A Leading Index for Small Metropolitan Areas

by

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ABSTRACT

Indexes of leading indicators have been constructed for numerous nations and relatively large regions (for example states) and have proven to be useful for forecasting purposes. Similar indexes have been developed for some major metropolitan areas. However, due to data constraints, relatively few small metropolitan areas have useful leading indexes. The purpose of this paper is to investigate construction of a leading index for a small metropolitan area and to test the effectiveness of this index as a tool for forecasting turning points in monthly regional employment levels.

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I. INTRODUCTION

It is obviously useful to be able to forecast the future. People have been trying to do it for millennia (and no, we won't cite the Bible or Nostradamus.) Business managers are no different; if local firms can accurately anticipate the onset of a local recession, they can better plan their resources and increase their profits–or at least, minimize their losses.

At the national level, the Conference Board's Index of Leading Indicators (ILI) is a much-watched portent of things to come. (See Conference Board.) Each month its release is heralded in the national media and pundits are asked for their interpretation of this high-tech crystal ball. In fact, the ILI has proven quite useful in predicting the onset of national recessions; as has often been noted, it has predicted nine of the last six recessions. Obviously, it sometimes gives a false signal, but many would argue that it's better to be incorrectly warned about a catastrophe that doesn't happen than to be unwarned about one that does. (Ask anyone who lives in Tornado Alley.)

At the sub-national level, things are a little more complicated than at the national level. Since state and local economies are typically more specialized than the national economy, they are liable to experience business cycles that have different timing and frequency than the national cycles. For example, Crone (1994) found that the Pennsylvania economy tended to experience longer recessions than the national economy during the period from 1972 to 1993, and its recoveries were less vigorous. Similarly, Delaware experienced a local recession in 1976-77 that was not shared at the national level, and missed the national recession of 1980 altogether (Crone, 1994.) As Crone points out, Pennsylvania and Delaware have industrial structures that do not precisely parallel that of the nation.

This principle also applies at the local level, of course. A local economy will not necessarily mimic the cycles of its state or its nation. This suggests that it is necessary to develop separate leading indicators for local areas, to supplement information from national and, where available, state indicators.

This paper presents the first steps in an attempt to do this for the Erie, Pennsylvania economy. Erie is in the northwestern corner of Pennsylvania. The official Erie Metropolitan Area (MA) consists of a single county, also named Erie. (The analysis in this paper applies to the Erie MA, not the City of Erie.) It has a population of approximately 280,000 and was #132 of the 273 metropolitan areas in the U.S. in terms of 1997 population.[1]

The Erie economy is different from both the state and the national economies. Manufacturing plays a bigger role in Pennsylvania than in the nation, and a bigger role in Erie than in Pennsylvania; and within manufacturing, durables also play a more important role than average. For 1997-98, manufacturing accounted for 26% of employment in Erie, but only 15% in the nation. Durables manufacturing employment was 18% of Erie total employment, but only 9% for the nation.

Given the greater cyclical instability of manufacturing employment than of non-manufacturing employment, and of durable manufacturing in particular, it is not surprising that Erie tends to have a business cycle with a greater amplitude (Kurre and Weller, 1989; Kurre, Weller and Woodruff, 1992.) Timing is another issue, however. Examination of a region's industrial structure does not obviously identify the region's cyclical timing patterns.

Those who try to analyze small areas typically face a major hurdle immediately: there is much less data available for small areas than for the nation. This is a key reason for the existence of relatively few composite indexes of leading indicators for small areas. Constructing a viable composite indicator requires timely, high frequency (preferably monthly) data on a number of relevant time series. In addition, the data series underlying the composites should be relatively smooth and subject to, at most, very minor revision subsequent to initial release. Testing the efficacy of composite indicators also requires that they be available over a relatively long span of time.

Unfortunately, as the size of a region falls, the number of series available to analysts also tends to fall, as well as their length, frequency, timeliness, and reliability. For example, at the small region (MA) level there are no published measures of aggregate economic activity analogous to gross domestic product (GDP), gross state product (GSP) or industrial production. Data on small MA personal income are only available annually and with a considerable time lag.[2] As these examples suggest, most of the typical measures used to construct national and large region indexes are simply not available at the small region level.

This means that local analysts sometimes need to get a little clever when trying to accomplish things that macroeconomists take for granted. Regional analysts must rely on close proxies for these fundamental economic measures, proxies such as total employment or hours worked. Some local areas also have to deal with the problem of inconsistent data series resulting from changing geographical definitions of the area.[3] Fortunately for us, Erie does not face this problem.

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[1] Rank #1 is the largest. Erie's population for 1997 is 279,401. Source: *State and Metropolitan Area Data Book 1997-98,* Table B-1; available online at: http://www.census.gov/Press-Release/metro01.prn

[2] Data on 1997 Personal Income for local areas were published in the May 1999 issue of the *Survey of Current Business*. The two-year lag makes this series virtually useless for forecasting purposes. See: Bailey (1999). Local area personal income data for 1982–97 are available on the web at: http://www.bea.doc.gov/bea/pub/0599cont.htm.

[3] The Office of Management and Budget periodically reviews the official definitions of Metropolitan Areas. As areas grow and spread out, it may become appropriate to add counties to some areas, and split counties from others to become their own autonomous Metro Areas. Since Metro Areas are typically—but not always--composed of whole counties, it is often possible to adjust earlier data to be consistent with new metro definitions. Definitions of metro areas can be found at: http://www2.whitehouse.gov/WH/EOP/OMB/html/bulletins/bulletins.html and http://www.bea.doc.gov/bea/regional/docs/msalist.htm.

II. PREVIOUS WORK

We are not the first to attempt construction of leading indicators for a subnational economy. Currently leading indicators are published regularly for New Jersey (Crone and Babyak 1996), Pennsylvania (Crone and Babyak 1996), Wisconsin (Tumpach 1999), and for the Las Vegas region of Southern Nevada (Gazel and Potts, 1995). Leading indicators have also been generated for Illinois (Fay, 1983), Texas (Kozlowski, 1983), Ohio and eight of its metro areas (Lesage and Magura, 1987), New Orleans (Conte, 1986), Milwaukee (Crane, 1993), and Philadelphia (Rufolo, 1979). It is interesting to note that several of these leading indicator projects, whose very nature requires constant updating to be useful, were one-time efforts or have been dropped from regular publication. Perhaps an ominous portent of its own?

There are a number of possible approaches to construction of leading indicators for subnational areas. One would be to try to identify a set of regional series that forecast the regional economy's turns. The emphasis here is on "regional"–no national data series are used. Indicators for Wisconsin (Tumpach 1999), Southern Nevada (Gazel and Potts 1995), Texas (Kozlowski 1983) and Illinois (Fay 1983) have been constructed in this fashion.

Despite the focus on "regional series", many of the subnational indicator efforts start by trying to mimic the national Index of Leading Indicators in content as well as concept. The national ILI currently consists of 10 series with various weights (See the Conference Board website.) State or regional efforts will sometimes start with an attempt to identify the same or proxy series at the relevant subnational level, with varying degrees of success. This seems to be a logical starting place; “if it works for the nation as a whole, it may work for our economy, too.” The logic underlying the use of some of the national indicators is clearly applicable at the local level. For example, building permits are often considered as a leading indicator, since they imply that construction activity will soon follow, along with perhaps increased expenditures on home furnishings, landscaping, realtors’ services to sell the previous house, etc.

In constructing a leading index for New Orleans, Conte (1986) started in quite a different place, however. He noted that the national ILI was not a very good leading indicator for the local economy, although it had been in the past. Clearly, something had changed, and he set out to identify factors that were relevant to New Orleans’ unique economy. As a result, he looked at factors that impact the oil, tourism/convention, and international shipping businesses.

Some of Conte's New Orleans indicators were national data series, however, and this represents yet another approach. It might be logical to combine national indicators with some local indicators in the regional composite index. Why not use the excellent, widely-available national data to capture the effect of the national cycle, but then add local series to adjust for the local economy's uniqueness and eccentricities? This is the approach taken for Pennsylvania (Anderson 1992), Milwaukee (Crane 1993), and Ohio and eight of its MSAs (Lesage and Magura 1987.)

A quite different tack is to follow the significantly more sophisticated approach of Stock and Watson (1989). This involves using vector autoregressive (VAR) techniques to identify a set of variables that will yield a consistently leading series for the overall economy—a leading series which may itself not be directly observable. Crone and Babyak (1996) do this for Pennsylvania and New Jersey, with apparent success.

