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Spillover Fluctuations between Inflation and Unemployment Concerning Different Macroeconomic Sectors in Iran

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Abstract

The main objective of this study is to analyze spillover fluctuations between inflation fluctuation and (un)employment fluctuation in relation to agriculture, industry and services sectors of Iran. In line with this, PANEL in Mean-MGARCH model has been used concerning Iran's agriculture, industry and services sectors over the period of time from spring 2002 to winter 2016. The results show that inflation fluctuations in each sector would spillover into the next period of all agriculture, industry and services sectors. (Un)employment fluctuations in each sector do not spillover into the next period of that sector or other sectors. The inflation and (un)employment fluctuations (conditional covariance) in each sector spillover into the joint inflation and (un)employment fluctuations of that sector and the other sectors.

1. Introduction

Economic performance is usually judged in relation to three macroeconomic main variables, namely (un)employment, inflation, and growth. A low unemployment/high employment rate is usually associated with a high GDP growth rate. Indeed, the main objective of policy makers is to decrease unemployment rate and increase GDP growth rate. Inflation (with different price ratio) has a huge impact on economic conditions. A high inflation rate will make investments be more risky, because it makes it harder to predict future interest and nominal wage growth rates. It also imposes other costs, such as menu costs, and leather footwear costs. Therefore, inflation and unemployment are major concerns of policymakers. Strict policies and regulations have been introduced in central banks to maintain inflation rate at a desired target level. The ultimate goal of these policies is to prevent society suffering from costs of rising

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inflation. Efforts to control inflation, keeping unemployment down is still difficult task for developed as well as developing countries. Whether the unemployment rate can be stabilized by increasing the overall demand for mobility and through financial or monetary policies, with or without increasing the level of prices, is an issue which has been widely discussed in the macroeconomic literature since Keynes (1936), and in particular after Philips (1958), where Philips Curve has been used by Phelps (1968); Friedman (1968); Lucas and Rapping (1969); Lucas (1976); Brunner et al. (1976); Layard and Nickel (1986, 1990); Blanch and Oswald (1994); Grub (1986); Cross (1988); Pissarides (2013); and most recently Blanchard (2016) to analyze total demand and total supply in macroeconomic models.

In almost all the previous studies, various aspects of the relationship between unemployment and inflation have been investigated in relation to different countries. Most of these studies have taken place of inflation and unemployment in the framework the movement on the Phillips Curve or shifting the Phillips Curve. Few studies have concentrated on the convexity of the Phillips Curve. The convexity of the Philips Curve states that, in general, an economy will experience less inflation when the level of employment fluctuations has limited in to the mean. In fact, volatility of these two variables may vary in different sectors of the economy. This issue has not been addressed yet, and the results of this study could shed light on anticipation of the effects of fluctuations and shocks of these two variables on different economic sectors.

An important feature of some economic and financial time series is that they have cluster volatility. Large fluctuation lead to large fluctuation and small fluctuation lead to small fluctuation. In other words, the current level of fluctuation has a positive relation with its past values. The MGARCH is one of the effective methods for modeling volatility. The main objective of this study is to apply PANEL in Mean-MGARCH model for analyzing spillover fluctuations between inflation and unemployment in relation to agriculture, industry and service sectors. In line with this, the data for conducting the study was collected from spring 2002 to winter 2016.

Concerning cross-sectional econometric models, one assumptions is homoscedasticity. Engle (1982) challenged this assumption through introducing the ARCH models. Subsequently, ARCH and multivariate GARCH (MGARCH) models were developed in which not only the variance but also the covariance of the residuals was taken into account. Considering the main objective of this study, which is to consider spillover fluctuations between inflation and unemployment, a MGARCH model has been used to model fluctuations caused by conditional heteroscedasticity.

Due to lack of data, a PANEL in MEAN-MGARCH model[1] has been used concerning different economic sectors. Cermeño and Grier (2006) have

[1] This model is introduced for the first time in this article which is an extension to the panel GARCH model.

combined the relevant features of Panel models and MGARCH. These models have been applied in financial economics. No study has investigated fluctuations between inflation and unemployment yet. Regarding spillover fluctuations, modeling provide policy makers with more information so that they can consider different economic sectors.

The second section of this article is devoted to a review of the relevant literature, theoretical foundations for and also empirical backgrounds to the study. Section 3 provides the readers with model specification and data description. The model is then estimated in section 4, and the article ends with the concluding remarks in section 5.

2. Literature Review

Philips showed the relationship between inflation and unemployment and stated that if unemployment is high, wage rises gradually, and if unemployment is low, wage increases rapidly. Philips hypothesis that if the unemployment rate is low, firms which are operating faster increase their wages so that they can absorb the already scarce workforce. This wage increases will decrease in higher unemployment rates. Both Friedman and Phelps believed that the government could not always swap higher inflation with lower unemployment. Unemployment is at its natural rate. Real wages are fixed, because workers who expect a certain inflation rate emphasize that their wages rise at the same rate to prevent decrease their purchasing power down. Now, suppose that the government will use fiscal or monetary policies to reduce unemployment to below its normal rate. Increasing demand from firms will encourage firms to raise their prices at a faster rate than workers predict.

