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A MODEL TO ESTIMATE A COMPOSITE INDICATOR OF ECONOMIC ACTIVITY (CIEA) FOR UGANDA

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Abstract

In this paper a Composite Indicator of Economic Activity (CIEA) for Uganda is developed and its applicability to explain short run fluctuations of the economy is illustrated. The CIEA is a more flexible and useful tool for short-term analysis and forecasting of economic activity than econometric models, especially for small, open and rapidly changing economies. The CIEA methodology is advantageous since composite indexes can reveal common turning point patterns in a set of economic data in a clearer and more convincing manner than the behavior of any individual component. The methodology adopted here is the famous Conference Board technique which has features similar to the Moore- Shiskin methodology. The CIEA is computed for the period January 2005 to April 2011 using monthly data of eight key variables, exports, imports, credit, VAT, PAYE, excise duty, cement production and sales for selected products. The results of the analysis reveal a general upward trend in economic activity. With reference to the recent past between January and April 2011, there was slowdown in economic activity in the months of February and April. Going forward, economic activity is expected to trend upwards for the reminder of the financial year. A snap shot comparison of the CIEA and quarterly GDP reveals a close correlation between the two series. The paper therefore recommends the adoption of the current CIEA in Uganda and proposes continuous improvement with more data.

Key words: business cycle composite index, lagging indicators leading indicators

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1. INTRODUCTION

The importance of high frequency timely indicators of economic activity in formulating macroeconomic policies is well researched. Formulation of economic policy specifically monetary policy requires constant feedbacks with the real economy because policy ultimately interacts with real agents i.e. business firms, consumers, labour markets among others. For example, an unexpected strengthening of output growth, may suggest a need for the monetary authority to increase the supply of liquidity in the economy. However, often the relevant statistics and information to judge the direction of economic activity are only available with significant lag, thus delaying appropriate policy actions. This problem is even more severe in developing/emerging markets where the lags of publication of relevant data are longer on average than in the developed economies.

Lately, the composite indicator of economic activity (CIEA) framework is gaining prominence among policy makers as a tool for estimating the direction of output over the short and medium term (see Roberto J. Tibana (2003) for Mozambique. The existence of a timely, available and reliable composite coincident economic indicator is essential for economic policy and business decision making because they provide useful picture of where we are and where we may be going. By definition, CIEA is a variable that is well correlated with the current level of economic activity (such as real GDP).

Within Bank of Uganda, due to the significant lag in the release of quarterly GDP series and the limited representation in part of the index of industrial production, variables ranging from private sector credit to imports and exports statistics, government and private sector expenditures have been employed to proxy developments in the real economy on a more frequent basis. These variables though useful, have been analyzed individually without a clear methodology to combine them into a single indicator thus often making conclusions out of them ambiguous. Composite indexes serve as handy summary measures of the behavior of the cyclical indicators and they tend to smooth out some of the volatility of individual series.

Ronny Nilsson (2000) summarizes the advantage of composite indexes as "The reason why a group of indicators combined into a composite indicator should be more reliable over a period of time

than any of its individual components is related to the nature and causes of business cycles. Each cycle has its unique characteristics as well as features common with other cycles. But no single cause explains the cyclical fluctuation over a period of time in overall activity. The performance of individual indicators will then depend on the causes behind a specific cycle. Some indicators will perform better in one cycle and others in a different cycle. It is therefore necessary to have signals for the many possible causes of cyclical changes and to use all potential indicators as a group".

The purpose of this paper is to develop a CIEA for Uganda. Composite indexes can reveal common turning point patterns in a set of economic data in a clearer and more convincing manner than the behavior of any individual component. Specifically, the paper surveys standard methodologies for construction of CIEA and uses this to construct Uganda's CIEA. In addition, the paper analysis how well the CIEA relates with economic activity (real GDP).

The rest of the paper is structured into five main sections. Section 2 delves into the literature on CIEA. Section 3 provides the CIEA methodology. Section 4 provides Uganda's CIEA and discusses it and section 5 concludes.

