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THE INFLUENCE OF POPULATION AND UNEMPLOYMENT TOWARDS THE TOTAL INDUSTRY IN USA BY USING PANEL ARDL MODEL ESTIMATION

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ABSTRACT

This paper aims to explore the influence of population and unemployment towards Gross Domestic Product (GDP) of the total industry development in case of four selected States in the United State: Texas, Florida, California and New York from the period: 1997 to 2022, by using panel data to determine the long run as well as the short run relationship. The estimated model of the D(GDP) series; Panel ARDL (4,4,4) for the long run equation have statistically a significant P-value (0.0004) & (0.0000) at level 5% & 1% for the coefficient value of Population (-3.011450) and Unemployment (-0.101874) respectively. The error correction term, here represented as COINTEQ01, is negative with an associated coefficient estimate of (-0.455554). This implies that about 45.55% of any movements into disequilibrium are corrected within one period. Moreover, given the t-statistic, namely (-2.517658), we can also conclude that the coefficient is highly significant with P-value equals (0.0154) which means that the variables have the ability to overcome the problems they suffer from, and the ability to correct structural imbalances during the long term. Also, we can conclude that Population (POP) has a significantly negative effects on GDP in the long run at level 1%, 5%, 10% and has a significantly negative effects on GDP in the short run at level 10%. Furthermore, Unemployment (UNPLOY) has a significantly negative effect on GDP in the long run at level 1%, 5%, 10% and has no significant effect on GDP according the selected panel States. The forecasting of GDP is significant and the ability of forecasting Panel ARDL model is satisfactory, with the root mean squared error equals (0.011313), and Theil Inequality Coefficient equals (0.106400) which is close to zero, that means, the predictive power of this model is very strong

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INTRODUCTION

The industry plays a major role by contributing a positive and innovative approach in strengthening the structure of the regional and national economy, as well as, raising the levels of economic growth. The development of the industry would provide job opportunities to the unemployed workers. Over and above, it has an important role in increasing the Gross Domestic Product. The best way to comprehend a country's economy is by looking at its Gross Domestic Product (GDP), as it measures the country's total output, this includes everything produced by the public and the entire companies in the country. It helps to follow economic fluctuations, the development of policies on population and determining economic policies. (S. Dutta, 2022). The unemployed is an individual whom is above a certain age without work and is able, willing and looking for work at the prevailing wage level,

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but he doesn't meet his imperative need. (ILO, 2022). Accordingly, it turns out that not everyone who does not work is unemployed, and at the same time; not everyone looking for a job is considered unemployed. The relationship between unemployment rate and economic growth shows the negative impact of unemployment on the economic growth. The higher the unemployment, the less the ways to enhance the economic growth of the society and vice versa (Al-Habees, 2012). Therefore, an increase in a country's GDP leads to a decrease in unemployment.

Many empirical papers have investigated the relationship between various macroeconomic determinants by using Panel ARDL Model: AĞAN B. (2022), The Impact of Technological Achievement on Economic Growth: Evidence from a Panel ARDL Approach (1990-2020); The ARDL model results reveal a statistically significant causality and positive relationships between the technology achievement index and GDP growth, gross capital formation, medium and high-tech exports, and employment significant at 1 percent level in the long run according to Pooled Mean Group (PMG) estimator. Appiah et al. (2020), Capital Market and Financial Development on Growth: A Panel ARDL Analysis (1981 to 2010); The results show that in both the long term and short term, there is a negative influence of capital market development on economic growth. Zardoub, Y. (2020). Exploring the links between financial flows and economic growth: a panel ARDL approach (2000-2015); results confirm the existence of a long-run relationship because the adjustment coefficient (error correction parameter) is negative and is statistically significant, and the PMG estimator is more consistent and more efficient. In the short-run, foreign direct investment affect the economic growth negatively, the effect is not significant in the long-run.

