
Review

Vol. 68, No. 1

January 1986

5 Estimating Exchange Rate Effects on
Exports: A Cautionary Note

17 Recent Revisions of GNP Data



The Review is published 10 times per year by the Research and Public Information Department of the Federal Reserve Bank of St. Louis. Single-copy subscriptions are available to the public free of charge. Mail requests for subscriptions, back issues, or address changes to: Research and Public Information Department, Federal Reserve Bank of St. Louis, P.O. Box 442, St. Louis, Missouri 63166.

The views expressed are those of the individual authors and do not necessarily reflect official positions of the Federal Reserve Bank of St. Louis or the Federal Reserve System. Articles herein may be reprinted provided the source is credited. Please provide the Bank's Research and Public Information Department with a copy of reprinted material.

In This Issue . . .

Homer Jones

1906–1986

It is with great sorrow that we mark the passing of our friend and mentor, Homer Jones. As director of research at the Federal Reserve Bank of St. Louis from 1958 to 1971, Homer presided over a staff that established new standards for the gathering and publication of monetary statistics and monetary research. His role in promoting the then-obscure notion that money growth affects economic activity was fundamental, and he was responsible, in large part, for whatever reputation this Bank has today for rigorous, scientific research.

Homer came to the Federal Reserve Bank of St. Louis in 1958 after working for the Federal Deposit Insurance Corporation and the Federal Reserve Board. When he retired from the St. Louis Bank in 1971, he was senior vice president and director of research. He earned his B.A. and M.A. at the University of Iowa in Iowa City, and his Ph.D. from the University of Chicago.

* * *

The dollar's exchange rate, which has been associated with many economic developments in recent years, continues to occupy a prominent place in policy discussions. In the first article in this *Review*, "Estimating Exchange Rate Effects on Exports: A Cautionary Note," Michael T. Belongia shows that alternative measures of the dollar's value offer quite different pictures of its behavior in recent years. Since 1980, for example, the real value of the dollar rose anywhere between 32 percent and 57 percent, depending on the exchange rate measure used. Belongia goes on to demonstrate that qualitative judgments about the effects of exchange rates on exports or the effects of interest rates and other variables on the exchange rate vary substantially, depending on the particular measure of the dollar's value used in the analysis. Moreover, because there is no generally accepted way to determine which exchange rate measure is "best," the author warns that conclusions based on analysis of only one exchange rate index must be viewed as tentative.

In the second article of this issue, "Recent Revisions of GNP Data," Keith M. Carlson discusses the nature and extent of the Commerce Department's recently released revision of the nation's income and product accounts. The article focuses on the effect of the Department's revision on nominal GNP, output and prices, and finds that, over the 1948–84 period, the revision had large effects on the levels of these variables, but very little effect on their rates of change. In addition, Carlson found that the revision had only a marginal effect on econometric estimates of certain key macroeconomic relationships.

Estimating Exchange Rate Effects on Exports: A Cautionary Note

Michael T. Belongia

SINCE the abandonment of fixed exchange rates in the early 1970s, the value of the U.S. dollar has gained increasing prominence in domestic and international economic policy discussions. The dollar's value generally fell against other currencies between 1973 and 1979; its declining value reduced U.S. consumers' purchasing power as prices of imported goods rose relative to domestically produced items. At the same time, U.S. industries that relied heavily on foreign sales, such as agriculture and manufacturing, benefitted as prices of U.S. goods fell relative to prices offered by competing exporters.

This situation was reversed from 1979 to early 1985, when the dollar made its persistent rise. Analysts now cite the dollar's historically high and rising value during this period as a fundamental, if not the primary, cause of declining producer incomes and loss of jobs in the U.S. agricultural and manufacturing industries in recent years.

While analysts generally agree on the qualitative aspects of the exchange rate's effect on U.S. exports, the actual magnitude and persistence of these effects are subject to considerable controversy. This article demonstrates that one source of this disagreement reflects differences arising from the use of various exchange rate indexes. Using U.S. agricultural exports as an example, this article shows that an analysis based on different exchange rate measures can render substantially different conclusions about the U.S. competitive position in world markets, the estimated effects of changes in the dollar's value on exports and the relationship between the exchange rate and other economic variables.

MEASURING THE EXCHANGE RATE: AN OVERVIEW

In examining the effect of exchange rate movements on exports, it is tempting to consider the exports of specific commodities to specific countries on a case-

by-case basis. For example, if the U.S. exported corn only to France, Germany and Japan, it might seem reasonable to assume that only changes in *bilateral* exchange rates — that is, changes in the dollar's value against the franc, deutsche mark (dm) and yen individually — affect exports to these countries. Yet, this approach would be misleading.

Aside from practical difficulties inherent in handling large numbers of bilateral rates simultaneously, changes in relative prices, including the relative prices of currencies, induce many forms of substitution among producers, consumers and nations. For example, a change in the value of the dollar that raised the price of U.S. relative to foreign corn would cause importers of U.S. corn to import corn from another country or to substitute other grains in place of corn in production and consumption. This relative price change also would give foreign corn producers an incentive to increase corn production. U.S. producers receiving a higher dollar-denominated price for their corn would face a similar incentive — at least in the short run — to shift resources from other crops into corn production. Simply looking at a variety of bilateral exchange rate movements will not capture fully these many and diverse substitution possibilities; to accomplish this, one needs a *single* measure of changes in the dollar's value relative to multiple currencies.¹

In the same way that the consumer price index represents a weighted sum of a specific sample of many individual retail prices, an exchange rate index is a weighted sum of the dollar's price in terms of a specific sample of foreign currencies. The weights used typically are the percent of total U.S. trade con-

Michael T. Belongia is a senior economist at the Federal Reserve Bank of St. Louis. David J. Flanagan provided research assistance.

¹This judgment, of course, abstracts from the many well-known problems with index numbers, including the use of fixed weights, and choice of base period, sample of countries and mathematical formula.

Table 1

Percentage Weights Assigned to Major Currencies in Five U.S. Dollar Exchange Rate Indexes

Country	Exchange Rate Index				
	FRB	MERM	SDR	MG	USDA
Germany	20.8	13.02	32.8	10.9	8.99
Japan	13.6	21.25	22.4	23.2	21.05
France	13.1	10.11	22.4	5.9	2.65
United Kingdom	11.9	5.06	22.4	9.2	4.63
Canada	9.1	20.28	—	30.3	8.31
Italy	9.0	7.47	—	4.1	4.78
Netherlands	8.3	3.24	—	3.0	11.26
Belgium	6.4	2.44	—	3.5	2.59
Sweden	4.2	2.73	—	1.7	—
Switzerland	3.6	1.69	—	2.8	1.17
Australia	—	4.86	—	2.4	—
Mexico	—	—	—	—	3.37
Spain	—	2.44	—	1.4	3.67
South Korea	—	—	—	—	4.65
Denmark	—	1.40	—	0.6	0.95
All Other	—	4.01	—	1.0	21.93
TOTAL	100.0	100.00	100.0	100.0	100.00

ducted with the individual countries selected. Currencies chosen for the sample usually are those of the countries that make up the five or ten largest shares of total U.S. foreign trade. For example, excluding imports from consideration, if the United States exported only corn and France bought half, while Germany and Japan each bought 25 percent, an index of the dollar's value could be constructed by multiplying the franc/dollar, dm/dollar and yen/dollar bilateral exchange rates by 1/2, 1/4 and 1/4, respectively, and adding up the resulting figures. The sum would be an export trade-weighted index of the dollar's value against the currencies of these three countries.

CHOICES OF EXCHANGE RATE MEASURES

A variety of alternative trade-weighted exchange rate indexes have been constructed and used. Among the best-known are those produced by the Federal Reserve Board (FRB), Morgan Guaranty (MG), the U.S. Department of Agriculture (USDA), the International Monetary Fund (MERM) and one constructed from International Monetary Fund data on Special Drawing Rights (SDR). Table 1 indicates the weights that each of these indexes assigns to different foreign currencies. The most narrow index is the SDR index, which as-

signs weights based on the four other currencies (besides the U.S. dollar) that make up SDRs.²

The FRB, MERM and MG indexes base their weights primarily on trade with the G-10 countries and Switzerland.³ These indexes reflect trade among developed, industrialized economies but do not include less-developed countries' (LDC) currency values.⁴ The MERM and MG indexes, however, are somewhat more broadly based than the FRB index in that they include Australia, Spain and several other countries. The USDA index has the broadest coverage, with more than 35 percent of its weight given to non-G-10 countries. This index, based only on trade in agricultural products, is designed specifically to assess changes in the competitiveness of U.S. agricultural products as the dollar rises or falls. Especially notable in the USDA index are

²SDRs are the International Monetary Fund's official unit of account and serve as an international reserve asset often used in place of gold for making international payments. Since SDRs are denominated in terms of only the U.S. and four other nations' currencies, however, a dollar exchange rate based on SDR weights reflects changes in the dollar against a very small range of currencies.