2. Literature Review

The concept of CIEA as a key variable for determining the direction of economic activity was first introduced by Burns and Mitchell in the 1920 and 1930s for the USA. Over time, CIEA has gone through several changes but heavily relying on the work of Burns and Mitchell. One milestone in the CIEA literature was by Koopmans's (1947) in form of criticism on account that it was a measurement without theory. Koopmans's criticism has spurred the production of a wide array of literature culminating into the development of sophisticated methodologies for combining individual series into composite indices such as the use of state-space and Kalmer filtering techniques.

In USA, Composite indicators were first published in November 1968 using the weighting scheme developed and applied by Moore and Shiskin (1967). To date, the official coincident index for US economic activity released by the Conference Board is calculated as a weighted average of four well-established, broad-based, timely series, namely, industrial production, personal income less transfer payments, employees on non-agricultural payrolls and manufacturing and trade sales. The underlying weighting procedure has been extensively used and it still forms the basis for numerous applications

for the construction of coincident indices of economic activity. Among these Layton and Moore (1989) for the US service sector, Phillips, Vargas, and Zarnowitz (1996) for the Mexican economy, Altissimo, Marchetti, and Oneto (2000) for the Italian economy and Lamy and Sabourin (2001) for Canada. Despite the popularity of the weighting approach and the satisfactory results it has provided this far, it has generated considerable criticisms especially that it uses weights that are subjectively chosen and that the analysis does not rely on any formal econometric framework.

Stock and Watson (1988a, 1989) made the first attempt to address the lack of subjectivity in the Burns and Mitchell model by developing an econometric approach to derive, among other indices, a new composite indicator for US economic activity. Stock and Watson develop a dynamic factor model using the series of Index of industrial production, real personal income less transfer payments, real manufacturing and trade sales, and employee-hours in non-agricultural establishments. In their method, the composite coincident indicator is derived as a single unobserved variable, "the state of the economy".

Lately all work in this area has been concentrated in developing versions of the Stock and Watson methodology but mostly concentrating on the US and other developed economies. Key extensions of the Stock and Watson model include Mariano and Murasawa (2003), who developed a factor model of time series with mixed frequencies.

3. Methodology

The approach for the construction of coincident/composite activity indicators involves the use of a reference series to check and validate the computed indicator. Usually this reference series is the quarterly GDP, or monthly industrial output. For Uganda both series are available, However, the quarterly GDP comes with lags of more than four months, while the usefulness of the index of industrial production (IIP) as a single coincident indicator faces considerable challenges since the share of the industrial sector in overall GDP over time has been falling while the share of services in GDP is steadily raising. In addition, IIP comes with significant lags hence making policies based on it reactionary rather than pro-active.

Some scholars have employed volume of sales of the manufacturing, wholesale and retail sectors, adjusted for price changes as a proxy for real total spending. This has the main drawback, as in the case of index of industrial production of having a partial coverage of the economy.

A variable with a close to global coverage is real personal income less transfers that underlies consumption decisions and aggregate spending. However, usual productivity growth and favorable terms of trade can make income behave differently from payroll employment, the other most common indicator with economy wide coverage, used in some economies is the number of employees on non-agricultural payrolls, whose changes reflect the net hiring (both permanent and transitory) and firing in the whole economy but still Uganda does not have such statistics.

Some authors focused on unemployment rather than employment, e.g. Boldin (1994) or Chin, Geweke and Miller (2000), on grounds that this series is timely and subject to minor revisions. Yet, typically unemployment is slightly lagging and not coincident.

The above just goes to indicate the difficulty of a choice of a single variable that provides a good measure of current economic conditions and is of a monthly frequency with less significant lags. Therefore, it is preferable to consider combinations of several coincident indicators, covering a sizeable spectrum of the entire economy falling under the key sectors of Industry, Services and Agriculture.

