Statistical Analysis of the Relation between Inflation and Unemployment in Democratic States using Spearman's ϱ Correlation Coefficient with Application in Albania

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Abstract

The main purpose of the present study is to investigate relation between inflation rate and unemployment rate in contemporary democratic states, using Spearman's ϱ correlation coefficient. We apply this method in Albania during the period January 2005-December 2014. Some results of the study include:

- The Central Limit Theorem is not applicable for the quarterly inflation rate as well as for quarterly unemployment rate in Albania during the period January 2005-December 2014 at the confidence level 99.99%. The official data for inflation and unemployment contradict the CLT at very high confidence level 99.99%.
- The inflation process in Albania during the period January 2005-December 2014 is an unfair game at the confidence level 99.2%.
- The unemployment process in Albania during the period January 2005-December 2014 is an unfair game at the confidence level 99.99%.
- The inflation and unemployment in Albania during the period January 2005-December 2014 are statistically dependent at the 96% confidence level.
- Spearman's correlation coefficient ϱ= 0.387 indicates a weak positive correlation between inflation and unemployment in Albania during the specified period.
- The official data for inflation and unemployment in Albania during the period January 2005- December 2014 are consistent with Friedman's hypothesis.

Keywords: Inflation, Unemployment, Relation, Spearman's ϱ, Friedman's hypothesis, Albania.

Introduction

Inflation and unemployment are a major focus on economic policy worldwide. Inflation is the process of a raise in the general level of prices of goods and services in an economy over a specified period of time. Most frequently, the term "inflation" refers to a rise in the Consumer Price Index (CPI), which measures prices of a representative fixed basket of goods and

services purchased by a typical consumer. The formula for calculating the quarterly inflation rate is:

$Inflation\ rate = \frac{P_0 - P_{-1}}{P_{-1}} 100\%$, where P_0 denotes the current average price level and P_{-1} denotes the average price level a quarter ago. During periods of inflation not all prices and wages rise proportionately. Because they don't, inflation affects income distribution. For example, retirees lose in relation with other groups when inflation is high.

Variations in relative prices lead to more uncertainty, making it harder for firms and companies to make investment decisions about the future. Taxation interacts with inflation to create more distortions. If the tax brackets are not adjusted correctly for inflation, people move into higher and higher tax brackets as their nominal income increases, even if their real income remains the same. Economists generally agree that high rates of inflation are caused by an excessive growth of the money supply. Today, most economists favor a low and stable rate of inflation, because low inflation may reduce the severity of economic recession and the risk of destabilizing the economy, see Sargent (2005), Taylor (2008),Mankiw (2010) and Giannellis (2011).

Unemployment, as defined by the International Labor Organization (November 26, 2007), is the state in which the people are without jobs, they have actively looked for work within the past four weeks, and ready to start work within two weeks. The unemployment rate is the percentage of total labor force unemployed: $unemployment\ \ rate = \frac{unemployed\ \ workers}{total\ \ labour\ \ force}$.

Economists and mathematicians care about unemployment for two main reasons:
Firstly, unemployment is still often associated with financial and psychological suffering, especially (particularly) when people remaining unemployed for long periods of time.
Secondly, unemployment rate provides a signal that the national economy may not be using some of it resources efficiently. If many workers who want to work do not find jobs, then the economy is not efficiently utilizing its human resources.
According to Marx (1863), "It is in very nature of the capitalist mode of production to overwork some workers, while keeping the rest as a reserve army of unemployment paupers".
One of the fundamental problems in Macroeconomics is the study of relation between inflation and unemployment. We will analyze this relation, over the period January 2005– December

2014, in Albania. The sources of the official data are INSTAT and Bank of Albania.

