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An early warning indicator of economic vulnerability constructing for Malaysian economy

Abstract. The initiative to capture the information content behind the rise and fall of the business cycle has popularized the study about leading indicators. Many of the foreign experiences shared by economically advanced countries evidently show that the leading indicators approach work well as a short-term forecasting tool. Thus, exploring into an indicator-based forecasting tool for business cycle analysis and economic risk monitoring, it would be an insightful move to the Malaysian economy as well as others emerging countries. By extending the ideology of indicator construction from the US NBER, the present study demonstrates a strong potential of the leading indicator approach to be a good gauge of the business cycle movement besides being a practically functional early warning indicator for economic vulnerability prediction.

Keywords: Business Cycle; Composite Leading Indicator; Early Warning Indicator; Turning Points

JEL Codes: E32; E37; C32; C43

Acknowledgement. *The authors acknowledge the financial support of the University of Malaysia Sarawak and Exploratory Research Grant No ERGS/01(01)854/2012(06).*

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Побудова індикатора раннього попередження економічної вразливості для малайзійської економіки

Анотація. Ініціатива володіння важливою інформацією під час злету і падіння ділового циклу, популяризувала дослідження з різних випереджальних індикаторів. Багато чого із зарубіжного досвіду, яким поділилися економічно розвинені країни, чітко показує, що випереджальні індикатори добре працюють як інструменти для короткострокового прогнозування. Таким чином, дослідження показників-інструментів прогнозування для аналізу бізнес-циклу та моніторингу економічного ризику буде серйозним кроком для Малайської економіки, а також інших країн, що розвиваються.
Ключові слова: бізнес-цикл; композитний випереджальний індикатор; індикатор раннього попередження; поворотні точки.

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Построение индикатора раннего предупреждения о возможной экономической уязвимости для малазийской экономии

Аннотация. Инициатива владения важной информацией во время взлета и падения делового цикла популяризовала исследования по различным опережающим индикаторам. Многое из зарубежного опыта, которым поделились экономически развитые страны, четко показывает, что опережающие индикаторы хорошо работают как инструменты для краткосрочного прогнозирования. Таким образом, исследование показателей-инструментов прогнозирования для анализа бизнес-цикла и мониторинга экономического риска будет серьезным шагом для Малазийской экономики, а также других развивающихся стран.

Ключевые слова: бизнес-цикл; композитный опережающий индикатор; индикатор раннего предупреждения; поворотные точки.

Introduction. Economic risk and uncertainty are intrinsic and ever-present, whilst attempt to cease their inburst is almost infeasible in reality. Yet, failure to foresee their arrival and have all attempts taken to minimize their potential danger may significantly depress the healthiness of economy. Also, the adverse impact and the cost of economic contraction, if not properly addressed and minimized, will likely to be deepened and spilled over to others neighboring markets. In this regard, the Asian financial crisis 1997–1998 and the recent sub-prime mortgage crisis 2008–2009 on top of others unpleasant economic phenomenon have gave down-to-earth lesson to the world, especially the seriously affected economies. The harshness of the past crises, especially the two-mentioned crises have created awareness among all the country about the importance of enhancing economic risks management.

Undoubtedly, attempt to build a resilience forecasting system, which is capable to access the impending economic dangers will be of value to all of the economic agents, for instance, the policymakers, business players, investors and also general public to solidify the ability to manage risks. As a result, cyclical analysis in the tradition of Mitchell and Burns (1938) [1] and Burn and Mitchell (1946) [2] is expanding rapidly with the aim to shed a light on the underlying facts behind the economy-wide fluctuation. Studies in this nature are commonly known as business cycle forecasting while the indicator approach commenced by the National Bureau of Economic Research (NBER) of the US have been in the forefront of business cycle forecasting since decades ago. The popularity and credibility of the indicator approach is attributable particularly to the ability of the indicator to foreshadow the changing economic scenario in the near future given its inherent leading nature against business cycle.

Furthermore, the intrinsic leading feature makes the leading indicator a functional early warning tool to signal the forthcoming economic vulnerability. Hence, the indicator-based forecasting tool is not merely to forecast the movement in the general economic activity, but also serves as a crisis alarming device given the ability of the indicator to signal vulnerable episode in an advanced time. Phillips (1998) [3] as well agreed that monitoring the economic variables that tend to be sensitive to cyclical changes no matter what their causes would be one of the forecasting approaches to predict recessions and expansions. Therefore, it makes a great sense to interpret the implicit facts behind the movement of a set of leading economic series to yield insightful information on the current performance of the economy besides permitting for notable projection on the future economic direction. A thoughtful contemporary and forward-looking interpretation on business cycle certainly maintains a great interest in macroeconomic and business cycle forecasting as its render an opportunity to moderate the severity of any unwelcomed economic event.

