New Tools for Analyzing the Mexican Economy: Indexes of Coincident and Leading Economic Indicators

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To judge the usefulness of the indexes more completely, their real-time performance must be studied over long periods of time and across many business cycles. To this extent, the Center for International Business Cycle Research will be producing and monitoring a corresponding set of Mexican composite economic indexes, along with their components.

During much of the 1990s, Mexico has been in the world spotlight for being a model economic reformer. The North American Free Trade Agreement (NAFTA), which took effect in 1994, was expected to stimulate even more growth and investment in Mexico. The start of NAFTA, however, coincided with the beginning of sociopolitical strife in Mexico, which hampered much of the trade agreement's potential economic impact. Then in late 1994, a steep peso devaluation rocked the world financial community and helped send the country into a deep recession.

The dramatic changes in Mexico over the past several years illustrate that, despite Mexico's important, growth-enhancing economic reforms, the volatility of its economy appears to be little changed from the 1980s when swings in the exchange rate and oil prices created an economic roller-coaster.[1] The continued sharp swings in the Mexican economy have led to an increased demand for timely economic data to monitor business cycle developments more closely.[2]

One method of monitoring business cycles in Mexico is through the construction of composite indexes of leading and coincident indexes. The U.S. composite index of leading economic indicators, published monthly by the Conference Board (CB), is one of the economic statistics most cited by the U.S. media and has long been used as a guide to the future direction of U.S. economic activity.[3] Although the index has come under increased criticism in recent years, many analysts continue to find it quite useful in monitoring the ups and downs of the U.S. business cycle.[4]

In this article, we create composite indexes of leading and coincident indicators for Mexico that are constructed in a fashion similar to that used for the U.S. indexes. We start by analyzing various economic indicators to determine which are sensitive to swings in the Mexican business cycle. We then define a coincident index and classify peaks and troughs in the Mexican business cycle in the period since 1980. The peaks and troughs in the cycle and overall movements in the coincident index and real gross domestic product (RGDP) are then used to determine what indicators consistently lead the business cycle. We find, perhaps not surprisingly, that the peaks and troughs in the Mexican economy are often difficult to foresee. The composite indexes we present, however, should be useful tools in analyzing and forecasting the Mexican economy.

The development and use of composite indexes of economic activity

The primary motivation for the construction of composite indexes of economic activity is the belief that there is no single proven and accepted cause of all observed business cycles. If different recessions are caused by different factors, then it is likely that no one indicator will perform best over all cycles. To increase the chances of getting true signals and reduce the chances of false ones, a host of indicators is combined from a wide range of economic sectors and processes.

Another reason for constructing composite indicators is that measurement errors, if independent across series, can be reduced by combining the series. Composite indexes can also reduce signals that are not indicative of cyclical fluctuations but the result of short-term events, such as an employee strike or a one-time tax law change that lumps certain activity into the end of a tax year.

By using simple, general theoretical arguments, but apart from any specific theory of the causes of business cycles, it is possible to find indicators that consistently lead, lag, or coincide with business cycle turning points. Leading indicators often represent future economic commitments, such as new orders for capital goods or building permits. The indicators also can embody expectations about future activity, such as help-wanted advertising, stock price indexes, and consumer confidence surveys. Coincident indicators typically represent broad economic measures, such as employment, output, and income.[5]

The popularity of the U.S. leading index has prompted the development of similar indexes for other countries. Klein and Moore (1985) describe how a broad set of economic indicators that have been shown to be strong cyclical indicators in the United States also performs strongly in a variety of market-oriented economies. As shown in Table 1, the performance of the indicators varies somewhat, but in general, the timing of the series is consistent across countries at both peaks and troughs of the growth cycles.[6] The evidence in Table 1

Table 1, Part 1
Median Lead (–) or Lag (+) of Individual Indicators at Growth Cycle Peaks in Months, Eleven Countries

Indicators: U.S. classification and U.S. titles	United States	Canada	United Kingdom	West Germany	France	Italy	Japan	Australia	Taiwan	South Korea	New Zealand	All countries
Leading indicators												
Average workweek, manufacturing	−3	−3	0	−8	−4	0	−4	−2	−8	−7	0	−3
New unemployment claims	−1	−1	NA	+2	−41	NA	NA	NA	NA	NA	NA	−1
New orders, consumer goods	−2	−2	NA	NA	−11	−8	NA	NA	+6	NA	0	−2
Formation of business enterprises	−11	NA	−8	−8	NA	−4	−10	−8	NA	NA	NA	−8
Contracts and orders, plants, and equipment	+1	+3	−3	−6	NA	NA	−5	−2	NA	−1	0	−2
Building permits, housing	−6	−3	−11	−10	−9	−2	−12	−5	−3	NA	+2	−6
Change in business inventories	0	0	−4	−4	+2	NA	−1	NA	NA	NA	−6	−1
Industrial materials price change	−8	−2	+3	−5	−2	0	−4	−5	NA	NA	−3	−3
Stock price index	−4	−3	−5	−6	−3	−6	−8	−7	0	−6	−7	−6
Profits	−4	−5	−4	−8	NA	NA	−10	−2	NA	NA	NA	−4
Ratio, price to labor cost	−8	+1	−14	−9	−4	+2	−2	−14	NA	NA	0	−4
Change in consumer debt	−6	−2	−16	−21	NA	NA	−9	−10	NA	NA	−3	−9
Median	−4	−2	−5	−6	−4	−5	−6	−5	−4	−2	0	−4
Coincident indicators												
Nonfarm employment	+1	+2	+2	+3	+6	+6	+2	+3	+1	+5	+9	+3
Unemployment rate	0	+1	+1	+3	0	+1	0	+1	+3	−6	0	+1
Gross national product	0	0	−13	0	−1	+1	−5	0	−10	+2	0	0
Industrial production	+3	0	0	0	0	0	0	0	0	+2	NA	0
Personal income	−1	+1	−4	−6	NA	NA	−9	−3	−4	NA	−4	−4
Manufacturing and trade sales	−1	−2	−3	−3	−2	−1	−8	−2	+2	0	0	−2
Median	0	0	−2	0	0	+1	−2	0	−1	+2	0	0

SOURCE: Center for International Business Cycle Research, Columbia University.

