Comprehensive Benchmark Revisions of The Conference Board Leading Economic Index® for the United States[1]

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The Conference Board

Abstract

Following an extensive reevaluation of existing indicators included in *The Conference Board Leading Economic Index*® for The United States, we propose a comprehensive revision of the composite index. In this paper we present the case for replacing three of the components and making a minor adjustment to one other component. The resulting index addresses structural changes that have occurred in the U.S. economy in the last several decades. The changes in the LEI composition include: 1) incorporating in the LEI a new Leading Credit Index (LCI) rather than real money supply (M2) starting in 1990 (real M2 remains in the index before 1990); 2) replacing the ISM Supplier Delivery Index with the ISM New Orders Index; 3) replacing the Reuters/University of Michigan Consumer Expectations Index with an equally weighted average of consumer expectations of business and economic conditions using questions from surveys conducted by Reuters/University of Michigan and The Conference Board; and 4) replacing "New Orders for (nondefense) Capital Goods" with "New Orders for (nondefense) Capital Goods excluding Aircraft." These changes are assessed using turning point analysis, probit models and an indicator scoring system based on Markov Switching models. Real time out-of-sample forecasting exercises are used to confirm that the changes to the composition help the LEI forecast more accurately future economic conditions.

Keywords: business cycles, turning points, leading economic indexes, Markov Switching, probit, out-of-sample forecasting, diffusion indexes

1. Introduction

The last comprehensive revision of the leading economic index (LEI) for the United States was implemented in 1996, after TCB had assumed responsibility for the Business Cycle Indicators program and started publishing the LEI. The 1996 revision introduced the interest rate spread as a measure which signals recessions through information form U.S. Treasury markets and the stance of monetary policy (the LEI component is the difference between the 10-year Treasury bond yields and the Federal Funds rate, set by the Federal Reserve). Other 1996 revisions involved changing or adjusting the measures used to cover manufacturing orders, commodity prices, and inflation. Since then, some methodological changes have been implemented in 2001 and 2005 as well, such as the re-introduction of trend adjustment, and the implementation of a new calculation method for

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the contribution of the yield spread component. (These revisions are documented in benchmark articles on the TCB web site.)

In March 2010 The Conference Board published an article, titled "Real M2 and Its Impact on The Conference Board Leading Economic Index® (LEI) for the United States" in which it communicated that it was considering removing real M2 from the LEI and replacing it with an indicator of financial conditions. Further research on this subject, the results of which and final recommendations for changes in the composition of the LEI, is discussed separately in a companion working paper entitled "Using a Composite Index of Financial Conditions Indicators to Predict Turning Points in the U.S. Business Cycle," by Levanon et. al. (2011) posted on The Conference Board web site. The major recommendation of this research is that because the real money supply component (real M2) has ceased to perform well as a leading indicator it should be omitted and that a newly developed Leading Credit Index (LCI) be incorporated into the LEI. This paper presents the results of our review of the other components of the LEI. It also compares the performance of an alternative index including the LCI and the other recommended revisions compared with the current index.

2. Revisions to the Composition of the LEI

The LEI is currently made up of ten components. Leaving the real money supply component aside (which is discussed in the working paper mentioned above), our recommendations affect the following leading indicators (1) Manufacturing New Orders for (non-defense) Capital Goods, (2) ISM Index of Supplier Deliveries and, (3) Consumer Expectations. Below are the changes, which will be discussed in greater detail in the following sections[2].

- Replace "New Orders for (nondefense) Capital Goods" with "New Orders for (nondefense) Capital Goods excluding Aircraft".

- Replace ISM Supplier Deliveries Index (i.e. vendor performance index) with the ISM New Orders Index for Manufacturing. In addition, it will be the level of this component, rather than its change, that contributes to the LEI (similar to the current approach for the interest rate spread and the new leading credit index components).

- Replace the Reuters/University of Michigan Consumer Expectations Index with a new component - a combination of Consumer expectations of Business and Economic conditions from the surveys conducted by Reuters/University of Michigan and The Conference Board. It will also be the level of this component that contributes to the index.

2.1 Methodology

To analyze the current components and select potential substitutes, we employed an approach that is based on probability models (probit models[3] and/or models based on

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[2] Van Dijk(2011) determines using a Bayesian estimation procedure allowing the LEI components to be weighted unequally that both the ISM Index of Supplier Deliveries and M2 would receive almost no weight on average.