Speaking of VAR, why do we bother with leading indicators at all, given that there are much more sophisticated methods of forecasting a local economy, such as VAR, transfer functions, state-space analysis, etc.? After all, the indicator approach is subject to the familiar criticism that it embodies measurement without theory (Koopmans 1947), and only relies on correlations in the timing of the indicators with that of the economy, rather than causal relationships.

The reason is that while those more sophisticated techniques are useful for forecasting the *amount* of change in various series, they do significantly less well at identifying the *turning points* in the series. And knowing the actual turning point in advance is key for the timing of important decisions. It is for this reason that we employ leading indicators as a complement to–not as a substitute for–other forecasting techniques.

III. CONSTRUCTING A LOCAL LEADING INDEX: A PROPOSED METHODOLOGICAL APPROACH

A. Basics

As mentioned above a number of techniques exist for constructing composite indexes. However, this paper will use a variant of the approach that the Conference Board currently uses to construct the U.S. composite indexes of leading and coincident indicators.[4] A brief synopsis of this approach follows. First, month-to-month symmetric percentage changes in each component series are calculated (if the series is already in percentage change form, simple arithmetic changes are used). Next, when there is more than one series being used to form the index, the month-to-month percentage changes are standardized to prevent fluctuations in the more volatile series from dominating those in less volatile series. This standardization is accomplished by deriving weights for each component series which are an inverse function of the standard deviation of the month-to-month percentage changes calculated in the previous step. These weights or series standardization factors are adjusted to sum to 1.00 (100%) over all component series. Adjusted or standardized month-to-month percentage changes in each component series are calculated by multiplying each raw month-to-month percentage change series by the corresponding series standardization factor. These adjusted or weighted month-to-month percentage changes are summed to obtain the month-to-month percentage changes in the composite index. The level of the resulting composite is calculated recursively from these percentage changes using the symmetric percentage change formula. Finally, the composite is re-based to 1992 = 100.

For some of our trial indexes, our approach differs from this standard approach. In some cases we manually select the standardization weights to be applied to the component series, giving successively more weight to the more volatile local series and successively less weight to the typically more stable national series. (Of course, the weights still sum to 1.00). Thus in some cases we try trading off smoothness in hope of gaining improved accuracy in predicting turning points at the local level. But prior to examining the efficacy of our approach, some additional methodological considerations and issues need to be discussed.

[4] See the Conference Board's "Business Cycle Indicators Website" at: http://www.tcb-indicators.org/ for full details.

B. Some Additional Methodological Considerations

i. Choosing the target series

Since leading economic indicators are supposed to lead the overall economy, evaluating their performance requires the choice of a reference or target series. This is normally some relatively high frequency measure of aggregate economic activity such as GDP, GSP, industrial production, personal income or, preferably, a composite indicator of current aggregate economic activity. As noted above, none of these measures are available at the small region level. What usually is available is employment data. For example, for the Erie MA monthly employment data (total and by industry) are available beginning in the early 1950s. This is the well known Bureau of Labor Statistics (BLS) “establishment data,” "payroll employment," or "form 790 data." This local series is the same as one of the series used to construct the national composite index of coincident indicators, specifically the national “employees on non-agricultural payrolls” series. Thus, by default, the target series used to evaluate the proposed small region leading indicator is regional non-farm employment.[5]

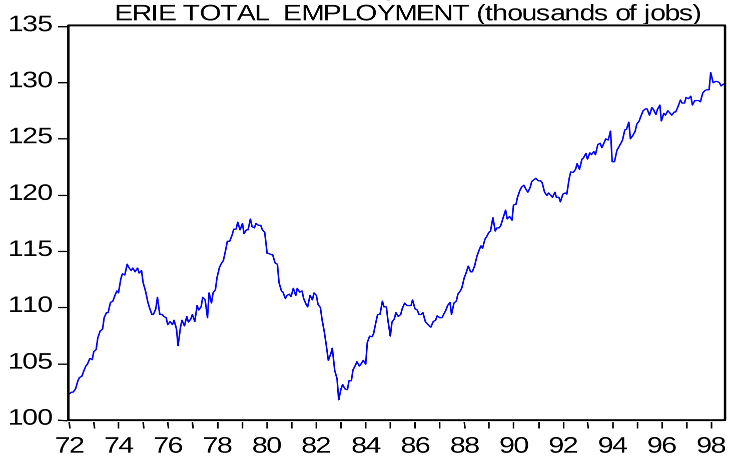
Although regional employment data series have several desirable characteristics, i.e., they are generally available, of high frequency (monthly), and cover long time spans, they are also subject to a number of shortcomings. For example, they are less timely than the national estimates (the Erie MA monthly estimates always lag the national estimates by one month), they tend to be more volatile, and they are subject to a number of subsequent revisions. For example, the preliminary estimate of April’s regional employment is released in June. A revised estimate for April is published in July. Subsequent benchmark revisions of the April, 1999 estimate will occur about March of 2000. The revisions are sometimes sizable. (For example, Runkle (1998) finds that revisions in *national* GDP and inflation data are substantial and can affect policy decisions.)

Given the characteristics of the employment data, the question arises as to which series to use as the target series when evaluating the performance of alternative local leading indicators–the preliminary series or one of the subsequent revisions? We have elected to use the “final revised” or benchmarked series as the target series . The rationale for this choice is that the leading indicator should lead or predict our best estimate of what is/was *actually occurring* in the economy at time (t), and our best estimate is the final benchmarked estimate.

Figure 1 shows Erie total nonagricultural employment in thousands of jobs, seasonally adjusted, over the study period.

[5] The BLS data, both local and national, are available online at: http://stats.bls.gov:80/datahome.htm.

Figure 1
ERIE TOTAL EMPLOYMENT (thousands of jobs)



ii. Evaluating leading indexes

Before we begin examination of actual leading indicator candidates, we must establish the criteria for judging them. How will we identify good or bad leading indicators? For our work, we established five criteria for judging the potential indicator series:

1) *Missed turning points.* A good leading indicator should not miss any turns in the target data series. Ideally, it should be able to predict *every* turn and not leave its adherents unwarned of a cyclical change in the economy.

2) *False turning points.* Conversely, a good leading indicator should not give signals for cyclical turns which do *not* eventually materialize in the target series. A leading indicator that consistently gives false alarms will quickly lose its credibility.

3) *Length of the lead.* The leading indicator series should lead the overall economy by a long enough period to be useful for planning purposes. If a series led by only one day, it would not be as useful for planning as if it led by six months. In general, the longer the lead, the better. Performance on this criterion can be measured by average lead at all turning points, and also at peaks and troughs separately.

4) *Consistency of the lead*. Can the leading indicator series be counted on to always lead the local economy by about the same number of months, or is the lead very different from cycle to cycle? The standard deviation of the timing of the turning points can help measure this, as well as the range of lead times (maximum lead minus minimum lead) over the study period.

5) *Variability of the index.* An extremely volatile series that has many ups and downs from month to month will obviously be harder to use in practice than a nicely-behaved series which consistently rises to its peak, and then consistently falls until its trough. The latter series would enable the user to identify a turning point with a high degree of certainty with relatively few months of data at the turn. A volatile series, on the other hand, makes it difficult to distinguish the actual turns in the cycle from random upticks. As a result, the user would need to see a longer period of the series moving in a single direction before being confident enough to

identify a turn. This means that a volatile series would need to have a longer lead than a smooth series to enable the same degree of forecasting performance. In other words, there is some tradeoff between variability of the series and length of lead time. A smoother series with a shorter lead time may be preferably to a more volatile series with a longer lead time.

Of course, these five criteria are not all equally important. As the name "leading indicator" implies, sufficient lead time is a *sine qua non* for a good leading indicator. Without that, a series doesn't even make the initial cut. But beyond that, there is some tradeoff with volatility, as explained above.

As for the first two criteria, catching all turning points is probably more important than avoiding false signals, based on the "tornado" argument cited at the beginning of the paper. It is better to be falsely warned about a crisis that does not materialize, than to be unwarned about one which does. But too many false turns means the series will not be believed when it IS eventually right; it will become "the little series that cried wolf" and will be disregarded.

In general, forecasts can be evaluated in at least two ways, one which might be called quantitative or magnitude based, and the other which might be called qualitative or timing based. Quantitative evaluations of leading indexes usually compare the forecast accuracy of indicator based regression type forecasting models with that of other non-indicator based models such as exponential smoothing and ARIMA models.

