Economists have long sought to identify the most appropriate measures of monetary services. The issue is of practical interest, because effective conduct of monetary policy presupposes an appropriate monetary measure, and it is of academic interest for the insight it provides into the nature of “moneyness.” In this paper we seek to identify a monetary aggregate appropriate to the Korean economy.¹

To presume that an appropriate monetary target exists is to assume a stable relationship between income and that aggregate. Theorists have argued this stable relationship is central to the definition of money, in the sense that the collection of assets whose purpose is to facilitate exchange will be held in proportion to the planned flow of transactions (Patinkin 1965, p. 599). In simplest terms our empirical work attempts to determine which, if any, definition of money satisfies this stability criterion for the Korean economy.
There are several reasons why an appropriate Korean monetary aggregate might differ from an appropriate monetary aggregate for the United States or some other less recently developed economy. First and most obvious is Korea's phenomenal growth. In 1970 per capita GNP was $273, by 1992 it had become $6750. This put the average growth rate of real GNP at 8.6 percent per year, with nominal GNP growing 22.7 percent per year (International Monetary Fund 1992). The effect of such rapid growth on the usefulness of monetary aggregates is itself an empirical issue.

One measurable difference associated with rapid growth has been high interest rates. During the period under study (1980-1993) the Korean economy experienced inflation of about 8 percent per year (CPI). Interest rates have also been high: "private loan rates" (or "curb rates" on nonofficial financial markets) ranged from 20 to 50 percent at an annual rate, while the "3-year corporate bond yield" ranged from 13 percent up to 30 percent. Such interest rates make the opportunity cost of holding balances in Korea particularly acute. We therefore take special care to account for the effect of interest rates in examining the long run relationship between money and income. We do this by treating the money-income relation as a function of interest rates. Thus we must seek a monetary aggregate whose relation to national output is a stable function of interest rates.

Korea's financial sector has also evolved rapidly. With the rapid growth of disposable income came increased demand for financial assets. Short- and long-term savings and time deposits have steadily increased in importance since the mid-1970s. The official designation of $M2$, which includes many of these elements, as the monetary target recognizes this evolution. However, since the early 1980s the Korean government has undertaken further reforms aimed at spurring financial liberalization and broadening the financial sector. These included establishment of a variety of nonbank financial institutions. These institutions, and the various new financial assets they introduced, have grown rapidly in market share during the last decade. Unlike commercial bank deposits, liquid assets at nonbanking financial institutions are not included in $M2$. The dynamic evolution of Korean financial markets, particularly the changing relative importance of money components, makes the stability of the relation between any individual monetary aggregate and income an empirical question. We investigate this issue by considering a variety of money definitions classified by the Bank of Korea ranging from $M1$ to $M3$. 

All data in the output relate to strata of foreign exchange and certain main results are based on a wider range of data. The paper takes account of these issues.
While the recent past has seen significant liberalization of financial markets, previous Korean policy aimed to achieve economic development through direct allocation of financial capital. Credit was allocated to strategic sectors, such as export and heavy industry, through a system of formal and informal guidelines supported by central bank rediscounts. At the same time, all interest rates were regulated, causing them to respond to economic reality only sporadically and with significant delay. Because this government regulation persists in our sample, the extent to which these interest rates reflect the true relative cost and availability of monetary and alternative assets remains questionable. This could render less attractive time series analysis based on monetary aggregates and their associated user costs constructed from these interest rates. However, a relatively unregulated corporate bond market and informal loan market were allowed to evolve. The resulting corporate bond rate and the curb rate can be viewed as reflecting market forces. We use these interest rates as a measure of the overall user cost of monetary assets. However this does not improve the relative-cost estimates of the various monetary assets. We treat the validity of these relative interest estimates as an empirical question and consider both simple sum and divisia formulations for all definitions of money used.

Thus, our primary empirical interest centers on whether there is a Korean monetary aggregate whose relation to economic activity is stable enough to make it useful as a policy target. We use Johansen’s cointegration estimation and testing procedure to seek such relations. Finally, the nature of the Korean economy induces us to focus particularly on the relative usefulness of more inclusive versus less inclusive definitions of money and of divisia versus simple sum aggregates. In particular, we are interested in the appropriateness of the officially designated measure, M2.