MATERIALS AND METHODS

The study uses annual data from 1997 to 2022 for four advanced and emerging economies in United States: Texas, Florida, California, New York, obtained from Federal Reserve Economic Data (https://fred.stlouisfed.org) within the annual data of Gross Domestic Product (GDP) of all industry total in millions of dollars and independent variables: Resident Population (POP) in thousands of person, Unemployment Rate (UNPLOY) in percent. The Panel Auto Regressive Distributed Lag (Panel-ARDL) Model was performed in same period (1997-2022) for the total of 104 balanced panel data observations; to describe the relation between the dependent variable GDP and the explanatory variables POP, UNPLOY, to estimate the appropriate lag structure of the Panel ARDL Model that describe the estimation in the long run or the cointegration relationship between the variables for the selected States.

We specify the model of this research in a functional form using:

GDP = f (POP, UNPLOY)

Where:

GDP: Gross Domestic Product of all industry total in millions of dollars.

POP: Resident Population in thousands of persons.

UNPLOY: Unemployment Rate in percent.

For the sake of simplicity, the production function is assumed to be Cobb-Douglas form:

$$(GDP)_{it} = A_{it} P_{it}^{\alpha_1} E_{it}^{\alpha_2} \qquad (1)$$

where i denotes country, t denotes time, A is the index of technological progress.

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α_1, and α_2 are the elasticities of population and unemployment respectively. When taking logs of equation (1) the following linear multivariate regression is produced:

$$\ln (GDP)_{it} = \alpha + \alpha_1 ln(POP)_{it} + \alpha_2 ln(UNPLOY)_{it} \qquad (2)$$

Equation (2) is estimated using a time series autoregressive distributed lag model (ARDL). (Pesaran et al, 1996), (Shin et al, 2001).

The panel ARDL equation is represented as follows:

$$\ln (GDP)_{it} = \alpha_i + \sum_{j=1}^{p} \alpha_{1,ij} ln(GDP)_{i,t-j} + \sum_{j=0}^{q_1} \alpha_{2,ij} ln(POP)_{i,t-j} + \sum_{j=0}^{q_2} \alpha_{3,ij} ln(UNPLOY)_{i,t-j} + \varepsilon_{it} \quad (3)$$

where i = 1,2,3,...N and t = 1,2,3,...T, $j = 1,2, \dots k$, k is a lag of regressors, α_i represents the fixed effects, $\alpha_1, \alpha_2, \alpha_3$ is the lagged coefficients of the independent variables and the regressors, and ε_{it} is the error term which is assumed to be white noise and varies across the three States and time. (Pesaran et al, 1998), (Shin et al, 2001).

The data were analyzed with Econometrics Views (EViews) Release 10.

RESULTS & DISCUSSION

Table (1): Descriptive Statistics for Annual Data Collected During 1997 – 2022 Categorized by Values of the States:

State	Mean	Median	Max	Min.	Std. Dev.	Obs.
Gross Domestic Product (GDP)						
California	2088156.	1949394.	3598103.	1071117.	701587.9	26
Florida	803111.2	805299.0	1070930.	559805.3	130502.1	26
New York	1256010.	1191806.	2053180.	718814.3	380790.3	26
Texas	1287762.	1245127.	2355960.	610157.3	473133.2	26
All	1358760.	1180350.	3598103.	559805.3	655212.3	104
Population (POP)						
California	36829.19	37140.39	39501.65	32217.71	2278.167	26
Florida	18715.97	18749.39	22244.82	14683.35	2231.040	26
New York	19278.84	19353.51	20108.30	18143.18	490.6471	26
Texas	24888.15	25021.83	30029.57	19355.43	3324.167	26
All	24928.04	21287.27	39501.65	14683.35	7665.430	104
Unemployment (UNPLOY)						
California	6.934615	6.250000	12.50000	4.100000	2.483053	26
Florida	5.346154	4.550000	10.80000	2.500000	2.341834	26
New York	6.007692	5.500000	9.800000	3.900000	1.666355	26
Texas	5.507692	5.100000	8.200000	3.500000	1.318157	26
All	5.949038	5.400000	12.50000	2.500000	2.076124	104

According the above table, California have the highest mean of GDP (2088156.) millions of dollars with Std.

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Dev. values (701587.9), the most population mean (36829.19) thousands of person with Std. Dev. values (2278.167) and unemployment rate (6.934615) with Std. Dev. values (2.483053). While Florida have the lowest mean of GDP (803111.2) millions of dollars with Std. Dev. values (130502.1), the minimum population mean (18715.97) thousands of person with Std. Dev. values (2231.040) and unemployment rate (5.346154) with Std. Dev. values (2.341834).

