Selection of the Scale Measure in Narrow Money Demand: The Cases of Japan and Germany

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The purpose of this paper is to apply pair-wise and multiple-alternative non-nested tests to the choice of the scale variable in the money demand functions of Japan and Germany. Findings based on the multiple-alternative procedure indicate that domestic absorption (income minus net exports) is the appropriate scale variable in the money demand function of Japan, while pair-wise tests produce somewhat mixed results. For Germany, private consumption is found to be the proper scale variable in the narrow money demand function by both type procedures. These findings contrast with the established literature that uses income measures as the scale variable. The choice of domestic absorption in Japan by the multiple-alternative procedure provides a role not only for consumption, which correlates with income measures, but also for investment and government spending, as determinants of the level of monetary balances held. The choice of consumption as the appropriate scale variable for Germany supports the shopping time model of money demand and the Mankiw-Summers proposition. These results have implications on formulation of monetary policy and the magnitude of the effect of fiscal policies such as government spending and tax cuts.

Introduction

In the realm of standard macroeconomics, there are few conventions as well established as the use of income as the measure of transaction (the scale variable) in

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specification of the narrow money demand function (MDF). Monetary and fiscal policy effects and the impacts of supply shocks, political actions, and changes in the consumer behavioral patterns generally are assessed by calibration of income-based money demand models, and international policy coordination plans are designed in the context of the same paradigm. The work of Saving (1971), Holmes and Smyth (1972), Mankiw and Summers (1986), Smith and Smyth (1990, 1991), Elyasiani and Nasseh (1994), and Elyasiani and Zadeh (1999), among others, have cast a shadow of doubt on this established convention in specification of the MDF. Saving (1971), Mankiw and Summers (1986), and Elyasiani and Nasseh (1994) provide theoretical and empirical support in favor of the consumption-based money demand specification for the U.S. Holmes and Smyth (1972) and Smith and Smyth (1990, 1991) present evidence in favor of disposable income for the same country. Elyasiani and Zadeh (1999) use pair-wise non-nested tests to investigate the appropriate scale variable in the MDF of selected OECD countries. They find that the scale variable is country specific.

The choice of the scale variable in the MDF has remarkable implications on formulation and implementation of fiscal policy. In the context of the consumption-based model advocated by Mankiw and Summers, the conventional wisdom that a tax cut boosts economic activity fails to hold. Mankiw and Summers demonstrate that, under reasonable parameterization of the model, tax cuts can be restrictive. In this framework, a decline in taxes will not lead to economic recovery; on the contrary, it may deepen the economic slowdown. Furthermore, in this framework policies designed to promote savings, if successful, will serve as an engine of expansion, rather than exerting a contractionary influence. Implications concerning monetary policy are far reaching. The Federal Reserve Bank can hit its monetary target only if it is knowledgeable about the location and the slope of the MDF. If the proper scale variable in the MDF is consumption or domestic absorption, but the Fed designs its policy on the basis of an alternative specification, it will be likely to miss the target.[1] There are also implications from the choice of the scale variable in money demand on modeling and forecasting of interest rate and exchange rate. Equilibrium values of these two variables are affected by the level of monetary balances and, hence, by any variable found to influence them. For example, if consumption is the proper scale variable, the consumption path will have to be introduced into the models designed to forecast interest and exchange rates.

The procedures employed to investigate the scale variable issue include nested procedures (e.g., Mankiw and Summers), as well as non-nested procedures (e.g., Elyasiani and Nasseh, 1994 and Smith and Smyth, 1990 and 1991). A weakness of the nested tests is that in such tests, one of the models considered unavoidably will

[1] See Mankiw and Summers for a more detailed analysis of the implications on monetary and fiscal policies.

be chosen, even if the considered set excludes the true model. This problem can be avoided using non-nested tests. Pair-wise non-nested tests are subject to the shortcoming that they overlook models other than the pair being tested, however; hence, they may fail to identify a scale variable as the preferred choice relative to all considered choices. Moreover, when the number of alternative models is large, the number of pair-wise tests needed to be performed also will be large. This will increase the probability of inconclusive outcomes.

The contribution of this paper is the use of pair-wise and multiple-alternative non-nested procedures to determine the appropriate measure of transaction activity in the MDFs of Japan and Germany. The choice of Japan and Germany is driven by the fact that these are two of the largest and most important economies of the world after the U.S. More importantly, the banking systems in these two countries are dissimilar to the U.S. and to each other. Japan has a banking system dominated by *keiretsue* organizations that allows commingling of banking and commerce and interlocking ownerships. In this system banks are monitored on an ongoing basis by their own managers, as well as by the managers of other affiliates. The German system is of the universal banking category *(Hausbank)* in the sense that it does not restrict the scope of banking activity. Thus, it can provide alternative sources of financing to the corporations, including underwriting their securities, holding their common stocks as investment, and providing them with loans. The multiple-alternative procedure employed allows the test of the propositions postulated by Holmes and Smyth (1972) and Mankiw and Summers (1986) in a general framework and provides a check of the robustness of the pair-wise non-nested test results.

According to the multiple-alternative test results obtained here, the appropriate scale variable for the Japanese narrow MDF is domestic absorption (DA) while that for Germany is consumption (C), with the latter receiving stronger support from the data. These findings contrast with the established convention that treats income as the undisputed scale variable, as well as with the work of Holmes and Smyth (1972), which suggests disposable income (YD) as the appropriate measure. The proposition advanced by Mankiw and Summers (1986) that consumption (C) is the proper scale variable does receive support from the German data.

