

The Effect of Inflation on Economic Growth in Qatar An Empirical Investigation: 1980-2011

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Abstract

This paper explores the relationship between inflation and economic growth for sustainable economic development in Qatar. Using annual data on Economic growth and inflation rate for the period of 1980 to 2011, co-integration and error correction models are estimated. The empirical evidence demonstrates that there exists a statistically significant long-run negative relationship between inflation and economic growth in Qatar. This result has important implications for both domestic policy makers and the development partners working for the country. Specifically, our conclusion is of direct relevance to the conduct of the monetary policy by the Qatar Bank.

Keywords: inflation, economic growth, co-integration, error correction model, Qatar

INTRODUCTION

Qatar is a small, open, well monetized economy with no interest rate ceilings on deposits, and where market forces determine the interest rates. It does not have a demographic trap, poverty trap, or a savings trap like some of the other developing countries. Since the mid 1990s, the continuous efforts by policy makers to diversify revenues, control public expenditures, and privatization have led to the improvement of productivity and enhanced long-term economic growth. Qatar's real Gross Domestic Product (GDP) has been growing at high rates of almost 6% during the last 10 years. The inflation rate is relatively low even when compared to the average rate of inflation for the industrialized countries. In recent years, some developments have taken place which have led to more effective fiscal policy, created a more favorable business and economic environment, and enhanced the role of the private sector. Despite the increase in oil prices and revenues, economic reforms have continued to be top priority for the decision makers. Meanwhile, other measures have taken place to build up a comprehensive legal and economic system which is attractive to foreign investment and consistent with a free market and outward-oriented Qatar economy. In 1990s, the government of Qatar started to amend the legislative and bureaucratic framework to ensure easy and adequate inflow of foreign capital. Law No. 25 of 1990 allowed non-Qatari capital to participate in a wide range of economic activities that were Qatari exclusive. In 2000, the Qatari government amended the laws that govern the legal and economic environment, thus allowing foreign investors to exercise 100% ownership in any project. The

exception to this is banking, insurance, and general trading where 51% Qatari partnership is still required. Also, the government introduced intellectual property right laws and reduced tariffs to comply with the World Trade Organization (WTO) standards.

In the mid of the last century, the literature about inflation showed **that** the economists spent much time to understand the reasons that causes inflation. The economists succeed to give details about the sources of inflation. But, until now the relation of inflation with the other macroeconomic variables such as the economic growth still debatable and there is still a disagreement about a lot of issues. Mankiw (2000) addressed the relation of inflation with the other macroeconomic variables as one of the most important unresolved questions of the macroeconomics. Specifically, Mankiw (2000) mentioned that both the cost of inflation and the cost of reducing inflation are topics on which the economists often disagree.

The nexus between inflation and economic growth have drawn extensive attention of macroeconomists, policy makers and the central bankers of both developed and developing countries. Specifically, the issue that whether inflation is necessary for economic growth or it is harmful generates a significant debate both theoretically and empirically. The issue originally evolves from the controversial notion between the *structuralists* and the monetarists¹. In this connection, more recent work by Paul, Kearney and Chowdhury (1997) involving 70 countries (of which 48 are developing economies) for the period 1960-1989 found no causal relationship between

inflation and economic growth in 40 per cent of the countries.

Mundell (1965) and Tobin (1965) predict a positive relationship between the rate of inflation and the rate of capital accumulation, which in turn, implies a positive relationship to the rate of economic growth. They argue that since money and capital are substitutable, an increase in the rate of inflation increases capital accumulation by shifting portfolio from money to capital, and thereby, stimulating a higher rate of economic growth (Gregorio, 1996). Conversely, Fischer and Modigliani (1997) suggest a negative and nonlinear relationship between the rate of inflation and economic growth through the new growth theory mechanisms (Malla, 1997). They mention that inflation restricts economic growth largely by reducing the efficiency of investment rather than its level.

