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# Developing Composite Leading Indicators to Forecast Industrial Business Cycles in Iran

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**A B S T R A C T**

Economic cycles are referred as repeatable movement of economic indicators with different domain and duration. Detection of these cycles may help in forecasting the contraction period or expansions of important parts of the economy specifically industry. In this regard, many economist and researchers have focused on composite leading indicators which are growing in terms of diversity of econometric methods. This paper studies 13 macro economical time series in order to develop the best composite indicator, reflecting business cycles of Iran's industry. Number of established licenses, production index of large industrial units, producer price index and import value index are the chosen variables that make the proposed composite leading indicator. The result of comparison between composite leading indicator and value added time series in the studied period (1997 up to 2012) showed a good correlation between the fluctuations of composite indicators and value added of industry. The result also showed that the proposed leading indicator has the ability to predict the business cycle for maximum 4 and minimum 1 period ahead and in average the forecasted period is equal to 3.2 seasons.

**Keywords**: ***Business Cycle, Composite Leading Indicator, Leading Indicators, Lagging Indicators, Coincident Indicators, Iran Industry.***

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## 1. Introduction

Demonstrating the role and position of industry in future economy of one country is dependent on a comprehensive study of the past events and current status of this sector in the economy and comparing it with the developed countries and emerging industrialized countries. Thus providing an image of the industry status of country and learning the features and functions of the Industrial enterprises from statistic, is the first step in any research of the future of the industry sector.

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Having such an image that demonstrating the weakness and strength of the current status, is certainly the master key to reforms of the economic-industrial development path, eliminating the growth obstacles, better usage of resources and opportunities, and step ahead to long-term positive trends.

### 1.1. Industry Sector

Industry and mining sector that is composed of manufacturing industries and power industries, is one of the main sectors of economy and has a great impact on growth and recession of Gross Domestic Production (GDP) of one country. According to the statistics, the industry and mining sector share of GDP has increased from 15.2% to 17.3% during 2000-2011, while Turkey and Korea as regional competitors experienced 29% and 38% respectively.

The growth rate of investment in industry sector on average has been 11% in the years leading up to 2011, and in these years it has been declined. Meanwhile investment supply in industry sector is highly effective. Calculation shows that for every 100 Rials increase in investment supply, results in 42 Rials increase in value added of industry and mining sector. Also the efficiency of this investment in whole economy system is 28 Rials.

The other sign of declining growth rate of investment in industry sector can be seen in establishment license numbers. The relevant official reports showed that number of establishment license has severely decreased in years 2007-2008. Number of establishment licenses that was recorded in 2008 is 26,176 which is less than the records in 2001. On the other hand, the share of employment in industry out of total employment has increased with a smooth trend from 31% to 33% during 2000-2011. Probably one of the reasons that cause this incoordination (between industry investment and employment) is exorbitant cost for creating one job opportunity during mentioned years.

Lack of one integrated information system for serving manufacturing industries with appropriate data about economic status and unstable business atmosphere that is unable to absorb the foreign investment and technology, are the main reasons for malfunctions in industry. In this study, we investigate 13 macro-economic variables and choose the most effective ones for shaping a composite leading indicator in order to forecast the recession and peak cycles of industry. The necessity for this indicator is that, it can help economists in early decision making, clarifying economic statistics, and increasing the private sector tendency for investment in industry.

### 1.2. Businesscycle Indicators

Fairly regular fluctuations in macro-economic variables such as GDP, consumption, investment, employment, prices and interest rate is called economic cycles. In Burns and Mitchell's idea, Economic cycles are devoted to the fluctuations in business's activities. Economic cycles include expansion periods in which simultaneously can be recognized in many economic activities, any expansion maybe followed by contraction period and again improved in the next expansion period. Generally, the period in which the economy decline and economic activities contracted is called recession and the period after that when economic status touch the nadir - lowest turning point in cycle- and activities begin to growth, is called expansion period. This period that the economy experience the recession and then expansion, the period between two consequence peek points, is called economic or business cycle.

The composite indicators that are used to describe the status of business cycles are in three types (Figure 1): leading indicators coincide indicators and lagging indicators. These indicators are very look like to the economic status movement of industry sector but there isn't any synchronization between them. Ones can occur after the other or earlier.

Now days, leading indicators are almost the most important indicators. These indicators study time series fluctuations in different periods and are used to project the future status of the economy. By the end of eighties, Organization for Economic Co-operation and Development (OECD), introduced a set of leading indicators for early detection of business cycles. This system can give more clear projection of economic status of different sectors to stakeholders.

Coincide indicators, are a kind of indicators in which their expansion and recession periods are synchronized with economic cycles thus they depict current status of economy. At last, lagging indicators follow the economic events and show the changes in planning and structure of economy.

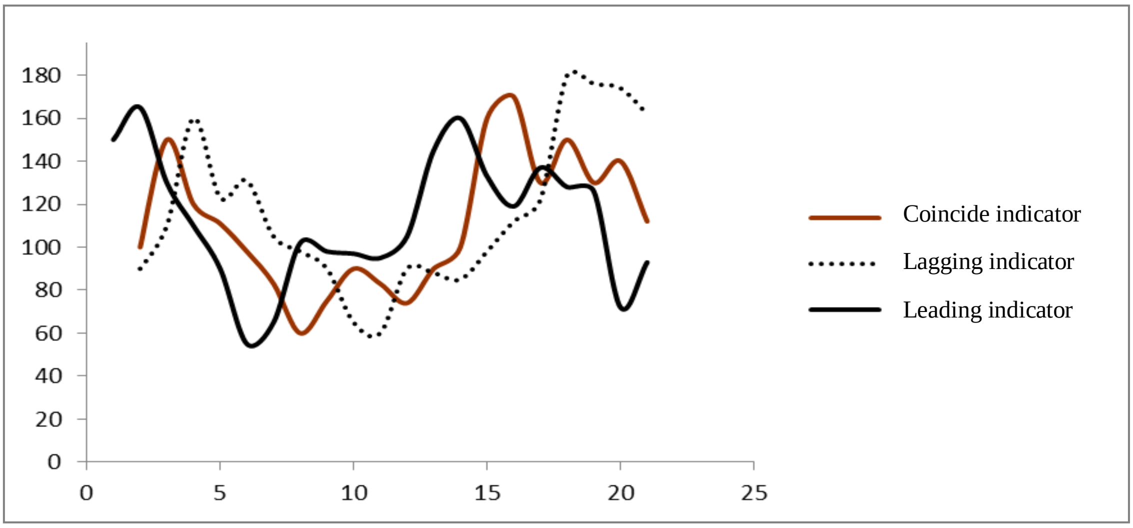


**Figure1.** A schematic presentation of composite indicators

Composite indicators, as it seems to be, are combination of indicators that can cover every indicator's weakness. The aim of structuring a composite indicator is to compound the proper indicators that mostly fit to industrial business cycles. This system should have the ability to predict the turning point in industry.

