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EVIDENCE ON OUTPUT-INFLATION TRADE-OFFS: THE CASE OF JORDAN

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Abstract

This paper is an attempt to examine the impact of the average rate of inflation and its variability on the output-inflation trade-off in Jordan for the sample period 1969-1991. Measures for average rate of inflation and its variability are approximated by a four-year moving average of current and past inflation rate, using equal and geometrically declining weights. The relationship between the average rate of inflation and the output-inflation trade-off is found to be insignificant, while the relationship between the variability of inflation and the output-inflation trade-off is found to be significant and negative. These results are consistent with the new Keynesian thesis that the variability of inflation has a negative impact on that trade-off.

1. Introduction

The purpose of this paper is to investigate the impact of nominal demand shocks on the output-inflation trade-off in Jordan for the sample period from 1969 through 1991. During the last decade, macroeconomists have renewed their interest in seeking an explanation for business cycles. This view was no doubt due to the fact that business cycle problem was not solved as it was believed in the late 1960's and early 1970's. Consequently, the search for an explanation of business cycles has become a relevant topic once again (Norrbin and Schlagenhauf, 1988).

Renewed interest in business cycle research has resulted in a large number of theories. Those theories range from the imperfect information model of Lucas (1973, and 1979) and Barro (1976), in which nominal rigidities of price and wage

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play no role, to traditional Keynesian models, in which the extent of rigidity is held constant.

According to the imperfect information models, business cycles can be explained by introducing imperfect information into an equilibrium model. As a result, a change in nominal variable can be confused with a relative price change. This confusion allows nominal variables to exert temporary real effects. Nominal impulses can be transmitted over time through internal propagation mechanism, even though they do not themselves have long-lived impacts. With this story, the aggregate factor would be associated with unanticipated changes in the nominal money supply or other nominal demand variables.

By contrast, central to traditional Keynesian paradigms is the notion that nominal demand shocks produce real effects. Critical to that outcome are nominal wage and price rigidities that allow the economy to deviate from full employment. Historically, rationales for those rigidities have been ad hoc and thus have detracted from the theory's appeal (Defina, 1991). In other words, it could be argued that traditional Keynesian theories allow no scope for average rate of inflation to influence that trade-off.

More recently, Ball, Mankiw, and Romer (1988) (henceforth BMR) have offered a notable model in which the output-inflation trade-off is permitted to depend on average rates of inflation and of the variability of aggregate shocks. According to BMR, price and wage rigidities result from the optimizing behavior of individuals. The price rigidity implies that business firms usually change prices infrequently because changing them involves costs. In other words, only a fraction of business firms alters prices at a given period of time. More precisely, nominal demand shocks may not cause price adjustment if the gain to a firm from changing prices does not exceed the associated adjustment costs. And because few firms are ready to change prices in a given period, adjustments that do occur will unfold gradually form an aggregate perspective. Together these elements imply aggregate price rigidities which allow nominal demand shocks to have real effects (Defina, 1991).

The importance of the BMR's model is that it focuses on a key prediction, namely, the degree to which nominal shocks affect output varies inversely with the average rate of inflation. As inflation trends higher, firms' profit-maximizing prices change more quickly on average. That in turn raises the benefit from more frequent price adjustment. Because higher average inflation causes more frequent price adjustment, nominal demand shocks have smaller impact on real effects as inflation ratchets upward. On the other hand, the BMR model also predicts that nominal demand shocks have smaller real effects as the variance of nominal demand shocks trends higher. This implies that when the variance of nominal demand shocks grows, firms' profit maximizing prices become more uncertain, leading firms to pursue more flexible pricing strategies other things being equal.

Empirical evidence on the sensitivity of output to nominal demand shocks provides important information for policymakers in less developed countries like Jordan. Continuous expansion of base money arises from a fiscal disequilibrium in less developed countries moves the economy to a higher inflation equilibrium. Therefore, the rapid increase in the average rate of money growth or its variability could affect negatively the output. This implies that the lower average inflation falls the more responsive is output to nominal demand shocks, such as changes in money growth. Hence, initial declines in rapid inflation engineered by a central bank might carry relatively small output costs, but attempts to eliminate inflation could become extremely expensive (Evans, 1989).

The next section of this paper reviews studies that are most clearly related to the subject. Section 3 describes the empirical methodology. Section 4 discusses the empirical results. Section 5 concludes.