Figure (1): Graph of the Study Series:

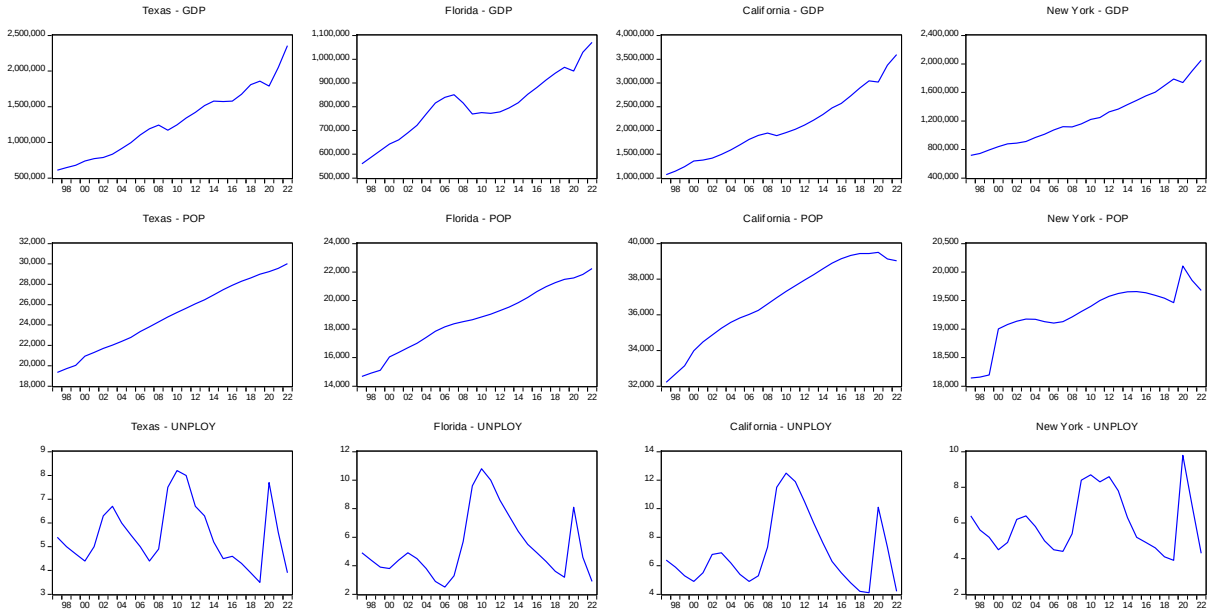

Figure (1)

The above figure shows that the series are not centered about zero and also the GDP & POP have trend in all selected States.

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Table (2): Panel Unit Root Test: Summary:

Levin, Lin & Chu t*, Null: Unit root (assumes common unit root process)			
Test for Unit Root in Level			
Include in test equation	GDP	POP	UNPLOY
Intercept	0.16969 (0.5674)	**-4.82861** **(0.0000)**	-1.63373 (0.0512)
Trend & Intercept	-0.79915 (0.2121)	-0.51097 (0.0715)	-0.35687 (0.3606)
None	5.75482 (1.0000)	2.76225 (0.9971)	-1.16476 (0.1221)
Test for Unit Root in 1st Difference			
Intercept	**-3.51085** **(0.0002)**	-1.58702 (0.0563)	**-4.50593** **(0.0000)**
Trend & Intercept	-2.70634 (0.0034)	-3.44115 (0.0003)	-3.49951 (0.0002)
None	-2.35010 (0.0094)	-2.15508 (0.0156)	-7.82394 (0.0000)

According to common unit root process, Levin, Lin & Chu t-statistic of GDP equals (-3.51085) is statistically significant at level 5% with p-value equals (0.0002), so we reject the null hypothesis: the GDP series has no unit root and we conclude that the series is stationary in 1st difference include in test intercept. Also t-statistic of POP equals (-4.82861) is statistically significant at level 5% with p-value equals (0.0000), so we reject the null hypothesis: The Population series has no unit root and we conclude that the series is stationary in level include in test intercept. Also t-statistic of UNPLOY equals (-4.50593) is statistically significant at level 5% with p-value equals (0.0000), so we reject the null hypothesis: The Unemployment series has no unit root and we conclude that the series is stationary in 1st difference include in test intercept.

