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Economic impact of unemployment and inflation on output growth in Bihar during 1990–2019

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Abstract. The effects of unemployment and inflation on output growth based on time series data of Bihar (India) over the period 1990–2019 has been examined in this paper. The physical capital expansion in terms of infrastructure development along with skill development to provide employment opportunities to the youth appears to be the major determinant of boosting the potential productivity of physical and human capital and affecting positively the economic growth. The results indicated that there are significant and certain benefits from the increased supply and improvement in the quality of physical capital which increases labor productivity as well as investment in human capital. Thus, it is recommended that Bihar makes large-scale investments in infrastructure and skill development and carry-on renewal at opportune moments to keep steady the positive trend of economic growth over the years. The investments may be in terms of mechanized technologies, supporting infrastructure and appropriating the knowledge relating to their management; and adopting new technologies and practices involving better innovation in agriculture, forestry, manufacturing, and relevant skill development to sustain the growth of value-added.

Keywords: Unemployment, inflation, output growth

1. Introduction

Bihar, an industrially backward state of India had suffered the least annual growth in the decade 1990–91 to 2000–01 [34] and worried researchers to examine the ground reality. It was realized that Bihar's economy had inherited many disadvantaged factors like high level of manpower supply, shortage of critical manpower, low level of physical capital stock, which resulted in the huge rate of unemployment. Unemployment is a term used when a person desires to work and is taking active steps to find employment but unfortunately is unable to find it. Unemployment has a negative influence on economic welfare, production, human capital, social exclusion, crime, and social instability that is a matter of serious concern. The high level of unemployment constitutes one of the most serious threats facing society and governance of Bihar, a low-income state of India, where people are compelled to migrate to other states in search of manual employment.

Bihar has a serious problem of unemployment because of many people who are unskilled and are not experienced to drive the economy forward. There is a gap between real wages and productivity, which results in a limitation to job creation in Bihar. The primary concern is to reduce the skill shortage that contributes to the gap, and therefore make skills development and education a priority. Resolving the youth unemployment problem requires short and long-term policies, such as public works programs and the development of the higher critical manpower needed for the economy through the education system. The shortage of resources and the scarcity of critical skills will eventually cripple the Bihar economy. To solve the critical manpower resources in the short run, Bihar has resorted to such practices as imparting critical skilled manpower as a means of corrective measures. The Bihar Skill Development Mission (BSDM) has been constituted by the Government of Bihar to empower the youth by providing them with the requisite skills to fuel the growth of the State of Bihar. The primary roles of BSDM are: to establish a

wide network of training centers for the youth and to provide employment opportunities to the youth.

Research evidence has shown that several labor market barriers exist that prevent people from overcoming unemployment and earning a living – most of which affect mainly the poor and arise from a pool of poverty leading to marginalization, inequality and further poverty. More importantly, however, is the overall impact of Bihar's unemployment situation on the economy from a macroeconomic perspective. This is accentuated by the influence of labor market fluctuations on monetary policy, changes in the gross domestic product (GDP) as accounted for by unemployment, as well as the relationship between unemployment and inflation in Bihar.

There appears to be a theoretical relationship between unemployment that is caused by critical manpower shortages and scarcity of productive inputs in the form of modern machinery, equipment and other critical inputs. The result is that domestic production falls short of the required output, which has to be met by imported goods and services. The tendency is for the economy to demand more imports than its exports. The consequence is building a trade deficit, which in the long run requires devaluation of the rupee and with its attendant inflation implications. To control inflation, the State government has put in place the Inflation Targeting (IT) framework of 3%–6%. This further affects people who are employed as their real wages are eroded via inflation. The Phillips Curve was developed to explain the trade-off between unemployment and changes in wages (inflation).

There is scant literature on inflation, unemployment and output growth, which are the three tremendously vital macroeconomic variables in Bihar's economy. The success of the economy is hinged on these variables which are indispensable fundamentals for the economic policies of Bihar. This study is an attempt to add knowledge and provide policy recommendations for the sustainable development of the Bihar economy. Such recommendations could be based after sorting out differences in the existing literature on the impact of inflation and unemployment on economic performances in different economies. For instance, Tenzin [1] has established that unemployment has no impact on output in Bhutan; Muryani and Pamungkas [2] have demonstrated using the Error Correction Model (ECM) that unemployment has significantly contributed to output growth in Indonesia. While Makaringe and Khobai [3] have shown using AutoRegressive Distributed Lag (ARDL) regression that unemployment has a depressing effect on output in South Africa. Bands et al. [4] have demonstrated that unemployment promotes output growth in South Africa. In the case of inflation, however, there are more consistent findings that inflation depresses output. For instance, Tenzin [1], Saidu and Muhammad [5], Muryani and Pamungkas [2], Munyeka [6], among others have all established that inflation depresses growth in the studies across different economic settings. The differences in the findings on the impact of unemployment on output may be explained by the nature of data at different periods under varying economic situations prevailing thereon. The differences in the impact of unemployment may also be caused by the non-consideration of omitted variables or an incomplete model. This study is designed to avoid the problem of omission of variables by considering the major factors that affect output such as physical and human capital, labor force which has been dropped because of its high correlation with physical capital (a correlation of over 0.94). The opinion of this study is that having included most of the variables that affect output, the finding of the impact of unemployment will likely reflect the true relationship in Bihar in the period under review. The paper has also carried out Karl Person's correlation test (an extensively used mathematical method in which the numerical representation is applied to measure the level of relation between linearly related variables) to establish the nature of the relationship among the variables to see how the variables are statistically related to know the nature of their correlation, apart from the nature of impact one has over the other (their regression coefficients and their t-ratios). Moreover, the knowledge of correlation gives us information about the likely presence of multi-collinearity and how to avoid it. This has the potency of improving the quality of regression outcomes.