Monitoring of several coincident indicators can be done either informally as it is the case at National Bureau of Economic Research (NBER). The NBER business cycle committee examines the joint evolution of index of industrial production, employment, sales and real disposable income, (Hall et al. 2003), or formally, by combining the different indicators into a composite index as is the case at the Conference Board in US and the Central Banks of Ghana and Rwanda within the continent. The formal approach could either be using econometric based models or still using the non-econometric model based approach of Moore and Shiskin.

3.1Non-econometric model based framework

In this approach, the composite indicators are first transformed to have similar ranges, and then aggregated using equal or different weights. Practically this is a five step procedure.

First, Month-on- month changes are computed for each component. If the component series is in percent change form or an interest rate, simple arithmetic differences are calculated. If the component is not in percent change form, a symmetric alternative to the conventional percentage change formula is used. For example, given an individual series x_{it} ,the month on month symmetric percentage change is computed using the formula:

$$C_{it} = 200 * \frac{(x_{it} - x_{it-1})}{(x_{it} + x_{it-1})}$$

Secondly, the month-on-month changes are adjusted to equalize the volatility of each component. Standard deviations of the changes in each component are computed. Illustratively, for each C_{it} a volatility measure, V_i , is computed as the inverse of its standard deviation.

Thirdly, these statistical measures of volatility are inverted, their sum is calculated, and they are restated so that the index's component standardization factors sum to one (these are known as the component Factors). This proceeds as follows; each C_{it} is adjusted to equalize the volatility of the components, the standardization factor being $S_i = \frac{V_i}{\sum_i V_i}$.

Fourth, the adjusted change in each component is the month-to-month change multiplied by the corresponding component factors given as, $m_{it} = S_i C_{it}$, these are then summed together with equal weights, yielding, $m_t = \sum_i m_{it}$.

Fifth, the level of the index is computed using the symmetric percentage change formula in generally given as:

$$CIEA_t = CIEA_{t-1} * \frac{(200 + m_t)}{(200 - m_t)}$$

The first month's value is based on the symmetric percentage formula: $CIEA_1 = \frac{(200 + m_1)}{(200 - m_1)}$

While the second value is based on a recursive formula used to compute the index levels for each month that data are available: $CIEA_2 = CIEA_1 * \frac{(200+m_1)}{(200-m_1)}$

Finally, the index is rebased to average 100 in any choice year. Illustratively, rebasing the index to average 100 in X base year is derived as follows:

- Computing B by rebasing to average 100, where B=Average for the twelve months of the base year;
- CIEA is then computed as: $CIEA_t = 100 * \frac{CIEA_t}{B}$

3.2 Econometric approaches of CIEA

Two econometric based model approaches have been used in the literature to compute composite indicator of economic activity, dynamic factor models and Markov regime switching models. These two techniques are entrenched on the premise that there is a single unobservable force underlying the current status of the economy. The only difference is that in the dynamic factor model, this unobservable force is a continuous variable while in the Markov switching models it's a discrete variable that evolves according to a Markov chain. Dynamic factor models first developed by Geweke (1977) and Sargent and Sims (1977) were introduced in the analysis of business cycles by Stock and Watson. They are pinned on the rationale that a set of variables is driven by a limited number of common forces and by idiosyncratic components that are either uncorrelated across the variables under analysis or in any case common to only a limited subset of them. As is a common practice with component analysis models, these models rely heavily on state-space techniques and Kalman filter methods. While the biggest asset of the model based approach of CIEA is the fact that, given data they can be implemented in real time. However they have the drawback of requiring relatively large data series and ex-ante classification of variables into coincident and leading or lagging. In addition they are quiet complex requiring knowledge of the new state of art econometric techniques.

4. Deriving the CIEA for Uganda

This paper uses the non-econometric model based approach used by the Conference Board to generate Uganda's CIEA. This choice is influenced by its relative simplicity and secondly its global usage by a number of countries.

The construction of CIEA commences with the choice of a reference series in our case the gross domestic product (GDP). Uganda mainly uses the value added approach of GDP computation which basically involves adding together the value of output produced by each of the productive sectors in the economy. A typical GDP series table generated by the Uganda Bureau of Statistics (UBOS) has the following categorization.