Literature Review

Most studies of money demand behavior are limited to one country, focus on income as the scale variable, and use nested testing procedures. Recently, however, some comparative studies of the money demand relationship in developed economies, some studies using alternative scale variables, and a good number of studies employing non-nested procedures have emerged in the literature. For example, Bomhoff (1991) estimates income velocity relationships for seven major industrialized countries using the Kalman filter approach, annual postwar data, and identical specifications for all countries. In this study, M1 velocity is found to be highly inter-

est elastic for almost all countries, while M2 velocity displays less interest sensitivity. Boughton (1991) focuses on the long-run properties of the money demand relationships in the large industrialized countries, including the U.S., U.K., Japan, Germany, and France, under various specifications. Boughton's results indicate that the long-run MDFs examined in his sample are stable. That is, there does exist, at least one cointegrating vector relating the arguments in the MDF for each country. Boughton's findings call into question some of the basic assumptions imposed in the conventional specifications of money demand, such as price homogeneity and unitary, or less than unitary, income elasticity.

Chowdhury (1992) investigates the functional form of the transaction demand for money equation in selected OECD countries: Japan, U.K., Canada, Germany, France, and Italy. He finds that, in terms of forecasting performance, the log first-difference form dominates the other three functional forms tested (linear, first-difference, and logarithmic specifications). In Chowdhury's study income elasticities are found to be close to unity for Germany and U.K. but significantly less than the unit value for the remaining countries. The interest elasticities are similar in magnitude for Canada and U.K. (0.12 and 0.14, respectively) while those in other countries are at least twice as high (Japan 0.25, France 0.27, Germany 0.33, Italy 0.44).

Hoffman, Rasche, and Tieslau (1995) use a log linear specification, the narrow concept of money, and quarterly data to investigate a central proposition of the neoclassical and neo-Keynesian monetarist models: namely, the existence of a stable long-run aggregate MDF for the U.S., U.K., Canada, Japan, and Germany during the postwar period. They report strong evidence for stability of the M1 function for all of these countries. While this result holds for Germany without any condition, imposition of unitary income elasticity is a necessary condition for stability to hold for the other countries. A priori imposition of the maintained hypothesis of unitary income elasticity is subject to dispute and, as discussed in the results section, is not supported by the findings of the current paper.

The noteworthy point here is that in a high majority of the money demand studies (Bomhoff, Boughton, Chowdhury, and Hoffman et al. among them), treatment of income as the scale variable is a maintained hypothesis. This hypothesis was challenged early by Saving (1971) and Holmes and Smyth (1972) and later by Mankiw and Summers (1986). Saving (1971) proposed a shopping time model of money demand in which consumption is a time-consuming activity and consumers hold monetary balances in order to reduce the time required for consumption. It follows that, in the shopping time model, monetary balances are determined by the level of consumption, rather than income, as suggested by the inventory-theoretic models. Holmes and Smyth (1972) claimed that, on theoretical grounds, disposable income (YD) is more suitable than current income (Y) as the scale variable in the MDF because income taxes are not a part of the spendable money. On the other hand,

Mankiw and Summers (1986) argued in favor of the proposition that money demand is based on consumption, rather than income, and provided empirical evidence that, for the U.S., consumption (C) is superior to income (Y), disposable income (YD), private spending (PS), and domestic absorption (DA) as the scale variable in the MDF. Using the U.S. data, Smith and Smyth (1990, 1991), and Elyasiani and Nasseh (1994) provided support for the Holmes and Smyth (1972) and Mankiw and Summers (1986) propositions, respectively.

Studies on the choice of the proper transaction measure in the MDF of countries other than the U.S. include the work of Brissimis and Leventakis (1985), Milbourne (1985), Marselli and Vannini (1988), Nasseh (1989), and Arestis and Demetriades (1991), all of which use non-nested tests. The Brissimis and Leventakis (1985) study is based on Greek quarterly data for the period 1975-I to 1982-I. The empirical findings of this study provide no support for permanent income, used as a proxy for wealth, over current income in the MDF of Greece. The results of the Brissimis and Leventakis (1985), however, are highly unreliable because the number of observations in this study (32 observations) is seriously limited and is bound to produce unreliable results in the context of cointegration or non-nested testing analysis. Milbourne (1985) investigates the Australian MDF. Milbourne's empirical results indicate that a MDF cannot be specified for Australia because either it does not exist or if it does exist, it cannot be found.

Marselli and Vannini (1988) report that, based on monthly observations of the U.K. money stock for the period February 1964 to April 1982, income and consumption are both rejected as the scale variable in the U.K. money demand function. An income-based specification of the U.K. money demand function also is rejected by Nasseh (1989), who finds evidence in favor of permanent income and wealth. The work of Arestis and Demetriades (1991), using annual data for Cypress for 1963-1988, supports income as the scale variable for the Cypriot MDF.[2]

The current study adopts a general open economy framework and applies pair-wise and multiple-alternative non-nested tests to the Japanese and German data. Application of the multiple-alternative tests to the data of these two countries, performed here for the first time, can shed additional light on the issue of the proper scale variable in the MDF by providing evidence in support or against the findings based on the U.S. data employing pair-wise or multiple non-nested tests.

Models, Data, and Stationarity

Model Specification

The MDF is specified within an open economy framework. The explanatory variables include a transaction measure, an opportunity cost measure, and an exchange rate variable. Five transaction measures are used as possible candidates for

[2] For a recent survey of literature on money demand see Duca and Vanhoose (2004).

the scale variable: income (Y), disposable income (YD), consumption (C), private spending (PS), and domestic absorption (DA). Private spending is defined as the sum of consumption and investment (PS = C+I), and domestic absorption is measured as income adjusted for net exports (DA=Y-NX= C+I+ G, where G is government expenditures and NX stands for net exports).