1.1. Literature review

In every economy around the world, labor is a driving force that induces consumer spending as well as output, more important for companies – ultimately contributing to the total output of the economy. Similarly, unemployment represents the unused potential that could have contributed to the economic output and thus affects the macroeconomy to a large extent [7]. Inflation erodes the buying power of the currency and must be harnessed for any economy to function well.

1.2. Theoretical literature review

When it comes to studying the economy, growth

and jobs are two primary factors economists must consider. There is a clear relationship between the two, and many economists have framed the discussion by trying to study the relationship between economic growth and unemployment levels. Economist Arthur Okun first started tackling the discussion in the 1960s, known as Okun's law which states that a country's gross domestic product (GDP) must grow at about four times faster in a year to achieve the desired reduction in the rate of unemployment. Okun's law "is intended to tell us how much of a country's gross domestic product (GDP) may be lost when the unemployment rate is above its natural rate." The logic behind Okun's law is simple. Because the output of the economy is dependent on the labor that it has used, it can be understood that a positive relationship exists between output and employment, which further explains the negative relationship between output and unemployment since the unemployed are not participants of the labor force Snowdon and Vane [8]. A positive relationship exists between output and employment because output depends on the amount of labor used in production. Inversely, a negative relationship exists between output and unemployment because unemployment is the labor force minus total employment. According to this principle, a one-percentagepoint decline in the rate of unemployment in one year produces a two percent increase in real GDP growth rate per year. Therefore, if, for instance, the potential rate of GDP growth is 2% per annum, then Okun's Law holds that real GDP should grow at approximately 4% for a year to achieve a two-percentagepoint fall in the unemployment rate Fuhrmann [9]. To hold the unemployment rate steady, the growth in the GDP rate must usually be twice the growth rate of employment potential.

1.3. Phillips curve and the augmented Phillips curve

The effects of any monetary policy can be divided between output growth and prices. With the role of expectations and price-stickiness, elected governments have an incentive to conduct their monetary policy with an inflationary bias. The Phillips curve plots the relationship between the recorded level of unemployment and the rate of change in wages, where the rate of change of money wages is used as a proxy for inflation (Phillips Curve shows an inverse relationship between inflation (money wage rate) and level of unemployment, i.e. lower the unemployment in an economy, higher the inflation (money wage rate) and vice – versa.) (Bias [10]). As unemployment falls the rate of inflation increases. This means that there is no change in real values, as the rate of inflation adjusts to new pressure demands due to wage increases Howells and Bain [11].

1.4. Growth theory and empirical literature

The classical growth theory asserts wages/inflation is determined at the natural market wage level. Classical economists (Smith [12]; David [13]; Mill [14]; Pigou [15]) confesses that the economy will decline with the increase in prices. Persistent increases in prices usually erode the value of a currency and lead to a decline in the growth of the economy. This leads to negative growth being experienced. Tenzin [1] has investigated the impact of unemployment and inflation on economic growth in Bhutan using data from 1998 to 2016. The study uses an autoregressive distributed lag (ARDL) model to estimate the parameters of the regression model. The results show that unemployment has no impact on economic growth in Bhutan, both in the short-run and the long run. Inflation has impacted economic growth in the long run. The reason given is that inflation causes uncertainty. Saidu and Muhammad [5] have studied the interaction between unemployment, inflation and economic growth in Nigeria. The paper uses Granger causality (Umaru and Zubairu [16]) to investigate the line of causality. Before applying Granger causality, unit root analysis was applied to determine the time-series features of the data to ascertain if the variables applied are stationary. The results show that the data are trending. The results of Granger causality indicate that inflation affects economic growth, but growth does not cause inflation. There is no relationship between economic growth and unemployment.

Muryani and Pamungkas [2] have explored the impact of unemployment, inflation, government expenditure, labor force, and gross fixed capital formation on economic growth in Indonesia. The paper estimates the parameters of the population regression using the Error Correction Model (ECM) (Amassona et al. [17]). The results show that unemployment and gross fixed capital formation promote economic growth. Labor force and inflation depress economic growth. Government expenditure does not affect economic growth.