Although the relationship between inflation and economic growth remains controversial or somewhat inconclusive, several empirical studies confirm the existence of either a positive or negative relationship between these two major macroeconomic variables. Moreover, with time a general consensus evolved that low and stable inflation promotes economic growth and vice versa (Mubarak, 2005). This further raises the question how low the inflation should be. The answer evidently depends on the nature and structure of the economy and varies across countries. In this regard, recently macroeconomists have adopted an econometric technique simply by looking at a nonlinear or structural break effect which states that the impact of inflation on economic growth could be positive up to a certain threshold level and beyond this level the effect turns to be negative (Sweidan, 2004). This supports both the view of the *structuralists* and the *monetarists* up to a certain extent, that is, low inflation is helpful for economic growth but once the economy achieves faster growth then inflation is detrimental for the sustainability of such growth.

Recent cross-country studies, which found inflation affecting economic growth negatively, include Fischer (1993), Barro (1996) and Bruno and Easterly (1998). Fischer (1993) and Barro (1996) who found a very small negative impact of inflation on growth. Yet Fischer (1993) concluded “however weak the evidence, one strong conclusion can be drawn: inflation is not good for longer-term growth”. Barro (1996) also preferred price stability because he believed it to be good for economic growth.

The purpose of this paper is to analyze the relationship between inflation and economic growth in *Qatar*. Annual data set on real gross domestic product (GDP) and consumer price index (CPI) for the period of 1980 to 2011 is used in the

analysis. The result of the empirical analysis is important for both domestic policy makers and the development partners, for sustained economic development. The analysis provides a presumption that inflation is a bad idea, but the case is not divisive without supporting empirical findings. The paper considers the effect on growth of inflation, and of “other determinants” such as fertility, education etc. Once the effects of the other determinants are removed, the residual growth is plotted against inflation. This plot is at the core of the study by Barro. The paper explores the inflation – growth relationship in a large sample over 30 years. Annual inflation rates were computed in most cases from consumer price indices. Data was also collated for the other determinants of growth, which included the growth rate of real GDP per capita, and the ratio of investment to GDP for the three decades.

The remainder of this paper is organized as follows: Section 2 reviews the empirical literature on inflation and economic growth. Section 3 discusses the conceptual empirical models viz., Co-integration and Error Correction Model. Section 4 discusses the model results. Section 5 summaries the paper.

LITERATURE REVIEW

The macroeconomic literature shows that the possibility to have either a positive or negative relation between inflation rate and economic growth exists. Sarel (1995) point out an important issue which is; the empirical studies before 1970, a period described by low inflation, find a positive or non-significant relation between inflation and economic growth. But, after 1970 the inflation started to be high and severe. For this reason many studies such as: Kormendi and Meguire (1985), De Gregorio (1991), Fischer (1993), Motely (1994), Barro (1995), Andres and Hernando (1997) find a negative relation between inflation and economic growth.

There have been extensive theoretical and empirical researches to date that attempt to focus on the relationship between inflation and economic growth. Barro (1995) explores the inflation–economic growth relationship using a large sample covering more than 100 countries from 1960 to 1990. His empirical findings indicate that there exists a statistically significant negative relationship between inflation and economic growth if a certain number of the country characteristics (e.g., fertility rate, education, etc.) are held constant. Maghyereh (2003) finds that the effect of the inflation rate on the economic growth is strongly negative and statistically significant.

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determinants” such as fertility, education etc. Once the effects of the other determinants are removed, the residual growth is plotted against inflation. This plot is at the core of the study by Barro. The paper explores the inflation – growth relationship in a large sample over 30 years. Annual inflation rates were computed in most cases from consumer price indices. Data was also collated for the other determinants of growth, which included the growth rate of real GDP per capita, and the ratio of investment to GDP for the three decades.