[3] The capacity of leading indicators to anticipate recessions can be tested by incorporating them into probit models. The structure of these models is to use the proposed leading indicators as t-quarters ahead lagged independent variables, where a binary dependent variable takes the value of 1 when economy is in recession and 0 when it is in expansion. This procedure will generate a series of predictions based upon the behavior of the variable describing the likelihood of a

Markov Switching4) to evaluate and score an indicator's ability to forecast turning points. We, then, ranked the different indicators based on these results. We also used turning point analysis used in The Conference Board indicator approach to supplement these methodologies. However, the turning point analysis was not very applicable to several indicators we looked at, since it is the levels of these series that provide information on the cyclical outlook. These indicators (often based on diffusion levels) would have to be cumulated around a threshold to make the indicator comparable to business cycle measure in levels. To confirm that the changes in composition produces a better index, the current LEI and an alternative LEI are compared in terms of forecasting ability using real time out-of-sample forecasting exercises (for a discussion and empirical results on the effects of composition changes in the LEI see McGuckin and Ozyildirim, 2004).

2.2 Performance of the LEI Components

Table 1 shows the ranking of the quadratic probability scores (QPS), calculated for the LEI and its ten current components. These values are calculated using 1-2 quarterly lags of the leading indicator in a probit model forecasting a recession indicator variable (a binary dependent variable taking the value 1 when the economy is in a recession). (In other tests based on QPS values n this paper we have also looked at 2-3 quarterly lags.) In general, leading indicators should reach peaks between 1 and 3 quarters in advance of the business cycle and reach troughs 1-3 quarters ahead as well. As expected, the LEI performs better than any of its individual components in signaling recession. For the components, the first differences of supplier delivery, real M2 and Reuters/University of Michigan consumer expectations were the worst performing, with the largest QPS. Thus, we decided to review further and asked whether suitable replacements for supplier deliveries and consumer expectations components could be found. (Note, an alternative index omitting real M2 performs better than the current LEI in terms of the QPS score. This topic is discussed extensively in a separate working paper as mentioned above). New orders for capital goods did not perform as poorly as these components, but we believe that a slight modification, for conceptual reasons, could also lead to an improvement in its cyclical properties.

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recession in the quarter t-periods into the future. The quality of the forecasts is measured by calculating an error term as the difference between the predicted recession probability and the binary value stating whether a recession occurred during that quarter. From these error values, a quadratic probability score (QPS) can be calculated and compared across different variables and their recession forecasts.

[4] Markov Switching models are based on the idea that the parameters of an econometric model are not constant over time and should instead be allowed to shift between multiple states. At each observation, the probability that a given variable is in the low or high regime state can be measured. Leading indicators should move into the low regime state in advance of a business cycle peak and remain there until the trough of the business cycle is approaching. In our approach, the way this method is used for evaluating leading indicators compares the timing of the periods with the highest low-regime probabilities with the timing of recessions. For example, in the 1959-2011 period, there were 34 quarters that are considered recessions. During that time, we compare the timing of the 34 quarters with the highest low-regime probabilities for each indicator with the timing of the recession quarters. We choose the same number of recession signal quarters, 34, as the number of quarters in recessions, because if we demand that leading indicators signal both peaks and troughs, then the duration of the recession signal needs to start before the peak and end before the trough. That means that the duration of the recession signal is roughly the same as the recession itself. We divide the sample into "good zones" and "bad zones." The good zone is a period where we would want a good leading indicator to signal a recession. In this method we defined the good zone as the zone that includes the three quarters prior to the beginning of the recession and quarters during the recession except for the last two quarters of the recession. The bad zone is a period between the last quarter of a recession and four quarters prior to the next recession. One quarter before the last quarter of the recession is a neutral zone because it is not clear if a good leading indicator should signal a recession during that quarter. For a more detailed description of the method, please see Levanon (2010).

Table 1 - QPS Ranking of the LEI and its Current Components

Ranking the Leading Economic Index and its Components Based on
their Ability to Signal a Rise in Recession Probability 1959-2011

Quadratic Probability Scores
(First difference, 1-2 Quarters Ahead)

LEI ex M2	0.1347
Current LEI	0.1400
Weekly Claims	0.1728
Yield Spread (level)	0.2013
Housing Permits	0.2037
S&P500	0.2139
Orders for Consumer Goods	0.2263
Orders for Capital Goods	0.2371
Weekly Hours	0.2422
Michigan Consumer Expectations	0.2561
Real M2	0.2716
Supplier Delivery	0.2771

2.3 New Orders for Capital Equipment ex Aircraft

In the aircraft industry, it could take up to five years from when orders are placed to when production actually begins. Aircraft orders are lumpy, which adds noise to the orders series that conveys little useful information regarding near-term production. Thus, by removing aircraft from the new orders for capital goods component of the LEI, we seek to improve the cyclical characteristics of the component. Removing aircraft orders makes the series less volatile, and will allow for a slightly better representation of overall new orders related to near term production activity.