Munyeka [6] has explored the relationship between inflation and economic growth in South Africa. The study applies quarterly data from 1993 to 2016. The study applies correlation and Ordinary Least Square (OLS) regression methods (Muellhauer and Banko [18]). The results of both analytical methods show that there is a negative and a significant relationship between the two variables. Mohseni and Joazaryan [19] have explored the impact of inflation and unemployment on economic growth in Iran. The paper uses the ARDL regression model to estimate

the parameters of the population regression model, using time-series data from 1996 to 2012. The results show that both inflation and unemployment impact negatively economic growth in the long run. Makaringe and Khobai [3] have investigated the impact of unemployment and economic growth in South Africa using quarterly data from 1994 to 2016. The study applies the ARDL regression model to estimate the coefficients of the regression. The results of the regression show unemployment depress economic growth in South Africa. Leisure [20] explores the relationship between employment and economic growth in South Africa. The study uses Toda-Yamamoto causality tests (Guru-Gharana [21]) to estimate the relationship. The paper uses quarterly data from 2000Q1 to 2012Q3. The results show that employment does not cause economic growth, but GDP causes employment.

Bands et al. [4] have explored the effect of log of output, real effective exchange rates, labor productivity, the budget deficit on unemployment in South Africa. The study uses Error Correction Model (ECM) in estimating the parameters of the regression model (Dhungal [22]). The results show that the log of GDP, labor productivity, and budget deficit increase unemployment. The real effective exchange rate does not affect unemployment. Osinubi [23] has explored the interaction between economic growth, poverty, unemployment, inflation, money supply, and saving rates in Nigeria. The paper uses OLS to estimate the relationship. The results show that unemployment significantly promotes growth and saving reduces growth. The results also show that growth has no impact on unemployment.

Aubrery [24] investigates the effect of inflation on economic growth in South Africa. The paper uses the Error Correction Method to estimate the parameters of the population. The paper establishes that inflation has not impacted the economic growth in South Africa. Madito and Khamalo [25] have explored the impact of unemployment and inflation on economic growth in South Africa. The paper uses quarterly data from 1967 to 2013. The study uses Johansen co-integration method to establish the existence of a long-run relationship among the variables applied in the study. The paper applied the error correction regression model to estimate the coefficients of the regression model. The results show that unemployment has no impact on economic growth.

1.5. Methodology and results

The most extensively famous single equation approach to co-integration is the Engle-Granger two-step procedure [26]. This approach has some limitations. One, it does not indicate which of the variable is a dependent variable and which variable is an independent variable. This issue is important as the determination of the dependent variable can affect the significance of the results. Second, when there are more than two variables, the Engle-Granger model cannot handle this. A more versatile model must be applied because we do not have a unique co-integrating relationship. This second problem explains why this study applies the autoregressive distributed lag (ARDL) model by Pesaran et al. [27,28] in this study. The ARDL model can be presented as follows:

$$Y_t = \sum_{j=1}^{p} \lambda_j Y_{t-j} + \sum_{j=1}^{q} \delta_j X_{t-j} + \varepsilon_t \tag{1}$$

Where: X_{t-j} are the Kx1 vector of explanatory variables, and the Y_{t-j} are the lagged dependent variable. The above ARDL model can be presented using vector equilibrium or error correction model (VECM) as follows:

$$\begin{aligned} \Delta Y_t = \theta_j (Y_{t-1} - \beta_t' X_{t-1}) + \sum_{j=1}^{p} \lambda_j Y_{t-j} \\ + \sum_{j=1}^{q} \delta_j X_{t-j} + \varepsilon_t. \end{aligned} \tag{2}$$

In Eq. (2), the β_t' is the estimated longrun parameters and the $\theta_j s$ are the equilibrium error correction parameters. The ARDL model is also called pool mean group (PMG) and it uses the generalized likelihood estimation technique and the leg length is determined by one of the information criteria like the Schwarz Bayesian information criterion [29].

The relevant data were taken from the various concerned Departments of the Bihar Government for 1990–91 to 2019–20 (30 observations). Table 1 shows the variables that are used in the study.

2. Results and their analysis

Results of data analyzed are presented using descriptive statistics, Karl person correlation coefficients, unit root test, Johansen cointegration test, and regression model following Pesaran et al. [27,28].