Qualitative or timing based evaluations, the focus of this paper, examine measures such as number of correctly predicted turning points, the number of missed turns, and the number of false signals exhibited by the indicator. (See, for example, Conte 1986, Crane 1993.) Other aspects of a qualitative evaluation include measures of average, maximum, and minimum lead times as well as some measure (usually the standard deviation) of lead time variability.

iii. Determining turning points

To qualitatively evaluate leading indexes as turning point predictors in a historical (as opposed to real time) context, a method must be devised to select turning points in both the candidate leading index and the target series. This could be done subjectively *via* inspection. However, to make this process replicable and at least nominally “objective,” we implemented (using the EViews programming language) a version of the Bry and Boschan (BB) turning point selection program, as revised by Watson, Denson, and King (see Bry and Boschan 1971 and Watson 1992). The BB program essentially determines peaks and troughs in a series by “homing in” on final turning point dates. This “homing in” is accomplished by successively refining tentative turning points in a 12 term equally weighted moving average of the seasonally adjusted input series. Candidate turns are selected by searching for individual observations which are higher (lower) than the preceding or following six observations. These preliminary turns are refined by successively searching other smoothed versions of the input series for turns in the immediate vicinity of the preliminary turns identified at the previous stage. First, a 15 term Spencer Curve (unequally weighted moving average) of the input series is searched, then a short term moving average of the input series, the length of this moving average being determined by the MCD (months for cyclical dominance). Finally, the actual unsmoothed seasonally adjusted input series is searched.

At each stage of this iterative search process, tentatively selected peaks and troughs are subjected to a number of decision rules and either kept or discarded. Representative rules include the following: selected peak and trough dates must alternate, complete cycles and individual cycle phases must be at least as long as some specified minima (BB use a minimum expansion or contraction phase length of five months and a minimum cycle length of 15 months, measured either peak to peak or trough to trough), and no turns are allowed within six months of the ends of the series being evaluated. Note that although subjecting a given series to the programmed selection procedure will produce replicable results, the seemingly “objective” results incorporate the subjectivity inherent in the programmed decision rules themselves.

The fact that the program automatically discards turning points which occur within six months of the ends of a series is extremely important if it is to be used to detect turning points in the composite leading indicator in real time. Assuming the data series underlying the composite leading indicator are available without a lag, the earliest the program could signal a turn would be seven months after the fact. If a composite leading indicator is extremely, and unrealistically, well behaved (for example, always exhibiting exactly a 15 month lead time and never providing a false signal), real time use of the program to call turns in the target series is not severely compromised–users would still end up with a consistent eight-month warning of impending cyclical turns in the target series. Unfortunately, real-world leading indicators tend to have highly variable lead times. Thus, in real-time forecasting situations users of leading indexes usually have to adopt one or more *ad hoc* rules (such as three successive monthly declines in the index) to "call" impending turns.

Another aspect of choosing turning points is whether to focus on turns in the raw indicator and/or target series, which can often be quite volatile, or turns in one of the smoothed versions of these series. Focusing on smoothed values may make it easier to “call” turning points since smoothing tends to reduce series volatility and hence highlight the cyclical component. The disadvantage of using smoothed versions of the indicator and/or target series is that it results in a loss of observations at the ends of the series. Couple the loss of observations associated with smoothing, with the two month lag associated with obtaining the preliminary estimate of regional employment (or a three month lag in the case of the initial revised value), and much potential lead time can be lost.

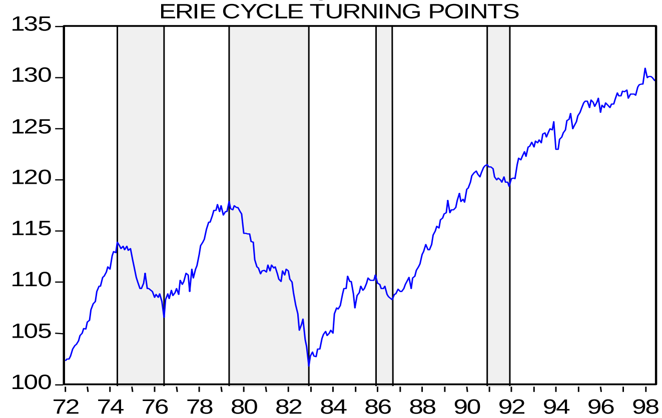
For this analysis we used monthly data from January 1972 through July 1998. In that period, Erie experienced four peaks and four troughs, as did the U.S. economy. However, they weren't the same four. Table 1 and Figure 2 show that Erie missed the national upturn in 1980-81 and continued in recession straight through to the trough in December 1982. However, Erie experienced an extra recession in 1985-6 that the nation did not.

These data imply that Erie employment generally lags the nation's official business cycle turning points, suggesting that Erie may be able to use the national economy–or some of its components–as a leading indicator. However, the table also shows considerable variation in the length of the lead.

Table 1
Turning Points, Erie and U.S.

	Erie	US	Erie Lead(-) / Lag(+) Peaks	Troughs
Peak	74;05	73;11	+6	
Trough	76;06	75;03		+15
Peak	79;05	80;01	-8	
Trough		80;07		
Peak		81;07		
Trough	82;12	82;11		+1
Peak	85;12			
Trough	86;09			
Peak	90;12	90;07	+5	
Trough	91;12	91;03		+9

Figure 2
ERIE CYCLE TURNING POINTS



IV. RESULTS

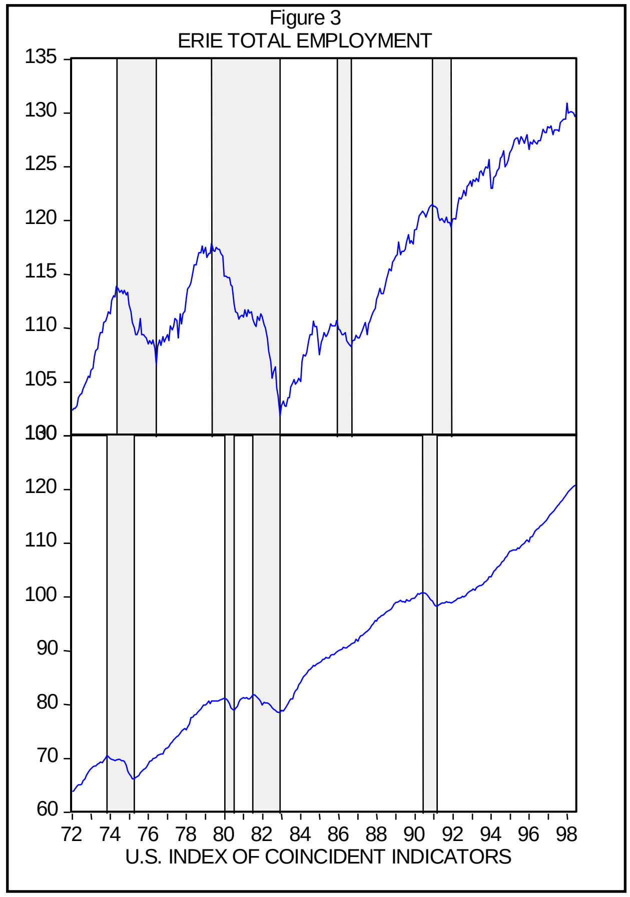
In our experimentation to identify leading indicators for the Erie economy, we have tried two approaches so far: 1) use of a single series as a leading indicator; and 2) a combination of national and local series.