Table 1, Part 2

Median Lead (–) or Lag (+) of Individual Indicators at Growth Cycle Troughs in Months, Eleven Countries

Indicators: U.S. classification and U.S. titles[a]	United States	Canada	United Kingdom	West Germany	France	Italy	Japan	Australia	Taiwan[d]	South Korea[e]	New Zealand	All countries
Leading indicators												
Average workweek, manufacturing	–2	–5	–2	–1	–3	+4	–4	–4	–12	–10	+3	–3
New unemployment claims[b]	–5	–2	NA	–3	NA	NA	NA	NA	NA	NA	NA	–3
New orders, consumer goods[c]	–2	0	NA	NA	–12	–9	NA	NA	–13	NA	–3	–6
Formation of business enterprises	–1	NA	–10	–4	NA	–7	–14	–8	NA	NA	NA	–8
Contracts and orders, plants, and equipment[c]	–5	0	–1	0	NA	NA	0	0	NA	–2	–4	0
Building permits, housing	–9	–9	–10	+2	–7	–2	–6	–7	–7	NA	–2	–7
Change in business inventories[c]	–2	0	–6	–1	+1	NA	–4	NA	NA	NA	–2	–2
Industrial materials price change	–4	–4	+3	+1	–1	+1	–7	+1	NA	NA	+3	+1
Stock price index	–4	–6	–8	–8	–9	–8	–4	–4	0	–1	–10	–6
Profits[c]	–2	–2	–3	–12	NA	NA	–10	–2	NA	NA	NA	–2
Ratio, price to labor cost	–7	0	–9	–6	–3	+1	–2	–9	NA	NA	+5	–3
Change in consumer debt[c]	–4	–11	–15	–18	NA	NA	–6	–6	NA	NA	–6	–6
Median	–4	–2	–7	–3	–5	–8	–5	–4	–6	–4	–2	–4
Coincident indicators												
Nonfarm employment	+1	0	+2	+6	+7	+8	+2	+4	0	+7	0	+2
Unemployment rate[b]	+1	+2	+1	0	+1	+7	+2	0	0	0	0	+1
Gross national product[c]	–1	–1	0	0	–4	–1	–2	0	0	+2	+2	0
Industrial production	0	0	0	0	–3	0	0	0	0	0	NA	0
Personal income[c]	0	0	–3	+6	NA	NA	+1	+1	+1	NA	+3	+1
Manufacturing and trade sales[c]	0	0	–1	0	0	–7	–1	–2	–4	0	–4	–1
Median	0	0	0	0	0	0	0	0	0	0	0	0

[a] The series available for each country are sometimes only roughly equivalent in content to the U.S. series. In some cases, two series are used to match the U.S. series and the median. The table includes all observations for both series. The periods covered vary for each indicator and each country but all are within the years 1948–87.

[b] Inverted.

[c] In constant prices.

[d] Additional leading indicators for Taiwan and medians at peaks and troughs are exports,[c] –9, –3; money supply,[c] –4, –4. Additional coincident indicators are freight traffic, 0, –4; bank clearings,[c] –4, –8.

[e] Additional leading indicators for South Korea are accession rate, –1, –5; letter of credit arrivals,[c] –2, –8; inventories to shipments,[b] –1, –3.

NA = no indicator available.

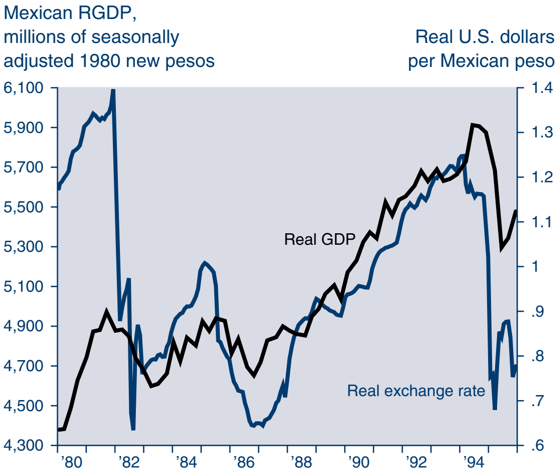
SOURCE: Center for International Business Cycle Research, Columbia University.

suggests that it would be useful to study these same indicators for Mexico.

It is also useful to examine variables that are specific to the dynamics of the Mexican economy. Changes in oil prices and the value of the peso have been important to the Mexican economy over the past two decades, as shown in Figures 1 and 2. A surge in oil prices from 1979 to 1981 fueled strong economic growth and government spending. In 1982, oil and oil-related products represented 77.6 percent of Mexico's total merchandise exports. When the price of oil began a sustained decline in 1982, a decreased supply of foreign exchange led to a dramatic depreciation of the Mexican peso. A recession soon followed.

In 1986, oil prices plunged, further weakening the real value of the peso, which had already begun to decline earlier in the year. Once again, Mexico entered a sharp recession. The dramatic decline in oil prices in 1986 resulted in a shift in merchandise exports to non-oil-related products. Although oil's share of merchandise exports declined to 12.2 percent in 1994, this industry remains an important source of economic activity in Mexico, and large swings in oil prices likely will have important impacts for many years to come. The important role that oil and international trade have played in the Mexican economy over the past two decades suggests that any study of the Mexican business cycle should include a close look at variables pertaining to these factors.[7]

Figure 1
Exchange Rates Play a Critical Role in Mexico



SOURCES: INEGI and Federal Reserve Bank of Dallas.

Choosing and evaluating the cyclical indicators

To choose the components of the Mexican leading and coincident indicators, we use an evaluation technique similar to the one the National Bureau of Economic Research (NBER) developed and used. Historically, the NBER has applied six criteria in the selection of components of composite indexes of cyclical activity. Each potential series has been analyzed for economic significance, statistical adequacy, timing at turning points, overall conformity to the business cycle, smoothness, and timeliness of release date. As Zarnowitz (1992) describes, these criteria address the following questions: How well understood and how important is the indicator in the formation of business cycles? How well does the series measure the economic variable or process in question? How consistently has the series led or coincided with business cycle turns? How well has the series conformed to measures of the business cycle over all points? How promptly can a cyclical turn in the series be distinguished from a shorter, temporary change? How promptly are the statistics available, and how frequently are they reported?