The new series -- New Orders for (nondefense) Capital Goods excluding Aircraft published by the U.S. Census Bureau-- only begins in 1968. Hence, it was spliced with the original orders for (non-defense) capital goods series to bring it back to 1959. The new orders components are deflated using the PPI for capital equipment.

The results from using the Markov switching model, shown on Table 2, illustrate a noticeable improvement in the new series' performance (from rank 18 to 11).[5] Table 3 shows the turning points for capital goods orders ex aircraft and the LEI that incorporates this component. The turning points of the new series vary little from the current orders series (new orders for nondefense capital goods). However, as expected, the new orders series has fewer extra turns, with only one extra turn compared to four for the old series. Finally, using orders excluding aircraft as the component for the LEI does not change the composite index's turning points.

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[5] Table 2 in Levanon et. al. (2011) shows that removing aircraft from capital goods orders leads to a marginally smaller QPS than the original component.

Table 2 – Markov Switching Results Rankings (1959Q2 – 2011Q1)

Relation of recession signal obtained by Markov Switching model to actual date of recession

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
variable	score	one to three quarters before recession	first quarter of recession	all quarters during recession except first and last two	second to last quarter of recession	last quarter of recession	one to three quarters after recession	other
Current US LEI	21	9	8	9	3	2	0	3
US LEI with LCI and no M2	20	9	7	9	4	4	0	1
New US LEI	19	7	7	10	5	5	0	0
Interest rate spread (levels)	17	16	4	5	1	1	0	7
New unemployment claims	12	7	4	10	4	4	1	4
Residential building permits	9	8	6	6	3	3	0	8
ISM new orders - inventories (levels)	8	7	3	9	4	4	1	6
New orders of consumer goods	6	8	3	7	4	7	1	4
S&P 500 Index	5	5	4	8	5	1	2	9
Reuters/Michigan survey of consumer expectaions	4	5	3	9	4	4	2	7
ISM new orders (levels)	1	3	5	7	5	7	2	5
Capacity utilization in manufacturing	1	3	3	8	7	8	2	3
New orders of capital goods excluding aircraft orders	1	4	3	8	5	5	3	6
Average weekly working hours	0	4	4	7	4	5	1	9
M2	-2	7	4	4	2	2	3	12
ISM Purchasing Managers' Index	-3	2	4	6	7	8	3	4
ISM supplier delivery index (levels)	-6	4	4	4	4	5	6	7
New orders of capital goods	-8	4	1	6	4	4	5	10
ISM supplier delivery index in differences	-12	4	3	3	2	3	0	19

Except when otherwise indicated, the series are all used in first differences rather than levels

Note: The variables are ranked according to the score they received in column 1. The score is calculated by adding the number of signals that occur before or during recessions and subtracting the number of signals that occur during expansions. That is. cols. 2+3+4-6-7-8. A signal occurs if the Markov switching model indicates a switch in the regime.

Table 3 – New Orders for Nondefense Capital Goods and the LEI

Leads/Lags (in Number of Months)

SUMMARY		New Orders Capital Goods	New Orders Capital Goods ex Aircraft		LEI with Cap Goods ex Aircraft	LEI Current
Business Cycle Peaks						
Apr-60		na	na		-10	-10
Dec-69		-8	-8		-8	-8
Nov-73		4	4		-9	-9
Jan-80		-10	-10		-15	-15
Jul-81		-6	-3		-8	-8
Jul-90		-12	-13		-18	-18
Mar-01		-9	-9		-11	-11
Dec-07		0	0		-5	-5
Mean		-5.9	-5.6		-10.5	-10.5
Median		-8.0	-8.0		-9.5	-9.5
St. Deviation		5.8	6.1		4.2	4.2
Extra Turns		4	1		1	1
Business Cycle Troughs						
Feb-61		na	na		-3	-3
Nov-70		-1	2		-7	-7
Mar-75		9	9		-2	-2
Jul-80		-2	-3		-2	-2
Nov-82		3	1		-10	-10
Mar-91		3	3		-2	-2
Nov-01		2	2		-1	-1
Jun-09		-2	-2		-3	-3
Mean		2.3	2.3		-3.9	-3.9
Median		2.0	2.0		-2.5	-2.5
St. Deviation		3.9	3.9		3.1	3.1
Extra Turns		4	1		1	1

