Economic Review
Federal Reserve Bank of Cleveland
Quarter III 1985

The Impact of Bank Holding Company Consolidation: Evidence from Shareholder Returns **2**

Several states have altered laws to give multi-bank holding companies (MBHCs) the option to convert to branch banking organizations by merging their affiliates into a single large unit. Economist Gary Whalen uses the event study technique to estimate the efficiency impact that such consolidation has had on a sample of 21 BHCs that did this from 1976 to 1983.

The National Debt: A Secular Perspective **11**

Economists John B. Carlson and E.J. Stevens examine the dynamics of federal debt over the past 40 years. They believe that conditions following World War II that led to a decline in federal debt relative to GNP are not likely to recur and that raising taxes and/or cutting spending is the only sure way to avoid unprecedented peacetime levels of future federal debt.

The Ohio Economy: A Time Series Analysis **25**

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Economic Review is published quarterly by the Research Department of the Federal Reserve Bank of Cleveland, P.O. Box 6387, Cleveland, OH 44101. Telephone: 216/579-2000.

Editor: William G. Murmann. Assistant editor: Meredith Holmes. Design: Jamie Feldman. Typesetting: Lucy Balazek.

ISSN 0013-0281

The Impact of Bank Holding Company Consolidation: Evidence from Shareholder Returns

by Gary Whalen

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Many states have chosen to legally restrict intrastate branching by banks to some degree. In a large proportion of such states, banks are able to circumvent the prohibition on statewide branching because they are permitted to adopt a multibank holding company (MBHC) form and to acquire affiliate banks throughout the state. However, because subsidiary banks in a MBHC continue to be separately incorporated entities, and because a number of legal-regulatory impediments to full organizational integration exist, it has been argued that MBHCs are imperfect substitutes for branch banking systems? That is, MBHCs may be less able to exploit size-related economies than pure branch banking organizations.

On the other hand, researchers such as O. Williamson have argued that it might be optimal for relatively large firms to operate as multi-divisional holding companies, rather than to merge all operating units into a single subsidiary.[2]

Beginning with New York in the mid-1970s, a number of states have amended their branching laws to permit MBHCs to transform their affiliates into branches by merging them into one large bank subsidiary (or several large ones). Interestingly, in states where such activity has been authorized, MBHCs have chosen to consolidate their subsidiary banks in varying degrees suggesting that the management of competing companies disagree about the expected net benefits of consolidation or, alternatively, about the costs of retaining the MBHC form.[3]

No empirical evidence currently exists on the net benefits of holding company consolidation. Such evidence could be of value because legislation authorizing such activity is currently being considered in several states. Measurement of the impact of total consolidation on the equity value of the consolidating MBHC is the subject of this study.[4]

In brief, the expected net benefits of consolidation are inferred by examining the behavior of the daily stock returns of a sample of 21 bank holding companies in seven states when the intention to merge their affiliates is first announced.[5] The behavior of their stock returns

1. See Mullineaux (1976, p. 277).

2. See the succinct summary of Williamson's views and supporting empirical evidence in Armour and Teece (1978).

3. It is also possible that the expected net benefits of consolidation are dependent on size and other characteristics of a particular MBHC.

4. In many of these states, MBHCs partially consolidated their subsidiaries. Such companies were not included in this study because of the heterogeneous nature of their organizational changes.

5. The states are New York, Florida, Ohio, New Jersey, Virginia, Alabama, and Tennessee. The number of companies drawn from each state is seven, three, three, one, foul: two, and one respectively.

over some period containing the announcement date presumably reflects investor estimates of the impact of the organizational change on the future profitability and market value of the banking organization. The event-study framework first used by Fama et al. (1969) is employed!

I. The Event Study Framework

In the event-study framework, the focus is on the observed behavior of a sample of firms' stock market returns, actually the "abnormal" portion of these returns, around the time at which some material development (the event) potentially affecting each firm's market value is initially made known.[7] "Abnormal returns" presumably reflect the capital market's estimate of the expected net impact of the development on the future profitability and market value of the firm. Abnormal returns may be observed prior to the event either because of market anticipation or leakage of information about the event. In an efficient market, only normal returns should be evident after the new relevant information is fully digested by market participants. However, if the announcement represents a strategic management decision, it is possible that abnormal returns prior to the event may precipitate rather than reflect the impact of the decision. The time pattern of the abnormal returns may suggest the direction of causality.[8]

In this study, the critical event is each MBHC's first public announcement of the intention to consolidate all of its subsidiary banks and effectively transform itself into a branch banking organization. Positive abnormal returns around the event date suggest that the announced consolidation is expected to boost future profitability and to generate net benefits for holding company shareholders.

The interpretation of negative abnormal returns is more difficult. Such returns may indicate that investors expect the change to depress the holding company's market value? Alternatively, because the decision to consolidate is a strategic one, the announcement might be the result rather than the cause of the negative abnormal returns.[10] Again, the timing of the returns should suggest which one of these interpretations is correct. In particular, negative abnormal returns very close to the announcement date suggest that the announcement is responsible for the negative returns, rather than the reverse.

It should be noted that the discovery of significant abnormal returns only provides insight on the consolidation impacts expected by shareholders. The presence of abnormal returns does not permit the analyst to unambiguously determine the effect of consolidation on social welfare. For example, positive abnormal returns could reflect either expected gains in efficiency due to consolidation or expected profitability increases due to consolidation-related changes in competition at the local level. In the latter case, the shareholders gain comes at the expense of holding company customers.

II. Methodology

The basic procedure used to calculate the abnormal returns for each company in this study is the same as that used in a large number of previous event studies published to date.

First, the event date for each company had to be determined. This date was defined to be the date on which a company's intention to consolidate was first reported in the financial press. These dates were discovered by searching the indexes of three publications: The Wall Street Journal, The American Banker, and Funk and Scott's Index of *Corporations* and Industries. Thus, announcement dates (AD), rather than effective dates, were used as event dates. In efficient markets, investors presumably react around the time at which a material development is announced rather than when the announced action is taken, and so cause the firm's stock price and market value to adjust around announcement dates rather than effective dates.

6. See Fama et al. (1969).

7. For various applications of the event study technique, see any of the various studies cited in the references.

8. See the discussion in Eisenbeis et al. (1984, p. 893) and in Jain (1985, pp. 221-22).

9. There is some fragmentary survey evidence that suggests that the impact of consolidation might be negative, particularly in the short run. There are several reasons this might be the case. Benefits of consolidation could be long-term and/or non-pecuniary. For example, consolidation might permit the parent to limit subsidiary risk-taking. In addition, loss of subsidiary independence might lower morale and productivity. See the discussion in the Association of Bank Holding Companies (1978, pp. 24-29).

10. Some responding MBHCs reported that organizational change was undertaken in response to financial difficulties. See Association of Bank Holding Companies (1978, p. 34).

11. Different estimation periods were tried, but this did not change the reported results in any material way.

12. A number of researchers have found that there is a strong industry effect on the returns of bank stocks and have argued that this influence should be controlled for in event studies of banking firms. See Eisenbeis et al. (1984, p. 883), Shick and Sherman (1980), and Keen (1983).

13. Alternative versions of equation (2) were estimated using techniques suggested in Scholes and Williams (1977) and Dimson (1979) to correct for statistical problems caused by infrequent securities trading. In addition, standardized abnormal returns were generated using the technique reported in Linn and McConnell (1983). Neither of these two methods produced results different from those reported and so are not presented.

14. The average proportion of the organization's total assets accounted for by the lead bank for these three large holding companies was about 98 percent, vs. about 56 percent for the rest of the sample.

Second, an interval around each company's event date, during which the impact of the event is expected to be discernible had to be determined. In this study, daily stock return data were used, and abnormal returns over the interval beginning 120 trading days before and ending 90 trading days after each company's event date were generated and examined?' This period will be referred to here as the examination Period.

Third, one of a variety of methods had to be used to generate "normal returns" for each company over the examination period. The first step in this process was to estimate a form of the "market model" equation for each company over the 140-day period beginning 260 trading days before its event date. This 140-day period is referred to as the estimation period. In the market model, the stock returns of a firm in any period are presumed to be a linear function of returns on a broad market index and occasionally of a second factor, the returns on an industry index. In this paper, the reported results were obtained using a two-factor version of the market model.[12] Symbolically, the estimated equations had the following general form:

$$(1) \quad R_{jt} = a_j + b_{1j}R_{mt} + b_{2j}R_{bt} + e_{jt},$$

where

R_{jt} = daily continuously compounded rate of return of company j,
R_{mt} = daily continuously compounded rate of return of Standard and Poor's 500 Index,
R_{bt} = daily continuously compounded rate of return of OTC Index of bank stocks,
e_{jt} = a stochastic disturbance term with standard properties, and
a_j, b_{1j}, b_{2j} = regression coefficients to be estimated.

"Normal returns" for each company over the examination period are simply its predicted returns obtained using its estimated market model equation and realized returns on each of the two stock indices.[13]

"Abnormal returns" for each company over the examination period were generated by subtracting normal returns from realized returns. Symbolically, abnormal returns were calculated using equation (2) below:

$$(2) \quad ar_{jt} = R_{jt} - RHAT_{jt},$$

where

ar_{jt} = "abnormal return" for the jth company,
$RHAT_{jt}$ = the predicted "normal return" for the jth company obtained using equation (1).

Because of the possibility that the returns of various companies might be affected by a variety of company-specific developments (aside from the specific event of interest) during the examination period, the abnormal returns of each company were not analyzed individually. Rather, as is typically done in event studies, various portfolios of subject firms were formed in event time, and the abnormal returns of the companies included in the portfolio were averaged cross-sectionally at each point in event time over the examination period to produce a series of average abnormal returns (AAR). Then this series was cumulated over various segments of event time to produce a cumulative average abnormal return measure (CAAR) for the particular sample of companies. These steps are represented in equation (3) and (4), respectively:

$$(3) \quad AAR_t = (1/J)\sum_{j=1}^{J} ar_{jt},$$

$$(4) \quad CAAR_{t2,\,t1} = \sum_{t=t1}^{t2} AAR_t,$$

where

AAR_t = the average abnormal return at event date t,
J = the number of companies in the sample,
$CAAR_{t2,t1}$ = the cumulative average abnormal return over the t2 - t1 trading day interval of event time.

The sign, size, and statistical significance of the cumulative average return measures indicate the capital market's estimate of the market value impact of MBHC consolidation and are the focus of the analysis in this paper.

If the event is perceived to have no significant impact on firm value, both the average return and cumulative average return measures should fluctuate randomly around zero over the examination period. If, on the other hand, the event is expected to have a beneficial impact on future firm profitability and market value, a preponderance of the average abnormal returns in the interval prior to the announcement date should be positive, causing the cumulative average abnormal return measure to be positive as well. A run of negative average abnormal returns in this period, due either to perceptions that the costs of consolidation will outweigh the benefits, or possibly to some other exogenous factor, will cause the cumulative average return measure to be negative.

If markets are efficient, and the consolidation announcement is responsible for the average abnormal returns observed, any marked runup or decline in the cumulative average return measure should cease once the information is fully digested by the market. It seems reasonable to expect that this process should be complete by the end of the day following the announcement date.

Table 1 Average and Cumulative Average Abnormal Returns
Entire sample

Event *date*	*AAR*	*CAAR*	*NP*[a]
AD - 90	-.0019	-.0019	8
AD - 85	-.0019	-.0165	12
AD - 80	.0067	-.0102	16
AD - 75	.0055	.0006	12
AD - 70	.0015	-.0066	10
AD - 65	-.0043	-.0141	8
AD - 60	-.0002	-.0188	9
AD - 55	-.0025	-.0237	7
AD - 50	.0020	-.0177	10
AD - 45	-.0016	-.0194	8
AD - 40	-.0007	-.0319	12
AD - 35	-.0045	-.0358	5
AD - 30	.0013	-.0402	10
AD - 25	-.0005	-.0427	11
AD - 20	-.0032	-.0500	6
AD - 15	-.0055	-.0580	3
AD - 14	-.0050	-.0631	8
AD - 13	.0045	-.0586	12
AD - 12	.0034	-.0551	12
AD - 11	.0015	-.0537	10
AD - 10	-.0039	-.0576	7
AD - 9	-.0032	-.0608	8
AD - 8	-.0036	-.0644	10
AD - 7	.0044	-.0600	13
AD - 6	.0018	-.0582	9
AD - 5	-.0008	-.0590	8
AD - 4	-.0017	-.0608	12
AD - 3	-.0013	-.0621	9
AD - 2	.0018	-.0602	11
AD - 1	.0020	-.0582	13
AD	-.0002	-.0585	7
AD + 1	.0034	-.0551	14
AD + 10	-.0034	-.0659	4
AD + 20	-.0024	-.0645	12
AD + 30	.0005	-.0656	9
AD + 40	-.0008	-.0606	8
AD + 50	.0041	-.0577	10
AD + 60	-.0018	-.0616	7

a. Number of companies with positive residuals.

III. Results

Average and cumulative average abnormal returns for selected trading days over the period from 90 trading days before to 60 trading days after the announcement date for the entire sample and several subsamples are presented in tables 1 to 3. The subsamples exclude one or more very large money center institutions. The rationale for excluding such institutions from the analysis is twofold. First, virtually all of their banking assets were concentrated in their lead institution prior to consolidation. Thus, consolidation might not strongly influence their market value.[14] Second, two of these three institutions announced their consolidation in 1975, when money tenter bank stocks were depressed due to the deep recession and related large loan losses.