In this paper, we will try to characterize the business cycles of Iran's industry sector using composite leading indicators methods. In this regard, section 2 describes theoretical bases of the composite leading indicators. Section3 present a brief review of related studies in Iran and other countries. Thereafter, our leading indicator and its application for the Iran's industry is introduced. At last section 5 discuss about the findings of study and offer some suggestion for future researches.

## 2. Theoretical Foundations

As mentioned, business cycles refer to the fluctuations in macroeconomic variables as GDP, consumption, investment, employment and value added of economy's sectors. In Burns and Mitchell's point of view, as pioneers of leading indicators, fluctuations in the overall performance of the country is called economic cycles [1]. In the mid-thirties, leading indicators attracted many politicians and businessmen. They found it an efficient tool in analyzing economic situation, however their interest dimmed as Coopman's study published [2], in which criticized Burns and Mitchell's model. Afterward, many researchers studied leading indicators from different aspects, from selection of features up to detection of turning points.

Generally, methods of forming composite leading indicators can be classified in two categories:

Non-model based methods

Model based methods

Non-model based methods, which are suggested by Burns and Mitchell and developed by Valentine [3] and Zarnowitz [4], initiate with selection of leading indicators components upon specific criteria. Then, using proper filters, characteristics of each of these components are extracted, the proper method for dealing with seasonal fluctuations and outliers is chosen, long term effect is eliminated, for better homogenization, data series should be normalized and by comparing the turning point of the component's series and referenced variable, the right components for constructing the composite leading indicator are selected. At last significant components combines together by appropriate techniques.

This method was created by Burns and Mitchell at National Bureau of Economic Research's office (NBER) and has been under developments and modifications during these years. In eighties, business indicators was developed in three classification-leading, coincide and lagging indicators- based on business cycles by OECD's members and now 11 leading indicators, 4 coincide indicators and 7 lagging indicators is known as the most important business indicators in literature.

Model based methods were introduced in seventies in order to cover non-model based method's weaknesses. These methods can be divided into two categories: Dynamic Factor Models and Markov Switching Models. Dynamic factor models were introduced in 1977 by Geweke [5], Sargent and Sims [6]. But after introduction of stochastic methods by Stock and Watson [7], they faded out. Stock and Watson's methodology is based on existence of shared drivers that changes the macroeconomic variables. These drivers are selected by the group of variables that are independent of referenced variables. In 2004, Proietti and Moauro presented a new algorithm based on Stock and Watson's work and used it in constructing coincide composite indicator for the Eurozone [8]. Carriero and Marcellino in 2005 compared methods of constructing composite leading indicators and showed that they have similar results [9].

Sims suggested using fixed parameters instead of variable parameters is the main weakness of Stock and Watson's method [10]. In fact, this judgment is come from the problem, whether the business cycles are exogenous facts that originated from exogenous factors or business cycles have endogenous and nonlinear reasons. Being endogenous phenomena makes implementation of a simple statistical model for designation business cycles, hardly achievable. Hamilton's Markov switching model fixes this problem [11]. Hamilton by using Markov chain concept, allowed the growth rate variables dependent to recession/expansion status of market.

In comparison with dynamic factor models, the Markov switching model uses a hidden driver in variable changes with discrete space in which do not have direct impacts on variables but specifies the behavior of variables in different periods.

Leading indicators method that are based on non-model based techniques, are argued in several aspects [10]: At first, although each of features are selected by multivariable analysis, they don't have any clear relation with referenced variables. For example in determining the weights of features, their relation with dependent variables is not considered. Second, weighting algorithm is a fixed process. It should be noted that although determining the weights is difficult, the use of dynamic weighting process can improve predictions of future shocks in time series. Third, lagging indicators don't take apart in construction steps of leading indicators whilst there is enough economic and statistical reasons which shows utilization of lagging indicators results more accurate predictions. At last, since the components are a kind of prediction for referenced variable, standard deviation of components should be considered, however computation of standard deviation in non-model based techniques is almost impossible.

The main benefit of non-model based methods is their simplicity. Indicators that are formed based on non-model based easily can be created, explained, and interpreted. Simplicity can be of major importance while dealing with the public and politician. Also there is no uncertainty and over fitting in this method. Although model based methods solve these defects, but complexity of model based methods make it difficult to interpret the result for the public.

## 3. Empirical Studies

### 3.1. Global Composite Leading Indicator Studies

In the late thirties, composite leading indicators were introduced by Burns and Mitchell [11]. After their pioneer works (1938 and 1946), leading indicators as a useful tool for predicting the future of the economy, attracted many researchers and practitioners [1 and 11].

Simultaneously, Valentine and Zarnowitz from NBER institution present a method of constructing composite leading indicator [3 and 4]. Later in 1947, publication of Koopmans's paper on leading indicators, attracted many economists and resulted in several researches [2]. These studies encompassed different aspects of the indicators, selection and assessment of the best components, feasible combination of them and surveying the methods of identifying the relation of components to referenced variable/variables.

In 1980, business cycles was developed in three categories by OECD's countries: Leading indicators, coincide indicators and lagging indicators and now there are 11 leading indicators, 4 coincide indicators and 7 lagging indicators that is referred as main indicators of business cycles. Composite indicators are used as evaluation criteria of economies and become a tool for political and public relation analysis of different countries. The number of these indicators is increasing (there are more than 160 indicators that is recorded) [12]. In fact, using these composite indicators is easier way than analyzing each of the series, and because of that OECD's members have started to use these indicators for their performance assessment since 1990 [13].

Recent studies of composite leading indicators can be categorized in four groups: surveying the behavior of business indicators in two recession period of USA in 1991 and 2001[14-18], using financial variables as leading indicators [19 and 20], the benefits of using updated leading indicators [21 and 22] and survey of operational features for composite leading indicators [23].

### 3.2. Composite Leading Indicator Studies in Iran

Leading indicator studies don't have a long history in Iran. Naeeni surveyed the main factors that play a role in business cycles [24]. Nili and Dargahi analyzed the recession status of Iran economy by using business cycles concept [25]. Also Bastanzad and Zanjani studied the characteristics of business cycles in Iran economy [26]. Sohrabzadeh showed behavior of 50 main variable of Iran's economy in his thesis [27]. In 2002, Khatayi and Daneshjafari presented a framework, based on NBER methodology, for constructing composite leading indicators [28]. And also Iranian Center for strategic research as an official institution in 2000 start a constant attempt in research about composite leading indicators in Iran, and published his researches periodically in domestic journals [29-35]. These studies showed that GDP is the best index reflecting Iran's economic status and suggested six indicators for constructing composite leading indicator: liquidity at constant prices, oil price, stock price index, construction permits issued for residential units, index of consumer expectations and number of unemployed.

