>0.007 (0.53)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>U.S. households</td>
<td>-0.121 (1.02)</td>
<td>0</td>
<td>0.051 (3.58)</td>
<td>-0.0026 (2.22)</td>
<td>-0.18 (0.70)</td>
<td>1.13 (5.19)</td>
<td>2.19 (0.0140)</td>
<td>.976</td>
<td>541-862</td>
<td>-0.015 (2.67)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>U.S. firms</td>
<td>-0.105 (0.67)</td>
<td>0</td>
<td>0.042 (3.11)</td>
<td>-0.0061 (2.71)</td>
<td>0.27 (1.56)</td>
<td>0.68 (1.36)</td>
<td>2.19 (0.0237)</td>
<td>.940</td>
<td>541-862</td>
<td>-0.020 (2.27)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>U.S. currency</td>
<td>-0.366 (4.38)</td>
<td>-0.366 (4.38)</td>
<td>0.057 (8.14)</td>
<td>-0.0015 (3.00)</td>
<td>0.17 (1.37)</td>
<td>0.79 (6.34)</td>
<td>2.08 (0.0091)</td>
<td>.948</td>
<td>541-862</td>
<td>-0.009 (2.88)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes: Real adjustment explanatory variable is $\log(M_{t-1}/(\text{POP}_{t-1}\text{POP}_t))$. Nominal adjustment explanatory variable is $\log(M_{t-1}/(\text{POP}_{t-1}\text{POP}_t))$. $t$-statistics in absolute value are in parentheses.

* Estimation technique is ordinary least squares.

b Only discount rate data available for $r_t$.

This is one way of testing for the presence of an autoregressive error. Provided that one has a consistent estimate of the autoregressive coefficient and its standard error, the $t$-test is valid asymptotically even if there are endogenous and lagged endogenous variables among the explanatory variables, which is the case in this paper. The equations in the serial correlation case were estimated using the method in Fair (1970).

Even though the Durbin-Watson statistic is biased towards zero when there is a lagged dependent variable in the equation, it is still a useful summary statistic. If the DW statistic is not close to two when there is a lagged dependent variable in the equation, there are likely to be serious serial correlation problems with respect to the error term. The DW statistic has thus been presented in tables 1 and 2. For the equations that are estimated under the assumption of a first order autoregressive error term, the summary statistics (including the DW statistic) are for the error term that exists after transformation to eliminate the autoregressive error component.

5 Note that "First $\hat{\rho}$" does not mean the value of $\rho$ after the first iteration of the iterative process that is used to estimate the equation. It is the value of $\rho$ after convergence for the first regression that was run.
The estimate of the coefficient of the log of the interest rate is presented in the penultimate column, and the standard error of the regression is presented in the last column. These results allow one to see the effects of using the log of the interest rate instead of the level. It should be noted that no “searching” was done for these results. Each equation has the same eight explanatory variables, and the sample periods have not been fiddled with to try to produce some desired result. In what follows a variable will be said to be “significant” if the t-statistic of its coefficient estimate is greater than 2.0 in absolute value.

The results in table 1 provide strong support for the nominal adjustment hypothesis. In 25 of the 29 cases, the nominal lagged adjustment variable dominates the real lagged adjustment variable in the sense of having a higher t-statistic. In 3 cases—Japan, Belgium, and Switzerland—the real variable dominates. In one case—Finland—there is essentially a tie.

There are no cases in table 1 where the coefficient estimates of both lagged money variables are significant and positive. (Both estimates are significant for Sweden, but the real lagged adjustment coefficient is negative.) There are eight equations where both lagged money variables are insignificant: Denmark, France, Switzerland, Finland, Portugal, Australia, Colombia, and the U.S. firm equation. This insignificance is due to the collinearity between the two lagged money variables. When only one variable is included, as in table 2 below, the variable is significant. In all but one of the eight insignificant cases, there is an obvious winner in the sense of one variable having a larger coefficient estimate and t-statistic than the other. (The exception is the tie for Finland.) In some of the cases in table 1 one lagged money coefficient is negative and the other is greater than one. Again, this problem goes away in table 2 when only one variable is included in the equation. The negative coefficients in table 1 all have smaller t-statistics in absolute value than the corresponding t-statistics for the positive coefficients. In summary, then, the test seems to work well. The test discriminates nicely between the two lagged money variables.