The paper proceeds by describing the sources and characteristics of our data in the second section. The third section outlines the particular money-output relation we test. The fourth section describes the statistical model and certain issues of its specification, while the fifth section contains the main results concerning monetary aggregates. The sixth section concludes.

DATA

Sources

All data used in this study were obtained from the Central Bank of Korea. These are quarterly time series observations spanning the period
Table 1. Definitions of Monetary Aggregates:
Each aggregate is the sum of components indicated by an *

<table>
<thead>
<tr>
<th>Component Asset</th>
<th>M1</th>
<th>M2A</th>
<th>M2</th>
<th>M2B</th>
<th>M3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Currency</td>
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<tr>
<td>2. Demand Deposits for Households</td>
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<tr>
<td>3. Demand Deposits for Business</td>
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<td>4. Savings Deposits</td>
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<td>5. Notice Deposits</td>
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<td>6. Liberal Savings Deposits</td>
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<td>7. Company Savings Deposits</td>
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<td>8. Short-term (&lt; 2 year) Time Deposits</td>
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<tr>
<td>9. Other Time and Savings Deposits</td>
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<tr>
<td>10. Deposits in Foreign Currencies</td>
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<tr>
<td>11. Long-term (&gt; 2 year) Time Deposits</td>
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<td>12. Installment Savings Deposits</td>
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<tr>
<td>13. Household Preferential Installment Savings Deposits</td>
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<td>14. Mutual Installment Deposits</td>
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<td>15. Housing Installment Deposits</td>
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<td>16. Workmen's Property Formation Savings Deposits</td>
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<td>17. Workmen's Long-term Savings Deposits</td>
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<td>18. Certificates of Deposit</td>
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<tr>
<td>19. Demand Deposits at Development Institutions</td>
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<td>20. Savings and Time Deposits at Developmental Institutions</td>
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<tr>
<td>21. Bills issued by Investment Institutions</td>
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<td>22. Cash Management Accounts at Investment Institutions</td>
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<td>23. Beneficial Certificates at Investment Institutions</td>
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<td>24. Securities Investment Savings at Investment Institutions</td>
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<td>25. Securities Finance Corporation Deposits at Investment Institutions</td>
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<tr>
<td>26. Money In Trust at Bank Trust Accounts</td>
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<tr>
<td>27. Mutual Savings and Finance Companies' Deposits</td>
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<td>28. Mutual Savings and Finance Companies' Public Borrowings</td>
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<td>29. Mutual Credit Companies' Deposits</td>
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<td>30. Credit Unions' Deposits</td>
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<td>31. Postal Savings Deposits</td>
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<td>32. Community Credit Cooperatives' Deposits</td>
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<tr>
<td>33. Other Financial Institutions' Time and Savings Deposits</td>
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<td>34. Foreign Currency Deposits at Other Financial Institutions</td>
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<tr>
<td>35. Insurance Company Reserves</td>
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<tr>
<td>36. Debentures Issued at Monetary Institutions</td>
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<tr>
<td>37. Debentures Issued at Other Financial Institutions</td>
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<tr>
<td>38. Repos at Monetary Institutions</td>
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<tr>
<td>39. Repos at Other Financial Institutions</td>
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<tr>
<td>40. Commercial Bills Sold</td>
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</table>

The definition of the monetary aggregates $M_1, M_2, M_2A, M_2B,$ and $M_3$ is given in Table 1. Each aggregate is the sum of components indicated by an *. The definition of each component is provided in the table. The components include:

1. **Currency**
2. **Demand Deposits for Households**
3. **Demand Deposits for Business**
4. **Savings Deposits**
5. **Notice Deposits**
6. **Liberal Savings Deposits**
7. **Company Savings Deposits**
8. **Short-term (< 2 year) Time Deposits**
9. **Other Time and Savings Deposits**
10. **Deposits in Foreign Currencies**
11. **Long-term (> 2 year) Time Deposits**
12. **Installment Savings Deposits**
13. **Household Preferential Installment Savings Deposits**
14. **Mutual Installment Deposits**
15. **Housing Installment Deposits**
16. **Workmen's Property Formation Savings Deposits**
17. **Workmen's Long-term Savings Deposits**
18. **Certificates of Deposit**
19. **Demand Deposits at Development Institutions**
20. **Savings and Time Deposits at Developmental Institutions**
21. **Bills issued by Investment Institutions**
22. **Cash Management Accounts at Investment Institutions**
23. **Beneficial Certificates at Investment Institutions**
24. **Securities Investment Savings at Investment Institutions**
25. **Securities Finance Corporation Deposits at Investment Institutions**
26. **Money In Trust at Bank Trust Accounts**
27. **Mutual Savings and Finance Companies' Deposits**
28. **Mutual Savings and Finance Companies' Public Borrowings**
29. **Mutual Credit Companies' Deposits**
30. **Credit Unions' Deposits**
31. **Postal Savings Deposits**
32. **Community Credit Cooperatives' Deposits**
33. **Other Financial Institutions' Time and Savings Deposits**
34. **Foreign Currency Deposits at Other Financial Institutions**
35. **Insurance Company Reserves**
36. **Debentures Issued at Monetary Institutions**
37. **Debentures Issued at Other Financial Institutions**
38. **Repos at Monetary Institutions**
39. **Repos at Other Financial Institutions**
40. **Commercial Bills Sold**

The definition of the monetary aggregates is given in Table 1. Each aggregate is the sum of components indicated by an *.
from 1980 through 1993, 56 observations in all. In addition to seasonally adjusted nominal and real GNP and price indices, the data include interest rates and total market values for 40 monetary assets. These were used to construct simple sum monetary aggregates based on the Bank of Korea classification method and their corresponding Divisia indices (following Barnett et al. 1984). The 40 monetary assets are classified into M1, M2A, M2, M2B, and M3. Table 1 lists the 40 monetary assets and indicates the specific composition of each aggregate. The narrow money measure, M1, consists of currency and demand deposits, while M2A includes short-term time and saving deposits at banking institutions in addition to M1 components. M2, known as the official monetary aggregate in Korea, further includes long-term time and saving deposits. M2B includes M2A components plus short-term liquid assets offered by nonbank financial institutions and M3 includes all 40 monetary assets. It should be emphasized that M2 is not a subset of M2B. M2 includes M2A components plus the long-term assets at the banking institutions while M2B includes M2A components plus short-term assets at the nonbanking financial institutions.

Divisia Aggregates

The Divisia indices require us to quantify the opportunity cost of resources, known as the user cost of money, tied up in money balances. Barnett (1982) suggests the following user cost formula for monetary asset $i$, $π_i = (R - r_i)(1 - T)/(1 + R(1 - T))$, where $r_i$ is the interest rate of asset $i$, $T$ is the marginal tax rate and the $R$ is the benchmark rate which is defined to be the maximum expected holding-period yield of a pure store-of-value asset. In the regulated Korean financial markets there are two market determined time series available as candidates for the benchmark rate, the “corporate bond rate” and the “private loan rate” or “curb rate.” We use the maximum of the corporate bond rate and other interest rates as a benchmark rate in our empirical study. However, as shown in Figure 3, the corporate bond rate and curb rate move very closely together; our empirical results based on the two rates do not differ qualitatively.

Given the real monetary assets and user costs, monetary aggregates are constructed by the Fisher ideal Index method using the formula:

$$Q_t = Q_{t-1} \left( \frac{\sum_i π_{t-1, i} m_{t-1}}{\sum_i π_{t, i} m_{t}} \right)^{1/2}$$
Figure 1. Monetary Aggregate Indices (Real)
Figure 1. Monetary Aggregate Indices (Real)

Figure 2. Compositions of Monetary Aggregates in M3
where $Q_t$ is the nominal aggregate index at time $t$, and $m_{it}$ is the nominal value of monetary asset $i$. Note that the resulting index is not a divisia index. However, both indices, as Diwert (1976) notes, belong to the class of Diwert-superlative index numbers and their differences are empirically indistinguishable. For this reason, we refer to the computed index as a divisia index. We compute the usercost for the quantity aggregate by dividing the total expenditure ($\Sigma \pi_{it} m_{it}$) by the resulting quantity aggregate, $Q_t$.