Samuelson and Solow (1960) were the first scholars who supported Philips' hypothesis in his paper for the United States to support a negative relationship between unemployment and inflation. The choice between the points on the Philips Curve depends on the estimation of unemployment and inflation in the community. Samuelson and Solow concluded that the relationship between inflation and unemployment was not stable in the long run, and labor productivity changes would shift the Philips Curve over time in a way that affects inflation and unemployment rates in one direction. For example, by moving the Philips Curve upward, both inflation and unemployment will rise simultaneously.

Later, Phelps (1968) and Friedman (1968) criticized Phillips' hypothesis and pointed out that there was no link between unemployment and inflation. In the late 1960s and early 1970s Friedman and Phelps challenged the stable relationship between inflation and unemployment. The mainstream analysis of inflation and unemployment is based on the assumption of a standard that economic agents make their own demands and decisions based on real variables, and thus do not have real effects on the long-term labor market equilibrium of the change in money supply. Expressing the theory of natural rates and expressing that real wages are of interest to employers and workers, Friedman accepted the relationship between inflation and unemployment in the short term, taking into account the pattern of adaptive expectations for the formation of expectations, and given the full adjustment of expectations in the long-run has challenged the relationship between inflation and unemployment in the long run.

In the 1970s, this fundamental point raised by Friedman and Phelps was substantially approved. When the average inflation rate rose from around 2.5 percent in the 1960s to around 7 percent in the 1970s, the unemployment rate did not fall below the initial Phillips curve, but increased from a figure close to 4 percent to over 6 percent. Friedman (1968), rejected the existence of a permanent exchange between inflation and unemployment, in which the determination of the wage rate was completely independent of the inflation rate. According to Friedman, the original Phillips curve, which relates the wage rate to unemployment, does not represent a relationship that is well-documented. Although wages are set in bargaining, employers and workers are interested in real wages, not nominal wages. Since wage contracts are negotiated for discrete periods of time, what actually affects the actual wage bill is the expected inflation rate for the negotiation period. Friedman believes that the Phillips Curve must be protected of the real wage change. Thus, in the initial Phillips Curve, the expected inflation rate as another variable that influences the determination of the wage rate. Friedman introduced the natural rate of unemployment which led to this view. Friedman (1977) also emphasized that there is a positive relationship between these two variables over a long period (beyond the frequency of the business cycle), due to the distorting effects of inflationary taxes. Friedman believes that, in the long run, the expected inflation rate will gradually equal the actual inflation rate. This means that the individual will gradually correct the forecast error of inflation and predict inflation with the same reality. Of course, the long run is not clear enough.

Lucas (1976) strongly opposed the suggestion to escape the Philips Curve, which suggests that there is a relationship between unemployment and inflation, and that policy makers do not create conditions that create a higher inflation rate. Slowly in a different case, people are anticipating inflation, and wage increases will be possible. In such cases, there is high unemployment and high inflation rates known as Lucas's critique. In the 1970s, New Classical school challenged the relationship between inflation and unemployment, even in the short run, by introducing a pattern of rational expectations to shape expectations. Indeed, if policies are declared and there is complete information, there will be no relationship between inflation and unemployment even in the short run. On the other hand, the New Keynesians introduced a new version of the Philips Curve by accepting rational expectations and incomplete market assumptions. The New Keynesian Phillips Curve has a negative slope in the short run and in the long run, so that this curve will be more vertical in the long run-term than short-term.

The natural rate and the rational expectations hypotheses increase even after the arguments of Phelps (1968) and Friedman (1968); Lucas (1973); Fisher

(1977) and others about the dynamics of wage prices in industrial economies. When unions and workers can properly forecast real wages and future incomes in the labor market to adjust their labor supply then the natural rate of unemployment remains unchanged. Monetary policy is ineffective in long-term. Under the assumption of rational expectations, most economists believe that only unexpected shocks may have real effects on the economy (Lucas and Raping, 1969; Lucas, 1976; Sargent and Wallace, 1975; Svensson, 1997). Orrenius (2016) showed that there is strong evidence that the Philips Curve in USA is nonlinear and convex. He indicated that short-term unemployment also has a strong relationship with average wage growth, while long-term unemployment only affects average wage growth. Donayre (2018) showed that the relationship between wage growth and unemployment in periods when inflation is higher than its long-term trend is weak, although during periods with lower than its long-run trend are weak and negative.

