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A Comparative Analysis of the Effects of Price Instability and Output Volatility on Economic Growth

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Abstract

Historical data indicate that the relationship between inflation and output does not align closely with the Philips curve's implications. Since the late 1980s, monetary policy has prioritized price stability as a key component of sustainable long-term economic growth. This emphasis reflects policymakers' assumption that output volatility poses less risk to long-term growth than inflation volatility, though this assumption lacks empirical support in the literature. To address this gap, this study investigates the impact of inflation and output volatility on economic growth by analyzing panel data from 1990 to 2020 across 68 countries. Fixed Effect Models are employed to account for country-specific, time-invariant factors that may influence the relationship between volatilities and growth. The findings reveal a significant negative impact of output volatility on economic growth, even when inflation volatility is accounted for, suggesting that policymakers should consider output volatility alongside price stability to support sustained economic growth.

Keywords: Inflation volatility, Output Volatility, Phillips Curve, Economic Growth

Authors:

Nadeem Iqbal: (Corresponding Author)
Assistant Professor, Department of Economics, University of Peshawar, KP, Pakistan.
Email: (nadeemiqbal@uop.edu.pk)

Aisha Rehman: PhD Scholar, Department of Economics, University of Peshawar, KP, Pakistan.

Wasim Shahid Malik: Professor, Department of Economics, University of Peshawar, KP, Pakistan.

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Title

A Comparative Analysis of the Effects of Price Instability and Output Volatility on Economic Growth

Abstract

Historical data indicate that the relationship between inflation and output does not align closely with the Philips curve's implications. Since the late 1980s, monetary policy has prioritized price stability as a key component of sustainable long-term economic growth. This emphasis reflects policymakers' assumption that output volatility poses less risk to long-term growth than inflation volatility, though this assumption lacks empirical support in the literature. To address this gap, this study investigates the impact of inflation and output volatility on economic growth by analyzing panel data from 1990 to 2020 across 68 countries. Fixed Effect Models are employed to account for country-specific, time-invariant factors that may influence the relationship between volatilities and growth. The findings reveal a significant negative impact of output volatility on economic growth, even when inflation volatility is accounted for, suggesting that policymakers should consider output volatility alongside price stability to support sustained economic growth.

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Contents

Authors:

Nadeem Iqbal: (Corresponding Author)
Assistant Professor, Department of Economics, University of Peshawar, KP, Pakistan.
Email: (nadeemiqbal@uop.edu.pk)

Aisha Rehman: PhD Scholar, Department of Economics, University of Peshawar, KP, Pakistan.

Wasim Shahid Malik: Professor, Department of Economics, University of Peshawar, KP, Pakistan.

Introduction

Stabilization of the general price level along with minimizing fluctuations in output are the overarching objectives of monetary policy. Prioritization of these two objectives has implications for volatility of output and inflation rate that in turn have effects on economic growth in the long run. If more weight is put on price stability as compared to output stabilization in monetary policy decisions, then the inflation rate remains within the acceptable range but at the cost of volatile output. Similarly, putting more weight on output stabilization makes the inflation rate volatile. Which volatility hampers economic growth the most remains a question that needs to be answered through research. In the late 1980s, there was a shift in

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monetary policy focus from output growth to price stability. The main reason behind this policy regime shift was the theoretical belief that price stability would provide an enabling environment for economic growth in the long run. However, this argument ignores the effect of strict inflation targeting on output volatility, which may hamper growth momentum. So, the benefits of price stability in the long run are compromised if output is not stable in the short run.

At a more basic level, the issue can be highlighted in terms of social loss function. Every individual wants to maximize their utility which depends on consumption and leisure. At the aggregate level, this translates to maximizing the social welfare function or minimizing the social loss function, which has price level and output as its arguments. Practically, public policy aims at minimizing deviations in output and inflation rates from their respective targets or normal values. So minimum variance of both output and inflation rate is desirable for the smooth functioning of the economy. However, both variances cannot be minimized simultaneously; the minimization of one, through policy intervention, renders the other to be out of control. So, from the policy's perspective, there is a volatility trade-off or variance tradeoff between output and inflation rate.