Bruno and Easterly (1995) examine the determinants of economic growth using annual CPI inflation of 26 countries which experienced inflation crises during the period between 1961 and 1992. In their empirical analysis, inflation rate of 40 percent and over is considered as the threshold level for an inflation crisis. They find inconsistent or somewhat inconclusive relationship between inflation and economic growth below this threshold level when countries with high inflation crises are excluded from the sample. In addition, the empirical analysis suggests that there exists a temporal negative relationship between inflation and economic growth beyond this threshold level. The robustness of the empirical results is examined by controlling for other factors such as shocks (e.g., terms of trade shocks, political crises, and wars). Finally, they find that countries recover their pre-crisis economic growth rates following successful reduction of high inflation and there is no permanent damage to economic growth due to discrete high inflation crises.

Sarel (1995) mentions that inflation rates were somewhat modest in most countries before the 1970s and after that inflation rates started to be high. Therefore, most empirical studies conducted before the 1970s show the evidence of a positive relationship between inflation and economic growth and a negative relationship between the two beyond that time period due to the severe inflation hike.

Malla (1997) conducts an empirical analysis using a small sample of Asian countries and countries belonging to the Organization for Economic Cooperation and Development OECD separately. After controlling for labor and capital inputs, the estimated results suggest that for the OECD countries there exists a statistically significant negative relationship between economic growth and inflation including its first difference. However, the relationship is not statistically significant for the developing countries of Asia. The crucial finding of this empirical analysis suggests that the cross-country relationship between inflation and long-term economic growth experiences some fundamental problems like adjustment in country sample and the time period. Therefore, inconclusive relationship between inflation and economic growth can be drawn

from comparing cross country time-series regressions with different regions and time periods.

Mallik and Chowdhury (2001) examine the short-run and long-run dynamics of the relationship between inflation and economic growth for four South Asian economies: Bangladesh, India, Pakistan, and Sri Lanka. Applying co-integration and error correction models to the annual data, they find two motivating results. First, the relationship between inflation and economic growth is positive and statistically significant for all four countries. Second, the sensitivity of growth to changes in inflation rates is smaller than that of inflation to changes in growth rates. These results have important policy implications, i.e., while moderate inflation promotes economic growth, faster economic growth absorbs into inflation by overheating the economy. Therefore, these four countries are on the turning point of inflation-economic growth relationship.

Faria and Carneiro (2001) investigate the relationship between inflation and economic growth in the context of Brazil which experienced persistent high inflation until recently. Analyzing a bivariate vector auto regression time series model with annual data for the period between 1980 and 1995, they find that although there exists a negative relationship between inflation and economic growth in the short-run, inflation does not affect economic growth in the long-run. Their empirical results also support the *super neutrality* concept of money in the long run. This in turn provides empirical evidence against the view that inflation affects economic growth in the long run.

Swaidan (2004) examines whether the relationship between inflation and economic growth has a structural breakpoint effect or not for the Jordanian economy from 1970 to 2003. He finds that this relation tends to be positive and significant below an inflation rate of 2-percent and the structural breakpoint effect occurs at an inflation rate equal to 2-percent. Beyond this threshold level inflation affects economic growth negatively.

Mubarik (2005) estimates the threshold level of inflation for Pakistan using an annual data set from the period between 1973 and 2000. He employed the *Granger Causality* test as an application of the threshold model and finally, the relevant sensitivity analysis of the model. His estimation of the threshold model suggests that an inflation rate beyond 9-percent is detrimental for the economic growth of Pakistan. This in turn, suggests that inflation rate below the estimated level of 9-percent is favorable for the economic growth. Moreover, the sensitivity analysis performed for the robustness of the threshold model also confirms the same level of threshold inflation rate.