The opportunity cost variable is the short-term interest rate: the three-month CD rate in the case of Japan and the three-month inter-bank offer rate (FIBOR) for Germany. The choice of the interest rate variable is based on availability of the data. The real exchange rate variable used is the product of the bilateral exchange rate (the value of domestic currency per U.S. dollar) and the ratio of the U.S. to domestic price levels. All variables, except the interest rates, are in real terms. A log-linear functional form is adopted.

Inclusion of an exchange rate variable in the MDF is demanded by theory and empirical evidence. Mundell (1963) introduced the idea of including an exchange rate variable in the MDF, in addition to the interest rate and a scale variable. He further argued that when the exchange rate is a significant determinant of money demand, the relative effectiveness of monetary policy will be reduced and that of fiscal policy will strengthen. More recently, Akiba (1996) provides further theoretical justifications for inclusion of the exchange rate in the MDF. Elyasiani and Zadeh (1999) also examine the choice of a scale variable in an open economy framework for selected OECD countries and find evidence of exchange rate significance. To maintain consistency and comparability with the extant literature, an exchange rate is included in the current study. Arize and Shwiff (1998) provide an extensive list of papers that include an exchange rate in the MDF.

Data and Stationarity

Quarterly time series data for Japan and Germany are used to estimate the model. The beginning of quarterly data series differs between the two countries. For Japan, the sample begins in 1979-I and ends in 2003-I, while the data for Germany begin in 1991-I and end at 1999-I. Bahmani-Oskooee and Shabsigh (1996) examine the stability of narrow and broad money demand (M1 and M2) for Japan over the period 1973-1990. They find that stability results are sensitive to the choice of lags and that, at least for M2, it is necessary to include the effective exchange rate of the Yen in the MDF to achieve stability. The beginning of the German sample period is chosen to coincide with German unification. Prior to unification, East and West Germany had different financial systems. Hence, a consistent and reliable data series cannot be constructed for the entire period. Moreover, for the German narrow definition of money (M1), Hansen and Kim (1995) find that “conventional sample split tests for structural break and Hansen SupF test indicate instability in 1990 due to

Unification."[3] Bahmani-Oskooee and Bohl (2000) also find that the German broad money demand function (M3) shows instability when pre and post unification data are combined. The sample-end point for Germany is the introduction of the Euro and the abandonment of the Deutschemark. Data sources include the OECD Main Economic Indicators, International Financial Statistics (IFS), and Global Insight.[4] The OECD Main Economic Indicators data set provides data on monetary balances, income, consumption, private spending, and domestic absorption. The IFS data set contains data on interest rate and exchange rate, and Global Insight is used as the source for disposable income data.

In modeling MDF, attention should paid to the issue of cointegration and stationarity; if data are not stationary, the distributions of the test statistics will differ from those derived under stationarity, and test results may be spurious.[5] The cointegrating equation in the current model relates the logarithms of real cash balances to a scale variable, interest rate, and exchange rate without an autoregressive transformation.[6] To test the null of non-cointegration versus the alternative of cointegration, the Dickey-Fuller and augmented Dickey-Fuller (ADF) tests for unit roots are applied to the residuals of the cointegrating equations. The decision rule is to reject the null (existence of a unit root) if the DF (ADF) t-statistic exceeds the relevant MacKinnon (1991) critical value in absolute terms.

In performing the ADF tests, four lagged difference terms are added to the test regression in order to ensure white noise error terms. The statistically insignificant lagged difference terms are then dropped from the equation. The results of the ADF tests are reported in Tables 1 and 2. The numbers in brackets under the ADF statistics in these tables indicate the statistically significant lagged difference terms retained in the final test equation.[7] The ADF results indicate that the arguments in the log specification of the MDF are cointegrated and, hence, no differencing is necessary.[8] MDF is estimated using the OLS method. The standard errors of the coefficients for autocorrelation are corrected by a procedure developed by Newey and West (1987). It is noteworthy that the heteroscedastic-and-autocorrelation-consistent (HAC) estimated coefficients are the same as the OLS coefficients. The HAC

[3] We would like to thank Scott Fuess, Jr., the associate editor of the journal for raising this issue.

[4] We would like to thank Mr. James Kelly of Global Insight for providing data for disposable income.

[5] Engle and Granger (1987) propose a set of seven residual-based test statistics for testing the null hypothesis of non-cointegration against the alternative of cointegration, but recommend the augmented Dickey-Fuller (ADF) test as the most appropriate procedure for most types of economic data.

[6] The models are not transformed for serial correlation. See Gujarati (1995) for justification.

[7] See Engle and Granger (1987, p. 107) for justification.

[8] Boughton (1991) also reports the presence of cointegration among the arguments in the MDF.

standard errors are larger than those of the OLS, however; consequently, the HAC t-ratios are smaller than the t-ratios produced by the OLS method.[9]

Table 1—Money Demand Regression Results for Japan, Quarterly Data 1979.1-2003.1 (Absolute values of t-statistics are in parentheses)

	Income (Y)	Consumption (C)	Private Spending (PS)	Domestic Absorption (DA)	Disposable Income (YD)
Scale Variable	0.764	0.822	0.656	0.827	0.903
Elasticity	(5.199)	(5.248)	(4.175)	(6.739)	(6.615)
Interest Rate	-0.153	-0.148	-0.163	-0.149	-.163
Elasticity	(10.347)	(9.387)	(10.897)	(10.864)	(13.701)
Exchange Rate	0.114	0.118	0.093	0.160	.162
Elasticity	(1.198)	(1.187)	(0.936)	(1.820)	(1.768)
Intercept	-3.186	-3.469	-1.549	-4.216	-7.133
	(1.400)	(1.495)	(0.643)	(2.195)	(2.957)
$\bar{R}^2$	0.956	0.955	0.953	0.960	.955
DF	-1.705*	-1.752*	-1.732*	-1.879*	-2.303**
ADF	-2.926**	-3.652***	-3.383**	-2.827*	-4.097***
Lags	[2]	[2]	[2]	[2]	[0]