A. The Single Series Approach

In the spirit of Occam's Razor, economic efficiency, and trying to get the biggest payoff for the least amount of work, we started by considering three individual series as possible single-series leading indicators for the local economy.

i. U.S. Index of Coincident Indicators (ICI)

Since Erie tends to follow the nation at turns, it makes sense to try using the national economy as a leading indicator. We started with the Conference Board's well-known Index of Coincident Indicators (ICI) for the national economy. Of course, turns in this series coincide closely with the official national turning points, although its turns are different from those official turns by a single month in a couple of cases.[6]



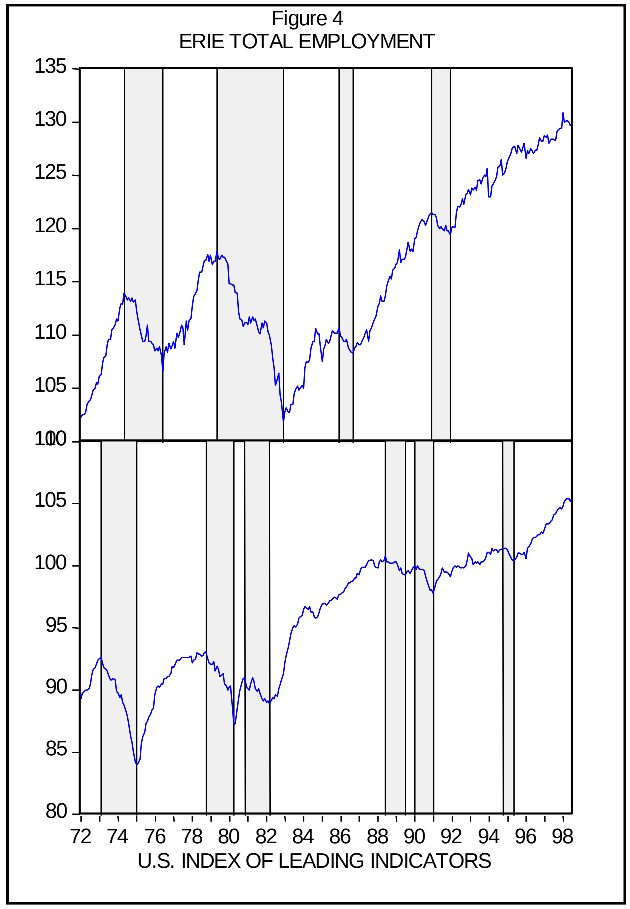
We will present the results of all these tests in two forms, a table and a graph. To facilitate comparison of the various indicators, we have compiled the results into a single table in the appendix, Table A-1. For each indicator tested, the table gives summary statistics on timing, number of missed and extra turns, etc. We also present a two-panel graph in the text for each potential indicator as it is discussed. Each graph will show the Erie economy (Erie total employment) in the top panel and the relevant indicator in the bottom panel. The gray "recession" bars make it easy to compare the timing of turning points in each potential indicator series with those in the Erie economy overall. The vertical axis on the Erie graph (top panel) measures thousands of jobs, and the vertical axis on the leading indicator graph (bottom panel) is typically an index with a base of 1992 =100.

Figure 3 shows that, relative to Erie, ICI had two missed turns (the peak and trough of Erie's 1985-86 cycle) and two extra turns (the turns associated with the national 1980-81 upturn in which Erie did not participate.) Average lead time of ICI compared to Erie employment was 4.6 months, with a mere 1.3 month lead for peaks and 7.8 month lead for troughs.

Aside from being rather short, lead time was also quite variable, ranging from 14 months for the June 1976 trough to an eight month lag at the May 1979 peak. This gave a range of lead times of 22.4 months, and a standard deviation of lead times of 7.8 months.

[6] See the Conference Board's "Business Cycle Indicators Website" at: http://www.tcb-indicators.org/ for full details.

ii. U.S. Index of Leading Indicators (ILI)



Given the relatively short lead time of the ICI indicator, especially at peaks, we turned next to the U.S. Index of Leading Indicators (ILI). Logic suggests that this series should give better lead times, although it still may not resolve the problem of missed and extra turns. The results are shown in Figure 4.

This series yielded a significantly better lead time, an average of 11.8 months, with an 11.1 month average lead at peaks and a 12.5 month lead at troughs. It also exhibited a smaller variability of lead times, ranging from a seven month lead at the May 1979 trough to a seventeen month lead for the June 1976 trough. This range of 10.2 months was less than half of the ICI's 22.4. The ILI also exhibited a significantly smaller standard deviation of lead times, with 3.8 months compared to the ICI's 7.8.

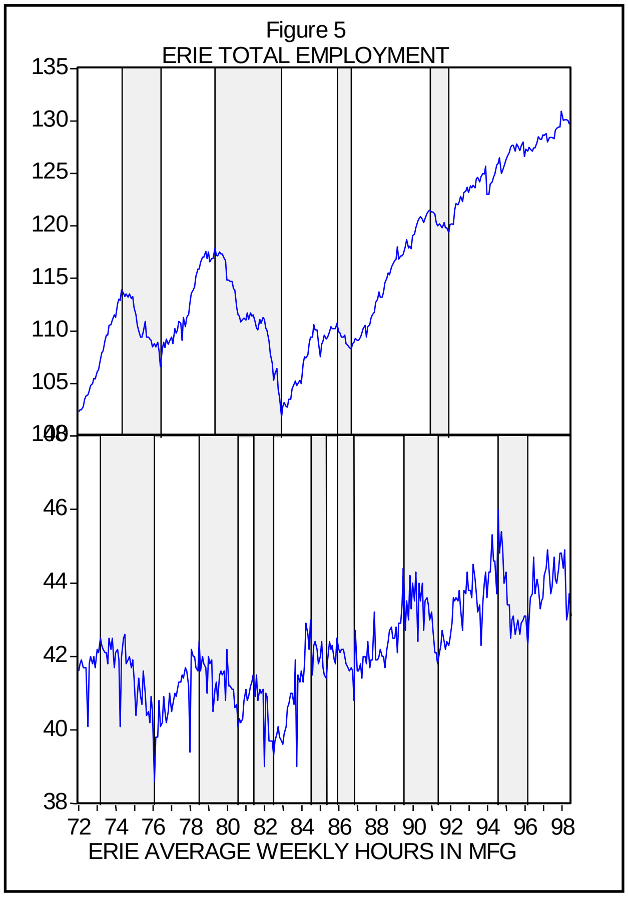
Like the ICI, ILI also missed the two turns for Erie's 1985-86 cycle. However, ILI had another problem; it showed 6 false turns. Given that there were only eight turns in the Erie series over this period, this is a serious problem. A user of this series would have broadcast false warnings for the Erie economy nearly half of the time.

iii. Average hours worked per week in Erie manufacturing industries

Given the performance of the national indicators, especially with regard to missed and extra turns, we next considered local data series. The likely candidates among the data series for a local economy would include:

1) average weekly hours in manufacturing,
2) average weekly initial claims for unemployment insurance, and
3) building permits.

Given that the impact of business cycles tends to be concentrated especially in the manufacturing sector and that the Erie MA has a relatively high concentration of jobs in manufacturing, the first two series listed above would seem to be primary candidates for inclusion in a local leading index. For the Erie MA, data on average weekly hours in manufacturing are available monthly from 1972:01 to the present. Unfortunately, initial claims for unemployment insurance are available only from 1982:01 to the present, and building permits data from 1988:01. As a result, our explorations for this paper use weekly hours worked in manufacturing in the Erie economy.



The economic logic for this indicator is intuitive; firms tend to increase the workweek of existing employees before undertaking the recruiting costs and decreased flexibility of hiring new workers. When it becomes clear that the increase in business is ongoing, then firms will add new employees. This series is used in the Conference Board's national Index of Leading Indicators, as well as Wisconsin (Tumpach 1999), Pennsylvania (Anderson 1992), Ohio (Lesage and Magura 1987), Texas (Kozlowski 1983), and Illinois (Fay 1983).

Figure 5 shows the results for Erie. (Note that this graph's lower panel reports actual weekly hours, not an index.) The Erie hours series has the advantage of catching the local business cycle in 1985-86 that both national indicator series missed. However, the Erie hours series also yielded 6 false turns, the same number as the U.S. ILI.

In terms of timing, Erie hours led the overall economy by an average of 7.7 months, with an average of 10.4 months at peaks and 5.1 months at troughs. The lead time was quite variable, however, ranging from a lead of seventeen months at the December 1990 peak to a *lag* of two months at the September 1986 trough, for a range of 19.3 months. The standard deviation of the lead times was 6.8 months, three months higher than the ILI's standard deviation.