CONCEPTUAL MODEL

This paper examines the extent to which economic growth is related to inflation and vice versa, the conceptual framework of Co integration and Error Correction Models (ECM) is applied. With the help of this framework it is possible to examine the short-run and long-run relationships between the two variables. The Engle-Granger (1987) two-step co integration procedure is used to test the presence of Co-integration between the two variables. If both time series are integrated of the same order then it is possible to proceed with the estimation of the following Co-integration regression:

$$GD\dot{P}_t = \alpha_1 + \beta_1 CPI_t + \varepsilon_1 \quad (1)$$

$$CPI_t = \alpha_2 + \beta_2 GD\dot{P}_t + \varepsilon_2 \quad (2)$$

Where $GD\dot{P}_t^*$ = log of real GDP, CPI_t^* = log of CPI at time t, and ε_1 and ε_2 are random error terms (residuals). Residuals ε_1 and ε_2 measure the extent to which $GD\dot{P}_t^*$ and CPI_t^* are out of equilibrium. If ε_1 and ε_2 are integrated of order zero, I(0), then it can be said that both $GD\dot{P}_t^*$ and CPI_t^* are co integrated and not expected to remain apart in the long run. If co-integration exists, then information on one variable can be used to predict the other.

There are few other techniques for testing and estimating co-integrating relationships in the literature. Of these techniques, the Johansen (1988) and Johansen and Juselius (1990) maximum-likelihood test procedure are the most efficient for testify the existence of a third co-integrating vector. This procedure gives two likelihood ratio tests for the number of co-integrating vectors: (a) the *maximal Eigen value test*, which tests the null hypothesis that there are at least "r" co-integration vectors, as against the alternative that there are "r+1", and (b) the *trace-test*, where the alternative hypothesis is that the number of co-integrating vectors is equal to or less than r+1.

In principle, there can be a long-run or equilibrium relationship between two series in a bivariate relationship only if they are stationary or if each series is at least integrated of the same order (Campbell and Perron, 1991). That is, if two series are integrated of the same order, I (d) for d = 0, 1, 2... then the two series are said to be co-integrated and the regression on the same levels of the two variables is meaningful (not spurious) and on long-run information is lost. Therefore, the first task is to check for the existence of stationary property in the series for growth rate ($GD\dot{P}_t^*$) and inflation rate (CPI_t^*).

To determine the non-stationary property of each variable, the paper test each of the series in the levels (log of real GDP and log of CPI) and in the first difference (growth and inflation rate). First, the DF test is used (Dickey and Fuller, 1979) and then the ADF test (Dickey and Fuller, 1981) with and without a time trend.

Since it is widely believed that both DF and ADF tests do not consider the cases of heteroscedasticity and non-normality frequently revealed in raw data of economic time series variables, the Phillips-Perron (PP) test for unit root has been used in the empirical analysis. Moreover, PP test an advantage over the ADF test when the concerned time series has serial correlation and there is a structural break. Therefore, the PP test provides robust estimates over the DF and ADF tests and is based on the following form of equation:

$$\Delta W_t = \alpha + \beta \left(t - \frac{T}{2}\right) + (\rho - 1)W_{t-1} + \mu \Delta W_{t-1} + \varepsilon_3 \quad (3)$$

The appropriate critical values of the *t-statistic* for the null hypothesis of non-stationarity are given by MacKinnon (1991). Further, an alternative testing procedure, i.e., KPSS (Kwiatkowski-Phillips-Schmidt-Shin) test has been performed where the concerned time series variables are assumed to be trend-stationary under the null hypothesis (Patterson, 2002). The KPSS test starts from the basic local level model:

$$W_t = \alpha_{t-1} + \beta + \eta_t + \pi_t \quad (4)$$

The KPSS test statistic is based on the following lagrangian multiplier (LM) statistic:

$$KPSS = \sum_t \frac{\hat{e}_r^2}{T^2 f_c} \quad (5)$$

Where, f is an estimator of the residual spectrum at frequency zero. The appropriate critical values for the LM statistic are given by KPSS (1992). In equations (3), Δf is defined as the first difference operator and