2.4 ISM Supplier Delivery Index

This component also ranks very low in the scoring based on the Markov Switching and probit model results (see Table 1 and Table 2). When the index for this component is above 50, it means that deliveries have slowed (i.e. more than 50 percent of respondents report slower deliveries) during the past month. This suggests that orders are probably higher. Thus whenever the index crosses the 50 threshold in either direction it indicates a turning point. In Table 6, it is apparent that during the past two decades, these turning points have not consistently anticipated peaks and troughs in the business cycles.

We considered several alternatives for the supplier deliveries component. One of them was the ISM new orders index. Another is the ISM new orders less inventories, composed of these two sub-indexes from the ISM Manufacturing Report on Business. The New Orders sub-index reflects the level of new order from customers, while the Inventories sub-index reflects the increases or decreases in inventory levels. The ISM indexes are diffusion indexes and are indicators of month-to-month change. This indicator has leading properties because in periods heading into recession, the New Orders sub-index begins to decline (while remaining in expansion territory) while the Inventories sub-index (a lagging indicator) starts to increase. Thus, the gap between two begins to fall. The indicator captures orders that are going to final sales rather than inventory building.

Table 2 shows that supplier delivery (in change and levels), ranked the lowest in our Markov switching results ranking, while new orders and new orders less inventories (in levels) performed much better. These are confirmed by the QPS rankings (see Table 5 in Levanon et. al., 2011). In these exercises both levels and changes in the indicators are considered because the indicators considered are diffusion indexes. Diffusion indexes are calculated based on responses relative to a reference period (better, unchanged or worse) to a question about the target variable. Thus, the level of a diffusion index is related to the growth in the target variable. If a diffusion index is further differenced (i.e. month to month change in the diffusion), this operation is akin to second differencing, and the result is not comparable to the growth of the target variable.

The results were mixed regarding the choice between new orders and new orders less inventories. We chose not to proceed with the new orders less inventories component because, while it performed very well empirically, the theoretical motivation for including it is more doubtful. Moreover, the interpretation of a difference of two diffusion indexes is also not straightforward.

We recommend omitting the ISM Supplier Delivery Index and adding a new component from the same survey, specifically the ISM New Orders Index for Manufacturing. In addition, it will be the level of this component, rather than its change, that contributes to the LEI (similar to the current approach for the interest rate spread component) because it is measured as a diffusion index.

Table 4 - Leads/Lags (in Number of Months) of ISM New Orders Index and LEIs*

SUMMARY		Supplier Deliveries Cumulated at 50	ISM New Orders Cumulated at 50	LEI plus ISM New Orders	Current LEI
Business Cycle Peaks					
Apr-60		-4	0	-10	-10
Dec-69		6	-1	-8	-8
Nov-73		10	9	-9	-9
Jan-80		-4	-8	-15	-15
Jul-81		-2	-1	-8	-8
Jul-90		-15	-14	-18	-18
Mar-01		-3	-8	-11	-11
Dec-07		9	-1	-5	-5
Mean		-0.4	-3.0	-10.5	-10.5
Median		-2.5	-1.0	-9.5	-9.5
St. Deviation		8.3	6.9	4.2	4.2
Extra Turns		4	2	2	1
Business Cycle Troughs					
Feb-61		5	0	-3	-3
Nov-70		10	0	-6	-7
Mar-75		9	2	-2	-2
Jul-80		4	0	-2	-2
Nov-82		3	1	-3	-10
Mar-91		14	2	-2	-2
Nov-01		1	0	-1	-1
Jun-09		-1	0	-3	-3
Mean		5.6	0.6	-2.8	-3.8
Median		4.5	0.0	-2.5	-2.5
St. Deviation		5.0	0.9	1.5	3.1
Extra Turns		4	2	2	1

*In order to properly compare turning points of diffusion indexes to business cycle indicators which are defined on levels of economic activity (instead of changes), the diffusion indexes have to be cumulated.

Table 4 shows the leads/lags of the supplier delivery index and our recommended new orders index compared to business cycle turning points. While the former is roughly coincident at peaks, it lags at trough; the latter is leading at peaks and roughly coincident at troughs (leading indicators often have shorter leads at troughs). The new orders index also shows fewer extra cycles – 2 vs.4 for the supplier delivery index. The table also shows the marginal impact of changing these components in the LEI. While there is no impact on peaks, the leads at troughs become slightly shorter (2.8 months vs. 3.8 months) but they are also somewhat less dispersed.