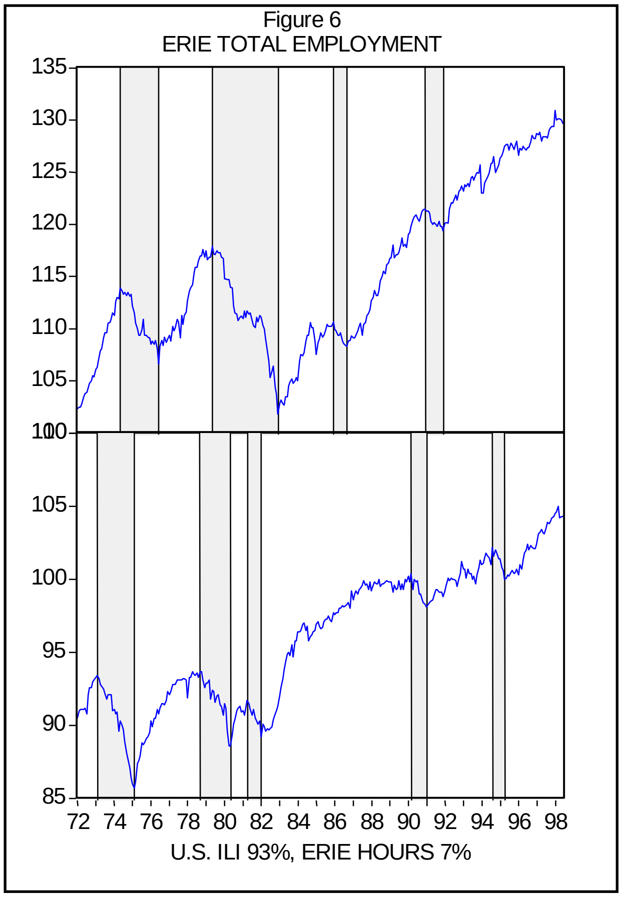
As the graph shows, this is a very volatile series. This volatility would make it more difficult to identify actual business cycle turns in a real forecasting setting, since significant up- or downturns in the hours series are not very trustworthy on a month-to-month basis. It would take several months of data moving in the same direction before the user could be confident enough to predict a coming turn in the cycle.

However, it may be noted that the U.S. hours worked series experiences the same kind of volatility as the Erie series, and is still a useful component of the national Index of Leading Indicators. This suggests that perhaps Erie hours could be combined with other series to yield a better indicator.

B. The Combined National / Regional Approach

The logic in the last section suggests that we should combine national data, which may give longer lead times and a less volatile series, with local data, which can help ensure that no local cycles are missed. This section will present several of the many combinations that we tried. In all of these, weekly hours worked in Erie manufacturing industries will be the local series.

i. Erie hours and the U.S. Index of Leading Indicators



For the national component we started with the U.S. Index of Leading Indicators, given that its performance was better than that of the ICI in terms both of greater length and less variability of lead time. In the initial run, we allowed the index program to set the weights for the two series in the index (ILI and Erie hours) in the usual way based on series volatility, as described in Section IIIA above.

The result is shown in Figure 6. The program assigned weights of 93% to the ILI and 7% to Erie hours, which is not surprising given their relative variabilities. This index exhibited 10 turns over the study period. Like ICI and ILI, it missed the Erie cycle of 1985-86, but it only exhibited 4 extra turns rather than the six of either ILI or Erie hours separately, so the index provides some improvement on this front.

In terms of lead time, the index exhibits an 11.8 month average lead, the same as the ILI. Lead at peaks was 10.8 months, and at troughs, 12.8. This is slightly shorter at peaks than the ILI's 11.1 months but significantly better than Erie hours' 7.7. The variability of the lead is little better than that of the ILI, with a range of 8.1 months and a standard deviation of 3.2. This index does yield improved performance over either the ILI or Erie hours alone, then. It is far from perfect, however.

We thought that it might be possible to improve the index's performance by manually assigning different weight to the national and Erie series. Through a trial and error process the local indicator components were given successively higher weights and the national composite index successively lower weights in order to (hopefully) devise a leading index which does a better job of predicting turns in the local economy.

We tried various combinations of weights, and present several here to give a feel for the process. Figure 7 shows the index with a weight of 80% for the national ILI and 20% for Erie hours. Like the 93/7 index, this one also missed the 1985-86 Erie cycle, and had four extra turns. But it provided an average 12.8 month lead, which is one month longer than the 93/7 index, and had a 12.8 month lead for peaks, two months better than the 10.8 month lead of the 93/7 index. Moreover, the variability of the 80/20 index's lead time was less, with a standard deviation of lead times of only 2.9 months, compared with 3.2 months for the 93/7 index, and a range of only 7.0 months compared with 8.1 for the 93/7 index.