³The Group of Ten, or G-10, countries include Belgium, Canada, France, West Germany, Italy, Japan, the Netherlands, Sweden, the United Kingdom and the United States.

⁴A less-developed country typically is defined as one in which per capita income is less than one-fifth of U.S. per capita income.

Differences Between Arithmetic and Geometric Means

The Federal Reserve Board changed the computation of its exchange rate index from one using arithmetic means to one using geometric means. The Board dropped the practice of using arithmetic means because, "as currencies diverged from each other over time, changes in currencies that rose against the dollar had a reduced impact on the index while changes in currencies that fell against the dollar had an increased impact on the index. As a result, arithmetic averaging imparted a systematic upward bias to the measurement of changes in the dollar's average exchange value."¹

The two formulas for calculating the index value at time t can be written as:

$$\text{Arithmetic mean: } \sum_{i=1}^n w_i E_{it}$$

$$\text{Geometric mean: } 100 \exp \sum_{i=1}^n w_i \log E_{it}$$

As mentioned in the text, the arithmetic mean is a simple sum of n currency values (E_i) weighted by

each currency's weight (w_i) in the index. The geometric mean, in contrast, averages the percentage changes in the individual exchange rates to determine the percentage change in the index.

The difference between the formulas can be illustrated by a simple example. Consider observations for five exchange rates, each with an index weight equal to 0.2, at two points in time.

Time 1	Time 2
$E_1 = 100$	$E_1 = 100$
$E_2 = 110$	$E_2 = 110$
$E_3 = 90$	$E_3 = 90$
$E_4 = 75$	$E_4 = 150$
$E_5 = 125$	$E_5 = 125$
Arithmetic mean = 100.0	Arithmetic mean = 115.0
Geometric mean = 98.52	Geometric mean = 113.17

Using the same values, the two techniques produce different index values and, thus, growth rates. For example, changing only E_4 between time 1 and time 2 produces a 15 percent change in the arithmetic index and a 14.87 percent change in the geometric index. Although this difference in the changes may seem small, similar changes will cause the gap between the two indexes to grow larger and larger over time.

the relatively large weights given to the Netherlands and such LDCs as Mexico and South Korea.

Problems in Index Construction

Constructing a multilateral exchange rate index is a difficult marriage of theory and practice.⁵ For example, choosing a base year for an index is difficult because, in theory, this base should be one in which absolute purchasing power parity holds and the countries used to construct the exchange rate index consume identical commodity bundles.⁶ It generally is not possible, however, to find a year in which absolute purchasing power parity held or actual consumption bundles across countries were identical.

Other practical problems associated with constructing an exchange rate index include the choice of

weighting schemes and the mathematical differences among alternative index formulas.⁷ One particularly important distinction arises between indexes that are constructed using arithmetic means (Laspeyres and Paasche indexes) vs. geometric means. Indexes constructed using arithmetic means give larger weights to those currencies that change more than other currencies in the index. In contrast, indexes created by geometric means respond to proportional exchange rate movements. For example, an exchange rate index based on an arithmetic mean of 10 countries' exchange rates will change by more than an index based on the geometric mean of the same countries' currencies, if some countries' currency values change by much larger amounts than the others. Thus, even if two indexes are constructed from the same currencies and the same trade weights, the method used to calculate the index can produce different measures of changes in the dollar's value (see shaded box above for one example).

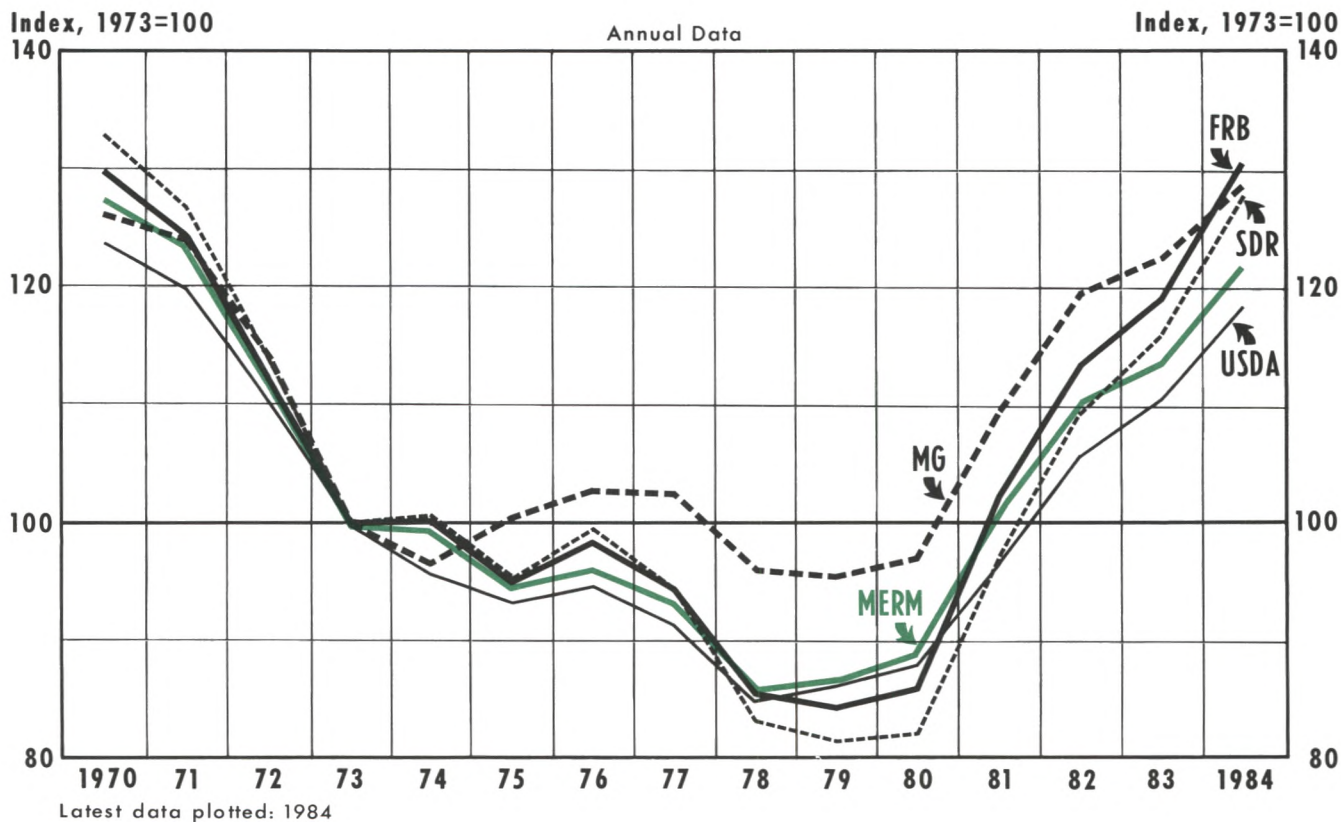
⁵See Dutton and Grennes (1985) for a detailed discussion of theoretical and statistical issues concerning the construction of exchange rate indexes. A similar discussion focusing on agricultural trade-weighted indexes is in Goolsby and Roberson (1985).

⁶Absolute purchasing power maintains that the exchange rate will be at a value that equates the price levels between nations.

⁷See Dutton and Grennes, pp. 20–27.

Chart 1

Selected Real Effective Exchange Rates Expressed as Value of Dollar



The difficulty of choosing an exchange rate measure for economic analysis is perhaps best illustrated by the relationships in chart 1 and table 2. Using measures of the real exchange rate, which are the nominal exchange rate indexes adjusted for differences in price levels between the United States and foreign countries, the chart shows that, between 1973 and 1980, the real value of the dollar fell as little as 3 percent based on the MG measure, or by as much as 14 percent based on the FRB measure. Similarly, the chart indicates that the real value of the dollar rose by as much as 57 percent (FRB) or as little as 32 percent (MG) between 1980 and 1984.

