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A COMPOSITE LEADING INDICATOR FOR THE TURKISH ECONOMIC ACTIVITY

Aslıhan Atabek

Evren Erdoğan Coşar

Saygın Şahinöz

STATISTICS DEPARTMENT

ANKARA

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The authors are expert statisticians at the Central Bank of the Republic of Turkey.

E-mails: Aslihan.Atabek@tcmb.gov.tr
Evren.Erdogan@tcmb.gov.tr
Saygin.Sahinoz@tcmb.gov.tr

Prepared by:
The Central Bank of the Republic of Turkey
Head Office
Statistics Department
İstiklal Caddesi No:10
06100 Ulus, ANKARA
TURKEY

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Aslıhan Atabek, Evren Erdoğan Coşar and Saygın Şahinöz*

The Central Bank of the Republic of Turkey, Head Office
Statistics Department

Abstract

This study aims to construct a composite leading indicator (CLI) for the Turkish economic activity and use this indicator to predict cyclical turning points of Turkish economic activity. The paper consists of two main parts. In the first part, we deal with the construction of the CLI, which is expected to provide early signals of turning points between expansions and slowdowns. Seven leading indicators that represent the supply, demand and policy side indicators of the general economic activity comprise the constructed CLI. The leading performance of the CLI is quite satisfactory with an average lead-time of five months at the turning points. The objective of the second section is to predict the cyclical turning points of the Turkish economic activity by employing a signaling rule, where the composite leading indicator constructed in the first part is used as an explanatory variable. We prefer to use Neftçi's sequential algorithm to forecast the turning point probabilities. The computed probabilities are then used to determine empirical rules for predicting turning points. Moreover, the approach used by the Centre d'Observation Economique (COE), which depends on combination of turning probabilities of different leading indicators, is also used to aggregate the peak and trough posterior probabilities of each leading indicator into a single index. The results indicate that the use of the CLI together with Neftçi's sequential algorithm may be more efficient in calling the future turning points.

Keywords: Composite Leading Indicator, Growth Cycles

JEL Classification: E32

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1. INTRODUCTION

Early detection of the business cycle turning points has always been a major concern to policy makers, businessmen and investors and business cycle researchers. Clearly, early recognition would allow them to trigger countercyclical policy measures. There exists an extensive literature, from the early landmark study by Burns and Mitchell (1946) to the more sophisticated study of Stock and Watson (1989), which attempts to find reliable forecasting tools for cyclical turning points in the economy.

An efficient way to predict turning points is to use leading indicators. Leading indicators are data series that tend to lead business activity. However, experience in many countries have shown that it is not reliable to use just one economic indicator for short term forecasting, because some leading series may produce false signals of future changes. In order to provide a more comprehensive measure of economic activity, composite leading indicators (CLI) have been developed in many countries. The CLI is based on a basket of economic indicators, which have a leading relationship with the economic activity. The CLI enables government and businesses to track the economy's performance and forecast this performance over the near term.

There are several papers analyzing the cyclical movements in the Turkish economy, and several studies have constructed a CLI. Some of these are Özatay (1986), Altay et al. (1991), Neftçi and Özmucur (1991), Çanakçı (1992), Selçuk (1994), Üçer et al. (1998), Küçükçiftçi and Şenesen (1998), Mürütoğlu (1999) and Alper (2000). It might be helpful to overview these studies briefly before the analysis:

- Özatay (1986) investigates the cyclical movements in the Turkish economy. The reference series used in this study includes the industrial production index (IPI), the production amount of cement, exports, real capital amount of newly constructed firms and imports of intermediate goods. The author examines the forecasting performance of several series but due to data problems, only the production amount of electricity is found as a leading indicator for the economic activity.
- Neftçi and Özmucur (1991) contribute to this literature from a different perspective. They construct an economic conditions index and a composite leading indicator. The economic conditions index is similar to the reference series of Özatay (1986), but the composite leading indicator is constructed from the money supplies, M1 and M2, the credits given to the banking sector, construction permits, consolidated budget

expenditures and employment in non-agriculture sector. The main contribution of this study is the calculation of the turning point probabilities by using Neftçi's sequential probability algorithm.

- Altay et al. (1991) follow the OECD approach and use the index of industrial production as the reference series. In this study, the number of insured workers, total imports, imports of intermediate goods and construction permits are selected as leading indicators.
- The composite leading indicator constructed by Mürütoğlu (1999) contains series, such as imports of intermediate goods, currency issued, deposit money bank credits, M2, consolidated budget monthly expenditures and real capital amount of newly constructed firms.
- The study of Alper (2000) is different from the studies given above in the sense that it does not construct a composite leading indicator. Instead, the author investigates the trend and cyclical components of Gross Domestic Product (GDP) by employing several filters such as Hodrick-Prescott, first difference and fourth difference filters.

The scope of this study is to present a composite leading indicator for the Turkish economic activity constructed by the joint work with OECD. This indicator is then employed to propose a suitable signaling rule for predicting turning points in the economy [1].

Generally, a turning point is announced as a peak or trough with some delay after it is observed. But early recognition of a turning point is very important for policy makers and economic agents; hence a real-time monitoring system is needed. In this respect, sequential probability algorithm proposed by Neftçi (1982) is applied in forecasting future turning points since it is a real-time monitoring system of the growth cycle.

The paper is organized as follows. In Section 2, the leading indicator system used in the OECD is summarized. Section 3 gives the steps followed in the construction of the CLI for the Turkish economic activity. Section 4 tackles turning point forecast in the standpoint of Neftçi's sequential probability algorithm and discusses its use as a decision rule. Finally, the main conclusions of the work are drawn in Section 5.

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[1] A shorter version of the combination of these two papers, Atabek et al. (2004), is presented on the IFC Conference, which is held on September 2004 in Basel. The authors would like to thank the participants of the Conference for their comments and suggestions.

2. OECD SYSTEM OF LEADING INDICATORS

The OECD has developed a system of "Composite Leading Indicators" to provide early signals of turning points (peaks and troughs) between expansions and slowdowns of the economic activity. The OECD compiles CLIs for 23 Member countries (including Turkey[2]) and for 7 country groups such as Euro area and G7. The data are available from the beginning of 1960s for many countries.

The OECD methodology is based on the growth cycle approach. The growth cycles are identified as a period of fast growth interrupted by a period of slower growth or, at worst, a small absolute decline in the economic activity. In this respect they are distinct from the classical (business) cycle, which shows first a rise and then a definite fall in the general economic activity (OECD (1987)). Thus, a contraction phase of a growth cycle does not necessarily indicate an absolute fall in the level of economic activity but rather coincides with a reduction in the growth rate below its long-run value (Artis et al., 1995).

In the OECD system, a single economic variable is used as the reference series around which the indicator systems are built. In theory, gross domestic product (GDP) is employed as the reference series, but due to the time lag in the publication of the GDP estimates and the availability of the series at annual or quarterly basis only, in practice industrial production index (IPI) is used as the main reference series. IPI has the widest coverage of the more cyclical parts of broadly defined output. Like GDP, IPI has the advantage of being a real variable, measurable, and of interest in its own right. Moreover, it is published a relatively short time after the end of the period to which it refers and this is the main reason of selecting this variable as the reference series.

The next step in OECD system is to determine the reference chronology. The reference chronology is the historical cyclical pattern that consists of the dates of the turning points in the reference series. The method of determining cyclical turning points used in the OECD system is established by United States National Bureau of Economic Research (NBER).

As mentioned before, the OECD cyclical indicator system uses the growth cycle or deviation from trend approach. This makes it possible to evaluate the cyclical similarities between series, which may be concealed by different long-term trends. The method of trend estimation used by the OECD for cyclical analysis is a modified version of the Phase-

[2] The CLI for Turkey is constructed as a joint work of the Central Bank of the Republic of Turkey and OECD in 2001.

Average-Trend (PAT) method developed by NBER. There are alternative detrending methods, such as moving average method, Hodrick-Prescott (HP) filter and seasonal difference transformation, used in the growth cycle studies. A detailed discussion of these alternative detrending techniques and their comparison with the PAT methodology can be found in Zarnowitz and Özyıldırım (2001) and Nilsson (2000). Since PAT methodology is employed in this study, the main steps of the PAT methodology are given below:

- first estimation and extrapolation of long-term trend (75 month moving average)
- calculation of deviations from moving average trend
- correction for extreme values
- identification of tentative turning points and determination of cyclical phases (i.e. expansions and slowdowns) according to Bry-Boschan routine which is discussed below
- new estimation and extrapolation of long-term trend in original series by calculation and correction of moving averages over cyclical phases (PAT trend)
- calculation of deviations from PAT trend
- identification of final turning points in original series according to Bry-Boschan routine.

And the detailed calculation of the PAT trend can be summarized as follows:

- calculation of phase averages of original seasonally adjusted data for all expansions and slowdowns
- calculation of three-term moving averages of phase averages (triplets)
- calculation of tentative (first) trend by connecting midpoints of triplets
- adjustment of the level of trend to match the seasonally adjusted series
- calculation of 12 month moving averages of the tentative trend to obtain the final trend.

The details of the Bry-Boschan routine can be found in Bry and Boschan (1971). According to this routine, the selection of a turning point must meet the following criteria:

- the phase duration (from peak to trough or trough to peak) must be at least 5 months
- the cycle duration (from peak to peak or trough to trough) must be at least 15 months
- in the case of a flat turning point zone or a double peak or trough in the turning point zone, the most recent value is selected as the turning point

- extreme values are ignored if their effect is brief and fully reversed.

The turning points finally chosen as inputs to the trend calculation are selected by taking into account the relationship between the variables used in the analysis. That is, care is taken to select the cyclical turning points corresponding to the reference chronology so that the trend estimation for each variable is done in a manner consistent with that for the other indicators and for the reference series itself.

2.1. Selection of the Component Series

Once the underlying cyclical behavior of the reference series has been established, the next step is to select indicators whose cyclical movements pre-date, coincide or follow those of the reference series. In the OECD system of leading indicators, candidate series are evaluated using several criteria and these are explained below.

2.1.1. Practical Consideration

- frequency of publication (monthly series are preferred to quarterly series)
- absence of excessive revisions
- timeliness of publication and easy accessibility for data collection and updating
- availability of a long time series of the data with no breaks

2.1.2. Relevance

- economic significance (economic reason for the leading behavior)
- breadth of coverage (series with a wide coverage, in terms of the representation of the economic activity concerned, are preferred to narrowly defined series)

2.1.3. Cyclical Behavior

- length and consistency of the lead of the indicator over the reference cycle at turning points
- cyclical conformity between the indicator and the reference series
- absence of extra or missing cycles in comparison with the reference series
- smoothness which is indicated by a small “Months for Cyclical Dominance” (MCD) value

In the OECD system, both the mean and the median lead of the indicators over the reference cycle at turning points are evaluated. But the median lead is preferred to the mean lead since mean is more sensitive to the extreme values. Consistency of the lead is evaluated by looking at the standard deviation of the median lead times at turning points. A small standard deviation indicates homogeneity of the leads at turning points. Cyclical conformity between the indicator series and the reference series is examined by visual inspection. In addition to this, the cross-correlation of the indicator series with the reference series is also examined at different lead lengths. A high cross-correlation means that the component series correctly leads the general cyclical behavior of the reference series cycles at all the stages.

2.2. Constructing CLI

After selecting the component series that individually fulfill the criteria given above, they are combined into a single composite indicator. In this way the risk of false signals is reduced and a cyclical indicator with better forecasting and tracking qualities than any of the individual components is obtained. The number of series used for the compilation of the OECD CLIs varies for each country, and ranges between five to eleven series. There are number of steps, such as periodicity, smoothing, normalization, lagging, weighting and aggregation, in combining individual indicators into a composite indicators index. These steps are summarized below.

2.2.1. Periodicity

If there are quarterly series, the de-trended indicator series are converted to monthly frequency by linear interpolation. Since no quarterly series is used in our analyses and all the series have the same periodicity (monthly), no interpolation is done.

2.2.2. Smoothing

It is necessary to ensure that all component series have equal smoothness. In this way it is guaranteed that month-to-month changes in the composite indicator are not influenced by the irregular movements in any of the indicator series. The OECD uses the MCD moving averages to smooth the series. MCD moving average method uses minimum (optimal) order of moving average, which is enough to eliminate irregular fluctuation from the data without affecting trend and cyclical movements. This method uses MCD span for which the ratio between the trend and the irregular component is less than 1, i.e. $I/C<1$ (where I denotes the irregular component and C denotes the trend-cycle component). In the analysis, all series are smoothed using their MCD value.