In using these six criteria, the cyclical timing and business cycle conformity measures are given more weight than the other measures. Moore and Shiskin (1967) first developed and applied a formal, detailed weighting scheme according to these criteria. Zarnowitz and Boschan (1975) and Zarnowitz (1992) explain the scoring system in detail. In choosing the components of the Mexican leading and coincident indexes, we use a similar evaluation technique based on measures of the last four of the NBER's six criteria.[8]

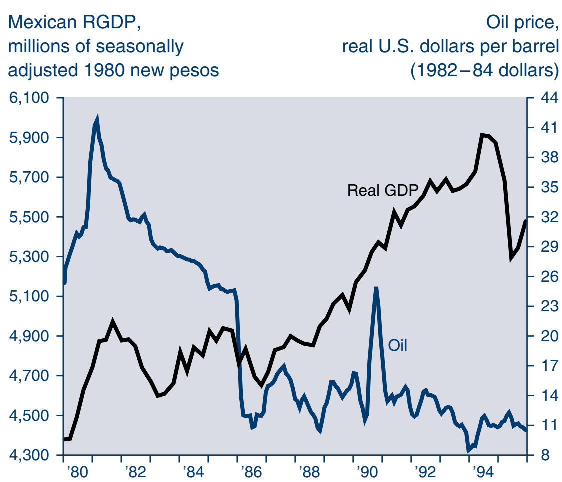
The first challenge in developing composite indexes of leading and coincident economic indicators is defining a business cycle chronology. Without first determining peaks and troughs in the business cycle, there would be no way to judge how an indicator performs at business cycle turning points. To classify indicators as leading, it is important to identify turning points on a monthly basis. The NBER dates the months of peaks and troughs in the U.S. business cycle by studying movements in a wide variety of monthly and quarterly economic indicators that measure factors such as output, employment, and income.

Business cycle turning points in the United States have historically been defined by increases and decreases in the level of economic activity. Since World War II, however, business cycles in many countries have been defined by swings in trend-adjusted activity, or growth cycles. In developing the growth cycle chronologies for the eleven countries shown in Table 1, Klein and Moore trend-adjust many coincident economic indicators by calculating and then eliminating flexible nonlinear trends in the series.[9]

Creating a Mexican index of coincident economic indicators

Data limitations severely limit the application of the Klein and Moore growth-cycle chronology to Mexico. Most monthly and quarterly economic time series for Mexico date back only to 1980. Because of the relatively short time period covered, it is difficult to define long-term trends and thus to define long-term growth patterns. Instead, we focus on the classical business

Figure 2
Large Oil Prices Swings Important to Mexico



SOURCES: INEGI and Federal Reserve Bank of Dallas.

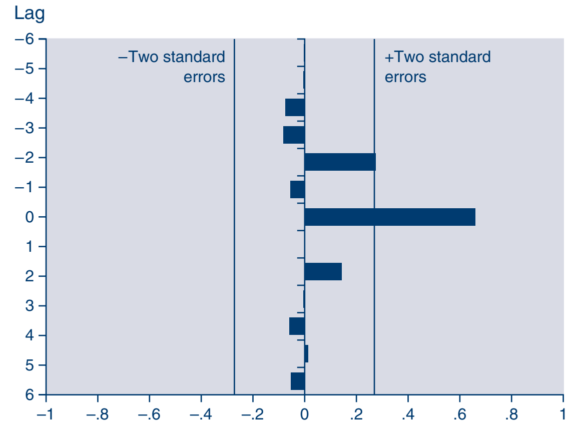
cycle chronology, which defines periods in which the level of activity either increases or declines.

The method we choose for compiling a business cycle chronology for Mexico is first to define a monthly coincident index for Mexico and then to use peaks and troughs in this series to determine business cycle turning points. We use turning points and overall movements in the index to judge the cyclical timing and conformity of potential leading indicators. To calculate the coincident index, we first try to obtain the list of coincident indicators shown in Table 1. Since these indicators have been shown to coincide with the business cycles in many countries, it is likely that they would perform in a similar manner in Mexico. To gain some confidence that this is so, we perform several tests based on the performance measures presented above.

We are able to obtain all the Klein–Moore coincident indicators except personal income.[10] The data we obtain for RGDP, employment, and industrial production began in 1980, and the unemployment rate and real manufacturing and trade sales began in 1987. As a starting point for our analysis, we first seasonally adjust all the data using the X-11 procedure developed by the U.S. Bureau of the Census. We then analyze how well each of the other indicators conforms to movements in RGDP. Although business cycles are defined by the movement in many economic indicators, one of the most important of these is RGDP. A positive attribute of RGDP is that it is the most comprehensive economic indicator available, measuring the combined effects of the utilization of labor and capital and the productivity of these factors. A significant impediment to its use, however, is that it is quarterly, which reduces its timeliness and its precision in dating turning points.

To measure conformity to RGDP, we calculate correlation coefficients between changes in RGDP and past and future quarterly changes in the candidate series. The candidate series and RGDP are first filtered to eliminate any spurious correlation due to both series following the same autoregressive or moving average process.[11] We calculate standard errors to test if the correlation coefficients are statistically significant. A statistically significant correlation between changes in the component series and changes in RGDP at a zero lag is a good indication that the series conforms well and is coincident with changes in RGDP. Similarly, statistical significance at lead quarters provides evidence of business cycle conformity with a leading relationship. This procedure is part of the identification stage of a single-input transfer function model and is described in more detail in Vandaele (1983).[12]

Figure 3
Cross Correlations Between Mexican RGDP and Industrial Production
(Both Series Have Been Prewhitened)



As an example of the conformity analysis, Figure 3 presents evidence that industrial production conforms well with RGDP and that the relationship is coincident. Although the figure contains some evidence that a shock to RGDP leads a change in industrial production by two quarters, the large 0.66 correlation coefficient at the coincident quarter is highly significant and provides strong evidence that the overall timing of the relationship is coincident.

The results of the cross-correlation analysis are used, along with the timeliness of release and smoothness criteria, to verify the usage of the Klein–Moore coincident indicators. Timeliness of release is measured by the number of days following the reporting period that the data are released. Smoothness is measured by the months-for-cyclical dominance (MCD) criteria. If the MCD is 3, then a three-month moving average of the series must be calculated in order for the trend/cycle movements to represent a larger share of any given change than the random, or noise, component. MCD estimation is part of the decomposition and seasonal adjustment of time series computed by the Census Bureau's X-11 program.[13]

The overall results of our analysis show that the potential coincident indicators we have collected are all useful in defining cyclical swings in the Mexican economy. The cross correlations show that all the series conform coincidentally with Mexican RGDP. Timeliness of release is generally slower than that for the respective data in most industrialized countries and represents a significant impediment to timely analysis of the economy. The approximate number of days to release following the end of the reporting month is thirty-nine for employment, fifty for the unemployment rate and manufacturing and trade sales, and sixty-seven for industrial production.[14] These long delays reduce the usefulness of the series in timely analysis of business cycles. The volatility of the series also varies. The MCD is 1 for employment, 3 for industrial production, and 4 for the unemployment rate and manufacturing and trade sales.