The results shown indicates that GDP & UNPLOY variables are integrated at I (1), while POP is integrated in I (0). However, the variables become stationary at the significance level of 1% and 5% in difference order I (0) & I(1), which are integrated of order I(d) with d less than 2. Thus, Panel ARDL Model is applicable for measuring the long-run relationship between series with different orders of integration (Shin et al, 2001).

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Table (3): Panel ARDL Model:

Dependent Variable: D(GDP)				
Method: ARDL				
Sample: 2001 2022				
Included observations: 88				
Maximum dependent lags: 4 (Automatic selection)				
Model selection method: Akaike info criterion (AIC)				
Dynamic regressors (4 lags, automatic): POP UNPLOY				
Fixed regressors: C				
Number of models evalulated: 16				
Selected Model: ARDL(4, 4, 4)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.*
Long Run Equation				
POP	-3.011450	0.785349	-3.834535	0.0004
UNPLOY	-0.101874	0.010437	-9.761298	0.0000
Short Run Equation				
COINTEQ01	**-0.455554**	**0.180943**	**-2.517658**	**0.0154**
D(GDP(-1))	-0.188296	0.197739	-0.952246	0.3459
D(GDP(-2))	-0.261952	0.296083	-0.884725	0.3809
D(GDP(-3))	0.198358	0.195232	1.016010	0.3149
D(POP)	1.932387	1.010853	1.911640	0.0622
D(POP(-1))	-1.365328	0.970068	-1.407456	0.1660
D(POP(-2))	-0.961705	0.639644	-1.503500	0.1395
D(POP(-3))	-1.791282	0.987077	-1.814733	0.0761
D(UNPLOY)	-0.054678	0.022659	-2.413040	0.0199
D(UNPLOY(-1))	0.019425	0.014130	1.374731	0.1759
D(UNPLOY(-2))	-0.026510	0.045297	-0.585240	0.5612
D(UNPLOY(-3))	0.036603	0.023995	1.525479	0.1340
C	20.32959	8.341830	2.437066	0.0187
@TREND	0.025107	0.010073	2.492628	0.0163
Mean dependent var	0.040204	S.D. dependent var		0.035902
S.E. of regression	0.015647	Akaike info criterion		-4.714851
Sum squared resid	0.011263	Schwarz criterion		-3.240094
Log likelihood	303.1722	Hannan-Quinn criter.		-4.117384

The above table (3), shows that the estimated model of the D(GDP) series Panel ARDL (4,4,4) for long run equation have a statistically significant P-value (0.0004) & (0.0000) at level 5% & 1% for the coefficient value of Population (-3.011450) and Unemployment (-0.101874) respectively.

As expected in the above table, the EC term, here represented as COINTEQ01, is negative with an associated coefficient estimate of (-0.455554). This implies that about 45.55% of any movements into disequilibrium are

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corrected within one period. Moreover, given the t-statistic, namely (-2.517658), we can also conclude that the coefficient is highly significant with P-value equals (0.0154), which means that the variables have the ability to overcome the problems they suffer from, and the ability to correct structural imbalances during the long term.
Also, we can conclude that Population (POP) has a significantly negative effects on GDP in the long run at level 1%, 5%, 10% and has significantly negative effects on GDP in the short run at level 10%. Furthermore, Unemployment (UNPLOY) has a significantly negative effect on GDP in the long run at level 1%, 5%, 10% and has no significant effect on GDP according the selected panel States.