The Central Limit Theorem (CLT)

If all random samples ($x_1, x_2 \ldots . x_n$)of a reasonably large size n>30 are selected from any random variable X with finite expectation μ and variance σ^2 , then the probability distribution of the sample mean $\bar{x}$ is approximately normal with expectation μ and variance $\frac{\sigma^2}{n}$. The speed of the convergence to normal distribution is on the order $n^{-0.5.}$ This approximation improves with larger samples, as $n \to \infty$.The convergence to normal distribution is uniform for all real numbers, see Kolmogorov (2002).

CLT explains why many probability distributions tend to be very close to the normal distribution. The amazing thing about CLT is that no matter what the probability distribution of the parent population X, the probability distribution of the sample mean approaches a normal curve.

The remainder of this paper is organized as follows: Section 2 presents the investigation of quarterly inflation rate dynamics; Section 3 presents the investigation of quarterly unemployment rate dynamics; Section 4 provides the analysis of relation between inflation and employment; and Section 5 presents the conclusion.

1. Dynamics of the Quarterly Inflation Rate

The data set in the quarterly inflation rate over the period January 2005- December 2014 in Albania, see Table 1.We calculate the statistical parameters for the data:

Sample size	40
Sample mean	1.285
95% confidence interval for mean	.8625 ; 1.7175
Median	1.80

Variance	1.829
Standard deviation	1.3524
Coefficient of variation	
Maximum	3.30
Minimum	- 1.40
Range	4.70
Interquartile range	2.40
Skewness	-.742
Kurtosis	-.848

In this study, using Kolmogorov-Smirnov-Lilliefors test as well as Shapiro-Wilk test for normality, we test the following hypothesis

H_0 : The quarterly inflation rates for Albanian over the period January 2005 – December 2014 follow a normal distribution.

H_1 : The quarterly inflation rates for Albania over this specified period follow a non-normal - distribution. Using SPSS (version 2013) we find the computed value of Kolmogorov-Smirnov-Lilliefors test=.213 and the corresponding significance level .000. Now we apply the Shapiro-Wilk test for normality. The computed value of the statistics is W = .870 and the associated significance is .000.

Decision Rule: Reject the null hypothesis H_0 at the confidence level 99.99%. In other words, the Central Limit Theorem is not valid for quarterly inflation rates over the specified period in Albania, at the confidence level 99.99%.

Definition(according to J.L.Stein and N.N.Vorobiev, 1974) The inflation process is said to be a fair game if the successive differences of inflation rates follow a normal distribution with mean equal to zero.

This important definition has found several applications in economic sciences, see Stein (1974), Lucas (2000), Sargent, Williams and Zha (2006), Stock and Watson (2007). The successive differences of quarterly inflation rate, over the period January 2005 – December 2014, in Albania are given in Table 1. We present the statistical parameters related to this data set.

Sample size	40
Sample mean	-.0175
95% confidence interval for mean	-.5465; .5165
Median	.10
Variance	2.736
Standard deviation	1.854
Coefficient of variation	
Maximum	3.30
Minimum	-4.30
Range	7.60
Interquartile range	1.17
Skewness	-.503
Kurtosis	1.078

We test the hypothesis

H_0: The successive difference of the quarterly inflation rates for Albania, over the period

January 2005 – December 2014, follow a normal distribution.

H_1: The successive difference of the quarterly inflation rates for Albania over this period follow a non-normal distribution.

We apply the Kolmogorov-Smirnov-Lilliefors test as well as the Shapiro-Wilk test for normality. The computed value of the KSL test is = .165, and the computed value of SW test is W = .937.

Decision Rule: Reject the null hypothesis H_0 at the confidence level .992. In other words, at the confidence level 99.2%, the inflation process, over the period January 2005 – December 2014, in Albania, related to the quarterly inflation rates, is an unfair game.