Although the Phillips hypothesis was forgotten in the 1980s, it was considered as an important tool for policymakers in many countries. In the 1990s, the Phillips Curve turned out to be interesting. For example, Smith and Alogoskoufis (1991) provided experimental data for the United States and Britain with emphasis on Lucas's critique. By contrast, King and Watson (1994) tested the Philips Curve using macroeconomic data for the United States. Their findings suggest an empirical support for the existence of a trade-off between unemployment and inflation in the period under review.

Mohammadi et al. (2015) analyzed the causal relationship between unemployment and inflation in Iran during the time period between 1978 and 2006. The results indicated that the relationship between unemployment and inflation has been based on the Phillips Curve.

Mohseni and Jouzaryan (2016) have analyzed the role of inflation and unemployment in economic growth in Iran for the time period between 1996 and 2012. Using the Autoregressive Distributed Lag (ARDL), the results showed that inflation and unemployment slowdowns long-term economic growth.

Bhattarai (2016) showed that there are long-term relationships between unemployment and inflation concerning OECD. While unemployment varies considerably within these economies, because of inflation targeting policies over the past two decades, inflation rates have stabilized at lower rates. The relationship between unemployment and inflation corresponds to the Philips Curve for 28 out of the 35 countries of the OECD.

Rezaiefar and Mehrjardi (2016) showed that there are short-term and long-term relationships between inflation and unemployment. They investigated the relationship between inflation and unemployment in rural areas of Iran using the new Philips Curve and examine the factors affecting inflation and unemployment for the time period from 1963 to 1993. The results showed that the relationship between unemployment and inflation in the short and long term in rural areas of Iran follows the theory of rational expectations.

Erfani et al. (2016) estimated the New Keynesians Phillips curve in Iran during the years 1959-2010. The results confirmed the effect of the production gap on current inflation. This study also showed that production gap has a significant and positive effect on current inflation.

Most economic schools of thoughts have accepted the Phillips curve. The adjusted Phillips Curve with expectations plays an essential role in almost all macroeconomic forecasting models which are used today by the governments and firms. To describe the relationship between unemployment and inflation, precise information about intensity, direction, scale and evolution is necessary. The important point regarding the relationship between inflation and unemployment is the correlation between the two variables using different models of econometrics. Given that unexpected shocks and volatility may have real impact on the economy, we intend to show how the fluctuations in (un)employment and inflation will affect each other to help economic policy makers in making better decisions.

Based on a review of the aforementioned studies, it is clear that no studies have yet examined the correlation between inflation and unemployment using data from the economic sectors. Secondly, according to the theory of rational expectations, most economists believe that only unexpected shocks may have a real impact on the economy. Adopting this hypothesis requires indicating the correlation between fluctuations in inflation and unemployment. No studies have addressed this either. Thirdly, in none of the aforementioned studies, the PANEL in Mean-MGARCH methodology has been used for both PANEL properties and the MGARCH specification. This study is an attempt to take into account all these limitations.

3. Empirical Model

3.1 Model Specification

The basis for estimating the Panel-GARH model is the methodology presented by Cermeño and Grier (2006). They used four specific models by a unique methodology to identify the most appropriate model. The estimation is based on maximization of the logarithm of likelihood function based on the numerical analysis in research conducted by Cermeño and Greer spillover of inflation and stock fluctuations in the United States and seven Latin American countries for the GARCH effects. Panel GARCH estimators show that there is significantly the conditional heteroscedasticity in the data.

There are some problems caused by the complexity of estimating some models with a large number of parameters. First, all conditional variance equations for the model are generalized to GARCH (p, q). The estimated models are limited to the GARCH model (1, 1). The higher category GARCH leads to a large number of parameters which should be estimated in the panel model. This, in turn, prevents the creation of many sub-models. Secondly, during the analysis, the independence of cross-sectional data is assumed. That is, the time series inside the panel are independent of each other. This assumption is equivalent to the fact that the covariance between internal panel shares is zero. This limitation significantly reduces the number of parameters which must be estimated in the equation of variance the structure of the panel.

The PANEL-GARCH model follows the methodology proposed by Cermeño et al. (2006, 2007 and 2014) and Lee (2010). The Property of this model is the simultaneous use of panel data and the GARCH. Supposed that:

$$Y_{it} = \mu_{it} + \sum_{k=1}^{K} \alpha_k Y_{i,t-1} + X_{it}\beta + \varepsilon_{it} \qquad i = 1, \dots, N \text{ and } t = 1, \dots, T\ \mu_{it} \tag{1}$$

where β is the vector of coefficients and ε_{it} is the disturbance term and the mean of zero that has the following conditions:

$$E[\varepsilon_{it}, \varepsilon_{js}] = 0 \qquad for\ \ i \neq j \text{ and } t \neq s \tag{2}$$

$$E[\varepsilon_{it}, \varepsilon_{js}] = 0 \qquad for\ \ i = j \text{ and } t \neq s \tag{3}$$

$$E[\varepsilon_{it}, \varepsilon_{js}] = \sigma_{ij,t}^2 \qquad for\ \ i \neq j \text{ and } t = s \tag{4}$$

$$E[\varepsilon_{it}, \varepsilon_{js}] = \sigma_{i,t}^2 \qquad for\ \ i = j \text{ and } t = s \tag{5}$$