Figure (2): Akaike Information Criteria:

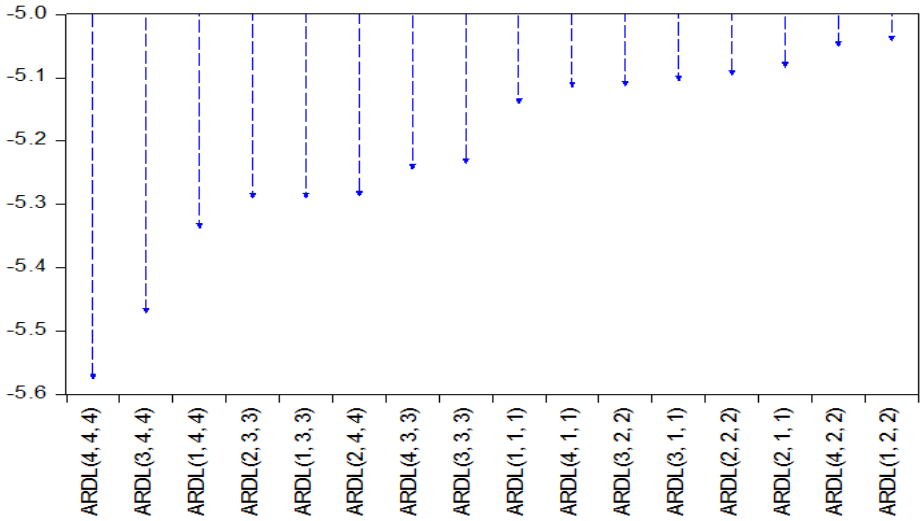

Figure (2)

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Table (4): Model Selection Criteria:

Model	LogL	AIC*	BIC	HQ	Specification
16	**303.172240**	**-5.572096**	**-3.939306**	**-4.914286**	**ARDL(4, 4, 4)**
12	294.585592	-5.467854	-3.947670	-4.855410	ARDL(3, 4, 4)
4	280.681611	-5.333673	-4.038701	-4.811961	ARDL(1, 4, 4)
7	274.554883	-5.285338	-4.102973	-4.808993	ARDL(2, 3, 3)
3	270.539932	-5.284998	-4.215239	-4.854019	ARDL(1, 3, 3)
8	282.412614	-5.282105	-3.874527	-4.715027	ARDL(2, 4, 4)
15	280.575207	-5.240346	-3.832768	-4.673268	ARDL(4, 3, 3)
11	276.145731	-5.230585	-3.935613	-4.708873	ARDL(3, 3, 3)
1	247.973371	-5.135758	-4.516424	-4.886244	ARDL(1, 1, 1)
13	258.830200	-5.109777	-4.152624	-4.724164	ARDL(4, 1, 1)
10	262.769361	-5.108395	-4.038635	-4.677415	ARDL(3, 2, 2)
9	254.420561	-5.100467	-4.255921	-4.760221	ARDL(3, 1, 1)
6	258.020702	-5.091380	-4.134227	-4.705767	ARDL(2, 2, 2)
5	249.453790	-5.078495	-4.346555	-4.783615	ARDL(2, 1, 1)
14	264.002965	-5.045522	-3.863157	-4.569177	ARDL(4, 2, 2)
2	251.643702	-5.037357	-4.192810	-4.697110	ARDL(1, 2, 2)

Table (4) & Figure (2) are showing that panel ARDL(4, 4, 4) Model; according criteria such as AIC, BIC & HQ is appropriate for evaluating the determinants of GDP for all industry in the selected countries.

Table (5): Short Run Equation for Texas:

Variable	Coefficient	Std. Error	t-Statistic	Prob. *
COINTEQ01	**-0.101070**	**0.010661**	**-9.480302**	**0.0025**
D(GDP(-1))	0.091940	0.033727	2.726020	0.0722
D(GDP(-2))	0.018918	0.038447	0.492048	0.6564
D(GDP(-3))	-0.008668	0.057839	-0.149872	0.8904
D(POP)	-0.920244	7.617023	-0.120814	0.9115
D(POP(-1))	-1.119474	1.413492	-0.791991	0.4862
D(POP(-2))	-1.560123	1.312049	-1.189074	0.3200
D(POP(-3))	-2.206716	1.053788	-2.094080	0.1273
D(UNPLOY)	-0.113625	0.000724	-156.9907	0.0000
D(UNPLOY(-1))	0.057267	0.001133	50.52754	0.0000
D(UNPLOY(-2))	0.061671	0.001178	52.34371	0.0000
D(UNPLOY(-3))	-0.023528	0.004966	-4.737700	0.0178
C	4.585351	19.28451	0.237774	0.8274
@TREND	0.006245	0.000144	43.51483	0.0000

As expected in table (5), the error correction term, here represented as COINTEQ01, is negative with an associated

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coefficient estimate of (-0.101070) with P-value (0.0025). This implies that about 10.11% of any movements into disequilibrium are corrected within one period short run equation for Texas.