2.2.3. Normalization

Normalization is done to provide the cyclical components of the series to have the same amplitude. If this were not done, the series with particularly marked cyclical amplitude would have excessive weight in the composite indicator. The series are normalized by using the formula given below:

$$\frac{(x - mean)}{(\sum |x - mean| / T)}$$

where x indicates the series and T indicates the sample size. The series are then expressed in the index-number form by adding 100 to all series. This procedure standardizes the amplitudes of the cyclical movements but leaves the relative magnitudes of the irregular movements unchanged.

2.2.4. Lagging

In the OECD system lagging is done in only one case, where the indicators selected for a particular country fall into two distinct groups of "longer-leading" and "shorter-leading" indicators. Combining the two types of indicators gave unsatisfactory results because of the interference between the two cycles. The alignment was improved by lagging the longer-leading group of indicators. The OECD Statistics Division uses the following partition into timing classification:

Median lag (months)	Classification
-10 or longer	Longer leading
-3 or longer	Shorter leading
otherwise	Coincident
+3 or longer	Lagging

For the Turkish CLI lagging is not necessary, since the lead times of the components are shorter than ten months and very close to each other. That is on average, peaks and troughs of selected components mostly coincide eliminating the possibility of mixing up the cycles.

2.2.5. Weighting

The relative contributions of the smoothed cyclical patterns of the components to the CLI can be set by means of weights. The weights of the series may depend on their past record in forecasting and tracking cycles or their relative freedom from revisions. In the OECD system, equal weights are used to obtain each country's composite leading indicator.

2.2.6. Aggregation

The composite leading indicator is obtained by averaging the normalized indices of each component series. For the CLI series, breaks may occur either at the beginning of the series due to different starting dates of the components or at the most recent dates due to different publication and updating lags. In that case a modification is done. A CLI constructed with an incomplete set of data is linked to the body of the index by the usage of a linking factor. The linking factor is equivalent to apply the growth rate of the “incomplete index” to the last point at which a full index is available.

Several CLIs are constructed following the steps given above as a combination of selected component series. The performance of these alternative CLIs can be evaluated in different ways. Since the OECD system of leading indicators is designed not only to pick out turning points, but also to give information about movements in the reference series, the general fit of the CLIs to the reference series at all stages of the cycle and their performance at turning points are examined.

To check the performance of the different CLIs at turning points, several properties, such as MCD values, the number of extra or missing cycles in the indicators, the mean and median leads at peaks, at troughs and at all turning points, the standard deviation of the median lead, the lead which maximizes the cross-correlation and the maximum cross-correlation, are evaluated.

The criteria used for choosing the best CLI are as follows:

- the lead time of the CLI at the turning points of the reference series cycles should be long
- the standard deviation of the median lead time at turning points should be low
- the CLI should not be particularly subject to irregular variations (MCD value should be small)
- the number of cycles in the CLI should not be different than that of the reference series (there should be no extra or missing cycles)
- except the other restrictions, the CLI with a high cross-correlation is preferred to other CLIs.

2.3. Presentation of the CLI

The presentation of the final CLI can be done in amplitude adjusted, trend restored and six-month rate of change forms.

2.3.1. Amplitude Adjustment

The final composite leading indicator has to be presented in such a form that it should be easily comparable with the reference series. For this purpose, an amplitude adjustment is applied to the composite index to give it the same form of the cyclical component as observed in the reference series. This adjustment refers to the deviation from the long-term trend of the series and focuses on the cyclical behavior of the indicator. Hence, this presentation makes it relatively easy to detect a new turning point. Amplitude adjustment is carried out by adjusting first the mean to unity and then adjusting the cyclical amplitude of the CLI to agree with that of the de-trended reference series by means of a scaling factor.

2.3.2. Trend Restoration

This adjustment is made to the composite index to give it the same trend as the reference series. Trend restoration is done by multiplying the amplitude adjusted CLI by the trend of the reference series in its original units. It enables direct comparison of the CLI with the reference series. In this way, it is possible to assess the general fit and to anticipate future developments in the reference series. Obviously, this will provide information about the likely rate and amplitude of changes. However, it is important to emphasize that component series are not selected only according to a strict quantitative criteria based on the cross-correlation with the reference series. Therefore, any information on the rate and the amplitude of future changes in the reference series cannot be considered as a real quantitative forecast (OECD 2001).

2.3.3. Six-month Rate of Change

The six-month rate of change of the CLI is less volatile and provides earlier and clearer signals for future turning points than the CLI itself. Hence, OECD prefers using the six-month rate of change to point possible turning points. The 6-month rate of change (T_t) of trend restored CLI (C_t) is calculated as follows:

$$T_t = \left(\sqrt[12/6.5]{\frac{12 \times C_t}{\sum_{i=1}^{12} C_{t-i}}} - 1 \right) \times 100$$

3. THE COMPOSITE LEADING INDICATOR FOR THE TURKISH ECONOMIC ACTIVITY

Before the implementation of the OECD system, the series have to be seasonally adjusted. The series utilized in the analysis are seasonally adjusted by using TRAMO/SEATS, which is developed by Gomez and Maravall (1998) and promoted by Eurostat. Detailed information about the TRAMO/SEATS technique can be found in Atuk and Ural (2002).

3.1. Reference Series

The preliminary step in the composite leading indicator approach is to choose a proxy for the economic activity, which is called reference series. Generally, GDP or IPI is used as a measure of economic activity. GDP data is available on a quarterly basis and it is published about one quarter after the quarter to which it refers. However, in the composite leading indicator approach, a series that is available at high frequency and published with less delay is preferred as the reference series. IPI has the advantage of being a monthly reported variable and its turning points are in line with those of the GDP. Since the turning points of IPI are not too different from those of GDP, its cyclical component is considered as a good proxy for the fluctuation of the overall economic activity. In the OECD CLI system, IPI is used as the reference series for most of the countries.

In some of the empirical works like Stock and Watson (1989), a coincident economic indicators index is constructed and used as the reference series. The main reason behind this approach is the idea that the reference cycle is best measured by looking at co-movements across several aggregate time series. In this approach, the series that cover other sectors of economic activity rather than manufacturing (like agriculture or service sector) and other macroeconomic variables like sales and employment are aggregated in one index. However in Turkey, no regularly published data on a monthly basis is available related to sales, consumption or labor statistics (like wage or employment). Therefore, in line with the OECD system, IPI is chosen as the reference series. It is calculated using Laspeyres index by State Institute of Statistics by utilizing the data related to 2005 items from 3500 establishments, which represent 81% of total industrial production value. The index is published about 5 weeks after the month to which it refers and available from 1985 on. The base year of the index is 1997. The turning points of IPI and the GDP are identified following the steps given in Section 2.

The compatibility of the turning points of IPI and the GDP ensures that the component series of the CLI are selected according to their leading behavior vis-à-vis the whole economy as well as the industrial sector. The cycles and the turning points of the GDP are given in Figure 1 and Table 1, respectively.

Figure 1. Cycles of Gross Domestic Product

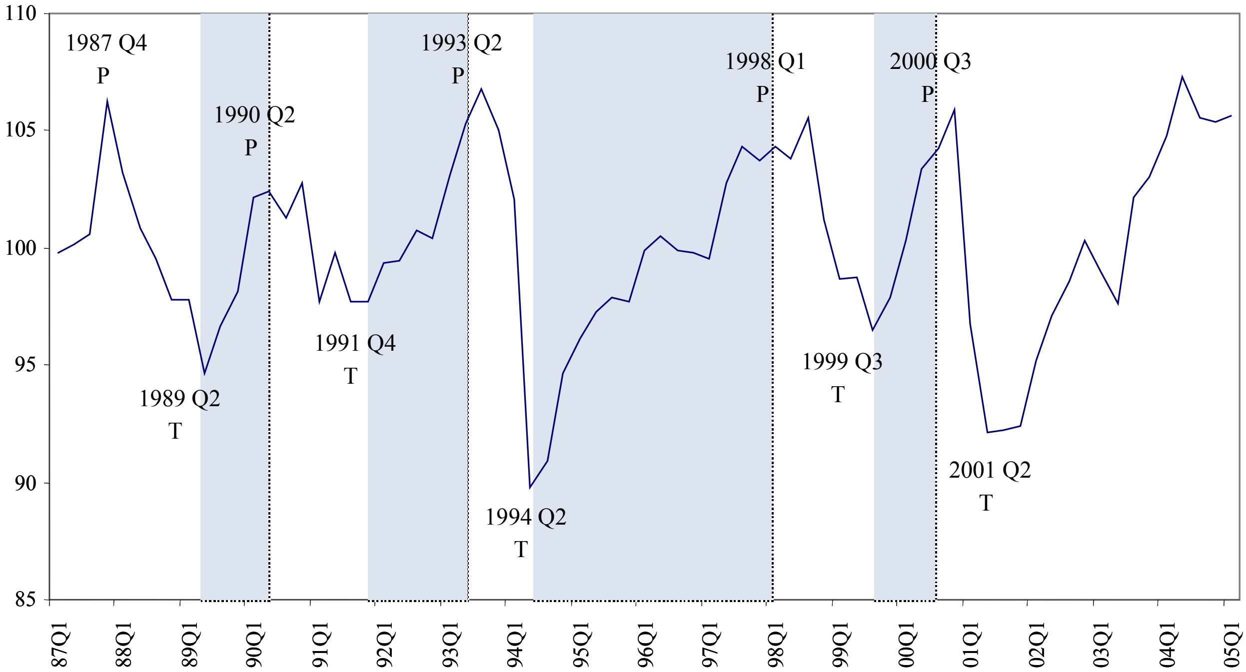


Table 1. Turning Points of Gross Domestic Product

Turning Points		Duration in Quarters	
Trough	**Peak**	**Slowdown**	**Expansion**
-	1987 Q4	-	-
1989 Q2	1990 Q2	6	4
1991 Q4	1993 Q2	6	6
1994 Q2	1998 Q1	4	15
1999 Q3	2000 Q3	6	4
2001 Q2	-	3	
Mean		5.0	7.3
Median		6.0	5.0

The cycles of IPI and the reference chronology of turning points are given in Figure 2 and Table 2, respectively.

Figure 2. Cycles of Industrial Production Index

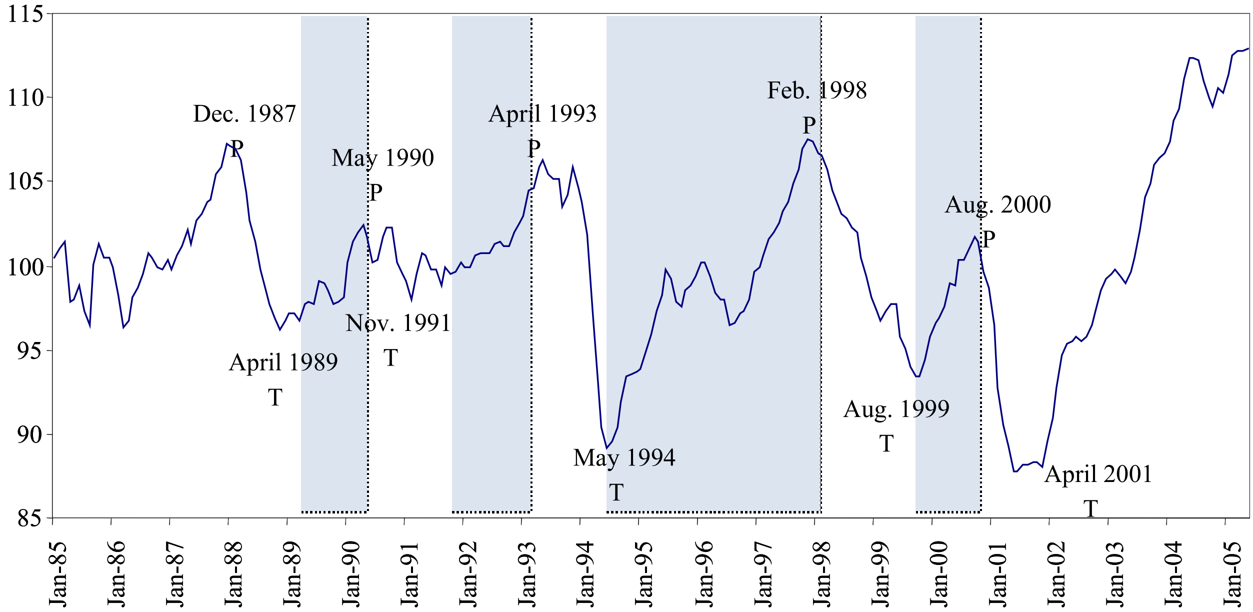


Table 2. Reference Chronology of Industrial Production Index

Turning Points		Duration in Months	
Trough	**Peak**	**Slowdown**	**Expansion**
-	December 1987	-	-
April 1989	May 1990	16	13
November 1991	April 1993	18	17
May 1994	February 1998	13	45
August 1999	August 2000	18	12
April 2001		8	-
Mean		14.6	21.8
Median		16.0	15.0

From Table 2 it can be seen that duration of slowdowns is generally longer than that of expansions except the expansion period between May 1994-February 1998. And Figure 2 indicates that slowdowns are much sharper than expansions. Both of these may imply an asymmetric distribution of observations between the two distinct periods.