Literature reviews show that there isn't any research on constructing composite leading indicator for Iran's industry sector and there isn't any systematic mechanism for forecasting the GDP. In this study, a five-step procedure is presented in order to construct- a composite leading indicator based on information of Iran's industrial sector of economy, furthermore performance of proposed leading indicator is investigated by real data.

## 4. Methodology

A five-step procedure is presented here in order to be used to construct CLI's this procedure starts from selection of features and ends with aggregation of individual indicators. All the steps of this method are critical, so it is important to consider the whole steps as an integrated system. All selection in one step can affect the options of following steps, thus in each step, in addition to adopting the best option, relevance and dependency of options should be checked.

Figure 2. A five-step algorithm to prepare CLI

represents the proposed procedure.

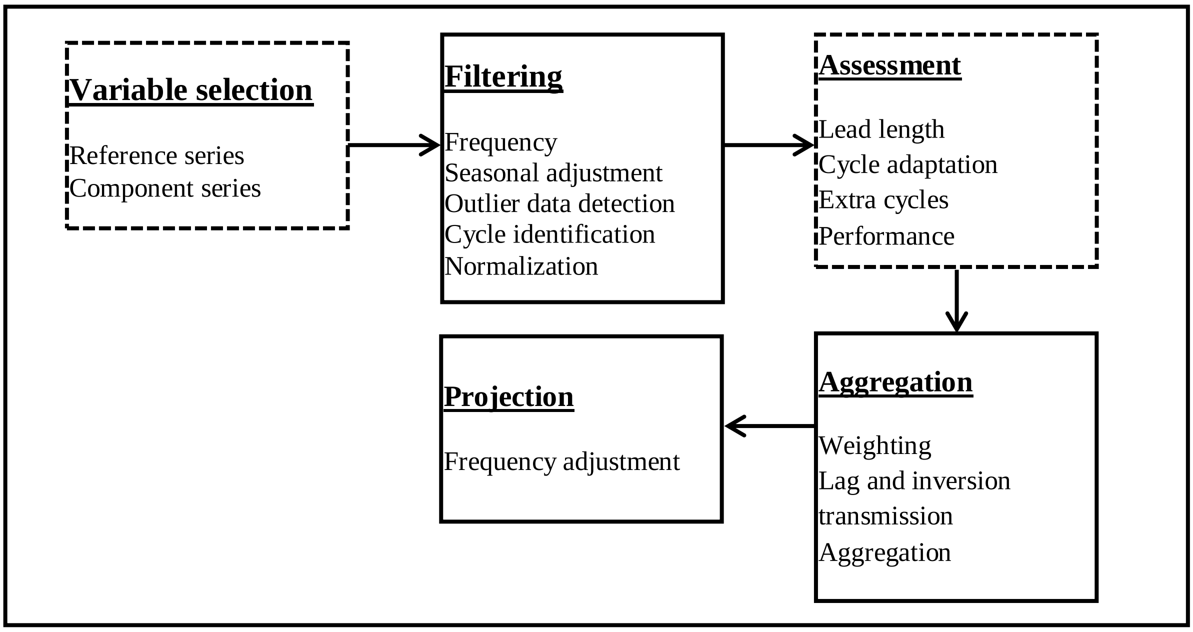


**Figure 2.** A five-step algorithm to prepare CLI

These five steps can be summarized as follows:

- Variable selection: In this step a series of data which can describe business cycles in the best way is selected as a reference series. In this regard, macro economical series which can help understanding the business cycles are collected. These series are called basic series or basic variables.
- Filtering: In filtering step, components of time series are analyzed with proper filtering methods and at last based on these components; peak and nadir points of series are detected.
- Assessment: components of each basic series are evaluated against reference series in this step. Lead time, period adaptation, and extra cycle and cross correlation is used as evaluation criteria.

- Presentation: at last, reference variables and different forms of composite leading indicator are assessed based on direction, average leading time and number of detected cycles.
-

### 4.1. Variable Selection

The strength and weakness of composite leading indicators is greatly depends on the quality of selected variables. Ideally, variables are selected based on the relevance, analytical quality, timelines and accessibility.

- Relevance: Observing the relation of fluctuations in reference series and components series is not enough. In addition to relevance, there should be also economical justifications for variable selection.
- Accuracy: Accuracy is closeness of provided values and original values. Accuracy has many characteristics but actually there isn't any general gauge for its evaluation.
- Timelines: Regular calculation of variables is a sign of scheduling in calculation and reporting of variables and compliance of responsible organization with schedule.
- Accessibility: Accessibility feature is the availability of source publisher and conditions of accessibility (distribution way, pricing policy, copyright). Interpretability: Interpretability of data is the ease of understanding and analyzing of variables.

Other factors that should be considered in this step are as follows [34]:

- Data publication periodicity: Monthly series is preferred to the seasonal or annual series.
- Revision: Data series with less revision are preferred.
- Length: Composite leading indicators with long time components are preferred.

Potential leading indicators can be categorized in four types of economic variables, which are used to evaluate their compatibility with CLIs.

- Initial stages: These types of variable are used to measure the initial stages of production such as new orders, construction permissions and etc.
- Quick response: The variables that react quickly to the changes of economy such as average working time, profit and stocks.
- Sensitive to expectations: These variables are used to measure the expectations such as stock price, raw material price or data of economical surveys about expectations.
- Main indexes: These variables are related to monetary policies and foreign economic developments such as money supply, terms of trade.

Variables that are used for developing a system of composite indicators should be selected somehow that strike a balance between these four categories. **Error! Reference source not found.** indicates potential list of reference variables and components.

In this step, Industrial unit employment index is omitted because of lack of sufficient data. Time series of this index is just available up to 2005 while reference series and the other components series are available up to 2011.

**4.2. Filtering**

Once the components of CLI have been selected, the second step-developing of leading indicators is started. This process attempts to omit the factors such as seasonal patterns, trends and outliers that can hide the components trend of CLI cycles.

The first step in filtering is unifying the frequency of data series. Time series of economic indexes are published with different periodicity (annually, seasonal and monthly). Linear interpolation is used for converting the long period series into shorter period series.

The purpose of developing a CLI is to determine the direction and size of changes in a short period of time. Despite, due to existence of seasonal patterns in time series, identification of main economic trends is being hard. Therefore Seasonal adjustment is another way of presenting the seasonal statistic of current economy status and prediction of future changes.