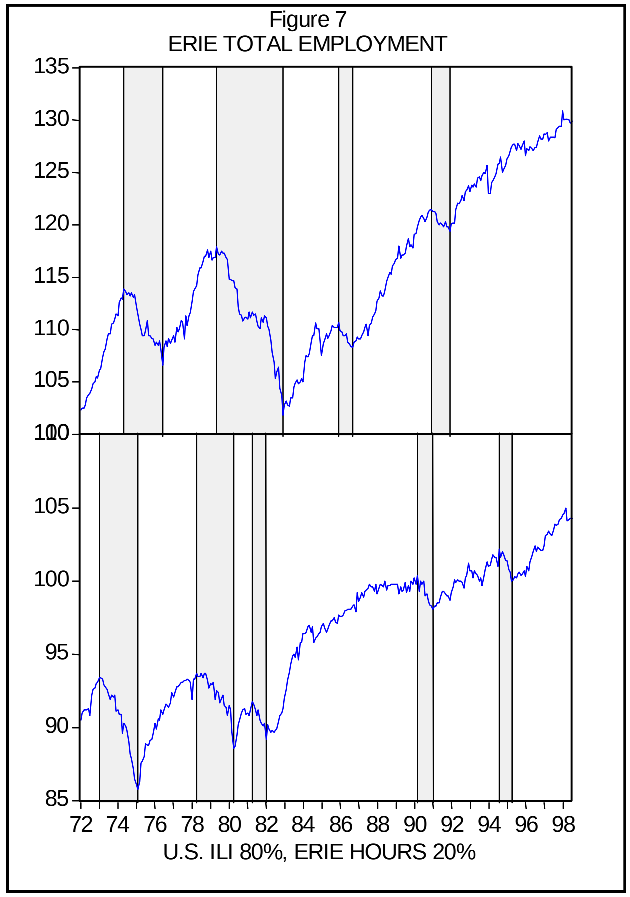


Figure 7
ERIE TOTAL EMPLOYMENT

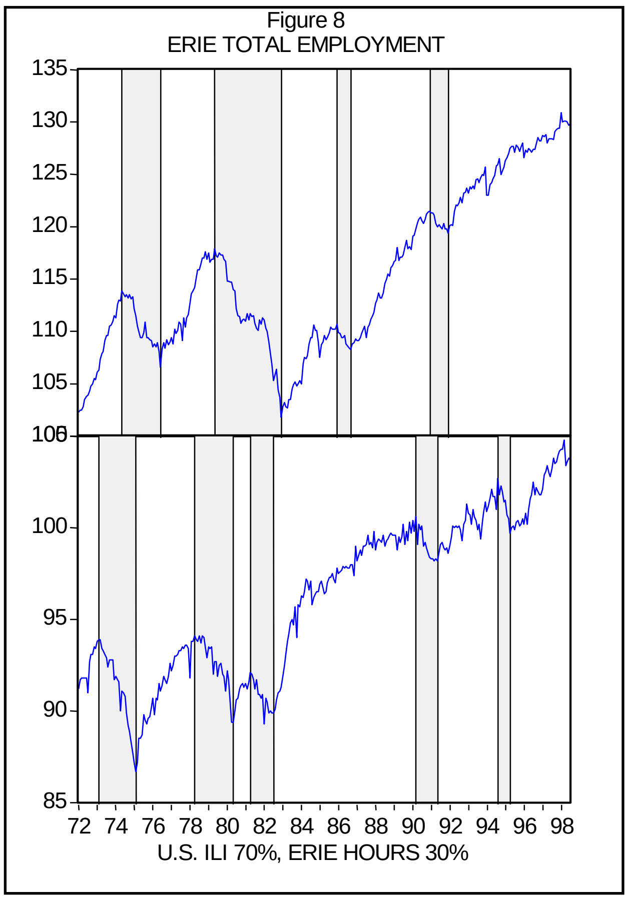


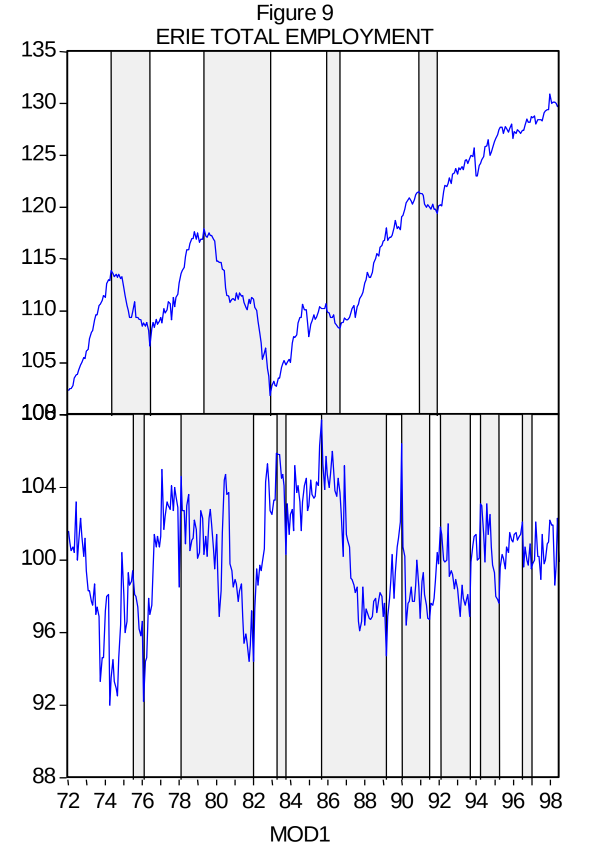
Figure 8
ERIE TOTAL EMPLOYMENT

Continuing in this vein, we next tried weights of 70% for the national ILI and 30% for Erie hours. These results are shown in Figure 8. Like the previous two indexes, the 70/30 index still missed the 1985-86 Erie cycle and had four extra turns. Its mean lead was only 11.0 months overall, though, with 12.5 for peaks and only 9.5 for troughs. Moreover, the variability of the index increased substantially, with a standard deviation of 4.5 months and a range of over 11 months. This index exhibited shorter lead times and greater variability, and still did not capture the unique Erie cycle of 1985-86. An index with 60/40 weights showed a continuation of this pattern, with the same missed and extra turns, even shorter lead times and roughly the same variability.

ii. Erie hours and individual components of the U.S. Index of Leading Indicators

Experiments in the previous section indicate that a combination of local and national series can give a better result than either separately. However, the various combinations of the national ILI with Erie hours were unable to capture the unique 1985-86 Erie cycle, and we considered this a significant failing. Given the lack of other Erie series, we decided to try various components of the ILI rather than the whole ILI index to see if we could resolve this problem. These models (MODs) are discussed next. All of these indexes use Erie hours as the local series. We allowed the indicator program to automatically assign weights to the various components, based on their relative variabilities.

Figure 9



MOD1 combined Erie hours (which was assigned a weight of 64%) with U.S. initial unemployment claims (20%) and U.S. building permits (16%). MOD1 did *not* miss the 1985-86 Erie cycle, although its trough for that cycle is two and a half years past the Erie trough. It also exhibited eight extra turning points– doubling the number of turns that actually occurred!

Mean lead was a miniscule 0.6 months, primarily due to that 30 month lag for the 1986 trough. The series was quite variable, as can readily be seen from the graph, with a standard deviation of lead times of 15.4 months and a range of 45.5 months (the largest of any series we tried.) Lead at peaks was 3.8 months and at troughs there was an average *lag* of 2.5 months. A look at the graphs shows that MOD1 does not conform very closely to the Erie economy.

While this index finally succeeds in capturing the 1985-86 Erie cycle, it does so at too high a price in terms of variability and loss of lead time. To try to remedy that we added another series, U.S. stock prices, which we expected to help smooth the index. MOD2 is thus composed of Erie hours (49%), U.S. initial unemployment claims (16%), U.S. building permits (12%) and stock prices (23%).

MOD2, which is shown in Figure 10, also succeeds in capturing the 1985-86 Erie cycle, but with very long lead times of 30 months for each of those two turns. This may raise the question in some minds as to whether the turns in the index series are actually leading those Erie turns or are unrelated. Assuming that they *are* related to the Erie turning points, the average lead at all turns for MOD2 is 20 months, with a 21.5 month lead at peaks and 18.5 month lead at troughs. This is the longest lead of any of the indicators that we tried. And while variability of this index was less than that of MOD1, it was still rather large, with a standard deviation of 8.6 months and a range of 19.3 months. It also exhibited six false turns.

To decrease the variability of the index, we added the U.S. real money supply (M2) to create MOD3. The components of MOD3 and the weights assigned by the index program are: Erie hours (17%), U.S. initial unemployment claims (5%), U.S. building permits (4%) and stock prices (8%) and real money supply (66%). Notice the heavy weight assigned to the money supply, reflecting its relative stability.

Figure 11 indicates that this combination succeeds in smoothing the index. However, MOD3 had trouble with the 1985-86 Erie cycle. If we assume that the 1986-87 turning points in MOD3 are related to the 1985-86 Erie cycle, then MOD3 lags at those turns by about a year. This results in poor average lead times (7.2 month lead overall, 6.1 months at peaks and 8.4 months at troughs), a rather high standard deviation of lead times (13.2 months) and a large range (35.5 months). MOD3 also shows 4 false turns, but this is better than the eight and six false turns respectively of MOD1 and MOD2.

Figure 11
ERIE TOTAL EMPLOYMENT

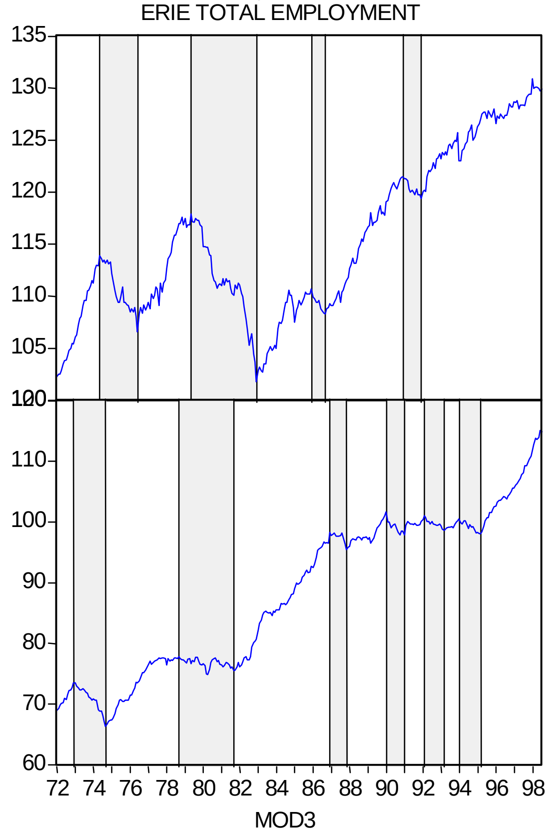
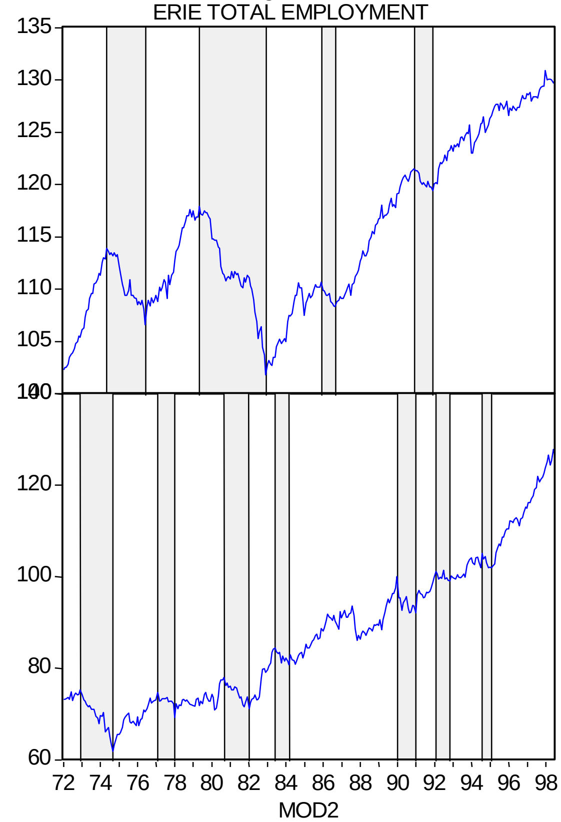


Figure 10
ERIE TOTAL EMPLOYMENT



With MOD4 we decided to focus on the fact that manufacturing plays a prominent role in the Erie economy. To the three components of MOD1 we added two manufacturing-oriented national series: manufacturers' new orders for consumer goods and manufacturers' new orders for capital goods. MOD4 is composed of Erie hours (40%), U.S. initial unemployment claims (13%), U.S. building permits (10%), new orders for consumer goods (28%) and new orders for capital goods (9%).