3.2. Candidate and Potential Component Series

After selecting the reference series, a database is constructed to cover the variables that represent all the economic activities. The series that constitute the database and their sources are given in Appendix 1.

In the analysis, Central Bank Business Tendency Survey (CBRT BTS) questions regarding the trend of the last and next three months are taken into consideration. As in the OECD system, the business survey results are used as the balance of positive over negative replies. Monetary aggregates (money supply, reserves, credits and deposits) and consolidated budget items are analyzed both in real and nominal terms.

After evaluation of the series according to the statistical and economic criteria given in Section 2, most of the series are excluded from the analysis due to their lagging properties or having high standard deviations at turning points. For example, the exchange rate variables, German Mark, US dollar and exchange rate basket, credits given to the companies and individual corporations, number of incoming tourists, construction statistics arranged according to construction permits, WPI, CPI and their subcomponents are eliminated since they are lagging. The variables taken from the Central Bank balance sheet, the cost of living indices for wage earners and the questions taken from BTS about the average price for the new orders received from the domestic and export markets are also lagging in addition to having high standard deviation at turning points.

In Turkey, lignite and hard coal are the mostly used energy inputs in the manufacturing industry. In this respect, the statistical properties of the production of lignite and hard coal series are also investigated. But due to their lagging structure, they are also eliminated from the analysis. Besides, the production amount of lignite has high standard deviation at turning points.

Although several interest rate variables are tried as candidate series, only interest rate on time deposits and discounted Treasury auctions interest rate are selected as potential indicators. The spread of interest rate variables have low correlation with the reference series and high standard deviation at turning points. Total sight and time deposits have missing cycles and they are slightly lagging.

The money supply variables M1, M2 and M2Y are excluded from the analysis since they are lagging and they have extra cycles. Net international reserves series is also excluded from the analysis since it is found to be coincident.

Foreign trade series, export and import price and volume indices are also tested but not kept as potential indicators not only because they are untimely but also export price and volume indices are not leading IPI. Export possibilities taken from the CBRT BTS is preferred to the exports data taken from the SIS since its leading performance is better. Furthermore, exports data taken from the SIS have a high MCD value.

Balance of payment variables, current account and capital account, are also eliminated since they are both lagging and untimely.

Consolidated budget items do not show proper cyclical pattern (they are found to be acyclical) and therefore could not be used in the analysis. Taxes on goods and services and VAT on import series are eliminated from the analysis since they are rather coincident.

Since the number of newly established and liquidated firms series do not have long historical values, they are not included in the analysis. Although the payment to production workers series is considered as a good leading indicator for the labor market, it is very untimely. Hence, it is excluded from the analysis.

Real effective exchange rate, which is taken as a proxy for the cost of inputs, has some good statistical properties like small MCD value and high cross-correlation. However, it is dropped from the analysis since it is mostly coincident and slightly lagging. The number of investment incentive certificates is taken as a proxy for the investments. While the leading capacity of this series is rather good at troughs, it cannot precede peaks successfully. Therefore it is excluded from the analysis.

Although the capacity utilization rate and the number of cars sold have high cross-correlations with fairly low standard deviations, they are also dropped from the simulations since they are rather coincident. Likewise, the production amount of durable goods is also excluded since it is slightly lagging the reference series.

As a result of the analysis, following series are selected as potential component series for the simulations:

- Production Amount of Durable Consumption Goods (Oven, Television, Refrigerator and Washing Machine)
- Production Amount of Electricity
- Interest Rate on Three Months Time Deposit
- Interest Rate on Six Months Time Deposit
- Interest Rate on Twelve Months Time Deposit
- Discounted Treasury Auctions Interest Rate

- Imports of Intermediate Goods
- Employment (number of employees)
- CBRT Business Tendency Survey Question Related to the Stocks of Finished Goods
- CBRT Business Tendency Survey Question Related to the Amount of New Orders Received From Domestic Market
- CBRT Business Tendency Survey Question Related to the Investment Expenditure
- CBRT Business Tendency Survey Question Related to the Volume of Output
- CBRT Business Tendency Survey Question Related to the Export Possibilities
- CBRT Business Tendency Survey Question Related to the Employment.

3.3. Simulation

Initially, several CLIs are constructed as the combinations of the potential component series given in the previous section. The statistical properties of constructed CLIs are very similar. The mean lead at turning points of CLIs varies from 3 to 5 months with standard deviations varying from 2.5 to 6.5. Almost all CLIs have one extra cycle between the years 1995-1996.

As a result of the simulations, interest rate on 3 months time deposit is preferred to 6 and 12 months time deposits due to its better performance in the CLI. But the discounted treasury auctions interest rate has a better leading performance since the median lead of discounted auctions interest rate is 6 months whereas it is only 1 month for interest rate on 3 months time deposit. The CLI simulations are improved by using the realized employment data rather than expectation. But the realized employment series has one missing and one extra cycle. Besides it is very irregular. Therefore, the employment expectation taken from the business survey is preferred as a proxy for labor sector variable.

The business survey questions are the potential components with longest lead-time. But, in order to limit the use of the survey questions, only the ones, which have better statistical properties and cover different sectors of the economy, are selected as potential indicators. In this respect, BTS questions related with export possibilities, stocks of finished goods, the amount of new orders received from domestic market and employment are included in the final simulations and BTS questions related with investment and volume of output are disregarded.

3.4. Final CLI

Out of the constructed CLIs, the series that shows the best performance is chosen as the final CLI. The final CLI consists of the following series:

- Production Amount of Electricity
- Discounted Treasury Auctions Interest Rate Weighted by the Amount Sold
- Imports of Intermediate Goods
- CBRT Business Tendency Survey Question Related to the Stocks of Finished Goods
- CBRT Business Tendency Survey Question Related to the Amount of New Orders Received From Domestic Market
- CBRT Business Tendency Survey Question Related to the Export Possibilities
- CBRT Business Tendency Survey Question Related to the Employment.

The graphs of the cycles of the component series are given in Appendix 2.

Import of intermediate goods, which is compiled according to the UN's foreign trade broad economic category (BEC) classification, is in value (million US dollars) and it is available from 1989 onwards. Discounted Treasury auctions interest rate is the average interest rate on government securities weighted by the amount sold. It is available from 1985 onwards and the Turkish Treasury publishes it. Production amount of electricity is published by the Turkish Electricity Transmission Joint-Stock Company (TETC) and its unit is kw/h. It has a quite long historical value, 1962 onwards.

The other four components of the CLI are expectations taken from the CBRT Business Survey. The survey questions in the CLI represent the foreign and domestic demand, labor market and consumption sides of the economy. The Business Tendency Survey of the Central Bank of the Republic of Turkey has been conducted monthly since December 1987, in order to get the opinions for the past and future economic conditions of the senior managers of the largest firms that guide the economic activity. The respondents which are chosen on the basis of Istanbul Chamber of Industry's ranking of the 1000 biggest firms and Ege Chamber of Industry's ranking of the 100 biggest firms, consist of the firms from both the private and public sectors. The economic sectors comprise mining, food, textiles, wood, paper products, chemicals, stone, metals, machinery and energy. The respondent firms from the public sector are 7 percent of the total respondents. The survey form has been sent to nearly 1100 firms each month but approximately 550 firms respond. The survey consists of questions about the general course of business in industry, investments, sales, productive capacity, capacity utilization, stocks, inflation rate and Turkish Lira credit interest rate expectations.

The turning points of the reference series and the component series are given in Table 3.

Table 3. Turning Points of the Reference and the Component Series of the CLI

		The Component Series						
	Reference Chronology	Imports of Intermediate Goods	Discounted Treasury Auctions Interest Rate	Production Amount of Electricity	CBRT BTS - Export Possibilities	CBRT BTS- Total Employment	CBRT BTS-New Orders Received from Domestic Market	CBRT BTS- Stocks of Finished Goods
P*	1987:12	-	1987:08	1988:02	-	-	-	-
T**	1989:04	-	1988:05	1988:12	-	1989:01	1988:07	1988:08
P	1990:05	1990:10	1990:08	1990:10	1988:09	1990:02	1990:04	1990:07
T	1991:11	1992:03	1991:05	1991:11	1991:01	1991:02	1991:01	1991:02
P	1993:04	1993:04	1993:07	1993:02	1992:07	1993:05	1993:04	1993:05
T	1994:05	1994:06	1994:06	1994:07	1994:02	1994:05	1994:05	1994:05
P	-	1996:04	1995:08	1996:04	1994:09	1995:05	1995:06	1995:07
T	-	1996:09	1996:01	1996:12	1996:09	1996:12	1996:10	1996:08
P	1998:02	1997:09	1997:04	1998:03	1997:08	1997:07	1997:07	1997:07
T	1999:08	1999:01	1998:12	1998:10	1998:11	1998:11	1998:11	1998:11
P	2000:08	2000:06	2000:07	2000:03	2000:03	2000:03	2000:03	2000:03
T	2001:04	2001:04	2001:03	2001:03	2000:12	2001:03	2001:03	2001:01

* Peak
** Trough

Looking at Table 3, some differences can be observed between the peak and trough dates of the components. But these differences are minor and therefore negligible.

Among the component series, no significant seasonality is found in the discounted Treasury auctions interest rate and in the CBRT Business Tendency Survey questions related to the export possibilities and total employment. The other component series are seasonally adjusted by using the TRAMO/SEATS method. In the compilation of the CLI, the counter-cyclical series, namely discounted Treasury auctions interest rate and CBRT Business Tendency Survey question related to the stocks of finished goods, are multiplied by minus one to take their inverse relationship with the reference series into account. The aim of this application is to ensure that the cycles of these series move in the same direction with the cycles of IPI. The statistical properties of the component series are presented in Table 4.

Table 4. Statistical Properties of the Component Series of the CLI

Component Series	Extra or missing cycles	MCD	Mean lead (+) at turning points (TP)			Median lead (+) at turning points (TP)			Standard deviation	Cross correlation	
			Peak	Trough	All TP	Peak	Trough	All TP		Lead (+)	Coeff.
Production Amount of Electricity	-	4	0	3	1	-1	1	1	4.3	1	0.39
Imports of Intermediate Goods	1X*	2	1	1	1	1	-1	0	4.1	1	0.69
Discounted Treasury Auctions Interest Rate	1X	3	2	5	3	1	6	3	5.2	3	0.49
CBRT BTS-Stocks of Finished Goods	1X	3	2	6	4	2	8	5	4.4	3	0.50
CBRT BTS-New Orders Received from Domestic Market	1X	2	3	6	5	3	9	5	4.2	3	0.68
CBRT BTS-Export Possibilities	1X	4	10	6	8	8	6	7	5.4	5	0.47
CBRT BTS-Total Employment	1X	2	4	4	4	4	3	3	3.7	3	0.66

* 1X: There is one extra cycle, which is not observed in the reference series.

A detailed investigation of Table 4 reveals that there are some differences between the mean and median lead times of the component series. But as given before, for the Turkish CLI lagging is not necessary, since the lead times of the components are shorter than ten months and very close to each other.

The turning points of the CLI and the statistical properties of the turning points are given in Table 5 and Table 6, respectively. An extra cycle, which is not observed in IPI, exists in the CLI between July 1995 and November 1996 with minor amplitude.