2.5 Consumer Expectations

Based on the results of the scoring exercise, we recommend replacing the current Reuters/University of Michigan Consumer Expectations component with an indicator comprised of (1) Consumer Expectations for the Economic Outlook 12 Months Ahead from the Reuters/University of Michigan survey and (2) Consumer Expectations for

Business Conditions 6 Months Ahead from The Conference Board survey. The new Consumer Expectations indicator will be a simple average of the normalized values of these two series. Since TCB's consumer expectations for business only begins in 1978, we will use the current consumer expectations component in the LEI for the period prior to that.

Table 5 reports the rankings based on the Markov Switching method. In levels, the proposed new consumer series (AVG_Mich_CCI) is among the highest ranked and is as good as some alternatives, including the current consumer expectations component. We also analyze the underlying questions separately to determine if any of them--especially those on economic and business conditions—could offer a better and more focused way of capturing the tendency of households and consumers with respect to business cycle conditions. Our research shows that Michigan's Consumer Expectations index and its sub-components performed better, with lower scores, prior to 1996. However, the performance of TCB's Consumer Confidence Index and its sub-indexes has improved with the addition of more recent years to the sample. For the entire period, it is the combination of Reuters/University of Michigan Consumer Expectations for Economic Conditions 12 months ahead and TCB's Consumer Expectations for Business Conditions 6-months Ahead which was among the best performers.[6]

3. Evaluating the New Composition of the LEI

Chart 1 shows the new LEI calculated using this new consumer tendency measure, the Leading Credit Index (LCI) discussed in Levanon et. al. (2011), new orders for nondefense capital goods excluding aircraft, and ISM New Orders[7]. In addition, these new LEIs reflect a two-period trend adjustment[8]. Table 6 compares the turning points of the new LEIs with the current version (US LEAD), an LEI with LCI and no M2 after 1990 and the new LEI which includes all proposed changes. On average, the lead of the new LEI is slightly longer at peaks and shorter at troughs than is the old LEI. Of note, the lead of the new LEI during the last cyclical peak was 21 months, much earlier than the 5-month lead of the current LEI. However, an above average lead in retrospect is in line with the experience of the economy heading into the recession. The new LEI declined much more sharply during the last recession, falling about 20% from peak to trough compared to a 7% peak-to-trough fall for the current LEI (Chart 2). In addition, unlike the current LEI and more in line with the pattern of the CEI, the new LEI has yet to reach its previous peak.

Table 2 shows that our proposed changes do not have much of an impact on the Markov Switching performance of the indexes. The current LEI receives a slightly better score than the new LEI. However, it is worth noting that the current LEI provides three false

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[6] Levanon et. al. (2011) shows that the ranking based on the QPS for the different consumer survey series and the underlying questions in the survey support these findings.

[7] Both the consumer tendency measure and ISM New Orders are normalized over their entire histories and then cumulated at zero when included as index components.

[8] The trend adjustment periods are 1959-1983 during which the CEI grew at an average rate of 0.24 percent per month and 1984-2009 during which the CEI grew at an average rate of 0.15 percent per month.

signals, that is signals during periods of expansion not proximate to recessions, whereas, the new LEI provides no false signals based on this approach.[9]

Table 5 - Markov Switching Results (1959Q2 – 2011Q1)

Relation of recession signal obtained by Markov Switching model to actual date of recession

	variable	(1) score	(2) one to three quarters before recession	(3) first quarter of recession	(4) all quarters during recession except first and last two	(5) second to last quarter of recession	(6) last quarter of recession	(7) one to three quarters after recession	(8) other
1	Interest rate spread	10	12	2	1	0	1	0	4
2	New unemployment claims	8	5	2	6	2	3	0	2
3	Residential building permits	6	5	4	3	2	2	0	4
4	AVG_MICH_CCI	5	3	2	6	3	3	1	2
4	Monthly changes in CCI current business conditions	5	2	3	6	3	3	1	2
4	Reuters/Michigan survey of consumer expectaions	5	4	1	6	3	1	1	4
4	Michigan index of economic sentiment 12 months ahead	5	3	2	6	3	2	1	3
8	New orders of consumer goods	4	4	2	5	2	4	0	3
8	CCI expected business condtions	4	5	2	4	2	3	2	2
10	Average weekly working hours	2	4	2	4	2	3	1	4
12	S&P 500 Index	1	2	2	5	3	1	3	4
13	CCI expected employment situation	0	3	2	4	2	3	2	4
14	New orders of capital goods	-1	3	1	4	3	3	2	4
15	CCI expectations index	-4	2	2	3	2	3	3	5
15	Monthly changes in CCI current employment situation	-4	0	1	5	4	3	4	3
17	M2	-9	3	2	0	1	1	2	11
18	ISM supplier delivery index in differences	-11	2	1	1	1	2	0	13
18	CCI expected income	-11	0	1	3	1	1	3	11

