International Journal of Engineering Research and General Science Volume 8, Issue 3, May-June, 2020
ISSN 2091-2730

Composite Economic Index for key states and USA as a whole

Dr. Chandrasekhar Putcha, Fellow, ASCE
Professor
Department of Civil and Environmental Engineering
CSUF Outstanding Professor AY 2006-07
California State University, Fullerton
Fullerton, CA 92834

Pujitha Srividya Suresh
APM at R T Western
Formerly, Graduate student
Department of Civil and Environmental Engineering
California State University, Fullerton

Sathya S. Kondapalli
Formerly Graduate student
Department of Civil and Environmental Engineering
California State University, Fullerton

Abstract- In their seminal work, Burns and Mitchell's (1946) definition of business cycles has two key features. The first is the co-movement or concurrence among the individual economic indicators, and the other feature is that business cycle is governed by a switching process between different phases. In general, extracting the co-movement among the economic indicators leads to the creation of the composite Economic indicators (CEI), which enables policy-makers to define the current state of the aggregate economy. That is, the creation of the CEI would inform us whether the economy is currently experiencing a slowdown, a boom, or whatever.

This paper uses three important economic variables in this study - Average Income per year, (AYPY), Unemployment rate per year (URPY), and Housing Prices per year (HPPY). A new method is developed for calculation of CEI in this paper. The study is done in two phases. In phase I, these are used to calculate the Composite Economic Index (CEI) for 4 key states - Texas, New York, Florida and California and in the second phase CEI is calculated for the whole of USA.

I. Introduction

This study is done in two phases. In phase I, this paper first develops a method for calculating composite Economic index (CEI) which is applied for key 4 states of USA reported earlier (Sloboda et al., 2017). In that paper, principles of statistics were employed to study the economic effect of three key variables, namely - Average Income per year (AIPY), Unemployment rate per year (URPY), and Housing Prices per year (HPPY) on the economy of four large states – Texas, New York, Florida and California. All these variables are considered probabilistic variables having well defined parameters (like mean value and standard deviation if it is Gaussian/Normal distribution which will be determined using chi-square test for the data available for these 4 random variables). In the present paper, which is an extension of the previous papers of the authors on this topic, an actual value of composite Economic Index (CEI) is calculated for 4 key states (Texas, New York Florida and California) followed for the whole of USA. It is perceived that such a single value of CEI for whole of USA will give a comprehensive idea about the overall Economy. It should also be mentioned that a probabilistic approach (covering the uncertainties in the three key variables mentioned) is used in the present rather than the traditional deterministic approach. Hence, the use of traditional indices either in terms of Unemployment, Housing (such as Schiller index) need not and has not been used in the present study as it will not affect the final value of Composite Economic Index (CEI).

As is well known, the economic index is a complicated factor and it depends on several variables. A simple method based on the principles of probability and statistics is proposed for calculation of CEI in this paper. This is done using the concept of coefficient of variation (V) of the random variable under study. This is because coefficient of variation V measures the volatility of the random variable. The random variables considered in this study are AIPY, URPY and HPPY. The coefficient of variation, V is defined as ratio of standard deviation and mean value of the random variable under consideration. In this study, the values of coefficient of variation, V are calculated for the three important random variables connected with the health of economy – AIPY (Annual Income Per Year), URPY (Unemployment Rate Per YEAR) and HPPY (Housing Prices Per YEAR) based on the available actual data which is used to calculate composite Economic Index (CEI). In the first phase, CEI values are calculated first for four key states – New York, Texas, Florida and California in the first phase. In the second phase, CEI is calculated for the USA as a whole. A formula is developed for calculating CEI in this study based on the coefficient of Variation (V) values using the principles of probability and

statistics (Ang & Tang, 2007). These results will be very useful to the general public, researchers and academicians as well as it gives the health of the ongoing economy in USA.

II. Methodology for Phase I study

1. Develop Time Series plot of all the 3 variables stated above – AIPY, URPY, and HPPY.

2. Derive mathematical equation based which best describes the behavior of each of these 4 variables based on regression analysis.

3. Check the adequacy of the equation developed using the standard adequacy tests. One is calculation of correlation coefficient (r) and the other is sy/x (standard error of estimate). For best fit, r should be >= 0.8 and s should be < sy where sy represents the standard deviation of the dependent variable y which is any of the three key variables identified earlier.

The expressions for r and Sy/x are taken from (Ang & Tang, 2007),

4. Derive the expression for CEI using the two methods.
5. Use it to calculate CEI for the key 4 states in USA (New York, Texas, Florida and California) in Phase I.
6. Calculate CEI for the whole of USA using the developed method for CEI in step 3.

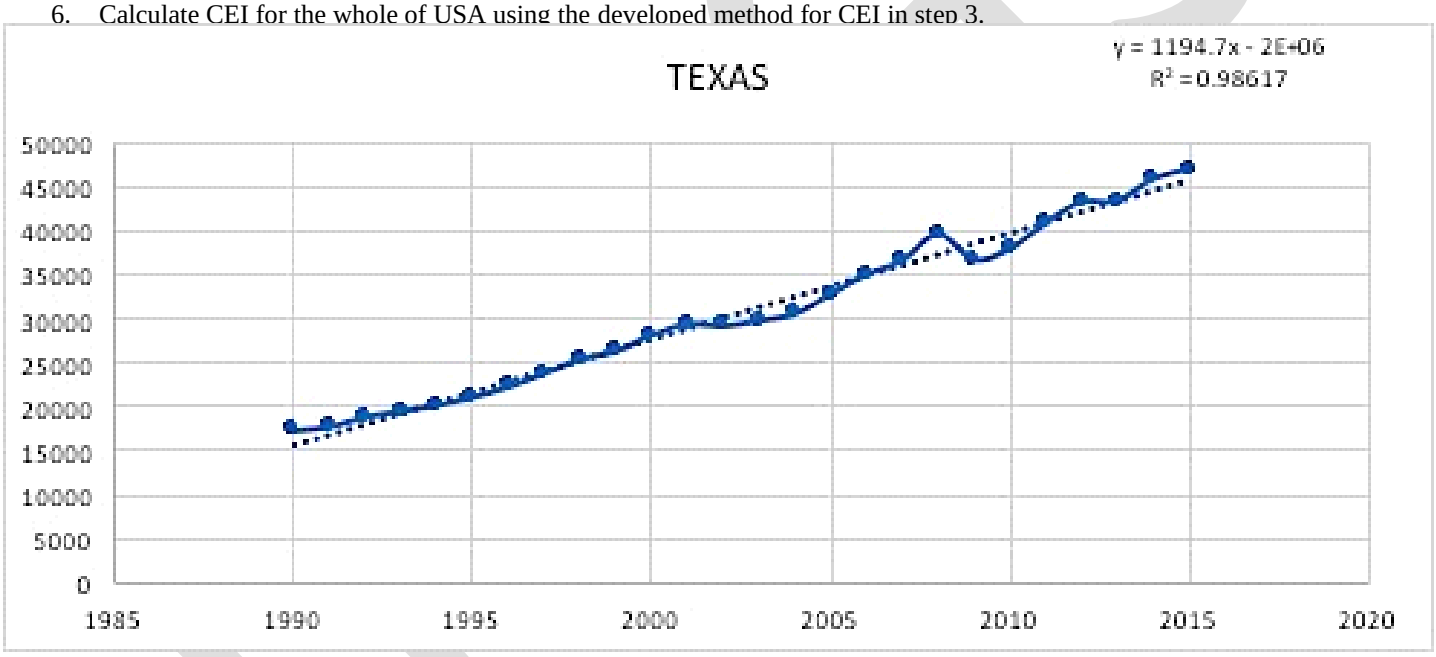

Fig. 1 Regression Analysis Average Income Per Year (AYPY)