The final variable that we use in the coincident index is a monthly estimate of RGDP. To estimate RGDP monthly, we use the method of best linear unbiased interpolation and extrapolation introduced by Chow and Lin (1971). The Chow–Lin procedure uses the monthly movements in related economic series to estimate the monthly movements of the quarterly series. A key feature of the Chow–Lin procedure is the restriction that the monthly interpolated values sum to the quarterly estimates. Since employment and industrial production extend back to 1980, and both have strong conformity to RGDP, we use these two series to interpolate RGDP. The estimated monthly measure is quite volatile, with an MCD of 3.

To construct the composite index, we calculate symmetrical monthly percent changes in each of the series by taking the monthly difference in the series and dividing by the average of the two months. The changes in each of the series are then standardized by dividing by the average absolute percent change in the series so that the most volatile series do not dominate movements in the index. Other than the standardizations, the changes in each of the series are given equal weights. The equally weighted standardized changes are summed across available indicators to create the change in the index. The index is given a base value of 100 for February 1980, and the changes are used to extend this level forward. Before 1987, movements in the index are based solely on changes in the three available series (RGDP, industrial production, and employment), while the post-1986 movements are based on the changes in all five of the indicators.

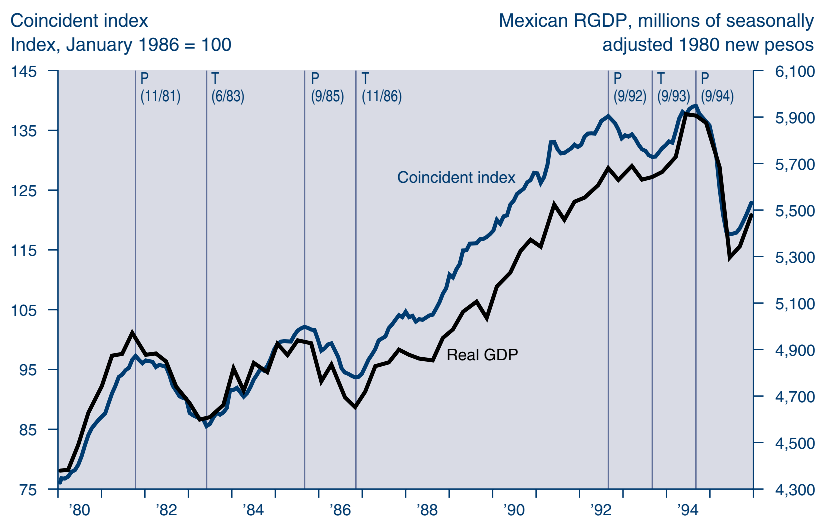
Before calculating the index, we determine the appropriate level of smoothing of the components so that the coincident index will be a useful measure of business cycle turning points. If the coincident index is highly volatile, then it would be difficult to distinguish a cyclical turn in the index from a shorter temporary change. Although taking a moving average of a series increases its smoothness, it also decreases its timeliness. For example, because a moving average best reflects the trend/cycle movements of the middle month, a three-month moving average that ends in June best reflects the trend/cycle movement only through May.

As mentioned earlier, one advantage of combining indicators into a composite index is that much of the noise in the individual series can be eliminated by offsetting shocks across indicators. To test the importance of this composite effect, we first compute a composite coincident index without smoothing any of the component series. The composite series is quite volatile, with an MCD of 3.

As a second experiment, we calculate an index with industrial production, manufacturing and trade sales, and the unemployment rate all smoothed using centered three-month moving averages. The composite index, computed with the three smoothed series, employment, and monthly RGDP, displays generally smooth movements and has an MCD of 1.[15] Although taking a centered three-month moving average of three of the components reduces the timeliness of the coincident index, the significant reduction in noise makes the index a much more useful measure of the business cycle. We therefore choose this method to calculate the coincident index.[16]

Overall movements in the coincident index track movements in RGDP, as shown in Figure 4.[17] Peaks and troughs in the index define four periods of economic recession in Mexico since the beginning of 1980. Although RGDP falls for three consecutive quarters beginning in the first quarter of 1988, its overall decline is

Figure 4
Mexican Coincident Economic Indicators



SOURCES: INEGI and Federal Reserve Bank of Dallas.

Box 1
The CIBCR Index of Coincident Indicators for Mexico

In an independent study directed by Geoffrey Moore at the CIBCR, a similar index of coincident indicators was constructed for Mexico using the same four monthly series as in the coincident index presented in this article: industrial production, real retail sales, insured employment, and the unemployment rate. In addition, Moore added a measure of real monthly earnings. Moore also treated RGDP differently; monthly values were generated by simple linear interpolation of the quarterly values. The six components were seasonally adjusted and standardized but were not smoothed.

The data covered the period from July 1982 through April 1995, just allowing the index to date the onset of the most recent Mexican recession in late 1994. The creators of the CIBCR index relied mainly on their long experience with the U.S. indicators and those for other countries guided by the U.S. model to make a quick first evaluation of the Mexican data. The resulting coincident index for Mexico, therefore, is experimental and tentative.

The index presented in this article, although somewhat more formally developed, is also experimental and will remain so until it accumulates a long, out-of-sample history. However, it is interesting to compare the two independently constructed indexes and reassuring to find that their results are very similar. As shown in Table A, there are two instances of coincident timing, three of one-month leads of the CIBCR index over our index, and two of one-month lags. On average, the two indexes have nearly coincident timing at both peaks and troughs.

Table A
Two Coincident Indexes for Mexico: A Comparison

Dallas Fed Index		CIBCR Index		Lead (–) or Lag (+) in Months CIBCR vs. Dallas Fed Index	
Peak	Trough	Peak	Trough	Peak	Trough
Nov. 1981		Nov. 1981		0	
	June 1983		July 1983		+1
Sept. 1985		Sept. 1985		0	
	Nov. 1986		Oct. 1986		–1
Sept. 1992		Oct. 1992		+1	
	Sept. 1993		Aug. 1993		–1
Oct. 1994		Sept. 1994		–1	

NOTE: See the accompanying article on the sources, methods, and composition of the two indexes.

slight and the coincident index decreased only briefly, for three months. Hence, we decided not to treat this 1988 episode as a business cycle contraction.

The dating of business cycle turning points has an important effect on the subsequent analysis of leading indicators. When and if a recession begins affects not only the timing of potential leading indicators but also the number of false signals given by the indicator. Because of this importance, we compare the turning points in our coincident index with the turning points in the coincident index for Mexico computed independently by Geoffrey Moore at the CIBCR. As described in the box titled “The CIBCR Index of Coincident Indicators for Mexico,” the Moore index is consistent with ours, with at most one-month differences in turning-point dates.