Table 1: Uganda's GDP table

Agriculture, forestry and fishing	**Industry**	**Services**
Cash crops	Mining and quarrying	Wholesale and retail trade
Food crops	Manufacturing	Hotels and restaurants
Livestock	Formal	Transport & communications
Forestry	Informal	Road, rail & water transport
Fishing	Electricity supply	Air transport & support services
	Water supply	Posts & telecommunication
	Construction	Financial services
		Real estate activities
		Other business services
		Public administration
		Education
		Health and social work
		Other personal & comm. services

Source: UBOS

Broadly, Uganda's CIEA should include variables contained in Uganda's GDP. However it is important to note that in this paper we are not attempting to construct a monthly GDP but rather a group of high frequency indicators that closely track the overall GDP.

4.1 Data sources, discussion of variables and justification

The data for constructing Uganda's CIEA was obtained from the Uganda Bureau of Statistics (UBOS), Bank of Uganda (BOU) and the Uganda Revenue Authority. The variables used cover the main sectors of the economy (industry, retail and wholesale trade, construction, exports and imports and taxes).

The agriculture sector though its share in overall GDP has fallen over time presently standing at 14.6 percent, still remains a key sector of the economy and employs the bulk of Uganda's population. The computation of CIEA uses exports of goods to proxy the agricultural sector activity given that a bigger proportion of Uganda exports are agricultural raw materials and semi-processed agricultural products. In fact there is slightly over 60 percent correlation between Agriculture GDP and exports.

The industrial sector, the second major sector of the Ugandan economy in terms of its share in overall GDP has made steady progress over the years and presently accounts for about 26 percent of the Uganda's GDP. This paper uses cement production to capture activity in the industrial sector since cement is a universal product in construction.

The services sector is currently the leading sector in the Ugandan economy presently accounting for slightly over 50 percent of total GDP. For activities in this sector, the CIEA uses credit as a proxy for the financial sector and sales of selected companies to proxy wholesale and retail trade.

In addition, the paper also includes imports to reflect domestic demand or consumption patterns, Pay as You Earn (PAYE) to proxy changes in employment and labour earning. Finally, Value Added Tax and excise tax collection are included. The justification for including PAYE instead of say NSSF collection is based on the fact that PAYE includes both government and private sector employees. Intuitively, a change in total PAYE would imply either a change in the total employment level or a change in employee earnings and under both instances activity should logically change.