Until the 1970s the volatility tradeoff between output and prices was not very famous, therefore, the debate was about the level tradeoff between these two variables. This latter tradeoff was summarized by a famous empirical relationship – the Philips curve. Later on, it was found that the Phillips curve relationship was flawed and there was no policy tradeoff between inflation and output or unemployment. Notwithstanding the failure of the Phillips curve to guide monetary policy, the volatility tradeoff still remains there in academic and policy debates. The issue is especially important for developing economies, which are at an early stage of development and are prone to external shocks that make their weak output base unstable. Developed economies have already grown and their prime concern is the sustainability of economic activity with full employment and a low inflation rate. Therefore, the shift of policy focus from output and employment to price stability put developing economies at risk of being permanently in a low-growth trap. This is because they are unable to stabilize output due to inflation targeting; this short-term volatility in output hampers long-run growth momentum.

Literature Review

There is abundant literature available in this area, but it lacks one important aspect. This literature can be categorized into three groups with regard to the objectives of the studies. The first of these three groups consists of studies that look at the relationship between inflation and growth. The main conclusion drawn from these studies is that there is a negative relationship between inflation and growth (Friedman, 1977; Fisher, 1993; Barro, 1996; Zhang et al., 2023). The second group of studies focuses on the relationship between inflation volatility and economic growth. Barro (1995), Motley (1994), Judson (1999), and Guo Lim (2024) estimate the relationship between inflation volatility and economic growth. For the analysis, some of them took time series data while others used panel data, but they reached a similar conclusion that the coefficient of inflation volatility is negative and significant in the regression of economic growth. The third group consists of studies that estimate the relationship between output volatility and economic growth. This is the area where literature is scarce, and it does not reach any conclusion. For instance, Abdelsalam (2020) concludes that there is a positive effect of inflation or output volatility on growth due to the lower opportunity cost of productivity. Harald Badinger (2008), on the other hand, discussed the problem of endogeneity and concluded that there is a negative effect of output volatility on economic growth. Despite the existence of literature on different aspects of the relationship between inflation rate, output, and long-run economic growth, there is limited evidence available on comparing the effects of output and inflation volatilities on economic growth. For policymakers to make informed decisions, the evidence regarding this comparison is of utmost importance. According to the Phillips curve, there is a stable, long-term relationship between inflation and unemployment. It means that high inflation and high unemployment cannot co-exist i.e. there is a trade-off between inflation and unemployment. If inflation is controlled through fiscal and/or monetary policies, then there will be an increase in unemployment. If there is an increase in the aggregate demand then unemployment will reduce but inflation will rise.in this relationship is in line with the Keynesian theory which attributes this negative relationship to the nominal rigidity. The data of 1970, however, did not support the Keynesian hypothesis that there is such a trade-off between inflation and unemployment and also shows a different situation i-e high inflation accompanied by high unemployment, and this type of situation is called stagflation. It was Milton Friedman who challenged Phillips's curve and developed the critique of the original Phillips curve there is no such thing as a tradeoff between inflation and unemployment because of the presence of the natural rate of

unemployment which is determined by the real factors in the economy and the long run Phillips curve which is a vertical straight line. According to Friedman Phillips curve is a short transitory relationship and long run the wage earners stick to money illusions and have no expectation that the prices will continue to rise. According to the monetarists, the Phillips curve becomes perfectly inelastic with respect to the rate of change in the price level at the natural rate of unemployment in the long run. According to James Tobin and Keynesian suggest that a Phillips curve relation exists which is quite flat at high levels of unemployment but tends to become vertical as the economy approaches critically low levels of unemployment. So from the whole discussion, it is concluded that in modern macroeconomics there is no tradeoff between inflation and unemployment or inflation and output but the volatility trade exists, in simple words, we conclude that in the Philips curve, we studied that there is a tradeoff between inflation and unemployment mean that if we reduce inflation than unemployment will increase and vice versa and volatility trade mean that if we stable inflation then the output will fluctuate again and again e.g the price of oil, dollar rate, and another increment which come from supply side due to which the economy face inflation. If we take the example of the oil prices nowadays if the inflation is increasing and the state bank commits that it will not let inflation more than 5%, so they will tight the policy due to which the output will decrease, and when the supply condition become better and the price of the oil will decrease then State bank will reverse the policy and output will become better and state bank will do this process again and again to keep the inflation stable and the output will be volatile.