**Characteristics of the Data**

An appropriate statistical technique should be able to accommodate the general structure of the data. In particular we must determine whether or not the data are fundamentally stationary. Figure 1 shows the simple-sum and divisia monetary aggregates for our sample period. When the Dickey-Fuller tests are performed to examine the stationarity of the real balance series, the null of nonstationarity of the series are not rejected at the 5 percent significance level. As mentioned earlier, $M2$ is not a subset of $M2B$. Nevertheless, as Figure 2 shows, $M2B$ includes a greater proportion of the value of $M3$ than does $M2$ during the entire sample period. This shows how rapidly nonbank financial institutions have grown during the sample period.

The interest rate series likewise presents the appearance of nonstationarity. Figure 3 plots corporate bond rates and the curb rates that were used in calculating the benchmark rate for divisia construction. The Dickey-Fuller test results also indicate that all usercosts and the interest rate series are nonstationary. While this suggests that interest rates should also be modelled as a nonstationary series, it is not a priori sensible to presume they are driven by the same trend process that generates output or real money balance in the sense of Stock and Watson (1988). Given these data characteristics, we wish the statistical model to be able to accommodate two distinct nonstationary components as well as the stationary relationship central to the concept of money.

**CRITERIA FOR COMPARING MONETARY AGGREGATES**

The relation between income and money is traditionally expressed in the "equation of exchange," which states that,
The $m_{t,j}$ is the nominal value and $m_{t,j}$ is the nominal value at time $t$. The resulting index is not a Divisia index as (D'Agostino, 1997b) notes, belong to the group of Laspeyres and their differences are not $0$. We refer to the computed index as $m_{t,j}$ by the resulting quantities $x_{t,j}$.

**Data**

To be able to accommodate nonstationary data we must determine the stationarity. Figure 1 shows the stationarity of the series for our sample period. We can examine the stationarity of the series. The stationarity of the series are not mentioned earlier, $M_2$ is nonstationary. Figure 2 shows, $M_2B$ includes a nonstationary series $M_2$ during the entire period and bank financial institutions suggest that all usercosts and the curb rates that are present for divisia construction.

The appearance of nonstationarity in the series and the curb rates that are present, the series for divisia construction. This suggests that interest in the series, it is not a priori, that the same trend process that suggests the sense of Stock and Watson, we wish the statistical significance of the nonstationary component is central to the concept of

**NONSTATIONARY AGGREGATES**

Traditionally expressed in
\[ m - y + v = 0 \]  

(1)

where, with all variables expressed as logs, \( m = \) real money supply, \( y = \) real income, and \( v = \) velocity. In itself, (1) is simply an identity defining velocity.

Our criterion that a useful monetary aggregate have a "stable" relation to income, adds empirical content to this definition by requiring that velocity, thus defined, be in some sense stable. The force of this requirement is to impose restrictions on the empirical long-run demand for money. In its general form, money demand is traditionally expressed as a function of real income and the user cost of balances. For example in log linear form the relation would be

\[ m + \alpha_1 y + \alpha_2 f(u) + \alpha_0 + \varepsilon = 0 \]  

(2)

where the \( \alpha_i \) are constants with \( \alpha_1 < 0 \) and \( \alpha_2 f(\cdot) \) a monotonic increasing function. Here \( u = \) user cost of real balances and \( \varepsilon \) is a random error term. Because we are seeking monetary aggregates that are stable in the long run, we view this money demand equation in a long run sense.

To express this relation in terms of velocity, we use (2) to substitute for \( m \) in equation (1) and then solve for \( v \) to get

\[ v = (1 + \alpha_1)y + \alpha_2 f(u) + \alpha_0 + \varepsilon. \]  

(3)

As indicated in the discussion of the data, output follows an unbounded upward trend, while interest rates follow a separate path. If equation (3) held, velocity (or \( \varepsilon \)) would be forced to grow unboundedly with output, contradicting our sense that a useful monetary aggregate should be associated with a stable velocity. Stability requires that velocity be independent of output, at least in the long run, and that the noise term be trendless. Imposing these requirements equation (3) becomes

\[ v = \alpha_2 f(u) + \alpha_0 + \varepsilon. \]

Thus stability of velocity means \( \varepsilon \) is stable and \( \alpha_1 = -1 \). Note that in the context of the money demand equation (2) imposing \( \alpha_1 = -1 \) requires that the (long run) income elasticity of demand for money be one. Substituting the velocity equation (3) back into the equation of exchange (1) produces the equation we estimate

\[ ... \]
Appropriate Monetary Aggregates and Cointegration

\[ m + \alpha_1 y + \alpha_2 f(u) + \alpha_0 + \epsilon = 0. \]  

(4)

Our criterion that a monetary aggregate have a stable relation to output is then expressed as four specific conditions:

1. Equation 4 (\( \epsilon \)) should be stochastically stable.
2. \( \alpha_2 f(u) \) should be monotonic increasing.
3. \( \alpha_1 = -1 \) (income doesn't affect velocity).