15. Again, it is possible that MBHCs consolidate to lower profit variability, rather than raise profitability.

A plot of the CAAR measure for the entire sample over the complete examination period appears in figure 1. Plots for the two subsamples are similar and are not included. CAAR measures calculated over various sub-intervals of the examination period and associated test statistics appear in tables 4 to 6. The methods used to develop the test statistics are detailed in the appendix.[15]

Table 2 Average and Cumulative Average Abnormal Returns
Excluding Citicorp

Event *date*	*AAR*	*CAAR*	*NP*[a]
AD - 90	-.0025	-.0025	7
AD - 85	-.0015	-.0142	12
AD - 80	.0073	-.0075	16
AD - 75	.0049	-.0006	11
AD - 70	.0017	-.0057	10
AD - 65	-.0052	-.0137	7
AD - 60	.0005	-.0167	9
AD - 55	-.0031	-.0203	6
AD - 50	.0018	-.0152	9
AD - 45	-.0024	-.0171	7
AD - 40	-.0010	-.0307	11
AD - 35	-.0041	-.0327	5
AD - 30	.0009	-.0371	9
AD - 25	.0012	-.0397	11
AD - 20	-.0028	-.0446	6
AD - 15	-.0054	-.0515	3
AD - 14	-.0045	-.0560	8
AD - 13	.0042	-.0518	11
AD - 12	.0030	-.0489	11
AD - 11	.0022	-.0467	10
AD - 10	-.0035	-.0501	7
AD - 9	-.0038	-.0539	7
AD - 8	-.0024	-.0563	10
AD - 7	.0050	-.0513	13
AD - 6	.0021	-.0493	9
AD - 5	-.0016	-.0508	7
AD - 4	-.0014	-.0522	12
AD - 3	-.0004	-.0526	9
AD - 2	.0032	-.0495	11
AD - 1	.0033	-.0461	13
AD	-.0008	-.0470	6
AD + 1	.0019	-.0451	13
AD + 10	-.0027	-.0584	4
AD + 20	-.0012	-.0511	12
AD + 30	-.0006	-.0569	8
AD + 40	-.0008	-.0493	8
AD + 50	.0072	-.0424	10
AD + 60	-.0020	-.0514	6

a. Number of companies with positive residuals.

Examination of the plot and the data in the tables reveal that beginning roughly 50 to 60 trading days prior to the announcement date, the CAAR measures turn negative and decline more or less steadily until the event date. The results are remarkably similar, regardless of the sample used. Formal tests indicate that the negative cumulative average abnormal return measures calculated from AD - 90 to AD + 1 are significantly different from zero for all three samples (see tables 4 to 6).

In the post-announcement period, the CAAR measures generally fluctuate around the level attained on AD + 1, which implies that average abnormal returns are essentially random during this period. Formal tests confirm that the CAAR measures calculated in this time period are not significantly different from zero.

Thus, if one looks only at the cumulative average return measures calculated beginning on AD - 90 and ending on AD + 1, the results suggest that investors expect consolidation to generate negative net benefits. This finding raises questions about the motives of holding company management.[15]

However, as noted above, the decision to consolidate is a strategic one and could be made in response to deteriorating corporate performance. This suggests that the impact of consolidation, particularly any positive impact, might be evident only for a relatively short time immediately around the announcement date. Accordingly, cumulative average abnormal return measures and appropriate test statistics were calculated over a variety of shorter sub-intervals within the examination period.

The data in tables 4 to 6 reveal that negative average abnormal returns in the pre-announcement period were heavily concentrated in the period from AD - 45 to AD - 8. CAAR meas-

ures calculated during this interval and the AD - 45 to AD - 3 period are negative and significant.

In contrast, CAAR measures calculated from the AD - 7 to AD + 1, AD - 2 to AD + 1 and AD - 2 to AD - 1 are uniformly positive, although their statistical significance is marginal. For the subsamples excluding the large money center institutions, the CAAR measures approach significance at the 10 percent level (two-tail test) and are significant for the AD - 2 to AD - 1 period.[16]

Table 3 Average and Cumulative Average Abnormal Returns
Excluding three large money-center banks

Event date	*AAR*	*CAAR*	*NP*[a]
AD - 90	-.0018	-.0018	6
AD - 85	-.0015	-.0147	11
AD - 80	.0084	-.0074	15
AD - 75	.0039	-.0043	9
AD - 70	.0013	-.0091	8
AD - 65	-.0032	-.0161	7
AD - 60	-.0003	-.0181	8
AD - 55	-.0037	-.0210	5
AD - 50	.0007	-.0161	7
AD - 45	-.0013	-.0163	7
AD - 40	-.0003	-.0319	11
AD - 35	-.0025	-.0303	5
AD - 30	.0009	-.0374	8
AD - 25	.0007	-.0381	9
AD - 20	-.0037	-.0424	4
AD - 15	-.0052	-.0471	3
AD - 14	-.0038	-.0509	8
AD - 13	.0006	-.0503	9
AD - 12	.0006	-.0497	9
AD - 11	.0017	-.0480	9
AD - 10	-.0027	-.0507	7
AD - 9	-.0009	-.0516	7
AD - 8	.0026	-.0490	10
AD - 7	.0016	-.0474	11
AD - 6	-.0011	-.0485	7
AD - 5	-.0009	-.0494	6
AD - 4	-.0001	-.0494	11
AD - 3	-.0003	-.0497	8
AD - 2	.0025	-.0472	10
AD - 1	.0031	-.0441	12
AD	-.0004	-.0446	6
AD + 1	.0019	-.0427	11
AD + 10	-.0032	-.0532	3
AD + 20	-.0020	-.0504	10
AD + 30	-.0007	-.0588	7
AD + 40	-.0024	-.0516	6
AD + 50	.0074	-.0450	8
AD + 60	-.0004	-.0501	6

a. Number of companies with positive residuals.

IV. Summary and Conclusions

The results do not provide strong support for the contention that subsidiary bank consolidation has a large positive impact on the expected future profitability and market value of MBHCs. In fact, negative significant cumulative average abnormal returns are observed for several time periods beginning before and ending just after the announcement date. The data indicate that the bulk of the negative average abnormal returns are clustered in the period beginning roughly 45 trading days before and ending just prior to the announcement date. These results suggest that investors expect that the costs of consolidation typically outweigh any benefits.

If this interpretation of the results is correct, it is difficult to explain why holding company management pursues such a course of action. It may be that partial rather than total consolidation is optimal for the typical MBHC. The observed preference of MBHCs for partial consolidation lends credence to this view. Alternatively, MBHC management might consolidate to reduce profit variability rather than raise profitability.[17] At any rate, the evidence indicates that the inability to consolidate does not impose significant efficiency costs on MBHCs. The implication is that legislation permitting total consolidation is likely to generate marginal benefits.

However, cumulative average abnormal returns are positive over very short intervals immediately around the consolidation announcement date and approach statistical significance in some cases. In particular, the

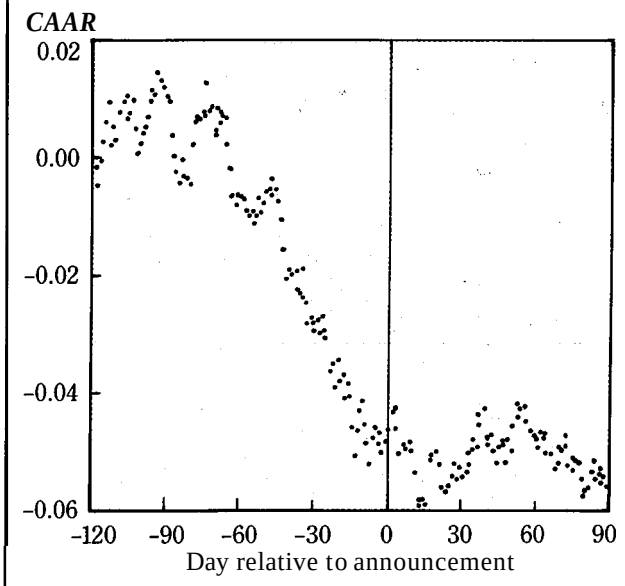
subsample results suggest that consolidation is expected to yield greater benefits for smaller MBHCs, which makes sense intuitively. Positive cumulative average returns following negative cumulative returns also suggest that consolidation might be the result rather than the cause of poor performance and does generate positive expected net benefits, albeit of rather modest proportions.

It should be noted that the failure to find a large positive consolidation impact could be due to a number of factors. The sample size is rather small. Further, although great care was taken in correctly identifying announcement dates, it is possible that the intention to consolidate may have been made public by some companies prior to the date used in this study. Other contaminating events, such as earnings or merger announcements, may have influenced the reported results. It is also possible that some part of the holding company stock price reaction may have occurred when it became apparent that state laws would be changed to permit consolidation, rather than when the company announced this action.

16. It should be noted that total consolidation is not the only way to limit subsidiary risk-taking. Selective corporate control over certain key subsidiary decisions and access to timely subsidiary performance data would also allow the parent company to monitor and limit the risk-taking of subsidiaries, while retaining the MBHC form.

17. Most of the CAAR measures calculated over short intervals around the announcement date are significant at the 10 percent level, if a one-tail test is used.

Fig. 1 Cumulative Average Abnormal Returns



Company returns might also be influenced by other provisions of the enacted legislation that affected competitive conditions throughout the state. More research on this issue is necessary before the findings presented here can be accepted as definitive.

Appendix

The procedure used to calculate the estimated standard errors of the CAAR measures and the resultant t-statistics is the same as that used in Ruback (1982) and several other event studies. The formula used to compute the t-statistics is given in equation (A1) below:

(A1) $t = CAAR_{t2,t1} / \text{se}(CAAR_{t2,t1})$

where

$CAAR_{t2,t1}$ = the cumulative average abnormal return over the t2 - t1 trading day interval of event time, and

$\text{se}(CAAR_{t2,t1})$ = estimated standard error.

The formula used to calculate this standard error is given in equation (A2) below:

(A2) $\text{se}(CAAR_{t2,t1}) = [Q \cdot \text{var}(\text{AAR}) + 2(Q-1) \cdot \text{cov}(\text{AAR})]^{1/2}$,

where

$Q = t2 - t1 + 1$,

$\text{var}(AAR)$ = the variance of the AAR_t series calculated using the following 60 trading days: AD - 120 to AD - 91 and AD + 61 to AD + 90,

$\text{cov}(AAR)$ = the covariance of the AAR_t series calculated over the same 60 day interval.

This formulation adjusts the estimated standard error for observed autocorrelation in the

AAR_t series, possibly introduced by the clustering of events in calendar time.

Table 4 Cumulative Average Abnormal Returns: All Companies (J = 21)

Time period	*CAAR*	t-statistic
AD - 90 to AD + 1	-.0551	-2.27[a]
AD - 45 to AD + 1	-.0373	-2.14[a]
AD - 45 to AD - 8	-.0466	-2.99[a]
AD - 45 to AD - 3	-.0443	-2.67[a]
AD - 7 to AD + 1	.0093	1.25
AD - 2 to AD + 1	.0070	1.43
AD - 2 to AD - 1	.0039	1.18
AD + 2 to AD + 60	-.0066	-0.34

Table 5 Cumulative Average Abnormal Returns: All Companies Except Citicorp (J = 20)

Time period	*CAAR*	t-statistic
AD - 90 to AD + 1	-.0452	-1.98[a]
AD - 45 to AD + 1	-.0304	-1.88[a]
AD - 45 to AD - 8	-.0416	-2.84[a]
AD - 45 to AD - 3	-.0379	-2.43[a]
AD - 7 to AD + 1	.0113	1.57
AD - 2 to AD + 1	.0076	1.59
AD - 2 to AD - 1	.0039	1.95[a]
AD + 2 to AD + 60	-.0063	-0.34

Table 6 Cumulative Average Abnormal Returns: All Companies Except Three Large, Money-Center Banks (J = 18)

Time period	*CAAR*	t-statistic
AD - 90 to AD + 1	-.0427	-1.94[a]
AD - 45 to AD + 1	-.0302	-1.93[a]
AD - 45 to AD - 8	-.0346	-2.48[a]
AD - 45 to AD - 3	-.0347	-2.33[a]
AD - 7 to AD + 1	.0063	0.91
AD - 2 to AD + 1	.0070	1.52
AD - 2 to AD - 1	.0056	1.72[a]
AD + 2 to AD + 60	-.0073	-0.42

a. Significant at 10 percent level, two-tail test.

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The National Debt: A Secular Perspective

by John B. Carlson
and E. J. Stevens

Recently, interest payments on the national debt have been growing faster than the economy (figure 1). Since 1977, there has been an 11.5 percent average annual increase in interest payments. If this difference between growth rates were to continue unchanged until the year 2013, the federal government would be forced to borrow or tax the equivalent of the entire gross national product simply to service its existing debt.

This alarming possibility may not seem likely, because Congress and the administration are seeking deficit reductions that would slow future growth of the national debt and debt service. Unfortunately, even a large deficit reduction might not be sufficient to prevent continued cancerous growth of interest payments if the interest rate cost of existing debt were to continuously exceed the growth rate of the economy. However, independent projections by both the Office of Management and Budget and the Congressional Budget Office have suggested that net interest payments are not likely to grow faster than the economy for very long!

