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EVIDENCE ON THE TWO MONETARY BASE MEASURES AND ECONOMIC ACTIVITY

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* The views expressed in this article are solely those of the authors, and should not be attributed to either Texas Tech University or to the Federal Reserve Bank of Dallas or the Federal Reserve System.

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I. Introduction

The effects of changes in monetary policy on the level of economic activity are obviously critical to forming appropriate policy. With the recent instability exhibited in the relationship between M1 and nominal GNP, alternative indicators/targets are being considered. One approach has been to look at broader monetary aggregates, such as M2 and M3. An alternative approach is to consider a more narrow measure of monetary policy. One such policy variable is the monetary base.1/ The Shadow Open Market Committee has long recommended targeting the monetary base. Recently, the House Banking and Monetary Policy Subcommittee concurred with this sentiment stating that the Federal Reserve should give "serious consideration to reporting target ranges for the monetary base."2/ The President of the Federal Reserve Bank of St. Louis has also recently proposed a quasi-rule for monetary base growth.3/

A slight problem exists despite the apparent concreteness in these declarations. The obstacle to implementing such a target is that unlike the monetary aggregates M1, M2 and M3--there is no single measure used for the monetary base. Within the Federal Reserve System itself there are two different monetary base measures: one calculated by the Board of Governors, the other calculated by the Federal Reserve Bank of St. Louis. It is important to set forth the differences between these measures, to the extent they differ, and to determine which base is the more desirable, if either can be so judged.

The purpose of this paper is to bring to the forefront the issues which distinguish the two different adjusted monetary base measures. In principle, the construction of the two series apply the same methodology--one that seems quite sensible for "dollarizing" reserve requirement ratio changes. Although cosmetic differences emerge in the implementation of this methodology, other, perhaps more substantiative, issues arise concerning what constitutes a reserve requirement ratio policy action. Certainly, disparate treatment of past Federal Reserve actions and what those actions mean for measuring reserve requirement ratio changes warrant investigation. We further attempt to infer the importance of the alternative strategies by examining these two measures in their abilities to explain changes in nominal GNP. It is useful to future research that investigators know which measure bears the closest relationship to GNP.

The two main results forwarded in this paper suggest that one base measure does outperform the other series in explaining movements in nominal GNP growth in the 1960s and 1970s. Evidence presented for the 1980s, however, does not strongly favor either base measure. The instabilities in the base-GNP relationship during the 1980s indicate the difficulties involved in accounting for reserve requirement ratio changes that were introduced by the Monetary Control Act of 1980.

The paper is organized as follows: Section 2 describes the two different methods employed to adjust the source base for changes in reserve requirements. Section 3 examines some of the issues involved in estimating the base-GNP relationship. Section 4 provides the empirical evidence of the relationship between the two bases and nominal GNP. Section 5 compares the relative predictive power of each base. Section 6 provides a brief summary of the results.

II. Adjusting for Reserve Requirements Changes

Both the Board of Governor's monetary base measure and the St. Louis adjusted monetary base measure share the source base--a measure which omits the effects of reserve requirement ratio changes. This common ground focuses on movements in the Federal Reserve System's consolidated balance sheet as they pertain to base changes. It is useful to characterize the source base before describing the adjustment procedure used to capture reserve requirement ratio changes.

Formally, the source base is calculated as follows:

$$(1)\quad SB \equiv A - NML,$$

where SB denotes the source base; A, Federal Reserve assets;, and NML, the non-monetary liabilities of the Federal Reserve. Non-monetary liabilities are the sum of all Federal Reserve liability and equity accounts less Federal Reserve credit. Federal Reserve credit consists of Federal Reserve notes outstanding and of financial institutions deposits at Federal Reserve banks.

According to equation (1), changes in the source base account for Federal Reserve balance sheet transactions. Traditionally, economists have considered the monetary authority as being endowed with three policy tools:

(1) open market operations; (2) discount window lendings; and (3) reserve requirement ratio changes. Both open market operations and discount window lending directly involve Federal Reserve asset transactions. Accordingly, source base changes reflect changes due to open market operations and discount window lending.

Reserve requirement ratio changes, however, do not involve balance sheet transations, and, therefore, are omitted from directly affecting the source base. Although reductions in reserve requirement ratios are generally perceived as expansionary monetary policy actions, for example, these actions alone will not give rise to alterations in the Federal Reserve's assets or liabilities. Hence, the source base would indicate policy inactivity despite reserve requirement ratio changes being undertaken.4/

This oversight has long been recognized. Both the Federal Reserve Bank of St. Louis (hereafter "St. Louis") and the Board of Governors (hereafter "Board") have estimated alternative base measures to correct for this defect. In effect, both measures attempt to "dollarize" this policy action by capturing the amount of reserves freed (absorbed) by reserve requirement reductions (increases). When combined with the source base, the outcome of the adjustment procedures yield a summary measure of all Federal Reserve policy actions.

The essence of the adjustment used by St. Louis and by the Board may be illustrated by modifying the relationship between the source base and M1, also known as the money multiplier, such that reserve requirement ratio changes do not directly affect the money multiplier. Constructing an adjusted monetary base is, therefore, a simple algebraic manipulation of the base-M1 relationship whereby changes in reserve requirement ratios affect M1 through the base measure, instead of through the money multiplier.

To formalize this modification, note that the money supply and source base are defined as:

$$(2)\quad M1 = C + D$$

and

$$(3)\quad SB = C + RR + ER$$ 5/

where C denotes currency held by the non-bank public; D, total checkable deposits; RR, required reserves; and ER, excess reserves. Dividing the right-hand side of equations (2) and (3) by D yields:

$$(2')\quad M1 = (1 + s)\ D$$

$$(3')\quad SB = (s + \rho + e)\ D,$$

where $s = C/D$; $\rho = RR/D$; and $e = ER/D$. Taking equation (2') and substituting for D using equation (3') yields the familiar money multiplier (cf. Burger (1971), for example):

$$(4)\quad M1 = (1 + s)\ SB\ /\ (s + \rho + e).$$

Equation (4) characterizes the approach wherein reserve requirement ratio changes induce money supply changes through the money multiplier. Note that the money multiplier, M1/SB, is a function of the policy variable, ρ.