Furthermore, as discussed in Section 2, sensible characterization of the data requires two common trend factors to describe the behavior of three variables. This implies there exists at most one set of parameter values, \( \alpha_i \), leading to a stationary \( \epsilon \). Stated formally:

4. The values of \( \alpha_0, \alpha_1 \) and \( \alpha_2 \) are unique up to stationarity of \( \epsilon \).

These restrictions are the criteria by which we evaluate various Korean monetary aggregates. In specifying the model (Section 4), we choose those specifications that produce results satisfying these criteria. Having specified the model, we compare monetary aggregates based on their ability to satisfy these criteria.

THE COINTEGRATION APPROACH

Given the characteristics of the data, Engle and Granger's (1987) cointegration approach seems a natural means to estimate the long-run equilibrium relation expressed in Equation (4). We follow Johansen's (1988, 1990, 1991) procedure to estimate the model and to test how well the various monetary aggregates satisfy our criteria. We first briefly discuss the cointegration technique and then discuss its specification issues in this section.

Let \( X_t \), be a \( p \)-dimensional vector integrated of order one, \( I(1) \), that can be represented by the Vector Autoregressive (VAR) process,

\[ X_t = \Pi_1 X_{t-1} + \cdots + \Pi_k X_{t-k} + \beta + \epsilon_t \quad (t = 1, \ldots, T) \]  

(5)

where \( \epsilon_t \) are a sequence of i.i.d. \( p \)-dimensional Gaussian random vectors, distributed as \( N(0, \Lambda) \). \( \Pi_i \) are \( (p \times p) \) matrices of parameters and \( \beta \) is a constant \( p \)-dimensional parameter vector. Following Engle and Granger (1987), Equation (5) can be rewritten in the equivalent Vector Error Correction Model (VECM) form:
\[ \Delta X_t = \Pi X_{t-1} + \Gamma_1 \Delta X_{t-1} + \ldots + \Gamma_{k-1} \Delta X_{t-k+1} + \beta + \epsilon_t \quad (6) \]

where

\[ \Gamma_i = \Pi_i (i = 1, \ldots, k-1), \quad \Pi = -I + \Pi_1 + \ldots + \Pi_k. \]

and \( \Delta \) is the first-difference operator.

The existence of the cointegrating relationship implies that the \( p \times p \) matrix \( \Pi \) has rank \( r < p \). If rank(\( \Pi \)) = 0 (the null matrix) then all elements of \( \Pi \) are integrated processes and have unit roots. In this case first-differencing would be called for, and hence, equation (6) would reduce to a VAR form in first-differences with no stationary long-run relations among the elements of \( X_t \). If \( \Pi \) is of full rank \( p \), then the assumed stationarity of the error terms in equation (5) requires all elements of \( X_t \) to be stationary in their levels, implying the absence of any stochastic trends in the data. In general, when \( \Pi \) has intermediate rank, \( r \leq p \), then there are \( r \) cointegrating relations among the elements of \( \Pi \), and \( p - r \) common stochastic trends.

If \( \Pi \) has rank \( r < p \), and hence the series are cointegrated, one can decompose \( \Pi \) so that \( \Pi = \gamma \alpha' \), where \( \gamma \) is a \( p \times r \) matrix and \( \alpha' \) is an \( r \times p \) matrix. Notice that because \( \Delta X_t \) and \( \epsilon_t \) are assumed to be stationary, \( \Pi X_{t-1} \) must also be stationary for equation (6) to make sense. The elements of the \( \gamma \) matrix are the loading factors (called error correction parameters or adjustment coefficients) which are the weights of the cointegrating vectors in the different equations. The \( i \)-th row of \( \gamma \) tells us how important each of these \( r \) cointegrating relations are to the dynamics of the \( i \)-th series. Therefore the existence of \( r \) cointegrating vectors, \( \alpha \), implies that there exists a \( p \times r \) matrix, \( \alpha \), such that \( \alpha' X_t \) is \( I(0) \) where \( r < p \). Johansen (1988, 1991) introduces a maximum likelihood method to estimate \( \gamma \) and \( \alpha \) and statistical procedures to test a series of restrictions on \( \gamma \) and \( \alpha \). If we let \( X_t \) contain the variables included in the modified equation of exchange, equation (4), namely real money balances, real income and a monotonic transformation of user cost, that is, \( \Pi = (m_p, y_p, \lambda(u)) \), our objective is to find the cointegrating vector, \( \alpha' = (1, \alpha_1, \alpha_2) \). Criterion 4, Section 3, implies the rank of \( \Pi \) should be one. Other criteria imply specific restrictions on the vector \( \alpha \).