B. New York

The fitted equation based on the regression analysis of the data for New York is shown in Fig 2 along with the actual equation, r value as well as the value of standard error of estimate Sy/x

y = 1428.7x - 3E+06
R= 0.9934
S y/x = 185384.3
S y = 996381.6725

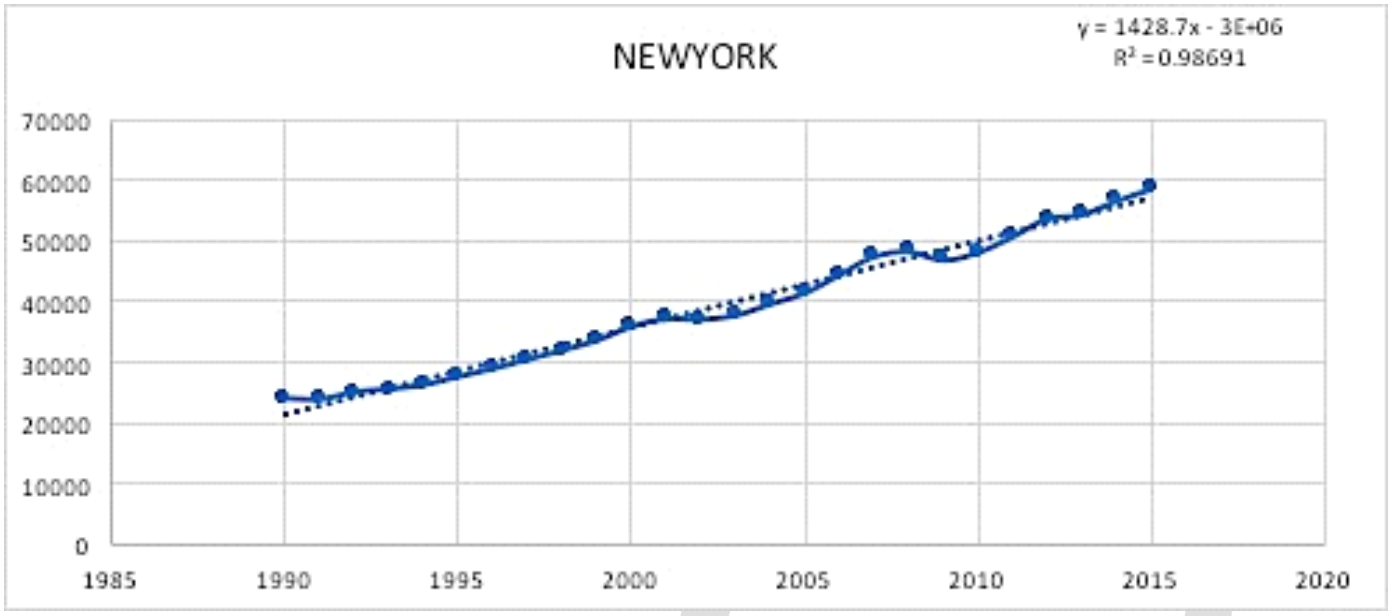

Fig. 2 Regression Analysis Average Income Per Year (AYPY)

C. Florida

The fitted equation based on the regression analysis of the data for Florida is shown in Fig. 3 along with the actual equation, r value as well as the value of standard error of estimate Sy/x

y = 1022.4x - 2E+06
R = 0.9871
S y/x = 16026.2
S y = 816103.1811

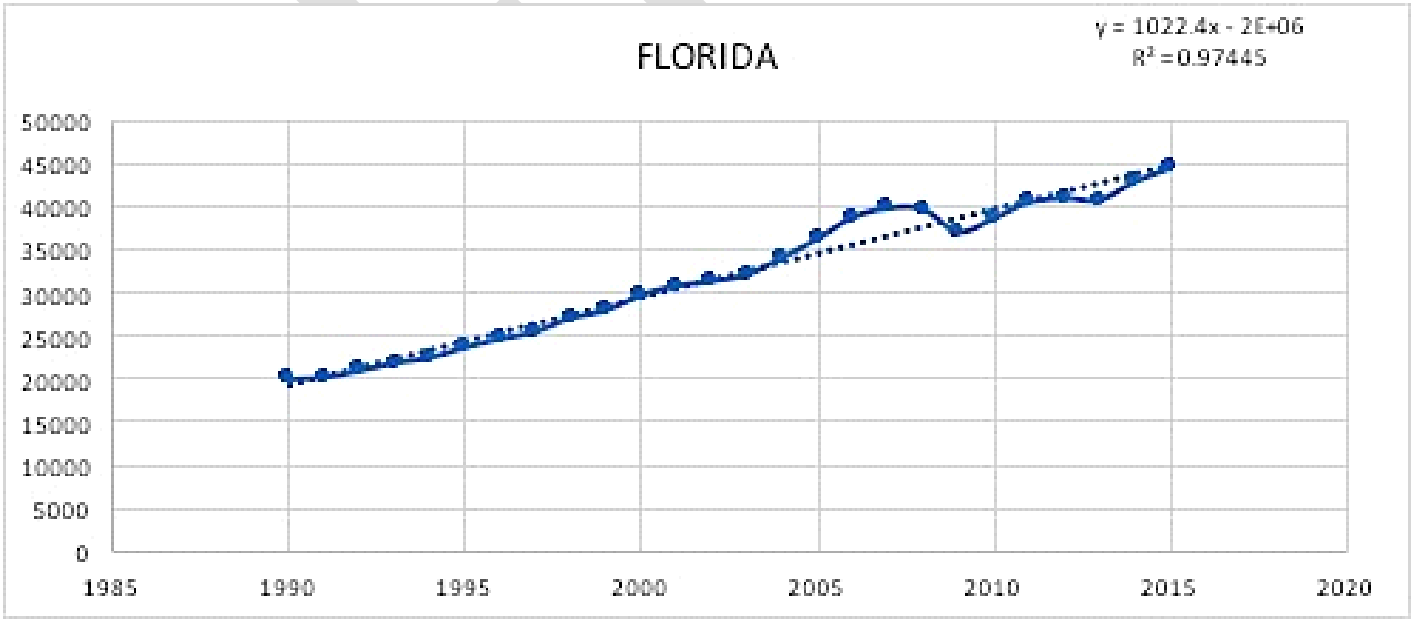

Fig. 3 Regression Analysis Average Income Per Year (AYPY)