The variables of real GDP (RGDP) and capital stock (KAPSTC) were measured using natural logarithms. While unemployment (UNEMP) and inflation rates (INFL) are measured using percentages and human capital is measured using the mean of secondary schools'

Table 1
Description of variables

Acronym of variable	Variable	Measurement of variable
INFL	Inflation rate	Inflation as measured by the consumer price index reflects the annual percentage change in the cost to the average consumer of acquiring a basket of goods and services that may be fixed or changed at specified.
RGDP	Real GDP	The annual percentage growth rate of GDP at market prices is based on constant price.
UNEMPL	Unemployment rate	Unemployment rate refers to the percentage of the labor force that is without work but available for and seeking employment.
HUCAP	Human capital	This is defined as the mean value of secondary enrolment and life expectancy.
KAPSTC	Capital stock	KAPSTC is estimated as the gross fixed capital formation of the State.

Source: Researchers' computations (Various Bihar Government Departments, 2020).

Table 2
Descriptive statistics-result

Description	lnRGDP	lnKAPSTC	UNEMP	INFL	HUCAP
Mean	26.52	24.77	27.90	5.83	98.80
Median	26.58	24.93	28.35	5.71	99.23
Std. Dev.	0.22	0.37	2.93	2.35	4.13
Skewness	−0.28	−0.32	−0.09	−0.50	0.13
Kurtosis	1.58	1.45	1.98	3.85	2.75
Jarque-Bera[2]	2.52	3.06	1.15	1.85	0.13
Probability	0.28	0.23	0.56	0.40	0.94

Source: 1. Researchers' computations (Various Bihar Government Departments, 2020). 2. Jarque-Bera test is a goodness-of-fit test of whether sample data have the skewness and kurtosis matching a normal distribution.

enrolment and life expectancy. The mean and median logarithm of RGDP and KAPSTC are about 26 and 25, respectively. The mean and median of inflation rates, unemployment rates and human capital index are about 6%, 28% units and 99 units, respectively. The inflation rate of about 6% appears to be at the upper limit of the targeted rate of 6% per annum. The unemployment rate of 28% is very high.

The spread around the mean appears to be below for all the variables as the standard deviation values are low. The low values of the skewness and Kurtosis tend to give evidence in favor of normally distributed variables. While the low values of the Jarque Bera statistic and their associated probabilities tend to show that the distributions are not statistically significant.

2.1. Correlating analysis

The table below shows the correlation matrix of the variable under study. The correlation matrix was evaluated by the guide given by Evans [30] to determine the relationships between the variables.

Based on the correlation range suggested above by Evans (2002), unemployment has a very strong negative relationship with the RGDP, the dependent variable and KAPSTC. Inflation rates (INFL) are weakly correlated with the dependent variable (RGDP) and capital stock (KAPSTC) and unemployment rates (UNEMP). Human capital (HUCAP) is highly correlated with both the dependent variable and the independent variables, except inflation rates.

Table 3
Correlation matrix

Variable	RGDP	KAPSTC	UNEMPL	INFL
KAPSTC	0.985**	–	–	–
UNEMP	−0.751**	−0.839**	–	–
INFL	−0.300	−0.229	0.039	–
HUCAP	0.804**	0.792**	−0.689**	−0.307

Note: Correlation range between 0–0.19 is very weak, 0.2–0.39 is weak, 0.4–0.59 is moderate, 0.6–0.79 is strong and 0.8–1.0 is very strong. The guide is suggested by Evans [30]. Note: (*) and (**) indicate significance at 5% and 1% levels respectively.

2.2. Unit root test

Variables need to be stationary; this is to avoid problems associated with non-stationary of a time series, such as spurious regression and persistence shocks. The unit root tests used in the study are the Augmented Dickey-Fuller (ADF) and Phillips and Perron (PP) tests.

2.3. Unit root results

The analysis of the stationary test was carried out with intercepts only. Examining the ADF test results at

Table 4
Results of Augmented Dickey-Fuller (ADF) and Phillips and Perron (PP) tests

	Levels			First difference		
Variables	ADF	5% critical value	Prob.	PP	5% critical value	Prob.
lnRGDP	0.467	−3.603	0.99	0.091	−3.603	0.99
ΔlnRGDP	−3.107	−3.612	0.12	−3.081	−3.612	0.13
Δ^2lnRGDP	−5.578	−3.622	0.00	−9.465	−3.622	0.00
lnKAPSTC	−1.309	−3.602	0.86	−0.993	−3.603	0.93
ΔlnKAPSTC	−3.104	−3.612	0.12	−3.105	−3.612	0.12
Δ^2lnKAPSTC	−6.022	−3.622	0.00	−6.531	−3.522	0.00
UNEMP	−1.262	−2.986	0.63	−1.262	−2.986	0.63
ΔUNEMP	−3.673	−2.992	0.01	−3.633	−2.992	0.01
INFLA	−1.377	−1.955	0.15	−1.312	−1.955	0.16
ΔINFLA	−5.047	−2.958	0.00	−6.063	−1.955	0.00
HUCAP	−1.280	−3.004	0.61	−1.571	−3.012	0.47
ΔHUCAP	−3.090	−3.012	0.04	−3.043	−3.3012	0.04

Source: Researchers' computations.