Accordingly, the present study seeks to establish an empirically and practically useful Early Warning Indicator (EWI) which is capable to offer remarkable early signal to the critical turning points in the business cycle. This is to aid the economic agents to stay alert with the future direction of an economy and respond promptly toward the changing economic scenario and upcoming economic danger. The practical implementation of EWI is especially important to national policymakers and central bank, since economic policy by nature requires a high degree of foresight in order to be effective. The rationale is that policy typically plays its role after a certain period of lag time. Hence, the key policy objective of macroeconomic stabilization may hardly achieve in an efficacious manner, if the policy action is not timely implemented to secure the weakening economic from translating into serious crisis or downturn. As such, closely scrutinizing the rise and fall in the economic activity through EWI is important for taking responsive stabilization and adjustment policies.

Noticing that the development of EWI withstands a sizable benefit to its potential users in the aspect of macroeconomic risk management and vulnerability anticipation, we perceived a vital role of EWI towards the Malaysian economy in this dynamic economic environment. Standing well-off as one of the emerging countries while making significant headway toward globalized and liberalized world, the Malaysian economy is unsurprisingly open to momentous external influences, consequently, conveys immense risk and uncertainty to the domestic market. Therefore, the exploration into a resilient early signaling tool to economic vulnerability serves as an important endeavor to the Malaysian economy since the ability to monitor and manage the arising risks and uncertainties in the economy is yet to be enhanced despite the currently available practices. In addition, building a sound forecasting tool for truthful short-term prediction is peculiarly worthwhile to confront with the diminishing capability of the existing economic indicator as an early signaling tool due to the evidence of false signal and erotic lead times as found by Yap (2009) [4]. Also, a study presented by Wong et al. (2012) [5] provided evidence of the diminishing lead time offered by the existing composite leading indicator (CLI). In this respect, it is imperative to examine if EWI could be a better alternative in forecasting incoming economic vulnerability.

Moreover, in contrast with the work of Zhang and Zhuang (2004) [6] who constructed an alternative leading indicator for the Malaysia economy based on Sequential Probability Model (SPM) proposed by Neftci (1982) [7], the present study implement the non-model based procedure commenced by the NBER and outlined methodically by Conference Broad (2000) [8]. More importantly, utilizing a non-model based framework which is consistent with the methodology of leading indicator construction in Malaysia ensure that the relative performance between the constructed indicator and benchmark indicator can be comparably drawn and the finding would be particularly meaningful in validating the evidence offered by [4]. Besides, we are benchmarking the performance of the constructed EWI

against the currently available indicator-based forecasting instrument, and forecasts evaluation on indicator's predictive ability via directional accuracy testing contributes to an exceptional exploration on indicator based study in Malaysia which is distinct from [6] which assess the predictive power of their constructed indicator against non-indicator-based forecasting models through Quadratic Probability Score (QPS) proposed by Diebold and Rudebusch (1989) [9].

Hence, the main **objective** of the study is to construct a novel EWI for the Malaysian economy with the aim of providing notable future projection to any vulnerable economic situation besides serving as a macroeconomic risk monitoring tool. Findings from the present study shows that the constructed EWI traced well most of the critical economic incidents in Malaysian business cycle and the remarkable leads time suggest a strong potential for EWI to work as a responsive signaling tool to presage impending vulnerable episode in the economy. Additionally, the EWI is found to be robust in terms of predictive accuracy and the directional accuracy have outperforms the publicly available composite leading indicator (CLI). The rest of the paper is organized into sections, as follows. The next section provides a review of related literature followed by a brief description of the data and reference series selection. The subsequent section goes into methodological aspects of the study and presentation of empirical findings with interpretations. The final section concludes.

Brief Literature Review. Despite the challenging task of analyzing and predicting the business cycle under an intrinsically dynamic economic environment, continuous evolvement in business cycle forecasting is still taking place over time. Endless research in this agenda has contributed to countless literature to sustain the practical significance of business cycle forecasting in economic setting. Since the first inspiration of the US NBER to develop an indicator-based forecasting tool for business cycle analysis venture into reality, the practice diffused promptly into other economies. However, most of the empirical study in this nature concentrated to a large extent at the industrialized or economically advanced economies, see for example, Herrera and Garcia (1999) [10], Bodart et al. (2003) [11], Kholodilin and Siliverstovs (2005) [12] and Schirwitz (2009) [13]. Literature in this domain is fairly little when we look at the emerging economies where the construction and application of indicator-based forecasting is a quite a recent practice in macroeconomics forecasting.