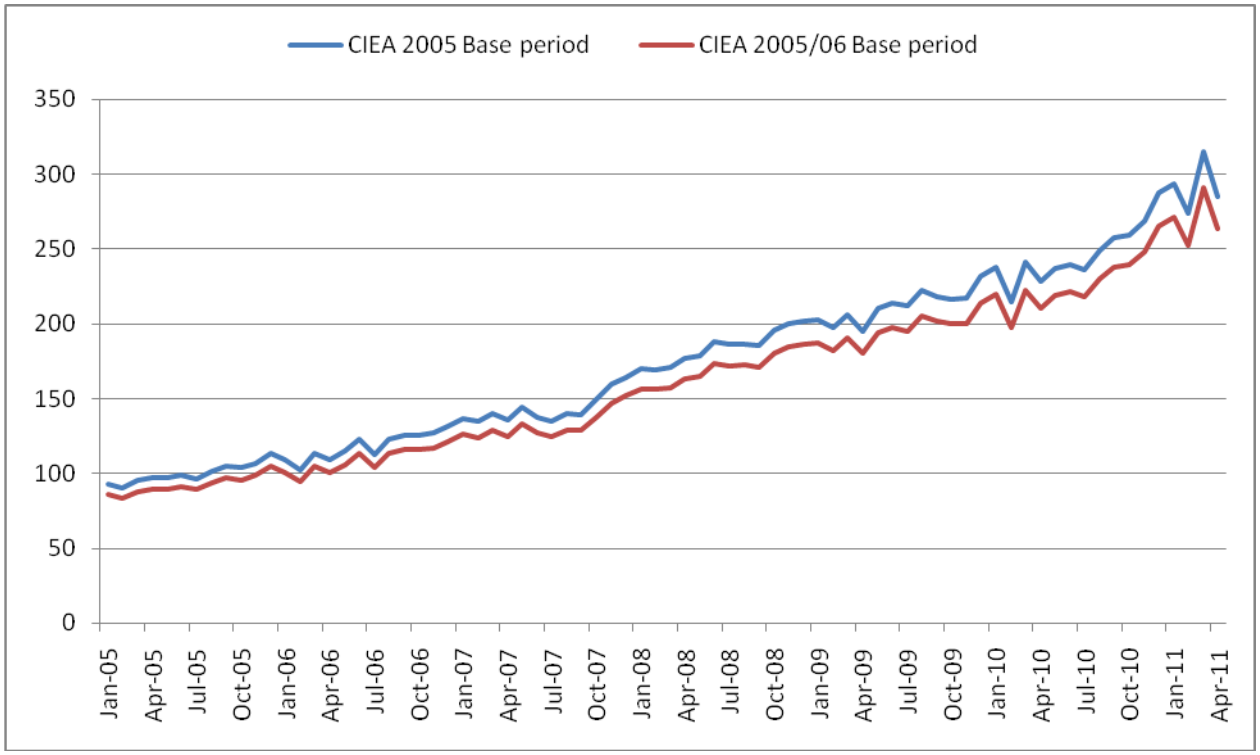
While the choice of the other two tax variables is because value added tax is a tax on value and any change in this tax should reflect a change in output. On the other hand excise tax is a sales tax as such other additional sales information can be captured by this variable.

4.2 Discussion of Results

Using the present methodology, all the eight chosen series have strong correlations with quarterly GDP as can be seen in the table of the simple correlation coefficients in the Appendix. In terms of robustness, the index correlates well with all the variables with a high of 97 percent correlation with sales of selected companies and a low of 84 percent with exports.

Uganda's CIEA overall has upward trend consistent with the GDP trend. In 2011, the index fell in February and April implying a fall in economic activity in these months, details are in Chart 1.

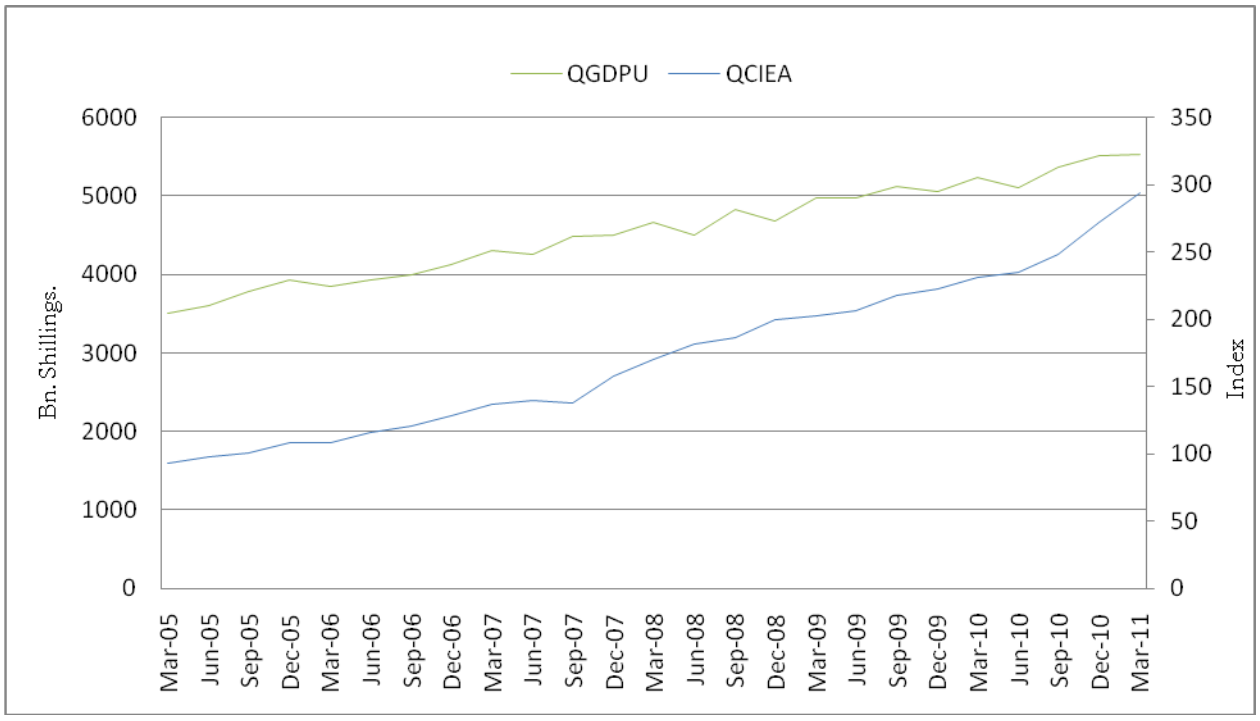
Chart 1: Uganda's CIEA for the period Jan 2005 to April 2011