Table 5. Turning Points of the CLI

Turning Points		Lead in Months	
Trough	Peak	Trough	Peak
June 1988	April 1990	10	1
February 1991	April 1993	9	0
May 1994	July 1995	0	-
November 1996	August 1997	-	6
November 1998	April 2000	9	4
March 2001	-	1	-

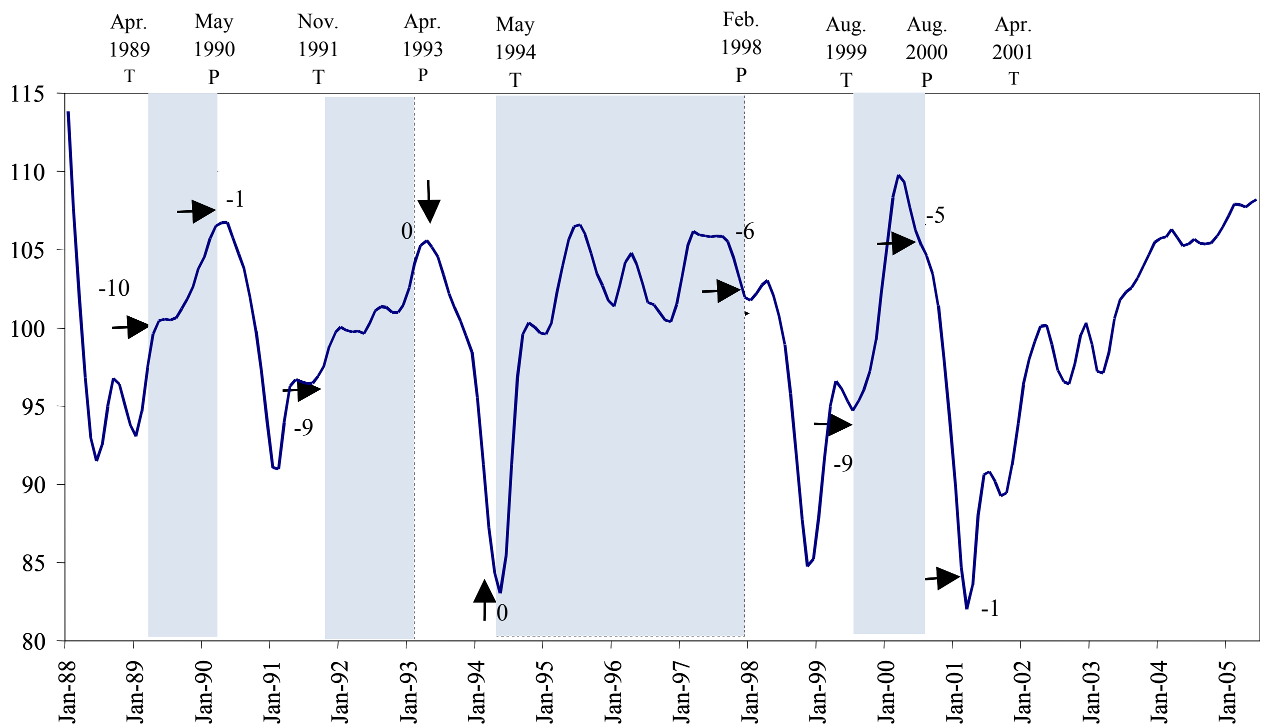
From Table 6 it is observed that the average lead-time at troughs is longer than the average lead-time at peaks. The CLI has a high cross-correlation with the reference series and it is quite smooth since the MCD value is small. In the construction of CLI, cross correlations are not used to weight component series but here, it is used to measure the performance of CLI.

Table 6. Statistical Properties of the CLI

	Extra or missing cycles	MCD	Mean lead (+) at turning points (TP)			Median lead (+) at turning points (TP)			Standard deviation	Cross correlation	
			Peak	Trough	All TP	Peak	Trough	All TP		Lead (+)	Coef.
CLI	1X	1	4	6	5	3	9	4	4.4	3	0.70

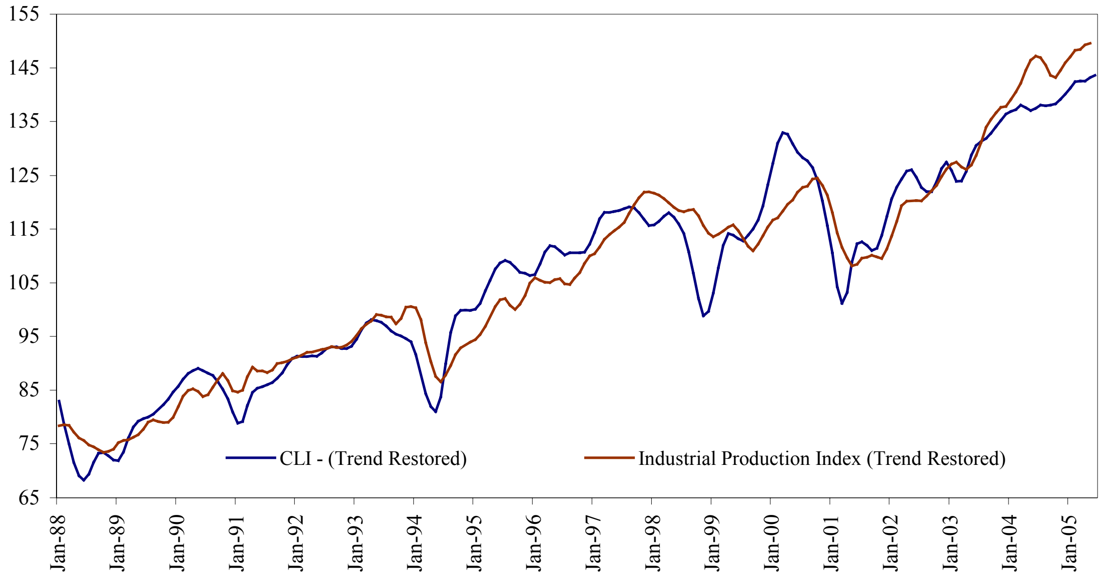
The cycles of the CLI are given in Figure 3. In this figure, the reference chronology of the turning points and the phases from trough to peak marked with shaded areas are given together with the lead times of the CLI over the reference series cycles at turning points.

Figure 3. Cycles of the CLI



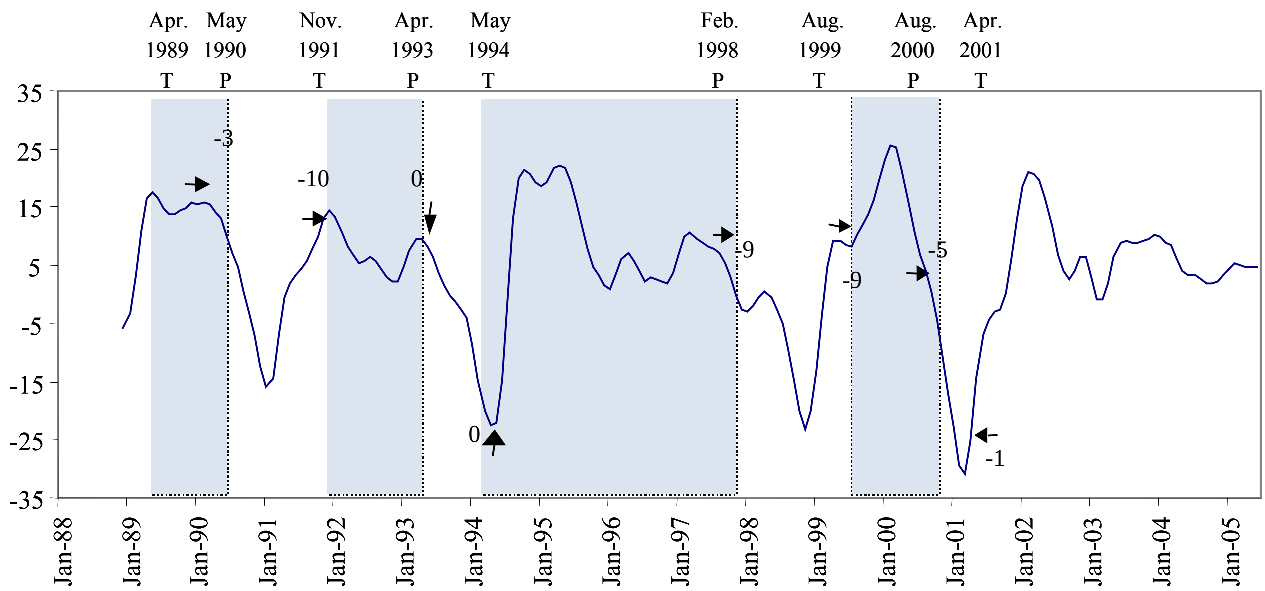
In order to compare the CLI with the reference series directly, the trend restored CLI is obtained by multiplying the cycles of the CLI with the trend of the reference series. The trend restored CLI and IPI are given in Figure 4.

Figure 4. Trend Restored IPI and CLI



The 6-month rate of change of the trend restored CLI provides earlier signals for the turning points of IPI than the cycles of the CLI. Figure 5 presents the 6-month rate of change of the trend restored CLI. In this figure, the reference chronology of turning points and the phases from trough to peak, marked with shaded areas, are given together with the lead times of 6-month rate of change of the trend restored CLI over the reference series cycles at turning points.

Figure 5. Six-Month Rate of Change (Trend Restored CLI)



4. PREDICTING CYCLICAL TURNING POINTS OF THE TURKISH ECONOMIC ACTIVITY

The turning points in the CLI and their lead times can be examined on an ex-post basis, see, for example, Diebold and Rudebusch (1989). But, recognition of CLI turning points may be difficult in real time, so that truly objective evaluation requires ex-ante real time monitoring rules for detecting the turning points in the reference series. So, while good ex-post turning point lead time performance is a necessary characteristic of an ex-ante useful CLI, it may be not sufficient.

The purpose of this section is to propose an empirical signaling system of turning points in the Turkish economy using the composite leading indicator and to provide information on the likelihood of future turning points.

Neftçi (1982) proposed a method aiming to transform movements of CLI into a measure for the probability of a cyclical turning point. Neftçi's method has some superiority over the other turning point forecasting methods since it is based on economic theory and statistical methods. As given in Niemira (1991), due to its dynamic characteristic, Neftçi's method provides additional information about the strength of a signal, hence increases the possibility of screening out false signals. Therefore the use of the CLI together with Neftçi's sequential probability algorithm may be more efficient in calling the future turning points. Due to these superiorities, we employ Neftçi's sequential algorithm to compute a suitable signaling rule for predicting turning points between expansions and slowdowns, where the composite leading indicator is used as the explanatory variable.

Besides calculating the probabilities directly from the outcomes of the composite leading indicator, the COE[1] approach (Anas and Nguiffo-Boyom (2001), Anas and Ferrara (2002)), which depends on combination of turning probabilities of different leading indicators into a single index, is also used. The philosophy of the COE approach is based on the idea that the combination of statistical information is easier to perform in the space of probabilities than in the space of time series.

In predicting turning point probabilities, the first step is to fit appropriate distributions to the expansion and slowdown periods of the series and then calculate turning point probabilities of the investigated series using Neftçi's methodology. In CEO approach, the distinction is that turning point probabilities are calculated for each component series of the

[1] The Centre d'Observation Economique

CLI and then aggregating these calculated probabilities into a single index with the help of COE approach. As a last step the probability forecasts are evaluated by the techniques given in Diebold and Rudebusch (1989). The steps followed in the analysis are discussed in detail below.

4.1. Fitting Distribution to the Phases of CLI and its Components

In this study, Anderson-Darling goodness of fit test is employed. Anderson-Darling test, a modified version of the Kolmogorov-Smirnov test, is one of the goodness of fit tests which aims to investigate if a sample of data comes from a population with a specific distribution.

The null hypothesis of the Anderson-Darling test is that the data follow a specified distribution and the test statistic is given as

$$A^2 = -N - S$$

$$S = \sum_{i=1}^{N} \frac{(2i-1)}{N} \left[\ln F(Y_i) + \ln(1 - F(Y_{N+1-i})) \right]$$

where N is the number of observations, F is the cumulative distribution function of the specified distribution and Y_i's are the ascending ordered data.

The Kolmogorov-Smirnov test is distribution free in the sense that the critical values do not depend on the specific distribution being tested. However, the Anderson-Darling test makes use of the specific distribution in calculating critical values. This has the advantage of allowing a more sensitive test and the disadvantage that critical values must be calculated for each distribution.

4.2. Neftçi's Sequential Probability Algorithm

The aim of the Neftçi's (1982) method is to detect the cyclical turning points which determine the beginning or the end of a cyclical downturn. In this approach, sequential analysis is used to calculate the probability of a cyclical turning point and the composite index (X_t) is assumed to have a stochastic behavior. This stochastic process, $\{X_t\}$, pass through two different unobservable states s_1 and s_2, which are expansion and slowdown states, respectively. As the number of observations increases, number of states that CLI passed by also increases.