A leading index for Mexico

Once we have calculated the coincident index, we can use it to judge potential leading indicators. All indicators are first seasonally adjusted using the X-11 procedure. The cyclical timing of potential leading indicators is judged by simply recording how many months prior to a peak (trough) in the coincident index the indicator reaches a maximum (minimum). The measures of conformity, smoothness, and timeliness are the same as those used for the coincident index. In evaluating the potential leading series, the measures of conformity and cyclical timing are given more weight than the other two performance measures. The measures of cyclical performance for the components that we select to be in the leading index are listed in Table 2.

As shown in Table 2, we select eight components covering various sectors of the economy. Stock prices, the ratio of price to labor cost, and the average workweek in manufacturing are from the list of leading indicators in Table 1.[18] Three other components are linked to leading indicators listed in Table 1 that were not available for Mexico. The combination of the real value of construction structures and imports of capital goods is related to the combination of housing permits, and contracts and orders for plant and equipment. Net insufficient inventories relative to sales is related to the change in business inventories. Finally, the real dollar price of oil and the real value of the peso relative to the dollar reflect the two major influences on the Mexican economy over the past two decades: oil and foreign trade.

The statistics on the months for cyclical dominance show a large variance in smoothness across indicators. If a leading indicator has a large lead time, then there is little cost in smoothing the indicator. For example, the ratio of price to unit labor cost has an MCD of 6, but the cross-correlation matrix reveals that this indicator has up to a fifteen-month lead with the coincident index. Taking a six-month (noncentered) moving average of this indicator causes some timing distortion in the sense that the timing of the noncentered moving average is not the same as the original series. In terms of its leading ability, however, the noncentered moving average merely shifts the series lead time to twelve months, still plenty of warning time and closer to the lead time of most of the other indicators.[19]

We first calculate the leading index without smoothing any of the eight components. The resulting composite index is highly volatile, with an MCD of 3. We then smooth all the components by their months for cyclical dominance. The resulting index is smooth and has an average lead time of 3.7 months over all peaks and troughs. Several of the components, however, no longer lead the cyclical peaks and troughs, so the monthly moving average of these indicators is reduced. The moving average of hours worked in manufacturing is reduced from six to three, and the moving average of imports of capital goods is reduced from four to two. This allows these indicators to turn prior to the cyclical turning points and yet remain smooth enough to be able to distinguish peaks and troughs in the series. The resulting composite leading index is generally smooth, with an MCD of 1.

The leading index shows a strong relationship with the coincident index, as shown in Figure 5. A peak in the leading index is defined as the maximum value of the leading index in

Table 2
Performance Measures of the Components of the Mexican Leading Index

Indicator	Average timing at turning points (months)	Lead months with statistically significant correlation with coincident index*	Months for cyclical dominance	Release lag (days after reporting period)
Average monthly hours, manufacturing	−5.4	0,1	6	56
Real value of construction structures**	−4.2	0	4	30−90
Real stock price	–10	1	2	12
Ratio, price to labor cost	−8.6	16,17	4	56
Net insufficient inventories	−5	0,4	6	45
Real peso−dollar exchange rate	−5.1	1,6,15	2	12
Oil price/U.S. CPI***	−8.3	1,3,5,7,9	1	12
Imports of capital goods	–.4	0,1,2,3,4,5,6,7,9	4	37

* A zero in this column indicates that there is a statistically significant correlation between changes in the variable and changes in the coincident index at the coincident month, while a 1 indicates there is a one-month lead between changes in the variable and changes in the coincident index. See the accompanying article for further details on the computation of this variable.

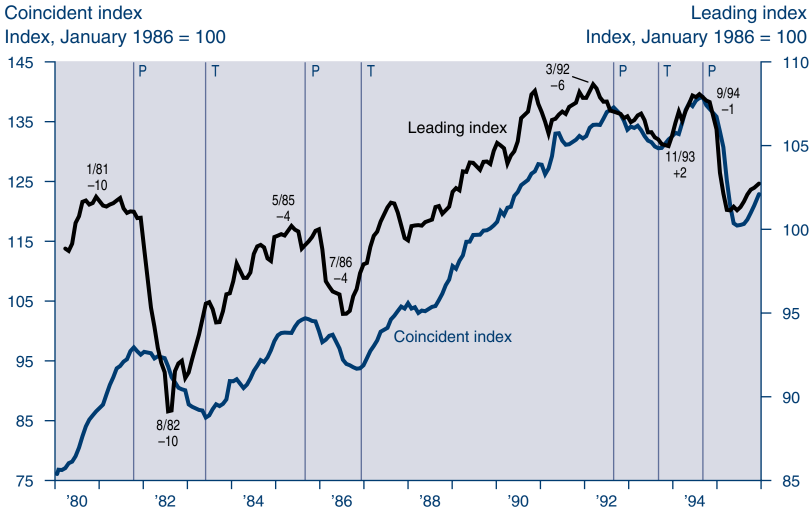
** Released every three months.

*** Consumer price index.

NOTE: Variables tested but not chosen were raw materials price index, capital goods production, production of machinery and equipment, real M1–M4, the growth rates of M1–M4 net decrease in manufacturing inventories.

Figure 5

Mexican Composite Indexes of Economic Activity



the expansion period prior to the recession, and a trough in the leading index is defined as the minimum value of the series in the recession period prior to the expansion. The cyclical timing of the leading index has generally been good, with an average lead time of about five months at peaks and four months at troughs. The index, however, lags by two months at the September 1993 trough and has several false signals of recession, particularly in the 1987–88 period and the period from 1990 to 1991. A cross-correlation analysis between changes in the leading index and changes in the coincident index shows significant positive leads at months one, three, five, and six, and a joint significance test of the first six months is strongly significant.[20]

Although the MCD for the leading index is 1, Figure 5 indicates that, as previously noted, the leading index often declines for brief periods, and several times for extended periods, without an ensuing recession. As shown in Figures 5 and 6, however, most of these declines are followed by at least a weakening of the coincident index or at least a one-quarter decline in RGDP. The sharp decline in the leading index from June 1987 to January 1988 is followed by a three-quarter decline in RGDP beginning in the first quarter of 1988 and a brief three-month decline in the coincident index beginning in February 1988. The brief but sharp decline in the leading index from November 1990 to March 1991 is followed by flatness in the coincident index from June 1991 to January of 1992 and a one-quarter decline in RGDP in the third quarter of 1991.