To gauge the robustness of the CIEA, this paper tracks the index against quarterly GDP. In order to perform our tests with real GDP, the paper transformed CIEA into the quarterly frequency by taking the average of monthly observations within a quarter. This avoids problems with interpolating real GDP to monthly and uses all available CIEA in a given quarter. As can be seen from the

graphical representation in Chart 2, the CIEA reflects well the economic cycle for the period 2005-2011 at least visually. To support our visual judgment, a further computation of the simple correlation coefficient a measure of the strength and direction of relationship between two variables was computed. The result shows a strong positive 0.976815 percent correlation between the two series, given the general rule of thumb that correlations in excess of 80 percent is a strong form of correlation.

Chart 2: Uganda's CIEA and quarterly GDP for the period Q1 2002 to Q1 2010



5. Conclusion

Information on economic activity in Uganda like most countries in the world come with lags thus giving policy makers considerable challenges in designing timely appropriate policies. The CIEA framework offers a more flexible tool for short-term analysis and forecasting of economic activity than pure econometric models, especially for small, open and rapidly changing economies. Composite indexes serve as handy summary measures of the behavior of the cyclical indicators and they tend to smooth out some of the volatility of individual series.

Uganda's constructed CIEA correlates well with the other variables in the index and also with quarterly GDP series. Hence it provides a good framework for forecasting economic activity on a more frequent basis. The paper recommends the adoption of the proposed CIEA framework by Bank of Uganda. The methodology suggested here is a non-econometric model based approach due to its relatively straight forward nature. Specifically, the methodology used by the Conference Board (previously the Department of Commerce) with features similar to the Moore- Shiskin methodology. In future, other variables to capture activities in the tourism sector and telecommunication services should be incorporated to the current framework to further enrich the CIEA.

Additional research on indicators for Uganda will involve forecasting the CIEA and identifying the leading, coincident or lagging indicators.