2. Previous Studies

Froyen and Waud (1980) examined the relationship between aggregate price of inflation variance and the terms of the output-inflation trade-off across ten industrialized countries for the sample period 1957-1976, using quarterly data. This study showed that variations in estimates of price inflation variance did not provide a sufficient explanation of variations in estimates of the terms of the output-inflation trade-off in tests both across countries or for a given country. Furthermore, the relationship between the variance of the change in nominal GNP and the output-inflation trade-off is found to be insignificant.

Katsimbris (1985) attempted to probe more deeply into the relationship between the average rate of inflation and its variability and the variance of the real rate of growth across eighteen industrialized countries. These relationships were examined on a country-by-country bases. The relationship between the variability of industrial production growth rate and the inflation rate was significant and positive for five countries. On the other hand, the association between the industrial production growth rate variability and the current inflation variability was significant and positive only in one country.

Defina (1991) examined the impact of average inflation on the output-inflation trade-off in forty three industrialized countries. The results provided empirical evidence rejecting the null hypothesis that average inflation imparts no impact on the output-inflation trade-off in thirteen out of the forty three countries studied. To test the robustness of these results, each equation was reestimated using the standard deviation of nominal GNP rather than that of inflation. The use of nominal GNP variability increased the number of countries for which the null hypothesis can be rejected-up to eighteen from thirteen.

3. Empirical Methodology

3.1 The Model to Be Estimaed

This paper adopts a simple model of macroeconomic fluctuations which has its origins in the work of BMR. To investigate the role of the average rate of inflation and its variability on the responsiveness of output to nominal demand shocks, a two-step procedure is used. The first step uses a short-run Phillips' curve equation. The basic form is

$$Ly_t = B_0 + B_1 Ly_{t-1} + B_2 DLX_t + B_3 T + e_t \qquad \text{.......... (1)}$$

where Ly is the log of real GNP, DLX is the change in the log of nominal GNP, T is a linear time trend, e is an error term, and B_0, B_1, B_2, and B_3 are coefficients. The coefficient B_2 measures the sensitivity of output to nominal demand shocks.

The second step underlies the arguments on which the coefficient B_2 depends. For BMR, the coefficient B_2 is permitted to depend on average rates of inflation and of the variability of aggregate shocks in each time period. That is

$$B_2 = f(M_t, V_t) \qquad \text{.......... (2)}$$

where M_t and V_t capture the average rate of inflation and of its standard deviation respectively. The dependency of B_2 on M_t and V_t is then nested directly within (1) yielding

$$Ly_t = B_0 = B_1 Ly_{t-1} + f(M_t, V_t) DLX_t + B_3 T + e_t \qquad \text{........... (3)}$$

Empirical evidence on the hypothesis that nominal demand shocks produce output-inflation trade-off can be obtained by choosing a specific functional form for f(.). Akerlof et al. (1988) realized an important shortcoming for the variance of inflation as a measure for nominal shocks. They argue that explanatory variables, such as the variance of aggregate demand shocks, are likely to be constants throughout the sample period. This, of course, forces the coefficient B_2 to be constant as well. The maintained specifications throughout the work are linear and nonlinear specifications, given by

$$B_{2t} = a_0 + a_1 M_t + a_2 V_t \qquad \text{.......... (2a)}$$

$$B_{2t} = b_0 + b_1 M^2_t + b_2 V^2_t \qquad \text{.......... (2b)}$$

Under the linear specification of f(.), the estimates of the coefficients are obtained by first substituting (2a) into (3) and then applying ordinary least squares to the resulting specification

$$Ly_t = B_0 + B_1 Ly_{t-1} + a_0 DLX_t + a_1(M_t{*}DLX_t) + a_2(V_t{*}DLX_t) + B_3 T + e_t \text{ .....(3a)}$$

Where a_1 is the coefficient on the interaction between M_t and DLX_t, and a_2 is the coefficient on the interaction between V_t and DLX_t.

The impact of average rate of inflation and its standard deviation on the output-inflation trade-off can be explored by testing the following set of hypotheses:

H^m_0: the null hypothesis that the average rate of inflation has no impact on the responsiveness of output, which is statistically significant ($a_1 = 0$).

H^m_1: the alternative hypothesis that the average rate of inflation has a negative impact on the responsiveness of output, (a_1 is negative).

H^v_0: the null hypothesis that the standard deviation of inflation plays no role which is statistically significant in affecting output, (a_2=o).

H^v_1: the alternative hypothesis that the standard deviation has a negative impact on the responsiveness of output, (a_2 is negative).