As far as this study concerned, few of the worth noting literatures on business cycle analysis carried out specifically for emerging economies were Everhart and Duval-Hernandez (2001) [14], [6], Mohanty et al. (2003) [15], Atabek et al. (2005) [16], Du Plessis (2006) [17], Bascos-Deveza (2006) [18], Zalewski (2009) [19] and Issler et al. (2012) [20]. Following the Organization for Economic Cooperation and Development's (OECD's) indicator compilation procedure, [14] constructed a CLI For the Mexican economy and concluded that the Hodrick-Prescott (HP) filter developed by Hodrick and Prescott (1980) [21] contributed fairly well in cycle extraction and that the constructed indicator met their research objective of building an indicator of economic activity for business cycle forecasting. Alternatively, [15] utilized the band pass (BP) filter to construct a business cycle indicator under growth cycle approach for the Indian economy. The study showed that the constructed indicator could predict the cyclical turning points at 6 months ahead of the reference series - Index of Industrial Production (IIP).

Meanwhile, [6] utilized the sequential probability model to build up a system of leading indicator for Malaysia and the Philippines. Predictive power evaluation based on QPS indicated that the constructed indicator performed better than non-indicator based forecasting models, suggesting that the composite indicator could be a useful predictor of economic activity. Then, [18] added to the literature on indicator construction and business cycle analysis for Philippines. Following a rule-based approach proposed by Artis et al. (1995) [22] in turning points detection, both studies by [6] and [18] consistently illustrated that the leading indicator work well in tracing the tuning points in business cycle for Philippines. Besides that, [20] proposed a composite leading index (CLI) for the Brazilian economy based on the Conference Board methodology. Based on QPS evaluation, [20] discovered that survey series of industrial activity contributed to better model of CLI.

Description of Data and Reference Series Selection. For the purpose of EWI construction, a bundle of macroeconomic and financial series which own certain desirable properties of a business cycle indicator as documented in the [8] and OECD (2001) [23] has been selected for empirical examination. This is to ascertain the inherent nature of each series in relation to the business cycle. To reach the goal of building an early warning tool to signal the critical turning points in Malaysian business cycle, only economic series with leading characteristic were selected for inclusion in the construction of EWI. Correlation analysis and visual inspection have been utilized to facilitate the selection of the component series. It is crucial to have component series that highly correlated with the business cycle as the evidence of correlation denotes that the selected component series possess significant interrelationship with the business cycle. This is a necessary condition to ensure the likelihood of the EWI to work well in tracing the business cycle. Hence, series which do not show significant correlation had been dropped from analysis, and ultimately only six component series which include domestic share price, share price in US, total exportation, money supply, number of new company registered and number of tourists' arrival make up the EWI construction in this study.

Furthermore, the currently available monthly data of CLI from 1981 to 2009 has been compiled from various issues of Malaysian Economic Indicators published by the Department Statistics Malaysia (DOSM). In this study, the CLI would function as a competing model in the evaluation of predictive accuracy and forecasting performance of the constructed EWI. For reference series selection, we adopted the real gross domestic product (GDP) as a representation of business cycle or general economy activity in Malaysia. This is consistent with the NBER routine but distinct from the OECD's and DOSM's approaches of using IIP and self-built coincident index (CCI), respectively as reference series in business cycle analysis. Nevertheless, there exists no general agreement on which series should be selected as the representation of the business cycle (European Central Bank, 2001) [24].

Hence, appropriate selection shall account for the common practice in business cycle literature as well as the nature of the economy and the representability of the selected proxy. In this instance, the present study regards the real GDP as a board-based and most ideal representation of Malaysian business cycle because it covers a wider range of economy activity and sufficiently reflects each of the real economic sectors in the country. To obtain series with higher frequency, interpolation technique proposed by Gandolfo (1981) [25] has been applied and the ratio of GDP to CPI was calculated to transform the GDP series into its real term. The monthly series of consumer price index (CPI) and quarterly series of GDP were extracted from various issues of the International Financial Statistics (IFS) Yearbook published by the International Monetary Fund (IMF).