Let Z (Z′) be an integer valued unobservable random variable denoting the date following a peak (trough). Z=i (Z′=i), for i=2,…,t with $T \geq t \geq 2$, means that a turning point has appeared between dates i-1 and i. It is assumed that the probability distribution of X_t in two states is different and independent from each other and the observations of the stochastic process between and within two states are independent.

If a peak has occurred between dates i and i-1, that is Z=i (T ≥ t>i ≥ 2), then:

$$P(X_1 \leq x_1, ..., X_i \leq x_i, ..., X_t \leq x_t) = F^1(x_1, ..., x_{i-1}) F^2(x_i, ..., x_t)$$

where $F^1(.)$ and $F^2(.)$ are the cumulative distribution functions for the expansion and slowdown periods, respectively.

Generally the probability distribution functions for the two different states ($f^1(x_t)$ for state 1 and $f^2(x_t)$ for state 2) are assumed to be normal but there are also studies using different distributions (Jorrat and Cerro (2000)).

The value of Z is not directly observable and the observations of X_t up to time t is used to see whether a turning point has started (Z ≤ t) or not (Z >t).

In the sequential algorithm, the prior probabilities of the cyclical turning points are assumed to be known. Let T_t be the a priori transition probability of the change from expansion to slowdown regime,

$$T_t = P(Z = t \mid Z > t - 1),$$

and T'_t be the a priori transition probability of the change from slowdown to expansion regime,

$$T'_t = P(Z' = t \mid Z' > t - 1).$$

With these information set up to time t, the aim is to maximize the posterior probability of a change in the economic activity. The optimal estimators (posterior probabilities) calculated by using Bayes' rule for peaks (P_t) and troughs (P'_t) are given as follows respectively:

$$P_t = \frac{[P_{t-1} + (1 - P_{t-1}) T_t] f^2(x_t)}{[P_{t-1} + (1 - P_{t-1}) T_t] f^2(x_t) + [(1 - P_{t-1})(1 - T_t)] f^1(x_t)}$$

$$P'_t = \frac{[P'_{t-1} + (1 - P'_{t-1}) T'_t] f^1(x_t)}{[P'_{t-1} + (1 - P'_{t-1}) T'_t] f^1(x_t) + [(1 - P'_{t-1})(1 - T'_t)] f^2(x_t)}.$$

where the posterior probabilities P_t and P_t' are initialized to 0 for the first observation. While calculating the posterior probabilities, likelihood that the latest observation in the CLI is from slowdown or expansion sample and likelihood of a slowdown (expansion) given the current length of the expansion (slowdown) relative to its historical average are combined with previous months probability estimates.

To estimate the parameters of the probability distribution functions ($f^1(x_t)$ and $f^2(x_t)$) and the a priori probabilities (T_t' and T_t), firstly two separate samples are obtained from observations that belong to expansion and slowdown regimes. Then the probability density functions are estimated by fitting a density function to observations of X_t in each regime. Following Neftçi and Özmucur (1991), a priori transition probabilities are assumed to be constant as is the case in most of the applied studies and they are estimated by using the average duration of expansion and slowdown regimes in the past.

4.3. The Centre d'Observation Economique (COE) Approach

Peak and trough posterior probabilities of each leading indicator can be aggregated into a single index by following the COE approach (Anas and Nguiffo-Boyom (2001), Anas and Ferrara (2002)). Main motivation behind the COE approach is the idea that combination of statistical information is easier to perform in the space of probabilities than in the space of time series. In this approach, first the probability of a future signal is computed for each leading indicator, x_t^k for k = 1,...,N, and then these probabilities are aggregated into a single index by using a weighting scheme that takes into account the performance of each leading indicator in signaling the turning points. The aggregated index is called IARC[2] and its formula is given as follows:

$$IARC = \frac{\overline{\beta}}{1-\overline{\alpha}} + \sum_{k=1}^{N} \left[\frac{(1-\alpha^k-\beta^k)}{\sum_{k=1}^{N}(1-\alpha^k)} \right] P_t^k$$

where N is the number of leading indicators, P_t^k is the Neftçi's sequential probability of a recent turning point of the k^{th} leading indicator, α and β are type I and type II errors. The type I error of the k^{th} leading indicator is defined as:

[2] In French, Indicateur Avancé de Retournement Conjoncturel (Leading Indicator of Cyclical Turning Points).

$$\alpha_t^k = P(R_t = 0 \middle| S_t^k = 1)$$

and the type II error of the kth leading indicator is defined as:

$$\beta_t^k = P(R_t = 1 \middle| S_t^k = 0)$$

where S_t refers to the unobservable expansion and slowdown states. R_t is a random variable defined on a forecast horizon H and R_t is equal to 1 if a cyclical turning point occurs between t and t+H, and 0 otherwise.

In other words, α represents the probability signaling a turning point which is not observed in the reference series and β denotes the probability missing a turning point which is observed in the reference series. The averages of the type I and type II risks are shown as $\bar{\alpha}$ and $\bar{\beta}$ in the formula.

4.4. Evaluation of Probability Forecasts

We used the techniques given in Diebold and Rudebusch (1989) to evaluate the probability forecasts. The turning point forecasts are evaluated by using accuracy and calibration as attributes.

Accuracy refers to the closeness, on average, of predicted probabilities (P_t) and observed realizations (R_t). As given before, R_t equals one if a turning point occurs over the horizon H and equals zero otherwise. Accuracy is measured by using Brier's (1950) Quadratic Probability Score, which is the probability forecast analog of mean squared error:

$$QPS = 1/T\sum_{i=1}^{T} 2(P_t - R_t)^2$$

The QPS ranges from 0 to 2 and a score of 0 corresponds to perfect accuracy. QPS is the unique proper scoring rule that is a function only of the discrepancy between realizations and assessed probabilities as shown by Winkler (1969).

Accuracy is also measured by the Log Probability Score (LPS), which is another strictly proper scoring rule:

$$LPS = -1/T\sum_{t=1}^{T}\left[\left(1-R_t\right)\ln\left(1-P_t\right) + R_t \ln\left(P_t\right)\right]$$

The LPS ranges from 0 to ∞, and a score of 0 corresponds to perfect accuracy. The difference between QPS and LPS is that large mistakes are penalized more heavily under LPS.

Calibration refers to the closeness of forecast probabilities and observed relative frequencies. Overall forecast calibration is measured by Global Squared Bias:

$$GSB = 2(\overline{P} - \overline{R})^2$$

where $\overline{P} = 1/T\sum_{t=1}^{T} P_t$ and $\overline{R} = 1/T\sum_{t=!}^{T} R_t$.

The GSB ranges from 0 to 2, and a score of 0 corresponds to perfect global calibration.

4.5. Application Results

4.5.1. Goodness-of-fit Test Results

Although the normal distribution is used in most of the empirical studies on turning point forecasting, the use of a distribution that fits better to the observed data may give superior forecasts. From this point of view, the Q-Q plots of the slowdown and expansion periods of the CLI and the component series are used to give an idea about the proper distribution. The Q-Q plots point out normal, lognormal and Weibull distributions for most of the series. For the series whose Q-Q plots indicate that data may follow normal, lognormal or Weibull distributions, the Anderson-Darling goodness-of-fit test is applied and the results of this test are presented in Table 7.

Table 7. Anderson-Darling Test Results

	Expansion			Slowdown		
	Normal	**Lognormal**	**Weibull**	**Normal**	**Lognormal**	**Weibull**
CLI	0.74*	0.72*	0.62	1.13***	0.84**	0.67*
Imports of Intermediate Goods	3.83***	4.59***	2.86***	0.37	0.64*	0.29
Discounted Treasury Auctions Interest Rate	1.69***	0.85**	-	1.86***	0.97**	-
Production Amount of Electricity	2.90***	3.19***	1.85***	0.73*	0.68*	0.61
CBRT BTS-Export Possibilities	1.82***	2.20***	3.66***	1.39***	1.95***	0.57
CBRT BTS-Employment	1.42***	2.03***	0.45	0.95**	1.80***	0.52
CBRT BTS-New Orders Received from Domestic Market	1.34***	2.28***	0.33	1.52***	2.49***	0.92**
CBRT BTS-Stocks of Finished Goods	1.03**	0.71*	-	0.56	0.53	-

* significant at 10% significance level, ** significant at 5% significance level, *** significant at 1% significance level

The conclusions drawn from Table 7 and Q-Q plots that are not given here can be summarized as follows:

- The Q-Q plots of the expansion and slowdown periods of the CLI plotted for some non-normal distributions indicate that the lognormal and Weibull distributions may fit the data. According to the Anderson-Darling test, the lognormal and Weibull distributions fit well to both expansion and slowdown periods of CLI. However, normal distribution only fits to the expansion period and the rejection of the null hypothesis at all the critical values indicates that normal distribution may not fit to the slowdown periods.
- For the expansion periods of the imports of intermediate goods and the production amount of electricity, none of the normal, lognormal and Weibull distributions give a good fit. However, for the slowdown period all the distributions fit to these series.
- For the discounted Treasury auctions interest rate, normal distribution, which is a symmetric distribution, does not give a good fit for the expansion and slowdown periods and the data is accepted to follow a lognormal distribution only at the 1 percent significance level.
- For the BTS (Business Tendency Survey) questions, normal and lognormal distributions give a good fit only for the stocks of finished goods series. Weibull distribution fits to the slowdown periods of all the survey questions except stocks of finished goods and performs relatively better than the other two distributions over the expansion periods.

To sum up, although in most of the empirical studies, the normal distribution is used; in this study it is found that normal distribution is inadequate for most of the series. This can be due to the poor specification of the expansion and slowdown regimes. Bearing in mind that in the OECD system, trend estimation for each variable is done in a manner consistent with the other indicators and the reference series (Nilsson 2000), the turning points of the component series may have minor differences from the visually observed turning points which might have created skewness. Another reason may be the possibility that the series are asymmetric which makes normal distribution inadequate for the series.

Another result derived from the goodness-of-fit tests is that the investigated distributions give better fit for the slowdown periods than the expansion periods. The investigation of the expansion periods shows that the expansion period between the years 1994-1998 may have a different behavior than the other expansion periods. From the results given in Section 3.4 it is observed that only in this period slowdown period is shorter than expansion and moreover slowdown is very sharp but expansion is smooth; implying possible asymmetric dynamics different than the ones observed in other periods. Since all slowdown (expansion) periods are analyzed together in themselves, the different dynamics of this expansion period may be effective on the results.

4.5.2. Probability Forecasts Using COE Approach

In this section, the results of the calculated peak and trough probabilities under the COE approach are presented. In accordance with the COE approach, the turning point probabilities are calculated for all components separately by using the normal, Weibull and lognormal distributions. But only the probabilities calculated using the normal and lognormal distributions are aggregated into one index, which is IARC. Aggregation for the normal distribution has been done due to its popularity in the literature. Lognormal is also used since the best fit is obtained by this distribution. The graphs of the calculated probabilities for each component series are not given here but their performance can be summarized as follows:

4.5.2.1. Imports of intermediate goods

The peak and trough probabilities obtained from the Weibull and the normal distributions are very similar to each other. However, with the lognormal distribution it is observed that the reliability and the forecast ability of the calculated probabilities get better.

4.5.2.2. Discounted treasury auctions interest rate

Similar to the results obtained for the imports of intermediate goods, the usage of the lognormal distribution improves the forecasting ability of the probabilities compared to the ones obtained from the normal and the Weibull distributions. For the normal distribution, probabilities increase continuously and do not decrease just before the end of a slowdown period.

4.5.2.3. Production amount of electricity

The probabilities obtained from lognormal distribution increase more slowly than the probabilities obtained from the normal and the Weibull distributions. In other words, they remain above the threshold value for few months longer than that of normal and Weibull distributions which provides more efficient and accurate determination of the peak dates. Although for peak probabilities, lognormal and the other two distributions differ from each other, for the trough probabilities normal and lognormal distributions give very similar results.

4.5.2.4. Expectations about export possibilities

For both peaks and troughs, lognormal distribution gives better results for the turning point probabilities.

4.5.2.5. Expectations about stocks of finished goods

The peak and trough probabilities obtained from lognormal distribution are superior to the ones obtained from normal distribution. With the normal distribution it is observed that the probabilities are declining just before the end of the slowdown periods.