D. California

The fitted equation based on the regression analysis of the data for California is shown in Fig.4 along with the actual equation, r value as well as the value of standard error of estimate Sy/x

y = 1306.1x - 3E+06
R = 0.9919
S y/x = 437293.1
S y = 907705.8567

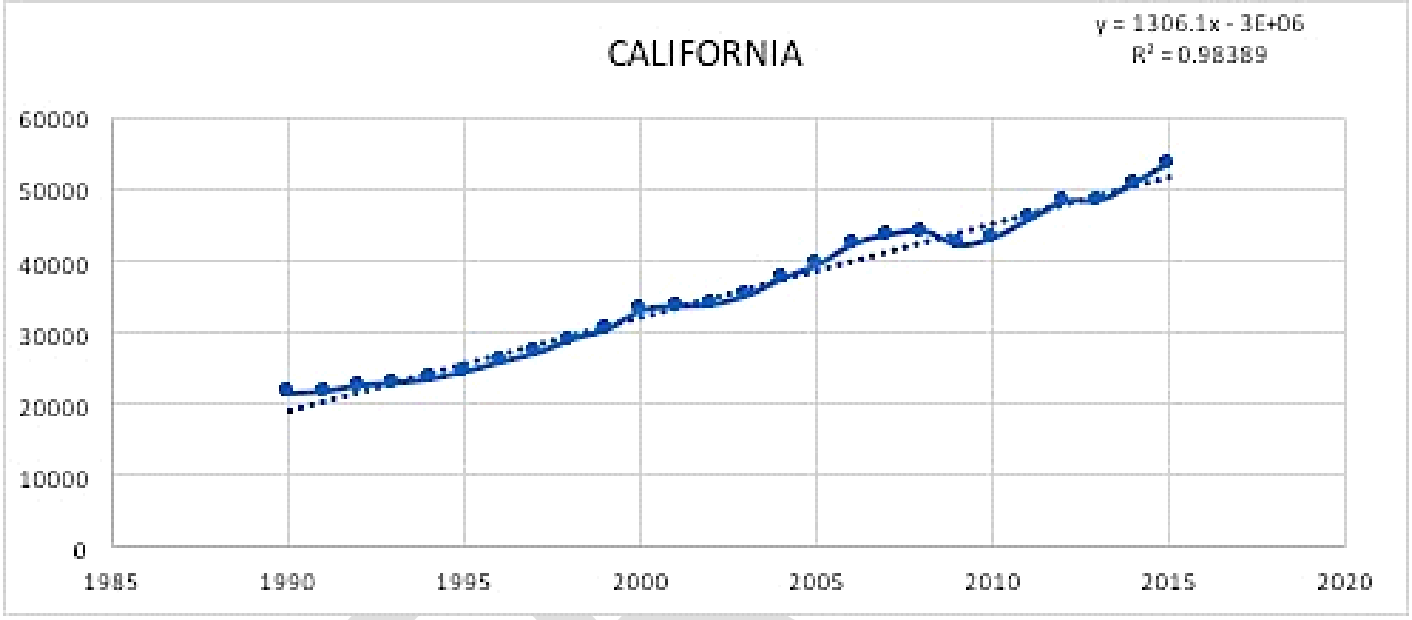

Fig. 4 Regression Analysis Average Income Per Year (AYPY)

2. Unemployment Rate Per Year (URPY)

A. Texas

The fitted equation based on the regression analysis of the data for Texas is shown in Fig.1 along with the actual equation, r value as well as the value of standard error of estimate Sy/x

y = -0.2548x + 518.8
R= 0.4372
S y/x = 1.389574515
S y = 47.54047899

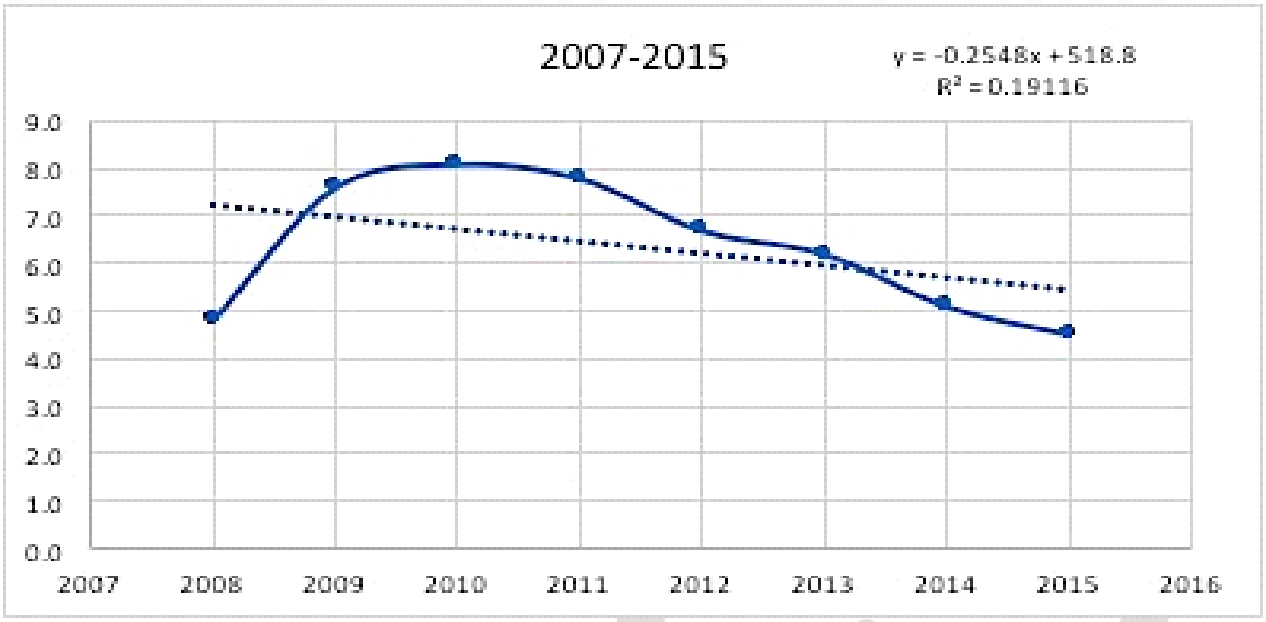

Fig. 5 Regression Analysis Unemployment Index Per Year (URPY)

B. New York

The fitted equation based on the regression analysis of the data for New York is shown in Fig.2 along with the actual equation, r value as well as the value of standard error of estimate Sy/x

y = 0.07x - 133.77
R = 0.12012
S y/x = 1.693938774
S y = 59.41841045

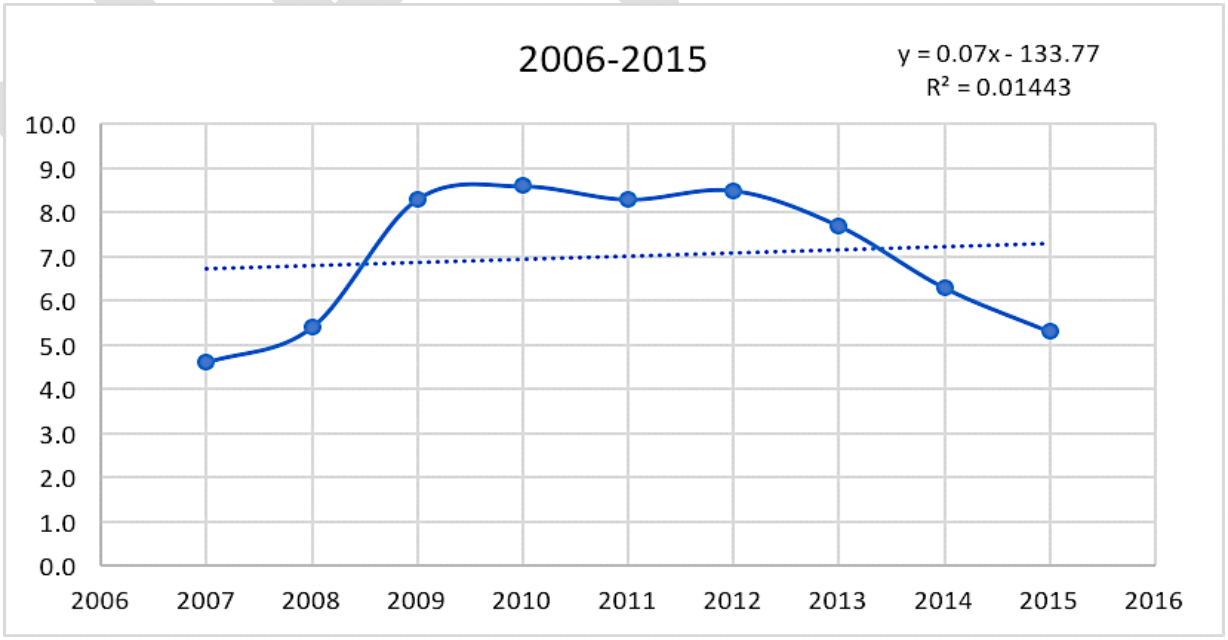

Fig. 6. Regression Analysis Unemployment Index Per Year (URPY)