Even putting aside the alarming possibility of an economic disaster 30 years from now, the fact still remains that the national debt and debt service costs have been growing very rapidly. In all but one of the past 10 years, the federal government has had to borrow not only the entire amount needed to pay the interest on the national debt, but also additional funds for non-interest expenditures. Moreover, this situation would continue for as far as the eye can see under all but the most sanguine projections discussed in this article.

This is not the first time that federal deficits have been large or that debt service needs have loomed large in federal budgets. This ***Economic Review*** offers two perspectives on the current federal debt situation. One is a historical view of the past 40 years, during which federal debt initially declined slightly from its wartime peak, and then began to accelerate. The other perspective is of the future, including several scenarios of what the next 40 years

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1. For a more detailed account of the short-term implications of these projections, see John B. Carlson (1985).

2. Theframework can in no way determine consistency among assumptions; this depends on the model of the economy used.

3. In practice, year-to-year changes in the federal debt do not precisely equal the corresponding annual federal budget deficits. The inequality results because Congress borrows to finance net spending on certain off-budget programs, and because the Treasury finances a small portion of the deficit through changes in various assets such as its cash balances. Here we use the term deficit to refer to both on-budget and off-budget items; we ignore the small changes in Treasury assets.

4. Although i, b, and m are treated as parameters here, they all vary substantially with time. Using average values only allows an approximation of a time path.

could be like. The framework for looking at both the past and the future is provided by investigating the relative values of economic growth, interest rates, tax rates, and seigniorage. The analysis shows that the factors favorable to a net reduction in debt relative to GNP during the past 40 years are not likely to recur in the next 40 years. Substantial expenditure and/or tax changes are the only certain methods for preventing unprecedented peacetime levels of the national debt in the future.

I. Debt Dynamics

The behavior of debt over time is complex; it involves the interaction of deficits, interest rates, and economic activity. Nevertheless, the government budget constraint provides a straightforward accounting basis for examining dynamic consequences of alternative assumptions as well as their consistency with certain expected long-run characteristics of the economy.[2] The logic of accounting requires that the change in total outstanding govern-

A Primer on Government Debt

References to "the public debt" mask many details that, upon closer inspection, are qualitatively important but quantitatively small. The lion's share of $1.577 trillion dollars of the federal debt outstanding at the close of fiscal year 1984 has been issued by the Treasury to finance budget deficits and, with the exception of savings bonds, is in marketable form held by the general public. The debt would be 21 percent greater if one were to include $331 billion of outstanding interest-bearing securities issued by non-government institutions (privately owned, not federally guaranteed, but with a special relationship to the government, for example, federal intermediate credit banks). Seventy-three percent of public and agency debt outstanding in 1984 was held by the public, U.S. government accounts held another 17 percent ($264 billion), and the Federal Reserve held the remaining 10 percent. Of the $1.577 trillion of federal debt, only about 11 percent was held by foreigners, and 80 percent of that was in the portfolios of foreign central banks and other official institutions. The inference that can be drawn from these calculations is that about 62 percent, or $1.0 trillion, of federal debt is directly held by domestic private owners, over 90 percent of which is in the form of marketable interest-bearing instruments and 10 percent in nonmarketable U.S. savings bonds.

Granted, a sizable federal debt exists, and most of it is willingly bought in the market and held by domestic private owners. What difference does it make whether the debt becomes larger or smaller, either absolutely or relative to the income and wealth of U.S. citizens? Three different approaches to thinking about this question can be identified, emphasizing the role of federal debt in cyclical stabilization of the economy, in meeting the portfolio needs of wealth owners, and as an alternative to taxation.

Federal debt can be a cyclical necessity. Even if the Treasury had no debt outstanding on average over a long sweep of years, debt might be issued in lean years, then retired in fat years to serve a useful public purpose. Cyclical variations in national income and output, originating from sources outside the federal budget, give rise to corresponding variation in tax receipts and inversely corresponding variations in expenditure, and thereby to federal deficits and debt outstanding. The result is a federal budget that acts as an automatic stabilizer as compared with one in which receipts were required to balance expenditures at all times. If the federal government is to act as an automatic stabilizer, then some government debt may be a cyclical necessity.[a]

Federal debt supplies a perfectly safe interest-bearing asset for private wealth owners' portfolios.[b] An increase in outstanding federal debt will make a difference to the functioning of the economy, because portfolio managers must be induced to substitute less risky federal debt for more risky private assets that directly or indirectly finance real capital. In this way, rapid growth of government debt would retard investment in new productivity-enhancing capital, thus slowing the growth rate of real income per capita.

Finally, there is the view that "we owe it to ourselves." Government can finance its operations either through taxes or through debts. The argument is that, given a level of government expenditures, the economy is essentially unaffected by the choice between these two methods of finance, because issuing debt rather than taxing to finance government expenditures implies that citizens would expect to pay future taxes necessary to service the new debt. Recognizing those increased future tax obligations, citizens would be expected to increase their saving as taxes are reduced.

a. The same function could be served by the Treasury accumulating holdings of private assets in fat years and reducing them in lean years.
b. "Perfectly safe:' of course, within a non-revolutionary environment.

ment debt, D, equal the budget deficit, which is the difference between federal government expenditures, E, and total government revenues, R.[3] This is expressed as:

$$D_t - D_{t-1} = E_t - R_t.$$

Public discussion about growth of the national debt typically focuses on the budget deficit. To better appreciate the dynamic elements of deficits and debt, it is useful to break the budget deficit into two components. One is the primary deficit (or surplus), defined as the difference between non-interest outlays and total revenues. The other component is interest outlays net of recoupments from federal taxes and the Federal Reserve. Combining these two components, we have:

$$D_t - D_{t-1} = X_t + i(1-m)(1-b)D_{t-1},$$

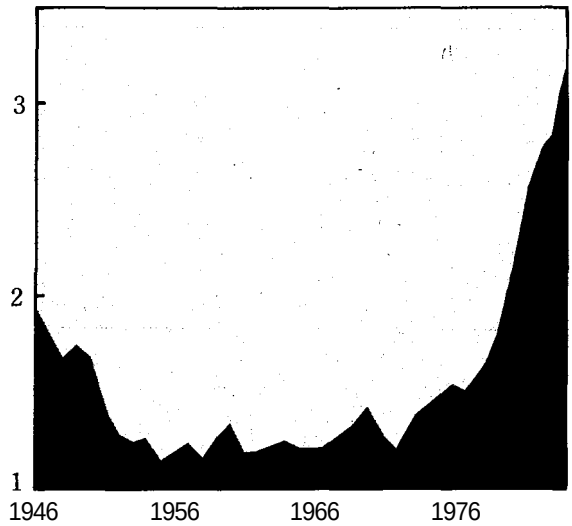
where X is the primary deficit, i is the average interest rate on Treasury debt, m is the average marginal tax rate, and b is the proportion of debt held by the Federal Reserve?

This dichotomy between the primary deficit and interest payments is useful because it highlights the importance of interest payments in determining debt momentum, that is, the tendency of the debt to grow on its own. Debt momentum is to a large extent predetermined by the level of current debt and by the market rates of interest at the various times that existing debt issues were sold. Federal revenues recouped from interest payments on the debt reduce the effective interest cost and thereby retard debt's momentum. These revenues include taxes on private holders' interest income from federal debt and the portion of interest income on Federal Reserve holdings of Treasury debt (seigniorage) that is returned to the U.S. Treasury? While tax rates and System holdings of Treasury debt can be altered to influence debt momentum, practical constraints limit the extent to which policymakers can change them. For example, non-inflationary monetary policy clearly implies some upper limit on Federal Reserve accumulation of Treasury debt. Tax rates may be easier to change, but any politically acceptable policy probably could not greatly alter the ***average*** marginal tax rate. Nevertheless, over long periods, these factors can change.

The primary deficit (or surplus), of course, also plays a role in debt dynamics by reinforcing or offsetting debt momentum. The size of the primary deficit is directly altered by changes in the budget, such as the policy initiatives embodied in the recent Congressional Budget Resolution for 1986. The primary deficit also includes the cyclical elements of the budget deficit that arise from the effects of the business cycle on revenues and income maintenance programs. Thus, the primary deficit tends to reinforce debt momentum during economic slowdowns and to offset momentum during economic recoveries.[6]

The magnitude of debt momentum by itself is not very instructive. What is relevant is its size relative to growth of the economy. Economic growth eases the burden of servicing

Fig. 1 Interest Payments
Percent of GNP



SOURCE: Congressional Budget Office.

5. Actually, $i(1-b)D_{t-1}$ isgreater than the recoupment from the Federal Reserve. The difference was about 11 percent in 1984, representing the portion of Federal Reserve income used to finance the operations of the Federal Reserve System.

6. We ignore minor secular elements affectingthe primary deficit that arise as a result of economic growth. These include the tendency for taxes to rise relative to income as higher individual (real) incomes are taxed at proportionally higher rates and governmental economies of scale.

debt. Additional national income and output can add to revenues and can reduce spending on social programs. The combination—sometimes called a fiscal dividend—can be used to make interest payments and, if sufficiently large, to pay down outstanding debt. In this sense, the burden of debt in the economy diminishes if its growth lags the growth of nominal national income. Thus, analyses concerned with economic implications of debt dynamics typically concentrate on the ratio of debt to income, measured by GNP.

Much attention has been given to the potential for runaway debt, that is, the possibility that the debt-to-GNP ratio will grow without limit. Sufficient conditions for runaway debt are that: 1) there be a primary deficit, and 2) the interest rate on Treasury debt net of taxes and adjusted for Federal Reserve holdings be greater than the trend growth rate of nominal GNP.[7] Realistically, this situation could not persist, because it would ultimately require that more than all of the income generated in the economy be used to purchase annual additions to the federal debt. The structure of runaway debt conditions therefore suggests that the budget and/or economic assumptions are untenable—that somehow something must "give."

Even if the trend growth rate of nominal GNP were greater than the net interest rate, debt could still grow for a time relative to GNP. This situation arises when the primary deficit adds to the debt faster than the excess of the

7. See Carlson (1985), Sargent and Wallace (1981), Tobin (1982), and Congress of the United States, Congressional Budget Office (February 1985).

Box 1 Federal Debt Dynamics

The steady-state properties of federal debt are derived from the government budget constraint, which requires that the change in total outstanding Treasury debt (including Federal Reserve holdings) be equal to the budget deficit. This is expressed as:

$$D_t - D_{t-1} = E_t - R_t,$$

where D is outstanding interest-bearing Treasury debt, E is government expenditures, and R is government revenues.[a] For simplicity, we abstract from government transfers and assume that the average marginal tax rate, m, is the same for all types of income and constant over time.

Expenditures can be divided into non-interest outlays, E' and interest payments net of taxes and adjusted for seigniorage:

$$i^a = i(1 - m)(1 - b)D_{t-1},$$

where i is the nominal interest rate on Treasury securities, and b is the proportion of Treasury debt held by the Federal Reserve. This allows separation of the budget deficit into two components—the primary deficit:

$$X_t = (E'_t - R_t),$$

and interest payments adjusted for taxes and seigniorage) Thus we have:

$$D_t - D_{t-1} = X_t + i^a D_{t-1}.$$

At time t, then, the level of federal debt equals:

$$D_t = xY_t + (1 + i^a)D_{t-1},$$

where $x = X/Y$ and is assumed fixed by fiscal policy.

Assuming nominal GNP grows at trend rate g, the time path of debt-to-GNP (d) is given by:

$$d_t = x + [(1 + i^a)/(1 + g)d_{t-1}],$$

since

$$D_{t-1} = d_{t-1}[y_t/(1 + g)].$$

When the debt-to-GNP ratio is stable:

$$d_t = d_{t-1} = d^*.$$

Hence:

$$d^*[1 - (1 + i^a)/(1 + g)] = x,$$

also when i and g are small

$$(1 + i^a)/(1 + g) \simeq 1 + i^a - g,$$

and

$$d^* = x/(g - i^a).$$

The level of d_t changes when $d_0 \neq d^*$. At any subsequent time t:

$$d_t = d^* + (d_0 - d^*)(1 + i^a - g)^t.$$

It can be seen from this last equation, that if $i^a > g$, the debt-to-output ratio grows without bound. Also, it is interesting to note debt grows relative to income when:

$$d^* > d_0 \text{ and } i^a < g.$$

a. For alternative derivations of these properties, see Congress of the United States, Congressional Budget Office (February 1985), Tobin (1982), and Wallich and Cohen (1985).
b. Because interest payments are net of tax recoupments and seigniorage, government revenues here are exclusively tax receipts on nominal income.

economic growth rate over the net interest rate subtracts. Nonetheless, this situation would not continue forever, because the algebraic value of the debt-to-GNP ratio would eventually reach a steady-state level, even if a primary deficit were allowed to persist at something like its current size. That steady-state level can be shown to be approximated by the ratio of the primary deficit (relative to GNP) to the economic growth rate/net interest-rate differential (see box 1). There is no a *priori* basis, however, for thinking that the portfolio of the private sector could accommodate every possible algebraic value of the steady-state debt-to-income ratio and still be consistent with general equilibrium in the economy. Of course, if the primary deficit were reduced sufficiently, then the debt-to-GNP ratio would fall, until a low algebraic value of the steady-state ratio were reached — again, if that were consistent with general equilibrium.