Methodology and Empirical Discussion. The EWI construction involves a step by step procedure of indicator-based ideology, first introduced by the NBER of the US during 1930s. The composite indicator compilation procedure outlined by the Conference Board [8] has been applied to construct the EWI for the Malaysian economy. After the construction of EWI, the index is then transformed into growth cycle based on the procedure proposed by Moore and Zarnowitz (1986) [26]. The rationale of having growth cycle approach is because we intended to study the growth rate of Malaysian business cycle instead of the classical business cycle or business cycle in its level form[1]. The justification is that the level form of business cycle conception is

[1] The business cycle conception of growth cycle and classical cycle own different interpretation. For the former, contraction means a slowdown or an absolute decline in economic activity. However, for the later, contraction involves only absolute decline or recessions.

less applicable to the Malaysian scenario, as the economy does not suffer from major oscillation in the level of general economic activity, but experienced fluctuations in the growth rates of economic activity (Ahmad, 2003) [27]. As such, measuring the business cycle by estimating the deviation of economic activity from its long-term trend will be more appropriate for the Malaysian context[2].

To obtain a smoothed cyclical component of the EWI for turning point analysis, this study followed the procedure suggested by Moore and Zarnowitz [26]. Firstly, seasonal adjustment through Tramo/Seats methods has been applied to eliminate the seasonal factor. Then, the seasonal adjusted series has been subjected to detrending using Hodrick-Prescott (HP) filter developed by [21] in order to yield a smooth estimate of long-run trend component of real GDP. The HP filter is a widely applied detrending framework used to decompose the seasonally adjusted time-series into trend, besides providing a smoothed trend to minimize problem. HP filter was first employed by Hodrick and Prescott in early 1980s to study the business cycle for the US during the postwar period. Thus far, it is one of the commonly applied techniques to extract the cyclical component in business cycle analysis. Recent studies in business cycle such as Everhart and Duval-Hernandez (2000) [28], Sussmuth and Woitek (2004) [29], Kranendonk et al. (2005) [30], [18], Klucik and Haluska (2008) [31], [19], Polasek (2010) [32] and many more applied the HP filter for cycle extraction.

Next, we applied the method of simple centered moving average to smooth out the irregularity. This is one of the smoothing techniques adopted and suggested by Zhang and Zhuang [6]. According to the authors, a moving average length of seven months is appropriate for the case of Malaysia. However, the present study employs a moving average length of five months, since it is empirically sufficient to smooth out the irregularity within the sample period. Finally, following most of the non-parametric business cycle study in literature, Bry-Boschan technique proposed by Bry and Boschan (1971) [34] has been used to identify the turning points from the depersonalized, detrended and smoothed reference series. To ensure consistency, similar procedure has been applied to RGDP and CLI series to yield their respective smoothed cyclical component. The former would serve as a proxy for Malaysian business cycle and later works as a benchmark indicator to evaluate the predictive accuracy and robustness of the constructed EWI. The performance of the EWI in predicting the critical scenario in Malaysian business cycle during 1991 to 2009 is visually presented in Figure. The important episodes as a result of the outbreak of critical economic downturns and crises are indicated with shaded area.

Upon the whole, Figure shows that the movement of the EWI is relatively coherent with the movement of business cycle represented by real GDP. In chorus, the traced peaks and troughs from turning point analysis are fairly consistent with the historical profile of Malaysian business cycle. Moreover, from Figure, it is obvious that EWI moves in advance of real GDP for most of the time and the turning points in EWI frequently appear a few months earlier than the turning points in RGDP. The visual evidence presented in Figure suggests that the constructed EWI traced successfully most of the historical economic downturns or crises that had happened in Malaysian during the period of 1991 to 2009. Furthermore, the remarkable lead times shown by the EWI fulfilled the aim of building an EWI to signal the vulnerable turning points in Malaysian business cycle.

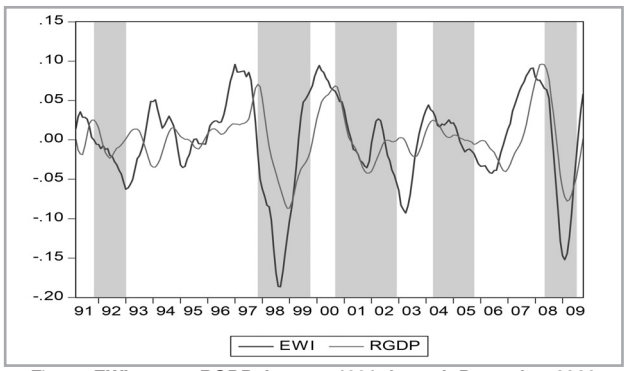

Figure: **EWI versus RGDP, January 1991 through December 2009**
Source: The Authors' own estimation