$\varepsilon_1, \varepsilon_2$ and ε_3 are the respective covariance stationary random error terms. All tests are carried out for both variables by replacing W_t with what and in equations (3)) (for the PP test), and (4) (for the KPSS test). Finally, the DF, ADF, PP, and KPSS unit root tests have been employed for residuals of equations (1) and (2), i.e., ε_1 and ε_2 . When residuals are found to be integrated of order zero, I(0), then it can be concluded that the two series $GD\dot{P}_t^*$ and CPI_t^* are co-integrated and thus a valid and stable long-run relationship exists between them. This also implies the existence of a stable long-run relationship between inflation and economic growth. Similarly, the Johansen (1988) and Johansen and Juselius (1990) maximum likelihood test procedure is an efficient technique for testing the co-

integrating relationship between the concerned time series variables. This procedure gives two likelihood ratio (LR) tests for the number of co-integrating vectors, namely, the trace test and the maximum Eigen value test.

Engle and Granger (1987) show that if two variables GDP^*_t and CPI^*_t are co-integrated, i.e., there is a valid long-run relationship, and then there exists a corresponding short-run relationship. This is popularly known as the *Granger's Representation Theorem*. Hendry's (1979, 1995) general-to-specific approach has been applied in this case where the Error Correction model (ECM) is used in the following form:

$$\Delta GDP^*_t = \alpha_1 + \sum_{j=0}^n \beta_1 \text{Lag} \Delta CPI^*_t + \sum_{i=1}^m \beta_2 \text{Lag} \Delta GDP^*_t - \beta_4 E_{C1t-1} + e_1 \quad (6)$$

$$\Delta CPI^*_t = \alpha_1 + \sum_{j=0}^n \beta_2 \text{Lag} \Delta GDP^*_t + \sum_{i=1}^m \beta_3 \text{Lag} \Delta CPI^*_t - \beta_5 E_{C2t-1} + e_2 \quad (7)$$

where Δ denotes the first difference operator, E_{C1t-1} and E_{C2t-1} are error correction terms, n and m are the number of lag lengths (determined by Akaike's Information Criteria (AIC) and e_1 and e_2 are random disturbance terms. Here i begins at one and j begins at zero in order for the series to be related within a structural ECM (Engle and Yoo, 1991). Finally, $0 \leq \beta_4$, $0 \leq \beta_5$ should hold for the series to converge to the long run equilibrium relation. According to this approach, three lags of both the explanatory and dependent variables and one lag of the residual from the co-integration regression have been included. The error correction terms E_{C1t-1} and E_{C2t-1} (which are the residual series of the co-integrating vector normalized for GDP^*_t and CPI^*_t) measure deviations of these series from the long-run equilibrium relations.

DATA AND MODEL RESULTS

The conceptual models discussed have been used in (1) to (7) an annual data of real GDP and CPI for the period of 1980 to 2011 retrieved from the IMF International Financial Statistics CD-ROM for the Qatar and WDI 2012. For the first part of the empirical analysis, i.e., the relationship between

inflation and economic growth, logs of real GDP (GDP^*_t) and CPI (CPI^*_t) have been considered. Further, real economic growth rates RGDP are calculated from the difference of logs of real gross domestic product (real GDP at 1995 prices). Likewise, inflation rates CPI are calculated from the difference of logs of CPI (2005 = 100).

For the second part of the analysis, bivariate relationship is explored between inflation and growth, Table.1 depicts the joint frequency distribution of the two variables. The annual percentage change in inflation rate is compared with economic growth rate. Interestingly, annual average inflation appears to exhibit positive relationship with growth rate, where the mean and median growth rates increase as inflation rate decrease.

Table 1: Summary Statistics of Annual Percentage change of Inflation and Growth Rate (1993 – 2005)

Variable	Observations	Mean	Median	Correlation Coefficient
Economic Growth rate	13	0.0712	0.044	0.0213
Inflation Rate	13	0.0218	0.0213	

It can be seen that both inflation and economic growth share a positive relationship. This positive relationship implies that higher inflation is positively correlated to growth.