Regarding the income and interest rate variables, only the equation for Austria has the wrong sign for both income and the interest rate. None of the other equations have the wrong sign for income; four other equations have the wrong sign for the interest rate, those for Sweden, South Africa, India, and the Philippines. Eight of the twenty-nine equations have significant estimates of the autoregressive coefficient of the error term. All the significant estimates are negative.

The results using the log of the interest rate are in general fairly close to the results using the level. There are four countries, France, Italy, Portugal, and Peru, where one form is significant and the other is not. The log form is significant for France and Peru, and the level form is significant for Italy and Portugal. Although not shown in table 1, the use of the log form resulted in only one switch regarding the dominant lagged money variable, which was for Finland. For Finland the results using the log form favored the nominal adjustment variable over the real adjustment variable, whereas the results using the linear form showed a tie.

A second set of results is presented in table 2. For this set the lagged money variable that was dominated was dropped from the regression and the equation was reestimated. In addition, for the five cases where wrong signs for the interest rate were obtained, the interest rate was dropped.

The results in table 2 are in one sense rather remarkable for macro results, especially given the low quality data for many countries. Of the 29 estimates of the income coefficient, 20 have t-statistics greater than two. Of the 24 estimates of the interest rate coefficient, 16 have t-statistics greater than two in absolute value. All the coefficient estimates of the lagged money variables are significant and less than one.

