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Analysis of the effects of relative price changes as supply shocks on inflation in Iran

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Abstract

This paper analyses the effects of relative price changes dispersion and skewness as aggregate supply shocks on inflation in Iran. For this purpose, we used total and state urban price index, for period 2004-2012 and Arellano and Bover (1995), Blundell and Bond (1998) method. The results show that relative price changes dispersion and skewness have positive and significant effect on inflation. In addition, the interaction between the dispersion and skewness has negative effect on inflation.

Keywords: Inflation, relative price changes dispersion and skewness, dynamic panel data approach

Introduction

Inflation has always been one of the most controversial issues in Iranian economy and various studies have been conducted based on inflation theories. However, one of the theories that has not been tested and analyzed is Ball and Mankiw's supply-side theory of inflation proposed in 1995. The opinion of most macro-economists about inflation rate and its effective factors is that in the long run, growth in money supply is the initial factor of inflation rate. However, there are more to be discussed on its short-term behavior. Certainly, monetary policy and other determinants of the aggregate demand have significant roles in this phenomenon. However, since 1970s and with the emergence of the stagflation phenomenon, some economists have emphasized the role of supply shocks or price shocks. Fundamentally, supply shocks are changes in some relative prices. For instance, the famous supply shock in the 1970s was increased relative price of food and energy. As a Theoretical matter, it is not quite clear why such changes in relative prices cause inflation.

There is a reliable piece of literature that well explains the relationship between inflation and distribution of relative price changes and includes many pieces of evidence showing the positive relationship between inflation and dispersion of relative price changes. However, the positive relationship between inflation and skewness in relative price changes has relatively been give less attention. The theoretical explanations about the causal mechanism accounting for the observed relationships are not definite. The existing theories explaining these relationships are divided into three categories; the first one indicates the direction of causality from inflation to the variability of relative prices, which in most empirical studies, the variability of relative prices means the dispersion of price changes among product groups. The second category assumes the variability of relative prices or skewness of relative price changes as the exogenous variable and shows that the inflation is caused by the distribution of relative price changes. The third category expresses that both variables of inflation and relative price variability are created by some exogenous factors.

Various empirical studies were carried out to test the theories of this literature. One of these theories serving as the basis for the present research is the study by Ball and Mankiw (1995) that assumes the dispersion/skewness of relative price changes as the supply-side shock, based on which proposes the supply-side theory of inflation.

Considering the above discussion and the stagflation dominating the Iranian economy, the following questions are raised and it is endeavored to answer them and propose appropriate political suggestions based on the existing literature.

1) Can we explain the inflation in Iranian economy using dispersion (second moment) of relative price changes?

2) Can we explain the inflation in Iranian economy using skewness (third moment) of relative price changes?

3) Can we explain the inflation in Iranian economy using the interaction (crossover) effects of dispersion and skewness of relative price changes?

In the second and third sections, the status of inflation in Iran and the theoretical principles of the research are expressed and the theory proposed by Ball and Mankiw is explained, and in the fourth section, empirical studies are reviewed. In the fifth section, we will examine the data and variables used in the research. In the sixth section, the panel data approach will be examined and in the seventh section, the results of model estimation and its analysis will be presented. The eighth section includes conclusion and policy implications.

The Status of Inflation in Iran

Since 1936 (the year Bank Melli Iran prepared the first index of Iranian economy), the total price level and cost of living index has always been increasing except for 1945, 1946 and 1950. The important point to be remembered, however, is that this increase has gone through many ups and downs. The trend of inflation rate for the period 1936-2013 is shown in diagram 1.