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Appendices

1. Correlation between the selected variables and QGDP

	Total exports	Total imports	Credit	VAT	Paye	Excise tax	Cement production	Sales of selected companies	QGDP
Mar-05	222.7	461.5	3,628.2	69,832,386.6	60,410,395.7	36.5	165,591.0	278,403,226.6	3,505.4
Jun-05	269.5	498.3	3,046.4	95,923,253.0	69,798,736.5	32.9	172,606.0	276,247,222.0	3,595.6
Sep-05	241.9	563.2	3,610.5	77,306,576.6	71,525,000.7	37.0	175,884.0	298,099,806.0	3,776.0
Dec-05	270.6	567.5	3,935.5	95,717,127.6	74,972,100.3	38.7	178,628.0	310,872,720.8	3,923.1
Mar-06	244.6	600.0	3,642.1	86,991,743.7	76,605,433.2	43.5	203,316.0	312,984,108.5	3,840.9
Jun-06	273.0	608.6	4,117.6	92,715,516.3	84,463,365.5	40.1	210,500.0	352,593,482.0	3,929.3
Sep-06	305.9	684.0	3,673.3	92,366,534.0	83,702,831.2	39.4	221,420.0	398,838,426.1	3,992.9
Dec-06	352.3	742.0	3,825.2	88,738,571.0	93,550,113.3	44.8	222,373.0	412,095,192.1	4,129.2
Mar-07	419.2	735.2	3,766.1	106,183,409.8	91,126,588.3	51.4	240,832.0	425,690,744.3	4,305.2
Jun-07	388.9	827.0	3,709.0	125,356,769.7	100,247,966.8	49.8	235,894.0	425,770,817.3	4,257.8
Sep-07	415.4	949.5	3,267.7	108,412,197.5	89,168,913.5	47.8	240,882.9	441,188,880.2	4,489.1
Dec-07	541.5	1,031.1	4,018.3	120,716,514.2	114,566,516.4	49.8	278,198.0	441,031,119.7	4,496.9
Mar-08	540.0	1,003.0	4,275.3	128,573,412.9	110,363,705.7	63.2	305,217.0	530,371,477.3	4,661.6
Jun-08	571.2	1,220.4	5,140.3	123,014,940.7	137,275,938.1	56.1	296,864.0	540,799,602.6	4,497.5
Sep-08	577.3	1,344.2	6,311.2	112,252,252.7	105,222,848.1	56.1	306,408.0	568,153,431.7	4,833.4
Dec-08	519.1	1,274.0	7,995.7	138,474,154.8	141,663,147.6	58.1	284,872.0	637,718,994.3	4,679.5
Mar-09	564.0	1,158.8	8,168.7	132,064,271.0	144,904,924.4	66.3	276,745.0	657,016,826.4	4,968.4
Jun-09	556.0	1,087.9	9,131.5	143,159,171.9	163,918,959.0	62.1	310,177.0	600,820,799.8	4,979.5
Sep-09	559.1	1,155.5	9,243.0	162,970,833.9	153,483,772.4	66.5	300,438.0	745,298,063.0	5,125.9
Dec-09	647.4	1,213.7	9,973.9	156,992,706.7	157,283,140.0	65.4	271,398.0	725,755,100.0	5,054.1
Mar-10	587.4	1,249.8	10,976.8	186,290,629.5	166,374,666.9	69.8	287,551.0	748,141,611.0	5,236.6
Jun-10	523.4	1,370.3	12,887.2	165,156,831.2	180,778,257.0	71.7	298,912.0	714,551,616.5	5,108.4
Sep-10	504.4	1,261.3	14,178.9	182,548,217.3	183,019,939.4	73.6	365,365.0	793,843,059.9	5,356.7
Dec-10	548.8	1,447.0	16,824.2	180,554,824.6	203,882,010.3	75.3	395,499.0	869,377,106.5	5,517.7
Mar-11	621.5	1,575.0	18,739.2	176,485,490.8	213,048,627.1	85.3	415,781.0	0.0	5,532.7
CORRELATION	0.90	0.95	0.87	0.94	0.95	0.97	0.93	0.97	

2. $m_t = \sum_{i=1}^{n} m_{it}$ $I_t = I_{t-1} * \frac{200 + m_t}{200 - m_t}, (\forall_t > 2)$ **Computation of CIEA**