Define B' 6/

$$(5)\quad B' = SB - \rho\ D = (s + e)\ D.$$

Now using the last term in equation (5) to substitute for D in equation (2') results in the following characterization:

$$(6) \quad M1 = (1 + s) B' / (s + e).$$

Note that in equation (6), reserve requirement changes, and hence all policy actions, affect M1 through the base measure. The money multiplier, M1/B', now reflects private sector behavior in the form of currency-to-deposit ratios decided on by households and excess reserves-to-deposit ratios chosen by banks. The money multiplier, M1/B', is independent of policy forces in the form of changes in ρ.

2.1 A Brief Comparison: St. Louis and the Board

In principle, the Board and St. Louis adopt similar methodologies to estimate the effects of reserve requirement ratio adjustments. Still, subtle, and potentially important, differences exist.

The three main points of difference between the St. Louis adjusted monetary base and the monetary base constructed by the Board are:

(i) the base period weight;

(ii) treatment of vault cash of nonbound institutions7/;

and

(iii) treament of growth in money market deposit accounts.

The effect of differences in the base weight will show up as differences in the levels of the alternative monetary base measures. Disparate treatment of vault cash and money market deposit accounts will contribute to changes in the growth paths of the two policy summary measures.8/

2.2 The Different Base Periods

To illustrate the different strategies employed with respect to the base period weights, consider the following example. In the St. Louis procedure, a reserve adjustment magnitude (RAM) is calculated based on the following:

$$(7)\ RAM_t = (r_b - r_t)' D_t,$$

where r denotes the (column) vector of reserve requirement ratios and D, the (column) vector of deposit types against which reserves must be held. Equation (7) indicates that RAM is measured in dollar terms. Subscript t denotes an arbitrary time period and b denotes the base period. By definition, RAM in the base period (period t=b) is zero.9/

Equation (7) indicates that an increase in reserve requirement ratios relative to the base period results in RAM falling. In other words, higher reserve requirement ratios absorb reserves. Note also that RAM calculates the effect of the reserve requirement change based on the deposit level in period t. RAM is isolating the difference in required reserves relative to the base period dependent upon the deposit level in the arbitrary time period. Alternatively, for example in the current period, RAM captures differences between required reserves today and what required reserves would be under the base period's reserve schedule. To obtain AMB, the source base is simply added to RAM:

$$AMB_t = SB_t + RAM_t.$$

In constructing their series, the Board uses a multiplicative "weight" to capture changes in reserve requirements. In the Board procedure, the current period is treated as the base period. In effect, the Board adjustment scheme updates past adjusted reserve levels every time reserve requirement ratio changes. The weight, which is the ratio of base (current) period to past reserve requirement ratios, sets "adjusted" reserves equal to unadjusted reserves in the base (current) period. In other words, like St. Louis, the Board sets source base equal to the monetary base in the base period.10/ In contrast to the St. Louis procedure, however, the Board adjusts required reserves relative to a past deposit levels.

Formally, a change in reserve requirements in the current period would adjust past period be according to the Board as follows:

$$(8) \quad TRA_{t-s} = r_{t-s}' D_{t-s} (r_t' D_t / r_{t-s}' D_t), \quad s = 1, 2, 3, \ldots,$$

where TRA denotes the "adjusted" required reserves of financial institutions. Equation (8) shows how the Board adjusts past required reserves relative to the current period. In any past time period denoted t-s, the Board's adjustment uses a weighted ratio of the vector of reserve requirement ratios in time period t to the past period.

Adding currency held by the non-bank public will yield the Board's monetary base adjusted for reserve requirement changes. Let the level of unadjusted reserves in any period t-s, s > 0, be defined as $r_{t-s}' D_{t-s}$. Again, adding the level of currency held by the nonbank public to unadjusted reserves will yield the Board's monetary base. The difference between the alternative Board measures (i.e., the adjusted and unadjusted monetary base measures) is obtained by subtracting the unadjusted reserves from equation (8), thus yielding:

$$(9) \quad BAF_{t-s} = (r_t - r_{t-s})' D_{t-s}, \quad \text{for all } s > 0,$$

where BAF denotes the Board's adjustment factor.

Equation (9) is similar to equation (7) in the sense that higher reserve requirement ratios result in reserves in period t-s being larger than in the current or base period (i.e.. denoted period t). For example, if reserve requirement ratios were raised today, RAM would be negative and BAF would be equal to zero. Relative to the previous period, i. e., period t-1, both the Board and St. Louis would have smaller BAF and RAM, respectively.

In effect, the Board is comparing past required reserves to what required reserves would have been with current reserve requirements in place. Equation (9), however, weights the change in reserve requirements by the deposit level in period t-s, whereas St. Louis uses the current period deposit level. Except in the special case where deposit levels are unchanged relative to the base period, (i.e., $D_{t-s} = D_t$ in our example) the levels of the adjustments, and hence, the levels of the alternative monetary bases will be different. In our example, an increase in reserve requirements in the current period, for instance, will result in the Board's measure being larger than the St. Louis measure in period t and in some arbitrary period t-s.

2.3 The Treatment of Vault Cash

Differences also appear in how the two methods treat vault cash of nonbound financial institutions. The Board simply adds the cash balances which exceed required reserves dollar for dollar into the monetary base measure. This approach amounts to the same treatment to such balances as that given to currency held by the public in calculating the monetary base. That is, after adjusting for reserve requirement ratio changes, the Board simply adds the currency held by the public and the excess cash reserves held by nonbound institutions to get the monetary base. The contribution of excess vault cash of nonbound financial institutions is formally denoted as E_t.

St. Louis, however, treats excess cash balances as being either freed or absorbed by reserve requirement ratio changes. To illustrate, suppose there is a change in reserve requirements for nonbound financial institutions. According to the St. Louis adjustment procedure, the change in reserve requirements would result in a change in RAM given by $(r_b - r_t)'$ D_t, where the superscript, N, denotes the application of the policy action to nonbound financial institutions. Comparing the alternative methodologies, the total contribution of the excess cash balances to the St. Louis adjusted monetary base in the current period will be $E_t + (r_b - r_t)'$ D_t. In contrast, the Board asserts that the contribution of this excess vault cash to the monetary base is equal to E_t.

The importance of the contrasting treatments of vault cash was heightened by the Monetary Control Act of 1980 (MCA). After 1980, all depository institutions became subject to the same reserve requirements.11/ Typically, nonbound institutions were not members of the Federal Reserve. Consequently, MCA meant a change in reserve requirements for these institutions, and subsequently divergent monetary base measures.