Under the nonlinear specification of f(.), the estimates of the coefficients are obtained by substituting (2b) into (3). This yields

$$Ly_t = B_0 + B_1Ly_{t-1} + b_0DLX_t + b_1(M^2_t*DLX_t) + b2(V^2*DLXt) + B_3T + e_t \quad (3b)$$

Where b_1 is the coefficient on the interaction between M^2_t and DLX_t, and b_2 is the coefficient on the interaction between V^2_t and DLX_t. Analogous to equation (3a), the same set of the previous hypotheses can be tested, except that the nonlinear terms of the average rate of inflation and its variability are introduced in equation (3b).

3.2. The Data

The basic data on nominal GNP and price level used throughout the study come from the International Monetary Fund International Financial Statistics. Real GNP is calculated as nominal GNP divided by the implicit GNP deflator, which can be viewed the best among all measures of prices. Simply, because it measures the prices of domestically produced goods and services (Barro, 1993: p.35). The base year is taken to be 1985. All observations are annual. Inflation is calculated as the percent change in the implicit GNP deflator implied by the data on nominal and real GNP.

The average rate of inflation during a period, needed to examine the impact of nominal demand shocks on the output-inflation trade-off, is approximated by a moving average of current and past inflation rate using both equal and geometrically decaying weights, the periods covered, say r, are the current year back through year t-r+1. The weight on the ith lag equals k^i,

where $$\sum_{i=1}^{r} k^i = 1$$

Trends in inflation variability of aggregate shocks are approximated by the standard deviation in inflation for the same rolling number of years used to calculate average inflation using the same weight mentioned above. The use of different measures and specifications for average rate of inflation and its variability may shed better light on the robustness of the results estimated.

4. Empirical Findings

In this section, equations (3a) and (3b) are estimated using ordinary least squares under linear and nonlinear representation of f(.), respectively. The theory provides no guidence on the lag length that must be used in this study. Here the R^2-adjusted criterion is used. This criterion reaches its maximum when the error variance assumes a minimum (Judge et al., 1988). The lag lengths of $r = 2,3,4$ and, 5 are tried. The lag length of $r = 4$ is found to have the maximum R^2-adjusted. Table 1 contains estimated coefficients based on the linear representation of f(.) using both equal and declining weights of a four-year moving average rate of inflation. The estimates reveal that the null hypothesis that a_1 equals zero is not rejected when both equal and declining weights are used. These results suggest that the interaction between M_t and DLX_t has the expected signs when both equal and decaying weights are used.

On the other hand, the null hypothesis that a_2 equals zero is rejected at the 5% level when both equal and declining weights are introduced. This finding is consistent with the new Keynesian thesis that inflation variability affects negatively the short-run output-inflation trade-off.

In light of the linear specification of f(.), the response of the log of real GNP (Lyt) to its Lagged value (Ly_{t-1}) turns out to be statistically significant at the 1% level when both equal and declining weights are used. The change in the log of nominal GNP (DLX_t) has a positive impact on the output-inflation trade-off which is statistically significant at the 5% and 1% levels when equal and declining weights are introduced, respectively. the coefficient of time trend, B_3, turns out to be statistically insignificant at the 5% level in all cases.

The F- statistics appear to be highly significant when equal and declining weights are used. The R^2 values show, also, a high amount of explanatory power since the R^2 can at most be one in the two equations estimated above. Interestingly, the results based on the linear specification of f(.) appear to be identical to those obtained on the basis of nonlinear specification.

The analysis now turns to the estimates of equation (3b) as the nonlinear terms of average rate of inflation and its variability are utilized. Table 2 contains the estimates of this equation when both equal and declining weights are introduced. The interaction between M_t^2 and DLX_t has the expected sign, but it turns out to have no impact which is statistically significant. This finding strengthens the null hypothesis that average rate of inflation plays no role in affecting the short-run output-inflation trade-off in Jordan for the sample period studied.

Table(1)

Ordinary Least-Squares Estimates of Equation (3a):
Linear Specification

Coefficients	Equal Weights		Declining Weights	
B_o	0.4224	(0.67)[a]	0.3587	(0.65)
B_1	0.9191	(9.73)	0.9324	(11.55)
a_o	1.9718	(2.64)	2.0899	(3.92)
a_1	-0.0123	(-0.26)	-0.0549	(-1.23)
a_2	-0.2301	(-2.62)	-0.1903	(-2.19)
B_3	0.0093	(1.51)	0.0061	(1.52)
Summary statistics				
Standard error	0.0414		0.0389	
R^2	0.9902		0.9913	
R^2- Adjusted	0.9864		0.9980	
F	262.286[b]		296.587	
Number of observations[c]	19		19	

Figures in Parentheses are t-ratios

a) t-statistic=2.160 at the 5% level, and 3.012 at the 1% level.

b) F- statistic =2.960 at the 5% level, and 4.860 at the 1% level.

c) After calculating the average rate of inflation on the basis of a four-year moving average.