There are four assumptions. The first condition assumes non-concurrent cross-sectional correlation and the second assumes no autocorrelation. The third and fourth assumptions can be defined by general conditions of the conditional variance-covariance processes. The conditional variance and covariance processes are represented by equations 6 and 7.

$$\sigma_{i,t}^2 = \emptyset_i + \gamma \sigma_{i,t-1}^2 + \delta \varepsilon_{i,t-1}^2 \quad i = 1, \dots, N \tag{6}$$

$$\sigma_{ij,t}^2 = \emptyset_{ij} + \eta \sigma_{ij,t-1}^2 + \rho \varepsilon_{i,t-1}\, \varepsilon_{j,t-1} \quad i \neq j \tag{7}$$

3.2 PANEL-GARCH-AR (P) Model

For N cross-sections and T time periods, the conditional mean equation for y_{it} can be written as a dynamic fixed effects panel model as follows:

$$y_{it} = \mu_i + \beta_1 y_{it-1} + \cdots + \beta_p y_{it-p} + \varepsilon_{it} \qquad i = 1,2, \dots, T \quad t = 1, \dots, N \quad \varepsilon_{it} \sim N(0, h_{it}) \tag{8}$$

According to the Belerslow (1986) model for a single time series, the conditional variance equation in the panel concept is as follows:

$$h_{it} = \alpha_{0i} + \sum_{m=1}^{q} \beta_{im} \varepsilon_{i,t-m}^2 + \sum_{n=1}^{p} \alpha_{ni} h_{i,t-m} + V_{it} \tag{9}$$

The prominent feature of this model, i.e. a variable coefficient model, is that all estimated coefficients are allowed to change, and no type of constraint is imposed on the parameters. The model 9 is without any limitations in the value of the parameters.

This model allows the variation all parameters of the mean and variance between the specific of each panel. Also, this model is in the standard linear form with a constant in the condition of the variance equation. Shao (2003) states that such a model can be estimated as a separate regression for each specific contribution in the panel. Model 9 is estimated with a separate regression for each variable in the panel.

3.3 PANEL in MEAN-MGARCH Model

In multivariate GARCH models, the number of parameters increases with increasing dimension. On the other hand, it is necessary to have a definite positive variance matrix. It is not easy to establish this property by the estimated parameters (Bowens et al. 2006). Linear combinations of single-variable GARCH models are linear combinations of several single-variable models, each of which is not necessarily a standard GARCH model. But nonlinear GARCH models of single-variable models allow researchers to individually determine each of the conditional variances and specify the conditional correlation matrix. Estimation of these models is not feasible using existing software and requires special programming. The Baba-Engle-Kraft-Kroner (BEKK) model is more involved in time series modeling (Bowens et al., 2006) which will be introduced in the general structure of the BEKK model. A BEKK model (1,1, K) is defined as following above

$$H_t = C^{*'}C^* + \sum_{k=1}^{K} A_k^{*'}\, \varepsilon_{t-1}'\varepsilon_{t-1}A_k^* + \sum_k^K G_k^{*'} H_{t-1}G_k^* \tag{10}$$

In a simpler form, a BEKK model (1, 1, K) is defined as follows:

$$H_t = C^{*'}C^* + A^{*'}\varepsilon_{t-1}'\varepsilon_{t-1}A^* + G^{*'}H_{t-1}G^* \tag{11}$$

According to the presented description, the models are presented as:

$$\begin{bmatrix} r_{1,t} \\ r_{2,t} \\ r_{3,t} \end{bmatrix} = \begin{bmatrix} \emptyset_{0,1} \\ \emptyset_{0,2} \\ \emptyset_{0,3} \end{bmatrix} + \begin{bmatrix} \emptyset_{1,11} & \emptyset_{1,12} & \emptyset_{1,13} \\ \emptyset_{2,21} & \emptyset_{1,22} & \emptyset_{1,23} \\ \emptyset_{1,31} & \emptyset_{1,32} & \emptyset_{1,33} \end{bmatrix} \begin{bmatrix} r_{1,t-1} \\ r_{2,t-1} \\ r_{3,t-1} \end{bmatrix} + \begin{bmatrix} \emptyset_{211} & \emptyset_{2,12} & \emptyset_{2,13} \\ \emptyset_{2,21} & \emptyset_{2,22} & \emptyset_{2,23} \\ \emptyset_{2,31} & \emptyset_{2,32} & \emptyset_{2,33} \end{bmatrix} + \dots \begin{bmatrix} \varepsilon_{1,t} \\ \varepsilon_{2,t} \\ \varepsilon_{3,t} \end{bmatrix} \tag{12}$$

$$\begin{bmatrix} \varepsilon_{1,t} \\ \varepsilon_{2,t} \\ \varepsilon_{3,t} \end{bmatrix} = \begin{bmatrix} h_{11,t} & h_{12,t} & h_{13,t} \\ h_{21,t} & h_{22,t} & h_{23,t} \\ h_{31,t} & h_{32,t} & h_{33,t} \end{bmatrix}^{1/2} \begin{bmatrix} z_{1,t} \\ z_{2,t} \\ z_{3,t} \end{bmatrix} \tag{13}$$