The divergent behavior of these indexes also is evident in table 2. The top portion of the table indicates that the USDA index has the lowest average quarterly

change, smallest standard deviation and smallest values for minimum and maximum changes. The SDR index, at the other end of the spectrum, has the largest values for three of these statistics; only the FRB index has a larger value for the mean quarterly change. The bottom portion of the table, which reports simple correlation coefficients, however, shows that changes in each index are correlated significantly. Overall, the data in chart 1 and table 2 indicate that, although movements in the indexes are positively correlated, there are substantial quantitative differences in their movements over time.

The problem of assessing the impact of exchange rate movements on exports might be somewhat ameliorated if there were a clear guide to choosing the best index. But, theoretical and statistical criteria that es-

Table 2

Summary Statistics for Changes in Alternative Real Exchange Rate Measures, 1/1973–1/1985

Index	Mean	Standard deviation	Minimum	Maximum
FRB	0.670	3.741	-5.858	8.292
MERM	0.470	3.181	-5.712	7.160
SDR	0.594	4.011	-7.644	8.747
MG	0.500	3.048	-6.122	7.143
USDA	0.260	2.538	-4.786	5.725

Correlation Coefficients and Significance Levels

Index	MERM	SDR	MG	USDA
FRB	0.983 (0.0001)	0.919 (0.0001)	0.854 (0.0001)	0.908 (0.0001)
MERM		0.976 (0.0001)	0.864 (0.0001)	0.921 (0.0001)
SDR			0.853 (0.0001)	0.909 (0.0001)
MG				0.835 (0.0001)

NOTE: Significance levels in parentheses

establish minimum standards of performance for an index do not offer clear guidelines for discriminating among alternative indexes that meet these basic standards.⁸ Without guidelines, two questions emerge: Does the choice of an index make a substantial difference in empirical work? If so, what other grounds might be used to choose the appropriate index? These questions are investigated below.

EMPIRICAL DIFFERENCES CAUSED BY ALTERNATIVE EXCHANGE RATE MEASURES: THE CASE OF FARM EXPORTS

The real issue in estimating empirical relationships between exchange rates and exports depends not so much on the levels of the alternative exchange rate series, *but on their specific changes over time*. That is, if the various index levels differ by constant absolute amounts (or constant proportions in logarithms), the magnitudes of the exchange rate coef-

ficient in an export equation will vary but the model's explanatory power will be the same across all measures. In contrast, if the exchange rate indexes are of similar magnitude but follow different paths around the same mean, both a model's exchange rate coefficient and its explanatory power will vary. The latter prospect is particularly relevant if an export equation derived from theory produces substantially different estimates of an exchange rate elasticity since there are no clear grounds, *a priori*, for preferring one single exchange rate index to another.

We can illustrate this problem by considering the case of farm exports. A general expression of the export demand for U.S. farm products can be written as:

$$\begin{aligned}
 (1) \ln X_t = & \alpha + \sum_{i=0}^m \beta_i \ln \text{FGNP}_{t-i} \\
 & + \sum_{j=1}^p \gamma_j \ln (\text{USAGP/USCPI})_{t-j} \\
 & + \sum_{k=1}^q \delta_k \ln \text{RER}_{t-k} + \varepsilon_t
 \end{aligned}$$

⁸See Dutton and Grennes, pp. 8–11, for a discussion of these criteria.

Table 3

Estimates of Equation 1 Over a I/1973–IV/1981 Sample

Exchange rate	Intercept	$\Sigma \ln \text{FGNP}$	$\Sigma \ln (\text{USAGP}/\text{USCPI})$	$\Sigma \ln \text{RER}$	\bar{R}^2	DW
FRB	4.686 (1.45)	0.825 (2.37) 2	-0.620 (5.25) 2	-0.671 (2.49) 3	0.93	1.60
MERM	14.396 (21.22)	— —	-0.964 (11.31) 8	-1.597 (12.59) 7	0.95	1.51
SDR	4.316 (1.51)	0.809 (2.47) 2	-0.594 (5.60) 2	-0.603 (2.74) 3	0.93	1.61
MG	-4.108 (4.19)	1.779 (12.48) 1	-0.365 (4.16) 2	— —	0.91	1.16
USDA	-1.229 (0.24)	1.611 (3.15) 2	-0.594 (4.07) 8	-0.226 (0.45) 5	0.94	1.66

NOTE: Absolute values of t-statistics are in parentheses. Lag lengths for right-hand-side variables, chosen in pretest estimation by a final prediction error (FPE) criterion, are shown below the t-statistics.

where:

- X = real exports of all U.S. farm commodities;
 FGNP = foreign real GNP;
 USAGP = index of U.S. farm prices;
 USCPI = index of U.S. consumer prices;
 RER = real, trade-weighted exchange rate, expressed in foreign currency units per dollar; and
 ϵ = a random error term.⁹

The model was estimated over several sample periods using quarterly data.¹⁰

The only difference among models was the choice of an index for the real exchange rate from the five series described in table 1. Each index was rebased to have a common value of 100 in I/1973. Tables 3 and 4 report these results. Results shown in table 3 apply to the first sample period, which ends in the fourth quarter of 1981 when real U.S. farm exports peaked; the second period results, reported in table 4, cover the entire period of flexible exchange rates up to the

first quarter of 1985. The critical results are those showing the estimated elasticities of farm exports with respect to the real exchange rate, which are shown in the fifth column of these tables. These values indicate the percentage change in real farm exports that will result from a 1 percent change in the real value of the dollar, as measured by the various indexes.

Although the general statistical characteristics and economic implications of the alternative models are broadly similar, there is considerable variation among the estimated elasticities, both across sample periods and across exchange rate measures. In table 3, the estimated exchange rate elasticity varies from zero (no effect) for the MG index and -0.23 for the USDA measure to -1.60 for the MERM index. Table 4 shows the estimated exchange rate elasticity varies from -0.80 (SDR) to -1.42 (MG). It also is interesting to note that extending the sample period raises the exchange rate elasticities for the MG and USDA indexes from zero and -0.23, respectively, to -1.42 and -1.23 in contrast to other indexes, which do not exhibit the same sensitivity to choice of an estimation interval. Thus, using the same model, it is possible to show that the demand for U.S. farm exports is either elastic or inelastic merely by changing the measure of the dollar's value used in the analysis. Clearly, the estimated response of farm exports to changes in the dollar's real value is sensitive both to the choice of sample period and the specific exchange rate measure used.

⁹This export equation is derived and discussed in Batten and Belongia (1984). This article also contains more detailed discussion on the distinction between real and nominal exchange rates.

¹⁰Lag lengths for right-hand-side variables were chosen by an FPE criterion following procedures outlined in Batten and Thornton (1984).

Table 4

Estimates of Equation 1 Over a I/1973–I/1985 Sample

Exchange rate	Intercept	$\Sigma \ln \text{FGNP}$	$\Sigma \ln (\text{USAGP/USCPI})$	$\Sigma \ln \text{RER}$	\bar{R}^2	DW
FRB	5.724 (4.22)	0.819 (5.65) 0	-0.643 (7.01) 7	-0.878 (9.50) 5	0.93	1.83
MERM	9.851 (5.90)	0.540 (3.36) 2	-0.759 (7.65) 8	-1.380 (9.10) 7	0.93	1.78
SDR	5.305 (3.96)	0.772 (5.20) 0	-0.590 (6.67) 7	-0.796 (9.38) 5	0.93	1.75
MG	8.096 (4.61)	1.016 (6.81) 0	-0.810 (7.19) 5	-1.423 (8.50) 5	0.92	1.61
USDA	8.451 (4.81)	0.630 (3.68) 0	-0.698 (6.48) 7	-1.229 (8.58) 5	0.92	1.49

NOTE: Absolute values of t-statistics are in parentheses. The number of lags for each right-hand-side variable, chosen in pretest estimation by a final production error (FPE) criterion, are shown below the t-statistics; zero lags indicate a contemporaneous value only.