The impact of the interaction between V_t^2 and DLX_t reveals empirical evidence rejecting the null hypothesis that the variance of inflation has no impact on the process of generating output-inflation trade-off when both equal and declining weights are used.

Finally, the resutls are broadly similar and lead to the same conclusions when both linear and nonlinear representation of (f.) are introduced. The response of output to inflation variability appears to be small but highly significant, especially, when nonlinear specification is used. These results suggest that the importance of the inflation rate variability in influencing that trade-off is statistically significant, and diminishing over time.

Table (2)

Ordinary Least-Squares Estimates of Equation (3b):
Nonlinear Specification

Coefficients	Equal Weights	Declining Weights
B_0	0.4823 (0.93)	0.1630 (0.36)
B_1	0.9106 (11.80)	0.9620 (14.53)
b_0	1.3879 (3.76)	1.2256 (4.30)
b_1	-0.0006 (-0.34)	-0.0009 (-0.51)
b_2	-0.0251 (-3.58)	-0.0274 (-3.41)
B_3	0.0104 (2.02)	0.0055 (1.38)
Summary Statistics		
Standard error	0.0363	0.0351
R^2	0.9924	0.9930
R^2- Adjusted	0.9896	0.9902
F	342.018	366.347
Number of observations	19	19

To capture the impact of aggregate supply shocks, a dummy variable (D) is added to the equations 3a-3b (where D= 1 for t = 1988 and 1989 and D=0 otherwise) As shown in appendix A, the results reveal empirical evidence showing that supply shocks turn out to have no impact which is statistically significant. Moreover, the variability of inflation turns out to have no impact which is statistically significant on that trade-off when linear terms of average rate of inflation and its variability are used. In general the results are found to be similar to those obtained without using a dummy variable.

5. Summary and Conclusions

This study investigated the impact of the average rate of inflation and its variability on the output-inflation trade-off in Jordan for the sample period from 1969 through 1991. The average rate of inflation is found to have no effect which is statistically significant on the output-inflation trade-off when equal and declining weights of a four-year moving average inflation rates are used. The variability of inflation is found to have a negative impact which is statistically significant at the 5% and 1% levels when linear and nonlinear specifications of average and inflation variability are used, respectively. The estimates of the linear and nonlinear specifications of the equations used to estimate the impact of average inflation and the variability of inflation turn out to be robust.

In recent years and especially since 1989, the Central Bank of Jordan continued to control the growth rates of various money and credit aggregates in attempt to reduce the rate if inflation from double digits in 1989-1991 to about 5 percent in 1992 and later, and to maintain the growth rates of gross domestic product at about 4 percent. The sensitivity of output to inflation variability shows that the lower variance of inflation falls, the more responsive is output to nominal demand shocks, such as changes in money growth variability. Hence rapid initial declines in the variance of inflation engineered by a central bank might carry relatively small output costs.

Appendix A

Ordinary Least-Squares Estimates of Equations

	LINEAR SPECIFICATION				NONLINEAR SPECIFICATION			
Coefficients	Equal Weights		Declining Weights		Equal Weights		Declining Weights	
B_0	0.1064	(0.17)	0.0669	(0.12)	0.2290	(0.43)	-0.0047	(-0.01)
B_1	0.9655	(10.54)	0.9745	(11.63)	0.9480	(12.04)	0.9861	(13.96)
a_0	1.7925	(2.55)	1.8491	(3.40)	1.2888	(3.56)	1.1720	(4.40)
a_1	-0.0167	(-0.38)	-0.0467	(-1.08)	-0.0005	(-0.26)	-0.0007	(-0.41)
a_2	-0.1672	(-1.88)	-0.1334	(-1.43)	-0.0200	(2.63)	-0.0226	(-2.39)
B_3	0.0076	(1.31)	0.0049	(1.04)	0.0088	(1.74)	0.0049	(1.20)
B_4	-0.0606[d]	(-1.76)	-0.0495	(--1.38	-0.0462	(-1.43)	-0.0345	(-0.99)
Summary statistics								
Standard error		0.0384		0.0377		0.0349		0.0351
R^2		0.9922		0.9925		0.9936		0.9935
R^2-adjusted		0.9883		0.9887		0.9903		0.9902
F		254.30		264.63		308.14		304.81
Observations		19		19		19		19

d B4 represents the coefficient of the dummy variable.

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