In this regard, techniques like TRAMO-SEATS, BV4, SABLE, STAMP and specially X11, X11-ARIMA and X12-ARIMA are among well-known techniques that used for seasonal adjustment. The mechanism of most of these techniques estimates the adjusted series by modeling the relation of unadjusted series and their triple component. Although there are lots of seasonal adjustment techniques, TRAMO-SEATS is a standard technique that is highly recommended for seasonal adjustment. Another benefit of this technique is its ability in estimation of non-systematic factors such as outliers. Figure 3. Value added of an industry before and after seasonal adjustment

depicts application of TRAMO-SEATS technique on value added of industry.

Residuals are used for evaluating the performance of seasonal adjustment. Residuals should be independent and normally distributed with mean 0. Test of the residuals shows that the null hypothesis is accepted in significant level of 5%. So residuals are independent random variables and fulfill the theoretical requirements (Figure 4. Test of normality of value added of industry

).

After estimating outliers' data and seasonal adjusting of time series, internal trend of time series is extracted. This trend shows the long term direction of time series and cycles of macroeconomic fluctuations. Among many filtering methods, Hodrik-Prescott filter is one of the most common techniques in filtering. This filtering method is based on following optimization model [35].

$$\min_{\tau_t} \sum_t \left(y_t - \tau_t\right)^2 + \lambda \sum_t \left(\tau_{t+1} - 2\tau_t + \tau_{t-1}\right)^2 \qquad (1)$$
$$y_t = \tau_t + c_t$$

In equation (1) time series ytis decomposed into trend element (τt) and cycle element (ct). The objective of model is to minimize the distance between trend and main series along with reducing the curvature of trend. The compromise between these two objectives is controlled by λ parameter. In this study, Eviews 7.2 is used to eliminate internal trends, also since using seasonal data λ parameter is assumed to be equal to 1600. Figure5. Cycles, trend and final seasonally adjusted series of industrial value added

depicts application of, Hodrik-Prescott filteron industrial value added series. , please refer to appendix [35].

**Table 1.** List of potential reference variables and components

| variable | type | source | accessibility | Frequency | Length | relevance | category |
|---|---|---|---|---|---|---|---|
| GDP of industry | Referenced | Central bank | good | seasonal | 1978-2012 | direct | ------- |
| Large workshop production index with more than 100 person | Component | Central bank | good | seasonal | 1978-2012 | direct | Quick response |
| Industrial units Establishment license | Component | Ministry of Industries and Mines | good | seasonal | 1978-2012 | direct | Initial stages |
| Industrial plants Commissioning license | Component | Ministry of Industries and Mines | good | seasonal | 1978-2012 | direct | Initial stages |
| Industry stock index | Component | Tehran exchange | good | seasonal | 1978-2012 | direct | Expectation-Sensitive |
| Large workshop employment index with more than 50 person(1369SH) | Component | Central bank | average | seasonal | 1978-1998 | direct | Quick response |
| Large workshop employment index with more than 100 person(1376 SH) | Component | Central bank | weak | seasonal | 1997-2005 | direct | Quick response |
| Large | Compon | Central | weak | seasonal | 2004- | direct | Quick response |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| workshop employment index with more than 100 person(1383 SH) | ent | bank | | | 2009 | | |
| The producers price index | Component | Central bank | good | seasonal | 1978-2012 | direct | Quick response |
| Import index | Component | Central bank | good | seasonal | 1978-2012 | reverse | Main indexes |
| Oil price | Component | Central bank | good | Monthly | 1978-2012 | direct | Expectation-Sensitive |
| Liquidity M2 | Component | Central bank | good | seasonal | 1978-2012 | direct | Main indexes |
| Total power generation | Component | Central bank | good | seasonal | 1978-2012 | direct | Initial stages |

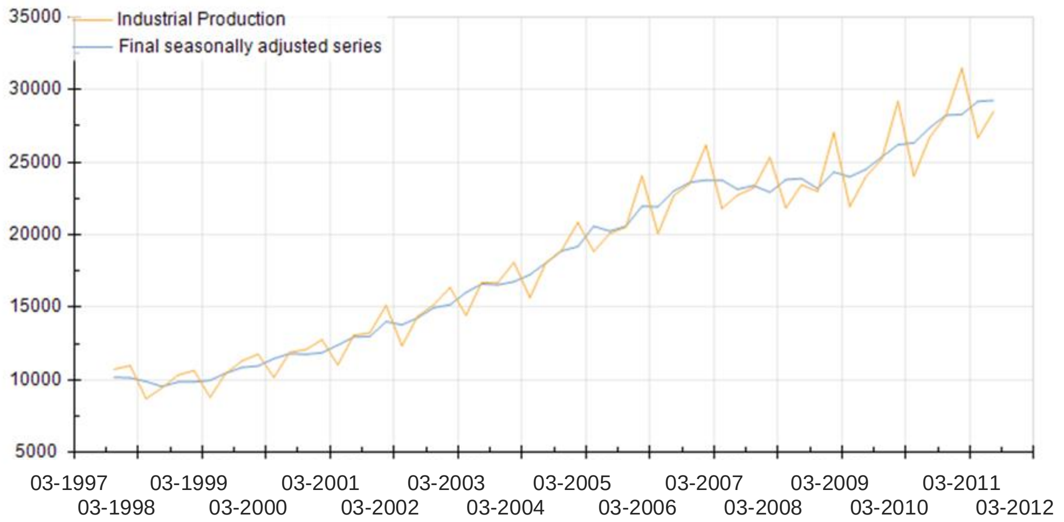


**Figure 3.** Value added of an industry before and after seasonal adjustment

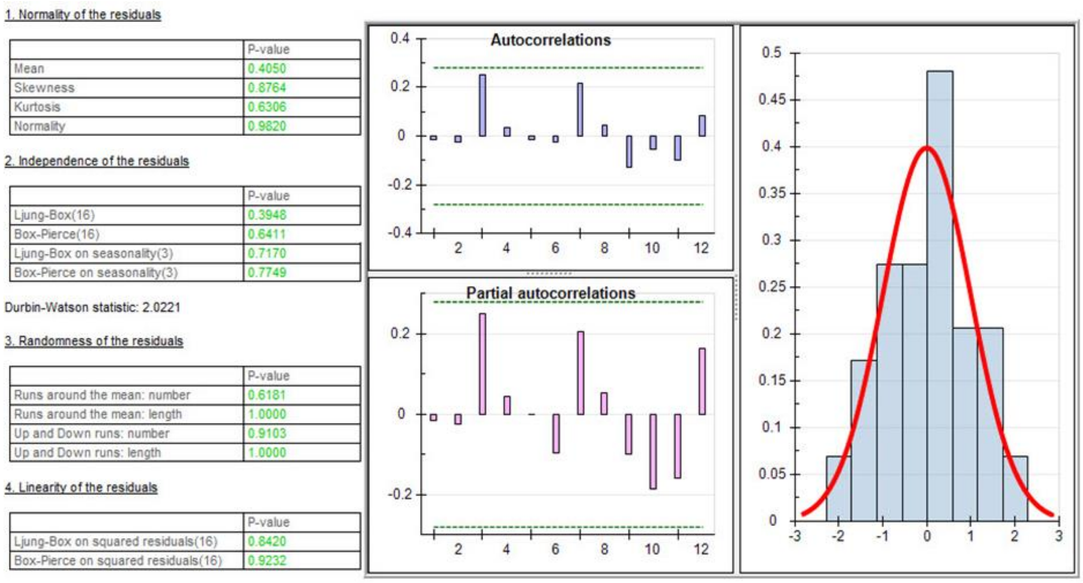


**Figure 4.** Test of normality of value added of industry

In order to determine the category of component variables (lead, lag and coincide type), the cross correlation between the cycle elements of component variables and reference series (value added of industry) should be calculated (Table 2).