CRITERIA FOR CHOOSING AMONG ALTERNATIVE INDEXES

The previous discussion demonstrated that alternative exchange rate measures diverge widely over time and have different estimated effects on farm exports. Unfortunately, neither economic theory nor index theory provides a clear criterion for preferring one exchange rate measure to another. There are, however, two approaches that can be used to indicate which index is potentially more useful: its out-of-sample forecasting performance and its relationship to variables that are thought to affect its value.

Out-of-Sample Forecasting Performance

The descriptive statistics for the in-sample estimations of equation 1 do not provide clear grounds for preferring a particular exchange rate index. This inconclusiveness, as we noted, leaves open the question of the true magnitude of the exchange rate elasticity. The choice of an index, however, can be based on how well it predicts the future path of exports; thus, its *out-of-sample* performance in predicting changes in farm exports is crucial. This criterion is examined in table 5 and chart 2.

The statistics in table 5 are derived from the esti-

Table 5

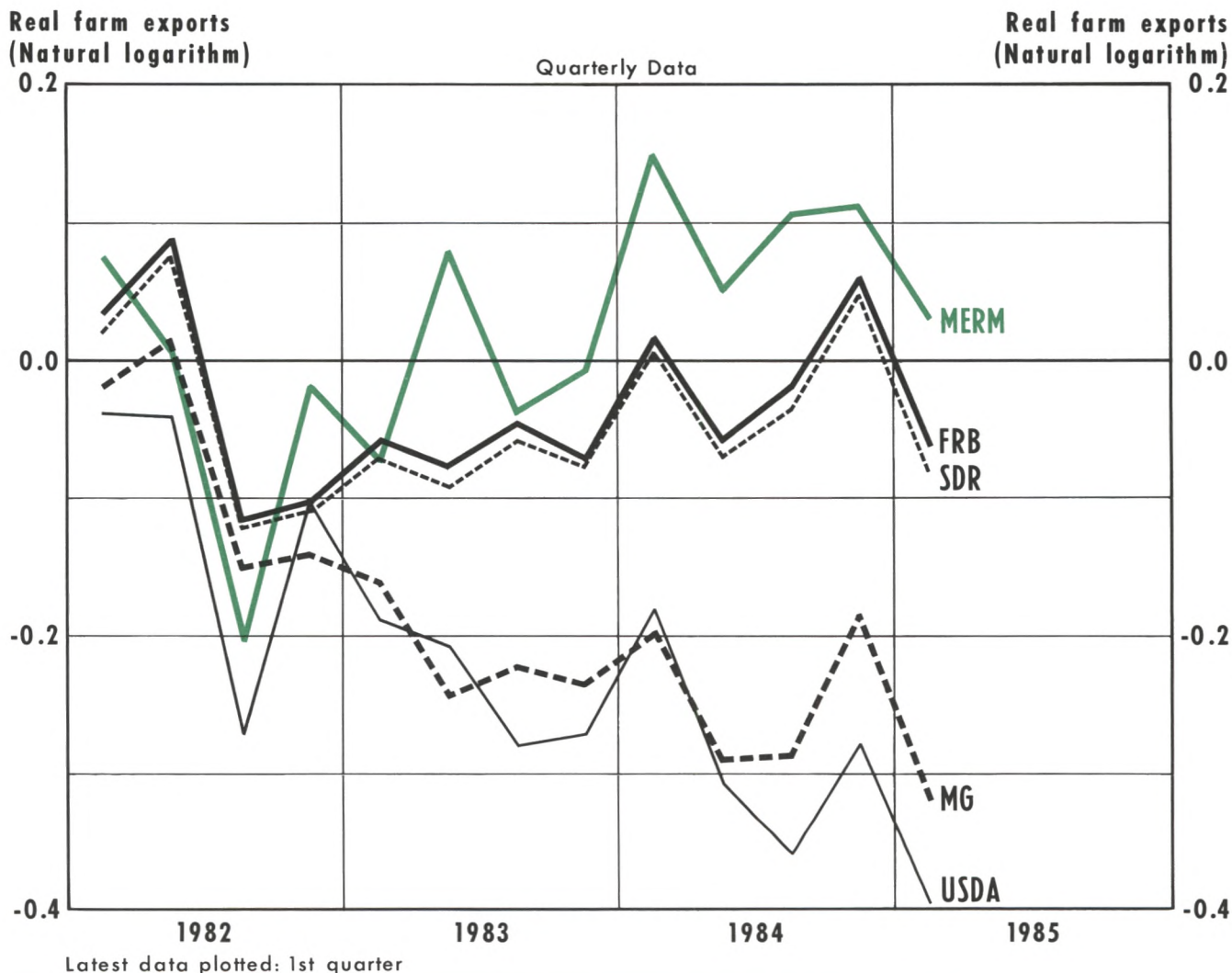
Out-of-Sample Error Statistics for Projected Farm Exports Using Alternative Real Exchange Rate Series (I/1982–I/1985)

Exchange rate series	Mean error	Mean absolute error	RMSE
FRB	-0.032	0.062	0.074
MERM	0.021	0.073	0.099
SDR	-0.044	0.066	0.080
MG	-0.188	0.190	0.229
USDA	-0.224	0.224	0.271

mated export equation coefficients reported in table 3. The estimated coefficients and the actual values for the equation's right-hand-side variables were used to simulate paths for farm exports over the period I/1982 to I/1985. The only difference among these alternative paths is the exchange rate measure used. Comparisons of actual farm exports over this interval with each of the simulated paths produce the error summary statistics reported in table 5.

Chart 2

Errors in Projected Farm Exports



On the basis of these measures, the FRB, MERM and SDR series perform substantially better than the other two. Ironically, the USDA index, which is designed specifically for empirical work on farm exports, performs much worse than the other measures. Moreover, it is clear from chart 2, which plots the out-of-sample (actual minus predicted) errors made in predicting farm exports, that the USDA index consistently overpredicts farm export volume by a substantial amount. The line denoted MG, which also indicates persistent overpredictions of exports, applies to the model that showed no significant exchange rate effect based on the MG index. These data point out

why care must be taken in choosing a particular exchange rate measure for use in empirical work and farm policy analyses that consider the expected future path of farm exports. Specifically, the data in table 5 and chart 2 indicate that, based on equation 1 and estimates of the MG or USDA index's future value, future farm exports would have been consistently overpredicted by large amounts, even if the exchange rate movement had been predicted perfectly.¹¹

¹¹It should be noted that, as in the previous analysis, these error statistics could vary over sample periods and specifications of export demand equations.

Exchange Rate Indexes and Other Variables

A second possible criterion for preferring one index to another is the index's relationship with variables thought to affect the dollar's value. This criterion is important because projections of future exports necessarily involve some prediction of the dollar's future value. Faced with a choice between an exchange rate index that apparently shares no significant relationship with variables that, theoretically, should influence it and one that is related systematically to, say, changes in interest rates, one would prefer the latter index, all other things equal.

There currently is widespread debate among economists over what factors affect the exchange rate. A fairly general theoretical model of international currency values, however, suggests four variables as the main influences. These include: differences in inflation rates between countries, differences in real rates of interest between countries, differences in real economic conditions that affect trade flows and differences in political or other risks associated with investments in different countries.¹²

We return to this issue by investigating how each of the alternative exchange rate indexes responds to changes in variables that are proxies for the theoretical factors listed above.¹³ The dependent variable in our investigation is the change in the various measures of the real exchange rate. To the extent possible, weights and countries used to compute each equation's right-hand-side variables are the same as those used to calculate the real exchange rate measure.¹⁴

The first model used can be written as:

$$(2) \Delta \ln RER_t = \alpha + \beta_1 \Delta RID_t + \beta_2 \Delta RID_{t-1} + \beta_3 \Delta \Sigma CAB_t + \beta_4 \Delta \Sigma CAB_{t-1} + \varepsilon_t$$

where

- $\Delta \ln RER$ = the change in the log level of the real exchange rate;
 ΔRID = the change in the *ex ante* real interest rate differential between the U.S. and foreign countries;
 $\Delta \Sigma CAB$ = the change in the U.S. cumulative current account balance; and
 ε_t = a random error term.

More detailed variable definitions and methods of construction appear in the appendix to this article. The subscript "t" indicates quarterly time periods. Each equation was estimated over the III/1974–III/1984 time period; the estimation period is shorter because of the availability of OECD inflation forecasts needed to construct the RID variable.