During periods of recession, the capitalist economy usually experiences a high unemployment rate. There remain a strong (considerable) theoretical debate regarding to the causes, consequences, and optimal solutions for the unemployment. Scientists distinguish between various types and theories of unemployment in capitalist countries: voluntary unemployment versus involuntary unemployment, classical (or real-wage) unemployment, Keynesian unemployment, Marxian unemployment, structural unemployment, frictional unemployment, hidden (or covered) unemployment, and long-term unemployment, see Blanchard (2011), Mankiw (2010), Anderton (2006), Keynes (2007), Harris (2005), and Marx (2009).

2. Dynamics of the Quarterly Unemployment Rate

The data set is quarterly unemployment rates, over the period January 2005 – December 2014, in Albania, see Table 1. We compute the statistical parameters for the data

Sample size	40
Sample mean	14.2025
95% confidence interval for mean	13.6770; 14.7280
Median	13.8000
Variance	2.700
Standard deviation	1.64809

Coefficient of variation	
Maximum	18.60
Minimum	12.5
Range	6.10
Interquartile range	.97
Skewness	1.472
Kurtosis	1.113

Using Kolmogorov-Smirnov-Lilliefors test as well as Shapiro-Wilk test for normality, we test the following hypothesis

H_0 : The quarterly unemployment rates over the period January 2005 – December 2014 follow a normal distribution.

H_1 : The quarterly unemployment rates over this specified period follow a non-normal distribution.

Using SPSS (version 2013) we find the computed value of KSL statistics .301 and the associated significance is .000. The computed value of SW test is W = .776 and the corresponding significance is .000.

Decision Rule: Reject the null hypothesis H_0 at the confidence level 99.99%. In other words, the Central Limit Theorem is not valid for quarterly unemployment rates, over the specified period January 2005 – December 2014, in Albania, at the confidence level 99.99%. The successive differences of quarterly unemployment rates over the period January 2005 – December 2014 in Albania are given in Table 1. We present the statistical parameters related to the data set

Sample size	40
Sample mean	.0850

95% confidence interval for mean	-.1056; .2756
Median	-0.5
Variance	.355
Standard deviation	.596
Coefficient of variation	
Maximum	1.60
Minimum	-1.50
Range	3.10
Interquartile range	.40
Skewness	.715
Kurtosis	2.204

Test the hypothesis

H_0: The successive differences of quarterly unemployment rates for Albania over the period January 2005 – December 2014 follow a normal distribution.

H_1: The successive differences of quarterly unemployment rates for Albania over this period follow a non-normal distribution.

We apply the Kolmogorov-Smirnov-:Iilliefors test as the Shapiro-Wilk test for normality. Using SPSS (version 2013), we find for both statistical test the significance .000. The computed value of KSL test is .198 and the computed value of SW test is W = .875.

Decision Rule: Reject the null hypothesis H_0 at the confidence level .9999. In other words, at the confidence level 99.99%, the unemployment process, over the period January 2005 – December 2014, in Albania, related to the quarterly unemployment rates, is an unfair game.

3. Relation Between Inflation and Unemployment

Scientific analysis of the relation between inflation and unemployment has gone through three stages. The first stage was the acceptance of a hypothesis associated with the name of British economist A. W. Phillips, who published a study in 1958 showing a stable negative relation between inflation and unemployment in the United Kingdom by using the data set from 1862 to 1957, see Philips (1958). In this study was constructed a smooth curve which is known as "Phillips curve": faster inflation is associated with lower unemployment. This relation was widely interpreted as a causal relation that offered a stable trade – off to policy makers. They could choose a low unemployment target. In that case they would have to accept a high inflation rate. Alternatively, the policy makers could choose a low inflation rate as their target. In that case they would have to reconcile themselves to higher unemployment rate. Unfortunately for this hypothesis, additional data set from USA, UK, Germany, France, Italy, Japan, Canada, etc failed to confirm with it. Statistical estimates of the Phillips curve hypothesis has been the subject of an intensive debate. Generally, empirical findings have produced the mixed results. Some scientists found the significant trade – off relation between inflation rates and unemployment rates, and other scientists does not, see Berentsen. Menzio and Wright (2011), Mulligan (2011), Zaman, Khan, Ahmad, and Beram (2011), Karanassou, Sala, and Snower (2010), Herman (2010), Lacker and Weinberg (2007), etc. On the theoretical side, the attack counter Phillips curve took the form of the natural rate hypothesis of Phelps (1967) and Friedman (1968).