4.5.2.6. Expectations about employment

The peak probabilities obtained from normal and Weibull distributions are very similar. With the lognormal distribution, the probabilities are found to be extremely smooth. Despite of the smoothness of the calculated probabilities their performances are not satisfactory since their levels are very low. The usage of the lognormal distribution for the trough probabilities improves the prediction performance.

4.5.2.7. Expectations about new orders received from the domestic market

Peak and trough probabilities calculated using Weibull and normal distributions are very similar but they give poor forecasts compared to the probabilities calculated using lognormal distribution.

In the case of normal distribution, the calculated trough probabilities for the BTS questions give poor results since the direction of the probabilities change just before the end of the slowdown periods. There may be two possible causes of this problem either the normal distribution may not be the right choice to explain the behavior of the slowdown periods or the selected turning points may not be adequate in representing the expansion and slowdown periods. In general, the normal distribution gives poor forecasts for all components especially for the troughs.

The peak and trough probabilities obtained from lognormal distribution are used in the construction of the IARC, since its performance is better than the other distributions for almost all series. Although the results with the normal distribution are not found to be satisfactory, it is also used in the construction of the IARC due to its' popularity in the literature. Type I and type II errors given in Section 4.3 are assumed to be zero for all series when lognormal distribution is used. On the other hand, the errors that are used in the aggregation of the peak and trough probabilities obtained from normal distribution are given in Table 8.

Table 8. Type I and Type II Errors for Normal Distribution

Components	Peaks		Troughs	
	Alfa	Beta	Alfa	Beta
Imports of Intermediate Goods	0	0	0	0
Discounted Treasury Auctions Interest Rate	0	0.2	0	0.2
Production Amount of Electricity	0	0	0	0.2
CBRT BTS - Export Possibilities	0	0	0	0
CBRT BTS – Total Employment	0	0.5	0	0.4
CBRT BTS - New Orders Received from the Domestic Market	0	0	0	0
CBRT BTS - Stock of Finished Goods	0	0.25	0	0

4.5.2.8. IARC

In this part, the performances of the IARC indices are evaluated. The graphs of the IARC indices for the normal and lognormal distributions are given in the Appendix 3. Although the dates of the turning points of each leading indicator are very close to each other, they are not exactly the same. As a result of this, the initial values of peak and trough probabilities in each phase are different from zero. Since the overall values of the forecasted probabilities are lower than the probabilities calculated for the CLI, the threshold value for the IARC index is chosen as 0.90.

The IARC index, which is calculated by using normal distribution, misses all the peaks except the first one, whereas the IARC index which is calculated by using lognormal distribution signals all the peaks. But for the third expansion period, the IARC index calculated by using lognormal distribution gives the signal of a peak 22 months before. This is a very long period, hence the reliability of the calculated probabilities decrease.

For the troughs, the IARC index calculated by using normal distribution catches only one turning point whereas the IARC index obtained by lognormal distribution is successful at predicting the turning points except the first one.

As a result, the inadequacies observed in the peak and trough probabilities of the components can also be observed in the aggregated index. Comparison of the peak and trough probabilities shows that lognormal distribution is better than normal distribution in explaining the behavior of the expansion and slowdown periods. However as a general conclusion, the IARC index gives poor results and therefore it cannot be used effectively in forecasting the future turning points of the Turkish economic activity.

4.5.3. Probability Forecasts Using CLI

Since the COE's approach gives poor results, the turning points are also forecasted in the usual way, using directly the outcomes of the CLI. This time, the threshold value is chosen as 0.95.

The results of the calculated peak and trough probabilities for the CLI shows that the peak probabilities obtained from Weibull and normal distributions are very similar, but the peak probabilities obtained from lognormal distribution are better since they are smooth and increase continuously.

For the trough probabilities, the Weibull distribution gives better results than normal distribution. But the calculated probabilities obtained using the lognormal distribution are superior to Weibull and normal distributions. The graphs of the calculated peak and trough probabilities of the CLI for normal and lognormal distributions are given in the Appendix 3.

The detailed investigation of the graphs shows that the lead times of the peak signals are very similar in normal and lognormal distributions. But for the troughs, the probabilities obtained by lognormal distribution gives better signals than normal distribution since the probabilities do not decrease before the occurrence of a trough.

4.5.4. Evaluation of Probability Forecasts

Table 9 gives the peaks and troughs observed in the reference series and CLI together with the leading performance of the CLI and the calculated posterior probabilities over the reference series turning points. Since the turning point forecasts obtained from the IARC indices are found to be inadequate in predicting the future turning points, the IARC indices are not regarded for the evaluations given in Table 9 and Table 10. The predictive power of the CLI and the calculated probabilities are evaluated by comparison of the leading time, signal leading time and recognition lag values. As given in Zhang and Zhuang (2002), the leading time is calculated as the difference between the time when a turning point in the CLI appears and the time when the corresponding turning point in the reference series that the CLI attempts to predict arrives. The signal leading time is the difference between the time when a signal of a turning point is issued and the time when the turning point in the reference series arrives. The recognition lag is the time required to recognize that a turning point in the CLI signals a turning point in the reference series and it is the difference between the leading time and signal leading time.

According to Table 9, the average leading time for the troughs is longer than the average leading time for the peaks whereas for the signal leading time the reverse is true. The calculated probabilities (both for normal and lognormal distributions) signal the fourth peak before CLI. By looking at the results in Table 9, it may be said that the use of the calculated probabilities does not bring extra gain to predict the future turning points since one of the troughs could not be predicted, leading time and signal leading times do not differ from each other considerably and no exact rule could be developed due to the different signal leading times at each turning point.

Table 9. Lead Times of the CLI and the Posterior Probabilities

				Lognormal Distribution		**Normal Distribution**	
	CLI	Reference Series	Leading Time	Signal Leading Time	Recognition Lag	Signal Leading Time	Recognition Lag
Peak 1	-	Dec 1987	-	-	-	-	-
Peak 2	Apr 1990	May 1990	-1	-1	0	-1	0
Peak 3	Apr 1993	Apr 1993	0	-3	-3	-1	-1
Peak 4	Aug 1997	Feb 1998	-6	-15	-9	-10	-4
Peak 5	Apr 2000	Aug 2000	-4	-2	2	-5	-1
Average			**-2.8**	**-5.3**	**-2.5**	**-4.3**	**-1.5**
Trough 1	Jun 1988	Apr 1989	-10	-4	6	-2	8
Trough 2	Feb 1991	Nov 1991	-9	-5	4	-3	6
Trough 3	May 1994	May 1994	0	missing	n.a.	-5	-5
Trough 4	Nov 1998	Aug 1999	-9	-1	8	-1	8
Trough 5	Mar 2001	Apr 2001	-1	-2	-1	missing	n.a.
Average			**-5.8**	**-3.0**	**4.25**	**-2.8**	**4.25**

* Negative sign denotes lead and positive sign denotes lag.

Like Jorrat and Cerro (2000) and Zhang and Zhuang (2002), the successes of the probability forecasts are evaluated by looking at the Quadratic Probability Score (QPS), Log Probability Score (LPS) and Global Squared Bias (GSB) statistics.

Table 10. Evaluation Measures of Probability Forecasts

		PEAKS						TROUGHS					
	Horizon	0	1	2	3	4	5	0	1	2	3	4	5
Normal Distribution	QPS	1.31	1.24	1.17	1.11	1.05	0.98	1.20	1.06	0.90	0.75	0.63	0.53
	LPS	1.99	1.85	1.73	1.63	1.53	1.43	2.35	2.08	1.72	1.36	1.05	0.82
	GSB	1.16	1.05	0.94	0.84	0.74	0.65	0.79	0.58	0.41	0.26	0.15	0.07
Weibull Distribution	QPS	1.26	1.19	1.13	1.07	1.01	0.96	1.14	0.99	0.84	0.69	0.58	0.50
	LPS	1.92	1.74	1.62	1.53	1.44	1.36	2.47	2.12	1.74	1.37	1.06	0.95
	GSB	1.12	1.00	0.90	0.80	0.70	0.62	0.81	0.60	0.42	0.27	0.16	0.07
Lognormal Distribution	QPS	0.86	0.81	0.77	0.73	0.69	0.65	1.28	1.11	0.94	0.77	0.63	0.51
	LPS	1.08	1.03	0.98	0.94	0.90	0.86	2.93	2.40	1.90	1.46	1.08	0.79
	GSB	0.74	0.65	0.56	0.48	0.41	0.34	1.00	0.76	0.56	0.38	0.24	0.14

The QPS, LPS and GSB are calculated for probability forecasts of the CLI under different distributions and exposed on Table 10. We used these measures to assess and compare the predictive power of the probability forecasts under different distributions. By looking at the QPS, LPS and GSB statistics for the peak predictions, it can be said that the lognormal distribution gives better peak forecasts than the other distributions. And the QPS, LPS and GSB statistics for the trough predictions show that the Weibull distribution gives better trough forecasts than the other distributions.

According to Table 10, for the lognormal distribution, at shorter forecast horizons, the peak predictions have lower QPS and GSB than the trough forecasts and this may show that using lognormal distribution, the peaks are predicted more accurately than the troughs. The results of the probability evaluation statistics are in harmony with the graphs of the peak and trough probabilities given in the Appendix 3. Looking at the graphs it can be said that, the peaks are better forecasted than the troughs and lognormal distribution improves clearly the forecasts.

Now generally speaking lognormal distribution, which is a right skewed distribution, gives better results. That means that low or moderate values are observed more compared to high values. As given before, slowdowns last longer than up downs except the expansion period between the years 1994-1998 (see Table 2). So, the nature of the data might be the reason for lognormal distribution giving good results.

5. CONCLUSION

This paper presents firstly the results of the joint work conducted with OECD on the construction of a composite leading indicator and secondly the results of a study about the prediction of the turning points of the Turkish economic activity. The Industrial Production Index is used as a proxy for economic activity, and an analysis is carried out with a broad set of demand, supply and policy variables. From the broad set of series, the seven variables with the most desirable features are selected as the leading indicators. The selected final components constitute a balanced subset of demand, supply and policy variables. After selecting the leading indicators, they are combined into a composite leading indicator in order to increase efficiency.

The OECD methodology is based on the growth cycle approach. Growth cycle is distinct from the classical (business) cycle which shows first a rise and then a definite fall in the general economic activity (OECD (1987)). Hence, there are some points that are thought to be important and necessary to note. A contraction phase of a growth cycle does not necessarily indicate an absolute fall in the level of economic activity, but rather coincides with a reduction in the growth rate below its long-run value (Artis et al., (1995)). A composite leading indicator is often easier for users to understand than econometric models, but it has also some limitations. Leading indicators do not offer the precision of an econometric model and are generally constructed to lead the turning points of the economic activity but not to forecast growth rates or intra-cyclical movements in the economy. Therefore, users must be aware of that composite leading indicators are complement, but not substitutes for the quantitative or long-term forecasts based on econometric models.

Another crucial point is the interpretation of the amplitude of the CLI. The composite leading indicator is constructed to assess the general fit and to foresee future developments in the reference series. Obviously, this will provide information about the likely rate and amplitude of changes. However, it is important to emphasize that component series are not selected according to a strict quantitative criterion such as cross-correlation with the reference series. Therefore, any information on the rate and the amplitude of future changes in the reference series (based on the information gathered from the CLI) cannot be considered as a real quantitative forecast and it may be misleading to evaluate the effects of a crises or an expansion period on the economic activity by comparing the amplitudes of the cycles observed in the CLI.

There may be minor differences in the constructed CLI between the consecutive months due to the revisions. These statistical revisions in the CLI occur because of the statistical revisions in the component series namely, imports of intermediate goods and production amount of electricity, and also because of the untimeliness of imports of intermediate goods data. Although these revisions do not create big differences in the observed turning point dates, it is more reliable to wait several months before the announcement of a new turning point. One drawback of the constructed CLI may be stemmed from the business survey questions. A detailed investigation of the CLI reveals that at the expansion periods, plateaus occur and that makes harder to determine the peak dates. But sharp decreases are observed in the slowdown periods, so the troughs can be easily identified. Generally, in the estimation period, the slowdown periods are started with external factors and ended with crisis. Since most of the components are taken from the business survey, the asymmetry observed between the expansion and slowdown periods of the CLI might be resulted from the use of business survey questions. In the expansion periods, the composition of the “up”, “same” and “down” responses does not change considerably since the economy is almost in a good situation and the “same” responses shows the continuity of the good economic conditions rather than a slowdown in the economic activity. Since the slowdown periods are generally ended with crisis, the responses are based on the worst scenario and a little recovery in the expectations shows an improvement compared to the general slowdown tendency.