The results reported in table 6 again reveal some differences among the alternative exchange rate measures. In general, the signs and magnitudes of individual coefficients are similar across equations. For example, the contemporaneous and lagged terms for the current account balance are significant in each equation. In contrast, the lagged real interest differential is significant only in the equations that use the FRB, MERM and USDA indexes. Overall, the MERM index demonstrates a slightly better fit than the other measures.

Another specification of changes in the real exchange rate maintains the arguments of the previous model and adds the effects of changes in the growth rates of the money stock both in the U.S. ($\Delta \Delta \ln M$) and abroad ($\Delta \Delta \ln M^*$). This expression can be written as:

$$(3) \Delta \ln RER_t = \alpha + \sum_{i=0}^3 \beta_i \Delta \Delta \ln M_{t-i} + \sum_{j=0}^3 \gamma_j \Delta \Delta \ln M_{t-j}^* + \sum_{k=0}^3 \delta_k (\Sigma CAB)_{t-k} + \sum_{p=0}^3 \tau_p \Delta RID_{t-p}$$

Although the summary statistics shown in table 7 indicate some difference in goodness-of-fit across equations, the divergence of the results' *qualitative* interpretations is more interesting. For example, changes in the growth rate of the U.S. money stock have significant effects on the SDR index, but not on the other four. Similarly, changes in the real interest differential exhibit significant effects on the FRB, SDR and MERM indexes, but not on the others. Finally, only the cumulative current account balance and intercept have a significant effect on the MG and USDA indexes. If we are looking for an exchange rate index that is related significantly to variables that economic theory

¹²These influences are derived from the general framework developed by Isard (1983). On the other hand, some economists who have investigated these relationships empirically have found changes in the exchange rate to behave as a random walk. See, for example, Meese and Rogoff (1983) and Hakkio (1985).

¹³Derivations of these specifications are based on analyses in Hooper and Morton (1982), Shafer and Loopesko (1983), and Isard. Estimates for a broader range of specifications for the FRB index only are reported in Batten and Belongia (1986).

¹⁴Construction of the *ex ante* real interest differential, ΔRID , depended on the availability of inflation forecasts for countries in the index. In those cases in which a country was not included in the OECD forecast survey, it was dropped from the analysis and all weights used to construct the index were expanded by a common proportion so the adjusted weights still summed to one.

Table 6

Applications of a Common Exchange Rate Equation to Alternative Exchange Rate Indexes

Exchange rate	Intercept	ΔRID_t	ΔRID_{t-1}	$\Delta \Sigma CAB_t$	$\Delta \Sigma CAB_{t-1}$	\bar{R}^2	DW
FRB	0.005 (1.05)	0.001 (0.71)	0.004 (2.04)	-0.007 (3.59)	0.008 (3.42)	0.28	1.57
MERM	0.004 (0.94)	0.001 (0.63)	0.004 (2.02)	-0.006 (3.80)	0.007 (3.60)	0.30	1.66
SDR	0.004 (0.79)	0.001 (0.46)	0.004 (1.70)	-0.007 (3.54)	0.009 (3.38)	0.26	1.65
MG	0.008 (1.89)	0.001 (0.33)	0.003 (1.70)	-0.005 (3.27)	0.006 (3.36)	0.23	1.90
USDA	0.005 (1.27)	0.001 (0.78)	0.003 (2.18)	-0.005 (3.47)	0.005 (3.26)	0.29	1.66

NOTE: Absolute values of t-statistics in parentheses.

suggests should determine currency values, the MG and USDA series are the weakest candidates.¹⁵ Choices among the other three, however, remain problematical.

SUMMARY

Changes in the exchange value of the dollar over the past six years have been attributed to a wide variety of economic developments. This article has shown, however, that determining how much the dollar has changed and what effect it has had on other variables can depend on the specific exchange rate index chosen for the analysis. Both the set of countries included in the index and the weighting scheme used to aggregate movements in foreign currency values will affect the interpretation.

Using farm exports as one example, the analysis showed that different exchange rate indexes produce large differences in the estimated effects of exchange rates on exports. Moreover, further analysis showed that different indexes exhibit substantial differences in their ability to predict future changes in the volume of exports. Finally, if one is interested in the effects of changes in money growth, interest rates, the current account balance or other variables on the exchange

rate, one must realize that the significance and magnitude of such effects vary widely across exchange rate measures. Because neither economic nor statistical theory gives a clear indication of which exchange rate index is the "best" measure, these broad differences in results suggest that considerable caution be used in relying on a single exchange rate measure to indicate the effects of changes in the dollar's value on exports.

REFERENCES

- Batten, Dallas S., and Michael T. Belongia. "The Recent Decline in Agricultural Exports: Is the Exchange Rate the Culprit?" this *Review* (October 1984), pp. 5-14.
- _____. "Monetary Policy, the Real Exchange Rate and U.S. Agricultural Exports," *American Journal of Agricultural Economics* (May 1986), forthcoming.
- Batten, Dallas S., and Daniel L. Thornton. "How Robust Are the Policy Conclusions of the St. Louis Equation?: Some Further Evidence," this *Review* (June/July 1984), pp. 26-32.
- Dutton, John, and Thomas Grennes. "The Measurement of Effective Exchange Rates Appropriate for Agricultural Trade," Department of Economics and Business (November 1985), North Carolina State University.
- Goolsby, O. Halbert, and Ronald R. Roberson. "Exchange Rate Developments and Their Impact on U.S. Agricultural Exports: 1970-84," U.S. Department of Agriculture, FAS Staff Report No. 5 (May 1985).
- Hakkio, Craig. "Does the Exchange Rate Follow a Random Walk? A Monte Carlo Study of Four Tests for a Random Walk," Research Working Paper 85-02, Federal Reserve Bank of Kansas City (June 1985).

¹⁵Estimates of other equations showed a similar diversity of results in which no right-hand-side variable was significant in all equations and different combinations of variables were significant across exchange rate measures.

Table 7

Applications of a Common Exchange Rate Equation to Alternative Exchange Rate Indexes

Exchange rate	Intercept	$\sum_{i=0}^3 \Delta \ln M_{t-i}$	$\sum_{j=0}^3 \Delta \ln M^*_{t-j}$	$\sum_{k=0}^3 (\Sigma CAB)_{t-k}$	$\sum_{p=0}^3 \Delta RID_{t-p}$	\bar{R}^2	DW
FRB	0.013 (2.99)	3.728 (1.81)	-0.959 (0.63)	-0.001 (4.31)	0.020 (2.72)	0.60	2.34
MERM	0.011 (2.64)	2.360 (1.15)	-0.405 (0.27)	-0.001 (3.87)	0.015 (2.23)	0.52	2.24
SDR	0.012 (2.74)	5.202 (2.46)	-1.715 (1.20)	-0.002 (4.69)	0.026 (3.29)	0.64	2.41
MG	0.013 (3.33)	1.300 (0.61)	0.596 (0.42)	-0.001 (3.13)	0.011 (1.69)	0.46	2.71
USDA	0.011 (3.23)	1.836 (1.22)	-0.145 (0.12)	-0.001 (4.32)	0.009 (1.75)	0.52	2.20

NOTE: Absolute values of t-statistics in parentheses.

Hooper, Peter, and John Morton. "Fluctuations in the Dollar: A Model of Nominal and Real Exchange Rate Determination," *Journal of International Money and Finance* (April 1982), pp. 39-56.

Isard, Peter. "An Accounting Framework and Some Issues For Modeling How Exchange Rates Respond to News," in Jacob A. Frenkel, ed., *Exchange Rates and International Macroeconomics* (University of Chicago Press, 1983), pp. 19-56.

Meese, Richard, and Kenneth Rogoff. "Empirical Exchange Rate Methods of the Seventies: Do They Fit Out of Sample?" *Journal of International Economics* (February 1983), pp. 3-24.

Shafer, Jeffrey, and Bonnie E. Loopesko. "Floating Exchange Rates After Ten Years," *Brookings Papers on Economic Activity* (1:1983), pp. 1-86.

(See appendix on next page)

APPENDIX

Definitions of Variables Used in Equations 1–3¹

Real Interest Differential (RID)

OECD forecasts of the CPI for individual countries for July are applied to quarters 1 and 2; forecasts for December are used for quarters 3 and 4. These trade-weighted *ex ante* inflation differentials are then subtracted from a trade-weighted nominal interest differential using Morgan Guaranty Trust three- to four-month comparable money market rates.