The natural rate hypothesis of Friedman and Phelp's (1967) states that there is some "natural rate of unemployment", and that monetary policy cannot keep unemployment below this level indefinitely. "The natural rate of unemployment", a term introduced by M. Friedman (1968) to parallel Knut Wickell's " natural rate of interest " is not a constant real number, but depends on random variables such as effectiveness of the labor market, the extent of competition of

monopoly, the barriers of encouragements to working in various occupations, and so on. The natural rate hypothesis represents the second stage of the relation between inflation and unemployment. This hypothesis contains the Phillips curve as a special case. The natural rate hypothesis implicitly assumes that the relation between inflation and unemployment is weakly stationary process in the Doob – Rozanov sense.

In recent years, in USA, UK, Germany, France, Italy, Japan, Canada, etc, higher inflation rate has often accompanied by higher unemployment rate, not lower unemployment rate as the Phillips curve would suggest, nor approximately the same unemployment rate as the natural rate hypothesis would suggest. This is the third stage of the relation between inflation and unemployment. According to the Friedman's Hypothesis, there is a positive association between inflation and unemployment, see Friedman (1976). In the contemporary literature, Friedman's Hypothesis states that **" If there are disturbances to aggregate supply rather than aggregate demand, then high inflation and high unemployment can occur together ", see Mankiw (2010), Karanassou, Sala, and Snower (2010).**

At the confidence level 99.99%, quarterly inflation rate and quarterly unemployment rate in Albania during the period January 2005- December 2014 follow non-normal distribution. Therefore, we cannot use Pearson's correlation coefficient to investigate (for Albania's case) the relation between inflation and unemployment. However, we can use Spearman's ϱ correlation coefficient between quarterly inflation rate (denoted by Y) and quarterly unemployment rate (denoted by X), as it does not rely on any assumptions on the probability distributions of random variables X or Y or the joint distribution of the vector random variable (X, Y), see Hollander and Wolfe (1973), Myers and Well (2003), Corder and Foreman (2014).

Spearman's ϱ rank correlation coefficient is a nonparametric measure of statistical dependence between two random variables X and Y. Spearman's ϱ assesses how well the relation between X and Y can be described using a monotonic function.

Spearman's ϱ correlation coefficient is appropriate for both continuous and discrete random variables. By definition, Spearman's ϱ= ϱ (X, Y) is calculated as the Pearson's correlation coefficient between ranked variables, see Corder and Forman (2014), Myers and Well (2003). For an arbitrary random sample $(x_1, y_1), (x_2, y_2), \ldots, (x_n, y_n)$selectedfrom the random vector (X,Y), the n raw scores (x_i, y_i) are converted to ranks (X_i, Y_i), and Spearman's ϱ correlation coefficient is computed by the formula:

$\varrho = 1 - \frac{6(d_1^2 + d_2^2 + \cdots + d_n^2)}{(n-1)n(n+1)}$, where $d_i = X_i - Y_i$ denotes the difference between ranks.

If Y tends to increase when X increases, then $\varrho > 0$

If Y tends to decrease when X increases, then $\varrho < 0$

If no tendency for Y to either increase or decrease when X increases, then $\varrho = 0$.

The sign of ϱ indicates the direction of association between random variable X and Y.

In applications, **r** denotes the observed value of ϱ. That means: **r** denotes random sample Spearman's correlation coefficient and ϱ denotes population Spearman's correlation coefficient.

Under the null hypothesis

H_0: $\varrho = 0$ (statistical independence between X and Y),

H_1: $\varrho \neq 0$ (statistical dependence between X and Y).