C. Florida

The fitted equation based on the regression analysis of the data for Florida is shown in Fig.3 along with the actual equation, r value as well as the value of standard error of estimate Sy/x

y = -1.1657x + 2354.1
R = 0.99666
S y/x = 0.202723919
S y = 44.4194552

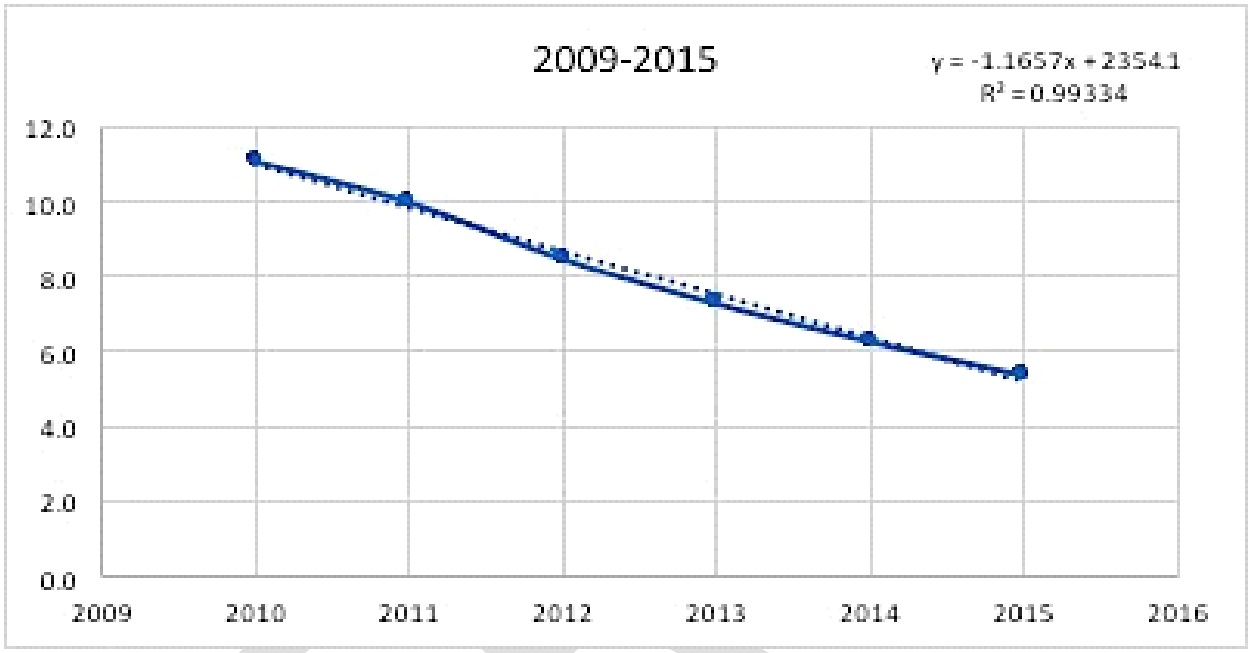

Fig. 7. Regression Analysis Unemployment Index Per Year (URPY)

D. California

The fitted equation based on the regression analysis of the data for California is shown in Fig.4 along with the actual equation, r value as well as the value of standard error of estimate Sy/x

y = -1.39x + 2807
R= 0.99971
S y/x = 0.054772256
S y = 40.04129119

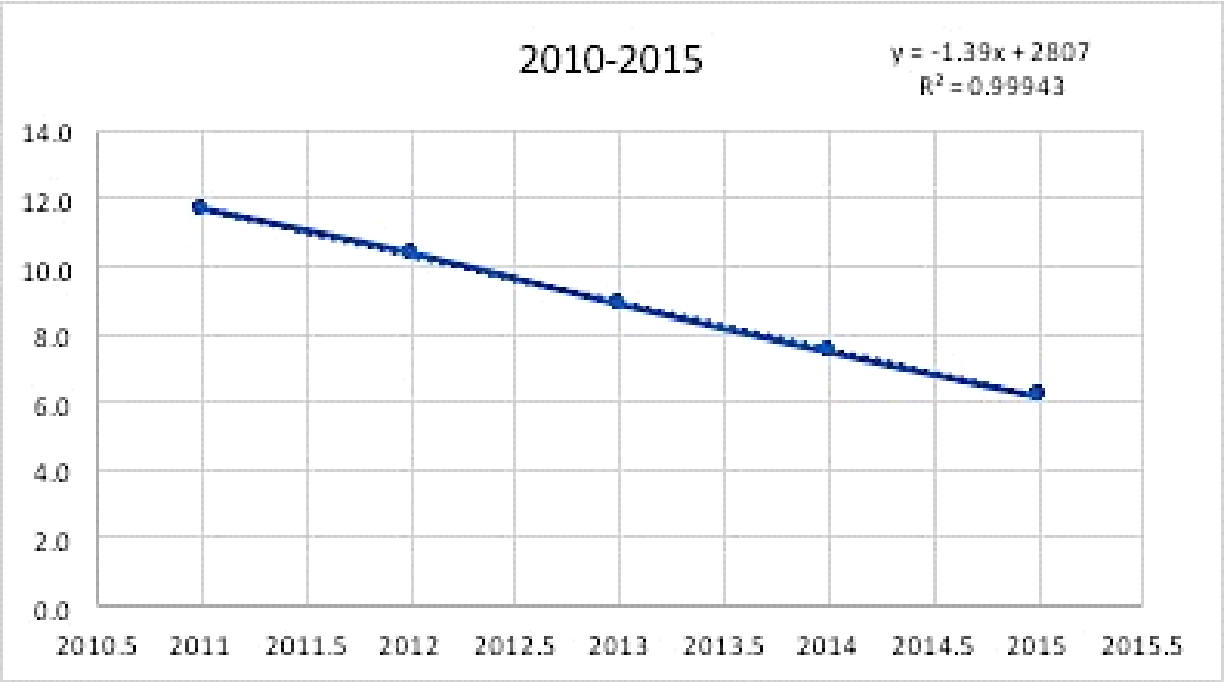

Fig. 8. Regression Analysis Unemployment Rate Per Year (URPY)