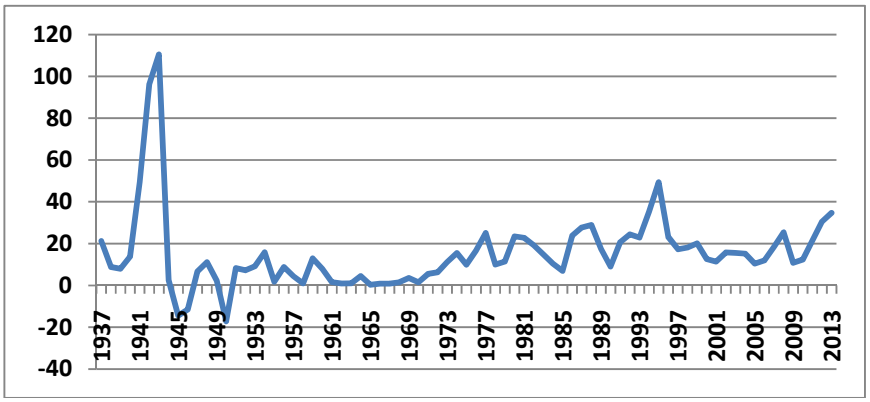

Diagram 1: The Inflation Rate in Iran (1937-2013)

Investigating the time series of inflation before and after the 1979 Revolution indicates the two characteristics of inflation in Iran. One of the characteristics is the high variation of inflation rate in Iran, one of the consequences of which is the decrease in the efficiency of price mechanism for the allocation of economic resources, which makes it difficult for economic agents to predict the future, increases the financial risk and disrupts the allocation of resources. The second characteristic is the chronic persistence of inflation. Studies on the reasons for inflation in Iran show that the most important causes of inflation are structural problems, dominance of public sector in economic activities and their competition with those working in the private sector, lack of state financial

discipline and continuous budget deficit, liquidity growth and implementation of monetary policies inappropriate for the economic conditions of the time. Thus, considering these factors, this study aimed at examining another aspect of the determinants of inflation proposed by Ball and Mankiw in 1995.

A Supply-Side Theory of Inflation

The classical theory of inflation rules out any implication of relative price changes—, which are believed to be driven by real factors—for aggregate inflation. According to this view, for a given stock of money, increases in some prices are offset by decreases in some other prices. Thus, the aggregate price level is unaltered. The aggregate price level changes only when money supply changes. In other words, according to the classical view, inflation is driven by aggregate demand factors only. During the 1970s high inflation was accompanied by a low level of output, a phenomenon called stagflation. The classical framework did not explain this phenomenon well. On the other hand, this could consistently be explained by changes in aggregate supply conditions. Also, a closer look at the anatomy of inflation during that period reveals that this inflation was mainly driven by changes in relative prices of a few commodities such as oil and food. Thus, the relative price changes had the essential traits of an aggregate supply shock. Economists, however, came up with various different stories to interpret relative price changes as supply shocks.

Ball and Mankiw (1995) exploit the positive relationship between inflation and relative price dispersion/skewness to propose a theory of aggregate inflation in which relative price changes are considered as aggregate supply shocks. They argue that the existence of such relationships is "a novel empirical prediction" of a menu costs model. Because of "menu costs" (the costs of adjusting prices) firms' responses to shocks are asymmetric: they adjust prices only in response to large shocks. Thus, large shocks have disproportionate effects on the price level and the resultant changes in relative prices have implications for aggregate inflation. If the distribution of desired price changes is skewed to the right, a shock will lead to more increases in relative prices than decreases, and inflation will be higher. On the other hand, when the distribution is skewed to the left, decreases occur more quickly than increases, and inflation is lower. This supply-side theory predicts that the skewness of relative price changes will be correlated with aggregate inflation. This theory further suggests that high variability of price changes magnifies the effect of skewness on inflation because a larger variance of shocks leads to more weight in the tails of the distribution. A given skewness shock then leads to an even greater disparity between the number of price increases and decreases.

In order to provide empirical evidence for their theory in the U.S., Ball and Mankiw estimate several regressions with the aggregate inflation as the dependent variable. These regressions include lagged inflation, standard deviation of relative price changes, skewness of price changes, and the interaction of standard deviation and skewness—one at a time, or all of them together—as repressors. They find that standard deviation and skewness of relative price changes have statistically significant positive effects on aggregate inflation.