Due to the limitations of a particular type of multivariate GARCH model, known as MGARCH models, it is written as follows:

$$\begin{aligned} h_{ik,ik,t} &= \alpha_0 + \alpha_1 u_{ik,t-1}^2 + \alpha_2 h_{ik,ik,t-1} \\ h_{ik,jl,t} &= \alpha_3 + \alpha_4 u_{ik,t-1}u_{jl,t-1} + \alpha_5 h_{ik,jl,t-1} \\ h_{jl,jl,t} &= \alpha_6 + \alpha_7 u_{jl,t-1}^2 + \alpha_8 h_{jl,jl,t-1} \end{aligned} \tag{14}$$

Model 14 includes conditional variances as a function of lagged disturbance terms, lagged conditional variance and covariance concerning N sectors and T time periods and in relation to the two variables of inflation and unemployment.

The PANEL in MEAN-MGARCH model is based on the methodology that Searmno et al. (2006, 2014, & 2017) and Lee (2010) estimated for the PANEL-GARCH model.

The conditional mean equations are estimated using panel data separately for inflation and again for (un)employment.

Conditional mean equations are written as follows:

$$U_{it} = \mu_{it} + \sum_{k=1}^{K} \alpha_k U_{i,t-1} + \varepsilon_{it} \quad i = 1,2,3 \quad and \quad t = 1, \dots, T \quad \varepsilon_{it} \sim N(0, h_{it}) \tag{15}$$

$$Inf_{it} = \mu_{it} + \sum_{k=1}^{K} \alpha_k Inf_{i,t-1} + \varepsilon_{it} \quad i = 1,2,3 \quad and \quad t = 1, \dots, T \quad \varepsilon_{it} \sim N(0, h_{it}) \tag{16}$$

where U_{it} is the unemployment vector and Inf_{it} is the inflation vector. The parameter μ_{it} captures the possible sectors (industry, agriculture, and services)[1] effects and ε_{it} is a disturbance term with zero mean and normal distribution along with the given assumptions 17, 18, 19 and 20:

$$E[\varepsilon_{it}, \varepsilon_{js}] = 0 \qquad for \quad i \neq j \; and \; t \neq s \tag{17}$$

$$E[\varepsilon_{it}, \varepsilon_{js}] = 0 \qquad for \quad i = j \; and \; t \neq s \tag{18}$$

$$E[\varepsilon_{it}, \varepsilon_{js}] = \sigma_{ij,t}^2 \quad for \quad i \neq j \; and \; t = s \tag{19}$$

$$E[\varepsilon_{it}, \varepsilon_{js}] = \sigma_{i,t}^2 \quad for \quad i = j \; and \; t = s \tag{20}$$

Equations (15) and (16) are estimated as panel AR (p) or PAR (p).

Conditional Variance Equation (MGARCH) are written as follows:

$$\begin{aligned} h_{ik,ik,t} &= \alpha_0 + \alpha_1 u_{ik,t-1}^2 + \alpha_2 h_{ik,ik,t-1} \\ h_{ik,jl,t} &= \alpha_3 + \alpha_4 u_{ik,t-1} u_{jl,t-1} + \alpha_5 h_{ik,jl,t-1} \\ h_{jl,jl,t} &= \alpha_6 + \alpha_7 u_{jl,t-1}^2 + \alpha_8 h_{jl,jl,t-1} \end{aligned} \tag{21}$$

Equations $h_{ik,ik,t}$ and $h_{jl,jl,t}$ are show the conditional variance of the residuals for each of the two variables of inflation and unemployment[2] and in relation to the three sectors, namely agriculture, industry, and services, and Equation $h_{ik,jl,t}$ shows conditional covariance between inflation and employment in the three sectors, and the coefficient α_5 shows of the spillover fluctuations between inflation and employment in the three sectors.

In this study, data on inflation and employment related to agriculture, industry, and services sectors in Iran was used to examine the effect of fluctuations of the two variables in the three sectors.

To do so, the sectoral quarterly data of inflation (INF) and employment (U) was used for the time period between from 2002:1 and 2016:4. The data was obtained from Statistical Center of Iran (www.amar.org.ir). Based on the data, the Panel in Mean-MGARCH model was estimated for these two variables and in relation to the three economic sectors. Table 1 shows a summary of the descriptive statistics regarding the variables used in the model.