In implementing the error correction model of (6), there are three specification issues to be considered: (1) the number of lags (parameter \( k \)), (2) the treatment of the constant term \( \beta \), and (3) the functional form...
of \( f(u) \). Selection of lags, \( k \), was determined by the Akaike criteria by estimating the VAR model (5). It turns out that in every case this criterion led to a two quarter lags (\( k = 2 \)). So far as the constant term \( \beta \) is concerned, the strong trend-like pattern shown in Figure 1 and Figure 3 suggests it should be included in the model. However, doing so as described in the specification of equation (6) leads to the model finding no cointegrating vectors. This can be seen in column 2 of Table 2, which reports the results of test for the number of cointegrating vectors when the constant is included in (6). We use \( \lambda_{\text{max}} \) statistics to determine the number of cointegrating vectors at the 5 percent significant level. One way of looking at the search for cointegrating vectors in equation (6) is as an attempt to organize the information in the residuals of a VAR of the first differences of the data. Finding no significant cointegrating vectors indicates the model found no significant residual information to explain. This could occur because there is no cointegrating relation, that is no stable relation such as equation (4) exists. Alternatively, particularly for shorter time series such as ours, it could result when unconstrained constant terms “soak up” the cointegrating relationship. Including a constant term in a differenced equation accounts for a deterministic drift in

### Table 2. Cointegration Tests

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<th>Monetary Aggregates</th>
<th># of cointegrating vectors*</th>
<th>( \lambda_{\text{max}} ) test statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Model A</td>
<td>Model B</td>
</tr>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>Simple Sum</td>
<td>M1</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>M2A</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>M2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>M2B</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>M3</td>
<td>2</td>
</tr>
<tr>
<td>Divisia</td>
<td>M1</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>M2A</td>
<td>2</td>
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<tr>
<td></td>
<td>M2</td>
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</tr>
<tr>
<td></td>
<td>M2B</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>M3</td>
<td>1</td>
</tr>
</tbody>
</table>

Notes: *The number of cointegrating vectors is based on \( \lambda_{\text{max}} \) test statistic (Johansen, 1991) at the 5 percent significance level. Model A is equation (6) without a constant term, \( \beta \). Model B includes the constant. In Model C, the constant is constrained to be part of the cointegrating vector. The test results reported in columns (4) and (5) refer to Model C. The critical values at the 5 percent significance level are 22.00 and 15.67 respectively, based on results tabulated in Osterwald-Lenum (1992).
that variable. Introducing three unconstrained constant terms in three differenced equations could allow the three variables to "drift" in a way corresponding to their cointegrating relationship. Under these circumstances, the residuals of the first differenced regression would retain no relation for the data to find, even when a true model involves cointegration.

Omitting the constant altogether causes the model to find two cointegrating relations for all choices of the monetary aggregate except divisia M3. (See results in column 1 of Table 2.) This violates Criterion (4) set in Section 3. With no constant term at all, so much variability is left in the differenced regression that two significant dimensions of variability remain. However, this result implies that there is a single "common factor" driving the nonstationary behavior of money, income and interest rates. As indicated in the introduction, the assertion that a common factor drives interest rates and the other variables does not seem attractive.