Table 5
Johansen co-integration test

Maximum eigenvalue statistics (ME stat.)				Trace statistics (T stat.)			
H_0	H_1	ME stat.	5% critical value	H_0	H_1	T stat.	5% critical value
$\Gamma = 0$	$\Gamma = 1$	251.42	88.80	$\Gamma = 0$	$\Gamma \geqslant 1$	121.87	38.33
$\Gamma \leqslant 1$	$\Gamma = 2$	129.55	63.88	$\Gamma \leqslant 1$	$\Gamma \geqslant 2$	55.49	32.12
$\Gamma \leqslant 2$	$\Gamma = 3$	74.06	42.92	$\Gamma \leqslant 2$	$\Gamma \geqslant 3$	36.66	25.82
$\Gamma \leqslant 3$	$\Gamma = 4$	37.40	25.87	$\Gamma \leqslant 3$	$\Gamma \geqslant 4$	25.04	19.39
$\Gamma \leqslant 4$	$\Gamma = 5$	12.37	12.52	$\Gamma \leqslant 4$	$\Gamma \geqslant 5$	12.37	12.52

Source: Researchers' computations.

levels, none of the variables are significant and the null hypothesis is rejected. At first difference three variables which are INFL, UEMPL and HUCAP are significant at the 5 percent level of significance and the null hypothesis of no unit root in the variable is not rejected. The null hypothesis of a unit root in the data is rejected in the case of RGDP and KAPSTC. This null hypothesis is not rejected after the second differencing. Looking at the results for PP at levels, none of the variables are significant and the null hypothesis is rejected. At first difference, like in the case of ADF test, three variables of UNEMPL, INFL and HUCAP are significant at the 5 percent level of significance, the null hypothesis that unit root exists in the variable is rejected. In the remaining two variables which are logarithms of RGDP and KAPSTC the null hypothesis cannot be rejected. After the second differencing the null hypothesis is rejected, and this study has concluded the logarithms RGDP and KAPSTC are stationary after the second differencing. Having established that all the variables are trending at a level, this study has tested the existence of co-integration using the Johansen co-integrating method.

Table 5 shows that the maximum eigenvalue statistics (ME Stat.) test of Cointegration rejects the null hypotheses (H0) of no co-integration from having zero co-integration (to having less than or equal to 3 Co integrating relationships The null hypotheses of having less than or equal to 4 Co-integrating equations (could not be rejected. The rationale for rejecting the null hypotheses is that the computed maximum eigenvalue statistics are greater than their 5% critical values; while the reason for accepting the null hypothesis is that the computed 5% critical value is lesser than their 5% critical value. This means that there are one, two, three and four co-integrating equation relationships in the model. Based on the trace statistics, Table 5 also shows that the null hypotheses of having zero co-integrating relationships (to having less than 3 co-integrating relationships) could not be accepted. This implies that the alternative trace hypothesis (H1) that there is 1 co-integrating relation to, greater than or equal to 4 co-integrating relationships could not be rejected. Thus, under both methods, there is evidence of having up to four co-integrating relationships among the variables applied in this study. The reason is that the computed trace statistics are greater than their 5% critical values. Thus, this study applies autoregressive distributed lag (ARDL) or pooled mean group (PMG) model developed by Pesaran et al. [27] to estimate both the short-run and the long-run relationship among the variables in Table 6.

Table 6
ARDL regression model (lnRGDP is the dependent variable)

Variable	Long-run relationship			Short-run relationship		
	Coef.	*t*-stat.	Prob.	Coef.	*t*-stat.	Prob.
ECM	–	–	–	−0.328	−6.780	0.00
Constant	4.600	1.071	0.30	–	–	–
lnRGDP	−0.328	−1.548	0.14	–	–	–
lnKAPSTC	0.154	2.362	0.03	0.471	2.714	0.01
UNEMP	0.003	1.601	0.13	0.009	1.130	0.27
INFLA	−0.004	−2.753	0.01	−0.011	−1.23	0.23
HUCAP	0.002	2.342	0.03	0.007	1.350	0.19
Adjusted R^2			0.99			
F – Statistics/Probability			1591/0.00			
ARCH test: Q-stat. lags 1 to 5			0.939to 9.037			
ARCH test Q-stat. prob. Lags 1 to 5			0.33 to 0.11			
B-G Serial Cor. LM test – F-Stat/Prob.			2.218/0.13			
B-P-G Heteroske. Test: F-Stat./Prob.			0.556/0.78			
Residual normality test: Jarque. Bera/Prob.			1.601/0.45			
A residual Normality test: Skewness/Kurtosis			−0.608/3.24			
2 highest variance decomposition proportion of the first column			0.512 and 0.146			

Source: Researchers' computations.