3. Housing Prices Per Year (HPPY)

A. Texas

The fitted equation based on the regression analysis of the data for Texas is shown in Fig.1 along with the actual equation, r value as well as the value of standard error of estimate Sy/x

y = -2271.6x + 5E+06
R = 0.14321
S y/x = 370144.6245
S y = 796794.3026

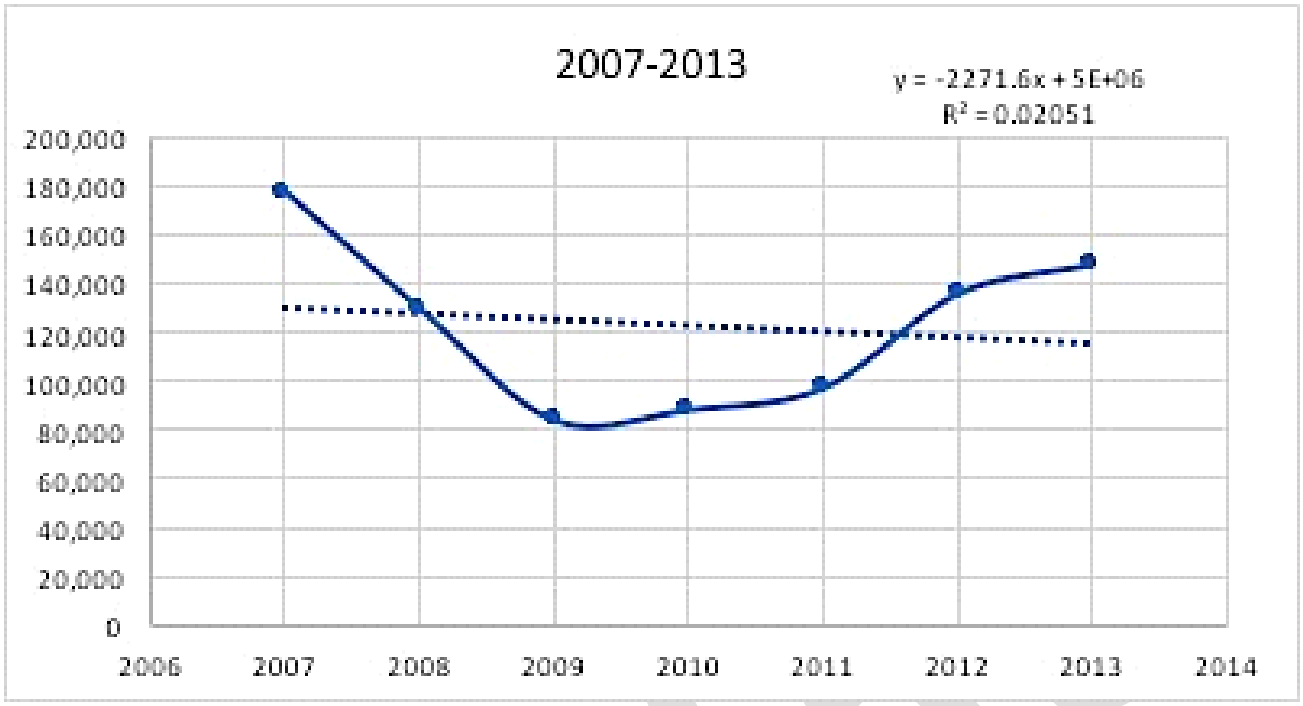

Fig. 9 Regression Analysis Housing Index Per Year (HPPY)

B. New York

The fitted equation based on the regression analysis of the data for New York is shown in Fig.1 along with the actual equation, r value as well as the value of standard error of estimate Sy/x

y = -4577.4x + 9E+06
R= 0.700464
S y/x = 269371.3551
S y = 260554.1854

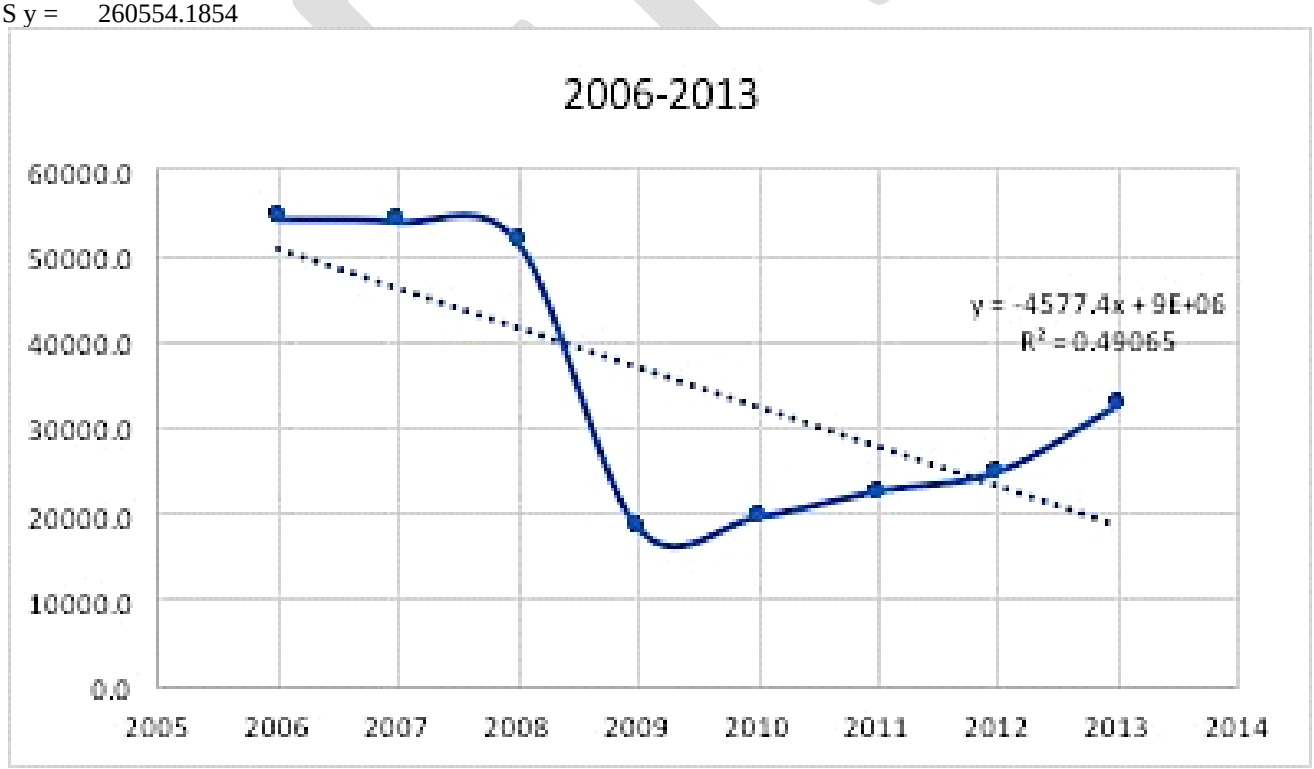

Fig. 10.Regression Analysis Housing Index Per Year (HPPY)