8. The measure of primary debt was calculated assuming an average marginal tax rate of 12 percent.

9. Although Congress did attempt to maintain the real value of social security benefits over longperiods, such adjustments, made through changes in the benefit formula, occurred infrequently and with a lag. For example, the benefit formula was changed only once between 1958 and 1971.

II. Debt Dynamics: 1946 to Present

During World War II, enormous primary deficits caused a five-fold increase in the level of federal debt (see box 2). Immediately after the war, the large primary deficits ceased, and the level of debt began an extended decline relative to GNP. Not until 1974 did the combined influence of primary deficits and interest rates begin to generate another sustained increase in the federal debt relative to GNP!

Figure 2 shows the absolute amount of the federal debt held in the private sector (excluding the Federal Reserve) and that same amount relative to GNP, both indexed to their 1946 levels. Although the dollar value of debt trended upward slightly until 1974, the debt-to-GNP ratio fell over the same period. This decline — from a little more than one year's output to less than one quarter's output — persisted through the Kennedy tax cut and even through the Vietnam military buildup. Reversal of the decline in the mid-1970s was initially a consequence of enlarged primary deficits resulting from the severe 1973–1975 recession, augmented by a one-time tax rebate in 1975. By the peak of the business cycle in 1979, however, at least the primary deficit had been eliminated (see figure 3).

An important characteristic of debt dynamics during the 28-year period of declining debt ratios, was the frequent occurrence of primary surpluses that actually produced a small cumulative net primary surplus from 1946 through 1974.8 While many factors could account for surpluses, an important factor was the budget's response to inflation. From 1946 to 1974, the GNP deflator rose at an average annual rate of 5.5 percent, but until 1972, few federal spending programs were indexed. Benefits from large entitlement programs, such as Social Security, did not increase automatically with inflation? On the other

Box 2 Debt Buildup in World War II

Large deficits in the United States typically have been limited to wartime. The deficits during World War II offer the most extreme example: they averaged 25 percent of GNP! The conditions for financing those deficits were unique to wartime. Economic resources were shifted from producing consumer goods to military uses. To implement this reallocation, the federal government instituted controls, including price controls and food and gasoline rationing. Individuals accepted these controls as requirements of patriotism, if not for their own long-term interest. Although credit controls were imposed to reduce demand for housing, automobiles, and appliances, these items simply were not available, because steel, wood, and labor were diverted to the war effort.

Individuals not in military service during the war typically worked a substantial amount of overtime. While their incomes were high, there was little to spend it on. Savings rates averaged 25 percent from 1942 to 1945, compared with a peacetime average of 6 percent. Thus, while the federal debt increased five-fold during the war, the government found many willing to purchase debt at very low rates of interest. To help keep rates low, the Federal Reserve was prepared to buy government securities not purchased by individuals. But the proportion of debt monetized by the Federal Reserve did not increase sharply, because private demand was sufficient. To promote private purchases of U.S. savings bonds, the government mounted an extensive advertising campaign that appealed to the people's patriotism.

hand, tax rates were not indexed until 1985. Revenues tended to grow proportionately more than income, as inflation placed more and more taxpayers in higher tax brackets. Thus, even a relatively low inflation rate was doubly favorable for restraining the primary deficit, because, without explicit federal action, it tended to increase revenues faster than non-interest expenditures.

Fig. 2 Federal Debt Held by Public

Percent of 1946 level

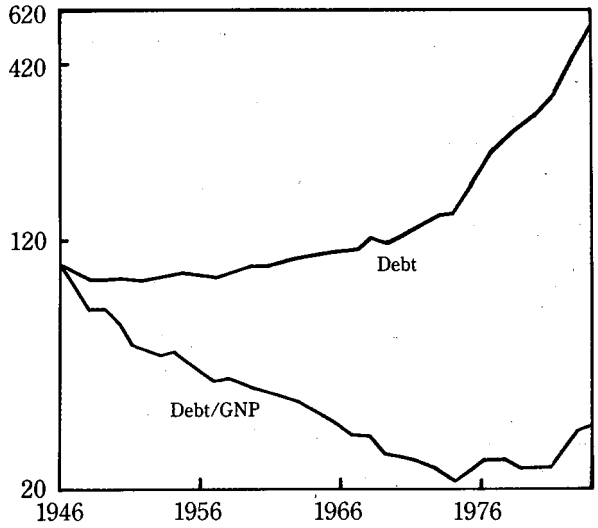
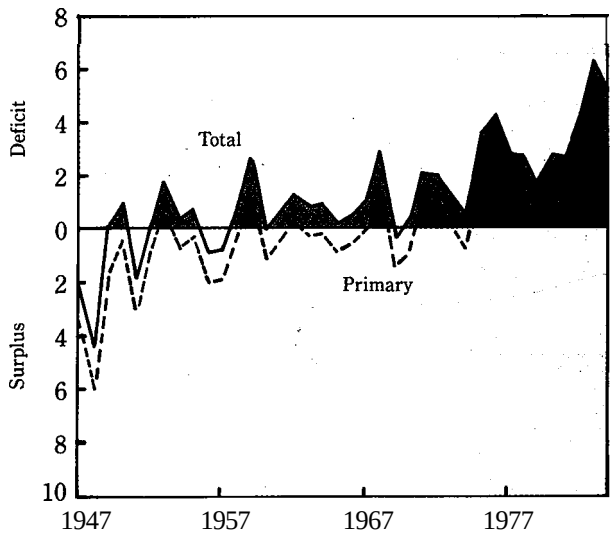


Fig. 3 Primary and Total Deficit[a]

Percent of GNP



a. Primary deficit assumes a marginal tax rate of 12 percent.

Since 1974, the budget has produced a cumulative primary deficit of about $430 billion. This turnaround owes largely to the Economic Recovery Tax Act (ERTA) of 1981, a tax initiative that sharply reduced the rate of growth of tax revenues. Large tax cuts were instituted with the expectation that there would be subsequent spending reductions in nonmilitary programs as well as additional revenues generated by more rapid economic growth. Subsequent output growth was relatively strong and generated proportionately more revenues, but the impact of ERTA fell short of supply-sider claims that it would produce sufficient revenue growth to eliminate the deficit. Moreover, Congress did not accept all the spending cuts initially sought by the administration. Because an important feature of ERTA was to index tax rates for inflation, the imbalance is likely to persist if substantial deficit cuts are not achieved.

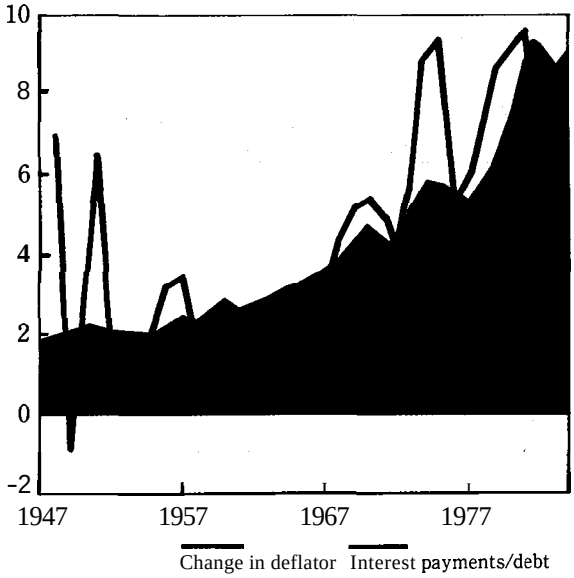
Another aspect of postwar debt dynamics was the apparent failure of interest rates to rise rapidly enough to anticipate the persistent, accelerating inflation beginning in the late 1960s. Relative price stability of the 1950s and early 1960s set a favorable tone for credit markets before the onset of more rapid inflation. Most federal debt had been auctioned at rates under 5 percent prior to 1966. When inflation began to accelerate in the late 1960s, it was apparently unanticipated. With a sizable portion of debt "locked in" at lower rates, the interest-rate cost of servicing debt adjusted only slowly to the higher rates of inflation (see figure 4).

This inertial resistance essentially could account for the continued decline of the debt-to-GNP ratio after the mid-1960s. Figure 5 shows

a rough estimate of what might have happened to the debt if inflation had been fully anticipated after 1965. It presumes that the average real interest rate would have equaled its average *ex post* rate during the low inflation period of 1954–1963, and then adds actual inflation rates for periods equal to the average maturity of the debt. Multiplying interest payments on the debt by the ratio of the adjusted interest rate to the actual rate provides an approximation of debt payments and the debt-to-GNP ratio, if inflation had been fully anticipated. On this basis, debt would have stabilized relative to GNP near its mid-1960s level, rather than declining further into the mid-1970s.

Fig. 4 Average Interest Rate on Debt and Inflation[a]

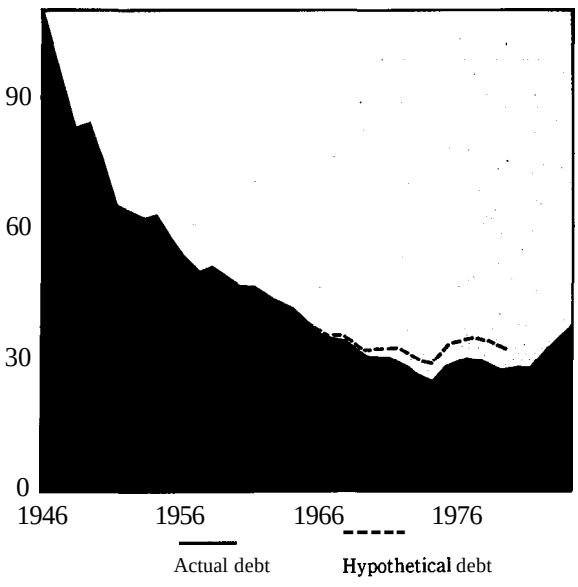
Percent



a Debt is adjusted for Federal Reserve holdings
SOURCE Congressional Budget Office

Fig. 5 Actual and Hypothetical Debt

Percent of GNP



SOURCE Congressional Budget Office

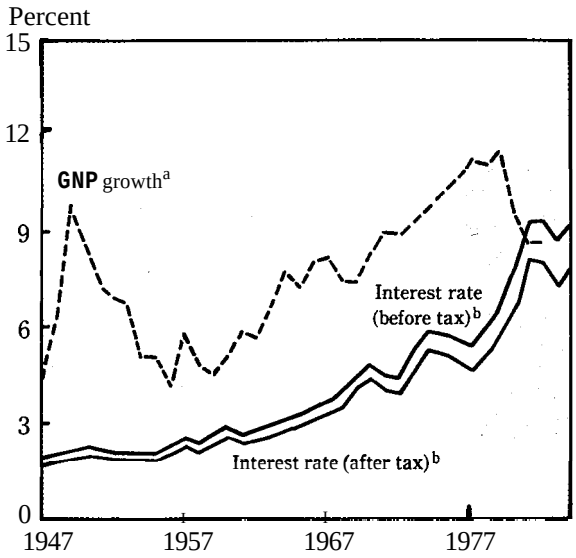
Taxes are another reason that, until recently, interest-rate costs of government debt were low relative to growth in nominal GNP (see figure 6). Estimates of the average marginal tax rate typically fall in the range of 12 percent to 25 percent. Even assuming the average marginal tax rate was only 12 percent, the annual interest-rate cost of the debt adjusted for taxes heretofore has never exceeded the five-year average growth rate of GNP.[10] The momentum of debt growth was never augmented by interest-rate costs in excess of the longer-term nominal growth rate of the economy.

When debt was declining relative to nominal GNP, seigniorage also played an increasingly important role in slowing the momentum of debt. The monetary policy that accompanied economicgrowth with low inflation in the 1950s and early 1960s produced, as a byproduct, an increase in Federal Reserve holdings of Treasury securities almost proportional to the increase in nominal GNP.[11] With debt declining relative to GNP, and Federal Reserve holdings rising proportionately with GNP, private sector holdings of the debt necessarily declined relative to GNP (see figure 7). In fact, Federal Reserve holdings increased to almost 19 percent of all outstanding federal debt in the postwar period. This meant that by the early 1970s, seigniorage was paying roughly one-fifth of the interest cost of all debt held outside the federal government itself.

The turnaround and rapid growth of debt since 1974 has not been matched by momentum-dampening seigniorage. Disinflationary monetary policy since 1979 has constrained money growth and the seigniorage it produces. As debt has grown abruptly relative to GNP, the share held by the Federal Reserve has dropped sharply. Moreover, the Monetary Control Act of 1980 reduced overall required reserves on deposits. This, in turn, reduced the demand for monetary base (and hence, Federal Reserve holdings of debt) for a given level of nominal GNP. Thus, the effects of seigniorage, so important to debt dynamics before the 1980s, have withered.