2.4. Diagnostic tests

Table 6 has shown that the estimated VAR model has a good fit of over 99%. Overall, its explanatory power is high. The high F-statistic with a low probability value shows that the overall model is significant. Lower values of Ljung-Box [31] Q-statistics and its high probability values of more than 5% indicate the absence of autoregressive conditional heteroscedasticity (ARCH) in the residuals of the estimated ARDL regression. The Breusch and Godfrey (B-G) Lagrange multiplier (LM) test (Asteriou et al. [33]) for serial correlation based on the F-statistic test along with its associated probability value could not reject the null hypothesis of no serial correlation in the residuals. The reason for accepting the null hypothesis is predicated on low F-statistic and its associated high probability values which are consistent with the null hypothesis. Similarly, the estimated F-statistic of the Breusch-Pagan-Godfrey (B-P-G) test along with its associated probability values have confirmed the null hypothesis that the variances of the ARDL regression model are homoscedastic. The reason for accepting the null hypothesis is that the computed F-statistic value is low giving credence to the null hypothesis. In the same way, the computed probability value is high. Again, this supports the null hypothesis of homoscedasticity of residuals. The estimated correlations of the explanatory variables are not too high as evidenced by the highest two variance decomposition of the first column which is 0.512 and 0.146. This is an indication of a lack of severe multicollinearity. Thus, this evidence has shown that the estimated ARDL model has not suffered from serial correlation, heteroscedasticity and multicollinearity. It is important to carry out the stability of the estimated coefficients using cumulative sum (COSUM) of recursive residuals as recommended by Brown et al. [32] in Fig. 1 below.

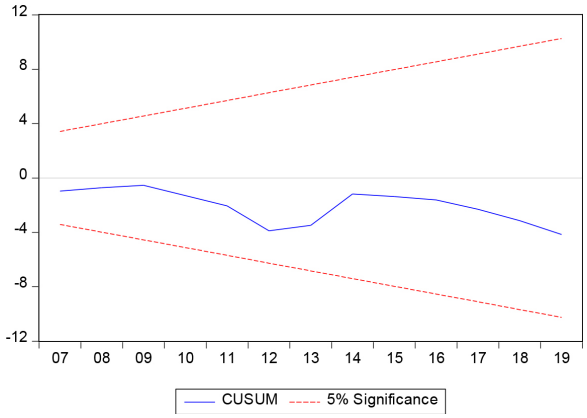

Fig. 1. Stability of the estimated coefficients using cumulative sum (COSUM) of recursive residuals.

Figure 1 shows that the estimated parameters are stable as they have not gone outside the critical lines. Thus, the estimated regression coefficients are stable. Based on all these diagnostic tests, this study uses the estimated ARDL regression model results as demonstrated below as the research findings of this study.

2.5. Research findings

Results indicated in Table 6 show that the logarithm of capital stock and investment in human capital (HUCAP) have a significantly stimulating impact on the

logarithm of output in Bihar in the long run. The result shows that a one percent increase in capital stock is liable to increase the real gross domestic by 0.154% in the long run, holding all other factors constant. A unit increase in human capital investment is susceptible to increasing real GDP by 0.002% in the log-run, assuming all other factors are held constant. The inflation rate, however, has a depressing impact on the real GDP in Bihar in the long run. A 1% increase in inflation is liable to reduce real GDP by 0.004% in the long run, holding other factors constant. The results have also shown that unemployment (UNEMPL) has no significant impact on the logarithm of real GDP in the long run as it has a greater significance level. The short-run results have shown that if the log real GDP deviates from its long-run, it recovers over 32% in one year. It would likely take about three years for the economy to recover from shock in the system. The results of short-run regression coefficients have also shown that only the logarithm of capital stock (lnKAPSTC) has an impact on the logarithm of real GDP (lnRGDP).

3. Discussion of findings

This study has investigated the impact of unemployment and inflation on economic performances in Bihar while using the logarithm of capital stock and human capital as control variables. The essence of the study is to find out if after controlling for the above variables, inflation rates and unemployment rates would still impact the logarithm of real GDP in Bihar. For instance, Tenzin [1] Saidu and Muhammad [5], Muryani and Pamungkas [2], Munyeka [6], to name but a few extant pieces of literature, have found that inflation depressed real GDP. This study has established that inflation significantly depresses economic performance in Bihar. This finding agrees with extant findings in this area such as the finding of Munyeka [6] in his study of the impact of inflation on economic growth in South Africa; Tenzi [1] study of the impact of inflation in Bhutan using ARDL; Muryani and PamungKas [2] of their study of Indonesia using ECM; among other studies. The reason advanced for inflation impacting negatively on growth in most studies is that inflation causes uncertainty and reduces investment, employment and consequently output [1].