In another sense, however, the results in table 2 are not that strong. Where the sample period seemed long enough for a given country, a test of the hypothesis that the coefficients are the same before and after the first quarter of 1973 was made. Many of the results in the literature for the United States show an instability of the coeffi-
<table>
<thead>
<tr>
<th>Country</th>
<th>$\hat{\beta}$</th>
<th>$\log(y_t/POP_t)$</th>
<th>$\hat{r}_t$</th>
<th>Real Adj.</th>
<th>Nominal Adj.</th>
<th>DW</th>
<th>SE</th>
<th>$R^2$</th>
<th>df</th>
<th>$\chi^2_A$</th>
<th>Real Adj.</th>
<th>Nominal Adj.</th>
<th>Sample</th>
<th>$\chi^2_B$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canada</td>
<td>0</td>
<td>0.059</td>
<td>-0.0044</td>
<td>0.94</td>
<td></td>
<td>2.15</td>
<td>.0282</td>
<td>.957</td>
<td>7</td>
<td>19.06$^c$</td>
<td>1.00</td>
<td>-0.14</td>
<td>731-854</td>
<td>1.42</td>
</tr>
<tr>
<td>Japan</td>
<td>0</td>
<td>0.053</td>
<td>-0.0044</td>
<td>0.93</td>
<td></td>
<td>1.97</td>
<td>.0228</td>
<td>.993</td>
<td>7</td>
<td>59.36$^c$</td>
<td>0.87</td>
<td>-0.27</td>
<td>731-854</td>
<td>7.33$^d$</td>
</tr>
<tr>
<td>Austria$^b$</td>
<td>0</td>
<td>0.002</td>
<td></td>
<td>0.96</td>
<td></td>
<td>1.60</td>
<td>.0225</td>
<td>.955</td>
<td>6</td>
<td>15.98$^d$</td>
<td>-0.46</td>
<td>1.26</td>
<td>731-861</td>
<td>0.15</td>
</tr>
<tr>
<td>Belgium</td>
<td>-0.240</td>
<td>0.057</td>
<td>-0.0050</td>
<td>0.86</td>
<td></td>
<td>2.06</td>
<td>.0193</td>
<td>.989</td>
<td>8</td>
<td>24.51$^e$</td>
<td>-0.54</td>
<td>1.38</td>
<td>731-844</td>
<td>0.40</td>
</tr>
<tr>
<td>Denmark</td>
<td>0</td>
<td>0.267</td>
<td>-0.0030</td>
<td>0.84</td>
<td></td>
<td>2.36</td>
<td>.0370</td>
<td>.878</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4.97</td>
</tr>
<tr>
<td>France</td>
<td>0</td>
<td>0.096</td>
<td>-0.0019</td>
<td>0.73</td>
<td></td>
<td>2.16</td>
<td>.0215</td>
<td>.868</td>
<td>7</td>
<td>45.31$^e$</td>
<td>-0.86</td>
<td>1.33</td>
<td>731-854</td>
<td>3.17</td>
</tr>
<tr>
<td>Germany</td>
<td>0</td>
<td>0.345</td>
<td>-0.0053</td>
<td>0.71</td>
<td></td>
<td>1.76</td>
<td>.0128</td>
<td>.992</td>
<td>7</td>
<td>5.83$^e$</td>
<td></td>
<td></td>
<td></td>
<td>3.50</td>
</tr>
<tr>
<td>Italy</td>
<td>0</td>
<td>0.113</td>
<td>-0.0031</td>
<td>0.94</td>
<td></td>
<td>1.93</td>
<td>.0188</td>
<td>.932</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2.86</td>
</tr>
<tr>
<td>Netherlands</td>
<td>0</td>
<td>0.407</td>
<td>-0.0086</td>
<td>0.43</td>
<td></td>
<td>2.01</td>
<td>.0183</td>
<td>.977</td>
<td>7</td>
<td>16.26$^e$</td>
<td>0.16</td>
<td>0.31</td>
<td>731-844</td>
<td>1.59</td>
</tr>
<tr>
<td>Norway</td>
<td>-0.730</td>
<td>0.087</td>
<td>-0.0023</td>
<td>0.95</td>
<td></td>
<td>1.97</td>
<td>.0347</td>
<td>.962</td>
<td>8</td>
<td>23.66$^e$</td>
<td>-0.67</td>
<td>1.46</td>
<td>731-844</td>
<td>0.08</td>
</tr>
<tr>
<td>Sweden</td>
<td>-0.468</td>
<td>0.49</td>
<td></td>
<td>0.65</td>
<td></td>
<td>1.54</td>
<td>.0238</td>
<td>.937</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2.44</td>
</tr>
<tr>
<td>Switzerland</td>
<td>0</td>
<td>0.040</td>
<td>-0.0079</td>
<td>0.89</td>
<td></td>
<td>2.21</td>
<td>.0299</td>
<td>.891</td>
<td>7</td>
<td>16.89$^d$</td>
<td>1.60</td>
<td>-0.78</td>
<td>731-843</td>
<td>1.31</td>
</tr>
<tr>
<td>U.K.</td>
<td>-0.344</td>
<td>0.119</td>
<td>-0.0043</td>
<td>0.93</td>
<td></td>
<td>1.85</td>
<td>.0223</td>
<td>.927</td>
<td>8</td>
<td>16.98$^d$</td>
<td>0.44</td>
<td>0.49</td>
<td>731-861</td>
<td>2.59</td>
</tr>
<tr>
<td>Finland</td>
<td>0</td>
<td>0.642</td>
<td>-0.0077</td>
<td>0.51</td>
<td></td>
<td>2.14</td>
<td>.0413</td>
<td>.912</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.94</td>
</tr>
<tr>
<td>Greece$^b$</td>
<td>-0.495</td>
<td>0.163</td>
<td>-0.0013</td>
<td>0.87</td>
<td></td>
<td>2.00</td>
<td>.0389</td>
<td>.988</td>
<td>8</td>
<td>5.93</td>
<td></td>
<td></td>
<td></td>
<td>5.26</td>
</tr>
<tr>
<td>Ireland</td>
<td>-0.250</td>
<td>0.074</td>
<td>-0.0045</td>
<td>0.95</td>
<td></td>
<td>1.96</td>
<td>.0310</td>
<td>.926</td>
<td>8</td>
<td>11.66</td>
<td></td>
<td></td>
<td></td>
<td>0.97</td>
</tr>
<tr>
<td>Portugal$^b$</td>
<td>0</td>
<td>0.181</td>
<td>-0.0051</td>
<td>0.81</td>
<td></td>
<td>2.05</td>
<td>.0322</td>
<td>.962</td>
<td>7</td>
<td>23.98$^e$</td>
<td>-0.15</td>
<td>0.62</td>
<td>731-834</td>
<td>2.97</td>
</tr>
<tr>
<td>Turkey$^{a,b}$</td>
<td>-0.412</td>
<td>0.211</td>
<td>-0.0029</td>
<td>0.85</td>
<td></td>
<td>2.07</td>
<td>.0505</td>
<td>.941</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>11.88$^e$</td>
</tr>
<tr>
<td>Australia</td>
<td>0</td>
<td>0.094</td>
<td>-0.0055</td>
<td>0.90</td>
<td></td>
<td>1.75</td>
<td>.0227</td>
<td>.937</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.63</td>
</tr>
<tr>
<td>New Zealand$^b$</td>
<td>0</td>
<td>0.018</td>
<td>-0.0083</td>
<td>0.88</td>
<td></td>
<td>2.03</td>
<td>.0337</td>
<td>.977</td>
<td>7</td>
<td>21.83$^e$</td>
<td>0.08</td>
<td>0.75</td>
<td>731-851</td>
<td>1.20</td>
</tr>
<tr>
<td>South Africa</td>
<td>0</td>
<td>0.095</td>
<td></td>
<td>0.96</td>
<td></td>
<td>1.79</td>
<td>.0357</td>
<td>.922</td>
<td>6</td>
<td>22.54$^e$</td>
<td>0.15</td>
<td>0.85</td>
<td>731-853</td>
<td>0.06</td>
</tr>
</tbody>
</table>
TABLE 2.—(Continued)