The appropriate test statistics is "Student's **t** distribution"

t= $r\sqrt{\frac{n-2}{1-r^2}}$with (n-2) degrees of freedom, see Kendall and Stuart (1973).

The data set consist of quarterly inflation rate and quarterly unemployment rate in Albania during the period January 2005-December 2014, see Table 1. The sample size is n=40.

Using SPSS (version 21, 2013) compute the sample Spearman's correlation coefficient r = 0.387

Test the hypothesis

H_0: $\varrho = 0$,

H_1: $\varrho \neq 0$ (two-tailed test)

Given the significance level $\alpha=0.04$

The appropriate test statistics is **t** distribution

t= $r\sqrt{\frac{n-2}{1-r^2}}$ with df = n-2

The observed value of test statistics is

t = $0.387\sqrt{\frac{38}{1-0.387^2}} = 2.587$

The critical value of t distribution is $t_c = t_{\alpha/2}$ (df) = $t_{0.02}$ (38) = 2.4286

Decision rule

$|t| = 2.587 > t_c = 2.4286$

Reject the null hypothesis H_0: $\varrho=0$ at the confidence level $\gamma=1-\alpha=96\%$.

In other words, the quarterly inflation rates and unemployment rates in Albania during the period January 2005- December 2014 are statistically dependent random variables at the confidence level 96%.

Spearman's correlation coefficient r=0.387 indicates a weak positive correlation between quarterly inflation rate and quarterly unemployment rate in Albania during the period January2005-December2014. Therefore, the Friedman's hypothesis holds (accepted) for the relation between inflation and unemployment.

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4. Conclusion

This study is concerned with three types of dynamic macro models over the period January 2005 – December 2014 in Albania:

i. Monetary macroeconomic models that focus on inflation dynamics,
ii. Labor macroeconomic models that focus on unemployment dynamics,
iii. Correlative models that seek to explain the relation between quarterly inflation rates and quarterly unemployment rates.

At the very high confidence level 99.99% the Kolmogorov's Central Limit Theorem is not valid for quarterly inflation rates. At the confidence level 99.2 % the inflation process, related to the quarterly inflation rates, is an unfair game. At the very high confidence level 99.99% the Kolmogorov's Central Limit Theorem is not valid for quarterly unemployment rates. At the same confidence level 99.99% the unemployment process, related to the quarterly unemployment rates, is an unfair game.

The contradiction between quarterly inflation rates or quarterly unemployment rates and the Central Limit Theorem is very serious, as this theorem is a fundamental statement of modern Probability Theory.

This contradiction (with CLT) implies that we cannot use Pearson's correlation coefficient to investigate the relation between inflation and unemployment in Albania during the specified period. However, we can use Spearman's ϱ correlation coefficient.

The Ministry of Finance and Bank of Albania have the responsibility for "unfair game" inflation process in Albania over the period January 2005 – December 2014. In order to successfully fight the inflation process or unemployment process as an "unfair game", some concrete actions must be suggested to the Albanian Government and Bank of Albania.

The main reasons for the departure of quarterly inflation rates and quarterly unemployment rates from normal distribution as well as the "unfair game" inflation process and unemployment process in Albania's market during the period January 2005 – December 2014, are:

- Excess demand for several sectors of the economy (goods, services, money, financial assets, labor force, etc).
- National debt and government expenditure.
- Monetary policy.
- Unemployment rate dynamics for labor costs.
- Level of corruption: Detection and penalty of corrupted activities.
- Money laundering process.
- How conflicting interests are solved.

- Legislative changes.
- Imported inflation, economic recession, financial crisis.

The "unfair game" inflation process and "unfair game" unemployment process in Albania during the period January 2005 – December 2014 implies economic loss for Albanian families: the mean value of this loss during the specified period is approximately estimated 25000 Albanian Lekë per family/per month.