In this study, also the results of the two approaches applied in predicting the cyclical turning points of the Turkish economic activity are presented. Both approaches are based on Neftçi’s sequential probability algorithm, but they have differences in the construction of the probabilities. The first one is developed by the COE and it is founded on the calculation of peak and trough probabilities of each leading indicator separately and then aggregation of these probabilities into a single index. The second approach is the direct use of the CLI in the calculation of the probabilities and it is frequently used in the empirical applications.

According to the results of this study, there is an asymmetry between the expansion and slowdown periods of the series in the sense that the duration of the expansion and slowdown periods differ from each other. In addition to this, the probabilities obtained for the longest expansion period give the signal of a peak nearly one year beforehand in line with the Neftçi methodology, which assumes that the longer the economy remained in one state the more likely it was to change to the other. But it is observed that as the duration of a phase increases, the reliability of the estimated probabilities decrease since they give very early (sometimes

10-15 months in advance) signals of a turning point. And this makes harder to forecast the date of the turning point accurately.

The performances of the calculated probabilities are not very satisfactory, especially for the probabilities obtained according to the COE approach since it is hard to develop a signaling rule due to the inconsistencies between the lead times. One reason for this problem may be the misspecification of the expansion and slowdown regimes. For instance, the observations in the expansion periods are very similar to each other. Especially for the slowdown period between the years 1994-1998, the CLI increases rapidly and stays at that level for many months which makes it difficult to separate the expansion and slowdown regimes. The inadequacy of the calculated probabilities may stem from the factors explained in Niemira (1991), that if a particular composite leading indicator does not seem to work well in calling turning points, it may be because of a) the leading indicator was not constructed properly b) the chronology used to compare the turning point signals is not a proper representation of the aggregate trend-adjusted cycle c) the growth recession/recovery environment is not sufficiently different.

As given in Niemira (1991), due to its dynamic characteristic, Neftçi's method provides additional information about the strength of a signal, hence increases the possibility of screening out false signals. Therefore the use of the CLI together with Neftçi's sequential probability algorithm may be more efficient in calling the future turning points.

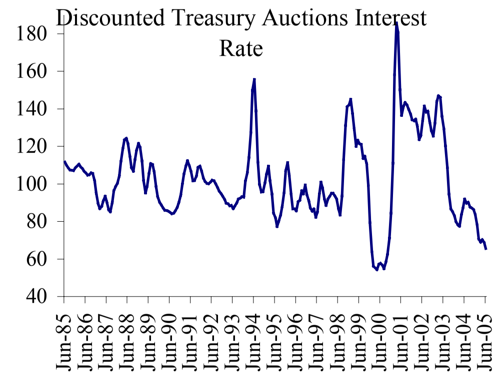
APPENDIX 1. Series Utilized in the Analysis

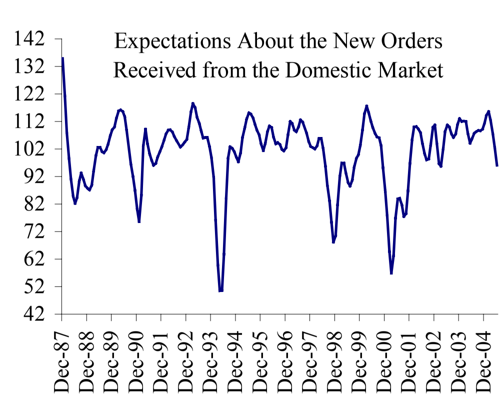
Series	Source
Production	
1. Production Amount of Durable Consumption Goods (Oven, Television, Refrigerator and Washing Machine)	SIS[1]
2. Production Amount of Electricity	TETC[2]
3. Production Amount of Lignite	SIS
4. Production Amount of Hard Coal	SIS
5. Capacity Utilization Rate	SIS
6. Construction Statistics According to Construction Permits	SIS
7. Established and Liquidated Companies	SIS
8. CBRT BTS Question Related to the Volume of Output	CBRT[3]
9. CBRT BTS Question Related to the Stocks of Finished Goods	CBRT
Sales	
1. Car Sales	AMA[4]
2. CBRT BTS Question Related to the Amount of New Orders Received from Domestic Market	CBRT
Investment	
1. Number of Investment Incentive Certificates	TREASURY[5]
2. CBRT BTS Question Related to the Investment Expenditure	CBRT
Prices	
1. Wholesale Price Index (WPI) (General and sub-items)	SIS
2. Consumer Price Index (CPI) (General and sub-items)	SIS
3. Price of Liquid Oil	POAS[6]
4. Cost of Living Indices for Wage Earners (General and sub-items)	ICC[7]
5. CBRT BTS Question Related to the Average Unit Cost	CBRT
6. CBRT BTS Question Related to the Average Price for the New Orders Received from the Domestic Market	CBRT
7 CBRT BTS Question Related to the Average Price for the New Orders Received from the Export Market	CBRT
Exchange Rates	
1. Real Effective Exchange Rate	CBRT
2. German Mark	CBRT
3. Euro	CBRT
4. US Dollar	CBRT
Central Bank Balance Sheet	
1. Domestic Credits	CBRT
2. Open Market Operations	CBRT
Tourism	
1. Number of Tourists	SPO[8]
Labor Sector	
1. Employment (Number of Employees)	SIS
2. Payments to Workers in Manufacturing Industry	SIS
3. CBRT BTS Question Related to the Employment	CBRT

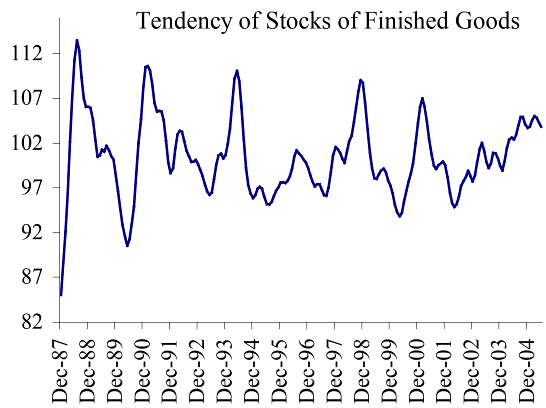
Financial Indicators	
1. Interest Rate on Three Months Time Deposit	CBRT
2. Interest Rate on Six Months Time Deposit	CBRT
3. Interest Rate on Twelve Months Time Deposit	CBRT
4. Spread of Interest Rate (The Difference Between Twelve Months Time Deposit and One Month Time Deposit)	CBRT
5. Spread of Interest Rate (The Difference Between Twelve Months Time Deposit and Three Months Time Deposit)	CBRT
6. Treasury Discounted Auctions Interest Rate Weighted by the Amount Sold	TREASURY
7. Time Deposits	CBRT
8. Sight Deposits	CBRT
9. M1	CBRT
10. M2	CBRT
11. M2Y	CBRT
12. Net International Reserves	CBRT
13. Credits to Companies and Individual Corporations	CBRT
Foreign Trade	
1. Imports (Total and sub-items)	SIS
2. Exports (Total and sub-items)	SIS
3. Export Price Index (General and sub-items)	SIS
4. Export Volume Index (General and sub-items)	SIS
5. Import Price Index (General and sub-items)	SIS
6. Import Volume Index (General and sub-items)	SIS
7. CBRT BTS Question Related to the Export Possibilities	CBRT
Balance of Payments	
1. Current Account	CBRT
2. Capital Account	CBRT
Consolidated Budget	
1. Taxes on Goods and Services	RTMF[9]
2. Value Added Tax (VAT) on Import	RTMF
3. Revenues	RTMF
4. Non-Interest Expenditures	RTMF
5. Primary Balance	RTMF
6. Budget Balance	RTMF
7. Interest Payments	RTMF

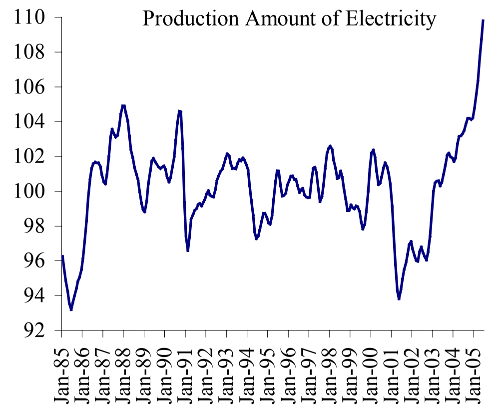
1 SIS: State Institute of Statistics
2 TETC: Turkish Electricity Transmission Joint Stock Company
3 CBRT: Central Bank of the Republic of Turkey
4 AMA: Automotive Manufacturers Association
5 TREASURY: Turkish Treasury
6 POAS: Petrol Ofisi
7 ICC: Istanbul Chamber of Commerce
8 SPO: The State Planning Organization
9 RTMF: Republic of Turkey Ministry of Finance

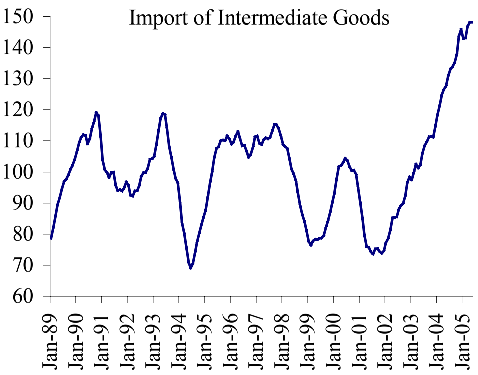
APPENDIX 2. Graphs of the Component Series