<table>
<thead>
<tr>
<th>Country</th>
<th>(\hat{\rho})</th>
<th>(\log(y_{t}/POP_{t}))</th>
<th>(r_{t})</th>
<th>Real</th>
<th>Nominal</th>
<th>DW</th>
<th>SE</th>
<th>(R^2)</th>
<th>df</th>
<th>(\chi^2_{\rho})</th>
<th>Real</th>
<th>Nominal</th>
<th>Sample</th>
<th>(\chi^2_{\rho})</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colombia(^{a,b})</td>
<td>0.036</td>
<td>-0.0008</td>
<td>-</td>
<td>0.75</td>
<td>2.22</td>
<td>0.0374</td>
<td>0.718</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>4.10</td>
</tr>
<tr>
<td></td>
<td>(0.22)</td>
<td>(0.34)</td>
<td>(8.30)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peru(^{b})</td>
<td>0</td>
<td>0.156</td>
<td>-0.0013</td>
<td>-</td>
<td>0.83</td>
<td>1.86</td>
<td>0.0463</td>
<td>0.986</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1.13</td>
</tr>
<tr>
<td></td>
<td>(1.04)</td>
<td>(0.89)</td>
<td>(12.12)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>India(^{a})</td>
<td>0</td>
<td>0.146</td>
<td>-</td>
<td>0.80</td>
<td>2.01</td>
<td>0.0374</td>
<td>0.823</td>
<td>6</td>
<td>13.11</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2.35</td>
</tr>
<tr>
<td></td>
<td>(2.10)</td>
<td></td>
<td>(11.10)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pakistan(^{a})</td>
<td>0</td>
<td>0.077</td>
<td>-0.0011</td>
<td>-</td>
<td>0.92</td>
<td>1.94</td>
<td>0.0274</td>
<td>0.967</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.18</td>
</tr>
<tr>
<td></td>
<td>(1.05)</td>
<td>(0.28)</td>
<td>(16.69)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phillipines(^{b})</td>
<td>0</td>
<td>0.067</td>
<td>-</td>
<td>0.85</td>
<td>1.69</td>
<td>0.0298</td>
<td>0.817</td>
<td>6</td>
<td>5.19</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.48</td>
</tr>
<tr>
<td></td>
<td>(3.02)</td>
<td></td>
<td>(13.16)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>U.S.</td>
<td>0</td>
<td>0.048</td>
<td>-0.0030</td>
<td>-</td>
<td>0.94</td>
<td>2.16</td>
<td>0.0140</td>
<td>0.976</td>
<td>4</td>
<td>6.04</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>8.30</td>
</tr>
<tr>
<td>households</td>
<td></td>
<td>(3.51)</td>
<td>(3.03)</td>
<td>(36.60)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>U.S.</td>
<td>0</td>
<td>0.042</td>
<td>-0.0055</td>
<td>-</td>
<td>0.96</td>
<td>2.19</td>
<td>0.0237</td>
<td>0.940</td>
<td>4</td>
<td>8.53</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.57</td>
</tr>
<tr>
<td>firms</td>
<td></td>
<td>(3.09)</td>
<td>(2.85)</td>
<td>(39.83)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>U.S.</td>
<td>-0.348</td>
<td>0.059</td>
<td>-0.0012</td>
<td>-</td>
<td>0.95</td>
<td>2.06</td>
<td>0.0091</td>
<td>0.948</td>
<td>5</td>
<td>9.35</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3.80</td>
</tr>
<tr>
<td>currency</td>
<td></td>
<td>(4.15)</td>
<td>(8.44)</td>
<td>(59.25)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes: Real adjustment explanatory variable is \(\log(M_{t-1}/POP_{t-1})\). Nominal adjustment explanatory variable is \(\log(M_{t-1}/POP_{t-1})\). \(t\)-statistics in absolute values are in parentheses.