The periods of sluggish economic activity in 1988 and 1991 would likely have been classified as growth recessions (*i.e.,* significant cyclical slowdowns in economic activity) if a growth-cycle chronology had been used. The fact that the leading index declined prior to these periods of weak growth is consistent with the U.S. leading index, which is, on the whole, better at signaling growth-cycle turns than business cycle turns as a result of its high sensitivity.

In contrast to the corresponding U.S. time series, it is not uncommon for the Mexican coincident index or RGDP to decline for a quarter during economic expansions. This volatility in the coincident indicators makes it difficult to develop a leading index that is sensitive only to business cycle turns and not to brief periods of decline within expansion phases. The instability of the coincident index and Mexican RGDP likely is an accurate reflection of the inherent instability of this developing economy.

While, ex post, it is easy to determine the peaks and troughs in the leading index, the volatility of the index makes this more difficult on a month-to-month basis. A popular rule used with the U.S. leading index is that three consecutive declines in the index is a strong signal that a recession is ahead, although it is important to note that this rule has never been endorsed by the NBER, CIBCR, or other serious students of business cycles. One weakness of this method is that it does not take into account the magnitude of the decline in the leading index. Diebold and Rudebusch (1989) show that a sequential probability method has a better forecasting record. The sequential probability method uses past data on changes in the leading index to estimate the probability that the leading index is in a contractionary (expansionary)

Figure 6

Mexican Economic Indicators

phase and thus is signaling a contraction (expansion) in the economy.

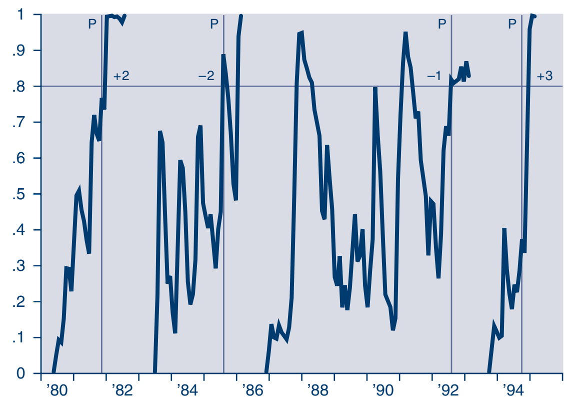
The probability of recession estimates the probability that the leading index has changed signaling regimes. For example, if the economy is in an expansion with the leading index persistently increasing and then the leading index declines for one month, the probability of recession estimates the likelihood that the leading index has begun a cyclical downturn and not just a brief decline. To further the example, if the leading index increases 1 percent and in the past this occurred fifteen times during expansions and only once during contractions, then the resulting probability would be high that the current change is signaling expansion. The method also allows the previous period's probability of recession or expansion to affect the current period's probability. For example, if the leading index is rising and then declines 1 percent, the probability of recession is less than if the 1-percent decline in the leading index is preceded by several months of decline. For more detailed information on the sequential probability method, see the box titled "Calculating the Probability of Recession and Expansion."

The probability of recession based on changes in the leading index shows that the index gives little early warning of upcoming recessions. As shown in Figure 7, the probability of recession reaches above 80 percent with a two-month lag, a two-month lead, a one-month lead, and a three-month lag. Thus, on average, the probability of recession is higher than 80 percent at 0.5 months following the beginning of the recession. The probability of recession also increases above 80 percent in two periods that are not followed by recession, although these signals are followed by declines in RGDP and the coincident index.

These results suggest that once a peak in the leading index has been reached, on average, it is not apparent that it is a cyclical peak until 0.5 months after the recession has begun. However, if the leading index is persistently increasing with no localized peaks, then it is correct to estimate that, on average, the expansion should continue for at least five more months. Thus, the timing ability of the leading index differs if it has recently changed direction.

While the performance of the leading index in predicting recessions seems poor, it is important to note that, in view of the volatility of the coincident indicators, the signal from the leading indicators may lead well in advance of any sign of recession given by changes in RGDP or the coincident index. As a test of the relative

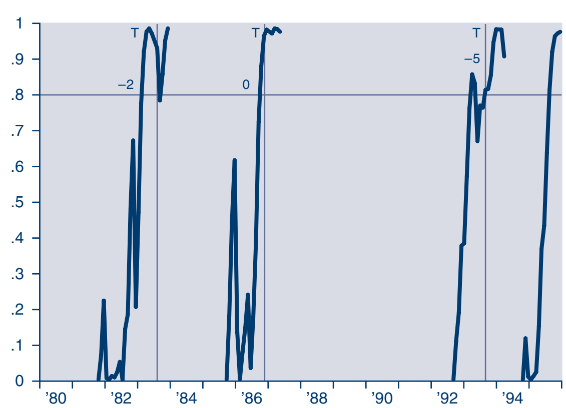
Figure 7
Probability of Recession in Mexico



signaling ability of the leading index, we apply the same recursive probability methodology that we use with the leading index to changes in the coincident index and to changes in RGDP. The recessionary signals from both series lag those of the leading index. Using the coincident index, the probability of recession increases above 80 percent with a one-month lead, a five-month lag, a three-month lag, and a zero lag with four peaks in the time period. Thus, the average signal occurs 1.75 months following the start of the recession, compared with the 0.5 months timing of the leading index. There is also one more false signal given by the coincident index. Counting the last month of the quarter as the signaling month, the average signal given by movements in RGDP lags the peak by 1.5 months with two more false signals than the leading index.

The ability of the leading index to signal upcoming expansions appears to be stronger. As shown in Figure 8, the probability of expansion rises above 80 percent with a two-month

Figure 8
Probability of Expansion in Mexico



Box 2
Calculating the Probability of Recession and Expansion

To calculate the probability of recession and expansion, we use a modified Bayesian updating formula due to Neftci (1982) and Diebold and Rudebusch (1989). The recursive probability is defined as

$$P_t = ((P_{t-1} + PL(1 - P_{t-1}))Fd_t)/((P_{t-1} + PL(1 - P_{t-1}))Fd_t + (1 - P_{t-1})(1 - PL)Fu_t),$$

where P_t is the probability of recession in period t and P_{t-1} is the probability of recession in the previous period. PL is the a priori probability that the leading index has entered a contraction phase, given that a month earlier it was in an expansion phase. Initially, Neftci (1982) postulates that the probability of recession may be affected by the length of the expansion: the longer the current expansion the more likely it is that a recession would occur in the next period. However, Diebold and Rudebusch (1991) find that, for the United States, the probability of recession is not dependent on the length of the current expansion. We assume that the time-independence results Diebold and Rudebusch find also hold for Mexico, and, thus, we set PL equal to a constant.