Overview of Empirical Studies

Muhammad Akmal (2012)

In an article named "*The Relationship between Inflation and Relative Price Variability in Pakistan*", Muhammad Akmal explored the relationship between inflation and relative price variability (RPV) by using disaggregated Consumer Price Index (CPI) data for Pakistan. He used three methods to assess the functional form and stability of the relationship between inflation and RPV; (a) visual assessment through scatter plots; (b) rolling regression analysis, and (c) Bai-Perron multiple structural break tests.

The results show that the methods (a) and (c) confirm that the relationship between inflation and RPV is approximately U-shaped and it is unstable over time. Whereas the rolling regression approach shows that the relationship is not significant across all rolling samples; however, coefficients signs are in right direction. The findings also suggest that the optimal inflation level for RPV is positive in Pakistan. Moreover, it may not always be good to follow an anti-inflationary policy if the relationship between inflation and RPV is non-linear, as below the threshold level of inflation, such policy may actually increase volatility in relative prices and carry more social cost than benefit.

Davis et al.[1] (2011)

Davis et al. examined the cost of inflation due to the misallocation of economic resources due to relative price variability. For this purpose, they used the data of nine economic sectors in seven OECD countries from 1970 to 2005 and applied dynamic panel data methods. The results showed that inflation changes the real shares of some sectors even when inflation is treated as endogenous.

Choi and Kim[2] (2010)

Choi and Kim's study aimed at examining asymmetry in the effect of inflation on relative price variability. They showed that the existing asymmetry resulted from the misspecification of the true model. The specified model was a piecewise linear regression model, while the existing relationship was a U-shaped one. For this purpose, the disaggregated monthly consumer price indices for three countries, Canada, Japan, and the US were used as research data, including 36 categories for Canada (1984M1-2005M5), 47 for Japan (1984M1-2006M7) and 38 for the United States (1984M1-2007M9).

Pou and Dabus[3] (2008)

The work of Pou and Dabus aimed at testing Ball and Mankiw's supply-side theory of inflation in order to predict that inflation in Spain (1975-2002) and Argentina (1960-1989) was positively related to the skewness of price changes distribution. They concluded that there was a positive inflation–skewness relationship in both countries at low inflation, even though the mean annual inflation rates were very different – 2.2% for Spain and 23% for Argentina. In higher inflation periods, skewness was not significant. Finally, their results suggested that the menu-costs model was not suitable beyond certain threshold of inflation.

Ball and Mankiw (1995)

Ball and Mankiw, who proposed the theory our study is based on, examined the relationship between inflation as the dependent variable and lagged inflation, second and third moments of relative price changes and mutual interaction of second and third moments as the independent variable presupposing the positive correlation between them. In their study, relative price changes are introduced as aggregate supply-side shocks, which is different from previous theories about supply-side shocks including technological changes. Ball and Mankiw claim that according to their model, menu-cost paradigm provides a unified interpretation of short-run fluctuations, in which frictions in price adjustment explain the effects of both demand and supply shocks. Using four-digit Producer Price Index (PPI) data and a one-period model focusing on the price behavior at the industry level, this theory was tested on the US economy from 1949 to 1989. Ball and Mankiw used multiple regressions in order to estimate the coefficients of variables effective in inflation as the dependent variable. In a way that:

[1] Davis, George K. & Hineline, David & Kanago, Bryce E.
[2] Chi-Young Choi and Young Se Kim
[3] M. Angeles Caraballo Pou and Carlos Dabus

In the first regression: lagged inflation,
In the second regression: lagged inflation and dispersion,
In the third regression: lagged inflation and skewness,
In the fourth regression: lagged inflation, dispersion and skewness,
In the fifth regression: lagged inflation, skewness, and the mutual interaction of skewness and dispersion,
In the sixth regression: lagged inflation, dispersion, skewness and the mutual interaction of skewness and dispersion,
are used as the independent variables.