2.4 The Treatment of MMDAs

Another product of financial deregulation was the intoduction of money market deposit accounts (MMDAs). St. Louis chose to treat the authorization of MMDAs as a policy action. To the extent that funds were transferred from other transactions accounts into MMDAs, and because MMDAs were not subject to reserve requirements, reserves were freed by the Federal Reserve's authorization. The Board, however, opted to not adjust for growth for deviations in the growth in personal MMDAs. Obviously, the growth of MMDAs would account for deviations in the growth of the alternative monetary bases through their effect on growth in the St. Louis RAM.

In summary, the St. Louis approach tends to treat a broader set of decisions as policy actions than does the Board. St. Louis' treatment of nonbound institutions and money market deposit accounts as policy actions contrasts the Board's laissez-faire tactics. The question then is to determine whether these alternative strategies matter with respect to changes in nominal GNP. Differences in estimating the two series, such as those discussed, will give rise to slightly different time series. Consequently, the two measures will explain movements in nominal GNP differently.

III. The Model

In this section, we compare the two adjusted monetary base series in their ability to explain nominal GNP behavior. This is done by estimating a reduced-form equation relating GNP growth to (separately) to growth in each of the base series. A comparison of the nominal GNP specifications with the St. Louis adjusted monetary base and the Board monetary base separately considered has four possible outcomes. Either the approach used by St. Louis adds information useful in explaining nominal GNP behavior compared to the procedures adopted by the Board, the Board's methodology contributes more information compared to that contributed by the St. Louis measure, both marginally contribute information, or there is no difference in the procedures adopted. For instance, the treatment of MMDAs as a policy action by St. Louis may yield additional information useful in explaining changes in nominal GNP. It is also possible that the Board's treatment as a non-policy action is supported in the context of explaining nominal GNP. Alternatively, it is possible that some convex combination of the two procedures best explains such that both measures marginally contribute to explaining changes in GNP growth. Finally, this particular policy action was small and unimportant in terms of explaining movements in GNP growth and, hence, the differences do not matter.

Another fundamental issue is imbedded in a nominal GNP specification which includes a monetary base measure. Specifically, the simple sum approach to estimating the monetary base presumes that a change in reserve requirements giving rise to $1 change in the monetary base has the same effect on nominal GNP as a $1 change in the source base. The validity of this restriction is, however, a testable hypothesis.

3.1 The Estimating Equation

A simple, reduced-form model specification is adopted to examine whether growth in the St. Louis' or Board's monetary base measures better explain nominal GNP growth behavior. The general form of the model estimated is:

$$(10) \qquad \dot{Y}_t = \alpha_0 + \sum_{i=1}^{4} a_i \dot{Y}_{t-i} + \sum_{i=1}^{4} \beta_i \dot{B}_{t-i} + \sum_{i=1}^{4} \lambda_i \dot{FG}_{t-i}$$

where Y denotes nominal GNP; B, a monetary base measure; and, FG is the high-employment government budget surplus. The latter term is included to allow for fiscal policy effects. Dots above the variables denote growth rates.

Because our interest focuses on the importance of RAM and this measure is not seasonally adjusted by the St. Louis bank, not seasonally adjusted data are used throughout the following empirical tests. To allow for seasonal variation in all variables, we calculate year-over-year changes using quarterly observation as follows:

$$(11)\quad \dot{x}_t = \frac{x_t - x_{t-4}}{(x_t + x_{t-4})/2} .$$

Taking four quarter differences with quarterly observations should allow for much of the common quarterly seasonal pattern in both series.12/

3.2 Lag Length Selection

An important issue is the lag-length structure postulated in equation (10). This equation postulated, ad hoc, four lags on all variables. Would an alternative lag structure yield different results? To address this question, final prediction error criteria were used to select the optimal lag length for the base measure and government budget surplus. The results from the estimations incorporating the optimal lag length are uniformly consistent with results forwarded using the ad hoc lag structure in equation (10). Consequently, the lag structure used throughout this paper includes four lags on both the monetary base variable and the high-employment government budget surplus variable.

3.3 Stability of the Model

Data are available for the period 1959I - 1988II. A number of substantiative changes were introduced during this period. The scope of these changes, such as those enacted in the Monetary Control Act of 1980 (MCA), or the introduction of MMDAs, was so broad that instability in the model is plausible. A Chow test was used to test the stability of the relationship given by equation (10) for both base measures. In both cases the null hypothesis that the post-1979 period has the same relationship as the pre-1980 relationship was rejected.13/ Thus, in our first analysis we consider the sample period 1959I - 1979IV, which tests indicated is a stable relationship. The post-1979 period is held out for subsequent out-of-sample investigation.

IV. Is There a Relationship Between Nominal GNP and the Adjusted Monetary Base?

In this section, we proceed with estimating the model presented above to compare the two adjusted monetary base measures in terms of explaining nominal GNP behvior. In addition, we investigate whether an implicit restriction imposed on the effects of the adjusted monetary base components on the nominal GNP is valid.

4.1 The St. Louis Adjusted Monetary Base

The effect of changes in the growth rate in the St. Louis adjusted monetary base on nominal GNP growth can be considered from two perspectives: the short-run and the long-run. Table 1 reports the parameter estimates obtained using the St. Louis adjusted monetary base in equation (10). Although none of the individual coefficients are significantly different from zero, two pieces of evidence suggest that a relationship between the adjusted monetary base growth and nominal GNP growth exists. A hypothesis that the sum of the four lagged coefficients on the adjusted monetary base equal zero is rejected. Moreover, the hypothesis that the long-run multiplier (estimated to be 0.8835) equals one is not rejected (F(1.63) = 0.86). Failure to reject the hypothesis of unity long-run elasticity is consistent with adjusted monetary base growth being proportional to nominal GNP growth. Fundamentally, both of these hypothesis are consistent with changes in St. Louis monetary base growth being related to nominal GNP growth.

Using adjusted monetary base growth in the specification implicitly imposes the restriction that changes in RAM growth have the same effect on nominal GNP growth as changes in source base growth. To investigate the validity of this restriction, adjusted monetary base growth is decomposed into the contribution from changes in RAM and the contribution from changes in source base.14/ With the inclusion of the St. Louis RAM variable in the nominal GNP equation, it is possible to address the issue of whether changes in the source base growth (relative to the adjusted monetary base growth) exert different effects on nominal GNP growth than changes in RAM growth.