Note: In Tables 1 and 2, ***, **, and * indicate significance of the DF and ADF test statistics at 1 percent, 5 percent, and 10 percent levels respectively, where the critical values are based on the MacKinnon's response surface regression given in MacKinnon (1991)

Empirical Results

Money Demand Coefficient Estimates

Tables 1 and 2 report the estimated M1 money demand elasticities with respect to transaction (scale) variable, interest rate, and exchange rate for Japan and Germany, respectively. All scale elasticities have the theoretically expected positive signs, but their magnitudes vary with the choice of the scale variable and between the two countries. Among the scale variables, disposable income (YD), domestic absorption (DA), and consumption (C) show a stronger elasticity than income (Y) in Japan, and consumption shows the strongest elasticity in Germany. The scale elasticities are in general considerably larger in magnitude for Germany than for Japan, regardless of the scale variable considered. This indicates that spending activities in Germany generate more transactions and require more monetary balances than in Japan. In other words, the turn-over of money is lower in the post-unification Germany than in Japan. The income elasticity values do not support the unitary elasticity assumption in the Hoffman, Rasche, Tieslau (1995) study of the Japanese money demand. The scale elasticities reported here are also dissimilar to, and exceed considerably, those found by Smith and Smyth (1991) for the U.S. narrow money in terms of magnitude.

[9] See Gujarati (1995) for more details and examples.

Table 2—Money Demand Regression Results for Germany, Quarterly Data 1991.1-1999.1 (Absolute values of t-statistics are in parentheses)

	Income (Y)	Consumption (C)	Private Spending (PS)	Domestic Absorption (DA)	Disposable Income (YD)
Scale Variable	1.851	2.161	1.891	1.884	1.920
Elasticity	(4.279)	(5.641)	(4.740)	(4.318)	(4.944)
Interest Rate	-0.149	-0.128	-0.170	-0.160	-0.189
Elasticity	(4.980)	(5.798)	(7.947)	(5.809)	(10.480)
Exchange Rate	0.262	0.336	0.334	0.333	.0338
Elasticity	(4.996)	(7.249)	(7.097)	(6.249)	(5.801)
Intercept	-22.458	-25.295	-22.501	-22.847	-2.434
	(3.962)	(5.274)	(4.392)	(4.002)	(2.865)
$\bar{R}^2$	0.964	0.972	0.970	0.968	0.971
DF	-2.363**	-3.493***	-2.982***	-2.384**	-1.808*
ADF	-2.440*	-6.007***	-4.328***	-3.854***	-3.718***
Lags	[0]	[0]	[0]	[1]	[0]

Note: In Tables 1 and 2, ***, **, and * indicate significance of the DF and ADF test statistics at 1 percent, 5 percent, and 10 percent levels, respectively, where the critical values are based on the MacKinnon's response surface regression given in MacKinnon (1991)

Interest elasticity measures have the theoretically expected negative signs for both countries and are statistically significant in all models. The magnitudes of these elasticities are small in all cases for both countries (between 0.12 and 0.17). Inclusion of the exchange rate in the MDF extends the analysis to an open economy framework and is likely to make the model more reliable. Theoretically, the sign of the exchange rate elasticity can be positive or negative (Arango and Nadiri, 1981). A positive exchange rate elasticity is indicative of regressive expectations or normal backwardation behavior. If expectations are regressive, a depreciation of the domestic currency (an increase in the exchange rate) will generate expectations of movements in the opposite direction. To profit from anticipated appreciation of the domestic currency, the public will increase its domestic money holdings concurrent with the increase in the exchange rate, resulting in a positive exchange rate elasticity of money demand. On the other hand, if depreciation of the domestic currency (a higher exchange rate) leads market participants to expect further declines in its value, they will choose to hold more foreign currency and less domestic currency, lowering the demand for money as a result. This establishes a negative elasticity for money demand with respect to the exchange rate (Bahmani-Oskooee and Pourheydarian, 1990).

According to the figures in Tables 1 and 2, the exchange rate elasticity in the Japanese MDF is statistically significant (with magnitude of 0.16) only for the specification using domestic absorption (DA). In the case of Germany, the exchange rate elasticities are highly significant for all specifications, with the magnitude of these elasticities standing at about 0.3. The positive and significant exchange rate elasticity models support the regressive expectations or normal backwardation pattern of

behavior in the currency markets for the two countries.[10] The stronger sensitivity of the German MDF to the exchange rate, compared to the Japanese case, is likely due to the fact that the former is an open economy while the latter remains a closed one, in spite of its advancement in technology and its substantial trading activity at the international level.[11]

In general, based on the coefficient significance and summary statistics, one may conclude that the estimated models are reasonable representations of the MDF in each country. The R-squared goodness of fit measure is also relatively high. To assess the relative adequacy of these models further, we apply the multiple-alternative and pair-wise non-nested tests.