Recently testing the directional accuracy of macroeconomic forecasts received increased attention in the field of forecasting because unreliable forecasts make no sense to users. In addition, only large predicted change is useful to forecast users Greer (2003) [35]. Hence, we applied the directional accuracy testing into the present study to investigate whether the EWI predicted accurately the direction of change in business cycle. We trichotomized the forecasts into trichotomous scenario, namely large predicted increase, no significant changes and large predicted decrease. In order to distinguish small from large changes, a relevant threshold or cutoff is required. We adopted a 5 percent cutoff following Greer [35]. The directional accuracy rate is first calculated as Cs/Ns x 100 percent, where Cs is the number of correct prediction for significant large changes, and Ns refers to total number of significant large change in the actual business cycle variable. To evaluate the predictive accuracy of the constructed EWI against the competing indicator-based model, that is, the publicly available CLI, the comparative finding for directional accuracy and binomial testing up to 6 months is tabulated collective in Table.

The binomial testing, in this context, has been incorporated to examine the robustness of the EWI as a forecasting tool. The aim of the test is to statistically verify that the EWI itself owns compelling predictive power, and the success of the prediction is independent from wild guess or mere chance. The null hypothesis for the binomial testing is that the probability of correctly predicting the direction of change in the forecasting model is 50 percent. In other words, the null hypothesis implies that the forecasting model performs indifferently from the wild guess. If the null hypothesis could be rejected, then we could expect two possible outcomes. In the case where the directional accuracy rate is more than 50 percent, the forecasting model is proven to be statistically outperforming wild guess. Conversely, if we have directional accuracy rate lower than 50 percent, wild guess will dominate the source of obtaining correct prediction. If this is the case, then the forecasting model is unable to beat wild guess in predicting the direction of change in business cycle.

The direction accuracy test results in Table also reveal that the constructed EWI could predict up to 94.6 percent accuracy on Malaysia's major business cycle turning points. In sharp contrast, the directional accuracy rate of the existing CLI was at best 13.5 percent. Furthermore, binomial test results called for a rejection of the null hypothesis at the 1% level of significance, indicating that the CLI is significantly outperformed by the wild guess. On the other hand, the binomial test results indicate that EWI performed significantly better than the wild guess. This is an important inference to justify that the source of success or correct prediction offered by EWI is owing to the predictive power of the indicator per cent, but not by a mere chance. The empirical assessment on predictive accuracy is apparently favorable to support the robustness of the EWI in business cycle forecasting given the strong evidence of directional accuracy. This again suggests that EWI holds compelling predictive power to foreshadow the changing phases in business cycle and offers reliable signal to economic vulnerability.

Summary and Conclusion. With the aim of providing the Malaysian economy a practically and empirically sound indicator-based forecasting tool, an EWI has been constructed using a set of macroeconomic series. The EWI is found to work well in tracing the business cycle in Malaysia with some lead times. Most of the critical tuning points, which were translated into

[2] See Niemira and Klein (1994) [33] for further argument on choosing the growth cycle approach in business cycle conception.

Table: **Directional Accuracy and Binomial Testing Results**

Lag (month)	Directional Accuracy (%)		P(Binomial)	
	EWI	CLI	EWI	CLI
1	86.49%	8.11%	0.000	0.000
2	91.89%	10.81%	0.000	0.000
3	94.59%	13.51%	0.000	0.000
4	94.59%	13.51%	0.000	0.000
5	89.19%	13.51%	0.000	0.000
6	83.78%	10.81%	0.000	0.000

Source: The Authors' own estimation

unpleasant economic experience during 1991 to 2009 have been predicted in advance by the EWI. The remarkable leads time of about 4 months on average enable the EWI to work as a responsive short-term forecasting tool in macroeconomic analysis and policy building. Besides that, the statistical tests on model's predictive accuracy suggest that the constructed EWI outperforms the current available CLI in forecasting the Malaysian business cycle. This finding again strengthens Yap's [4] argument on the diminishing capability of the CLI as an early signaling tool. One significant possibility that leads to a weaken CLI is the diminishing capability of the component series to reflect the contemporary economic environment. In other words, such phenomenon implicitly suggests that continuous updating and revising the composite indicator is notably a crucial task to sustain the accuracy and competency of the indicator-based forecasting tool in the face of dynamic economic environment.

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Received 2.03.2015