Estimation results for the new, expanded regression are reported in Table 2. The coefficient on the first lag of the St. Louis RAM (SRAM) variable is significantly different from zero and close to unity. Four separate hypothesis were considered corresponding to the each of the coefficients on the lagged St. Louis RAM variables being equal to source base counterparts, i.e., $SRAM_i = SSB_i$, for i = 1 to 4. In each case, the hypothesis is not rejected. In addition, a joint hypothesis that the coefficients were all equal simultaneously was considered. The joint test statistic, F(4,59) = 2.26, provided only marginal evidence in favor of decomposing the adjusted monetary base. Thus, the evidence generally supports the implicit restrictions imposed by the simple sum approach. In other words, a one-percentage point increase (decrease) in source base growth has the same effect on nominal GNP growth as a one-percentage point increase (decrease) in SRAM achieved through reserve requirement changes.

The equality in the estimated shocks to source base and SRAM suggest that there is no advantage to looking at each component separately. Combining these effects, as done in the St. Louis adjusted monetary base, does not apparently destroy any useful information.

In summary, changes in nominal GNP growth are related to changes in St. Louis adjusted monetary base growth in a reduced-form setting. The results with the St. Louis measure suggest that the long-run elasticity of nominal GNP growth with respect to St. Louis adjusted monetary base growth is not different from unity. Further, the evidence suggests that no gain is achieved by decomposing adjusted monetary base growth into source base and RAM components. In effect, this result validates the implicit restirction imposed when specifying the adjusted monetary base that changes in RAM have the same effect on nominal GNP as changes in source base.

4.2 The Board Monetary Base

The Board's adjustment procedure is now investigated. How well does the Board's adjustment for reserve requirement changes, and hence their summary measure of monetary policy actions, explain movements in nominal GNP growth? Table 3 reports the results using the Board's base measure in equation (10). None of individual coefficients on the lagged Board base variables are statistically significant. The hypothesis that the sum of the coefficients on the base variables equals zero, however, is rejected. This finding suggests that the Board monetary base growth is related to changes in nominal GNP growth. The long-run multiplier also suggests the presence of a Board base-income relationship. Contrary to the St. Louis measure, however, the hypothesis that the long-run elasticity (here estimated to be 0.7447) is equal to unity is rejected (at the 7% level) when the Board measure is specified (F(1,61) = 3.54).

Table 4 reports regression results considering the inclusion of Board's adjustment factor (BAF) variable along with the contribution of the unadjusted base to monetary base growth. The coefficient on the first lagged BAF variable is marginally significant and close to unity. The Board measure also implictly imposes the restrictions that the effects of base growth and adjustment growth (relative to monetary base growth) are the identical. In the separate tests that each pair of lagged of coefficients are equal, the hypothesis is not rejected for the second, third and fourth lagged values. Marginal evidence exists for the hypothesis that the first lagged coefficients are different (F(1,59) = 3.59). The joint hypothesis that the four lagged coefficients for the decomposed Board monetary base is not rejected at the five-percent level (F(4,59) = 1.89). Thus, the data generally suggest that combining the two components is acceptable.

4.3 Both Measures Simultaneously

Since the two alternative base series purport to measure the same thing--a summary measure of monetary policy actions--their comparison is highly useful. The results in reported in Tables 1 and 3 indicate somewhat disparate findings for the two measures. First, with the unity long-run elasticity as a benchmark for a monetary policy variable, the data suggest that the St. Louis base is consistent with this hypothesis, while the Board base is not.

Second, the adjusted R^2 suggest slightly different explanatory power for the different measures. Again, the St. Louis version appears to provide better explanatory power with an R^2 of 0.814 versus an R^2 of 0.798 when the Board measure is specified. Although both of these findings seem to favor St. Louis base, it is hardly convincing evidence that the St. Louis adjustment procedure is better.

Two further means of comparison are useful. First, a formal specification test, developed by Pesaran (1974), will be used to attempt to discriminate between the two models. Second, the relative contribution that the differing series may have in explaining GNP developments. Depending on the outcome of the first investigation, this last comparison looks into whether one procedure augments the information coming from the "best" procedure. That is, by including both measures simultaneously in nominal GNP growth regression, does the loser of the specification test contribute further explanatory power.

Neither the Board nor St. Louis procedures are nested inside the other. Consequently, it is appropriate to apply the non-nested test methodology developed by Pesaran. In the Pesaran procedure, the researcher chooses the "true" model, which is specified as the model of the null hypothesis. The competing model is then set as the alternative model. Pesaran interprets rejecting the null hypothesis is consistent with the rejecting the null model in favor of the alternative model. In this investigation, the original null hypothesis is that the Board's model is the "true" specification. The test statistic for the Pesaran test is distributed as a standard normal. In our case the test statistic is calculated to be -3.18. Thus, the hypothesis is rejected at the five percent level.15/ The data suggest that the St. Louis adjusted monetary base is preferred over the model using the Board measure.

It is still possible that the different adjustment procedures would give rise to some contributions from the Board monetary base supplementing information already incorporated from the St. Louis base. A simple way to address this issue is by specifying a regression with St. Louis adjusted monetary base and deviations between the St. Louis and the Board measures included. Table 5 reports the regression results for such an experiment. In this setting, there is marginal evidence that the first lagged coefficient on the St. Louis base is different from zero. None of the individual coefficients on the lagged deviation variables, however, are statistically statistically significant. In addition, a joint test that all the lagged deviations coefficients equal zero is not rejected (F(4,59) = 1.53). Given the evidence that the St. Louis adjusted monetary base is better, including the deviation term amounts to testing the marginal information contribution made by the Board measure over and above the information contributed by the St. Louis adjusted monetary base. The data suggests that the Board measure does not contribute information useful in explaining movements in nominal GNP growth, at least over the 1959- 1979 sample period.

V. Out-of-Sample Information

Attention is now turned to the ability to explain nominal GNP growth out-of-sample over the horizon 1980I - 1987IV. One-step ahead forecasts were calculated for the period. In a sense, out-of-sample comparisons are stronger tests of the model because of the evidence presented that the model was unstable after 1979IV.

Generally, comparisons of alternative forecasts use sample mean square error information. For example, Goldfeld (1973) used the root mean square error comparisons to compare competing specifications of the money demand function. Ashley, Granger and Schmalenesee (1980) also base forecasting comparisons on the sample mean square error. We will look at both the root mean square error and the sample statistics forwarded by Ashley, et al as basis for comparing the "quality" of the one-step ahead forecasts using the St. Louis and Board base measures.