Multiple and Binary Non-nested Test Results

The multiple-alternative test procedure has some advantages over the pair-wise tests, but lacks strong power. This procedure compares all alternative models simultaneously, is more likely to identify one model as the selected model, and is computationally simple. Pair-wise tests also do render useful information about the relative performance of any two models, but the intransitivity of the test results in these procedures may lead to conflicting outcomes. Because the description of the test procedures is available elsewhere in the literature, only a brief presentation of the multiple-alternative procedure is included here in an appendix. [12]

The results of the multiple and pair-wise non-nested test procedures are displayed in Tables 3 and 4. The diagonal entries in these tables are the F-statistics for the multiple P-tests of the null, given in each row/column, against all alternatives. The off-diagonal elements are the t-statistics for the binary P-tests of the null scale variables, specified in the corresponding row, against the alternative scales, given in the corresponding column.

According to the multiple P-test statistics displayed in Table 3, in the case of Japan the outcome of the race among the scale variables is clear-cut. In this case, the

[10] Although the exchange rate is not significant in all of the Japanese models estimated, it is retained in the model in order to avoid the omitted variable problem. It is noteworthy that when significance of a variable in a model is uncertain, it is better to err on the side of inclusion because the consequences of adding an insignificant variable are far less significant than the consequences of an omitted variable. Specifically, even if a completely redundant variable is included in the model, the estimators will not be biased or inconsistent, while omission of a variable, which is correlated with an included regressor (the case here), will have those consequences (Kmenta, 1986). Other studies arguing for and including an exchange rate variable in the Japanese MDF include Elyasiani and Zadeh (1995, 1999).

[11] Studies of stock market linkages similarly show that the Japanese stock market demonstrates a low degree of interdependence with the other stock markets and is rather isolated. For example, see Arshanpalli and Doukas (1993). Similar results are found for the Japanese currency market (Elyasiani and Kocagil, 2001)

[12] For a review of non-nested testing procedures and issues see McAleer (1995).

model based on domestic absorption (DA) fails to be rejected, while those based on consumption (C), income (Y), private spending (PS) are all rejected. It is noteworthy, however, that the stringency with which domestic absorption escapes rejection as the scale variable is not high; although it can not be rejected at 5 percent, it can be rejected at 10 percent. Moreover, the binary test results for Japan are only broadly, but not fully, consistent with the multiple test findings, due to intransitivity of these tests. According to the test statistics reported in Table 3, in binary tests between domestic absorption (DA) and other scale variables, the domestic absorption (DA) model rejects the income (Y), consumption (C), and personal spending (PS) models as the null at the 1 percent level, and the disposable income (YD) model at the 5 percent significance level. When the null is reversed, domestic absorption (DA) is also rejected by some of the other scale variables. These findings clearly show the ambiguity of the pair-wise tests.

Table 3—Multiple and Binary Non-nested Test Results for Japan

	Income (Y)	Consumption (C)	Private Spending (PS)	Domestic Absorption (DA)	Disposable Income (YD)
Income	5.116**	1.154	1.275	3.811**	0.055
	(0.002)	(0.251)	(0.206)	(0.000)	(0.956)
Consumption	2.073*	6.493**	0.185	5.348**	1.157
	(0.041)	(0.000)	(0.854)	(0.000)	(0.250)
Private	2.37*	1.254	7.540**	3.751**	1.584
Spending	(0.044)	(0.212)	(0.000)	(0.000)	(0.117)
Domestic	2.609*	3.791**	2.008*	2.061	1.326
Absorption	(0.011)	(0.000)	(0.048)	(0.093)	(0.188)
Disposable	0.849	0.407	0.309	2.480*	6.058
Income	(0.398)	(0.685)	(0.758)	(0.015)	(0.000)

Note: In Tables 3 and 4, diagonal entries are F-statistics of multiple P-tests. Off-diagonal entries are absolute t-statistics of binary P-tests. p-values are in parentheses. A single asterisk indicates rejection of the model in row i by the model in column j at $\alpha = 0.05$, and double asterisks indicates the same for $\alpha = 0.01$

The finding that, based on the multiple-alternative test procedure, domestic absorption (DA) is the proper scale variable in the Japanese MDF conflicts with Mankiw and Summers' proposition favoring consumption (C) and provides evidence against the Holmes and Smyth view favoring disposable income (YD). Both of these studies use the narrow definition of money and employ U.S. data. The binary test results also conflict with the Mankiw and Summers' proposition, as consumption (C) fails to reject income (Y), disposable income (YD), or personal spending (PS), though it is rejected by income (Y) and domestic absorption (DA)**.** The finding in favor of domestic absorption (DA = Y-NX = C+I +G) indicates that consumption (C), investment (I), and government expenditure (G), rather than consumption alone, are relevant in determining the level of monetary balances held by the public, though not necessarily to the same degree. Hence, changes in investment, and government

spending, also should be considered by the policy makers in Japan for formulation and implementation of the money supply decisions.

According to the multiple P-test statistics in case of Germany (Table 4), consumption (C) emerges as the proper scale variable in the MDF, as it fails to be rejected, while income (Y), disposable income (YD), private spending (PS), and domestic absorption (DA) are all rejected at the 5 percent level of significance. This finding accords with the result obtained by Mankiw and Summers (1986) and points to an important role for permanent income (proxied by consumption), rather than current income in money demand decisions, as well as policy formulation by German policy makers. This result is also consistent with Smith and Smyth (1991) for the U.S. money demand and supports the consumption variable in the international context.