An obvious feature of our study is the severity of rejecting the fair game hypothesis in Albania's market during ten years (January 2005 – December 2014). Therefore, there is a suspect for the presence of excessive speculation in Albania's market, associated with excessive speculators.

Excessive speculation causes sudden or unreasonable fluctuations or unwarranted changes in the price of commodity. Excessive speculation drives prices away from the competitive price consistent with available information.

It is found, for Albanian economy during the period January 2000- December 2012 that an increase of 1% in annual unemployment rate, on average, leads an increase of 2.3% in the annual inflation rate; see Kolaneci and Sota (2013).

The inflation and unemployment in Albania during the period January2005-December2014 are statistically dependent, at the 96% confidence level.

Spearman's correlation coefficient r=0.387 indicates a weak positive correlation between quarterly inflation rate and unemployment rate in Albania during the specified period. The data set, presented in Table1, is consistent with **famous Friedman's hypothesis: If there are disturbances to aggregate supply rather than aggregate demand, then high inflation and high unemployment can occur together.** This situation includes a plethora of economic-social-technological conditions such that: economic crisis, privatization process, company bankruptcy, industrial decline, real-wage unemployment (classical unemployment), Marxian unemployment, seasonal unemployment, frictional unemployment, hidden (or covered) unemployment, technological unemployment, political corruption, and excessive speculation.

The "unfair game" inflation process and "unfair game" unemployment process for Albania's case are transitory or persistent? The answer to this question is crucial for Albanian people.

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Table1. Quarterly inflation rate, successive differences of quarterly inflation rate, quarterly unemployment rate, and successive differences of quarterly unemployment rate in Albania.

Year	Quarter	Inflation Rates(%)	Succ. Diff. Infl. Rates(%)	Unemploy. Rates(%)	Succ. Diff. Une. Rates(%)
2005	Q1	3.3	1.3	13.1	-1.5
	Q2	-1	-4.3	12.7	-0.4
	Q3	-1.4	-0.4	12.6	-0.1
	Q4	1.9	3.3	14.2	1.6
2006	Q1	2	0.1	14	-0.2
	Q2	0.2	-1.8	13.9	-0.1
	Q3	-1.2	-1.4	13.8	-0.1
	Q4	1.8	3	13.7	-0.1
2007	Q1	2.2	0.4	13.7	0
	Q2	-0.8	-3	13.5	-0.2
	Q3	0.4	1.2	13.2	-0.3
	Q4	1.7	1.3	13.4	0.2
2008	Q1	2.4	0.7	13.1	-0.3
	Q2	-0.3	-2.7	12.7	-0.4
	Q3	-0.8	-0.5	12.6	-0.1
	Q4	1.2	2	12.5	-0.1
2009	Q1	1.8	0.6	12.7	0.2
	Q2	-0.1	-1.9	12.7	0
	Q3	-0.7	-0.6	12.8	0.1

	Q4	2.2	2.9	13.7	0.9
2010	Q1	3	0.8	13.9	0.2
	Q2	-1	-4	13.8	-0.1
	Q3	-0.6	0.4	13.5	-0.3
	Q4	1.8	2.4	13.5	0
2011	Q1	2	0.2	14	0.5
	Q2	2.5	0.5	13.8	-0.2
	Q3	2.3	-0.2	13.9	0.1
	Q4	2.4	0.1	13.9	0
2012	Q1	2.4	0	14	0.1
	Q2	2.4	0	13.8	-0.2
	Q3	2.7	0.3	14.1	0.3
	Q4	2.4	-0.3	14.1	0
2013	Q1	2.5	0.1	14.8	0.7
	Q2	2.2	-0.3	16.4	1.6
	Q3	1.5	-0.7	17.2	0.8
	Q4	1.5	0	17.1	-0.1
2014	Q1	1.9	0.4	18.6	1.5
	Q2	1.6	-0.3	17.7	-0.9
	Q3	1.8	0.2	17.4	-0.3
	Q4	1.3	-0.5	18	0.6