As Table 1 shows, the mean inflation values for all the three sectors are almost equal while this is not the case for the mean employment values. Inflation variation range in the agriculture sector has been between 0.8 and 47.1, in the industry sector between [0.9, 70.7] and in the services sector between [7.6, 40.2]. These show that the standard deviation in the industry sector has been the highest. Employment variation range in the agriculture sector has been between [16, 28], in the industry sector between [28.5, 38] and in the services sector

[1] The reason for choosing these sectors was the availability of employment data for them. Employment data was not available for other sectors. The sum of employments concerning three sectors of agriculture, services and industry accounted for about 99% of total employment in Iran, i.e. the share of employment of other sectors was less than 1 percent.

[2] In this study, employment is a proxy of unemployment. Due to the lack of unemployment seasonal data in the sectors of Iran's economy, unemployment data has been replaced by employment data.

between [43, 51.5]. These show that although the standard deviation in the agriculture sector has been higher than that in the other sectors, the differences have not been as considerable as those of the inflation rate.

Table 1. The descriptive statistics of the variables (2002:1 to 2016:4)

	Inflation Rate in Agriculture Sector	Inflation Rate in Industry Sector	Inflation Rate in Services Sector	Employment in Agriculture Sector	Employment in Industry Sector	Employment in Services Sector
Mean	17.22500	16.61833	17.71833	20.70345	32.04310	47.24310
Median	16.15000	11.80000	15.95000	20.30000	32.15000	47.35000
Maximum	47.10000	70.70000	40.20000	27.70000	35.10000	51.50000
Minimum	0.800000	0.900000	7.600000	16.10000	28.50000	43.00000
Std. Dev.	12.36724	16.09457	6.817388	3.065826	1.597928	1.949639
Skewness	0.793799	2.034697	1.089470	0.400132	-0.153422	-0.114168
Kurtosis	3.007287	6.684150	4.119465	2.405034	2.338232	2.862432

Source: Calculated using the data retrieved from www.amar.org.ir and www.cbi.ir

4. Empirical Results
4.1 Initial Data Test

One of the most important problems in time series analysis is the existence of a unit root. The existence of a unit root implies that the data is non- stationary and this leads to problems with the validity of the tests performed. Before modeling and using the panel, the time series characteristic test is used through panel unit root test. Several unit root tests have been proposed to investigate the existence of unit root in panel data, some of which include Levin Lin and Chou (2002), Brighton (2000), Im, Pesaran and Shin (IPS) (2003), ADF-Fisher and PP-Fisher and Chui (2001). The unit root test of the Table 2 is based on the assumption that each time series follows a different AR process.

This study has benefitted from Im, Pesaran and Shin (IPS) (2003), ADF - Fisher Chi-square and PP - Fisher Chi-square unit root test. Based on the results in Table 2, all variables are stationary.

Table 2. Unit Root Test

Series	Im, Pesaran and Shin W-Stat		ADF - Fisher Chi-Square		PP - Fisher Chi-Square	
	Statistics	Prob.	Statistics	Prob.	Statistics	Prob.
U	-3.29534	0.0005	22.1227	0.0012	28.4612	0.0001
INF	-2.78898	0.0026	18.8997	0.0043	11.7356	0.0681

Source: Research Findings

Based on the test results in Table 3, the null hypothesis, i.e. the presence of fixed cross-sectional effects, is rejected. Therefore, the employment model can be estimated with the assumption of the presence of cross-sectional effects.

Table 3. Fixed effects test (employment)

Fixed Effects Test	Statistics	Degrees of Freedom	Prop
Cross-Section F	16.132	(2,173)	0.0000
Cross-Section Chi-square	30.163	2	0.0000

Source: Research Findings

Based on the Table 4, the null hypothesis, i.e. the presence of fixed cross-sectional effects, cannot be rejected. Therefore, it is necessary to use the pooled method and/or the random effects method one, which is then used by the test *Breusch* and Pagan will also be considered.

Table 4. Fixed effects test (inflation)

Fixed Effects Test	The Statistics	Degrees of Freedom	Prob.
Cross-Section F	.0022	(2,169)	0.99
Cross-Section Chi-square	.0047	2	0.99

Source: Research Findings

The result of the Breusch and Pagan test in Table 5 indicates that the LM test statistic is equal to 1.521 while the critical value is 3.84. Consequently, the null hypothesis (H_0) cannot be rejected. Threfore, the pooled model approach can be used.

Table 5. Breusch and Pagan test

Test	Statistics	Results
LM	1.521	Not rejecting the hypothesis H_0

Source: Research Findings

4.2 Information Criterion

Regarding inflation rate, the results in Table 6 show that the best estimate is based on the information criteria and $\bar{R}^2$ of AR(2) which has the highest $\bar{R}^2$ and the lowest SC, AC and HQC. Therefore, using this model, the results concerning inflation model estimation are shown in Table 7.