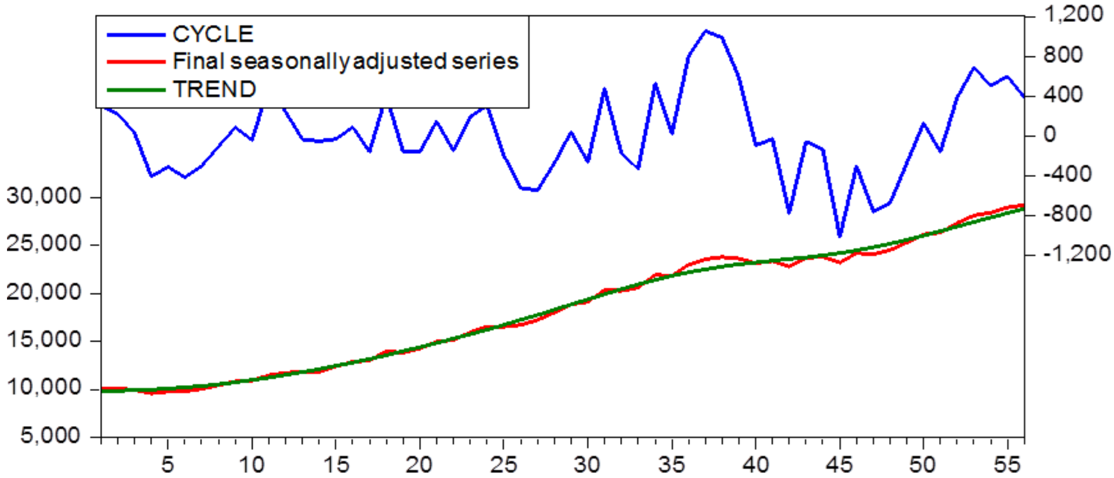


**Figure5.** Cycles, trend and final seasonally adjusted series of industrial value added

**Table 2.** Correlation of components variables and referred series

| Economic variable | Cross Correlation | Explanation |
|---|---|---|
| Industrial units Establishment license | $\rho$0.571(+4)= | Compatible with cycle, 4 leading season |
| Industrial plants Commissioning license | $\rho$0.567(+2)= | Compatible with cycle, 2 leading season |
| Producers price index | $\rho$0.552(+4)= | Compatible with cycle, 4 leading season |
| Import value index | $\rho$-0.561(+3)= | against with cycle, 3 leading season |

| | | |
|---|---|---|
| Oil price | $\rho$0.429(-2)= | Compatible with cycle, weak correlation |
| Liquidity M2 | $\rho$0.503(-2)= | Compatible with cycle, weak correlation |
| Industrial plants production index | $\rho$0.603(+6)= | Compatible with cycle, weak correlation |
| Industrial stock index | $\rho$0.542(-4)= | Compatible with cycle, 4 leading season |
| Total power generation index | $\rho$0.259(-6)= | Compatible with cycle, So weak correlation |

For detail explanation of the Table 2, one component variable is described, for example, Industrial units Establishment License has a correlation of 0.571 with GDP of industry. The positive correlation of this variable shows compatibility with GDP of industry. Experimental studies showed that variables should be selected that their cross correlation is not lesser than 0.55.

1. Component series of industrial units' establishment license, Industrial plants Exploitation license, Producers price index, Import value index and Industrial plants production index are leaded indicators for value added of industry.
2. Total power generation index can be assumed as a lagged component but due to weak correlation it won't be useful for developing CLI.
3. Industrial unit establishment and Commissioning license are highly correlated with reference series, however due to their high correlation, industrial units establishment license is selected for CLI.
4. Import value index with negative correlation shows an opposite behavior toward GDP of industry.
5. The other variables are not taken apart in CLI due to their negative intervals and insignificant correlation.

In the next step, by calculation of time series cycles with Harding-Pagan algorithm, peak and trough points of series are determined among many fluctuations. This algorithm is as follows:

1. Identifying the potential turning point in time series.
2. A method to ensuring changing peaks and trough points.
3. A group of rules for determination the turning points that decompose the cycles by cycle duration, phase and cycle amplitude. These rules are known as Censoring Rules.

In this regard, the phase can be assumed as a triangular. Figure 6. Schematic presentation of cycle and phase

shows an economic recession, that point A is a peak and point C is a trough. Height of this triangular is severity of phase and base of triangular is duration of one economic cycle. With this information the area of triangular can be calculated. This area can be a proxy for cumulative decline from peak to trough. For implementation of this algorithm, 2months is used as a minimum duration of the phase, 5 seasons for minimum duration of a cycle, 2 seasons for minimum distance of turning points and threshold of amplitude is 25% [34].

For comparisons of determined cycles of component series with turning points of reference series, first turning points of reference series are calculated then by determination of turning points of component series, average duration of recession period, average duration of growth period and average lag time and lead time are identified. This information is listed in tables 3-7.

Furthermore, to eliminate the effects caused by dimension of different data series, following equation (2) is used in order to normalize them:

$$I_{qc}^{t} = \frac{x_{qc}^{t} - E_t(x_{qc}^{t})}{E_t(\left|x_{qc}^{t} - E_t(x_{qc}^{t})\right|)} \quad (2)$$

Literatures suggest two methods in order to aggregate component variables: the first one is using an equal weighting for each component and the second one use equation (3) for determining the weights of components [28].

$$Y_t = \sum_{i=1}^{n} \left( L_i \times \frac{N_i}{T_i} \right) \times X_{it} \quad (3)$$

Which Li is an average leading time for variable i, Ni is number of leading situation in comparison with reference series and Ti number of leading, lagging and coincide situations of variable i in comparison with reference series.

Comparing the result of the weighting methods, as it is shown in Figure 7. Comparing the turning points of equal weighting CLI with reference series

and 7, as it is depicted both methods reveals almost similar results (**Error! Reference source not found.** and **Error! Reference source not found.**).