As a result, it first showed that there was a correlation between the inflation and third moment (skewness) of industry price changes and this correlation was a robust feature of these data. Secondly, the empirical validation of their theory provides evidence for menu-cost models of price adjustment. Menu-cost models were developed to explain monetary non-neutrality. They gain credibility from their ability to fit the facts regarding inflation and relative-price changes. It can be concluded that the empirical results of the estimated model is in line with the theory.

Data and Basic Variables

In order to answer the questions raised in the first section, the overall consumer price index (CPI) for urban households and the CPI for urban households in terms of main product groups in all provinces of the country from 2004 to 2012 are used as research data. The main product groups include:

1) Foods and drinks,
2) Tobacco,
3) Clothing and footwear,
4) Housing, water, electricity, gas and other fuels,
5) Furniture, supplies and services,
6) Health and hygiene,
7) Transportation,
8) Communications,
9) Recreation and cultural affairs,
10) Education
11) Restaurant and hotel,
12) Miscellaneous products and services.

The overall and provincial CPI data were collected from the price index database of the Central Bank of Islamic Republic of Iran. The variables used in this research and obtained using the above data are as follows:

Inflation Rate: Inflation is the increasing and irregular trend of increase in prices in the economy. This variable is estimated by using the CPI and includes the growth rate of consumer product and service price levels for urban households.

We define $P_{j,t}$ as the CPI for all products in the province j in the year t, and use it to estimate the inflation rate. Therefore, the inflation rate in the province j in the year t is as follows:

$$DP_{j,t} = LnP_{j,t} - LnP_{j,t-1} \quad (1)$$

Relative Price Variability (RPV): This variable is the dispersion or standard deviation (second moment) of relative price changes, which is estimated for the province j in the year t as follows:

$$VP_{j,t} = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}(DP_{i,j,t} - \overline{DP}_{j,t})^2} \qquad \text{And} \qquad \overline{DP}_{j,t} = \frac{1}{n}\sum_{i=1}^{n} DP_{i,j,t} \qquad (2)$$

Where $\overline{DP}_{j,t}$ is the average price changes (average among products) in province j during period t. i shows the product group and n indicates the number of product groups.

Skewness of Relative Price Changes: Skewness is defined as the asymmetry in relative price changes and is calculated as follows:

$$SP_{j,t} = \frac{1}{n}\sum_{i=1}^{n}\left(\frac{DP_{i,j,t} - \overline{DP}_{j,t}}{VP_{j,t}}\right)^3 \qquad (3)$$

Dynamic Panel Data Approach

In dynamic panel data, when the dependent variable appears on the right side as a lagged variable, OLS estimators are not consistent. The econometric method used in many economic studies to solve this problem is the two-stage least squares (2SLS) econometric method. A prerequisite to using 2SLS method is finding a suitable instrumental variable to solve the endogeneity problem of explanatory variables. However, application of this method has certain limitations such as difficulty in finding suitable instrumental variable and the limitation of such variables. Moreover, this method cannot solve the problem of correlation between explanatory variables and reduce or remove the linearity of model. A suitable econometric method for removing or reducing the endogeneity problem of explanatory variables is the estimation of model using Generalized Method of Moments (GMM) dynamic panel data.

Using GMM dynamic panel data approach has other advantages such as considering the asymmetry of individual variance, more information and removal of the biases in sectional regressions, which results in more accurate estimations with higher efficiency and less linearity in GMM. GMM dynamic panel data method is used when the number of sectional variables (N) is more than the number of years (T) (i.e. N>T), which is the same in this research. It means that the number of provinces as the sectional units is more than the number of years as the sample time-series.