Table 6. Information criterion using inflation data

	AR	$\bar{R}^2$	Schwarz Criteria	Akaike Criteria	Hannan-Quinn Criteria
1	AR(1)	0.737470	6.574794	6.538905	6.553460
2	**AR(2)**	**0.792022**	**6.325457**	**6.325457**	**6.347552**
3	AR(3)	0.790431	6.354599	6.354599	6.384418
4	AR(4)	0.790250	6.378024	6.378024	6.415758

Source: Research Findings

Table 7 show that all coefficients of AR (2) model are positive and significant at a 1% level of probability.

Concerning employment, the results in Table 8 show that the best estimate is based on information criteria and $\bar{R}^2$ of AR(1), AR(2), AR (3), and AR(4) models. Therefore, the results of estimating the panel model are shown in Table 9.

Table 7. Results of estimation of inflation model using Pool method

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	17.23695	2.100140	8.207526	0.0000
C(1)	1.258867	0.067846	18.55486	0.0000
C(2)	0.463634	0.068135	-6.804603	0.0000
Mean dependent var		17.33822	R-squared	0.794427
S.D. dependent var		12.43365	Adjusted R-squared	0.792022
Akaike info criterion		6.325457	S.E. of regression	5.670314
Schwarz criterion		6.379924	Sum squared residual	5498.071
Hannan-Quinn criter.		6.347552	Log likelihood	-547.3148
Durbin-Watson stat		2.024004	F-statistic	330.4100
			Prob. (F-statistic)	0.000000

Source: Research Findings

Table 8. Information criterion using employment data

	AR	$\bar{R}^2$	Schwarz Criteria	Akaike Criteria	Hannan-Quinn criteria
1	AR(1)	0.979927	3.845550	3.773772	3.802882
2	AR(2)	0.980032	3.873564	3.782786	3.819611
3	AR(3)	0.988924	3.316296	3.206062	3.250790
4	**AR(4)**	**0.990415**	**3.203861**	**3.073696**	**3.126523**

Source: Research Findings

Table 9 show that all coefficients of AR (4) model are significant at a 1% probability level.

Table 9. Estimates of the unemployment model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	33.31463	0.758272	43.93493	0.0000
C(1)	0.550742	0.073118	7.532226	0.0000
C(2)	-0.387372	0.080150	-4.833094	0.0000
C(3)	0.341037	0.080813	4.220086	0.0000
C(4)	0.383424	0.071839	5.337267	0.0000
R-squared	0.990759		Mean dependent var	33.31667
Adjusted R-squared	0.990415		S.D. dependent var	11.26035
S.E. of regression	1.102436		Akaike info criterion	3.073696
Sum squared resid	195.6739		Schwarz criterion	3.203861
Log likelihood	-251.1905		Hanna-Quinn criter.	3.126523
F-statistic	2876.934		Durbin-Watson stat	1.570905
Prob. (F-statistic)	0.000000			

Source: Research Findings

4.3 Panel in Mean-MGARCH Model

Using the residuals obtained from panel data mean equations (Tables 7 and 9), we have estimated the MGARCH model through the following steps.

The Panel in Mean-MGARCH model is estimated in model 22;

$$\begin{aligned} h_{1k,1k,t} &= \alpha_{0(1,k,1)} + \alpha_{1(1,k,1)}u^2_{1k,t-1} + \alpha_{2(1,k,1)}h_{i1,i1,t-1} \\ h_{1k,2k,t} &= \alpha_{3(1,k,2)} + \alpha_{4(1,k,2)}u_{1k,t-1}u_{2k,t-1} + \alpha_{5(1,k,2)}h_{1k,2k,t-1} \\ h_{2k,2k,t} &= \alpha_{6(2,k,2)} + \alpha_{7(2,k,2)}u^2_{2k,t-1} + \alpha_{8(2,k,2)}h_{2k,2k,t-1} \end{aligned} \quad (22)$$

where the index (1) represents inflation, (2) represents employment and the index K refers to the sector. A significant α_1 indicates that shocks on inflation are transferred to the next period; the significance of the coefficient α_2 shows that inflation fluctuations are transferred to the next period, too. The significance of the coefficient α_5 indicates that there are spillover fluctuations between inflation and employment, while the significance of the coefficient α_7 indicates that shocks on employment are transferred to the next period. The coefficient α_8 reveals that fluctuations of employment are transmitted from one period to the next period.