C. Florida

The fitted equation based on the regression analysis of the data for Florida is shown in Fig.3 along with the actual equation, r value as well as the value of standard error of estimate Sy/x

y = -12581x + 3E+07
R= 0.5567
S y/x = 5357042.352
S y = 596339.1292

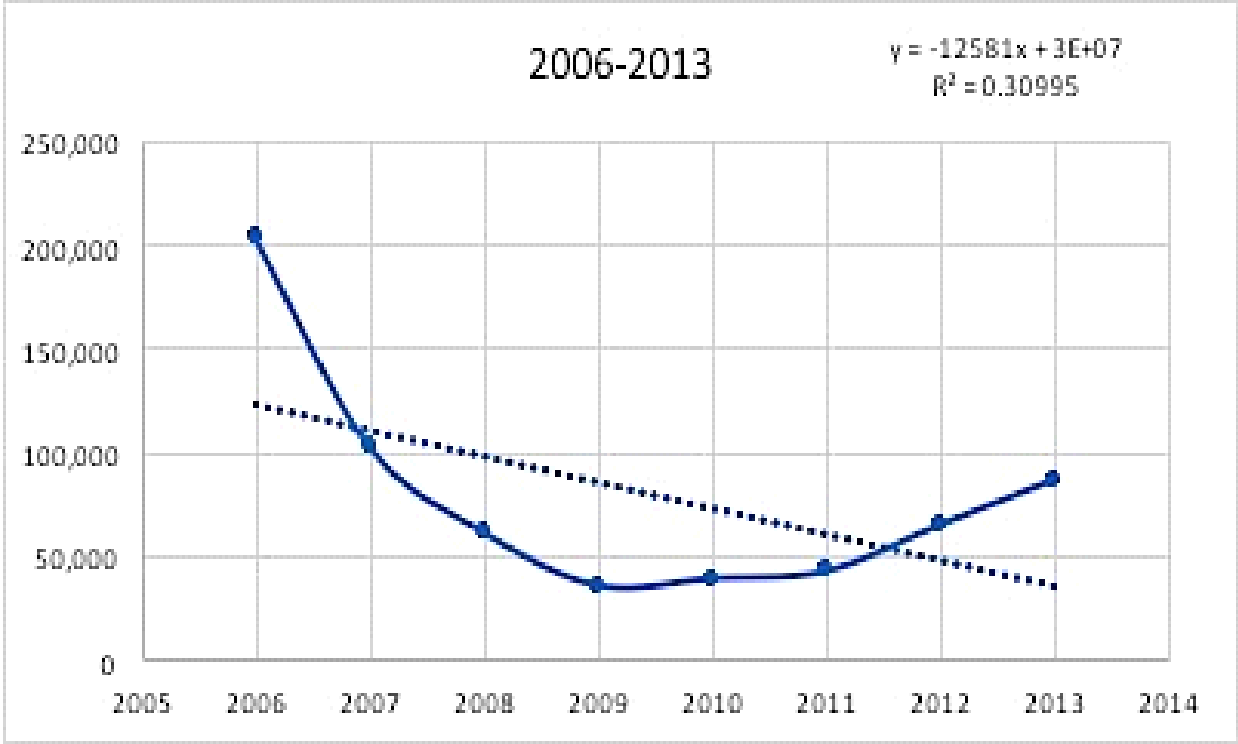

Fig. 11 Regression Analysis Housing Index Per Year (HPPY)

D. California

The fitted equation based on the regression analysis of the data for California is shown in Fig.1 along with the actual equation, r value as well as the value of standard error of estimate Sy/x

y = -16215x + 3E+07
R= 0.77063
S y/x = 3070195.729
S y = 559847.5023

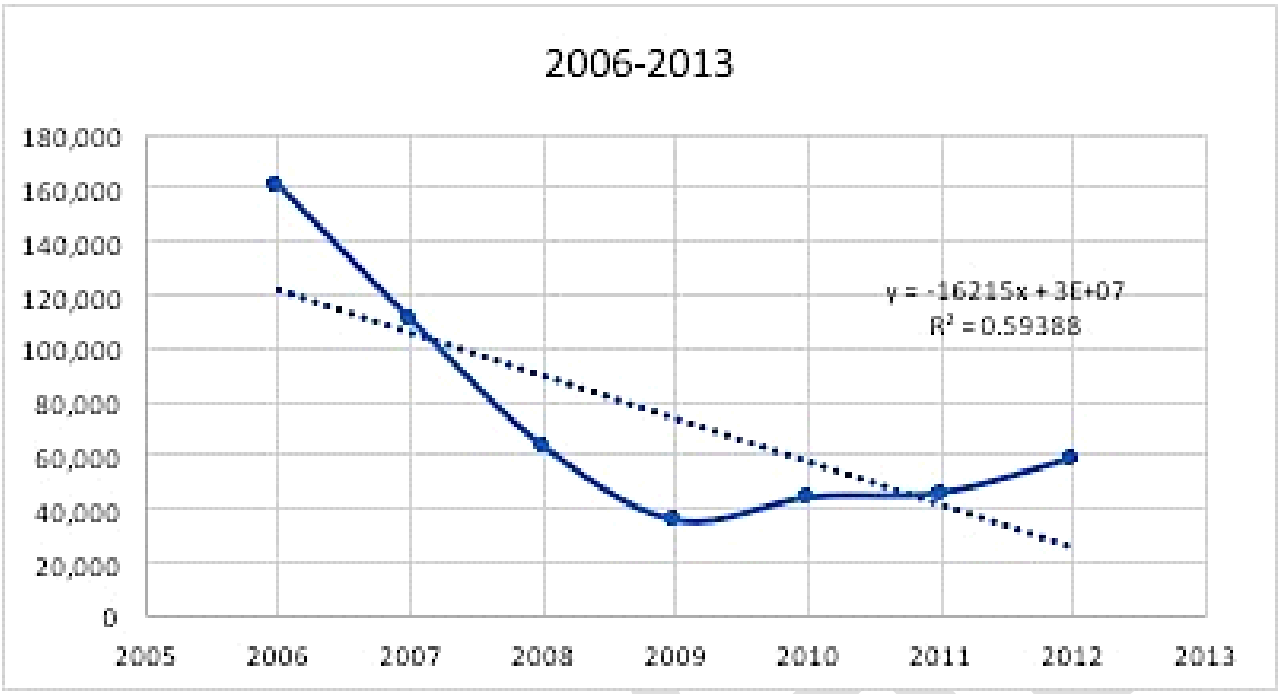

Fig. 12. Regression Analysis Housing Index Per Year (HPPY)

IV. Development of method for calculation of CEI

IV.1 Method I

The Composite Economic Index (CEI) is calculated based on the following equation:

Based on principles of probability and statistics (Ang & Tang, 2007) one can easily derive the expression of composite Index (CEI) as,

$CEI = P_1 * P_2 * P_3$ (1)

P_1 = probability of exceedance of threshold value for variable 1 (AYPY)

P_2 = probability of exceedance of threshold value for variable 2 (URPY)

P_3 = probability of exceedance of threshold value for variable 3 (HPPY)

IV.2 Method II

Using the concept of Coefficient of Variation (V), which indicates the volatility in the random variable being considered, CEI can be e

$CEI = V_1 * V_2 * V_3$ (2)

Where, V_1 = coefficient of variation of the Random variable 1 (AYPY)

V_2 = coefficient of variation of the Random variable 2 (URPY)

V_3 = coefficient of variation of the Random variable 3 (HPPY)

V. Methodology for Phase II study

As in Phase I study, three key variables affecting the economy are considered in this study - AIPY (Annual Income per year), URPY (Unemployment Rate per year) and HPPY (Housing Prices per year). The statistical analysis of this data is performed as follows (Sloboda et al., 2018):