Motivation

The motivation for this study came from recent post-COVID-19 price hikes that resulted from supply chain disruptions and increased demand for commodities due to economic recovery after lifting lockdowns. High inflation rates are observed all over the world but developing countries are especially in the policy dilemma because they also face balance of payments problem and consequent exchange rate risk. So, it is a challenge for their monetary policy to achieve its objectives at minimum cost. If they control inflation more tightly then it will be controlled at the cost of lost output and the latter will become more volatile thereby creating more unemployment. If on the other side, the policy makers take an expansionary policy stance then the inflation rate will further increase but output loss will be lower. In this scenario, policymakers, to make informed policy decisions, need evidence on the comparative costs of output and inflation volatilities.

Problem Statement

The main objective of monetary policy is price stability along with stable output. In the contemporary world, central banks put more weight on inflation due to which the output remains more volatile against shocks that hit the economy. So, in the long run, price stability is achieved at the cost of making output more volatile in the short run. This runs the risk of the very objective of price stability as volatile output, just like inflation, hampers long-run economic growth. Previous literature focuses more on inflation and growth nexus, and the effect of inflation volatility or output volatility on economic growth. But there is no evidence, to the best of our knowledge, on comparative analysis of the effects of inflation and output volatilities on economic growth. Our study hypothesizes that output volatility hampers economic growth even if the effect of inflation volatility is controlled. This needs to estimate the effect of one volatility on economic growth in the presence of the other volatility, which this study aims to do.

Objectives

The main objectives of the paper are:

- To estimate and compare the effects of output and inflation volatilities on economic growth in a panel of countries.

Hypotheses

- Higher inflation volatility reduces economic growth.
- Higher output volatility reduces economic growth.
- Output volatility is harmful to economic growth, even if the effect of inflation volatility is controlled.

Significance of Study

This study is very important in macroeconomics to understand the relationship between economic growth with inflation volatility and output volatility. Many studies have found the relationship between inflation and economic growth but no study, to our knowledge, is available that compares the effects of inflation and output volatilities on economic growth. This study aims at finding, through comparative analysis, which of the two volatilities is more harmful. This will be an important piece of evidence for researchers in the field. The evidence will be especially important for policymakers who have to

decide the weight attached to each of these volatilities in the social loss function.

The rest of the paper proceeds as follows. Section 2 consists of the theoretical framework and empirical methodology. Moreover, it elaborates construction of variables and mentions data sources. Section 3 explains empirical findings while section 4 concludes the study.

Methodology

Theoretical Framework

This study derives its theoretical foundation from neo classical theory of volatility trade-off between inflation and output. This theory is based on aggregate demand and aggregate supply framework and is considered a substitute for the Phillips curve relationship which failed to hold in the 1970s.

The volatility which is explained in the above paragraph is discussed in the model which is as follows.

$$y_t = \propto -\psi r_t + v_t \quad (1)$$

$$p_t - p_{t-1} = \phi y_t + p_t^e - p_{t-1} + \mu_t \quad (2)$$

$$r_t = r + \gamma(\ {}^{e}_{Pt} - 0) \quad (3)$$

$$p = E_{t-1}(p_t) \quad (4)$$

Here y means for natural log of real output p means price level; v and u are stochastic shocks and r is the interest rate. Equations 1 and 2 are the aggregate demand function and the supply side of the goods market, which is a standard expectation augmented by Phillips's curve. Equation 3 is the central bank reaction function. Equation 4 defines rational expectation. By simple substitution, equations 5 and 6 are derived:

$$y_t = -\psi\gamma E_{t-1}(p_t) + v_t \quad (5)$$

$$p_t = \phi y_t = E_{t-1}(p_t) + \mu_t \quad (6)$$

By taking expectation and substitution, equations 5 and 6 become:

$$y_t = v_t$$

$$p_t = \phi y_t + u_t$$

These reduced-form lead to the following volatility expressions:

$$var\ (y) = \sigma_v^2$$

$$var\ (p) = \phi^2\sigma_v^2\ + \sigma_u^2$$

After deriving the output and price variance the revised solutions are:

$$y_t = (\psi\gamma u_t\ + v_t)/(1 + \psi\gamma\phi)$$

$$p_t = \Phi y_t + u_t$$

The results indicate that demand shocks have a relatively minor impact on real output, whereas supply shocks lead to a more significant effect on real output. Consequently, monetary policy encounters a persistent volatility trade-off, but it does not experience a lasting trade-off between the average real output level and inflation.