Given that the value of PL is time-independent, the fixed value of PL is somewhat arbitrary. Initially, PL was set equal to the number of past contraction phases divided by the cumulative length of past expansion phases as put forth in Diebold and Rudebusch. This value, which was equal to 0.032, resulted in a very low probability of recession throughout most of the expansion period, with the probability increasing above 30 percent prior to recessions. Increasing PL to 0.15 resulted in an upward shift of the probability distribution, so that the probability of recession was higher throughout the expansion and increased above 80 percent prior to recessions. By increasing PL to 0.15, the number of false signals given by the index did not change nor did the timing of the signal created by the index; the sole change was a shift in the signaling rule from a probability greater than 30 percent to a probability greater than 80 percent. Since the 80-percent signaling rule was more intuitive, we set PL equal to 0.15.

Fd_t and Fu_t in the above equation denote the likelihoods that the latest change in the leading index came from the contraction phase of the index and the expansion phase of the index, respectively. That is, Fd_t measures how probable the latest leading index change would be if the leading index were currently in its contractionary phase, and Fu_t measures the probability of the current change if the leading index were in its expansionary phase. The larger the current decline in the leading index, the larger is Fd_t relative to Fu_t. Following Diebold and Rudebusch, we assume that changes in the leading index are normally distributed. Furthermore, if P_t is greater than 0.95 we restrict P_{t-1} in the next period to equal 0.95. This prevents the probability of recession estimate from getting stuck at a value of 1.

In the month that the leading index reaches a cyclical trough, the probability that the leading index is in its contractionary phase is set equal to zero and the recursive probability of recession in subsequent months is calculated using the equation above. Once the leading index reaches a cyclical peak, the probability that the leading index is in its expansionary phase is set to zero and a modified version of the above equation calculates the recursive probability of an upcoming recession. The modification switches Fd_t and Fu_t and replaces PL with the a priori probability that the leading index has entered its expansion phase, given that in the prior month it was in its contractionary phase.

lead, a coincident change, and a five-month lead. Once again, the lead times are representative of the lead of the actual start of the expansion, not the realization that the expansion has started based on changes in aggregate indicators such as output and employment. Applying the recursive probability of expansion to changes in the coincident index and RGDP results in signals given well past the actual trough in the business cycle. The average signal of expansion occurs three months following the start of the expansion when changes in the coincident index are used and six months when changes in RGDP are used.

While the leading index appears to have some predictive content, its usefulness is sharply hampered by reporting lags in the data. The lead times discussed above do not account for timeliness of release of the indicators. Long reporting lags delay the calculation of the leading and coincident indexes as much as ninety days following the end of the reporting month.[21] This reduces the actual lead (increases the lag) in the realization of turning points. The timing of the signals given by the leading index relative to those given by RGDP and the coincident index, however, remains the same since the reporting lags are similar across the two indexes and RGDP.

Overall, our findings indicate that the leading index has some usefulness in predicting changes in the Mexican business cycle, although data volatility and long reporting lags limit the amount of advance warning the index can give. As an example, for the most recent recession, movements in the leading index did not signal an 80-percent probability of recession until December 1994, three months after the recession began (although the recession was somewhat mild in the fourth quarter of 1994 and intensified in the first half of 1995). The timing of the signal was weakened further by reporting lags that delayed the calculation of the December leading index until the latter half of March. Although a strong recession signal from the leading index did not occur until six months after the recession began, similar signals did not appear from movements in RGDP until the second week in May. A strong signal of recession from the coincident index occurs about the same time as the signal from the leading index, although in the past, changes in the coincident index have signaled a high probability of recession later than the leading index.

As shown in Figure 7, the probability of recession is quite volatile, reflecting much uncertainty about the economic outlook. While this volatility can be the result of a poor selection of indicators or poor computational techniques, it likely reflects, at least in part, the general volatility and uncertainty that actually exists in this dynamic economy. Much of the uncertainty likely rests in social and political factors that often change rapidly and are difficult to predict. For example, 1994 alone brought an armed uprising, the assassination of a presidential candidate, an assortment of kidnappings, presidential elections, and a dramatic currency devaluation. One area of future research would be to try to include indicators that are more sensitive to the important political and social factors that affect the Mexican economy.

Summary

Over the past decade, the Mexican economy underwent significant economic reforms that set the stage for improved economic growth in the late 1980s and early 1990s. While the country seemed on track for another year of economic growth in 1995, a sudden, unexpected peso devaluation sent the economy into the depths of recession. This sudden shock and past shocks to the Mexican economy have increased the demand for timely economic indicators to help monitor where the economy is and where it is headed.

In this article, we develop indexes of leading and coincident indicators that are similar to those the NBER developed for the United States and other countries. The coincident index comprises five series that have been shown to track the business cycle movements in many countries. The leading index comprises eight series that tend to lead movements in the Mexican economy. The components represent a wide variety of economic sectors and processes.

An evaluation of the composite leading index shows that, while the index peaks prior to recessions, strong signals of recession usually are not given until right at, or slightly after, the cyclical turning point. Also, volatility in the index led to several false signals over the time period since 1980. Nonetheless, the signals of recession given by the leading index generally result in fewer false signals of recession and have a greater lead time (shorter lag time) than the signals given by changes in RGDP and the coincident index. The leading index performs somewhat better in signaling upcoming expansions, with an average lead time of 2.3 months and no false signals. Using changes in the coincident index or RGDP, the signal of economic expansion does not occur for several months after the trough.

To judge the usefulness of the computed indexes or their components more completely, the real-time performance of the series must be studied over long periods of time and across many business cycles. To this extent, the Center for International Business Cycle Research will be producing and monitoring a corresponding set of Mexican composite economic indexes, along with their components. The finalization of the indexes and their monthly production are still in their early stages.[22]

Notes

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1 For a detailed discussion of Mexico's economic past, the events leading up to the 1995 economic crash, and the long-run outlook, see Gould (1995).

2 The need for timely, accurate data on Mexico was thought to be so important that the group of countries that provided a $50 billion loan to Mexico in 1995 stipulated as a part of the agreement that Mexico commit to economic and financial transparency. In response, Mexico began producing and publishing some economic and financial information on a more

timely basis. International reserve data, for example, which until 1994 had been released only three times per year, are now published on a weekly basis.

[3] The index originated in a 1938 study conducted for the NBER by Wesley Mitchell and Arthur Burns and has been further developed in work by Geoffrey Moore and others at the NBER and the Center for International Business Cycle Research (CIBCR), Columbia University. The Conference Board is a private, business-sponsored research organization. Before December 1995, the U.S. Department of Commerce, Bureau of Economic Analysis (BEA) produced the composite indexes of leading, coincident, and lagging economic indicators. It should be noted that the indexes developed and maintained by CIBCR differ from those of the Commerce Department and Conference Board.