In Table 2, results of the unit root tests have been reported. The tests for non-stationarity show that ΔGDP^*_t is stationary based on DF, ADF, and PP, except for KPSS tests. In case of the first difference log of inflation, DF, PP, and ADF tests succeed. Since the DF, ADF and PP tests are preferable to KPSS it can be concluded that the first difference log of inflation is also stationary, I(1). Thus the findings of unit root tests suggest that both the variables ΔGDP^*_t , ΔCPI^*_t and GDP^*_t are integrated of order zero. Further, Table 2 shows that CPI^*_t is integrated of order one based on the DF, ADF, PP, and KPSS tests. Therefore, CPI^*_t non stationary I(0).

Table 2: Unit Root Tests with DF, ADF, PP, and KPSS

Decision	KPSS		PP		ADF		DF		DECISION
Variables	With trend	Without trend	With trend	Without trend	With trend	Without trend	With trend	Without trend	
ΔGDP^*_t	0.36 I(0)	0.047 I(0)	-9.27*** I(1)	-8.80*** I(1)	-4.47*** I(1)	-4.17*** I(1)	-4.80*** I(1)	-4.44*** I(1)	I(1) Stationary
ΔCPI^*_t	0.086 I(0)	0.097 I(0)	-4.40*** I(1)	-4.76*** I(1)	-4.16*** I(1)	-4.50*** I(1)	-4.62*** I(1)	-4.57*** I(1)	I(1) Stationary
GDP^*_t	0.50 I(0)	0.50 I(0)	-5.16*** I(1)	2.34 I(0)	-3.62* I(1)	3.75** I(1)	-4.40*** I(1)	3.89*** I(1)	I(1) stationary
CPI^*_t	0.094 I(0)	0.21 I(0)	-2.82 I(0)	-2.43 I(0)	-2.71 I(0)	-2.32 I(0)	-3.03* I(1)	-2.39** I(1)	I(0) Non-stationary

Notes:

- a) *, ** and *** means significant at 10-percent, 5-percent and 1 percent levels respectively.
- b) Lag length for ADF tests have been decided on the basis of AIC.
- c) Maximum Bandwidth for PP and KPSS tests have been decided on the basis of *Newey-West* (1994).
- d) All tests have been performed on the basis of 5-percent significance level using Econometric Views5 Package.
- e) The DF, ADF and PP tests are based on the null hypothesis of unit roots while the KPSS test assumes the null hypothesis of stationarity.

In Tables 3 and 4, the estimated results of the relationship between ΔGDP^*_t and ΔGDP^*_t have been reported. They show that there is and positive long-run relationship between CPI and real GDP in Qatar which in turn implies a long-run *positive* relationship between inflation and economic growth for the country. The coefficients are statistically insignificant and positive for both regressions (1) and (2). Furthermore, Tables 3 and 4 illustrate that, on average, a 1-percent increase in CPI in Qatar leads to increase in real GDP by 1.35 percent. On the other hand, on average, a 1-percent increase in the real GDP leads to increase in CPI rate by 0.039 percent. These results are statistically insignificant.

Table 3: Estimation of the Real GDP Model (1) Using OLSM

$$GDP^*_t = \alpha + \beta CPI^*_t + \beta_1 Time + \varepsilon_1$$

Variable	Coefficient	SE	t-statistic	Sig
Constant	-1.97	8.23	-0.24	0.81
CPI^*_t	1.35	1.81	-0.74	0.47
Time	0.052	0.039	1.34	0.210
Mean dependent variable	R-Squared			0.91
4.77				
S.D. dependent variable	Adjusted R-Squared			0.90
0.343				
AIC	-1.37	S.E. of Regression		0.11
F-statistics	52.89	Sum Squared Residual		0.12
Prob.(F-statistics)	0.0000	D.W.Statistic		1.38
Schwarz Criterion	-1.24			