Table 4—Multiple and Binary Non-nested Test Results for Germany

	Income (Y)	Consumption (C)	Private Spending (PS)	Domestic Absorption (DA)	Disposable Income (YD)
Income	3.475*	3.268*	1.904	0.909	1.770
	(0.021)	(0.003)	(0.067)	(0.371)	(0.087)
Consumption	1.571	1.187	0.870	1.012	1.031
	(0.127)	(0.339)	(0.391)	(0.319)	(0.311)
Private Spending	1.082	2.983**	2.787*	0.467	1.358
	(0.288)	(0.006)	(0.046)	(0.644)	(0.185)
Domestic Absorption	1.151	3.216**	1.532	3.489*	1.254
	(0.258)	(0.003)	(0.136)	(0.020)	(0.219)
Disposable Income	2.362*	3.752**	2.578*	1.821	4.630**
	(0.025)	(0.000)	(0.017)	(0.079)	(0.005)

Note: In Tables 3 and 4, diagonal entries are F-statistics of multiple P-tests. Off-diagonal entries are absolute t-statistics of binary P-tests. p-values are in parentheses. A single asterisk indicates rejection of the model in row i by the model in column j at $\alpha = 0.05$, and double asterisks indicate the same for $\alpha = 0.01$

Binary test procedures applied to the German data produce results consistent with those of the multiple tests. According to these tests, every scale measure is dominated by consumption (C) at the 5 percent probability level, while none dominates consumption (C) when the null hypothesis is reversed. The findings based on the binary procedures reinforce the multiple-test results. Among other scale variables, in the pair-wise tests between disposable income (YD) and other scale variables, YD rejects none while it is rejected by all. The strong rejection of disposable income (YD) fails to support the Holmes and Smyth (1972) proposition.

Some pair-wise tests produce inconclusive results. For example, neither personal spending (PS) nor domestic absorption (DA) is rejected as null versus the other. The difference between these two variables, the level of government spending, seems not to offer a considerable advantage or disadvantage as the scale variable for the MDF in Germany. Both measures are strongly rejected by private consumption, and nei-

ther is rejected by disposable income (YD). The inconclusive outcomes reached here in some pair-wise tests are in a sense similar to that of Bernanke, Bohn, and Reiss (1988) and Stockton and Struckmeyer (1989) who reject all the models that they consider. Overall, the findings on German data make consumption (C) the most preferred scale measure for this country. This is dissimilar to the finding on the Japanese MDF and provides international confirmation for the shopping time model of Saving (1971) and the Mankiw and Summers (1986) proposition.

Discussion

It is interesting to compare the results found in the current study to those reached in Elyasiani and Zadeh (1999) based on pair-wise tests using both narrow and broad definitions of money and also with Smith and Smyth (1991) who apply multiple and pair-wise tests to U.S. data. The findings reached here based on multiple-tests, are similar to the findings in the Elyasiani and Zadeh (1999) for Japan but not those for Germany. In the case of Japan, under the narrow definition, both studies select domestic absorption (DA) for the scale variable among the candidates tested, though the results based on the pair-wise tests are mixed. The outcome of the comparison is quite different in the German case. For Germany, the finding here favors consumption as the winner, while in the latter study, under the M1 definition, the consumption-based model is eschewed in favor of income, disposable income, private spending, and domestic absorption, though not with the same strength. Differences in findings between the two studies are due to differences in the test procedure, as well as to the sample periods chosen. In the Elyasiani and Zadeh study the sample period runs between 1977 and 1990, while the current study uses data for unified Germany over the 1991-1999 period. It is possible that after unification, consumption plays a more considerable role for the German money demand while the relative importance of investment and government expenditures declines. As unification matures over time and institutions in East and West Germany become fully integrated, investment may again reach prominence and the scale variable in the MDF may approach personal spending or domestic absorption.

In comparing the current results with those of Smith and Smyth (1991), it should be noted that the institutional structures in Japan and Germany are different from that in the U.S., and the sample periods are also dissimilar. The models specified in the latter study include distributed lags (constrained by a second-degree polynomial) and a time trend as regressors and are estimated subject to a partial adjustment mechanism. The main finding of this study based on the multiple P-test is that consumption is the strongest model among those tested. This result is consistent with our findings on Germany but dissimilar to the Japanese case.

Why is the choice of the scale variable different for Japan and Germany? While it is difficult to pinpoint the exact reasons for the dissimilarity, some clarifying points can be made in this regard. The scale variables considered here comprise dif-

ferent combinations of expenditures, with income (Y) being the broadest measure and consumption (C) the narrowest. Different types of spending (consumption, investment, government spending), all do increase the level of transactions and do generate demand for money, but not at the same rate. Depending on the payment habits, transaction patterns, and the transaction technology prevailing in a given country, each component of total expenditures plays a different role and takes a different level of significance.[13] It is possible that in one country consumption strongly dominates other components of GDP in generating demand for money. This may be, for example, because in a given country cash is the dominant medium of payment and it has a lower turnover than other media, such as demand deposits, generated when bank loans are made to finance investment projects. Alternatively, in a given country, investment may be financed through intra-conglomerate credit arrangements or retained earnings, limiting its impact on deposits and monetary balances. Transaction balances generated by government expenditures generally are not included in the definition of money and are not expected to impact the money demand level proportionately.

Between Japan and Germany, the contributory factors to dissimilarity in the scale variables include differences in transaction technology (payment by cash, checks, ATMs, credit cards, debit cards, EFTs), and dissimilarities in financing methods of corporate investment projects. The payment technologies in Japan and Germany are dissimilar. For example, the use of ATMs differs between the two countries. Japan has a larger number of ATM machines, a smaller number of transactions per inhabitant, and a larger denomination per transaction. Germany has been slow in developing ATM networks, mostly because of the prohibitive charges on the use and leasing of domestic telephone lines (Saunders and Cornett, 2003, Chapter 14). The common use of ATMs in Japan is likely to reduce the demand for cash and checking deposits and, thereby, to diminish the import of consumption relative to investment and government spending in determination of monetary balances. This is likely to put the three spending categories on more of an equal footing. Hence, domestic absorption receives a higher chance of becoming the choice for scale variable. In the case of Germany, the high cost of ATMs provides an incentive for consumers to hold more cash and demand deposits. This strengthens the effect of consumption on money demand and makes it a more appropriate choice for the scale variable. The stronger effect of consumption on the German money demand is consistent with the higher elasticity of money demand with respect to consumption shown in Table 2.