Table 6 reports the one-step ahead forecast errors for the period 1980I - 1987IV using both the St. Louis and the Board models estimated previously. After 1982II, the forecast errors are (with only one exception) positive regardless of the monetary base measure. Thus, the data suggest that the equations estimated over the period 1959I - 1979IV systematically over-predict nominal GNP growth throughout most of the 1980s. This evidence is consistent with a slowing in the monetary base velocity growth rate in the post-1982II period.16/

Table 7 reports the root mean square errors of the forecasts over the 1980I - 1987IV period as well as several sub-periods during the 1980s. Over the entire forecast sample, the root mean square error is slightly lower for nominal GNP growth forecasts using the St. Louis measure. Similarly, over the period 1980I - 1982IV, the forecasts generated using the St. Louis adjusted monetary base do better. The hypothesis that the root mean square errors are equal is not rejected for either forecast sample. Results using the Ashely, et al procedure are also consistent with the hypothesis that the St. Louis model does not offer significant improvement over the Board model in terms of forecasting over either period.17/

Table 7 also reports root mean square errors calculated for two additional sub-periods. Because MMDAs were introduced in 1983, it would be interesting to see how including 1983 forecasts errors affected root mean square calculations. Also the introduction of contemporaneous reserve accounting in 1984 may affect forecasting nominal GNP growth. To examine how this change affected forecasts errors, the root mean square errors were calculated for the period 1984I - 1987IV. In both cases, the root mean square forecasts using the Board model were smaller than those using the St. Louis adjusted monetary base. The hypothesis that the root mean square errors were equal for both sub-periods is not rejected.

In summary, the evidence does not suggest that either model produces better forecasts over the 1980s. Thus, in contrast to the in-sample results, the out-of-sample information do not strongly favor using the St. Louis adjusted monetary base forecasts over the Board monetary base forecasts for nominal GNP growth.

VI. Summary

This paper has examined the relationship between the two adjusted monetary base measures and nominal GNP. Using the adjusted monetary base growth variables to explain nominal GNP growth first raises the question whether decomposing the adjusted monetary base into reserve requirement adjustment component and source base component is useful. The findings presented here are consistent with a one percentage point increase in monetary base growth due to reserve requirement ratio changes have the same effect on nominal GNP growth as if one percentage point increase was due to source base growth, regardless of the adjustment measure. Thus, both decompositions make sense .

The evidence provided in this paper also suggests that the St. Louis adjustment procedure may be slightly more appropriate than the Board adjustment procedure in explaining the 1959 - 1979 period. Perhaps the most compelling evidence is the use of specification tests. The specification tests also are consistent with favoring the St. Louis adjusted monetary base model over the Board monetary base model. In the out-of-sample period, 1980 - 1987, however, there was little difference between the ability of the two base measures to predict nominal GNP behavior.

FOOTNOTES

1. Evidence supporting the adjusted monetary base as the appropriate monetary policy variable to control nominal GNP as been provided in Andersen (1975) and in Andersen and Karnosky (1977). More recently McCallum (1987) has proposed a monetary base rule based on monetary base behavior.

2. This quote was taken from <u>Futures</u>, July 1988, pg. 40

3. See "A Revolt at the Federal Reserve," Lindley H. Clark Jr., <u>Wall Street Journal</u>, October 27, 1988.

4. Haslag and Hein (1989) compare alternative specifications of a nominal GNP equation with source base and the St. Louis adjusted monetary base as the measures of monetary policy. This paper shows that reserve requirement ratio changes do matter for stabilization purposes.

5. Technically, source base is defined as the difference between sources and uses of the base. Operationally, sources are Federal Reserve assets and uses are non-monetary liabilities of the Federal Reserve. Equation (3) specifies source base to a function of Federal Reserve credit, or the monetary liabilites of the Federal Reserve. Double-entry accounting implies that a necessary and sufficient condition for changes in the source base is that Federal Reserve credit changes. Hence, equation (3) is equivalent to the formal definition of the source base.

6. This example assumes that the only reserveble deposits are D.

7. The term "nonbound" refers to those depository institutions which maintain vault cash balances in excess of their required reserves.

8. See Gilbert (1983) for a more detailed exposition of the differences between the Board and St. Louis adjustment procedures.

9. The issues involved with selecting the base period are by no means trivial. Gilbert (1980) and Tatom (1980) identify some the problems inherent to the Depository Institution Deregulation and Monetary Control Act of 1980. In effect, the scope of the reforms introduced in this legislation were very broad. In particular. it was difficult to select one period where institutional comparability was maintained before and after the base period. Thus, making the link between pre- and post-deregulation critical.

10. It is important to note that the Board's unadjusted base is different from the source base. The construction of the source lends itself to account for changes in currency issued by the Treasury, whereas the Board unadjusted base is effectively Federal Reserve Credit which does not include Treasury currency. Consequently, decomposing into source base and adjustment factor components are not relative to the same source base. We continue to use this terminology simply our of convenience. The Board refers to their source base counterpart as the "monetary base not adjusted for reserve requirements".

11. Toma (1988) provides a historical review of the changes introduced by DIDMCA, specifically with respect to reserve requirement ratio changes. After 1980, the Federal Reserve monopolized reserve requirement ratios. Before 1980, however, Toma claims that prior to DIDMCA's imposition of uniform reserve requirement ratios a competitive environment existed for these ratios, due to the competition between state banking authorities and the Federal Reserve System.

12. Charts 1 - 4 are the autocorrelation functions for the following variables (each first transformed according to equation (11)): nominal GNP, the St. Louis adjusted monetary base, the Board monetary base adjusted for reserve requirement ratio changes and the high-employment government budget surplus. The autocorrelation functions suggest that all the variables are stationary.

13. The values of the F test for St. Louis and the Board to determine the stability over the entire sample are F(13,84) = 2.60 and F(13,84) 2.08, respectively.

14. Source base and RAM changes are measured in relation to the St. Louis adjusted monetary base (SAMB). That is,

$$SSB_t = (SB_t - SB_{t-4}) / (SAMB_t + SAMB_{t-4})/2$$

where SSB denotes the contribution of source base growth to adjusted monetary base growth. Similarly,

$$SRAM_t = (RAM_t - RAM_{t-4}) / (SAMB_t + SAM_{t-4})/2,$$

where SRAM is the contribution of RAM growth to adjusted monetary base grwoth. This decomposition means that $SAMB_t = SSB_t + SRAM_t$. Use of the decomposition technique facilitates testing the hypothesis that a 1 percentage increase in the source base component has the same effect on nominal GNP growth as a one percentage point increase in the RAM component.

15. Pesaran indicates that the specification test may not be symmetric. For completeness, the specification test was specified with the null and alternative hypotheses reversed. With the St. Louis measure as the null hypothesis, the specification test statistic was calculated to be -0.15. Because we fail to reject the null hypothesis, this result is consistent with the St. Louis adjusted monetary base being the "better" of the two models.