CCI: Consumer Confidence Index® from The Conference Board

All series are in levels except when stated that they are in simple differences

Note: The variables are ranked according to the score they received in column 1. The score is calculated by adding the number of signals that occur before or during recessions and subtracting the number of signals that occur during expansions. That is. cols. 2+3+4-6-7-8. A signal occurs if the Markov switching model indicates a switch in the regime.

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[9] Table 10 in Levanon et. al. (2011) shows the probit model results for the new LEI. The QPS for the alternative versions of the LEI are very close and all better than those of the individual components. In signaling a recession 1-2 quarters ahead the new LEI performs slightly better than the current version. When signaling 2-3 quarters ahead, the current LEI has a slightly smaller QPS. These findings also suggest omitting real M2 and adding LCI makes the most substantial contribution to the forecasting ability of the LEI.

Table 6 – Leads/Lags (in Number of Months) of New LEIs

		New LEI with all changes	LEI with LCI and no M2	USLEAD
Business Cycle Peaks				
Apr-60		na	-10	-10
Dec-69		-8	-8	-8
Nov-73		-9	-8	-9
Jan-80		-15	-15	-15
Jul-81		-8	-8	-8
Jul-90		-18	-18	-18
Mar-01		-14	-14	-11
Dec-07		-21	-21	-5
Mean		-13.3	-12.8	-10.5
Median		-14.0	-12.0	-9.5
St. Deviation		5.2	5.0	4.2
Business Cycle Troughs				
Feb-61		na	-11	-3
Nov-70		-5	-7	-7
Mar-75		0	-2	-2
Jul-80		-2	-2	-2
Nov-82		-3	-10	-10
Mar-91		0	-2	-2
Nov-01		-1	-1	-2
Jun-09		-3	-3	-3
Mean		-2.0	-4.8	-3.9
Median		-2.0	-2.5	-2.5
St. Deviation		1.8	4.0	3.0

4. Real Time Out-of-Sample Forecasting Exercises

4.1 Construction of Real Time Indexes

To confirm that the proposed changes to the LEI will result in improved ability to forecast future economic conditions, real time out-of-sample exercises are conducted comparing the forecasting performance of various alternative versions of the LEI to that of the current LEI. These exercises are similar in approach to those described in Diebold and Rudebusch (1991) and Ozyildirim, Schaitkin and Zarnowitz (2010). In these exercises, real time vintages of the LEI are produced replicating the dataset that would have been available at the time of production (i.e. at a given period no data from the future that wouldn't have been available to the forecaster is used in the calculation of the index or the forecast). Missing data is forecasted using autoregressive models (see McGuckin, Ozyildirim, Zarnowitz, 2007). Changes in these LEI vintages are then used to produce forecasts of future changes in CEI. By comparing these forecasts to actual changes in CEI, the performance of alternative versions of the LEI can be compared.

Real time vintages are used in these forecasting exercises in order to test how the procedures used to forecast data that is missing at the time of production will affect the forecasting power of the index in real time. Both the current LEI and the alternative version including all proposed changes contain series that require forecasting. Table 7 shows the differences in series composition between the current and new versions of the LEI and indicates series that have to be forecasted with an asterisk. With the exception of

the LCI, all of these series are forecasted using two monthly lags of percent changes in the series, and a constant. These forecasting equations are estimated in real time.

Table 7 – Comparison of components

	New orders capital	New orders capital goods ex air*	Vender performance	ISM New Orders	Michigan Consumer Expectations	Average of CCI and Michigan Survey	M2*	LCI*
Old (Current) LEI	x		x		x		x	
Proposed New LEI		x		x		x		x

	Yield Spread	Average Weekly Hours, Mfg	Unemployment claims	Mfrs' new orders consumer goods*	Residential building permits	Stock prices
Old (Current) LEI	x	x	x	x	x	x
Proposed New LEI	x	x	x	x	x	x

Because the LCI is itself an index, real time vintages must be created to serve as a component in the real time vintages of the LEI. The two quarterly components, the Senior Loan Officer Survey and security repurchases are forecast for different numbers of months depending on which month during the quarter the index is being produced for. One month of debit balances at margin accounts is always forecasted. The table below shows how many months of each component would be forecasted for the vintages produced to represent the first quarter of the year. The same pattern repeats for subsequent quarters. Forecasts are made using two lags of the variable (which is in levels for the Senior Loan Officer Survey and in changes for the other two series) and the current lag of the Chicago Federal Reserve Bank's Financial Conditions Index.