Table (6): Short Run Equation for Florida:

Variable	Coefficient	Std. Error	t-Statistic	Prob. *
COINTEQ01	**-0.264740**	**0.004763**	**-55.58660**	**0.0000**
D(GDP(-1))	0.210395	0.025199	8.349313	0.0036
D(GDP(-2))	0.282860	0.023323	12.12809	0.0012
D(GDP(-3))	0.778303	0.024370	31.93689	0.0001
D(POP)	2.296391	0.756028	3.037441	0.0560
D(POP(-1))	-1.102413	0.191328	-5.761903	0.0104
D(POP(-2))	-0.376705	0.103846	-3.627538	0.0361
D(POP(-3))	-0.250651	0.072529	-3.455879	0.0408
D(UNPLOY)	-0.027363	9.25E-05	-295.7860	0.0000
D(UNPLOY(-1))	0.022887	0.000123	185.7605	0.0000
D(UNPLOY(-2))	-0.014921	0.000114	-130.6393	0.0000
D(UNPLOY(-3))	0.089997	0.000313	287.8062	0.0000
C	11.26011	6.509462	1.729807	0.1821
@TREND	0.016740	9.90E-06	1690.598	0.0000

As expected in table (6), the error correction term, here represented as COINTEQ01, is negative with an associated coefficient estimate of (-0.264740) with P-value (0.0000). This implies that about 26.47% of any movements into disequilibrium are corrected within one period short run equation for Florida.

Table (7): Short Run Equation for California:

Variable	Coefficient	Std. Error	t-Statistic	Prob. *
COINTEQ01	**-0.930863**	**0.019273**	**-48.29947**	**0.0000**
D(GDP(-1))	-0.552774	0.047121	-11.73100	0.0013
D(GDP(-2))	-1.084303	0.047956	-22.61042	0.0002
D(GDP(-3))	-0.053887	0.015660	-3.441010	0.0412
D(POP)	3.845747	1.656128	2.322131	0.1029
D(POP(-1))	-3.968477	0.537889	-7.377879	0.0051
D(POP(-2))	-2.405740	0.256426	-9.381799	0.0026
D(POP(-3))	-4.416971	0.573918	-7.696168	0.0046
D(UNPLOY)	-0.012027	0.000101	-119.4901	0.0000
D(UNPLOY(-1))	-0.008266	0.000713	-11.59261	0.0014
D(UNPLOY(-2))	-0.152994	0.000598	-255.8251	0.0000
D(UNPLOY(-3))	0.025488	0.000475	53.65014	0.0000
C	42.66209	26.89939	1.585988	0.2109
@TREND	0.053230	3.31E-05	1608.789	0.0000

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As expected in table (7), the error correction term, here represented as COINTEQ01, is negative with an associated coefficient estimate of (-0.930863) with P-value (0.0000). This implies that about 93.09% of any movements into disequilibrium are corrected within one period short run equation for California.

Table (8): Short Run Equation for New York:

Variable	Coefficient	Std. Error	t-Statistic	Prob. *
COINTEQ01	**-0.525543**	**0.023263**	**-22.59158**	**0.0002**
D(GDP(-1))	-0.502747	0.031741	-15.83919	0.0005
D(GDP(-2))	-0.265281	0.030622	-8.663102	0.0032
D(GDP(-3))	0.077683	0.025041	3.102218	0.0532
D(POP)	2.507654	1.546644	1.621352	0.2034
D(POP(-1))	0.729052	0.058190	12.52891	0.0011
D(POP(-2))	0.495749	0.082391	6.017001	0.0092
D(POP(-3))	-0.290788	0.063050	-4.611994	0.0192
D(UNPLOY)	-0.065698	0.000627	-104.8085	0.0000
D(UNPLOY(-1))	0.005814	0.000224	25.90834	0.0001
D(UNPLOY(-2))	0.000204	0.000203	1.005199	0.3889
D(UNPLOY(-3))	0.054456	0.000272	200.3585	0.0000
C	22.81079	38.15536	0.597840	0.5921
@TREND	0.024215	4.43E-05	546.3891	0.0000

As expected in table (8), the error correction term, here represented as COINTEQ01, is negative with an associated coefficient estimate of (-0.525543) with P-value (0.0002). This implies that about 52.55% of any movements into disequilibrium are corrected within one period short run equation for New York.