16. The rule set forth by McCallum said that monetary base growth should respond inversely to velocity shifts. Accordingly, the decline in velocity growth in the early 1980s would have induced higher base growth for the same nominal GNP growth path.

17. For the record, in both cases the mean forcasts errors were positive when using the Ashley, et al procedure.

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Table 1 - Nominal GNP Growth and Adjusted Monetary Base Growth

(Sample period: I/1959 - IV/1979)

$$\dot{y}_t = \beta_o + \sum_{i=1}^{4} \beta_i \dot{y}_{t-i} + \sum_{i=1}^{4} \alpha_i \dot{SAMB}_{t-i} + \sum_{i=1}^{4} \lambda_i \dot{FG}_{t-i} + \varepsilon_t \ .$$

Coefficient	Estimate	Standard Error
β_o	0.016*	0.005
β_1	0.847*	0.127
β_2	-0.197	0.167
β_3	0.057	0.169
β_4	-0.247*	0.127
α_1	0.362	0.292
α_2	0.173	0.474
α_3	-0.175	0.473
α_4	0.117	0.294
λ_1	-0.729 E-3	0.136 E-2
λ_2	-1.331 E-3	0.144 E-2
λ_3	0.540 E-3	0.140 E-2
λ_4	0.511 E-3	0.119 E-2

adj R^2 = 0.814

Ljung-Box Statistic for White Noise Residuals

$$\chi^2_{(6)} = 6.12$$

$$\chi^2_{(12)} = 12.10$$

Table 2 - Nominal GNP Growth and the St. Louis Adjusted Monetary Base Growth

(Sample period: I/1959 - IV/1979)

$$\dot{y}_t = \beta_o + \sum_{i=1}^{4} \beta_i \dot{y}_{t-i} + \sum_{i=1}^{4} \alpha_i \dot{SSB}_{t-i} + \sum_{i=1}^{4} \alpha_i' \dot{SRAM}_{t-i} + \sum_{i=1}^{4} \lambda_i \dot{FG}_{t-i} + \varepsilon_t$$

Coefficient	Estimate	Standard Error
β_o	0.012*	0.005
β_1	0.801*	0.139
β_2	-0.234	0.179
β_3	0.154	0.178
β_4	-0.236	0.125
α_1	0.533	0.466
α_2	0.303	0.731
α_3	-0.285	0.713
α_4	0.214	0.439
α_1'	1.078*	0.507
α_2'	-0.202	0.870
α_3'	0.355	0.858
α_4'	-0.039	0.553
λ_1	-0.979 E-3	0.142 E-2
λ_2	-0.910 E-3	0.153 E-2
λ_3	-0.344 E-3	0.145 E-2
λ_4	-0.278 E-3	0.119 E-2

adj $R^2 = 0.827$

Ljung-Box Statistics for White Noise Residuals

$\chi^2_{(6)} = 6.52$

$\chi^2_{(12)} = 14.65$

Table 3 - Nominal GNP Growth and the Board Monetary Base Growth
(Sample period: I/1959 - IV/1979)

$$\dot{y}_t = \beta_o + \sum_{i=1}^{4} \beta_i \dot{y}_{t-i} + \sum_{i=1}^{4} \alpha_{iB} \dot{AMB}_{t-i} + \sum_{i=1}^{4} \lambda_i \dot{FG}_{t-i} + \varepsilon_t \cdot$$

Coefficient	Estimate	Standard Error
β_o	0.019*	0.005
β_1	0.922*	0.129
β_2	-0.185	0.175
β_3	0.050	0.178
β_4	-0.275*	0.135
α_1	0.336	0.303
α_2	-0.171	0.453
α_3	0.034	0.451
α_4	0.165	0.283
λ_1	-0.750 E-3	0.137 E-2
λ_2	-1.166 E-3	0.145 E-2
λ_3	0.920 E-3	0.143 E-2
λ_4	0.754 E-3	0.127 E-2

adj $R^2 = 0.798$

Ljung-Box Statistic for White Noise Residuals

$$\chi^2_{(6)} = 6.66$$

$$\chi^2_{(12)} = 12.21$$

Table 4 - Nominal GNP Growth and the Board Adjusted Monetary Base Growth
(Sample period: I/1959 - IV/1979)

$$\dot{y}_t = \beta_o + \sum_{i=1}^{4} \beta_i \dot{y}_{t-i} + \sum_{i=1}^{4} \alpha_i B\dot{S}B_{t-i} + \sum_{i=1}^{4} \alpha'_i \, BA\dot{F}_{t-i} + \sum_{i=1}^{4} \lambda_i \dot{F}G_{t-i} + \epsilon_t \, .$$

Coefficient	Estimate	Standard Error
β_o	0.017*	0.005
β_1	0.934*	0.135
β_2	-0.248	0.185
β_3	0.141	0.183
β_4	-0.300*	0.132
α_1	0.306	0.476
α_2	0.046	0.704
α_3	0.022	0.698
α_4	0.234	0.439
α'_1	1.009	0.528
α'_2	-0.663	0.820
α'_3	0.657	0.810
α'_4	0.002	0.561
λ_1	-0.996 E-3	0.140 E-2
λ_2	-0.964 E-3	0.148 E-2
λ_3	0.349 E-3	0.143 E-2
λ_4	0.218 E-3	0.125 E-2

adj $R^2 = 0.809$

Ljung-Box Statistics for White Noise Residuals

$\chi^2_{(6)} = 8.06$

$\chi^2_{(12)} = 15.74$

Table 5 - Nominal GNP Growth Equation with St. Louis Adjusted Monetary Base Growth and Deviations (DEV = SAMB - BAMB)

(Sample period: I/1959 - IV/1979)

$$\dot{y}_t = \beta_o + \sum_{i=1}^{4} \beta_i \dot{y}_{t-i} + \sum_{i=1}^{4} \alpha_i \dot{BAMB}_{t-i} + \sum_{i=1}^{4} \alpha_i' DEV_{t-i} + \sum_{i=1}^{4} \lambda_i \dot{FG}_{t-i} + \varepsilon_t$$