Month of Index being produced (Indexes produced for the month after)			
	January	February	March
Debit balances at margin accounts	1	1	1
Senior Loan Officer Survey	0	1	2
Security repurchases	4	2	3

Each month, a real time vintage of the LEI can be calculated using the data for components that would have been available at the time of production, which is in the middle of the next month, along with forecasts for missing data. For each vintage, revisions to the LEI result from both the replacement of forecasted data with actual data, as well as from standardization and trend adjustment factors are calculated separately for each vintage. For the purpose of comparing the current LEI to the new LEI, separate sets of vintages for the two versions are created starting in May 1990 because that is when the LCI first becomes available.[10]

4.2 Out-of-Sample Forecasting in Real Time

Using changes in the LEI vintages, out-of-sample forecasts can be calculated which reflect the forecasts for future changes in the CEI that would have made at the time of production. Forecasts are calculated using a benchmark model which uses vintages of the current LEI and an alternative model which uses vintages of the alternative LEI. The equations below show forecasts computed using 6 lags of the LEI and a 6-month horizon:

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[10] Table 12 in Levanon et. al. (2011) shows the structure of vintages created starting with January 1996 and ending July 2011.

$$CEI_t = c + \sum_{i=1}^{k} \delta_{1,i} oldLEI_{t-i} + \varepsilon_{1,t}$$

$$CEI_t = c + \sum_{i=1}^{k} \beta_{2,i} newLEI_{t-i} + \varepsilon_{2,t}$$

where CEI denotes the coincident economic index (dlogs), oldLEI denotes the current LEI (dlogs) and newLEI denotes the alternative versions of the LEI (dlogs). For the initial forecast, the equation is estimated over an in-sample period from May 1990 to December 1995 using the first vintage of the LEI. The forecast then uses this equation to predict future growth in the CEI. This prediction is then compared to the actual growth rate of the CEI for the month being forecasted. The exercise is then repeated using the next vintage of the LEI and a month is added to the in-sample estimation period until a forecast is made for July 2011. A set of errors are computed for both the alternative LEI and the current LEI. The mean squared errors (MSE) produced by the two versions of the LEI are compared to determine whether the alternative LEI produces more accurate forecasts than the current LEI. Exercises are conducted using various forecast horizons, numbers of lags and 1, 3 and 6 month changes in the indexes.

Table 8 reports the reduction in MSE by the model that uses the alternative LEI compared with the model using the current LEI for each forecasting exercise. For all of the exercises, the alternative LEI outperformed the current LEI. In addition, a version of the LEI where the only change from the current LEI is that the LCI replaces money supply also shows improvement over the current LEI across all of the exercises. This finding provides additional evidence that including the LCI will enhance the forecasting power of the index. However, this improvement is not as large as when all of the proposed changes are made.

Table 8 – Improvement of alternative LEI over the current LEI

	Initial in-sample period 1990-95, out-of-sample period 1996-11								
	Forecast improvement of model with alternative LEI compared with old LEI for dl								
	One month forecast horizon			Three month forecast horizon			Six month forecast horizon		
	1 lag	3 lag	6 lag	1 lag	3 lag	6 lag	1 lag	3 lag	6 lag
Current LEI with LCI instead of M2	-8.4%	-14.0%	-12.1%	-9.2%	-13.4%	-12.1%	-9.8%	-10.1%	-7.2%
Alternative LEI	-20.9%	-28.5%	-25.4%	-24.5%	-26.3%	-23.9%	-19.3%	-17.7%	-10.0%
	Forecast improvement of model with alternative LEI compared with old LEI for dl3								
				Three month forecast horizon			Six month forecast horizon		
				1 lag	3 lag	6 lag	1 lag	3 lag	6 lag
Current LEI with LCI instead of M2				-23.1%	-21.4%	-20.2%	-17.9%	-16.3%	-12.7%
Alternative LEI				-46.5%	-42.5%	-41.0%	-30.0%	-27.0%	-18.2%
	Forecast improvement of model with alternative LEI compared with old LEI for dl6								
							Six month forecast horizon		
							1 lag	3 lag	6 lag
Current LEI with LCI instead of M2							-21.2%	-19.2%	-19.0%
Alternative LEI							-36.0%	-33.8%	-31.9%