[13] To account for these dissimilar effects on demand for monetary balances, Enzler et al. (1976) have proposed the use of a weighted average concept of spending components as the scale variable for money demand. These authors do report an improvement in fit and a considerable reduction in post-sample error with this measure.

Investment also can be a source of distinction in money demand between the two countries. Japanese corporations often belong to *Keiretsues*; organizations under which banks and corporations are commingled. This arrangement allows corporations to have access to bank loans to finance projects. Bank loans are deposited to the checking accounts of corporations, increasing the relative effect of investment on money demand in Japan. The German banking system, however, is designed based on the *Hausbank* approach (universal banking) and features strong monitoring of corporate firms by banks. In this model, firms rely on a principal bank, which is universal in nature, in the sense that it provides all the financing needs of the firm, including seed capital, initial public offering (IPO) of stocks, bond underwriting, and working capital. In this system, availability of multiple sources of financing allows corporations to avoid strong reliance on bank loans and/or holding large deposits to finance investments. The level of monetary balances held (or demand for money in Germany) is thus not heavily determined by investment spending, as measured relative to consumption spending. These two forces combine to reduce the relative power of consumption and bring it closer in importance to investment and government expenditures, as determinants of money demand in Japan. This makes domestic absorption the appropriate scale variable in demand for money in that country. In Germany, the relative power of consumption is strengthened and the relative power of investment is curtailed by the same two forces, giving superiority to consumption as the scale variable in money demand.

If domestic absorption or income net of net exports is the appropriate choice for the scale variable in the money demand function, it will indicate that all components of income, except net exports, play a role in determining monetary balances in Japan. The finding that only the domestic components of income influence money demand is not surprising because the Japanese economy is a closed economy. Studies of stock market linkages also show that the Japanese stock market is not strongly (or in some studies even weakly) linked to the markets of other countries (Arshanpalli and Doukas, 1993). Similarly, research on currency interdependence has revealed that the Japanese yen demonstrates little interdependence with other currencies (Elyasiani and Kocagil, 2001). Lower significance of the exchange rate in MDFs estimated for Japan is consistent with the choice of domestic absorption as the appropriate scale variable for the Japanese MDF.

Conclusion

The contribution of this paper is the application of pair-wise and multiple-alternative non-nested procedures to the quarterly data of Japan and Germany in order to investigate the appropriate scale variable for the narrow money demand function in these two countries. The multiple-alternative test, applied to these countries here for the first time, allows simultaneous consideration of all the scale variable choices and provides a test of robustness of the findings based on the pair-

wise procedures. The propositions of Holmes and Smyth (1972) and Mankiw and Summers (1986) are tested within this framework of analysis. Empirical results indicate that, according to the multiple-test procedure, domestic absorption (namely the sum of consumption, investment, and government expenditure) can serve as the scale variable in the narrow money demand function of Japan. In pair-wise tests this measure beats other scale candidates, although it also is beaten by some. For Germany, consumption emerges as the proper measure in both multiple and pair-wise tests. Overall, the finding is that the appropriate scale variable in the money demand function is not necessarily a measure of current income, as the conventional wisdom maintains, and that it need not be identical for different countries.

If domestic absorption is the appropriate scale variable in the Japanese money demand function, consumption expenditures, which correlate with the conventionally accepted income measures, do play a role in determination of monetary balances held by the public, but so do investment and government expenditures. Under this condition, the Japanese policy makers should use a measure of spending that includes consumption, investment, and government spending, rather than the narrower measure (consumption) or the broader measure (income) in formulation and implementation of monetary and fiscal policies. The extensive use of ATMs in Japan may have reduced the consumer need for cash and checking account deposits, thereby making the effect of consumption on money demand less prominent. The effect of corporate investment demand on monetary aggregates is due to the fact that investment is financed by bank loans, much more so than by issuance of new stocks and bonds. Bank loans are made generally by depositing funds in the demand deposit accounts of the borrowing company, raising the monetary balances held by the private sector as a result. Large Japanese corporate borrowers often belong to a *keiretsue* organization, an entity that combines banking and business enterprises and provides for substantial financing of the investment projects through the affiliated banks. This makes investment also an important determinant of money demand. The fact that the net export component of income does not exert an influence on money demand in Japan may reflect the fact that Japan is a closed economy. The findings in the literature that the Japanese stock and currency markets are also unrelated to the other markets in the industrialized countries are consistent with this view.

In Germany, consumers' avoidance of ATMs due to the high ATM costs results in an increase in the share of currency in total transaction balances and a reduction in their turn-over rate. This, in turn, strengthens the effect of consumption on money demand. Moreover, the universal banking system prevailing in Germany allows banks to own equity stakes in commercial firms and to provide them with seed capital, IPO financing, bond underwriting, working capital, and equity financing. This relationship facilitates financing of the latter's investment projects, lowering the need for bank loans and holding of substantial monetary balances. This, in turn, weakens the effect of investment spending on money demand. German policy makers will do

better to consider consumption in their monetary policy formulation, rather than the broader income measures, to evaluate the effects of monetary and fiscal actions.

Future research should focus on broader concepts of money such as M2 and M3, which serve as stores of value rather than as media of exchange, and on investigation of the scale variable for other industrialized and emerging markets. It would be also interesting to compare and contrast the forecasting performance of the traditional models and models based on the appropriately selected scale variables and on forecasting performance of the interest rate and exchange rate models based on these two specifications of the money demand function.