As it seen, both types of CLI have predicted the GDP of industry for almost 3.2 seasons ahead. However, recently this difference has increased up to 4 seasons which provides a good opportunity for economist and politicians to make a decision for economy. The results show that two CLIs detect correctly 9 turning points among 10 points which is a good result for developed CLI performance.

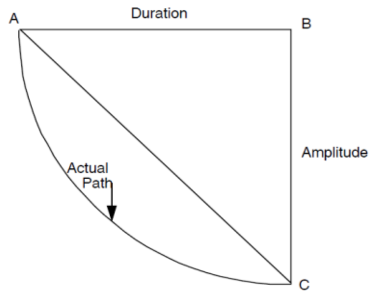


**Figure 6.** Schematic presentation of cycle and phase

It is worst mentioning that seasonal data of this survey are between 1997/05-2011/04. The proposed CLI has some limitations that are mostly originated from Harding-Pagan algorithm. For example, this algorithm did not detect any turning points in two last periods. This issue limits the forecasting capabilities of developed CLI. On the other hand, predictions are based on the third season of 2011and there isn't any updated data for current periods. Undoubtedly the model is so designed that by updating of component series, the developed CLI of new periods can be predicted.

**Table 3.** Turning points of reference series

| | Troughs (YYYY -S) | Peaks (YYYY -S) | Growth period length (Season) | Recession period length (Season) | Total cycle period (Season) (trough to trough) | Total cycle period (Season) (peak to peak) | Distance from referred series (Season) Lead(-) Lag(+) Coincide(0) |
|---|---|---|---|---|---|---|---|
| | 1999-1 | 2000-2 | 5 | 9 | 14 | 13 | - |
| | 2002-3 | 2003-3 | 4 | 3 | 7 | 7 | - |
| | 2004-2 | 2005-2 | 4 | 2 | 6 | 6 | - |
| | 2005-4 | 2006-4 | 4 | 8 | 12 | 16 | - |
| | 2008-4 | 2010-4 | 8 | - | - | - | - |
| Max | | | 8 | 8 | 14 | 16 | - |
| Min | | | 4 | 2 | 6 | 6 | - |
| Ave. | | | 6.25 | 5.5 | 9.75 | 10.5 | - |

**Table 4.** Turning points of industrial establishment license and its comparison with reference series

| | Troughs (YYYY-S) | Peaks (YYYY-S) | Growth period length (Season) | Recession period length (Season) | Total cycle period (Season) (trough to trough) | Total cycle period (Season) (peak to peak) | Distance from referred series (Season) Lead(-) Lag(+) Coincide(0) |
|---|---|---|---|---|---|---|---|
| | 1999-1 | 1999-3 | 2 | 7 | 9 | 13 | -4 |
| | 2001-2 | 2002-4 | 6 | 7 | 13 | 9 | -3 |
| | 2004-3 | 2005-1 | 2 | 3 | 5 | 5 | -1 |
| | 2005-4 | 2006-2 | 2 | 8 | 10 | 17 | -2 |
| | 2008-2 | 2010-3 | 9 | - | - | - | -1 |
| Max | | | 9 | 8 | 13 | 17 | -4 |

| | | | | | |
|---|---|---|---|---|---|
| Min | 2 | 3 | 5 | 5 | -1 |
| Ave. | 4.2 | 6.25 | 9.25 | 11 | -2.2 |

**Table 5.** Turning points of industrial production index and its comparison with reference series

| | Troughs (YYYY-S) | Peaks (YYYY-S) | Growth period length (Season) | Recession period length (Season) | Total cycle period (Season) (trough to trough) | Total cycle period (Season) (peak to peak) | Distance from referred series (Season) Lead(-) Lag(+) Coincide(0) |
|---|---|---|---|---|---|---|---|
| | 1999-1 | 1999-3 | 2 | 8 | 10 | 12 | -3 |
| | 2001-3 | 2002-3 | 4 | 4 | 8 | 7 | -4 |
| | 2003-3 | 2004-1 | 3 | 3 | 6 | 7 | -5 |
| | 2004-4 | 2005-4 | 4 | 4 | 8 | 12 | -4 |
| | 2006-4 | 2008-4 | 8 | - | - | - | -8 |
| Max | | | 8 | 8 | 10 | 12 | -8 |
| Min | | | 2 | 3 | 6 | 7 | -3 |
| Ave. | | | 4.2 | 4.75 | 8 | 9.5 | -4.8 |

**Table 1**. Turning points of Production price index and its comparison with reference series

| | Troughs (YYYY-S) | Peaks (YYYY-S) | Growth period length (Season) | Recession period length (Season) | Total cycle period (Season) (trough to trough) | Total cycle period (Season) (peak to peak) | Distance from referred series (Season) Lead(-) Lag(+) Coincide(0) |
|---|---|---|---|---|---|---|---|
| | 1998-3 | 1999-3 | 4 | 7 | 11 | 12 | -4 |
| | 2001-2 | 2002-3 | 5 | 5 | 10 | 7 | -4 |
| | 2003-4 | 2004-4 | 2 | 5 | 7 | 9 | -4 |
| | 2005-3 | 2006-3 | 4 | 3 | 7 | 9 | -1 |
| | 2007-2 | 2008-3 | 6 | - | - | - | -9 |
| Max | | | 6 | 7 | 11 | 12 | -9 |
| Min | | | 2 | 3 | 7 | 7 | -1 |
| Ave. | | | 4.2 | 5 | 8.75 | 9.25 | -4.4 |

**Table 2.** Turning points of Imports value and its comparison with reference series

| | Troughs (YYYY-S) | Peaks (YYYY-S) | Growth period length (Season) | Recession period length (Season) | Total cycle period (Season) (trough to trough) | Total cycle period (Season) (peak to peak) | Distance from referred series (Season) Lead(-) Lag(+) Coincide(0) |
|---|---|---|---|---|---|---|---|
| | 1999-4 | 1999-1 | 7 | 2 | 9 | 8 | -2 |
| | 2002-1 | 2001-2 | 6 | 3 | 9 | 5 | -6 |
| | 2004-1 | 2003-3 | 2 | 2 | 4 | 12 | -4 |
| | 2005-4 | 2004-4 | 10 | 3 | 13 | 9 | -4 |
| | 2010-1 | 2008-2 | - | 7 | - | - | -3 |
| Max | | | 10 | 7 | 13 | 12 | -6 |
| Min | | | 2 | 2 | 4 | 7 | -2 |
| Ave. | | | 6.25 | 3.4 | 8.75 | 8.5 | -3.8 |