			$CIEA_t = 100 * \frac{I_t}{B}$ 2005 base period	2005/06 base period
Jan-05	0.80	1.01	92.99	85.81
Feb-05	-2.67	0.98	90.54	83.55
Mar-05	4.93	1.03	95.12	87.78
Apr-05	2.30	1.06	97.34	89.82
May-05	0.04	1.06	97.38	89.86
Jun-05	1.57	1.07	98.92	91.28
Jul-05	-2.35	1.05	96.62	89.16
Aug-05	4.70	1.10	101.26	93.44
Sep-05	3.91	1.14	105.31	97.18
Oct-05	-1.48	1.12	103.76	95.75
Nov-05	3.10	1.16	107.03	98.77
Dec-05	6.07	1.23	113.73	104.95
Jan-06	-4.11	1.18	109.15	100.72
Feb-06	-6.48	1.11	102.30	94.40
Mar-06	10.61	1.23	113.76	104.98
Apr-06	-3.94	1.19	109.37	100.93
May-06	4.97	1.25	114.95	106.07
Jun-06	6.90	1.34	123.17	113.66
Jul-06	-8.79	1.22	112.79	104.08
Aug-06	8.38	1.33	122.66	113.19
Sep-06	2.26	1.36	125.46	115.77
Oct-06	0.07	1.36	125.55	115.85
Nov-06	1.11	1.38	126.95	117.15
Dec-06	3.26	1.42	131.15	121.03
Jan-07	4.08	1.48	136.62	126.07
Feb-07	-1.48	1.46	134.61	124.21
Mar-07	3.70	1.51	139.69	128.90
Apr-07	-3.01	1.47	135.54	125.07
May-07	6.57	1.57	144.75	133.57
Jun-07	-4.94	1.49	137.76	127.13
Jul-07	-2.16	1.46	134.82	124.41
Aug-07	3.91	1.52	140.20	129.37
Sep-07	-0.51	1.51	139.48	128.71
Oct-07	6.77	1.62	149.26	137.74
Nov-07	6.73	1.73	159.65	147.32
Dec-07	3.01	1.78	164.53	151.83

Jan-08	3.11	1.84	169.72	156.62
Feb-08	-0.03	1.84	169.67	156.57
Mar-08	0.56	1.85	170.62	157.44
Apr-08	3.82	1.92	177.26	163.57
May-08	0.73	1.94	178.55	164.77
Jun-08	5.16	2.04	188.01	173.49
Jul-08	-1.00	2.02	186.14	171.76
Aug-08	0.32	2.02	186.73	172.31
Sep-08	-0.61	2.01	185.60	171.27
Oct-08	5.30	2.12	195.70	180.59
Nov-08	2.10	2.17	199.85	184.42
Dec-08	1.06	2.19	201.99	186.39
Jan-09	0.36	2.20	202.73	187.08
Feb-09	-2.74	2.14	197.25	182.02
Mar-09	4.59	2.24	206.52	190.57
Apr-09	-5.66	2.12	195.16	180.09
May-09	7.39	2.28	210.12	193.90
Jun-09	1.73	2.32	213.79	197.28
Jul-09	-0.96	2.30	211.75	195.40
Aug-09	4.97	2.41	222.54	205.36
Sep-09	-1.83	2.37	218.51	201.64
Oct-09	-0.76	2.35	216.86	200.12
Nov-09	0.19	2.36	217.27	200.50
Dec-09	6.54	2.51	231.96	214.05
Jan-10	2.70	2.58	238.31	219.91
Feb-10	-10.52	2.33	214.50	197.93
Mar-10	11.77	2.62	241.32	222.69
Apr-10	-5.63	2.47	228.11	210.50
May-10	3.98	2.57	237.37	219.04
Jun-10	1.09	2.60	239.96	221.44
Jul-10	-1.50	2.56	236.39	218.14
Aug-10	5.35	2.70	249.38	230.13
Sep-10	3.41	2.80	258.02	238.10
Oct-10	0.67	2.82	259.77	239.71
Nov-10	3.35	2.91	268.63	247.89
Dec-10	6.91	3.12	287.85	265.63
Jan-11	1.98	3.18	293.62	270.95
Feb-11	-6.95	2.97	273.89	252.74
Mar-11	14.06	3.42	315.32	290.97
Apr-11	-9.97	3.09	285.36	263.33