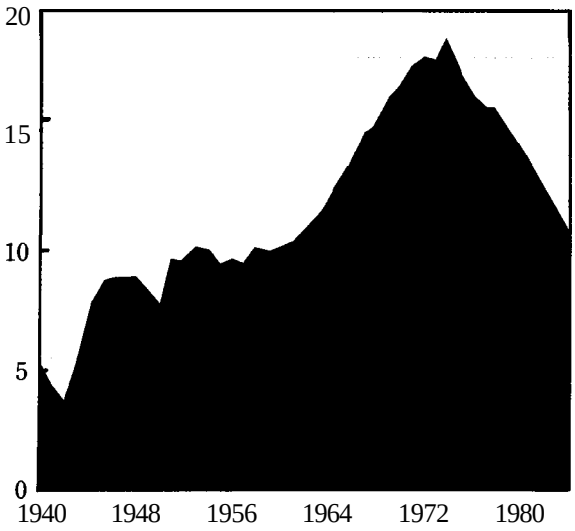
This historical perspective emphasizes some unique conditions that influenced debt dynamics in the postwar period. Of particular importance were frequent primary surpluses, low interest rates, and (relatively) high returns from seigniorage. Recreating the social and political forces leading to those same conditions is not possible. History, therefore, offers a poor basis for anticipating the future federal debt situation. But history does provide a kind of benchmark. If future debt-to-GNP levels are within the range of past experience, at least we know that these levels once proved manageable.

Fig. 6 Interest Rates and GNP Growth



a. Five year average growth rate.
b. Interest payments/federal debt.
SOURCE: Congressional Budget Office.

Fig. 7 Federal Reserve Holdings



SOURCE: Congressional Budget Office.

III. The Next 40 Years

Long-term projections of the national debt, using the framework of primary deficits and net interest payments, rest on assumptions about the trend growth rate of nominal GNP, on the size of the primary deficit relative to GNP, on the level of interest rates, and on marginal tax rates and seigniorage. To be meaningful, a set of these assumptions must be mutually consistent with attainable future states of the economy. Lacking a generally accepted quantitative, long-run, macroeconomic model by which to generate a unique plausible set of those assumptions, we consider several different sets of assumptions to produce various debt scenarios. These scenarios should not be viewed as forecasts, but simply as

10. For the methods used in estimating average marginal tax rates, see Seater (1985) and Barro and Sahasakul (1983).

11. It is true that the monetary base grew less rapidly than GNP. However, Federal Reserve holdings of Treasury debt tended to increase more rapidly than the monetary base until the 1980s, after which there seems to be no clear trend.

potential levels of the debt-to-GNP ratio that can be compared to levels experienced over the past 40 years. Levels that fall outside the range of past experience are, *ipso* facto, alarming. Moreover, the projections can be examined in the context of widely accepted beliefs, or "stylized facts:' about other long-run economic relationships that are thought to characterize the U.S. economy.

Table 1 contains an array of points along various steady-state paths of the debt-to-GNP ratio. Alternative values of the ratio for a common time horizon correspond to alternative assumptions about (1) the size of future primary deficits and (2) the differential between the rate of economic growth and the net rate of interest on Treasury debt. The steady-state values, based on the formula in box 1, extend in time to horizons of five, 10, and 40 years. A final array, based on an infinite horizon, approximates eventual steady-state values toward which the debt-to-GNP ratio tends in the very long run.

Two characteristics of these arrays are notable. First, the longer-run values of the debt-to-GNP ratio are clearly sensitive to what appear to be small differences in the values chosen for the assumptions. Second, however, the time paths of the alternative steady states are somewhat slow to distinguish themselves from one another. After five years, the debt-to-GNP ratio appears relatively unaffected by the indicated range of differences in the growth/net interest assumption; after 40 years

Table 1 Debt-Output Ratio: Sensitivity to Changes in the Primary Deficit and Growth-Interest Differential

After 5 Years

$g - i^a$ \ x	0.5	1.0	1.5	2.0	2.5
1.5	.36	.38	.41	.43	.46
1.0	.37	.39	.42	.44	.46
0.5	.38	.40	.42	.45	.47
0.1	.38	.41	.43	.46	.48

After 10 Years

$g - i^a$ \ x	0.5	1.0	1.5	2.0	2.5
1.5	.36	.40	.45	.50	.55
1.0	.37	.42	.47	.52	.56
0.5	.39	.44	.48	.54	.59
0.1	.41	.46	.51	.56	.61

After 40 Years

$g - i^a$ \ x	0.5	1.0	1.5	2.0	2.5
1.5	.35	.50	.65	.80	.95
1.0	.41	.57	.74	.90	1.07
0.5	.47	.66	.84	1.02	1.20
0.1	.54	.74	.93	1.13	1.33

Long-Run Steady State

$g - i^a$ \ x	0.5	1.0	1.5	2.0	2.5
1.5	.3	.7	1.0	1.3	1.7
1.0	.5	1.0	1.5	2.0	2.5
0.5	1.0	2.0	3.0	4.0	5.0
0.1	5.0	10.0	15.0	20.0	25.0

Legend:
x: Primary deficit relative to nominal GNP (percent).
$g - i^a$: Growth-interest differential (percent).

the effect is quite significant (measured as a percent of either the low or high value), although nowhere near as substantial as in the ultimate steady state. The same pattern is evident when the effect of differences in assumed values of the primary deficit is traced. In this case, however, even the difference between the indicated high and low values at the end of five years is quite noticeable—equivalent to 10 percent of GNF!

Three paths of the debt-to-GNP ratio appear in figure 8, corresponding to three particular sets of assumptions. The first, scenario A, is *not* drawn from sets of values in table 1, but is based on our extrapolation of Congressional Budget Office (CBO) estimates that assume the July 1985 budget resolution is achieved.[12] The CBO analysis only contained projections through 1990 and was based on two important additional assumptions: that the economy would achieve an average real growth rate of 3.4 percent and that market interest rates would decline, in part because of continuing low inflation. The projections indicate that the *primary* deficit would be eliminated by 1988, and, in the absence of any rebound in the primary deficit and of any deviation from the economic assumptions, our extrapolation shows continuing decreases in debt and interest payments as a percent of GNP over the next 40 years—a refreshing outcome indeed.

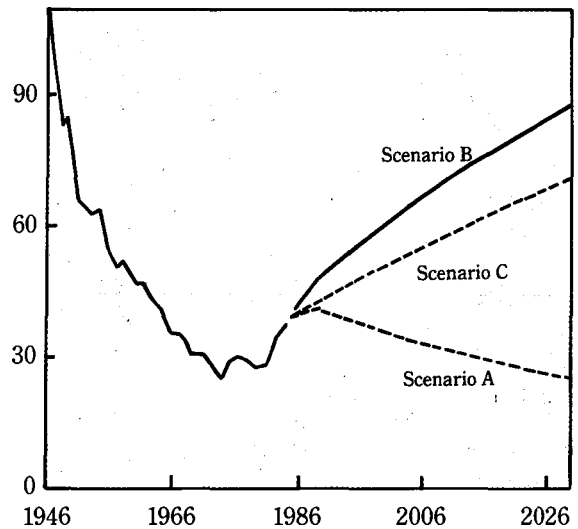
Scenario B, also examined by the CBO, assumes that *none* of the budget savings included in the July 1985 budget resolution is achieved. Again, the CBO projections only extended through 1990. Without budget cuts, the CBO projects that the primary deficit would decline from the 1984 level of 3 percent to about 1.5 percent in 1990, as the economy would approach its assumed full-employment growth trend. In extrapolating, we have taken 2 percent as the value in the long run, representing an average of lower and higher values that might be achieved during future business cycles.[13] The other CBO assumption was that while the level of market interest rates would be slightly higher than the growth rate of nominal GNP (as has been the case for the past year), rates would nonetheless fall short of the growth rate of nominal GNP by 1.5 percent, after adjusting for the marginal tax rate on interest income and seigniorage. If the primary deficit and the growth/net interest-rate relationship were to stabilize at these average levels, our extrapolations show that the federal debt would continue to increase relative to GNP until it eventually stabilized at about one and one-third times nominal GNP (shaded values in table 1). This result would advance only gradually, however; at the end of 40 years, the federal debt would be "only" 90 percent of a year's nominal GNF!

Scenarios A and B suggest a range of possible outcomes, extrapolating from medium-term projections that were based on commonly used methodology. Where in this range of outcomes the future might lie depends on the extent to which deficit reductions are achieved and maintained.

Neither of these scenarios is entirely satisfactory. The assumptions are drawn from averages of medium-term projections as proxies for long-run equilibrium values. Moreover, the projections themselves are derived from

Fig. 8 Federal Debt

Percent of GNP



12. It is assumed here that the primary deficit is zero after 1988, so that the nominal level of debt grows at a rate equal to the average interest rate adjusted for taxes and seigniorage. Based on averages over the forecast horizon, nominal income growth and nominal interest rates are assumed to be 2.8 percent and 7.5 percent.

macroeconomic models and economic "rules of thumb" heavily influenced by post-World War II experience. But the unique combination of secular influences of this period—demobilization, rising inflation, and high seigniorage—is not likely to be repeated. Thus, models estimated over this period could be biased and, as argued below, biased toward a high growth-rate/interest-rate differential and a consequent underestimate of future debt growth.

Scenario C is based on assumptions that are consistent with a smaller growth-rate/interest-rate differental. Such a hypothetical case might be described as follows: Accelerating inflation beginning in the mid-1960s apparently was to some extent unanticipated. This suggests that the interest rates of this period, on average, were low relative to their "true" equilibrium values—that is, values consistent with non-inflationary economic growth. This experience is unlikely to be repeated. Inflation awareness has grown with the experience of rising inflation, as well as with the experience of declining inflation. Furthermore, since 1979, the Federal Reserve has maintained a policy of disinflation. A major consequence has been that interest rates have varied more immediately and substantially to impulses arising in the real sector. This, in turn, makes it less likely that future interest rates will be "stuck" below their equilibrium levels.

The case for a smaller growth-rate/interest-rate differential seems even more plausible when one considers the productivity experience of the current expansion. Even with record levels of investment, productivity increases have been below levels for comparable stages of the cycle in the postwar period. If, in fact, trend growth of productivity is increasing around its 1970s rate of less than 1 percent, and if labor force growth were to stabilize at less than 1.5 percent, then trend output growth could be less than 2.5 percent. Moreover, as indicated in figure 6, nominal pretax interest rates recently have exceeded the growth rate of nominal income. In fact, in the third quarter of 1985 nominal income grew at 6.7 percent, while nominal interest rates on Treasury securities averaged over 8.0 percent for a wide variety of maturities. All of this suggests that the equilibrium interest rate need not be less than the nominal growth rate, let alone the CBO assumption, which after tax is 1.5 percentage points lower.

A smaller growth-rate/interest-rate differential would produce a smaller fiscal dividend. Thus, it is likely to be associated with a higher primary deficit relative to output. It therefore seems reasonable that consistent assumptions would involve both a lower growth-rate/interest-rate differential and a higher primary deficit. In the context of table 1, the potential bias of secular elements would result in assumptions toward the southeast for each time horizon.

To illustrate, consider a growth-rate/*net* interest-rate differential of 0.5 percent. While this scenario implies a pre-tax nominal interest rate slightly above the growth rate of nominal GNP, it would still be associated with an after-tax interest rate below the growth rate. This is not as favorable as the CBO assumption and is not as likely to be associated with the vanishing primary deficit of scenario A. Suppose that the primary deficit were reduced to 1.0 percent of GNP, roughly one-third its recent level, and half the 2.0 percent of scenario B. The associated debt path appears as scenario C in figure 8. The debt-to-GNP ratio under this alternative would rewind over the next 40 years back to a level comparable to that during the Korean War. In the longer run, the ratio would tend toward the unprecedented steady-state value of two times GNP, five times its current value.

The relevance of economic assumptions may be demonstrated in another way. How could the eventual debt-to-GNP ratio be maintained at its current 0.4 value if the growth-rate/net interest-rate differential were the 0.5 value assumed in scenario C? The primary deficit would have to be 0.2, or the equivalent of a $7.7 billion primary deficit today, roughly

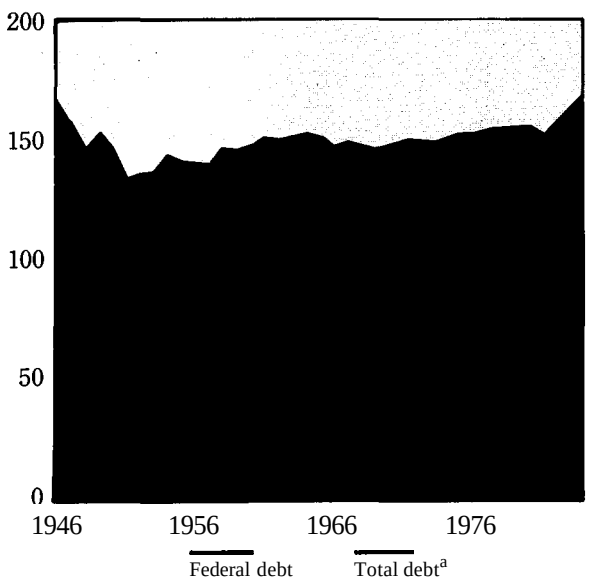
13. This assumption is conceptually equivalent to basing an estimate of the primary deficit on a mid-expansion estimate of the structural deficit. For a discussion of the practical advantages of a mid-expansion measure of the deficit, see de Leeuw and Holloway (1983).

14. This is not literally true. OASDZ surpluses usually are invested in nonmarketable Treasury issues that are included in debt subject to the debt ceiling. The focus here, however, is on debt held outside the federalgovernment and Federal Reserve System.

$110 billion less than its current value.