4.3 Assessing component changes

The three changes described in this paper can be tested using out-of-sample forecasting by creating three alternative indexes in which each of these changes is made separately. The MSE for the alternative index can then be compared to the MSE of the current index which of course contains the current version of the component. A reduction in MSE would provide evidence that the component change enhanced the forecasting ability of
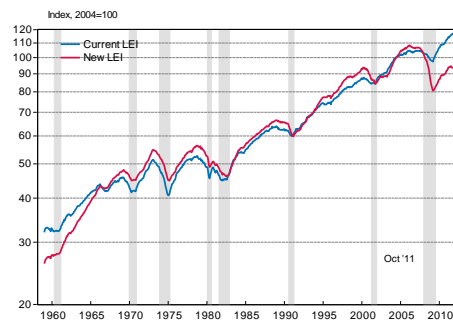
the index. Because the three proposed new series are all available starting at least from 1978, these exercises can be conducted using an initial in-sample period of 1978 to 1989 with vintages being created starting with the production of a January 1990 index. The same forecasting equations are used as for the earlier exercises. Table 9 illustrates the degree of improvement produced by each of these three changes to the LEI.

Table 9 – Improvement over current LEI resulting from component changes

	Initial in-sample period 1978-89, Out of Sample 1990-11								
	Forecast improvement of model with alternative LEI compared with old LEI for dl								
	One month forecast horizon			Three month forecast horizon			Six month forecast horizon		
LEI with New Orders for Capital Equipment ex Aircraft	0.5%	0.0%	-0.7%	0.5%	-0.2%	-0.7%	0.0%	0.2%	0.5%
LEI with Average of CCI and Michigan Consumer Expectations	-7.0%	-12.9%	-13.8%	-7.8%	-10.4%	-11.0%	-5.7%	-7.2%	-6.7%
LEI with ISM New Orders	-4.5%	-7.7%	-7.4%	-6.4%	-7.6%	-7.4%	-3.9%	-4.3%	-3.6%
	Forecast improvement of model with alternative LEI compared with old LEI for dl3								
				Three month forecast horizon			Six month forecast horizon		
LEI with New Orders for Capital Equipment ex Aircraft				-0.3%	-0.2%	-0.3%	0.2%	0.2%	0.6%
LEI with Average of CCI and Michigan Consumer Expectations				-20.2%	-20.3%	-21.5%	-12.8%	-13.2%	-10.2%
LEI with ISM New Orders				-13.1%	-12.8%	-11.8%	-8.5%	-7.9%	-5.1%
	Forecast improvement of model with alternative LEI compared with old LEI for dl6								
							Six month forecast horizon		
LEI with New Orders for Capital Equipment ex Aircraft							-0.3%	0.3%	-0.1%
LEI with Average of CCI and Michigan Consumer Expectations							-19.9%	-18.1%	-16.1%
LEI with ISM New Orders							-12.2%	-10.3%	-8.1%

These exercises provide strong evidence that the ISM and consumer confidence changes improve the forecasting capabilities of the index. This supports our earlier finding that making all changes results in greater improvements than removing money supply and replacing it with the LCI. The removal of aircraft orders from the new orders for capital equipment component seems to have almost no impact on the forecasting power of the index. In general these real time out-of-sample forecasting exercises demonstrate that each of these proposed changes will make the LEI a better tool for forecasting future economic growth.

Chart 1 – New LEI[11], 1959-2011

Chart 2 – New LEI, Current LEI and CEI, 2006-2011

Index, 2004=100
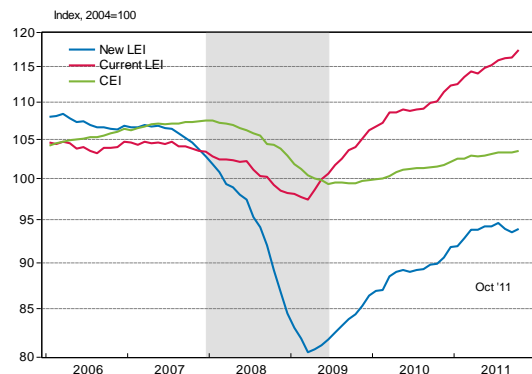
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