Table 10. Estimation of the PANEL in Mean-MGARCH model

	Services Sector			Industry Sector			Agriculture Sector		
	Coefficient	z-Statistic	Prob.	Coefficient	z-Statistic	Prob.	Coefficient	z-Statistic	Prob.
$\boldsymbol{\alpha_{0(1,k,1)}}$	2.40E-05	3.340421	0.0008	2.59E-05	0.013782	0.9890	5.84E-05	0.007706	0.9939
$\boldsymbol{\alpha_{1(1,k,1)}}$	-0.000175	-4033.888	0.0000	-0.000207	-1007.942	0.0000	-0.000188	-3806.640	0.0000
$\boldsymbol{\alpha_{2(1,k,1)}}$	0.053106	400.7033	0.0000	0.057465	43.13868	0.0000	0.048621	287.2919	0.0000
$\boldsymbol{\alpha_{3(1,k,2)}}$	8.78E-05	3.165058	0.0016	7.79E-05	0.344210	0.7307	8.84E-05	0.042561	0.9661
$\boldsymbol{\alpha_{4(1,k,2)}}$	0.006063	647.5993	0.0000	0.006064	144.1305	0.0000	0.006064	200263.9	0.0000
$\boldsymbol{\alpha_{5(1,k,2)}}$	0.274725	501.9307	0.0000	0.274732	1042.553	0.0000	0.274850	52107.15	0.0000
$\boldsymbol{\alpha_{6(2,k,2)}}$	5.69E-39	7.45E-80	0.9999	1.40E-39	3.31E-80	0.9999	1.10E-39	2.89E-81	0.9999
$\boldsymbol{\alpha_{7(2,k,2)}}$	2.50E-40	1.78E-79	0.9999	1.27E-40	5.91E-80	0.9999	2.73E-40	2.18E-80	0.9999
$\boldsymbol{\alpha_{8(2,k,2)}}$	3.877293	0.027573	0.9780	0.925522	0.004170	0.9967	1.384299	0.004758	0.9962

Source: Research Findings

Table 10 shows that shocks on inflation in service, industry and agriculture sectors are transferred to next period, although its value is small. Inflation fluctuations of the previous period in service sector, industry sector and agriculture sector are transferred to the current period, and 5% of inflation fluctuations are transferred to the next period. The significance of the coefficient α_5 indicates that there is spillover fluctuations between inflation and unemployment in service sector, industry sector and agriculture sector. Spillover fluctuations between inflation and employment in three sectors is about 27%. Spillover fluctuations between inflation and employment will lead to the confirmation of the rational expectation hypothesis for Iran's economy. Shocks on employment in the three are not transferred to the next time period. The coefficient α_8 is not statistically significant, and thus employment fluctuations are not transmitted from one period to the next in the three sectors.

Therefore, if policy makers are looking for economic stability, they are advised to pursue the supply side policy. The results show that inflationary shocks, unlike occupational shocks, are transferred from one period to the next.

5. Concluding Remarks

Understanding the relationship between economic variables in different economic sectors can be of great importance for assessing past economic policies and future strategies. Without knowing the interconnection between variables and economic sectors, identification of appropriate policies for achieving sustainable economic growth can be difficult. Inflation and unemployment are the two most important macroeconomic variables and a matter of concern for policy makers.

The main objective of this study was to analyze spillover fluctuations between inflation and (un)employment in relation to Iranian agriculture, industry and services sectors. In line with this, we a PANEL in Mean-MGARCH model was used for the time period between spring 2002 to winter 2016 in relation to agriculture, industry and services sectors of Iran. The results showed that inflation fluctuations in each sector spillovered to the next period for all agriculture, industry and services sectors. (Un)employment fluctuations in each sector did not spillover to the next period for that or other sectors. Inflation and unemployment co-fluctuations, i.e. conditional covariance, in each sector spillovered to the inflation and unemployment conditional covariance of that and other sector. These findings can be justified by the fact that inflation spreads throughout the economy much faster than (un)employment. Therefore, keeping down inflation would be more effective than controlling unemployment.

The findings confirmed the existence of a short-term relationship between inflation and unemployment and the theory of rational expectations in Iranian economy for the time period under study. Under the rational expectation hypothesis, the majority of economists tend to believe that only unanticipated policy shocks could have real impacts in the economy (Lucas and Rapping 1969; Lucas, 1976). Consequently, inflation targeting would become the major target of central banks in most advanced economies resulting in more stability in price levels.

The results showed that reducing inflation rate is more preferable than reducing unemployment rate in Iranian economy. Because inflation rate can affect both inflation and (un)employment rates of the next period reducing unemployment, i.e. rising employment, rate can only affect employment and inflation rates of the current period and inflation rate of the next period but not employment rate of the next period. Price stability is preferred to reduction in unemployment, i.e. increasing employment rate.

Research findings also showed that the structure of inflation and employment in the three sectors of agriculture, industry and services were similar, and thus policies affecting inflation and unemployment rate in these three sectors could have similar effects. Considering this, it is recommended that common policies be taken in relation to these three sectors.

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