MOD4, shown in Figure 12, also captured all four of Erie's cycles, but exhibited five false turns which were all in the current decade. Mean lead time was only 6.5 months, with 7.6 months at peaks and 5.3 months at troughs. MOD4's performance in lead time is adversely affected by its eleven month lag for the trough of the 1986 recession. Standard deviation of the turns was still rather high at 8.6 months, and the range of lead times was also large at 26.4 months. To try to smooth this index, we successively add stock prices (to get MOD5) and the real money supply (to get MOD6).

Figure 13
ERIE TOTAL EMPLOYMENT

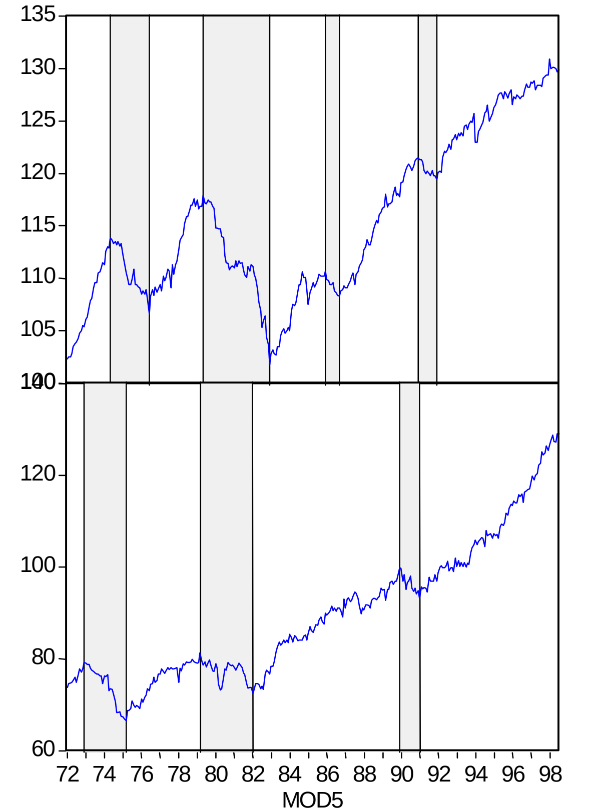
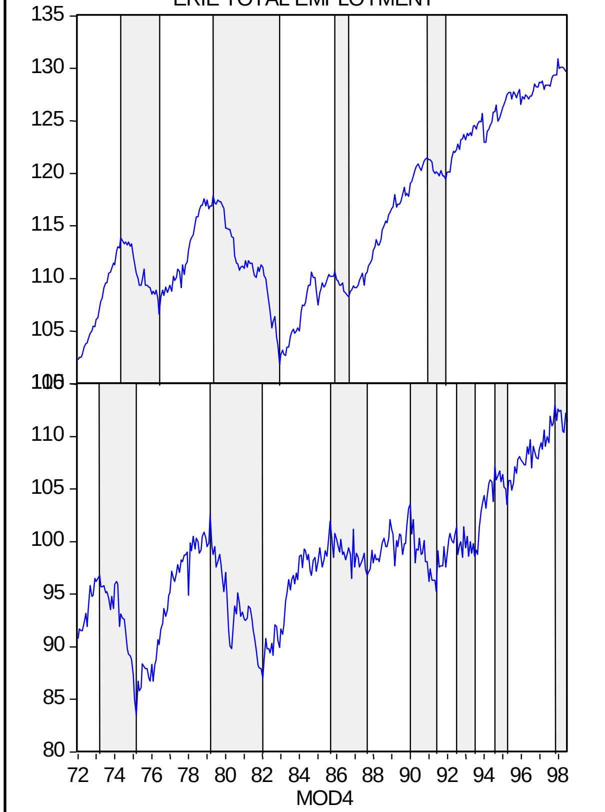


Figure 12
ERIE TOTAL EMPLOYMENT



MOD5 thus consisted of Erie hours (34%), U.S. initial unemployment claims (11%), U.S. building permits (9%), new orders for consumer goods (24%), new orders for capital goods (7%) and stock prices (16%). Figure 13 shows that MOD5 missed the 1985-86 Erie cycle, but did not give any false signals. For the three cycles that it captured, its average lead time was 11.5 months (10.5 at peaks and 12.5 at troughs.) It succeeded in leading at every turn, and its standard deviation of leads was only 5.2 months, with a range of 15.2 months.

MOD6 adds the real money supply to this mix, and its components and weights are: Erie hours (14%), U.S. initial unemployment claims (4%), U.S. building permits (4%), new orders for consumer goods (10%), new orders for capital goods (3%), stock prices (7%) and real money supply (58%).

The predominant weight placed on the money supply series and drop in the Erie hours weight resulted in significantly different results. Specifically, MOD6 missed the 1985-86 local cycle and added four false turns in the early 1990s. Lead time increased to 12.3 months, though, with 11.8 months at peaks and 12.8 at troughs. Moreover, the leads were relatively consistent, with a standard deviation of timing of only 3.5 months and a range of 9.1 months. Lead time on the turning points that it captured was good.

Figure 15
ERIE TOTAL EMPLOYMENT

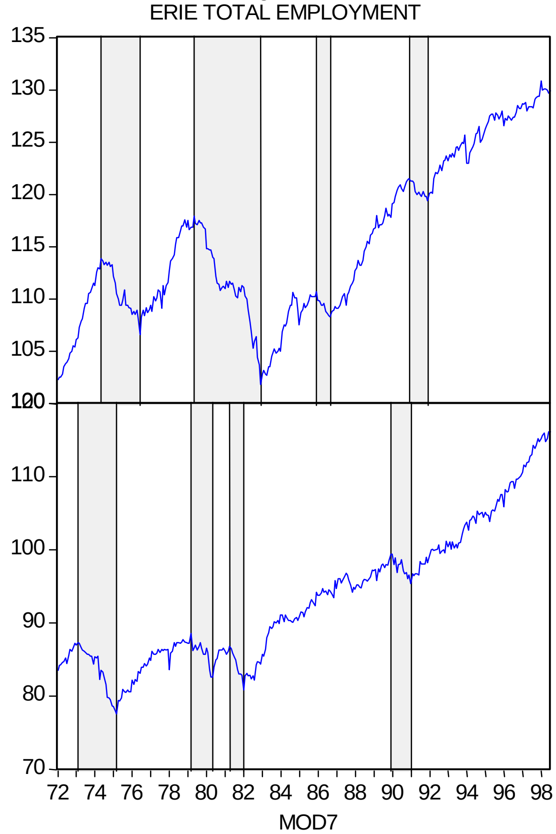
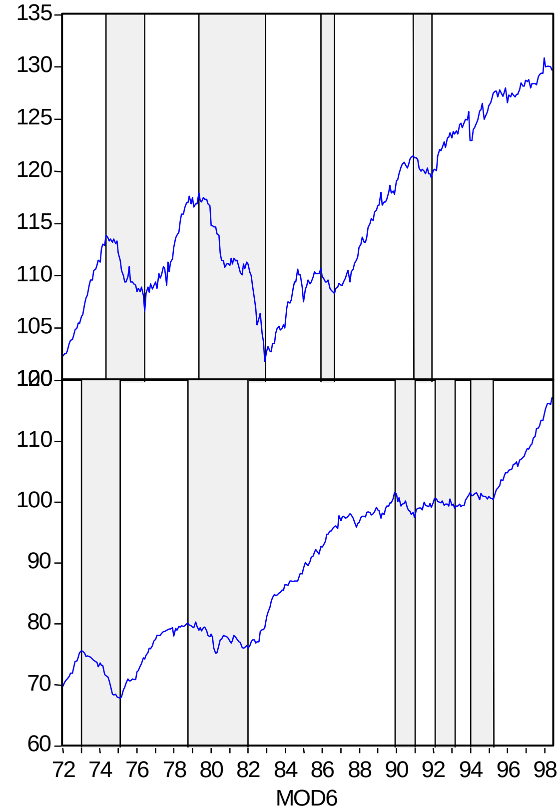


Figure 14
ERIE TOTAL EMPLOYMENT



We tried adding one more of the ILI individual components to the mix: U.S. weekly hours worked in manufacturing. MOD7 consisted of Erie hours (19%), U.S. initial unemployment claims (6%), U.S. building permits (5%), new orders for consumer goods (13%), new orders for capital goods (4%), stock prices (9%) and U.S. hours (44%).