Coefficient	Estimate	Standard Error
β_o	0.010	0.005
β_1	0.723*	0.149
β_2	-0.135	0.175
β_3	0.025	0.171
β_4	-0.141	0.137
α_1	0.603	0.326
α_2	-0.002	0.484
α_3	-0.157	0.471
α_4	0.086	0.300
α_1'	-0.182	0.579
α_2'	1.106	0.798
α_3'	-0.182	0.833
α_4'	0.054	0.635
λ_1	-0.439 E-3	0.141 E-2
λ_2	-2.003 E-3	0.149 E-2
λ_3	0.577 E-3	0.149 E-2
λ_4	-0.361 E-3	0.129 E-2

adj $R^2 = 0.820$

Ljung-Box Statistics for White Noise Residuals

$$\chi^2_{(6)} = 7.59$$

$$\chi^2_{(12)} = 13.58$$

TABLE 6
FORECASTS ERRORS FROM ST. LOUIS AND THE BOARD MODELS

DATE	STLOUIS	BOARD
8001	-0.016952	-0.019672
8002	0.022706	0.022639
8003	0.004347	0.005047
8004	-0.014559	-0.015572
8101	-0.008119	-0.007948
8102	-0.013430	-0.009380
8103	-0.004916	-0.000179
8104	0.024802	0.028373
8201	0.023447	0.030490
8202	-0.007517	-0.005872
8203	0.023087	0.019316
8204	0.002746	0.001984
8301	0.013832	0.010520
8302	0.014248	0.009145
8303	0.017501	0.013617
8304	0.013656	0.007085
8401	0.003175	-0.000652
8402	0.020117	0.020142
8403	0.010611	0.009916
8404	0.016236	0.017673
8501	0.009765	0.010013
8502	0.005371	0.008212
8503	0.001161	0.003037
8504	0.008270	0.007595
8601	0.020772	0.017980
8602	0.027842	0.023999
8603	0.025216	0.022600
8604	0.033017	0.028423
8701	0.026730	0.022403
8702	0.022161	0.015713
8703	0.028363	0.021555
8704	0.011411	0.010860

Table 7 - Root Mean Square Errors for One-Step Ahead Forecasts, 1980-I-1985IV

Monetary Base Measure	Root Mean Square Error
1980I - 1987IV:	
St. Louis	0.01434
Board	0.01436
1980I - 1982IV:	
St. Louis	0.01598
Board	0.01699
1980I - 1983IV:	
St. Louis	0.01572
Board	0.01560
1984I - 1987IV:	
St. Louis	0.01946
Board	0.01696

CHART 1

```
                                ARIMA PROCEDURE

                       NAME OF VARIABLE      =      CGNPO
                       MEAN OF WORKING SERIES= 0.0809825
                       STANDARD DEVIATION    = 0.0268485
                       NUMBER OF OBSERVATIONS=         80
                                AUTOCORRELATIONS

LAG COVARIANCE CORRELATION -1 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 1          STD
  0 .000720842     1.00000 ⊞                    ⊞********************⊞          0
  1 .000631161     0.87559 ⊞                .   ⊞******************  ⊞   0.111803
  2 .000498807     0.69198 ⊞             .      ⊞**************      ⊞    0.17795
  3 .000362605     0.50303 ⊞            .       ⊞**********          ⊞   0.208895
  4 0.00022872     0.31730 ⊞           .        ⊞******  .           ⊞   0.223524
  5  0.0001713     0.23764 ⊞           .        ⊞*****   .           ⊞   0.229085
  6 .000153782     0.21334 ⊞           .        ⊞****    .           ⊞   0.232146
  7 .000147818     0.20506 ⊞           .        ⊞****    .           ⊞   0.234584
  8 .000162015     0.22476 ⊞           .        ⊞****    .           ⊞   0.236814
  9 .000182403     0.25304 ⊞          .         ⊞*****    .          ⊞   0.239466
 10 .000189023     0.26223 ⊞          .         ⊞*****    .          ⊞   0.242785
 11 .000188851     0.26199 ⊞          .         ⊞*****    .          ⊞     0.2463
 12 .000163856     0.22731 ⊞          .         ⊞*****    .          ⊞   0.249759
 13 .000137314     0.19049 ⊞          .         ⊞****     .          ⊞   0.252332
 14 .000114835     0.15931 ⊞          .         ⊞***      .          ⊞   0.254123
 15 .000108095     0.14996 ⊞          .         ⊞***      .          ⊞   0.255368
 16 .000108445     0.15044 ⊞          .         ⊞***      .          ⊞   0.256467
 17 0.00010927     0.15159 ⊞          .         ⊞***      .          ⊞   0.257567
 18 .000108333     0.15029 ⊞          .         ⊞***      .          ⊞    0.25868
 19 .000073648     0.10217 ⊞          .         ⊞**       .          ⊞   0.259769
 20 .000043304     0.06007 ⊞          .         ⊞*        .          ⊞   0.260271
 21 .000023043     0.03197 ⊞          .         ⊞*        .          ⊞   0.260444
 22 .000010762     0.01493 ⊞          .         ⊞         .          ⊞   0.260493
 23 .000029855     0.04142 ⊞          .         ⊞*        .          ⊞   0.260504
 24 0.00006482     0.08992 ⊞          .         ⊞**       .          ⊞   0.260586
                           '.' MARKS TWO STANDARD ERRORS
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CHART 2

```
                                ARIMA PROCEDURE

                       NAME OF VARIABLE      =  CSTLBASO
                       MEAN OF WORKING SERIES= 0.0585764
                       STANDARD DEVIATION    =   0.02179
                       NUMBER OF OBSERVATIONS=        80
                                AUTOCORRELATIONS