Figure (3): Forecasting Panel Sample 1997-2022 of GDP:

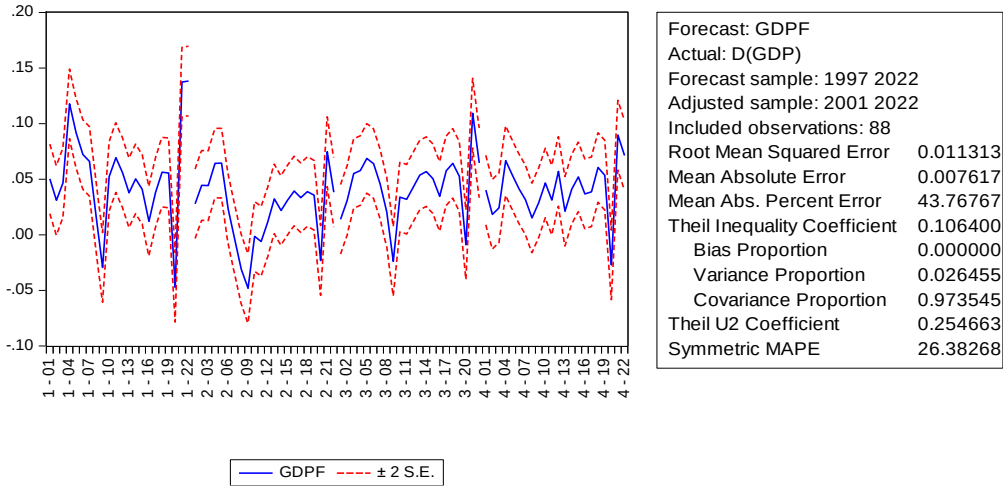

Figure (3)

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As shown in the above figure, the root mean squared error equals 0.011313, while Theil Inequality Coefficient equals 0.106400, which is close to zero, this means that the predictive power of this model is very strong. Bia proportion is equal to zero, which means, there is no gap between the actual GDP and the predictive value and they are moving closely, which means they are passing through 50% confidence interval so, the forecasting of GDP is significant and the ability of forecasting Panel ARDL Model is satisfactory.

CONCLUSION:

The standard test proved the existence of panel cointegration between the dependent variable Gross Domestic Product (GDP) of all the industries, in millions of dollars and in independent variables: Resident Population (POP) in thousands of person, Unemployment Rate (UNPLOY) in percent. The estimated model of the D(GDP) series Panel ARDL(4,4,4) for long run equation have statistically a significant P-value (0.0004) & (0.0000) at level 5% & 1% for the coefficient value of Population (-3.011450) and Unemployment (-0.101874) respectively.

The error correction term, here represented as COINTEQ01, is negative with an associated coefficient estimate of (-0.455554). This implies that about 45.55% of any movements into disequilibrium are corrected within one period. Moreover, given the t-statistic, namely (-2.517658), we can also conclude that the coefficient is highly significant with P-value equals (0.0154), which means that the variables have the ability to overcome the problems they suffer from, and the ability to correct structural imbalances during the long term.

Also, we can conclude that Population (POP) has a significantly negative effects on GDP in the long run at level 1%, 5%, 10% and has a significantly negative effects on GDP in the short run at level 10%. Furthermore, Unemployment (UNPLOY) has a significantly negative effect on GDP in the long run at level 1%, 5%, 10% and has no significant effect on GDP according the selected panel States.

Bia proportion is equal to zero, that means, there is no gap between the actual GDP and the predictive value and they are moving closely, which is passing through 50% confidence interval; so, the forecasting of GDP is significant and the ability of forecasting Panel ARDL Model is satisfactory, with the root mean squared error equals (0.011313), and Theil Inequality Coefficient equals (0.106400) which is close to zero, that means, the predictive power of this model is very strong.

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