Table 5: Estimation of the CPI Model (2) Using

$$OLSM \quad CPI^*_t = \alpha + \beta_{11} GDP^*_t + \beta_{12} Time + \varepsilon_2$$

Variable	Coefficient	SE	t-statistic	Sig
Constant	4.39	0.220	19.94	0.000
GDP^*_t	0.039	0.052	0.75	0.47
Time	0.0018	0.0044	4.04	0.0023
Mean dependent variable	R-Squared			0.64
4.70				
S.D. dependent variable	Adjusted R-Squared			0.60
0.067				
AIC	-4.91	S.E. of Regression		0.019
F-statistics	124.38	Sum Squared Residual		0.0035
Prob.(F-statistics)	0.000	D.W.Statistic		0.51
Log-likelihood	34.92	Schwarz Criterion		-4.78

The findings of the estimated equations (1) and (2) are :) there is a linear causation between CPI and real GDP in Qatar. The estimated coefficients are statistically insignificant and positive implying that both CPI and real GDP affect each other positively..

Table 5 shows the DF, ADF, PP, and KPSS unit root tests for residuals of equations (1) and (2), i.e., ε_1 and ε_2 . The results suggest that the residuals are integrated of order one, I(0). Therefore, it can be concluded that the two series, ΔGDP^*_t and ΔCPI^*_t are co-integrated and thus a valid and stable long-run relationship exists between inflation and economic growth in Qatar.

Table 6: Unit Root Tests for the Residuals of equation (1) and (2)

Error	DF	ADF	PP	KPSS	Decision
ε_1	-2.57 I(1)	-2.15 I(1)	-2.16 I(1)	0.26 I(0)	I(1)
ε_2	-3.47 I(1)	-3.30 I(1)	-3.43 I(1)	-0.21 I(0)	I(1)

Notes:

- a) Lag length for ADF tests have been decided on the basis of AIC.
- b) Maximum Bandwidth for PP and KPSS tests have been decided on the basis of *Newey-West* (1994).
- c) All tests have been performed on the basis of 5-percent significance level using Econometric Views 4 Package.
- d) The DF, ADF and PP tests are based on the null hypothesis of unit roots while the KPSS test assumes the null hypothesis of stationarity.

Moreover, the results for Johansen maximum likelihood test reported in Table 6 shows the acceptance of the null hypothesis of co-integration between economic growth (ΔGDP^*_t) and inflation (ΔCPI^*_t). In particular, the computed trace, the maximum Eigen value statistics and their corresponding critical values indicate that the null hypothesis of co-integration ($r = 1$) can be accepted under both of these tests. Both maximum Eigen value and trace tests indicate no co-integrating equation. This reconfirms there is no long-run relationship between inflation and economic growth in Qatar.

Table 6: Johansen Test for Co-integration

 ΔGDP^*_t and ΔCPI^*_t

1-percent Critical Value	5-percent Critical Value	Test Statistics	Null Hypothesis
Maximum Eigen value Test			
18.63	14.07	10.26	None
6.65	3.76	2.83	At most 1
Trace Test			
20.04	15.41	13.10	None
6.65	3.76	2.83	At most 1

Note: The results reported in the above table are based on the assumptions of a constant and a linear trend in the data with optimal lag length 3. AIC and LR tests have been used to determine the optimal lag length that makes the residuals white noise.

ϕ Mackinnon Haug-Micheil (1999).

The second stage of the Engle-Granger procedure comprises of the estimation of the ECM. Sargan (1984) uses the error correction mechanism and later it has been popularized by Engle and Granger who corrected that for disequilibrium. The ECM has several advantages: first, the ECM incorporates both the short-run and long-run effects assuming that the variables are co-integrated. The second one is that assuming co-integration; all the terms in the model are stationary so that standard regression techniques are valid (Harris, 1995). The estimated coefficients of the error correction term (long-run effects) and the lagged values of the two series (short-run effects) are presented in the table 7.