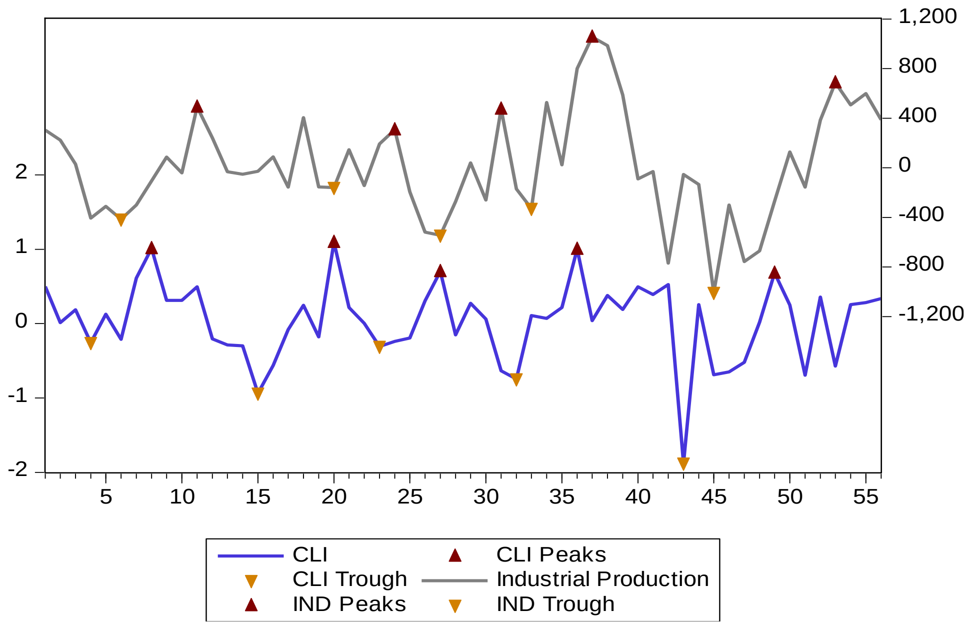


**Figure 7.** Comparing the turning points of equal weighting CLI with reference series

**Table 8.** Turning points of equal weighting CLI and its comparison with reference series

| | Troughs (YYYY-S) | Peaks (YYYY-S) | Growth period length (Season) | Recession period length (Season) | Total cycle period (Season) (trough to trough) | Total cycle period (Season) (peak to peak) | Distance from referred series (Season) Lead(-) Lag(+) Coincide(0) |
|---|---|---|---|---|---|---|---|
| | 1998-4 | 1999-3 | 4 | 7 | 11 | 12 | -3 |
| | 2001-2 | 2002-3 | 5 | 3 | 8 | 7 | -4 |
| | 2003-2 | 2004-2 | 4 | 5 | 9 | 9 | -4 |
| | 2005-3 | 3006-3 | 4 | 7 | 11 | 13 | -1 |
| | 2008-2 | 2009-4 | 6 | - | - | - | -4 |
| Max | | | 6 | 7 | 13 | 13 | -4 |
| Min | | | 4 | 3 | 8 | 7 | -1 |
| Ave. | | | 6.4 | 5.5 | 8.75 | 10.25 | -3.2 |

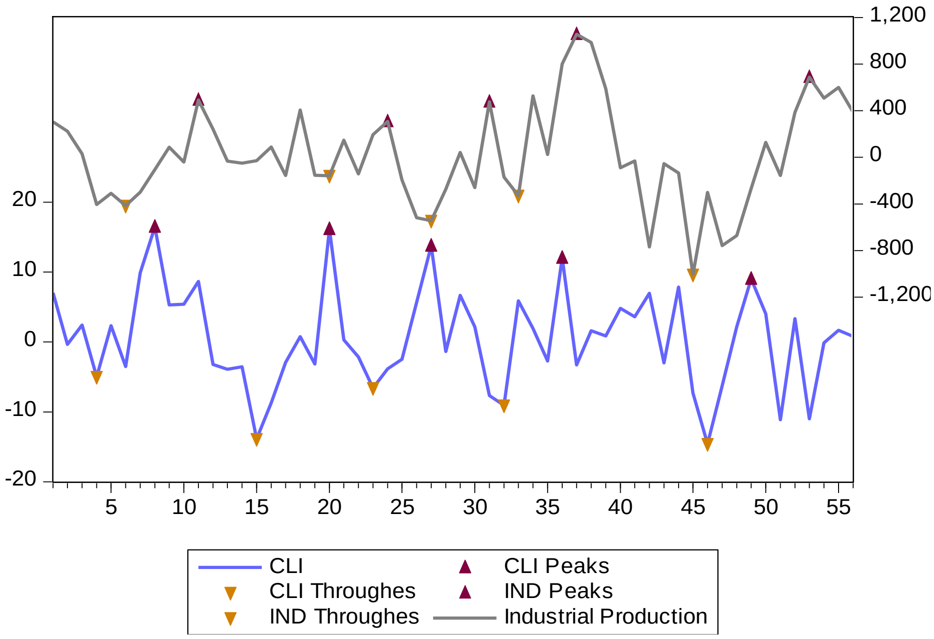


**Figure 8.** Comparing the turning points of CLI with reference series

**Table 9.** Turning points of CLI and its comparison with reference series

| | Troughs (YYYY-S) | Peaks (YYYY-S) | Growth period length (Season) | Recession period length (Season) | Total cycle period (Season) (trough to trough) | Total cycle period (Season) (peak to peak) | Distance from referred series (Season) Lead(-) Lag(+) Coincide(0) |
|---|---|---|---|---|---|---|---|
| | 1998-4 | 1999-3 | 4 | 7 | 11 | 12 | -3 |
| | 2001-2 | 2002-3 | 5 | 3 | 8 | 7 | -4 |
| | 2003-2 | 2004-2 | 4 | 5 | 9 | 9 | -4 |
| | 2005-3 | 3006-3 | 4 | 10 | 14 | 13 | -1 |
| | 2009-1 | 2009-4 | 3 | - | - | - | -4 |
| Max | | | 5 | 10 | 14 | 13 | -4 |
| Min | | | 3 | 3 | 8 | 7 | -1 |
| Ave. | | | 4 | 6.25 | 10.5 | 10.25 | -3.2 |

## 5. Conclusion and Further Research

This study suggests a five-step procedure in order to develop CLI for business cycles in industry of Islamic republic of Iran. Tow CLI has been suggested for mentioned reference series, one symmetric and asymmetric, in which both of them reveals similar results in case of forecasting business cycles of industries. In this regards, the proposed CLI was able to predict 9 out of 10 changing points in value added of industry. This study shows that industry has experienced through points in 1999/1, 2002/1, 2004/2, 2005/2, 2008/2 and has touched peaks in 2000/2, 2003/1, 2004/4, 2005/4, 2009/2. On the other hand the mean recession and growth duration in studied period are respectively 20 and 24 month. Also mean cycle time of industry is equal to 28 month.