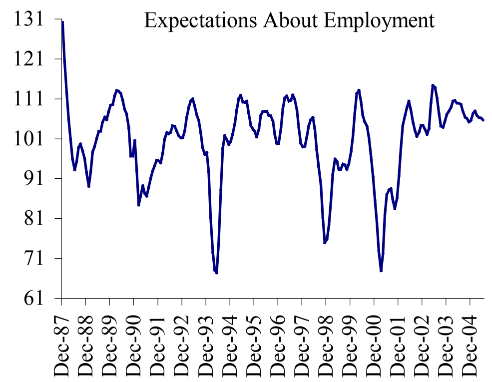






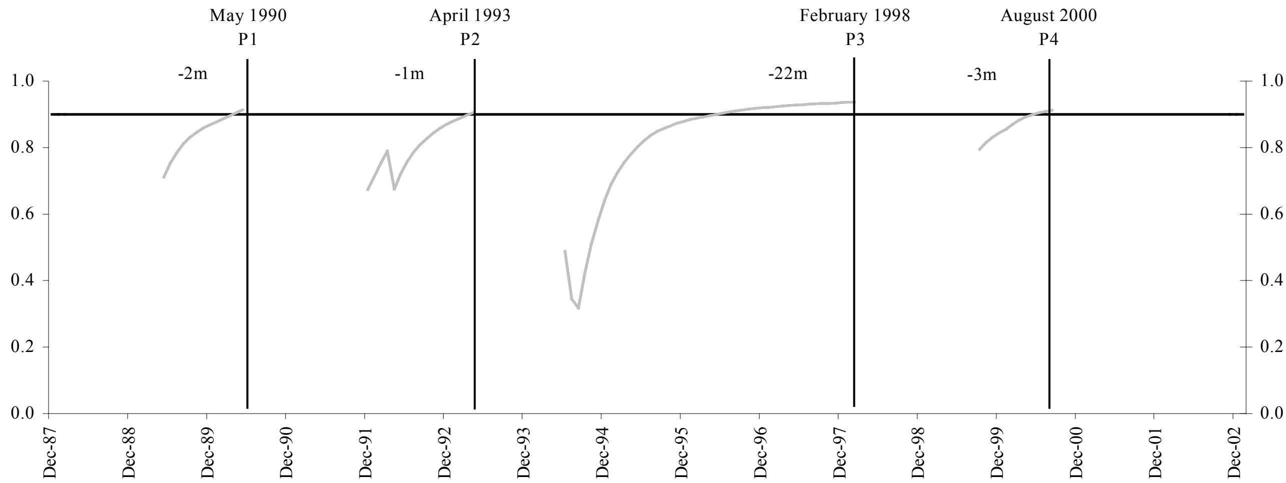




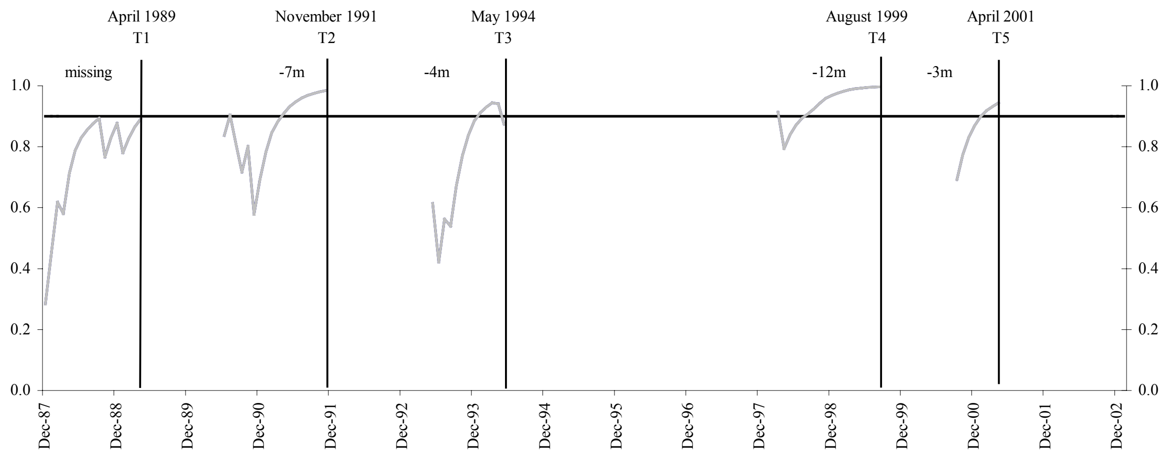


APPENDIX 3. Graphs of the Peak and Trough Probabilities

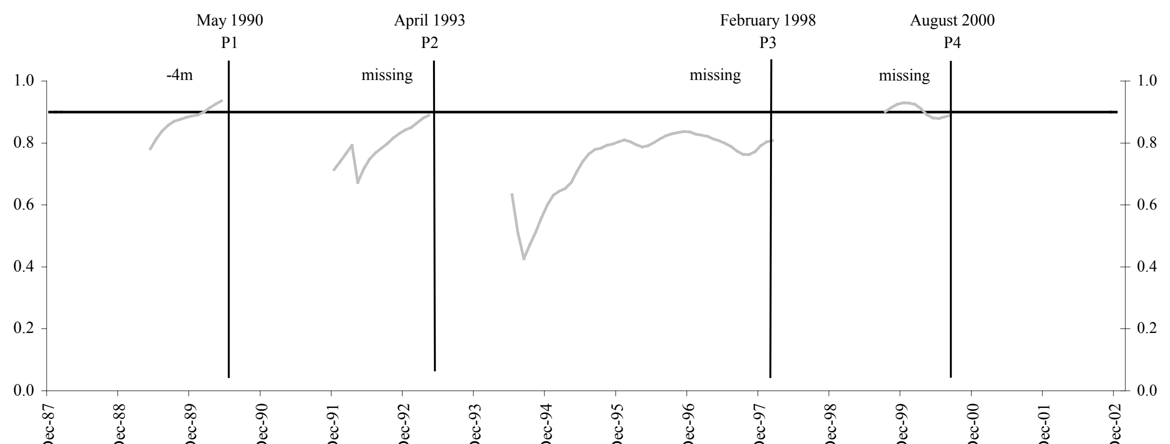
Graph 1. Peak Probabilities of the IARC; Lognormal Distribution



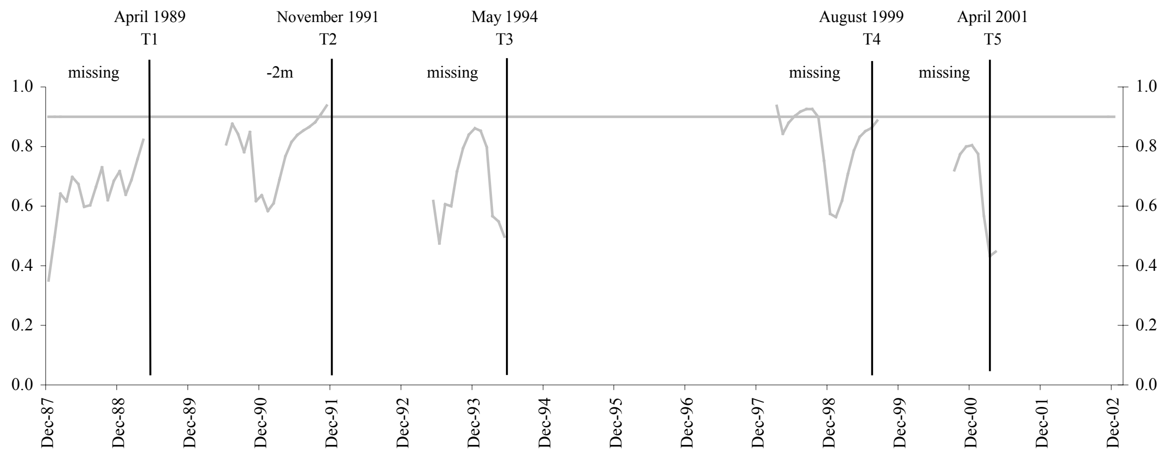
Graph 2. Trough Probabilities of the IARC; Lognormal Distribution



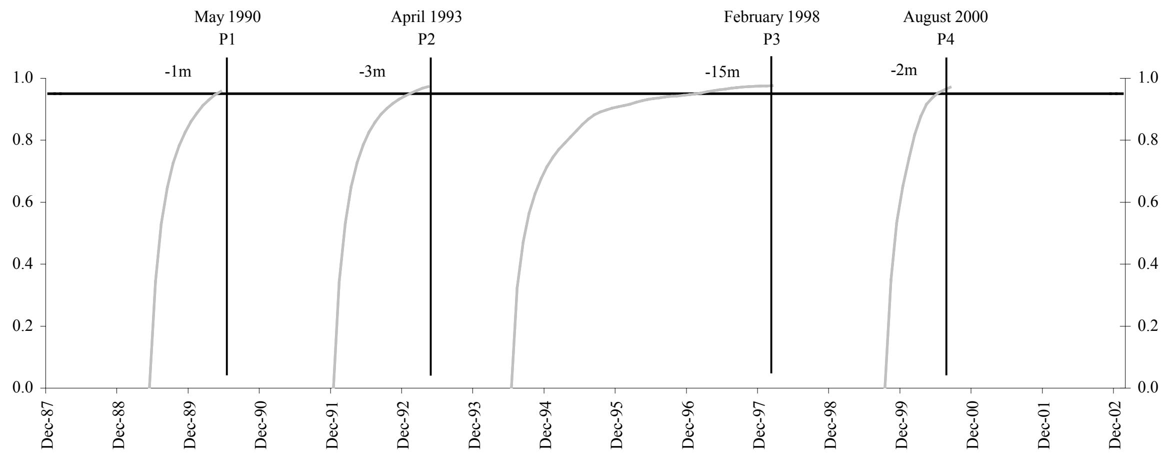
Graph 3. Peak Probabilities of the IARC; Normal Distribution



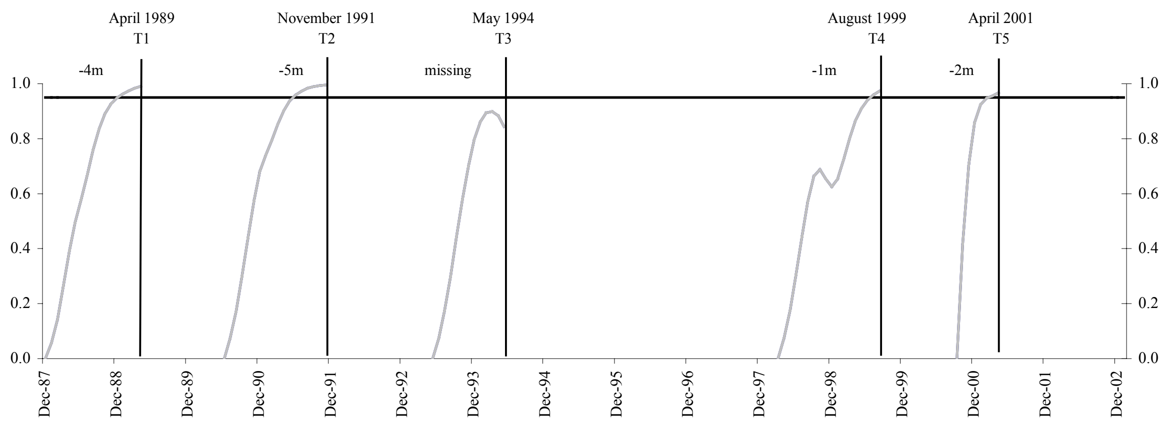
Graph 4. Trough Probabilities of the IARC; Normal Distribution



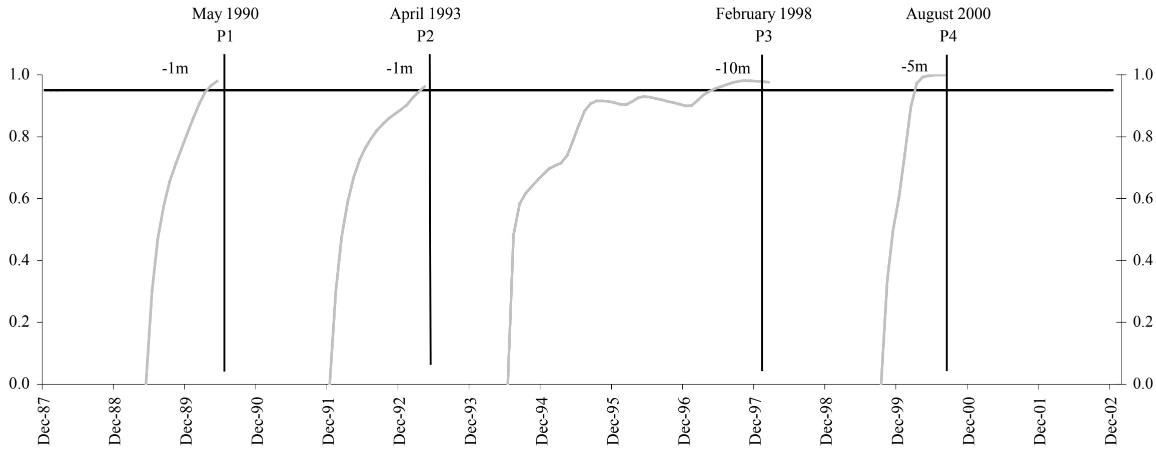
Graph 5. Peak Probabilities of the CLI; Lognormal Distribution



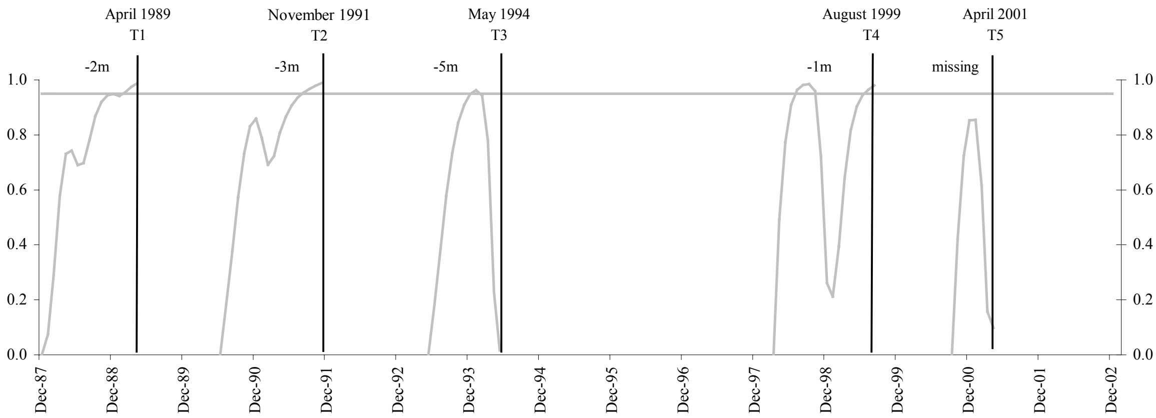
Graph 6. Trough Probabilities of the CLI; Lognormal Distribution



Graph 7. Peak Probabilities of the CLI; Normal Distribution



Graph 8. Trough Probabilities of the CLI; Normal Distribution



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