Useful projections—those with a semblance of future reality—should not be found to depend entirely on the precise values of their underlying assumptions. The three scenarios described here seem useful in that sense. The first, assuming prompt, substantial, and permanent deficit reduction, yields a declining debt-to-GNP ratio, with the speed of the decline depending on the size of the excess of the economic growth rate over the net interest rate. The second, extrapolating current short-run conditions into the long run, and the third, using relatively general long-run economic relationships and a sizable cut in the primary deficit, yield results quite different from the first. In either case, the debt-to-GNP ratio will slowly grow toward and might eventually exceed even the extreme values of the past. The higher the primary deficit and the higher the net interest rate relative to the rate of economic growth, the sooner those values will be realized.

Fig. 9 Federal Share of Total Debt
Percent of GNP



a. Total domestic nonfinancial debt.
SOURCE: Board of Governors of the Federal Reserve System, *Flow of Funds.*

IV. Caveats

Judging the usefulness of these projections also requires recognition that the assumptions might be interdependent. As noted above, less favorable economic assumptions might be associated with a higher primary deficit, reflecting a smaller fiscal dividend. The resulting debt-to-GNP ratio would be even larger than implied by the change in economic assumptions alone. Or, an assumption of greater seigniorage induced by expansionary monetary policy might produce more rapid inflation. The increase in the growth-rate/net interest-rate differential might be offset by a larger primary deficit as nominal federal spending grows relative to indexed tax receipts. The growth-rate/net interest-rate differential also might narrow as rising inflation expectations raise nominal interest rates and, perhaps, lower real economic growth. The resulting debt-to-GNP ratio could be higher than implied by increased seigniorage alone.

Bearing these possibilities in mind, what are the economic consequences of the various scenarios of the future? Are they consistent with widely held beliefs? Failure to follow through with the recent budget resolution both by actually achieving the entire deficit reduction and by extending deficit reduction beyond 1988, could mean that by early in the next century, the federal debt relative to GNP easily could exceed levels reached at the end of World War II. The challenge is to imagine how that result might be accommodated in an economic and social atmosphere less structured than the war-based economy of World War II.

An important budgetary caveat concerns the ominous debt implications of this country's commitment to Social Security, especially if demographic factors become less favorable. Recent 75-year projections published by the Social Security Administration indicate that while the old age and survivor and disability insurance (OASDI) trust funds will continue to generate surpluses into the early part of the next century, the rate of increase of these sur-

pluses relative to GNP will begin to decline in the 1990s. Because OASDI Trust Fund surpluses reduce the borrowing needs of the Treasury, the rapid buildup of these funds over the next 10 years is an important force in keeping the primary deficit from growing relative to GNP.[14] If deficit reduction measures are not sufficient to reduce the primary deficit when OASDI funds generate increasing surpluses, what will happen to primary deficits and the debt when OASDI surpluses begin to decline?

Another budgetary caveat is that tax reform legislation introduces additional uncertainties. One has to do with achieving revenue neutrality. For example, the administration has presented a plan it describes as revenue-neutral, but other analyses suggest that the plan will actually reduce revenues and thereby might widen the deficit. A second uncertainty has to do with potential indirect effects of reform on net interest payments. To the extent that average marginal tax rates were to be reduced, the momentum of debt will accelerate as the after-tax interest rate rises relative to GNP growth.

Finally, a more fundamental economic caveat is that a rising debt-to-output ratio seems inconsistent with the observed constancy of the private domestic savings rate over the postwar period in the United States. This phenomenon, sometimes called Denison's Law, is akin to another empirical regularity, the relatively stable ratio of domestic nonfinancial debt (private and government) to nominal GNP (see figure 9).[15] An oft-cited implication of this proportionality is that a decrease in the growth of federal debt augments the growth of private (nonfederal) debt relative to GNP and might enable more private domestic investment. Thus, the current concern is that federal credit demands could crowd out private credit demands and thereby stifle the private investment that is necessary to a growing economy.

Secular trends in federal and private debt from 1946 through the mid-1970s contrast strikingly with their trends over the next 40 years according to scenarios B and C. The decline in federal debt through 1973 was met with a roughly equal rise in nonfederal debt, particularly in debt of households and businesses. This decline might have helped account for robust postwar growth, particularly in the 1960s.

Projections of a rising secular trend of federal debt imply that something must give. Either the private domestic savings rate must rise, breaking Denison's Law in order to supply the extra funds required to finance higher debt-to-GNP ratios, or the nation must experience rising rates of net foreign investment, thus evading Denison's Law in order to supply the extra funds. A third possibility is that investment in private capital must decline, complying with Denison's Law to offset the government demand for extra funds.

So far in the current economic recovery, Denison's Law has been evaded. Enlarged private and public demands for credit have been met by a record inflow of net foreign capital. This is not a cost-free consequence of a rising debt-to-GNP ratio. Growing foreign indebtedness requires growing payments out of GNP to service foreign debt. Capital investment may maintain economic growth, but the fruits of that growth will be enjoyed by the foreign investors who made it possible. Moreover, substantial adjustment costs must be paid as the capital inflow drives up the foreign exchange value of the dollar and reduces the competitive position of trade-related industries. Thus the international adjustments created by the rising debt-to-GNP ratio carry significant costs, both directly, and (potentially) indirectly through inefficiencies associated with protectionist measures.

V. Conclusion

Prospects for slowing growth of the national debt improved somewhat in August 1985, when Congress passed a budget resolution for fiscal year 1986. Although subsequent analysis suggests that budget savings would be less than purported, the impact on the national debt

15. For a detailed discussion of this phenomenon, see David and Scadding (1974). See also Friedman (1981) and Wallich and Cohen (1985), who argue further that the constant ratio of debt to output weighs against the Ricardian Hypothesis on the irrelevance of debt.

still would be significant if the resolution's budget targets were achieved. But budget resolutions are only resolutions and are frequently foresaken, particularly during periods of economic stress. The more recent congressional effort to mandate a sequence of deficit reductions leading to a balanced budget early in the next decade may be viewed as building annual legislative roadblocks in the path of the growing national debt. Whether such roadblocks could be effective can only be known when future federal budgets are known.

Uncertainty about actual federal budgets for 1986 and beyond is not the only issue troubling analysts. The reliability of deficit projections based on macroeconomic models and on rules of thumb is always tenuous. Here we have provided a secular perspective that demonstrates that .future economic conditions are likely to be less favorable for constraining the debt-to-GNP ratio than they were for most of the postwar period. Whether this change is embodied in the models on which deficit and debt projections are based, is not clear.

Cutting the primary deficit remains the most certain method of preventing continuing increases in the debt-to-GNP ratio. The challenge is to look beyond annual increases to the steady advance of unprecedented peacetime levels of federal debt—and then to take the budgetary initiatives required to reverse the process.

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The Ohio Economy: A Time Series Analysis

by James G. Hoehn
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What do regional economic statistics, such as those for Ohio, convey about the present and future state of the regional economy? What do they say about the sources of regional fluctuations? To what extent do they reflect national conditions versus regional factors? Which regional and national series are most useful to watch? What degree of accuracy can a regional forecaster hope for?

These questions are addressed by regional economic models of both the time series and structural variety. The latter, in a setting in which the nature of economic relationships is already reasonably well known and data sets are adequate, may best embody answers to these and related questions. But given the incomplete theory and data actually available, time series methods can be very helpful in interpreting and forecasting regional economic statistics. Here we summarize both some suggested time series methods and the answers they provided to the above questions for the Ohio economy. (The working paper by Hoehn and Balazsy [1985] provides greater detail on some of these methods and answers.)

The analysis here can augment or precede efforts to make more elaborate structural interpretations. The analysis also uncovers and measures important phenomena—for example, the decline in Ohio's growth after 1977 that cannot be attributed to overall national conditions—that would probably not be as transparent in a structural model and might be distorted by its assumptions. Time series methods provide measures of relationships and events without elaborate interpretations imposed on them; that is at once their advantage and their drawback, vis-à-vis structural models.

An important impediment facing the regional economist is the lack of reliable and timely measures of aggregate activity. Direct comprehensive measures of output are unavailable. In practice, regional economists have come to place greatest emphasis on the establishment-survey, or payroll, employment series. They are available on a timely basis, disaggregated by major industrial categories. The survey

directly covers a substantial minority of employment. The sample is relatively fixed from one month's survey to the next, so that movements do not significantly reflect changes in the sample. This is both a virtue and a vice: the sample fixity prevents movements from reflecting changes in the sample, as can occur in the household-survey employment series, but shifts of employment away from the mostly large-firm employment that dominates the survey can bias measured growth. The payroll series is revised early each year to largely eliminate accumulation of such bias, but it can still build up within the year.

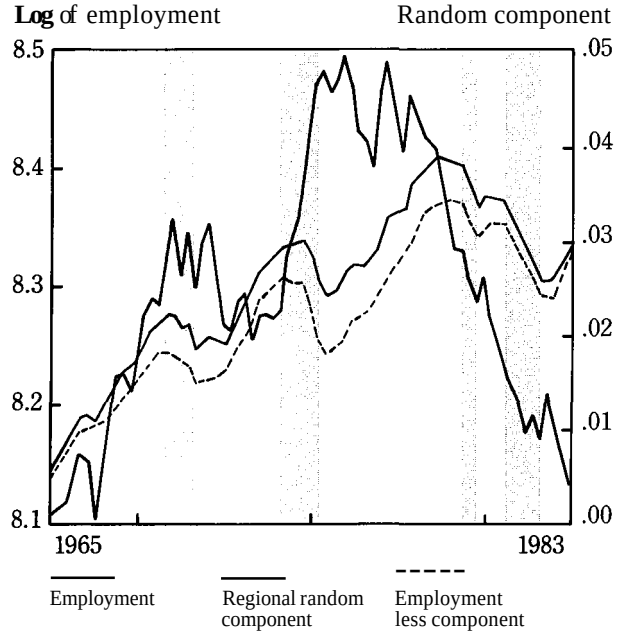
By contrast, the household-survey series, because it is based on a small sample in terms of individuals directly covered, reflects a substantial sampling error. Standard sampling errors, even for quarterly growth rates, suggested by the collecting agency are quite high relative to the observed fluctuations in the series. The accuracy of payroll figures is most likely less affected than the household-survey series by changes in the labor force, because the household survey series necessarily require assumptions about population growth that are confirmed only at the time of population censuses. Of course, any employment series cannot exactly reflect output, because of changes in technology or productivity and in nonlabor inputs.

Empirical findings to be presented here conform to expectations about the relative usefulness and accuracy of the employment series. Payroll employment, as measured, displays a closer coherence with the cyclical variation in other series, both national and regional? Movements in the payroll series also tend to persist from one quarter to the next, unlike the household-survey series. Also, the former tends to foreshadow the latter, although not vice versa.

These properties of the payroll series suggest that they are relatively more accurate indicators of employment and are more useful in understanding and predicting regional trends. But lacking a comprehensive output series, we have looked to personal income in particular and to the other regional series in general for confirmation of conclusions drawn from the payroll series. These series include household-survey employment and the labor force, (nominal) personal income, retail sales, housing starts, the factory workweek, and consumer prices. The properties of these series are of independent, if secondary, interest.

Figure **1** shows, as the solid dark blue line, the quarterly averages of seasonally adjusted Ohio payroll employment from **1965** to 1983.[2] The most obvious characteristics of that series are long-term growth and variability in growth. The variability appears somewhat cyclical. Factors determining fluctuations in regional growth tend to persist in the same direction for a short time (but typically less than a year, as we shall see). Forecasts should therefore reflect not merely the long-run growth of the

Fig. 1 Payroll Employment and Components



NOTE: Shaded areas indicate recessions.

1. For example, payroll employment was more closely related to personal income than was household-survey employment. The correlation coefficients of quarterly growth rates were 0.87 and 0.55, respectively. The correlations with the U.S. index of approximately coincident indicators were 0.87 and 0.58.

2. The data shown are those actually used in the study, and are given in Hoehn and Balazsy (1985).

3. The most critical assumption is that the parameters are stable over the sample period. However, this assumption is less of a problem in the out-of-sample simulations we use as a check on our within sample period results.

series, but also give special consideration to growth in the most recent quarters. These characteristics pertain to the properties of the series in isolation and require no theoretical knowledge to acquire. For deeper understanding, and possibly more accurate forecasts, the series must be related to other series, regional and national.

As a vivid illustration, consider the effects of national recessions, as identified by the National Bureau of Economic Research. They are shown in figure 1 as the shaded areas. We shall show how the national composite indexes of leading and coincident indicators are particularly useful proxies for the national business cycle. We formally express their relationship with Ohio employment by a trickle-down model.

A number of time series models for 10 seasonally adjusted quarterly Ohio series will be sequentially considered to establish the forecasting signals available from a variable's (a) own past, (b) other regional variables' pasts, (c) national variables' pasts and, in some cases, (d) contemporaneous relationships with other variables. Analysis also helps us understand the characteristics, quality, and usefulness of various available regional indicators. Comparisons of the models' performance in a 1965–1983 sample period and a 1979–1983 out-of-sample forecast simulation are designed to assess these potential sources of information. Finally, the particularly successful trickle-down model is further studied to yield insight into the sources of regional growth fluctuations in Ohio from 1965 to 1983.