This study has also established that unemployment has not significantly impacted real GDP in Bihar. This finding has disagreed with the finding of Maringe and Khobai [3] who uses the ARDL regression model to demonstrate that unemployment has reduced economic performance in Bihar. The finding of this study has also contradicted the findings of Babda et al. [4] who established that unemployment promotes economic growth in South Africa; Saidu and Muhammad [5] who have also established that unemployment promoted economic performance in Nigeria. The findings of this study are consistent with the finding of Leshoro [20] from his study of South Africa that unemployment has no impact on economic growth; Tenzin [1] who has studied the impact of unemployment in Bhutan and find no impact of unemployment on real GDP; Saidu and Muhammad [5] who have also established from their study that unemployment has no significant impact on economic growth in Nigeria. The possible reasons for unemployment not affecting growth might be attributed to, the use of log of real GDP, the nature of the regression model applied and controlling for the possible impact of human capital and physical capital. It is important to note that two of the extant literature cited above, Leshoro [20] and Saidu and Muhammad [5] both use causality models while Tenzin (2019) applies the ARDL model with the log of real GDP. There is no definitive conclusion predicated on the reasons presented above.

The study has established that investment in physical capital and human capital has significantly promoted economic performances in Bihar. The possible reasons are an investment in human capital improves the productivity of the labor forces and hence increases output; investment in physical capital increases the amount of capital per unit of labor and this has the potency of increasing productivity per worker. The overall effect is the increase in output and therefore economic performance.

4. Conclusion

The study provides useful insight into the effects of unemployment and inflation on output growth based on time series data of Bihar over the period 1990–2019. It shows that unemployment and inflation rates are negatively correlated with real GDP. While unemployment is significantly correlated, the inflation rates are insignificantly correlated with real GDP. The results are in line with a prior expectation as an increase in GDP leads to the creation of jobs which lowers unemployment. The study has also demonstrated that both physical and human investments have significantly promoted the log of real GDP in Bihar. Inflation rates have a depressing impact on the log of real GDP. The unemployment prob-

lem has no direct effect on the real GDP in Bihar. To tame the problem of unemployment in Bihar requires rather control variables that have a direct impact on the real GDP. In this study, two such variables have been identified that stimulate the real GDP, which is invested in physical and human capital. Investment in human capital can enable Bihar to overcome the problem of shortage of critical skills alluded to as the major cause of unemployment in Bihar. The availability of physical capital is liable to increase the productivity of the workforce and is susceptible to increase not only labor productivity but increase employment which might likely reduce unemployment. The physical capital expansion along with human capital development in terms of skill development appears to be the major determinant of boosting the potential productivity and affecting positively the economic growth. The results indicated that there are significant and certain benefits from the increased supply and improvement in the quality of physical capital which increases labor productivity as well as investment in human capital. Thus, it is recommended that Bihar makes largescale investment in infrastructure and skill development and carry on renewal at opportune moments to keep steady the positive trend of economic growth over the years. The investment may be in terms of mechanized technologies, supporting and appropriating knowledge relating to their management, and adopting new technologies and practices involving better innovations in infrastructure and manufacturing process and skill development to sustain the growth of valueadded.

The paper has established that inflation rates have a depressing impact on the log real GDP in Bihar. The possible reason advanced for this finding is that inflation creates uncertainty, and this reduces economic growth. The implication is that reducing inflation in Bihar can help engender economic growth and reduce unemployment. The reasoning here is that there may be no direct effect of unemployment on real GDP but there is an indirect impact. Any factor that affects GDP is liable to reduce unemployment. Therefore, monetary policies that reduce inflation are liable to affect real GDP and hence reduce the unemployment rates.

Conclusively, this research is essential for policymaking for Bihar. For instance, Sustainable Development Goal number 8 (SDG8) is designed "To promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all". The results of this paper have shown that to achieve this objective, it is necessary to increase investment in both physical capital and human capital and to reduce inflationary tendency in Bihar's economy.