Table 7: The Error Correction Model

Variables Equation	ΔCPI^*_t	ΔGDP^*_t
Constant	0.022)188.16 (	0.166)1.28(
$E_{C_{t-1}}$	1.000 (207.66)*	-0.33 (-0.88)
$LAG2 \Delta GDP^*_t$	-0.00026 (-0.61)	-0.40 (-0.88)
ΔCPI^*_t	-	-1.09 (-0.21)
$LAG1 \Delta CPI^*_t$	-0.0024 (-0.52)	-2.13 (-0.45)
ΔGDP^*_t	-0.00117 (313.77)*	-
Adjusted R ²	0.99	0.39
D.W.Statistics	1.92	1.77
Serial Correlation	0.39	0.087
Ramsey Test	0.41	1.37
Normality	3.85	0.63
Heteroscedasticity	0.25	0.39

Notes: 1. Figures in parentheses are *t-value* and .
*(**) denotes rejection of null hypothesis
at 1% and 10% significance level

- For diagnostics, Godfrey's (1978a, 1978b) LM test for serial correlation, Ramsey's (1969, 1970) RESET test for functional form, White's (1980) general heteroscedasticity test for heteroscedasticity and for normality, Jarque-Bera (1980) and Bera-Jarque (1981) tests have been performed.

The empirical results show the existence of short-run and long-run relationships between inflation (CPI) and economic growth (RGDP) in Qatar.

The estimated coefficients of the error correction terms (β_5) are statistically significant at 1-percent level for CPI to real GDP with positive signs. On the other hand, 33 percent (error correction term -0.33) of the deviation of the CPI from its long-run equilibrium level is corrected each year. The estimated results in the ECM also show that short-run changes in real GDP affect CPI negatively. Therefore, economic growth rates affect inflation rates negatively in Qatar.

CONCLUSIONS

This paper explores the empirically relationship between inflation and economic growth in the context of Qatar, between 1980-2011 through co-integration and error correction models.

The test for non-stationarity show that the first difference log of economic growth is stationary based on DF, ADF, and PP, except for KPSS tests. In the case of the first difference log of inflation; DF, PP, and ADF tests succeed although the KPSS test fails. Since the DF, ADF and PP tests are preferable to KPSS it can be concluded that the first difference log of inflation is also stationary, I(1). Thus the findings of unit root tests suggest that both the variables is the first difference log of economic growth and the first difference log of inflation, are integrated of order one.

The estimated results of the relationship between the first difference log of economic growth and the first difference log of inflation show that there is no long-run relationship exist between inflation and economic growth in Qatar between 1993 to 2005 which in turn implies a long-run positive relationship between inflation and economic growth for the country. The coefficients are statistically insignificant and positive, on average, a 1-percent increase in CPI in Qatar leads to increase in real GDP by 1.35 percent. On the other hand, on average, a 1-percent increase in the real GDP leads to increase in CPI rate by 0.039 percent. These results are statistically insignificant.

These results imply that: (a) there is a linear causation between inflation and economic growth in Qatar. (b) Both inflation and economic growth affect each other positively.

The results of the residuals suggest that they are integrated of order one, I(1). Therefore, it can be concluded that the two series, the first difference log of economic growth and the first difference log of inflation are co-integrated; this implies that a valid and stable long-run relationship exists between inflation and economic growth.

The estimated coefficients of the error correction terms (β_5) are statistically significant at 1-percent level for CPI to real GDP with positive signs. On the other hand, 33 percent (error correction term -0.33) of the deviation of the CPI from its long-run equilibrium level is corrected each year. The estimated results in the ECM also show that short-run changes in real GDP affect CPI negatively. Therefore, economic growth rates affect inflation rates negatively in Qatar

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