Developing CLI on other sector of economy such as agriculture and oil and new methods for cycle identification can be an interesting topic to be followed by statistician. On the other hand chronology of industrial cycles can provide useful information about growth and recession periods in industry.

## References

[1] Burns, A. F. and Mitchell, W. C. (1946). *Measuring Business Cycles*. National Bareaue of Economic Research, New York.

[2] Koopmans, T. (1947). Measurement Without Theory. *Review of Economics and Statistics*, Vol. 29, No. 1, pp. 161-179.

[3] Valentine, L. M. (1987). *Business Cycles and Forcasting*. South-Western Publishing co., Cincinati, Ohaio.

[4] Zarnowitz, V. and Boschan, C. (1975). Cyclical indicators: an evaluation and new leading indexes. *Business Condition Digest*, pp. 185-198.

[5] Geweke, J. (1977). *The dynamics factor analysis of economics time series*. In: Aigner, D. J. and Goldberger, A. S. (Eds), Latent Variables in Socio-Economic Models. North-Holland, Amsterdam, Chapter 19.

[6] Sargent, T. J. and Sims, C. A. (1977). *Business cycle modeling without pretending to have too much a priori economic theory*. In: Sims, C. et al. (Eds.), New Methods in Business Cycle Research. Federal Reserve Bank of Minneapolis.

[7] Stock, J. H. and Watson, M. W. (1989). *New Indexes of coincident and leading economic indicators*. In: Blanchard, O. and Fischer, S. (Eds.), NBER Macroeconomics Anuual. MIT Press, Cambridge.

[8] Proietti, T. and Moauro, F. (2004). Dynamic factor analysis with nonlinear temporal aggregation constraints. *Econometrics 0401003*, Economics Working Paper Archive at WUSTL.

[9] Carriero, A. and Marcellino, M. (2005). *Building composite coincident indicators for European countries*. Mimeo, Bocconi University.

[10] Sims, C. A. (1989). *Comment on Stock and Watson (1989)*. In: Blanchard, O.; Fischer, S.; (Eds), NBER Macroeconomics Annual. MIT Press, Cambridge, MA, pp. 395-397.

[11] Mitchell, W. C. and Burns, A. F. (1938). *Statistical indicators of cyclical revivals*. National Bureau of Economical Research, New York.

[12] Bandura, R. (2008). *A Survey of Composite Indices Measuring Country Performance: Update*. United Nations Development Programme-Office of Development Studies.

[13] Saltelli, A. (2007). Composite indicators between analysis and advocacy. *Social Indicators Research*, Vol. 81, pp. 65-77.

[14] Schumacher, C. and Breitung, J. (2008). Real time forcasting of german GDP based on a large factor model with mountly and quarterly data. *International Journal of Forcasting*, Vol. 24, No. 10, pp. 386-398.

[15] Dueker, M. J. (2005). Dynamic forcasts of qualitative variables: A Qual VAR model of US recessions. *Journal of Business and Economic Statistics*, Vol. 23, No. 1, pp. 96-104.

[16] Stock, J. H. and Watson, M. W. (2003). Forcastingoutput and inflation: the role of asset prices. *Journal of Economic Literature*, Vol. 41, No. 3, pp. 788-829.

[17] Filardo, A. J. (2002). *The 2001 US recession: what did recession prediction models tell us?*. Paper prepared for a book honoring Geoffrey H. Moore, Bank of International Settlements.

[18] Drechsel, k. and Maurin, L. (2011). Flow on conjunctural information and forecast of euro area economic activity. *Journal of Forecasting*, Vol. 30, No. 3, pp. 336-354.

[19] Gertler, M. and Lown, C. S. (2000). *The information in the high yield bond spread for the business cycle: Evidence and some implications*. NBER Working Paper Series No. 7549.

[20] Hamilton, J, D. and Kim, D. H. (2002). A re-examination of the predictability of economic activity using the yield speard. *Journal of Money, Credit and Banking*, Vol. 34, No. 2, pp. 340-360.

[21] Layton, A. P. and Katsuura, M. (2001). Comparison of regime switching, probit and logit models in dating and forcating US business cycles. *International Journal of Forcasting*, Vol. 17, No. 5, pp. 403-417.

[22] Granger, C. W. J. and Machina, M. J. (2006). *Forcasting and decision theory*. In: Elliotth, G., Granger, C. W. J. and Timmermann, A. (Eds.), The Handbook of Economic Forcasting. Elsevier, Amsterdam. pp. 81-98.

[23] Banerjee, A. and Marcellino, M. (2006). Are there any reliable leading indicators for US Inflation and GDP growth?. *International Journal of Forcasting*, Vol. 17, No. 3, pp. 137-151.

[24] Jalali Naeini, S. (1996). *Analyzing business cycles of Iran.Institute for Research in Planning and Development of Iran*. Tehran, Iran.

[25] Nili, M. and Dargahi, H. (1998). *Analyzing the recession of Iran economy based on business cycles and its solution*. 8thAnnual Conference on Monetary and Exchange rate Policy, Iran.

[26] Bastanzadeh, H. and Moghadam Zanjani, M., V. (1999). Business cycles of Iran economy. *Ravand*, No. 36 and 37.

[27] Sohrabzadeh, J. (2000). *Business cycles of Iran*. Master thesis, Faculty Of Economics, University Of Tehran.

[28] Khatayi, M. and Danesh Jafari, (2001). Business cycles of Iran. *Iranian Journal Of Trade Studies*, Vol. 5, No. 18, pp. 1-28.

[29] Tabatabei Yazdi, R. (2001). Forecasting through strategic indicators. *Rahbord*, No. 19, pp. 238-344.

[30] Tabatabei Yazdi, R. (2001). Forecasting through strategic indicators, application of leading indicators. *Rahbord*, No. 20, pp. 344-352.

[31] Tabatabei Yazdi, R. and Malek, F. (2002). Forecasting of Iran economy in 2002 through strategic indicators, application of leading indicators. *Rahbord*, No. 22, pp. 343-352.

[32] Tabatabei Yazdi, R. and Malek, F. (2003). Iran economy in 2003 through leading indicators, application of leading indicators. *Rahbord*, No. 29, pp. 111-120.

[33] Tabatabei Yazdi, R. and Malek, F. (2003). Iran economy in 2004. *Rahbord*, No. 32, pp. 223-234.

[34] Tabatabei Yazdi, R. and Malek, F. (2005). Iran economy in 2005. *Rahbord*, No. 35, pp. 183-202.

[35] Rafal, W. and Michal, Z. (2015). A note on using the Hodrick–Prescott filter in electricity markets. *Energy Economics*, Vol. 48, pp. 1-6.