LAG COVARIANCE CORRELATION -1 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 1        STD
  0 .000474806    1.00000  ⊞                    ⊞********************⊞          0
  1 0.00044279    0.93257  ⊞                .   ⊞******************* ⊞   0.111803
  2 .000394963    0.83184  ⊞             .      ⊞*****************   ⊞   0.185047
  3 .000348431    0.73384  ⊞           .        ⊞***************     ⊞   0.227027
  4 .000309657    0.65218  ⊞          .         ⊞*************       ⊞   0.254959
  5 .000280175    0.59008  ⊞         .          ⊞************        ⊞   0.275023
  6 .000255704    0.53854  ⊞        .           ⊞***********.        ⊞   0.290418
  7 0.00023454    0.49397  ⊞        .           ⊞********** .        ⊞   0.302644
  8 .000217805    0.45872  ⊞       .            ⊞*********   .       ⊞   0.312559
  9 .000205897    0.43364  ⊞       .            ⊞*********   .       ⊞   0.320865
 10 .000199431    0.42003  ⊞       .            ⊞********    .       ⊞   0.328109
 11 .000188325    0.39664  ⊞       .            ⊞********    .       ⊞   0.334762
 12 .000168482    0.35484  ⊞      .             ⊞*******      .      ⊞   0.340586
 13 .000151813    0.31974  ⊞      .             ⊞******       .      ⊞   0.345176
 14 .000136182    0.28682  ⊞      .             ⊞******       .      ⊞   0.348859
 15 .000125544    0.26441  ⊞      .             ⊞*****        .      ⊞   0.351794
 16 .000118945    0.25051  ⊞      .             ⊞*****        .      ⊞   0.354269
 17 0.00011085    0.23346  ⊞      .             ⊞*****        .      ⊞   0.356477
 18 .000103154    0.21726  ⊞      .             ⊞****         .      ⊞   0.358383
 19 .000099341    0.20922  ⊞      .             ⊞****         .      ⊞   0.360026
 20 .000097268    0.20486  ⊞      .             ⊞****         .      ⊞   0.361542
 21 0.00009303    0.19593  ⊞     .              ⊞****          .     ⊞    0.36299
 22 .000083842    0.17658  ⊞     .              ⊞****          .     ⊞    0.36431
 23 .000071652    0.15091  ⊞     .              ⊞***           .     ⊞   0.365378
 24 .000062594    0.13183  ⊞     .              ⊞***           .     ⊞   0.366156
                           '.' MARKS TWO STANDARD ERRORS
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CHART 3

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                                ARIMA PROCEDURE

                       NAME OF VARIABLE      =  CBDBASED
                       MEAN OF WORKING SERIES= 0.0562254
                       STANDARD DEVIATION    = 0.0234164
                       NUMBER OF OBSERVATIONS=        80
                                AUTOCORRELATIONS

LAG COVARIANCE CORRELATION -1 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 1        STD
  0 .000548329    1.00000  ⊞                    ⊞********************⊞         0
  1 .000512597    0.93483  ⊞                .   ⊞******************* ⊞  0.111803
  2 .000466864    0.85143  ⊞             .      ⊞*****************   ⊞  0.185332
  3 .000421827    0.76930  ⊞           .        ⊞***************     ⊞  0.229066
  4 .000381059    0.69494  ⊞          .         ⊞**************      ⊞  0.259358
  5 .000346059    0.63112  ⊞         .          ⊞*************       ⊞  0.281674
  6 .000310319    0.56594  ⊞        .           ⊞***********.        ⊞  0.298828
  7 .000275799    0.50298  ⊞        .           ⊞********** .        ⊞  0.311938
  8 0.00024891    0.45394  ⊞       .            ⊞*********   .       ⊞  0.321916
  9 .000229762    0.41902  ⊞       .            ⊞********    .       ⊞   0.32982
 10 .000218074    0.39771  ⊞       .            ⊞********    .       ⊞  0.336409
 11 .000204628    0.37318  ⊞      .             ⊞*******      .      ⊞  0.342236
 12 .000184468    0.33642  ⊞      .             ⊞*******      .      ⊞  0.347285
 13 0.00016767    0.30578  ⊞      .             ⊞******       .      ⊞  0.351335
 14 .000153645    0.28021  ⊞      .             ⊞******       .      ⊞  0.354646
 15 .000145327    0.26504  ⊞      .             ⊞*****        .      ⊞  0.357403
 16 .000141704    0.25843  ⊞      .             ⊞*****        .      ⊞  0.359851
 17 .000137009    0.24987  ⊞      .             ⊞*****        .      ⊞  0.362164
 18 .000134168    0.24469  ⊞     .              ⊞*****         .     ⊞  0.364312
 19 .000133882    0.24416  ⊞     .              ⊞*****         .     ⊞  0.366361
 20 .000133961    0.24431  ⊞     .              ⊞*****         .     ⊞  0.368389
 21 .000130601    0.23818  ⊞     .              ⊞*****         .     ⊞  0.370409
 22 .000115428    0.21051  ⊞     .              ⊞****          .     ⊞  0.372318
 23 .000095086    0.17341  ⊞     .              ⊞***           .     ⊞  0.373803
 24 .000077581    0.14149  ⊞     .              ⊞***           .     ⊞  0.374807
                           '.' MARKS TWO STANDARD ERRORS
```

CHART 4

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                              ARIMA PROCEDURE

                      NAME OF VARIABLE       = CHEFGBSO
                      MEAN OF WORKING SERIES= 0.184116
                      STANDARD DEVIATION     =  1.41901
                      NUMBER OF OBSERVATIONS=       80
                              AUTOCORRELATIONS

LAG COVARIANCE CORRELATION -1 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 1        STD
  0    2.01359    1.00000  |                   |********************|         0
  1    1.05011    0.52151  |               .   |**********         |  0.111803
  2   0.210525    0.10455  |             .     |**   .             |  0.138922
  3  -0.596396   -0.29619  |             ******|     .             |  0.139902
  4   -1.20026   -0.59608  |       ************|     .             |  0.147533
  5   -0.74751   -0.37123  |            *******|      .            |  0.175068
  6   0.130777    0.06495  |            .      |*     .            |  0.184646
  7   0.477411    0.23709  |            .      |***** .            |  0.184931
  8   0.764903    0.37987  |           .       |********           |  0.188692
  9    0.29902    0.14850  |           .       |***    .           |  0.198021
 10  -0.342349   -0.17002  |           .    ***|       .           |  0.199408
 11  -0.663385   -0.32945  |           .*******|       .           |  0.201212
 12  -0.677305   -0.33637  |           .*******|       .           |  0.207846
 13  -0.426142   -0.21163  |          .    ****|        .          |  0.214542
 14  0.0553283    0.02748  |          .        |*       .          |  0.217136
 15   0.224547    0.11152  |          .        |**      .          |   0.21718
 16   0.302843    0.15040  |          .        |***     .          |  0.217894
 17   0.137786    0.06843  |          .        |*       .          |  0.219188
 18 -0.0583223   -0.02896  |          .       *|        .          |  0.219455
 19 -0.0185022   -0.00919  |          .        |        .          |  0.219503
 20 -0.0415448   -0.02063  |          .        |        .          |  0.219508
 21  0.0637673    0.03167  |          .        |*       .          |  0.219532
 22   0.160171    0.07955  |          .        |**      .          |  0.219589
 23   0.151183    0.07508  |          .        |**      .          |  0.219949
 24     0.1261    0.06262  |          .        |*       .          |  0.220269
                           '.' MARKS TWO STANDARD ERRORS
```