I. A Time Series Methodology

Before presenting results, some explanation of methods is helpful. One major advantage of the time series methods we use is that they are quite transparent. They can be replicated in this and other contexts. These methods are appropriate in many contexts in which a priori information about relationships is scarce or inadequate. We regard the economic process at the regional and national levels to be an example of such contexts. Our methods are informative, although less informative than methods that use stronger correct prior information. A reader in possession of such information may rightfully regard a time-series approach as neglecting it, resulting in inefficiency in extracting knowledge. We do not ask the reader to accept an elaborate structural hypothesis of our own at the outset of the analysis, nor do we impose such a hypothesis on the data. We shall make some structural speculations and interpretations of our results after the data have spoken through a set of more neutral statistical hypotheses, in the form of simple linear time series models. Of course, even these models involve some ad hoc assumptions, although they are minimal.[3]

Our objective is to model, consequently predict and, in some sense, explain, the movements of Ohio series. Each quarter is treated as a separate event. Each variable is analyzed in terms of a quarterly growth rate, measured as the change in the natural logarithm. (When multiplied by 100, this rate is essentially a percentage.) The various models to be considered condition expected growth rates on various potential sources of information. By comparing the performance of alternative models, which differ by including or excluding some variable or variables, we can assess the information value associated with the addition of a source or sources of information. We shall always allow models to reflect information about its parameters from historical data. The comparisons will involve the effect on model performance from the addition of some past growth rates of the series itself (own-lags), or that of some other series or group of series. (Contemporaneous relationships are largely irrelevant for forecasting, although important for structural analysis.)

For example, the ***random walk*** (with drift) model simply predicts that the historical average growth will occur in any quarter in the future; it uses no past growth rates except, of course, in the calculation of the average—the key parameter in the random walk model.

The autoregressive model we consider uses the past two quarterly own-lags to forecast a quarter's growth rate. The information gain from using the series' own past growth can be measured by comparing the size of a typical forecasting error of the autoregressive model with that of the random walk model. If a variable is characterized by cyclicity, or persistence, then the autoregressive model will have typically smaller errors.

Additional information from other variables, both regional and national, was assessed by measuring the reduction in typical forecast error after including the first two lags of those variables. We have tried a list of 27 possible variables—the other nine regional and 18 national variables—each individually as possibly useful. Each of these trials created a bivariate model, in which a series' growth was conditioned on its own recent growth rates and those of one other variable. Finally, two multivariate models, a trickle-down and a stepwise model were tried. The trickle-down model predicts a series' growth rate using the two most recent own-lags plus one lag each of payroll employment, the U.S. composite index of leading indicators, and the U.S. composite index of approximately coincident indicators.

As it turned out, the (total) payroll variable in each equation for the other nine regional series generally had very little explanatory power once the national variables (and own-lags) were included, justifying the characterization "trickle-down." In order to use the trickle-down model to forecast more than one quarter ahead, we augmented it with equations for the two national variables. They included, as regressors, two own-lags and one lag of the other national variable. The equation for Ohio payroll employment and for the two national variables are shown in the box in section III. Their implications will be analyzed extensively there.

The stepwise model used a variant of the familiar stepwise regression procedure. It searched opportunistically among regressors suggested by their significance in the bivariate tests, in order to find a well-fitting equation. A similar, but less mechanistic, method of model construction proved successful for Texas in an earlier study (Hoehn 1984). The stepwise model helps us assess the total information available without regard to source, and is less dependent on ad hoc, prior assumptions than the trickle-down model. In forecasting more than one quarter ahead, the stepwise model used two-lag autoregressive equations to provide the prerequisite forecasts of the national variables.

In implementing this methodology of assessing information gain, we have necessarily imposed certain ad hoc, although reasonable, and commonly made, assumptions. First, the lag structures described were assumed to be sufficiently long to capture all the information. The series were seasonally adjusted, so longer lags would not be necessary to capture seasonal influences. We openly acknowledge that the X-11 seasonal adjustment procedure may not be entirely adequate, however. The models implemented were linear in the growth rates and were estimated using ordinary least squares.

The information value of a series for predicting another series was measured in two different ways to provide confirmation. First, the models (except the stepwise) were constructed from a long sample from 1965 to 1983. The standard error of the equation for a given model was used as the measure of a typical forecasting error. Then the information gain is measured by comparing the standard errors of the equations. For example, the gain from using two own-lags is measured by the reduction in the standard error of the autoregressive model relative to that of the random walk model (whose standard error is identical to the standard deviation of the growth rate). The reduction is stated as a percent of the standard error of the benchmark, or simpler, model. The calculation of standard errors automatically controls for the tendency of least squares regression to "overfit" a prespecified relationship, so that addition of actually uninforma-

tive variables does not tend to reduce standard errors or to produce spurious measured information gains. However, the stepwise procedure searched a long list of possible variables for information, so that the overfitting tendency cannot be adequately controlled by this method. Its performance can only be assessed by a second method.

The second method measures information by the reduction in the root mean square error (RMSE) of alternative models' forecasts during a simulation period from 1979 to 1983. To simulate real-time forecasting, each model's forecast was based on parameter estimates constructed using data for periods prior to the period forecast. The stepwise model was specified (its information variables and their lags chosen) using only data through 1978; it was not respecified in the simulation, giving it a handicap it would not suffer in real-time forecasting. (Of course, its parameter estimates were updated during the simulation period.) For all models, we give emphasis to and report RMSEs for the one-quarter-ahead and four-quarter-ahead forecasts. Our results for longer forecast horizons are less interesting, other than to confirm the frequently bemoaned lack of useful information about growth rates beyond a year.[4] Models of longer-term growth would involve demographic and other factors not included in our cyclical analysis.

II. Time Series Properties of Ohio Economic Statistics

This battery of time series tests and confirmations yielded results that probably conform to, yet may strengthen, refine, and extend, the knowledge that economists studying regions such as Ohio already possess. Some results, such as the relative importance of the national business cycle in accounting for regional fluctuations, may vary across regions; other results may be more general.

First, there is a degree of cyclicity, persistence, or autocorrelation in the regional economy, according to comparisons of the autoregressive and random walk models. The first column of numbers in table 1 shows significant information gains for payroll employment, personal income, and consumer prices, confirmed by the reductions in RMSEs shown in the next two columns. We speculate that the lack of autocorrelation in household-survey employment and retail sales may, in large part, reflect measurement error. As a simple illustration, if the latter tended to reverse itself each quarter in terms of the level of the series, as would be the case for sampling errors, then the observed first-order autocorrelation (correlation between adjacent periods) in growth rates would tend to be pulled away from its true value toward minus one-half. Of course, the nature of measurement errors is far more complex (see Green [1969], Korns [1979] and U.S. Department of Labor [1985]). Depending on the exact nature of the measurement error, the true cyclical properties of the underlying series, and the relative influence on the observed series of each, they might roughly cancel out in the sense of producing no persistence in the observed series. Measurement and sampling errors are likely to be particularly large for household-survey employment and retail sales because the samples are small. This interpretation of the household-survey employment series is reinforced by the slight negative autocorrelation in the labor force series obtained by the same samples.5

The degree of persistence in payroll employment is not large; it accounts for less than 18 percent of the standard deviation of total payroll growth rates, and about one-tenth of its manufacturing and nonmanufacturing categories taken separately. Although this persistence may be slightly understated due to measurement problems, the conventional X-11 seasonal adjustment procedure may tend to overstate it somewhat. Examination of the autocorrelation of adjacent growth rates suggests that cyclical factors influencing total payrolls tend to persist in the same direction

4. This reveals itself as a lack of further reduction in root means of square error measured in (log) levels of series, beyond the one-year horizon.

5. We confess that time aggregation—the averaging of data from more than one point in time—can create spurious positive autocorrelation. See Tiao and Wei (1976). The use of monthly data would eliminate this problem for the employment surveys, but would make lag structures more complex, the resulting models less transparent, and seasonal adjustment issues more serious.

6. The potential of the interest rate and inflation to provide leading information is consistent with new interpretations of the business cycle that stress changes in productivity. A study by Litterman and Weiss (1983) suggests that innovations in real interest rates precede innovations in output.

for only a few quarters. Autocorrelations are 0.57, 0.32, and 0.22 for lags one through three, respectively, 0.23 being equal to the approximate .05 two-tailed critical value.

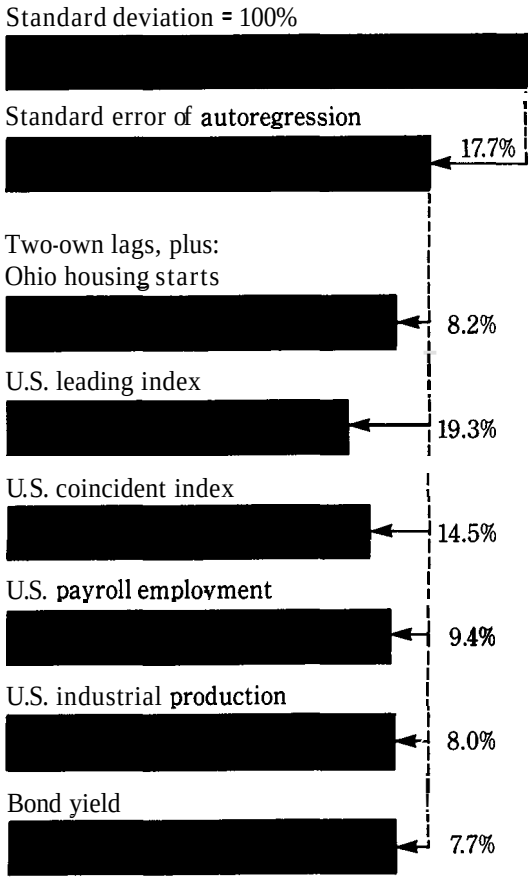
The lack of substantial autocorrelation beyond a few quarters is consistent with the notion that cyclical factors tend to persist in the same direction for only a short period. A short duration and relatively small amplitude of the business cycle is suggested in studies of national and international data by Nelson and Plosser (1982) and Stulz and Wasserfallen (1985).

Most persistence in Ohio payroll employment beyond a single quarter is attributed to the nonmanufacturing category, whose autocorrelations are significant at up to five lags. By contrast, the manufacturing sector's growth rate is significantly autocorrelated only at the first lag, although the second lag's autocorrelation is nearly significant. Beyond the second lag, manufacturing employment autocorrelation declines rapidly. A higher magnitude of persistence in total payroll employment in comparison to its components seems paradoxical, but is due to independent fluctuations in and intersectoral shifts between the two. (Interestingly, once their relation with the U.S. coincident index is controlled for, they display a slightly negative relationship.) Hence, cyclical movements of the total are somewhat obscured in the components.

The bivariate tests suggested that the two national composite series contain particularly valuable information about the future course of Ohio payroll employment, confirming prior notions upon which the trickle-down model was built. Indeed, these two series proved more informative than any others, as shown in figure 2, which depicts gains from the six most t series. t t the .01 level, in descending order, were the two t indexes, U.S. payroll employment (one of four components in the coincident index), Ohio housing starts, U.S. industrial production (also a iden index component) a term interest rate, the U. consumer] d U.S. manufacturing payroll employment, and the gross national product deflator.

The composite indexes seem to summarize reasonably well the information available from national data. Perhaps the long-term interest rate, classified as a "lagging indicator" but showing leading information here, is the maior element omitted from those two corn- i s, posites. Among the significant leading Ohio variables, housing starts contribute information about future payroll employment at the .01 level in the bivariate tests. However, we discovered later that the series did not add

Fig. 2 Information Sources for Payroll Employment



7. We tried adding one lag of starts to the payroll equation of the trickle-down model. The standard error of the equation rose as a result.

any incremental information after the leading and coincident series were included? The payroll measure gives leading information about the future household-survey employment and labor-force series, but not vice versa. In fact, of all the intraregional bivariate leading relationships found, the strongest was from payroll to household-survey employment, whose standard error was reduced by over 13 percent. The manufacturing workweek was included in our study in the hope it would provide advance information about manufacturing payrolls. Instead, the workweek was foreshadowed by manufacturing payrolls. This result is inconsistent with the prevailing characterization of the workweek as leading. (Its national counterpart is included in the composite index of leading indicators.) The result is nevertheless consistent with the results of Beveridge and Nelson (1981), who find that its national counterpart is a lagging indicator of the business cycle.

Based on the bivariate results, we regard cyclicity in payroll employment as largely linked to the national cycle, an interpretation to be reinforced in the next section. Results for personal income were quite similar in that the same series that were informative about payrolls were generally also informative about income. The two composite indexes were again most valuable, followed by U.S. payrolls, the manufacturing component of U.S. payrolls, and Ohio housing starts. However, the inflation and interest-rate variables were insignificant, while real gross national product was significant, at the 1 percent level.