Current Account Balances (Σ CAB)

U.S. current account balance accumulated since 1970; billions of dollars.

Trade-Weighted Rest of World Money (M^*)

Money stock for various countries indexed to I/1973 and weighted by same trade weights used in construction of the respective exchange rate indexes.

U.S. Money Stock (M1)

M1 indexed to I/1973.

Foreign GNP (FGNP)

Foreign real GNP or GDP measures indexed to I/1973 and trade-weighted.

U.S. GNP

U.S. real GNP indexed to I/1973.

USAGP

Unit value of agricultural exports index; I/1973 = 100.

USCPI

U.S. consumer price index; I/1973 = 100.

¹Trade-weights for each variable are those applied to the respective exchange rate indexes. All exchange rates are real and indexed to I/1973 = 100.

Recent Revisions of GNP Data

Keith M. Carlson

IN December 1985, the U.S. Department of Commerce announced a major revision of the nation's income and product accounts.¹ This revision, which is done about every five years, was the eighth of its kind. The purpose of this comprehensive revision was to update the gross national product (GNP) accounts, reflecting any new information, new procedures, and changes in the economic structure.

The U.S. income and product accounts were created in the 1930s, though they were not published on a regular basis until after World War II.² Their purpose is to provide a measure and understanding of the economic health of the nation. (For a brief summary of national income accounting, see the shaded box on p. 18.)

This article discusses the nature and extent of the most recent revision, along with some background information to aid the nontechnical reader. The article focuses on the effect of the revision on GNP, output

and prices. The effect of the revision on the interpretation of post-World War II economic fluctuations and on certain key historical relationships also receives consideration.

THE MAGNITUDE OF THE REVISION

The shaded box on page 20 describes the major sources of the revision. Although GNP data for earlier years were also affected somewhat, the revision primarily affected GNP data from 1970 to 1984.

Nominal GNP

Table 1 summarizes the effect of the revision on nominal GNP for alternate years from 1948 to 1984. The revision has increased the level of GNP in each year shown; the largest changes, however, have occurred since 1970. The revision had little impact on the annual growth rates of nominal GNP; it raised the growth rate from 1948–84 from 7.6 to 7.7 percent.

Real GNP Growth

Nominal GNP revisions can be compared directly in terms of dollar amounts; constant-dollar, or real, GNP estimates cannot be as easily compared because the base period has been shifted. Consequently, to compare the effect of the revision on real GNP estimates, one must examine its impact on the growth rates of the old and revised real GNP estimates.

Keith M. Carlson is an assistant vice president at the Federal Reserve Bank of St. Louis. Sandra Graham and Thomas A. Pollmann provided research assistance.

¹A detailed discussion of the revision can be found in various articles in the *Survey of Current Business*. See U.S. Department of Commerce (1985b, 1985c).

²For a discussion of the historical development of the U.S. income and product accounts, see U.S. Department of Commerce (1985a).

The Essentials of National Income and Product Accounting

The national income and product accounts provide a statistical summary of the economy, showing the volume, composition and uses of the national output. The total production of the nation is measured in two ways: in terms of products, that is, the value of goods and services, and in terms of the incomes generated in production. The accompanying table summarizes the national income and product account for 1984.

The left side of the table, the income side of the account, shows wages and salaries and other forms of income, indirect business taxes and capital consumption allowances (and other small items) generated in the production process. The total of these items is labeled "charges against gross national product." (Because the two sides of the income and product account are estimated independently, given imperfections in the source data, they are not necessarily equal. The error is called statistical discrepancy; it has no economic significance.)

The right side of the table, the product side, is divided into the major markets for the economy's output: personal consumption, business investment, government purchases and net exports. The sum of the expenditures is the gross national product (GNP).

The table is only one of many in the accounts, but it is the most fundamental one. Among the most important of the remaining accounts are those that show the receipts and expenditures of the major economic groups in the economy. The personal income and outlay account shows the income receipts and expenditures of persons. The government receipts and expenditures account summarizes the activities of federal, state and local governments. The foreign transactions account summarizes international transactions that impinge on U.S. income and product. Finally, the gross saving and investment account cuts across economic groups, showing their saving and investment transactions in summary form.

National Income and Product Account, 1984 (billions of dollars)

Compensation of employees	\$2,221.3	Personal consumption expenditures	\$2,423.0
Proprietors' income	233.7	Gross private domestic investment	674.0
Rental income	10.8	Government purchases of goods and services	736.8
Corporate profits and inventory valuation adjustment	273.3	Net exports of goods and services	-59.2
Net interest	300.2		
National income	3,039.3		
Business transfer payments	17.3		
Indirect business tax and nontax liability	310.6		
Less: Subsidies less current surplus of government enterprises	10.1		
Capital consumption allowances	418.9		
Statistical discrepancy	-1.5		
CHARGES AGAINST GROSS NATIONAL PRODUCT	\$3,774.7	GROSS NATIONAL PRODUCT	\$3,774.7

NOTE: Numbers may not add due to rounding.

SOURCE: Council of Economic Advisers.

Table 1

A Comparison of Old and Revised Nominal GNP: 1948–84 (dollar amounts in billions)

	Old	Revised	Percent change
1948	\$ 259.5	\$ 261.6	.81%
1950	286.5	288.3	.63
1952	348.0	351.6	1.03
1954	366.8	372.5	1.55
1956	421.7	428.2	1.54
1958	449.7	456.8	1.58
1960	506.5	515.3	1.74
1962	565.0	574.6	1.70
1964	637.7	649.8	1.90
1966	756.0	772.0	2.12
1968	873.4	892.7	2.21
1970	992.7	1,015.5	2.30
1972	1,185.9	1,212.8	2.27
1974	1,434.2	1,472.8	2.69
1976	1,718.0	1,782.8	3.77
1978	2,163.9	2,249.7	3.97
1980	2,631.7	2,732.0	3.81
1982	3,069.3	3,166.0	3.15
1984	3,662.8	3,774.7	3.06

Table 2 summarizes, on a peak-to-peak basis, the growth of the old and revised estimates of real GNP from 1948 to 1985. The growth of real GNP was higher only for the earliest period, which includes the defense buildup for the Korean War. All other revised peak-to-peak growth rates were lower; as a result, real GNP growth for the entire IV/1948–III/1985 period was revised downward about 0.2 percent, from a 3.4 percent annual growth rate using the old estimates to a 3.2 percent rate with the revised data.

GNP Deflator

Changes in the GNP deflator reflect changes in both prices and the composition of spending. Consequently, revision of the GNP accounts affects estimates of the deflator via several channels. Table 3 summarizes rates of change in the GNP deflator for peak-to-peak periods from 1948 to 1985.

With only two exceptions, IV/1948–II/1953 and I/1980–III/1981, the change in the deflator was revised upward. In conjunction with the virtually identical-sized revisions in the growth of real GNP summarized in table 2, it is clear that the revision primarily redistributed a given change in nominal GNP from real output to higher prices. For the period as a whole, the

Table 2

The Growth of Real GNP: Old and Revised Series (compounded annual rates of change)

Peak-to-Peak	Previous	Revised	Direction of revision
IV/1948 – II/1953	5.3%	5.7%	+
II/1953 – III/1957	2.2	1.8	–
III/1957 – I/1960	3.0	2.8	–
I/1960 – III/1969	4.2	4.0	–
III/1969 – IV/1973	3.5	3.0	–
IV/1973 – I/1980	2.7	2.5	–
I/1980 – III/1981	1.1	0.6	–
III/1981 – III/1985 ¹	2.6	2.4	–
IV/1948 – III/1985 ¹	3.4	3.2	–

¹Data calculated by the previous method are not available after III/1985.

Table 3

Changes in the GNP Deflator: Old and Revised Series (compounded annual rates of change)

Peak-to-Peak	Previous	Revised	Direction of revision
IV/1948 – II/1953	2.2%	1.9%	–
II/1953 – III/1957	2.5	2.9	+
III/1957 – I/1960	1.9	2.3	+
I/1960 – III/1969	2.6	2.8	+
III/1969 – IV/1973	5.2	5.9	+
IV/1973 – I/1980	7.6	8.0	+
I/1980 – III/1981	9.8	9.6	–
III/1981 – III/1985 ¹	4.1	4.3	+
IV/1948 – III/1985 ¹	4.1	4.3	+

¹Data calculated by the previous method are not available after III/1985.

revised deflator increased at a 4.3 percent annual rate, up slightly from the previously estimated 4.1 percent rate.