In order to estimate the model using this method, it is necessary to first specify the instrumental variables used in the model. The consistency of GMM estimator depends upon the validity of the assumption of no serial correlation in the disturbance terms and instruments which can be tested by using the three specification tests of Arellano and Bond (1991), Arellano and Bover (1995) and Blundell and Bond (1998). The first test is Sargan test of over-identifying restrictions and tests the validity of instruments. The second test is a statistic that tests the existence of second-order serial correlation in first-order subtractive disturbance terms. Non-rejection of null hypothesis for both tests provides evidence for the assumption of no serial correlation and validity of instruments. GMM estimator is consistent if there is no second-order serial correlation in disturbance terms of first-order subtractive equation.

The estimated model is based on dynamic estimators using the GMM method. Its empirical framework is derived from the model used by Baltagi (2007), which can be defined as follows:

$$y_{it} = \alpha y_{it-1} + \beta' x_{it} + \eta_i + \phi_t + \varepsilon_{it} \qquad (4)$$

where α_{it} is the intercept, y_{it} the dependent variable, and y_{it-1} the dependent variable with a time lag. x_{it} also includes the independent variables used under instrumental variables and η_i is the individual or constant effects of countries, ϕ_t the constant effects of time, and ε_{it} the disturbance term.

In the specification of model (4), it is assumed that the disturbance terms have no correlation with individual or constant effects and with some explanatory variables and lagged values of variable. If η is correlated with some explanatory variables, then using first-order subtraction would be a suitable method to remove the constant or individual effects of units. Because in this way, using constant effects method leads to biased estimators of coefficients and it is necessary to use first-order subtraction for equation (4). Under such conditions, therefore, equation (4) turns to this equation:

$$\Delta y_{it} = \alpha \Delta y_{it-1} + \beta' \Delta x_{it} + \Delta \phi_t + \Delta \varepsilon_{it} \quad (5)$$

In equation (5), the first-order subtraction of the lagged dependent variable (Δy_{it-1}) is correlated with the first-order subtraction of disturbance terms ($\Delta \varepsilon_{it}$). Moreover, there is the endogeneity problem for some explanatory variables, which is not considered in the model. Thus, it is necessary to use instrumental variables in the model to solve this problem.

Considering this literature, the empirical research model is specified as follows to estimate the coefficients:

$$DP_{j,t} = \alpha + \beta_1 DP_{j,t-1} + \beta_2 VP_{j,t} + \beta_3 SP_{j,t} + \beta_4 \left(VP_{j,t} \times SP_{j,t} \right) + u_{j,t} \quad (6)$$

where $DP_{j,t}$ is the inflation rate, $DP_{j,t-1}$ the inflation rate with a time lag, $VP_{j,t}$ the relative price variability (RPV), $SP_{j,t}$ the skewness of relative price changes, and $VP_{j,t} \times SP_{j,t}$ the mutual interaction of relative prices and skewness of relative price changes. If needed, virtual variables of time and sections will also be used.

Model Estimation and Discussion

In this section, considering the limitation of the period and high number of sections, the methods of Arellano and Bover (1995), Blundell, and Bond (1998) were used because they are suitable for this type of data. The results are presented in Table 1:

Table 1: Estimation Results
Dependent Variable: Inflation Rate

Variable	Coefficient	Z-Statistic	P-Value
$DP_{j,t-1}$	0.4026	3.5	0.000
$VP_{j,t}$	0.431	2.27	0.023
$SP_{j,t}$	0.0215	2.09	0.036
$VP_{j,t}*SP_{j,t}$	-0.4263	-3.55	0.000
Constant	-0.2945	-5.22	0.000

The results of Table 1 show that the coefficients of all variables effective in the inflation rate are statistically significant. What is to be discussed, however, is the consistency or inconsistency of the impact direction of these variables on the inflation rate with that of relevant theories. A lagged inflation rate with a coefficient of 0.4026 leads to an increase in the inflation rate in current period. Dispersion of relative price changes with a coefficient of 0.431 has a positive effect on the inflation rate, which is in line with Ball and Mankiw's theory; in a way that with the increased relative price variability, the inflation rate is positively influenced by this increase. The coefficient of the term for skewness of relative price changes with a coefficient of 0.0215 causes the increase of inflation rate and this, too, is in line with the theory. This means that as the skewness of relative price changes in Iran increases, inflation rate grows.