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References

[1] Tenzin U. The nexus among economic growth, inflation, and unemployment in Bhutan. South Asia Economic Journal, 2019, 20(1), 94–105. doi: 10.1177/1391561418822204.
[2] Muryani P., and Pamungkas A. The impact of unemployment rates, labor force, capital, inflation rates and government expenditure on economic growth in Indonesia. American Journal of Engineering Research, 2018, 7(3), 109–119.
[3] Makaringe S.C., and Khobai H. The effect of unemployment on economic growth in South Africa (1994–2016). MPRA Paper No. 85305, March 2018. 2018.
[4] Banda H., Ngirande H., and Hogwe F. The impact of economic growth in unemployment in South Africa: 1994–2012. Investment Management and Financial Innovations, 4 July 2016, 13(2), 246–255.
[5] Saidu B.M., and Muhammad A.A. Have unemployment and inflation substantially affected economic growth? Journal of Economics and Development Studies, 2018, 3(2), 132–139.
[6] Munyeka W. The Relationship Between Economic Growth and Inflation in the South African Economy. Mediterranean Journal of Social Sciences, July 2014, 5(15), 119–129.
[7] Simpson S.D. 'Macroeconomics: Unemployment', viewed 27 March 2019, 2013. from http://www.investopedia.com/university/macroeconomics/macroeconomics8.asp.
[8] Snowdon B., and Vane H.R. Macroeconomics: Its Origins, Development and Current State, Edward Elgar, Cheltenham. 2005.
[9] Fuhrmann R. 'Okun's Law: Economic Growth And Unemployment' viewed 27 March 2019, 2016. from http://www.investopedia.com/articles/economics/12/okuns-law.asp.
[10] Bias P.V. A Note on the Textbook Philips Curve. Research in Bussiness and Economics Journal. 2011.
[11] Howells and Bain K. The economics of money, banking and Finance. A European Text. PrenticeHall, Fourth Edition. 2008.
[12] Smith A. An Inquiry into the Nature of Causes of Wealth of Nations. W. Stahan and T. Cadall, London. 1776.
[13] David R. Principle of Political Economy and taxation. John Murry. 1817.
[14] Mill J.S. Principles of Political Economy. John W. Parker. 1848.
[15] Pigou A.C. Economics of Welfare (4th ed.) (London: Macmillan, 1932). 1920.
[16] Umaru A., and Zubairu A.A. Effect of inflation on the Economic Growth and Development of the Nigerian Economy" An Empirical Evidence. International Journal of Business and Social Science, 3. 2012b.
[17] Amassona, Ditimi dan Nwosa, Philip I. The impact of unemployment rate on Productivity growth in Nigeria: An Error Correction Modeling Approach. Journal of Economics and Sustainable Development. Vol. 4(9). 2013.
[18] Muellhauer A.J., and Banco J. Estimating Monetary Policy for South Africa. Working Paper 89, Santiago, Central Bank of Chile. 2001.
[19] Mohseni M., and Jouzaryan F. Examining the effect of inflation and unemployment on economic growth in Iran (1996–2012). Procedia Economics and Finance, 2016, 36, 381–389.

[20] Leshoro T.L. Does Economic Growth Lead Employment in South Africa? Journal of Economics and Behavioural Studies, June 2013, 5(6), 336–345.
[21] Guru- Gharana K.K. Economic Investigation of Relationships among Export, FDI, and Growth in India: An Application of Toda-Yamamoto-Doludo-Lutkephol – Granger Causality Test, The Journal of Developing Areas, 2012, 46(2).
[22] Dhungal K.R. Estimation of short and long-run equilibrium coefficients in error correction model: An empirical evidence from nepal. International Journal of Econometrics & Financial Management, 2014, 2(6), 214–219.
[23] Osinubi T. Macroeconometric Analysis of Growth, Unemployment and Poverty in Nigeria. Pakistan Economic and Social Review, Winter 2005, 43(2), 249–269.
[24] Aubrey M. The effects of inflation targeting on economic growth in South Africa. University of Limpopo. Master of Commerce. 2015.
[25] Madito O., and Khumalo J. Economic Growth – Unemployment Nexus in South Africa: VECM Approach. Mediterranean Journal of Social Sciences, September 2014, 5(20), 79–84.
[26] Engle and Granger. Co-integration and error correction: Representation, estimation, and testing. Econometrica, 1987, 55(2), 251–276.
[27] Pesaran M., Shin Y., and Smith R. Pooled mean group estimation of dynamic heterogeneous panels. Journal of the American Statistical Association, 1999, 94, 622–634.
[28] Pesaran M., Shin Y., and Smith R. Bound testing approach to the analysis of long-run relationships. Journal of Applied Econometrics, 2001, 16(3), 289–326.
[29] Schwarz G. Estimating the dimension of a model. The Annals of Statistics, 1978, 6(2), 461–464.
[30] Evans M.K. Practical Business Forecasting. Blackwell Publishers: United Kingdom. 2002.
[31] Ljung G., and Box G. On measures of lack of fit in time-series models. Biometrika, 1979, 66, 265–270.
[32] Brown R.L., Durbin J., and Evans J.M. Techniques for testing the constancy of regression relationships over time. Journal of Royal Statistical Society, 1975, (2), 149–163.
[33] Asteriou D., and Hall S.G. The Breusch-Godfrey LM test for serial correlation, Applied Econometrics (Second ed.). New York: Palgrave Macmillan. 2011, 159–61.
[34] Directorate of Economics & Statistics, Government of Bihar. The trend in Growth & Pattern of State Domestic Product, Bihar (1948–49 to 2011–12); A Centenary Celebration Document. 2012.
[35] Planning & Development Department, Government of Bihar: Annual Plans for the year 1990 to 2020; Seventh to Twelfth Five Year Plans.
[36] Peter Ireland. The Classical Theory of Inflation and Its Uses Today. Economic Policies for the 21st Century, The Manhattan Institute, New York. 2014.
[37] RSA National Treasury. Confronting youth unemployment: policy options for South Africa. Discussion paper for public comment. National Treasury, February 2011. 2011.