THE EFFECT OF THE REVISION ON BUSINESS CYCLES

As pointed out above, the revision had only a minor effect on the growth of nominal GNP: the growth of real GNP was revised downward slightly and the in-

The Sources of National Income and Product Accounts Revision

The Commerce Department divides the sources of revision into two major categories: (1) definitional and classificatory, and (2) statistical.¹ Definitional and classificatory changes update the accounts to reflect the changing structure of the U.S. economy. Statistical changes incorporate newly available and revised source data, improved estimating procedures and a shift in the base period for calculating constant-dollar estimates and the associated price indexes.

Definitional and Classificatory Changes

This category includes: (1) reclassification of certain business expenditures as investment, (2) changed treatment of federal employment benefit programs, (3) changed treatment of certain foreign transactions, and (4) reclassification of certain government assistance programs. Despite numerous definitional and classificatory changes, the revision of nominal GNP arising from this source was primarily attributable to (1) the capitalization of major replacements to residential structures and (2) the imputation of a social insurance fund for military retirement. The net effect of other changes on GNP was slightly negative.

Expenditures for the replacement of major items (like a roof or a heating system) in a house were reclassified as investment in residential structures. Previously, such replacements were charged off to current expense. This change increased nominal GNP by \$14.1 billion in 1984.

The Defense Authorization Act of fiscal 1984 established a military retirement trust fund in which contributions by the government are equal to benefits paid. These expenditures are now treated as national defense purchases; previously, such benefits had been included in government transfer payments. This change increased nominal GNP in 1984 by \$16.7 billion.

Statistical Changes

These changes include the shift of the base period from 1972 to 1982, the incorporation of new and revised data from regularly used sources available annually or on a "benchmark basis," the use of new source data, and new estimation procedures.

The statistical changes with the largest impact were as follows:

- (1) *Improved adjustments for misreporting on tax returns.* Although these adjustments are related to "underground" activities, the adjustment itself is not a measure of the size of the underground economy.² These adjustments increased 1984 nominal GNP by \$44.1 billion.
- (2) *Improved methodology and new data for residential investment.* Residential investment was revised upward by \$25.2 billion in 1984.³ About half of this increase was attributable to the new procedure of capitalized major replacements to structures; the rest reflected statistical changes due to new data.
- (3) *The shift in the base period from 1972 to 1982.* This shift reduced the rate of real growth and, for a given path of nominal GNP, increased the rate of change in the GNP deflator. See box on opposite page for an example.
- (4) *Improved price index for computers.* This change had no effect on nominal GNP; however, it improved estimates of real producers' durable equipment expenditures. Previously, the Commerce Department had assumed that computer prices had remained unchanged. The Commerce Department now incorporates a 10 percent decline per year in computer prices from 1970 to 1984. This change substantially increases estimates of real computer expenditures over the period.

²For example, GNP does not include illegal activities. For a detailed discussion of the underground economy, see Carson (1984) and Parker (1984).

³This leaves \$14.9 billion of statistical changes affecting nominal GNP that are attributable to other changes. The Commerce Department did not allocate these remaining changes.

¹A listing of these changes is provided in U.S. Department of Commerce (1985b, 1985c).

The Effect of Shifting the Base Period on Real GNP Growth

The effect on real GNP of shifting to a more recent base period can be shown by using a simplified example in which there are only two commodities, A and B. Real GNP can be obtained by multiplying the quantities of A and B sold in each year by their prices in the base period. For example, real GNP growth can be calculated as follows:

(1) Using year 1 as base period:

	Price (dollars)		Quantity (number)		Value (dollars)	
	Year 1	Year 2	Year 1	Year 2	Year 1	Year 2
A	\$5	\$9	10	11	\$ 50	\$ 55
B	6	7	10	16	60	96
					\$110	\$151

$$\text{Real GNP growth} = \frac{\$151}{\$110} = 1.373 \text{ or } 37.3\%$$

(2) Using year 2 as base period:

	Price (dollars)		Quantity (number)		Value (dollars)	
	Year 1	Year 2	Year 1	Year 2	Year 1	Year 2
A	\$5	\$9	10	11	\$ 90	\$ 99
B	6	7	10	16	70	112
					\$160	\$211

$$\text{Real GNP growth} = \frac{\$211}{\$160} = 1.319 \text{ or } 31.9\%$$

In both cases, the growth rate of real GNP is a weighted average of growth rates of A and B. In case 1, the weights are based on the prices in year 1; in case 2, the weights are based on prices in year 2. The example reflects the assumption that the price of A rises more than the price of B, while the quantity of A increases less than B. As a result, A receives more weight when year 2 is used as the base period than when year 1 is used.

crease of the GNP deflator was revised upward slightly. Because these changes are due chiefly to the shift of the base period from 1972 to 1982, they had no significant effect on the general movement of prices and real GNP over the post-World War II period.

Table 4 summarizes real GNP growth over expansions and contractions on the old and the revised basis. An examination of the quarterly movements of real GNP around turning points reveals no changes in the timing of the business cycle. There were, however, some changes in the severity of contractions and the strength of expansions.

The left side of table 4 reveals that real growth in all economic expansions was revised downward, except for the Korean War expansion of 1949–53. Real growth during the 1970–73 and 1980–81 expansions was reduced most by the revisions; all revisions, however, were minor. Moreover, the ordering of the expansion periods from strongest to weakest was left unchanged by the revision.

The right side of table 4 summarizes the effect of the revision on the severity of recessions. The effect was

not as uniform as for expansions: recessionary declines in real GNP were revised upward during some contractions and downward during others. Five contractions were found to be more severe than previously estimated, although in no case was the revision dramatic. The largest downward revision in real growth was for the 1948–49 recession.

THE EFFECT OF THE REVISION ON KEY MACROECONOMIC RELATIONSHIPS

One question of interest to economists is whether the revision influenced certain key macroeconomic relationships that are used in analyzing the economy and formulating economic policy. While many relationships could be examined, this section focuses specifically on four of them.³ Simple summary relationships were estimated for the 1956–84 period using

³For a summary and discussion of such relationships for the 1956–81 period, see Carlson and Hein (1983).

Table 4

Real GNP Growth over the Business Cycle: Old and Revised Series (compounded annual rates of change)

Expansion	Previous	Revised	Change	Contraction	Previous	Revised	Change
IV/1949 – II/1953	7.3%	8.0%	+0.7	IV/1948 – IV/1949	-1.4%	-2.0%	-0.6
II/1954 – III/1957	3.9	3.4	-0.5	II/1953 – II/1954	-3.2	-3.0	+0.2
I/1958 – I/1960	5.5	5.4	-0.1	III/1957 – I/1958	-6.6	-7.0	-0.4
IV/1960 – III/1969	4.7	4.5	-0.2	I/1960 – IV/1960	-1.5	-1.4	+0.1
IV/1970 – IV/1973	5.3	4.6	-0.7	III/1969 – IV/1970	-0.5	-0.7	-0.2
I/1975 – I/1980	4.4	4.1	-0.3	IV/1973 – I/1975	-3.9	-3.5	+0.4
II/1980 – III/1981	3.3	2.7	-0.6	I/1980 – II/1980	-9.0	-9.1	-0.1
III/1982 – III/1985	4.6	4.3	-0.3	III/1981 – III/1982	-3.0	-3.4	-0.4

percentage changes (where applicable) on a fourth-quarter-to-fourth-quarter basis. No attempt was made to search for the "best" equation; rather, the equations were chosen for their illustrative simplicity. They are intended solely to illustrate the effect of the revision on the various relationships in the simplest form possible.