1. Plot the density function of each of the three key variables. These are shown in Figs. 13-15

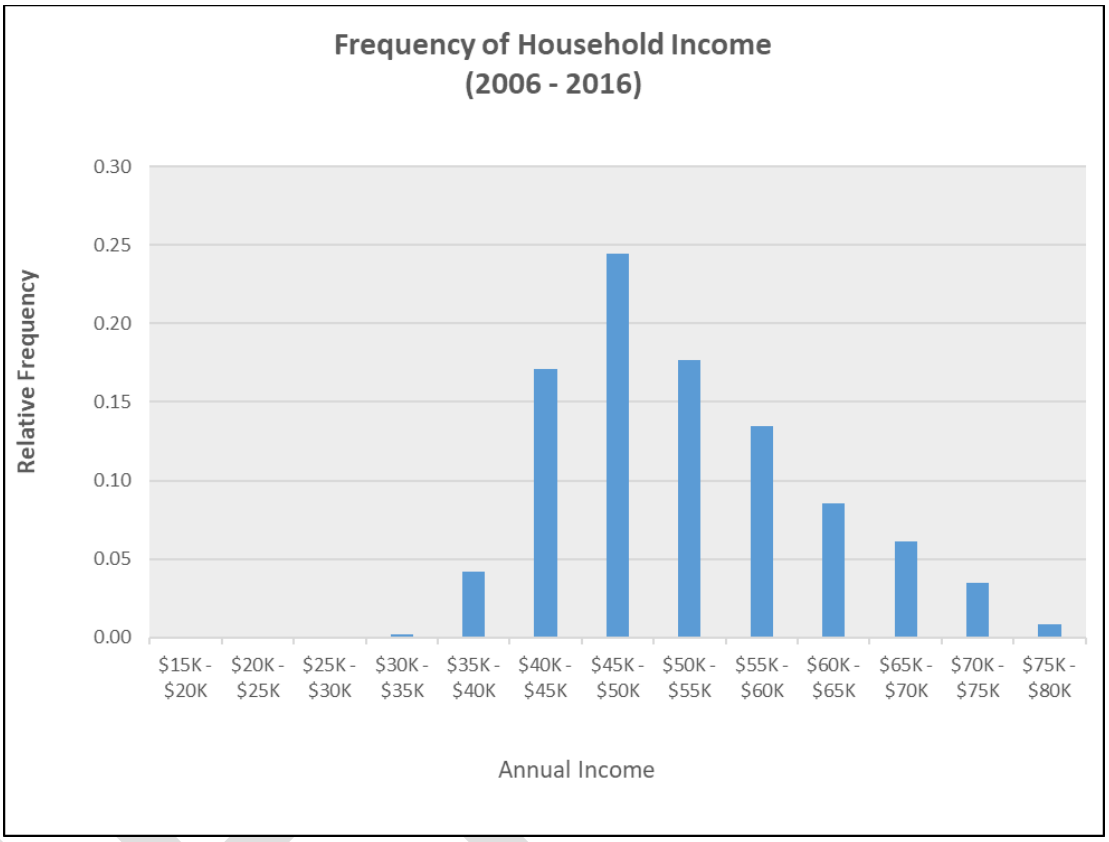

Figure 13. Density Function of Annual Income per Year (AYPY)

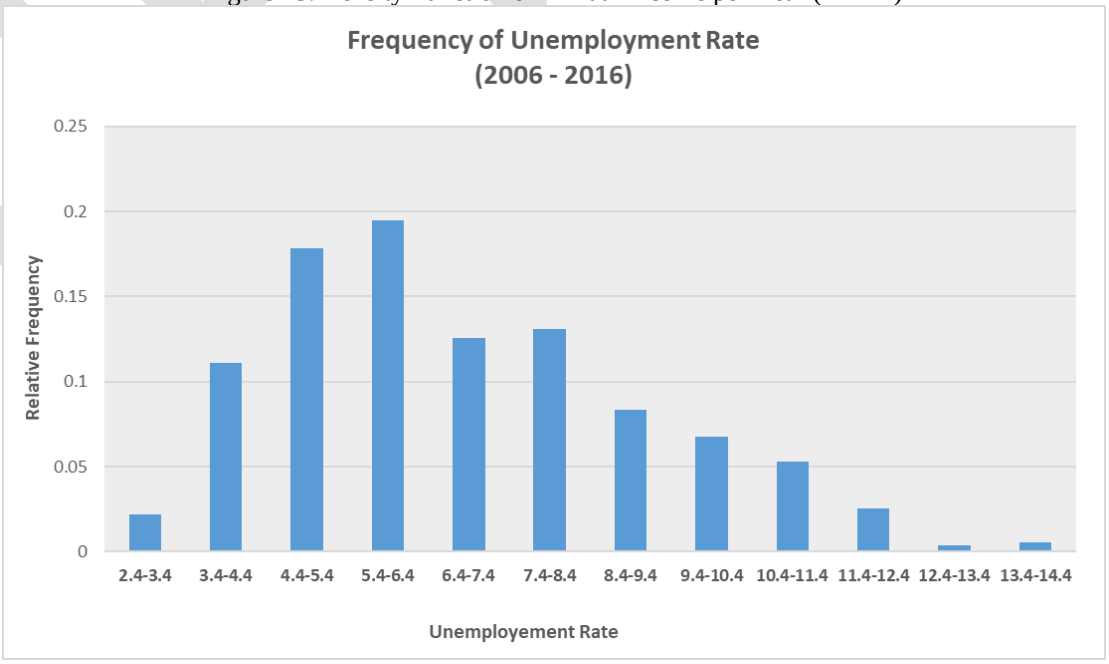

Figure 14. Density Function of Unemployment Rate per Year (URPY)

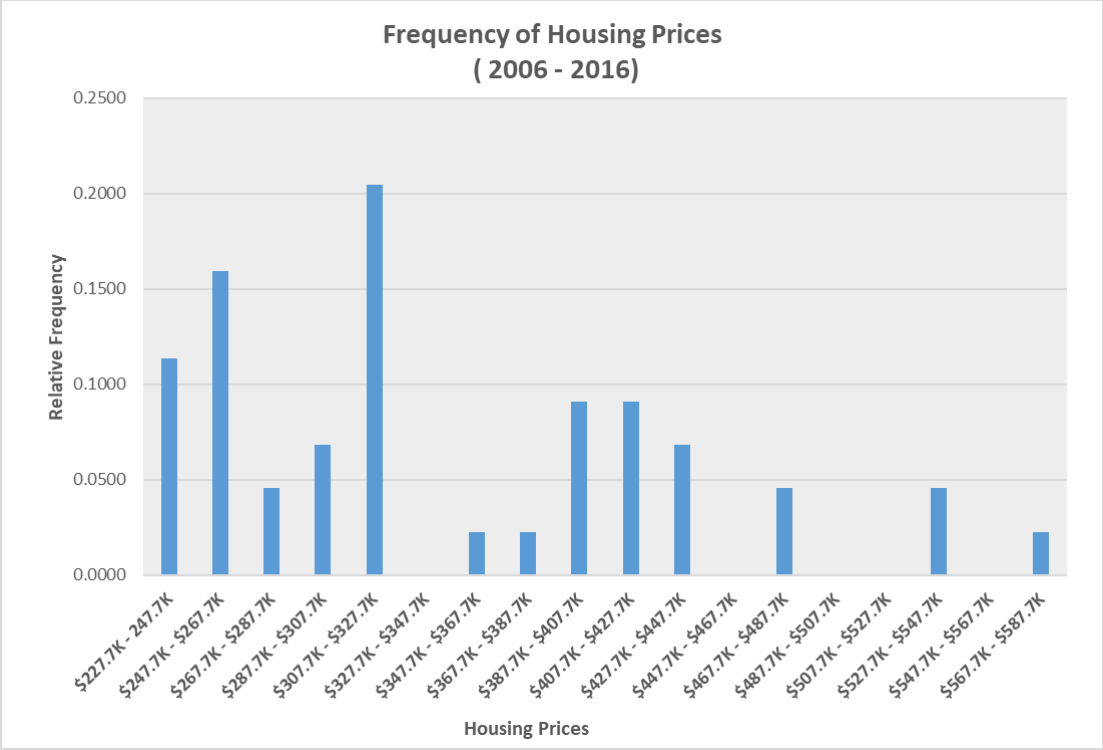

Figure 15. Density Function of House Prices per Year (HPPY)