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Appendix—The Multiple Non-nested Test Procedure

Suppose the non-nested models are specified as:

$$y = X_i\beta_i + \varepsilon_i \quad i = 1, \ldots, m \tag{1}$$

where, y is $T \times 1$ vector of observations on the dependent variable, X_i is a $T \times k_{id}$ matrix of observations on k_{id} linearly independent regressors, β_i is a $k_i \times 1$ vector of unknown parameters, and ε_i is assumed to be iid $N(0, \sigma_i^2, I)$. The simplest case of this procedure is a paired test of the model H_1: $y = X_1 \beta_1 + \varepsilon_1$ against the alternative H_j: $y = X_j \beta_j + \varepsilon_j$. In this case, the t^{th} rows of the two models can be written as (2) and (3) below and a non-nested test can be derived by artificial nesting of the two alternative models (Davidson and MacKinnon, 1981; McAleer, Pesaran, and Bera 1990):

$$H_1: y_t = f_{1t}(\beta_1) + \varepsilon_{1t} \tag{2}$$

$$H_j: y_t = f_{jt}(\beta_j) + \varepsilon_{jt.} \tag{3}$$

The artificially nested model can be presented by combining the two alternatives H_1 and H_j as:

$$H_c: y_t = (1-\lambda)\, f_{1t}(\beta_1) + \lambda\, f_{jt}(\beta_j) + \varepsilon_t. \tag{4}$$

The latter specification introduces a straightforward test in which H_c reduces to H_1 if $\lambda=0$ and to H_j if $\lambda=1$. The complication of this procedure, however, is that the artificial model (4) is not estimable because the parameters λ, β_1, and β_j cannot be identified. A solution to this problem, proposed by Davidson and MacKinnon (1981), is to replace the H_c model in (4) by $H_c^{'}$ in which the parameters of the alternative model H_j are replaced by their consistent estimates:

$$H_c^{'}: y_t = (1-\lambda)\, f_{1t}(\beta_1) + \lambda\, f_{jt}(\hat{\beta}_j) + \varepsilon_t. \tag{5}$$

Here, the validity of H_1 can be tested by testing the null hypothesis of $\lambda = 0$ using any standard significance test. Two possibilities for such a test are proposed by Davidson and McKinnon (1981): the J test which uses the t-statistic for $\lambda = 0$ from nonlinear estimation of (5) and the P-test employed here, which uses the t statistic for $\lambda = 0$ from the Gauss-Newton regression.

The easiest way to derive the P-test is to take first order Taylor-series approximation to (5) around the estimated parameter values $\beta_i = \hat{\beta}_i$ and $\lambda = 0$ and to estimate the resulting linear relationship using the ordinary least squares technique (OLS). The Taylor series approximation produces the following model:

$$y_t - f_{1t}(\hat{\beta}_1) = \hat{F}_{1t}^{'} d + \lambda\,(f_{jt}(\hat{\beta}_j) - f_{1t}(\hat{\beta}_1)) + \varepsilon_t, \tag{6}$$

where $\hat{F}'_{1t} = [\partial f_{1t} / \partial \hat{\beta}_1] = x_{1t}$ and $d = (\beta_1 - \hat{\beta}_1)$.

Noting that $y_t = f_{1t}(\hat{\beta}_1) + \hat{\varepsilon}_{1t} = f_{jt}(\hat{\beta}_{jt}) + \hat{\varepsilon}_{jt}$, it follows that: $f_{jt}(\hat{\beta}_j) - f_{1t}(\hat{\beta}_1) = \hat{\varepsilon}_{1t} - \hat{\varepsilon}_{jt}$, so that (6) can be rewritten as (7):

$$\hat{\varepsilon}_{1t} = \hat{F}'_{1t}d + \lambda(\hat{\varepsilon}_{1t} - \hat{\varepsilon}_{jt}) + \varepsilon_t. \quad (7)$$

Equation (7) constitutes a computationally simple procedure that does not require nonlinear estimation. In this equation, the first term is a constant term in the regression model, the residuals $(\hat{\varepsilon}_{1t} - \hat{\varepsilon}_{jt})$ serve as the regressors, and λ is the parameter to be estimated. The simple OLS technique allows estimation of the parameter λ. The attractive feature of this approach is that the binary non-nested test of H_1 against H_j is reduced to a simple t-test of significance of the parameter λ in the auxiliary linear regression (7). It is well-known that the OLS method provides linear unbiased as well as consistent and asymptotically normally distributed estimators, but these estimators are no longer efficient (i.e., minimum variance) in the presence of heteroscedasticity, autocorrelation, or both. Therefore, in such cases, the usual OLS standard errors will be incorrect and should not be used for inference. In this paper, we still use the OLS method (in the binary as well as in the multiple non-nested tests), but correct the standard errors for autocorrelation using a technique developed by Newey and West (1987). The corrected standard errors are known as heteroscedastic-and-autocorrelation-consistent (HAC) standard errors or as Newey-West standard errors.

Similar to equation (7) above, the multiple non-nested test of H_1 versus the m-1 alternatives is the OLS-generated F-test of the hypothesis $\lambda_2 = \lambda_3 = \ldots = \lambda_m = 0$ from the following compound model:[14]

$$\hat{\varepsilon}_{1t} = \hat{F}'_{1t}d + \sum_{j=2}^{m} \lambda_j \left(\hat{\varepsilon}_{1t} - \hat{\varepsilon}_{jt}\right) + \varepsilon_t \quad (8)$$

This procedure is used in the empirical section to choose among alternative scale variables simultaneously.

[14] For derivation see McAleer, Pesaran, and Bera (1990).