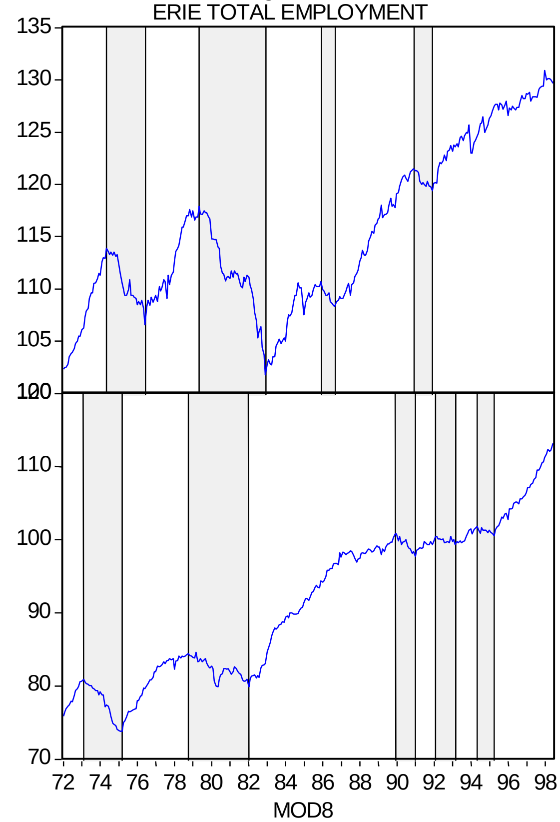
Figure 15 shows that this series also missed the 1985-86 Erie cycle and incorrectly added the national 1981-82 cycle. It yielded an average lead of 11.1 months with 9.8 months at peaks and 12.5 months at troughs. Standard deviation of the leads was reasonable at 4.8 months with a range of 13.2 months.

Our final model, MOD8, added the real money supply to this mix, so its components were: Erie hours (11%), U.S. initial unemployment claims (3%), U.S. building permits (3%), new orders for consumer goods (8%), new orders for capital goods (3%), stock prices (5%), U.S. hours (25%) and real money supply (43%).

This addition succeeded in smoothing the series, while raising lead times. The average lead time was 12.0 months, with an 11.5 month average lead for peaks and a 12.5 month average lead for troughs. Standard deviation of the lead times was among the smallest of all indexes tried, at 3.0 months, with a range of only 8.2 months.

Unfortunately, this index again missed the 1985-86 Erie cycle and included four false turns in the early '90s.

Figure 16
ERIE TOTAL EMPLOYMENT



V. CONCLUSIONS AND NEXT STEPS

A. Conclusions

So what have we learned from these experiments? What generalizations can we make?

1) The task seems possible. Initial results indicate that it should be possible to devise a useful index of leading indicators for the Erie economy, despite Erie's rather small size and lack of good regional data.

2) The basic approach of combining series from national and local economies seems to be productive. The relatively simple combinations that were tried in this paper showed significant improvements over use of either national or local series alone. Finding the *right* combination is the trick.

3) We're not done yet. None of the indicator series that we have tried thus far gave excellent performance on all our evaluative criteria. The results are promising enough to keep us trying, though.

B. Next Steps

The key approach to be pursued is the search for a set of local and national series that, combined, will provide a good leading indicator for turning points in the Erie economy. This will follow a number of possible paths:

1) Consider other local data series that we already have. We currently have employment data series for several local industries, for a very long time span. It may be the case that one or more of these series can be used as a component of the local leading indicators.

2) Search for other local data series that may be useful. The early part of this paper explains the problems associated with the paucity of local data. However, the explosion of information on the World Wide Web encourages us to search for data that may be hiding out there in cyberspace. A veritable cornucopia of new data sites have gone online recently, as federal and state government agencies have gotten their websites up and running, and academics and others seek to share their data. New guides that have recently become available (such as Cortright and Reamer 1998) and websites that function as guides to data sites (such as EconData.Net at http://www.hevanet.com/lad/sources.htm, the University of Michigan Documents Center's Statistical Resources on the Web at http://www.lib.umich.edu/libhome/Documents.center/stats.html, and the Dismal Scientist at http://www.dismal.com/) are certainly encouraging.

   We plan to search for such series as:
   -local help-wanted advertising;
   -purchasing managers' data at the local level;
   -earlier data for building permits and initial claims for unemployment;
   -retail sales; and
   -other series that have proved useful in other local areas.

   Of course, we would welcome information like this with open arms!

3) Consider other national series that may be useful. In this paper we have experimented with some of the national series that comprise the U.S. Index of Leading Indicators. We plan to investigate more of these. But there is no reason to confine ourselves to the ILI components. It makes sense to consider which national series might drive the local economy, and look for timing relationships among them. In this, we would be following in the footsteps of Conte for the New Orleans economy.

4) Consider using state series. We have not yet attempted to incorporate data for the state of Pennsylvania into our analysis. Data should be available for the state that are not available for sub-state regions. Given that the Erie economy is more similar to the Pennsylvania economy than the national economy, it may prove useful to incorporate state economic series into the index. An obvious candidate would be the state's indexes of leading indicators. We are fortunate that there are two different leading indexes for our state that might be used (Anderson 1992, and Crone and Babyak 1996). It might even be useful to combine leading indexes from neighboring states.

5) Formalize the rules for evaluating alternative indexes. In this paper we lay out five criteria for evaluation of the indexes. In our analysis, we use informal guidelines in choosing among the relative strengths and weaknesses of the various indexes. We need to formalize this process, perhaps by assigning explicit weights to the five criteria. This would

permit us to do a type of robustness test for the various candidate series, to see if slight changes in an index's composition (such as a slight change in the weights) would have much effect, and whether it would be positive or negative in terms of performance. This approach might allow us to generate a score for each of the potential index series, to help us choose among competing alternatives.

We should also consider whether there are other criteria to add to our five. ■

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TABLE A-1
Summary of Results for
Tested Leading Indicator Series

	US ICI	US ILI	ERIE HRS	US93 H07	US86 H14	US80 H20	US70 H30	US60 H40	MOD1	MOD2	MOD3	MOD4	MOD5	MOD6	MOD7	MOD8
Number of turns	8	12	14	10	12	10	10	10	16	14	12	13	6	10	8	10
Missed turns	2	2	0	2	2	2	2	2	0	0	0	0	2	2	2	2
-peaks	1	1		1	1	1	1	1					1	1	1	1
-troughs	1	1		1	1	1	1	1					1	1	1	1
Extra turns	2	6	6	4	6	4	4	4	8	6	4	5	0	4	2	4
-peaks	1	3	3	2	3	2	2	2	4	3	2	3		2	1	2
-troughs	1	3	3	2	3	2	2	2	4	3	2	2		2	1	2
Mean lead	-4.6	-11.8	-7.7	-11.8	-11.8	-12.8	-11.0	-10.3	-0.6	-20.0	-7.2	-6.5	-11.5	-12.3	-11.1	-12.0
Median lead	-6.1	-11.1	-8.6	-11.1	-11.1	-12.2	-11.2	-9.7	-4.6	-19.3	-11.1	-8.6	-11.7	-11.7	-11.7	-11.7
Std dev of lead	7.8	3.8	6.8	3.2	3.2	2.9	4.5	4.2	15.4	8.6	13.2	8.6	5.2	3.5	4.8	3.0
Max lead	-14.2	-17.2	-17.3	-16.2	-16.2	-16.2	-16.2	-16.2	-15.1	-30.5	-21.3	-15.3	-17.2	-16.2	-15.3	-15.3
Min lead	8.2	-7.1	2.0	-8.1	-8.1	-9.2	-5.1	-5.1	30.4	-11.1	14.2	11.1	-2.0	-7.1	-2.0	-7.1
Range of lead	-22.4	-10.2	-19.3	-8.1	-8.1	-7.0	-11.1	-11.1	-45.5	-19.3	-35.5	-26.4	-15.2	-9.1	-13.2	-8.2
Peaks only																
Mean lead	-1.3	-11.1	-10.4	-10.8	-10.8	-12.8	-12.5	-11.2	-3.8	-21.5	-6.1	-7.6	-10.5	-11.8	-9.8	-11.5
Std dev	8.2	4.0	7.5	3.8	3.8	3.5	3.0	2.7	13.0	8.9	12.7	6.0	7.7	4.6	6.9	4.1
Troughs only																
Mean lead	-7.8	-12.5	-5.1	-12.8	-12.8	-12.8	-9.5	-9.5	2.5	-18.5	-8.4	-5.3	-12.5	-12.8	-12.5	-12.5
Std dev	7.2	4.2	5.6	2.9	2.9	2.9	5.9	5.9	18.8	9.3	15.6	11.6	2.4	2.9	2.4	2.4

Best of row
Second best of row
Third best of row
Rest