[4] For recent criticism of the leading ability of the U.S. leading index, see Koenig and Emery (1994). For research that supports the use of the leading index, see Auerbach (1982) and Koch and Rasche (1988).

[5] For a more detailed explanation of the reasons for combining indicators into composite indexes, see Zarnowitz (1992, 316–17).

[6] The results in Table 1 were derived from data currently available. Because these data are revised often, the results do not reflect real-time data and are thus subject to the criticism presented in Koenig and Emery (1994).

[7] For a more detailed discussion on the role of oil prices and exchange rates on the Mexican economy, see Gould (1995).

[8] In general, all the potential series studied are highly economically significant. Statistical adequacy is hard to determine without a detailed study of the process by which each series is calculated. We have left these criteria for further research.

[9] They first compute deviations from seventy-five-month moving averages. These deviations are then divided into business cycle phases, and a three-phase moving average is calculated and defined as the trend. Turning-point selection criteria developed in Bry and Boschan (1971) are then used to date turning points in the trend-adjusted series. For more information on this process, see Klein and Moore (1985, 29–41).

[10] The series obtained for Mexico are sometimes different from the respective series calculated in the United States. For example, the employment series for Mexico is the number of workers who are covered by social insurance and represents a much smaller fraction of the total employed than the employment series for the United States. We obtain the monthly inventory-in-relation-to-sales series and the raw materials price index from Banco de México. The U.S. refiners' acquisition cost of crude oil published by the U.S. Department of Energy is used as a measure of the nominal oil price. The nominal peso/U.S. dollar exchange rate and the U.S. and Mexican CPIs are from International Monetary Fund, International Financial Statistics. The rest of the series is from INEGI.

[11] Each of the candidate series is first made into a random (white noise) process by an appropriate ARIMA model, and this model is then used to filter RGDP. Because the time series process of each series is unique to the series, different ARIMA models are used for different candidate series. The appropriateness of the ARIMA model is judged by the lack of statistical significance between changes in the error term from the model and lag changes in the error term.

[12] The procedure, described in Vandaele (1983, 267–99), is easily performed with statistical packages such as SAS.

[13] The statistical computer package SAS reports an MCD in its PROC X-11 procedure.

[14] We estimate the timeliness of release using data through June 1995. Actual release dates may vary. Over the past year and continuing into 1996, Mexican government agencies have increased their efforts to release economic data on a more timely basis. Thus, the release lags in this study are tentative.

[15] Because industrial production is released later than the other series, we also have tried an index with only the unemployment rate and manufacturing and trade sales smoothed. This index, which has an MCD of 2, is erratic, with peaks and troughs that are sometimes hard to distinguish.

[16] One way to increase the timeliness of the coincident index is to estimate the most recent month's change in the three smoothed series by calculating a two-month moving average in each of the series and using its most recent change to estimate the current month's change in the smoothed series. This process will increase the timeliness but will also lead to increased revisions.

[17] Calculating the coincident index without monthly RGDP results in essentially the same relationship between the index and quarterly RGDP as that shown in Figure 4.

[18] In our index, we look at real stock prices. Inflation in Mexico has been significantly higher (and more variable) than in the countries shown in Table 1, so that deflating the stock price index is necessary to reduce inflation distortions.

[19] It is important to center moving averages in the components of the coincident index, since this index is used to designate the actual month a recession starts or ends. The same is not true of the leading index. The turning points in the leading index have no particular interpretation other than as a signaling device of upcoming changes in the economy.

[20] Changes in the leading index are first converted to a white noise process with an appropriate ARIMA model and then the coincident index is prefiltered with the same model.

[21] See note 14.

[22] For more information of the availability of the indexes and their components, call the CIBCR at (212) 688-2222.

References

Auerbach, Alan J. (1982), "The Index of Leading Economic Indicators: 'Measurement Without Theory,' Thirty-Five Years Later," *Review of Economics and Statistics* 64, 589–95.

Bry, G., and C. Boschan (1971), *Cyclical Analysis of Time Series: Selected Procedures and Computer Programs*, National Bureau of Economic Research, Technical Paper no. 20, New York.

Chow, Gregory C., and An-Ion Lin (1971), "Best Linear Unbiased Interpolation, Distribution, and Extrapolation of Time Series by Related Series," *Review of Economics and Statistics* 53 (4): 143–59.

Diebold, Francis X., and Glenn D. Rudebusch (1989), "Scoring the Leading Indicators," *Journal of Business* 62 (July): 369–91.

——— and ——— (1991), "Turning Point Prediction with the Composite Leading Index: An Ex Ante Analysis," in *Leading Economic Indicators: New Approaches and Forecasting Records*, Kajal Lahiri and Geoffrey H. Moore, eds. (Cambridge, UK: Cambridge University Press), 231–56.

Gould, David M. (1995), "Mexico's Crisis: Looking Back to Assess the Future," Federal Reserve Bank of Dallas *Economic Review*, Second Quarter, 2–12.

Klein, Philip A., and Geoffrey H. Moore (1985), *Monitoring Growth Cycles in Market-Oriented Countries*, National Bureau of Economic Research Studies in Business Cycles, no. 26 (Cambridge, Mass.: Ballinger Publishing Company).

Koch, Paul D., and Robert H. Rasche (1988), "An Examination of the Commerce Department Leading-Indicator Approach," *Journal of Business and Economic Statistics* 6 (April): 167–87.

Koenig, Evan F., and Kenneth M. Emery (1994), "Why the Composite Index of Leading Indicators Does Not Lead," *Contemporary Economic Policy* 12 (January): 52–66.

Moore, Geoffrey, and J. Shiskin (1967), *Indicators of Business Expansions and Contractions*, (New York: National Bureau of Economic Research).

Neftci, Salih N. (1982), "Optimal Prediction of Cyclical Downturns," *Journal of Economic Dynamics and Control* 4 (November): 225–41.

Vandaele, Walter (1983), *Applied Time Series and Box-Jenkins Models* (New York: Academic Press).

Zarnowitz, Victor (1992), *Business Cycles: Theory, History, Indicators, and Forecasting*, National Bureau of Economic Research Studies in Business Cycles, vol. 27 (Chicago: University of Chicago Press).

———, and C. Boschan (1975), "Cyclical Indicators: An Evaluation and New Leading Indexes," *Business Conditions Digest* 75 (May): v–xv.