Money and Nominal GNP

The relationship between money and GNP is a fundamental one in terms of the monetarist view of how total spending is determined. In a simple version, it can be estimated as the relationship between the four-quarter percent change of nominal GNP (\dot{Y}_4) and the four-quarter percent change of money (\dot{M}_4).⁴ The equation used here also includes a dummy variable (D) for the 1982–84 period because previous studies have indicated that the relationship shifted significantly after 1981.⁵

When this equation was estimated over the 1956–84 period, using both the previously published and revised data, the results were those shown in lines 1a and 1b of table 5. An inspection of the estimated equations indicates a slight strengthening in the relationship between nominal GNP and money, with the coefficient on money staying close to its theoretically expected value of one. The t -statistics (measures of the precision of the coefficient estimates) increased; \bar{R}^2 , a measure of the explanatory power of the equation, also rose. The standard error (SE) of the equation, a

measure of the accuracy of the fitted equation in terms of its dependent variable, was reduced by 4 percent. The Durbin-Watson (DW) statistic, a measure of residual correlation, showed a slight improvement.

Inflation and Money Growth

The relationship between inflation and money growth is another fundamental one in macroeconomics. Since, during the 1970s and 1980s, changes in the price of energy played a key role affecting movements of the price level, this variable was also included in the estimation of the relationship. The estimated equation for inflation (\dot{P}_4) includes the 16-quarter rate of change of money (\dot{M}_{16}) measured from fourth quarter to fourth quarter, the four-quarter percent change of the relative price of energy (\dot{P}_4^e), and the dummy variable discussed earlier.⁶

When estimated over the 1956–84 period, the results were those shown in lines 2a and 2b of table 5. As the statistics show, the revision improved the inflation equation marginally; both \bar{R}^2 and the standard error improved slightly, and the coefficient on money stayed close to its expected value of one. In addition, the t -statistics all increased. Signs of positive autocorrelation also appeared to be removed.

Unemployment Rate and Real GNP

Another relationship of interest to macroeconomists is the relationship between the unemployment rate and the growth of real GNP, a variant of what is called Okun's law. In the simple relationship esti-

⁴For estimation purposes, only fourth-quarter data were used from each calendar year.

⁵With the exception of the unemployment-real GNP equation, results presented here include this dummy variable.

⁶The choice of 16 quarters for money growth reflects previous research. See Carlson and Hein.

Table 5

Macroeconomic Relationships Using Old and Revised Data

Money and Nominal GNP

(1a) Using previously published data:

$$\dot{Y}_4 = 3.83 + .89 \dot{M}_4 - 3.51 D$$

(4.10) (5.10) (2.35)

$$\bar{R}^2 = .46$$

$$SE = 2.25$$

$$DW = 2.12$$

(1b) Using revised data:

$$\dot{Y}_4 = 3.80 + .91 \dot{M}_4 - 3.77 D$$

(4.26) (5.43) (2.64)

$$\bar{R}^2 = .50$$

$$SE = 2.15$$

$$DW = 1.97$$

Inflation and Money Growth

(2a) Using previously published data:

$$\dot{P}_4 = .08 + .97 \dot{M}_{16} + .08 \dot{P}_4^E - 3.05 D$$

(.14) (7.68) (3.06) (3.46)

$$\bar{R}^2 = .82$$

$$SE = 1.15$$

$$DW = 1.65$$

(2b) Using revised data:

$$\dot{P}_4 = .21 + 1.00 \dot{M}_{16} + .07 \dot{P}_4^E - 3.10 D$$

(.39) (8.31) (3.14) (3.67)

$$\bar{R}^2 = .84$$

$$SE = 1.10$$

$$DW = 1.89$$

Unemployment Rate and Real GNP

(3a) Using previously published data:

$$\Delta U_4 = 1.20 - .34 \dot{X}_4$$

(7.36) (8.15)

$$\bar{R}^2 = .70$$

$$SE = .64$$

$$DW = 2.01$$

$$\rho_1 = -.28$$

(3b) Using revised data:

$$\Delta U_4 = 1.15 - .35 \dot{X}_4$$

(7.34) (8.11)

$$\bar{R}^2 = .70$$

$$SE = .67$$

$$DW = 1.99$$

$$\rho_1 = -.37$$

Short-Term Interest Rate and Inflation

(4a) Using previously published data:

$$RS = 2.40 + .91 \dot{P}_4 + 1.22 D$$

(2.07) (5.67) (.92)

$$\bar{R}^2 = .54$$

$$SE = 1.25$$

$$DW = 1.89$$

$$\rho_1 = .74$$

(4b) Using revised data:

$$RS = 3.47 + .72 \dot{P}_4 - .69 D$$

(1.98) (3.95) (.45)

$$\bar{R}^2 = .39$$

$$SE = 1.40$$

$$DW = 1.88$$

$$\rho_1 = .85$$

NOTE: Absolute value of t-statistics in parentheses.

mated below, ΔU_4 is the change in the unemployment rate from fourth quarter to fourth quarter, and \dot{X}_4 is the percent change in real GNP from fourth quarter to fourth quarter.

When this relationship was estimated from 1956 to 1984, the results were those shown in lines 3a and 3b of table 5. Because the residuals were negatively correlated, the equations were adjusted for first-order serial correlation. The estimates indicate that the explanatory power of the relationship was unchanged using the revised data and that a 1 percent increase in output still reduces the unemployment rate by about one-third of a percentage point. The standard error increased only slightly, and the estimated coefficients did not change significantly.

Short-Term Interest Rate and Inflation

Interest rates generally move with the expected rate of inflation. Because expected inflation cannot be observed directly, estimates of its effect on interest rates require the use of "proxies"; the actual rate of change in the GNP deflator is used here as an approximation for the expected rate in the interest rate equation. The four-month commercial paper rate (RS) was estimated as a function of the four-quarter rate of inflation (\dot{P}_4) measured from fourth quarter to fourth quarter and the dummy variable described previously.⁷ It was necessary to estimate the equation using a first-order serial correlation adjustment.

Lines 4a and 4b of table 5 show the results. The short-term interest rate relationship deteriorated when estimated with the revised data. Such a result is probably not surprising, since the revised data are different than those that were used by market participants to form expectations. Even though the coefficient on inflation declined, it is not significantly different from one, its theoretically expected value.

SUMMARY

The Department of Commerce has recently revised the GNP accounts. The revision results from a variety of changes, including a shift of the base period from 1972 to 1982. This change in base period affects constant-dollar, or real, estimates as well as serving as the base year for the price indexes.

⁷A similar attempt was made to estimate a long-term interest rate equation but the results were meaningless. Conventional adjustments were unsuccessful in removing the positive correlation of the residuals.

Subscriber: Please include address label with subscription inquiries or address changes.

The revision resulted in substantial increases in the level of nominal GNP from 1948 to 1984. It had little effect on the *rates of change* of GNP. The revised figures for real GNP yield a slower pace of economic growth; it was revised downward from a 3.4 percent annual rate to a 3.2 percent rate from 1948 to 1985. The rate of change of the GNP deflator was revised upward, from a 4.1 percent rate to a 4.3 percent rate over the period.

While the revision had no effect on business-cycle turning points, it had some impact on the strength of expansions and the severity of recessions. Revisions of the growth of real GNP over the business cycle were within the -0.7 to $+0.7$ percentage-point range.

This article also examined the effects of the revision on simple versions of certain key macroeconomic relationships. These relationships cover the impact of money growth on nominal GNP and inflation, the relationship between real GNP growth and unemployment, and the impact of inflation on short-term interest rates.

The results were mixed. The two relationships linking money growth to GNP and inflation improved

marginally using the revised data. The other relationships deteriorated marginally. On net, the revision had no major effect on the pattern of recent fluctuations in the economy.

REFERENCES

- Carlson, Keith M., and Scott E. Hein. "Four Econometric Models and Monetary Policy: The Longer-Run View," this *Review* (January 1983), pp. 13–24.
- Carson, Carol S. "The Underground Economy: An Introduction," *Survey of Current Business* (May 1984), pp. 21–37.
- Parker, Robert P. "Improved Adjustments for Misreporting of Tax Return Information Used to Estimate the National Income and Product Accounts, 1977," *Survey of Current Business* (June 1984), pp. 17–25.
- U.S. Department of Commerce, Bureau of Economic Analysis. "Simon Kuznets and the Early Development of National Income and Product Estimates," *Survey of Current Business* (July 1985a), pp. 27–28.
- . "An Advance Overview of the Comprehensive Revision of the National Income and Product Accounts," *Survey of Current Business* (October 1985b), pp. 19–28.
- . "Revised Estimates of the National Income and Product Accounts of the United States, 1929–85: An Introduction," *Survey of Current Business* (December 1985c), pp. 1–19.