\(x^2\): Test of hypothesis that coefficients before and after 1973IV are the same.

\(\chi^2\): Test of hypothesis that coefficients of \(\log(y_{t-1}/POP_{t-1})\) and \(r_{t-1}\) are zero. Degrees of freedom equal two except for the five countries where \(r_{t}\) is not in the equation. For these five countries there is one degree of freedom.

Critical \(x^2\) values for 1, 2, and 4-8 degrees of freedom are, respectively, 3.84, 5.99, 9.49, 11.07, 12.59, 14.07, and 15.51 at the 5% confidence level and 6.63, 9.21, 13.28, 15.09, 18.11, 21.88, and 28.09 at the 1% level.

\(a\): Estimation technique is ordinary least squares.

\(b\): Only discount rate data available for \(r_{t}\).

\(c\): Possible structural break point taken to be 1975IV rather than 1972IV.

\(d\): Hypothesis rejected at the 5% level.

\(e\): Hypothesis rejected at the 1% level.

Cicenets before and after 1973, and so it is of interest to test for this. A chi-squared test was used. 8

Twenty tests were performed in table 2. The hypothesis of structural stability was rejected at the 1% level in 8 cases and at the 5% level in 5 cases. It was not rejected in 7 cases. Interestingly enough, the hypothesis was not rejected for any of the 3 U.S. equations. These results thus indicate some lack of structural stability. In only 2 of the rejected cases, however, were the chi-squared values extremely large—Japan and France. In a loose sense one might say that the lack of stability seems moderate.

When the hypothesis of structural stability was rejected for a country, the equation was estimated for the second subperiod (1973I to the end of the data) with both lagged money variables included. In other words, the test of the real versus nominal adjustment hypotheses was made for the second subperiod. Partial results from these regressions are presented in table 2. In only two cases, Canada and Belgium, were the results reversed from those in table 1 for the whole sample period. For Canada
the results switched from the nominal to the real hypothesis, and for Belgium they switched from the real to the nominal hypothesis. The support for the nominal adjustment hypothesis is thus not changed by restricting the analysis to the period after 1973.

A final test of the money demand equations was made, which is a test of the dynamic specification. Consider a model in which a variable $y_t$ is postulated to be a function of a vector of variables $z_t$. Hendry, Pagan, and Sagan (1984) show that the model

$$y_t = \beta_1 z_t + \beta_2 z_{t-1} + \beta_3 y_{t-1} + \epsilon_t$$

is quite general in that it encompasses many different types of dynamic specifications. The present demand for money equations are based on the implicit assumption that $\beta_2$ is zero. This specification can thus be tested against the more general Hendry et al. specification by including the variables in $z_{t-1}$ in the equation and testing whether they are significant. The two variables in this case are $\log(y_{t-1}/POP_{t-1})$ and $r_{t-1}$. These two variables were added to the equations in table 2, and a chi-squared test of the hypothesis that the coefficients of the two variables are zero was performed. The chi-squared values are presented in table 2. The test has two degrees of freedom except for the five countries where the interest rate is excluded, where it has one degree of freedom. (For countries where the interest rate is excluded, $r_{t-1}$ was not added to the equation.)

The equations did much better on this test than they did on the first test. The hypothesis was rejected at the 1% level in only one case—Turkey—and it was rejected at the 5% level in only two cases—Japan and the U.S. equation for households. The dynamic specification of the money demand equations thus seems reasonable.

IV. Conclusion

The results of estimating money demand equations for 27 countries in this paper are strongly in favor of the nominal adjustment hypothesis. The equations themselves are quite good in terms of the number of coefficient estimates that are of the right sign and that are significant. Also, the equations stand up well when tested against a more general dynamic specification. There is, however, some evidence of structural instability before and after 1973, although the instability is generally moderate. The instability does not affect the conclusion that the nominal adjustment hypothesis dominates the real adjustment hypothesis.

REFERENCES


Hwang, Ha-shin, "Test of the Adjustment Process and Linear Homogeneity in a Stock Adjustment Model of Money Demand," this REVIEW (Nov. 1985), 689–692.