A third possible approach, suggested by Johansen, is to allow constant terms, but to constrain them to be a part of the cointegrating vector. That is, we set \( \beta = \gamma \alpha_0 \), where \( \alpha_0 \) is an \( r \times 1 \) vector. This means that any stationary relationships found by the estimator are permitted constant terms, while all deterministic drift is removed from nonstationary (driving) forces. Imposing this restriction eliminates the possibility that a deterministic drift might proxy for a cointegrating relation, while still allowing the stationary relation to have a non-zero mean. Table 3 column 3 presents the results of the log-likelihood test of this constraint, that is \( \chi^2 \)—distributed with 2 degrees of freedom. For all cases except the use of Divisia M3 as the monetary aggregate, the constraint cannot be rejected. Furthermore, its imposition leads the Johansen estimator to find a single cointegrating relationship, conforming to our a priori view of the data structure, in a majority of cases (see column 3 of Table 2). For these reasons, it is the basis for all results reported in this paper.

Finally we must specify \( f(u) \), the functional form through which the user cost of money enters the relationship. Here too, we are able to find a specification that has a plausible economic explanation and that leads to estimates most in harmony with the structure of the data outlined previously. The three functional forms we try are \( \alpha_2u \), \( \alpha_2\ln(u) \), and \( \alpha_2/(1+u) \) where \( u \) is the curb rate for simple sum monetary aggregates and the index user cost for divisia aggregates. Recalling that the other variables are all measured as logs, the functional form \( \ln(u) \) implies, from equation (2) that the elasticity of velocity with respect to user cost is constant. From a meaningful point of view, \( f(u) = (1/u) \) falls when user cost falls, and their use for more difficult, more plausible.
stion. From equation (3) we see that this same elasticity can more meaningfully be interpreted as the interest elasticity of demand for money. When \( f(u) = u \) this elasticity increases with user cost and when \( f(u) = (1/u) \) it decreases with user cost. Recall that money demanded falls when user cost rises because people find ways to economize on their use of money balances. If such economies become increasingly more difficult to find, the decreasing elasticity case would seem the more plausible. It also turns out that using either the \( u \) or \( \ln(u) \) specifi-
cation often leads to two cointegrating vectors, violating the criteria set forth previously except the few cases where the use of ln(\(u\)) gives the similar results as the specification of \(1/u\). Based on these two considerations, we use \(1/u\) for our investigations. Note that this specification requires (because of criterion 2) that \(\alpha_2 < 0\).

For the simple-sum aggregates we use the curb rate as our measure of usercosts, \(u\). For the divisia aggregates the usercosts emerging from the construction of the indices explained in Section 2 were employed. To summarize, the specification used involves two lags, a constant vector constrained to be part of the cointegrating relation, and velocity modeled as a function of \((1/u)\).

RESULTS: IMPLICATIONS FOR THE CHOICE OF MONETARY AGGREGATES

We now consider which monetary aggregates best fit the criteria described in Section 3. For this purpose, we use the model as specified in Section 4. Additionally we impose the requirement that exactly one cointegrating vector exists. This permits testing of the additional criteria even for those cases in which the tests indicate two cointegrating vectors may exist, as shown in Table 2. Including the specification of user costs, the cointegrating relation is,

\[ m + \alpha_1 y + \alpha_2 (1/u) + \alpha_0 = \varepsilon \]  

(7)

The results appear in Table 3. Columns (1) and (2) of Table 3 report the estimates of the cointegrating vectors for both simple sum and divisia aggregates for definitions of money from \(M1\) to \(M3\). The sign of \(\alpha_2\) is always negative as required by criterion 2. Column (4) reports test statistics for the null hypothesis that \(\alpha_1 = -1\) (criterion 3). It is rejected solely for \(M1\) and \(M2A\) simple sum, while the other monetary aggregates are acceptable by this criterion. Column (5) reports the estimate of \(\alpha_3\) that results when this constraint, \(\alpha_1 = -1\), is imposed. The estimates always retain the appropriate negative sign. This test eliminates only the least inclusive of monetary aggregates, simple-sum \(M1\) and \(M2A\) and divisia \(M1\).