The leading or lagging character of the series can be tentatively judged in view of

Table 1 Information Gains and Forecast Simulation Results

	Cyclicity			General interdependence					
	Autoregressive (univariate)			Trickle-down			Stepwise		
Ohio Series	Information gain[1]	Reduction in RMSE[2] 1-step	4-step	Information gain[3]	Reduction in RMSE[5] 1-step	4-step	Information gain[4]	Reduction in RMSE[5] 1-step	4-step
Payroll employment (establishment survey)	17.7[b]	26.4	12.7	19.5[b]	20.2	6.8	34.2	14.6	6.3
Manufacturing	10.1[b]	14.7	1.1	25.3[b]	24.7	14.8	36.1	18.1	3.9
Nonmanufacturing	9.6[b]	28.2	15.6	7.5[a]	0.0	-2.7	21.7	-9.8	-1.7
Household-survey employment	-0.8	-1.9	-2.0	16.1[b]	11.0	4.9	24.9	20.7	6.0
Labor force	2.4	-3.9	-4.2	7.6[a]	7.5	21.5	16.7	4.7	34.9
Personal income	7.6[b]	10.3	2.4	18.4[b]	23.7	5.1	26.3	-4.3	5.1
Retail sales	2.0	1.4	-0.5	1.2	11.0	1.9	4.9	5.7	-1.2
Housing starts	-1.0	-2.8	-2.5	9.0[b]	5.6	8.6	15.6	17.6	25.2
Factory workweek	-0.5	0.8	1.2	25.5[b]	17.6	17.6	37.5	5.6	7.8
Consumer prices	19.1[b]	7.7	9.1	0.7	0.0	3.3	7.7	-3.8	-5.9

a. Significant at the .05 level.
b. Significant at the .01 level.
NOTE: All series were seasonally adjusted. (Data sets and sources described in Hoehn and Balazsy [1985].)
1. The percent reduction in standard error of equation relative to the random walk model, for the 1965:IVQ to 1983:IVQ sample period.
2. The percent reduction in root mean square error relative to the random walk model, for the 1979:IQ to 1983:IVQ simulation period.
3. The percent reduction in standard error of equation relative to the univariate autoregressive model, for the 1965:IVQ to 1983:IVQ sample period.
4. The percent reduction in standard error of equation relative to the univariate autoregressive model, for the 1965:IVQ to 1978:IVQ sample period. Warning: The calculated information gain does not control for the "overfitting" arising from opportunistic selection of regressors.
5. The percent reduction in root mean square error relative to the univariate autoregressive model, for the 1979:IQ to 1983:IVQ simulation period.

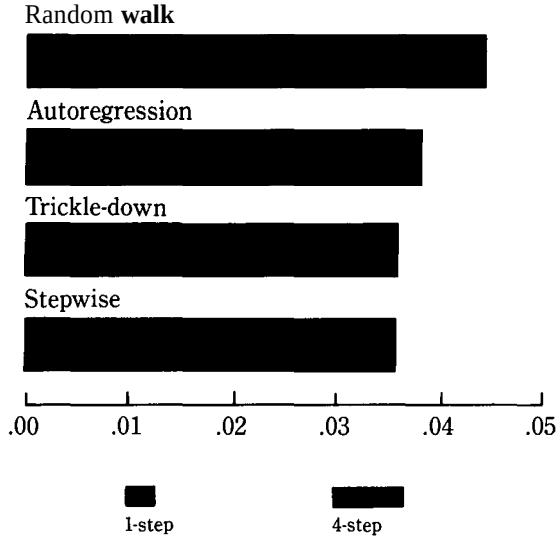
the above results and interpretations of quarterly data. We regard housing starts as leading, hours as lagging, and most other series as approximately coincident. The household-survey series for employment and labor force would probably be coincident, aside from the measurement errors they contain. The labor force series may be a noncyclical series, since it is contemporaneously uncorrelated with any series other than household-survey employment. Measurement errors in both household-survey series may give them a lagging appearance; the other series, particularly the payroll series, are needed to help locate their true, underlying level. The Ohio consumer price series was virtually unrelated to any other, except national price series, and so could be called an irrelevant or non-indicator.

The trickle-down and stepwise models of payroll employment and its components, and of personal income, fit better, in the sense of standard errors of equations, than either the autoregressive or any of the bivariate models. Employment according to the household survey was slightly more closely related to two past values of the coincident index than to the regressors of the trickle-down model (of which the first lag of the coincident index was the most powerful). The trickle-down model's standard errors for retail sales and consumer prices were no smaller than for their autoregressive equations, a result that conforms to the bivariate evidence that these variables cannot be forecast by using other information. Although retail sales were related to other series within a given quarter (the correlation with payroll employment was 0.28), no leading information about it from other series was uncovered.

The out-of-sample forecasts of the trickle-down and stepwise models provide evidence that simple multivariate forecasting models can perform successfully, having lower RMSEs than simple autoregressive models. As shown in table 1, the improvements are reasonably consistent across the 10 regional variables. The trickle-down model had a RMSE at least as small as the autoregressive model in one-quarter-ahead forecasts for all variables and provided statistically significant information gains in eight cases, at the .05 level. For payroll employment, the gain and the reduction in RMSE was about one-fifth (figure 3). Much of that improvement appears to come from information about manufacturing employment.

This evidence of the forecasting ability of simple multivariate models roughly replicates a previous result by Hoehn (1984) for Texas. While the improvement over the univariate autoregressions should not be exaggerated, it is meaningful, consistent, and to our knowledge has not been documented for structural models or for unparsimonious time series models (such as the "Bayesian vector autoregressive" models) commonly employed.

Fig. 3 RMSEs of the Payroll Forecasts for Models



III. National and Regional Fluctuations

The trickle-down model can help address the linkage between national and regional fluctuations. It suggests that variations in payroll employment over periods of several quarters

can be mostly attributed to national developments, as summarized, apparently rather well, by the two composite indexes.

The trickle-down model describes the determination of payroll employment according to the three equations shown in the accompanying box. Movements in payroll employment are attributed to the disturbances or shocks to each of the three equations. These shocks feed through the equations to generate the observed changes in the three variables. (While not observed directly, these disturbances can be estimated as residuals in the fitted equations.) The shocks to the national indexes' equations clearly reflect national events. But so, to some extent, do those to the payroll equation, creating some ambiguity. However, this ambiguity is eliminated by attributing any portion of payroll shocks that are statistically related to the national equation shocks to national events. The part of the payroll shock (linearly) unrelated to national events can be found by regressing the residual from the trickle-down equation for payrolls on those for the national indexes. The residuals from this regression represent both distinctly regional events and idiosyncratic elements of the region's response to national events. In the vector autoregression ("VAR") literature, these are called ***orthogonalized*** shocks because they are "washed" of correlation. These residuals have a variance only 41 percent as great as that of the payroll equation's disturbance term, because correlation with national equation errors accounts for 59 percent (R^2). The interpretation is that even short-run movements in Ohio employment are largely accounted for by national events. Over longer time horizons, the importance of national events looms larger, as national shocks create persistent

The Trickle-Down Model of Payroll Employment

Sample: 1965:IVQ to 1983:IVQ

(1) $\Delta\ln PAYROLL_t = -.0004 - .06\Delta\ln PAYROLL_{t-1} + .36\Delta\ln PAYROLL_{t-2} + .18\Delta\ln LEAD_{t-1} + .16\Delta\ln COIN_{t-1} + e_{1t}$
(.0008) (.20) (.12) (.06) (.13)

standard error of equation = .0065

(2) $\Delta\ln LEAD_t = .0057 + .84\Delta\ln LEAD_{t-1} + .22\Delta\ln LEAD_{t-2} - .89\Delta\ln COIN_{t-1} + e_{2t}$
(.0024) (.12) (.13) (.19)

standard error of equation = .0192

(3) $\Delta\ln COIN_t = .0015 + .02\Delta\ln COIN_{t-1} + .22\Delta\ln COIN_{t-2} + .51\Delta\ln LEAD_{t-1} + e_{3t}$
(.0016) (.16) (.12) (.09)

standard error of equation = .0128

PAYROLL = Ohio payroll (establishment-survey) employment, seasonally adjusted.
LEAD = Index of leading indicators.
COIN = Index of approximately coincident indicators.

NOTE: Fi in parentheses are the standard errors of estimates of the parameters.

Random Regional Component

Let the national component of e_{1t} be:

$$\hat{e}_{1t} = E[e_{1t}|e_{2t}, e_{3t}] = k_1 e_{2t} + k_2 e_{3t}.$$

Then the orthogonalized error is:

$$e^*_{1t} = e_{1t} - \hat{e}_{1t}, \text{ and,}$$

the random regional component of $\ln PAYROLL_t$ is:

$$(1 - L)^{-1}(1 + .06L - .36L^2)^{-1} e^*_{1t},$$

where L is the lag operator.

fluctuations in the composite indexes that trickle down and feed through the payroll equation. As shown in table 2, a 1 percent positive shock to the leading index is followed by a progressive increase in Ohio employment, peaking at 0.81 percent in five quarters. The typical movement of Ohio payrolls in the wake of orthogonalized shocks to the coincident index—washed of their correlation with the shocks to the leading index—is more immediate, but fades, meaning that increases in the coincident index that are not validated by the leading index tend to be followed by unsustainable increases in Ohio payrolls. Given the relative magnitudes of the orthogonalized errors, and the response patterns just described, forecasting errors at long-term horizons owe about 85 percent of their variance to national events, as shown in table 3.

Table 2 Response of Ohio Payroll Employment to Orthogonalized Shocks

Quarters ahead	National shocks: Index of leading indicators, Unit[a]	National shocks: Index of leading indicators, Standard[b]	National shocks: Index of coincident indicators, Unit[a]	National shocks: Index of coincident indicators, Standard[b]	Regional shocks: Payroll employment, Unit[a]	Regional shocks: Payroll employment, Standard[b]
1	.13	.25	.46	.44	1.00	.42
2	.37	.71	.59	.56	.94	.39
3	.57	1.09	.59	.56	1.30	.54
4	.73	1.40	.46	.44	1.26	.53
5	.81	1.55	.29	.27	1.39	.58
6	.82	1.57	.13	.12	1.37	.57
7	.79	1.52	.01	.01	1.42	.59
8	.75	1.44	-.04	-.04	1.41	.59
9	.71	1.36	-.05	-.05	1.43	.60
10	.68	1.30	-.03	-.03	1.42	.59

a. Percent response of payroll employment to a 1 percent shock.
b. Percent response of payroll employment to a shock of typical size, i.e., one standard deviation.

Table 3 Decomposition of Variance of Ohio Payroll Employment Forecast Errors

Quarters ahead	Standard deviation[a]	Percentage of variance attributable to: Leading index	Coincident index	Payroll employment
1	.65	14	45	41
2	1.18	40	36	23
3	1.79	55	26	19
4	2.37	66	18	16
5	2.91	72	13	15
6	3.35	76	10	14
7	3.73	78	8	14
8	4.04	79	7	14
9	4.31	80	6	14
10	4.54	80	5	14

a. Percent.

Although the national series, particularly the leading index, have considerable leading information about regional employment growth, this does not necessarily imply that Ohio lags behind the economy over business cycles. Other evidence suggests the relation between national and Ohio payroll employment may be essentially contemporaneous. The timing relation can be summarized by the cross-correlation function—the correlation of growth rates, after the latter are washed of autocorrelation, at various leads and lags. (Spurious results can arise without such a washing.) We implemented the washing by using residuals in regressions with two own-lags for the two employment series. The contemporaneous correlation of those residuals was 0.83. No other correlations were significant, although the correlation between the Ohio payroll residual and the national payroll residual lagged once was 0.21, not far from the 0.23 critical value for the .05 significance level. The lagged correlation, however, might easily be a result of larger measurement error in the Ohio series, time aggregation (Tiao 1972), or seasonal adjustment problems. Hence, the evidence provides weak support for anything other than a contemporaneous relation between Ohio payrolls and its national counterpart.

The trickle-down model also permits a decomposition of the historical values of the payroll series into a long-run growth component and random components attributable to national and regional shocks? Figure 1 shows the overall payroll series, with the random regional component (right-hand scale, blown up) and the payroll series minus its random regional

component superimposed. The random or cyclical regional component reflects the impact on the level of the payroll series arising from the orthogonalized shocks to its equation. It is essential to bear in mind that, because the long-run growth has been removed, the random regional component, which starts at zero, necessarily also ends the sample at nearly zero. It is the movements of the component during particular periods, compared with other periods in the sample, that is informative.

The random regional component rises during the economic expansion of the late 1960s. During the 1973–1975 recession, the component again rose sharply, greatly cushioning the impact of the national recession? Indeed, the decline of 115,000 jobs during the six-quarter recession would have been 90,000 larger without the aid of the component. But from the late 1970s to the end of 1983, the regional component declined, accounting for a loss of 189,000 jobs from 1977:IIIQ to 1983:IVQ. In contrast to the 1973–1975 recession, distinctly regional factors appear to have aggravated Ohio's economic weakness in the early 1980s. Furthermore, the rise and subsequent fall of the component might reflect a kind of structural change in the region; perhaps the underlying long-run growth rate declined in a permanent way after the mid-1970s.

Conclusion

Time series methods can be used to exploit limited prior information and data sets to acquire insight into economic systems. In this study, we designed and applied time series methods to Ohio and (a) assessed the quality and quantity of information in various indicators of economic activity in Ohio, (b) developed relatively efficient forecasting schemes, (c) provided insight into the sources of variation in sectors of the Ohio economy, and (d) uncovered and measured phenomena for further analysis. The methods employed were simple and transparent and could be applied in other contexts, such as in other regional economies.

8. Our time series model cannot break down the long-run growth of the series into components attributable to national and regionalfactors; to do so would require additional structural information.

9. Our colleague, Philip Israilevich, speculates that smaller increases in (regulated) electricity prices in Ohio, compared with the nation, during the mid-1970s oil price increases may be responsible for the uncharacteristically moderate decline of Ohio employment in that recession period. An alternative or complementary explanation would stress the increased demand for new, less energy-intensive capital goods as energy prices rose. (Ohio is a major capital goods producing state.) We are unable to provide convincing tests of these hypotheses without an extensive, more structural analysis, which is beyond the scope of our study.

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