2. A chi-square test is performed to determine which distribution these three variables follow.
3. The statistical parameters of this distribution are determined. Since these density functions are not normal (based on step 2), the corresponding parameters, μ (Mean value) and σ (standard deviation) are determined from the following equations:

$$\mu_1 = \frac{(\sum_{i=1}^{n} x)}{n} = \$52{,}106.52 \quad (3)$$

$$\sigma_1 = \frac{\sum_{i=1}^{n}(x-\mu)^2}{n-1} = \$8{,}956.19 \quad (4)$$

$$\mu_2 = \frac{(\sum_{i=1}^{n} x)}{n} = 6.76 \quad (5)$$

$$\sigma_2 = \frac{\sum_{i=1}^{n}(x-\mu)^2}{n-1} = 2.27 \quad (6)$$

$$\mu_3 = \frac{(\sum_{i=1}^{n} x)}{n} = \$344{,}197.7 \quad (7)$$

$$\sigma_3 = \frac{\sum_{i=1}^{n}(x-\mu)^2}{n-1} \quad \$89{,}852.1 \quad (8)$$

4. Using the two methods explained in Section IV, with the threshold values of Annual Income per year (AIPY), Unemployment Rate Per Year (URPY) and Housing Prices Per Year (HPPY), the probabilities of the following events are calculated.

Method I for calculation of CEI

$P_1 = P(AIPY < AYPY_{threshold}) = \Phi(AIPY_{threshold} - \mu_{AIPY}) / \sigma_{AIPY}$ (9)
$P_1 = \Phi((59{,}055 - 52{,}106.52) / 8{,}956.19) = 0.7823$

$P_2 = P(URPY < URPY_{threshold}) = \Phi(URPY_{threshold} - \mu_{URPY}) / \sigma_{URPY}$ (10)
$P_2 = \Phi((4.10-6.76) / 2.27) = 0.121$

$P_3 = P(HPPY < HPPY_{threshold}) = \Phi(HPPY_{threshold} - \mu_{HPPY}) / \sigma_{HPPY}$ (11)
$P_3 = \Phi((372{,}166.7 - 344{,}197.7) / 89{,}852.1) = 0.6217$

5. Combine these probabilities to get value of Composite Economic Index (CEI) using the following equation:

$$CEI = P_1 * P_2 * P_3 \quad (10)$$

$$CEI = 0.7823 * 0.1210 * 0.6217 = 0.0588$$

Method I for calculation of CEI

Using this methodology, calculate:

$$V_1 = V_{AIPY} = \sigma_{AIPY} / \mu_{AIPY} = 52,106.52 / 8,956.19 \quad (11)$$
$$V_1 = 8,956.19 / 52,106.52 = 0.1719$$

$$V_2 = V_{URPY} = \sigma_{URPY} / \mu_{URPY} \quad (12)$$
$$V_2 = 2.27 / 6.76 = 0.3356$$

$$V_3 = V_{HPPY} = \sigma_{HPPY} / \mu_{HPPY} \quad (13)$$
$$V_3 = 89,852.1 / 344,197.7 = 0.2610$$

These coefficient of variation values of V for each of the key variables can be combined to get the Composite Economic Index (CEI) for USA using the following equation:

$$CEI = V_1 * V_2 * V_3 \quad (14)$$
$$CEI = 0.1719 * 0.3356 * 0.2610 = 0.0151$$

VI. Results

VI.2 Results for Phase II study

The probability values and the Coefficient of variation (V) values are tabulated in Tables 1 and 2 respectively.

Table 1. Probabilities for Key Economic Variables

Name of Variables	P_1	P_2	P_3
AIPY	0.7823		
URPY		0.121	
HPPY			0.6217
CEI	0.0588		

Table 2. Coefficient of Variation (V) for Key Economic Variables

Name of Variables	V_1	V_2	V_3
AIPY	0.1719		
URPY		0.3356	
HPPY			0.2610
CEI	0.0151		

VI. 1 Results for Phase I Study

Method II has been used to calculate the composite index for the 3 variables and 4 key states. These are shown in Table 1 below.

Table 1 Coefficient of Variation (V) for Key Economic Variables for Texas

Name of Variables	V_1	V_2	V_3
AIPY	0.261		
URPY		0.067	
HPPY			0.569
CEI	0.009		

Table 2 Coefficient of Variation (V) for Key Economic Variables for New York

Name of Variables	V_1	V_2	V_3
AIPY	0.249		
URPY		0.084	
HPPY			0.651
CEI	0.013		

Table 3 Coefficient of Variation (V) for Key Economic Variables for Florida

Name of Variables	V_1	V_2	V_3
AIPY	0.272		
URPY		0.055	
HPPY			0.46
CEI	0.00688		

Table 4. Coefficient of Variation (V) for Key Economic Variables for California

Name of Variables	V_1	V_2	V_3
AIPY	0.259		
URPY		0.04	
HPPY			0.46
CEI	0.005		

VI.2 Results for Phase II study

The probability values and the Coefficient of variation (V) values are tabulated in Tables 1 and 2 respectively.

Table 5. Probabilities for Key Economic Variables

Name of Variables	P_1	P_2	P_3
AIPY	0.7823		
URPY		0.121	
HPPY			0.6217
CEI	0.0588		

Table 6. Coefficient of Variation (V) for Key Economic Variables

Name of Variables	V_1	V_2	V_3
AIPY	0.1719		
URPY		0.3356	
HPPY			0.2610
CEI	0.0151		

VII. Discussion of Results and Conclusions

As can be seen from Tables1-3, that the Composite Economic Index (CEI) is highest for Texas followed by New York, Florida and California. These numbers are to be interpreted as relative numbers in the sense, based on the data considered, and for the period considered, the economy of Texas is best. On the other hand, the composite economic index is higher than the CEI for the four key states considered. It shows the economy of USA is robust. A method based on the principles of probability and statistics has been developed for developing the Composite Economic Index (CEI) which has been used in the present study. These results should be useful for academicians and practicing economists.

REFERENCES:

1. Ang, A.H-S and Tang, W.H. (2007). **Probability Concepts in Engineering,** John Wiliey & Sons, 2nd Edition.

2. Sloboda, B., Putcha, C.S., Suresh, P.S. and Kodapalli, S.S., "State by State Analysis of Composite Economic Indices in USA", presented at JSM 2017 conference in Baltimore, MD.

3. Sloboda, B., Putcha, C.S., and Nguyen, H. , " The Measurement of the Aggregate Economic Performance for the United States via the Composite Economic Index (CEI) presented at JSM 2018 in Vancouver.