As an additional test of the model we consider the stationarity of the cointegrating relation (7) when the restriction, \(\alpha_1 = -1\), is imposed. If the Johansen estimates are performing properly, the residuals, \(\varepsilon\), from
the cointegration relation should be stationary. While log likelihood ratio tests of this restriction ($\alpha_1 = -1$) may not be statistically significant, imposing this restriction may or may not disrupt the stationarity of the residuals of the cointegration relation. If the Dickey-Fuller test rejects nonstationarity we interpret this as evidence consistent with an appropriate monetary aggregate. We use the augmented Dickey-Fuller test procedure with two lag terms, consistent with the vector error correction model specification used in this study. Column (6) Table 3 reports the results of applying the augmented Dickey-Fuller test to the estimated cointegrating equation. The null hypothesis of a unit root for this equation is rejected for $M2B$ and $M3$, while it is not for less inclusive definitions of money. Together these results suggest the more inclusive definitions of money, $M2B$ and $M3$ work better since they permit the theoretically correct coefficient for $\alpha_1$ and pass the Dickey-Fuller test.

The reader will have noticed that the foregoing testing procedures to determine an appropriate monetary aggregate are not nested hypotheses. Non-rejection of a hypothesis (e.g., $\alpha_1 = -1$) for a monetary aggregate does not necessarily imply the existence of a stable relationship between the aggregate and real income. For example, the null $\alpha_1 = -1$ may not be rejected because the standard error of the estimate is large or because the data may not fit to a model. To ascertain whether this is likely to be the case column (7) of Table 3 reports the weighted $R^2$ of the vector error correction model. A low $R^2$ coupled with rejection of $\alpha_1 = -1$ suggests this spurious rejection is not occurring. As can be seen from this table, the $R^2$ increases with inclusiveness of the monetary aggregate, suggesting this is not a problem.

Two general conclusions emerge. First more inclusive monetary aggregates, specifically $M2B$ and $M3$, are most appropriate although we are unable to distinguish between the two. Furthermore we do not find noticeable differences between simple sum and divisia aggregates. This may be the result of the direct regulation of Korean money and capital markets.

**CONCLUSION**

In order to examine the appropriate money measure for the Korean economy, we establish criteria for a useful monetary target variable. Using the cointegration technique, we find that money measures more
inclusive than the current official measure, $M2$, seem to better satisfy these criteria. The fact that the more inclusive monetary measures work better for the Korean data suggests that, by the time of our data sample, the Korean financial sector had already evolved to the point where these forms of money played an important role in the economy. At the same time, there is no pronounced difference in the performance of the divisia and simple sum money definitions. With government regulation rather than market forces dominating the interest rates associated with most monetary elements, these interest rates do not appear to be very reflective of the user costs of various forms of money. As recent policy changes freeing these interest rates appear in the data, we would expect such differences to emerge.

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NOTES

1. In order for a monetary aggregate to be theoretically “admissible,” as Barnett (1982) notes, monetary asset component in the aggregate must be weakly separable from all consumption goods and other financial assets. However, we do not address the issue of separability in this paper. Given the alternative monetary aggregates, we examine empirically which aggregate is most appropriate as a policy target variable in the Korean Economy. The most recent empirical study on the monetary aggregates related to the separability issues can be found in Swofford (1995).

2. We focus on these two data series because they are two of the very few Korean interest rates that respond rapidly to market conditions. Most others were regulated directly or indirectly and exhibit considerable stickiness.

3. Constructing a divisia index requires positive quantities of all included assets. Since new instruments were being introduced throughout our sample period, this requirement makes it difficult to calculate a well defined divisia index for the broader definitions of money. We avoid this problem by using the Fisher ideal index instead.

4. The Dickey-Fuller test results are not reported here.

5. One might question the implications of modelling interest rates as a nonstationary series or a series integrated order of 1, $I(1)$, because integrated series are unbounded, while interest rates do not fall below zero. However, as Hall, Anderson and Granger (1992) point out, the empirical evidence suggests that the time series property of interest rates is rather closer to those of $I(1)$ series than to those of $I(0)$ series. For example, interest rates exhibit high serial correlation that falls only slowly with increasing lags.
first differences of the series generally exhibit some weak negative dependence, suggesting some overdifferencing. The autocorrelations in the levels, however, decay more slowly than would be implied by an autoregressive process of order one. This observation would be particularly true of Korean interest rates as seen in Figure 3.

6. Using a utility maximization approach Barnett and Xu (1995) show theoretically that simple sum and theoretic exact velocities depend on user cost. Our formulation is consistent with this result.

7. The lag length, $k = 2$, was robust to the specification of $f(u)$.

8. We find no qualitative differences in our results when different specifications for $f(u)$ were used.

REFERENCES