The coefficient of the mutual interaction of dispersion and skewness of relative price changes, though significant, is against the theory of Ball and Mankiw in terms of impact direction and this implies that inflation is negatively influenced by the mutual interaction of these two variables. However, the theory expresses that when there is skewness in relative price changes, relative price variability can lead to increased or decreased price levels, depending on whether it is skewed to right or left.

Arellano and Bond's test was used to ensure the accurate specification of equation and lack of autocorrelation between disturbance terms. Its null hypothesis is the lack of first-order autocorrelation between subtractive disturbance terms. This test is used when the two-stage methods of Arellano and Bover (1995), Blundell, and Bond (1998) are used to estimate the equation coefficients. Momentary conditions and the results obtained from this test are only valid on the condition that there is no autocorrelation in individual disturbance terms. Since the rejection of null hypothesis (i.e. lack of first-order autocorrelation in subtractive disturbance terms) is not an indicator of wrong specification, we will examine the null hypothesis of no autocorrelation with higher order (for example second-order) in subtractive disturbance terms of first-order. The results indicate the rejection of null hypothesis of no first-order autocorrelation; however, the null hypothesis of no second-order autocorrelation cannot be rejected and this shows that there is no second-order autocorrelation in subtractive disturbance terms of first-order. Therefore, there is no evidence proving the estimated model does not have an accurate specification. The result of Arellano and Bond's test is depicted in Table 2:

Table 2: Arellano and Bond's test

Autoregressive Order	Z-Statistic	P-Value
1	-2.9962	0.0027
2	0.999	0.3178

The above output does not present evidence that the model is misspecified.

Conclusion and Policy Implications

In this paper, we tested the supply-side theory of inflation proposed by Ball and Mankiw and examined the effects of dispersion and skewness of relative price changes on inflation in Iranian economy. For this purpose, the overall CPI and provincial CPI data for 12 main product groups in urban areas from 2004 to 2012 were used. Dynamic panel data approach and the methods by Arellano and Bover (1995) and Blundell and Bond (1998) were utilized to estimate the coefficients of effective variables in the inflation due to the existence of a lagged dependent variable in the right side of the model as an effective variable in inflation. The results obtained from the estimation of

this model indicate that the coefficients of dispersion and skewness of relative price changes and inflation rate with a time lag are in line with the theory; in a way that the dispersion and skewness of relative price changes and inflation rate of the previous period have a positive significant effect on inflation.

The positive effect of dispersion and skewness of relative price changes on the general level of prices shows that the increase in the dispersion of relative price changes leads to an increase in the general level of prices, which is due to the asymmetry in price shocks and lack of proper signaling by the market to economic agents in order for resources to be optimally allocated in different economic sectors. In other words, a kind of instability is created in economic agents' decision-making due to the high amount of changes in relative prices of different economic sectors. As a result, implementing certain activities to predict shocks and thus business behaviors as well as implementing policies to prevent high RPV can contribute to the establishment of stability and confidence in economic agents' decision-making and prevent the decrease in people's power of purchase and creation of constant welfare costs.

Moreover, considering the fact that in this research the current period's inflation rate is influenced by the inflation rate with a time lag (the previous period's inflation rate) and a kind of retrospective expected inflation is dominant, it is necessary for the government and especially the central bank to take practical measures to create stability in the general level of prices in a low rate. In order to provide a transparent and reliable anchor for economic agents in order to shape their inflationary expectations and change them from retrospective to prospective expectations, the central bank should declare its quantitative goals for inflation in the form of official prediction and explain its programs and the way it is going to realize these goals to the public.

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