Empirical Methodology

We check the effect of output and inflation volatilities on the GDP growth rate. We estimate this relationship in a panel of 68 countries covering the time period 1990 to 2020. Countries are at different stages of development, so single country study does not show the complete picture. Moreover, we use a five-year window to measure standard deviations of output and inflation rate and average values of other variables. Such windows cannot be used in a single country, especially when high-frequency data are unavailable. Our main equation is as follows:

$$y_{it} = \alpha_i + \gamma t + \psi X_{it} + \beta Z_{it} + v_{it}$$

Where,

y_{it} represents the growth rate of real GDP in country i at time period t,

Z_{it} is the vector of control variable which consists of trade openness, investment to GDP ratio, and labor force growth rate.

X_{it} is a vector of the main variables of concern - inflation rate and output volatilities.

ψ (β) are row vectors, which contain coefficients attached to two volatilities (control variables),

α_i and γt are country and time-specific effects,

and v_{it} is the error term.

Country-specific effects represent idiosyncratic characteristics of countries that depend on development stage, institutions, size, etc. while time-fixed effects represent global economic conditions. These two effects are very much relevant to our empirical investigation. However, we also use specification tests to identify whether or not the use of a way fixed effect model is appropriate.

The Hausman test is used to find out whether the results of the fixed effect model or the random effect model are more consistent and preferred. Under the null hypothesis of the Hausman test, the random effect estimator is more efficient than the fixed effect estimator though both are consistent; therefore, the RE estimator is superior. The alternate hypothesis states that the FE estimator is consistent, while RE is not, hence the former is preferred. The Hausman test

is based on chi-square distribution and is computed as:

$$H = [\alpha_c - \alpha_e]'[COV_c - COV_e]^{-1}[\alpha_C - \alpha_e]$$

Where α_c and α_e are the coefficient vectors from the consistent and efficient estimator respectively. COV_c and COV_e are the covariance matrix of consistent and efficient estimators respectively.

While the Hausman test is used to choose between FE and RE estimators, the Likelihood ratio test is used to select between different versions of fixed effect mode. i.e. Cross section fixed, time fixed, or two-way FE model. The formula of the LR test is given below:

$$LR = -2\,Ln\left[\frac{L(Model_1)}{L(Model_2)}\right] = 2\,[loglik(Model_2) - loglik\,(Model_1)]$$

Where $L(Model_1)$ and $L(Model_2)$ represent the likelihood of model 1 and model 2. And $loglik(Model_2)\ and\ loglik\,(Model_1)$ show the natural log of model 1 and 2 final likelihood. The likelihood test follows the chi-square distribution.

Construction of Variables:

Inflation Volatility

Inflation volatility means short-term fluctuations in the inflation rate. Volatility is measured by the standard deviation in a 5-year window of inflation rate measured through the GDP deflator.

Economic Growth

Economic growth as the annual percentage growth rate of GDP measured at constant dollars of 2015.

Trade Openness

Trade openness shows the relationship of a country's trade to the outside world and how strong it is. We measure it as the ratio of the sum of exports and imports to GDP.

Investment

Investment is either a net addition to the country's capital stock or it covers the depreciation of existing capital stock. We measure this variable as the ratio of gross fixed capital formation and GDP.

Inflation Rate

Inflation rates refer to decreasing value of currency and increasing prices of goods and services. We measure the inflation rate as the percentage growth rate of the GDP deflator.

Output Volatility

Output volatility represents short-term fluctuations in economic activity. GDP is a trend variable, which can be decomposed into permanent and transitory components. To find short-term fluctuations we remove trends from GDP. We fit the trend in the logarithm of GDP and then estimate the residual, which represents the state of the business cycle. We then measure volatility using the standard deviation of residual in the 5-year window.

Data and Data Source

The study uses secondary data for 68 countries covering time period 1990 to 2020. The choice of countries is consistent with empirical literature on economic growth. In particular, we follow (Feng, 2020) for the selection of countries (Feng, 2020) take 89 countries with a variety of characteristics. We initially considered the same 89 countries but then dropped the countries for which data on our variables are missing for at least five consistent years. The choice of time period is based on the historical turning point of monetary policy focus from economic growth to price stability. We use 5-year windows for standard deviations of the inflation rate and de-trended GDP and average values of all other variables. Data have been taken from World Development Indicators (WDI).

Empirical Findings

Our main hypothesis is that output volatility hurts economic growth even if the effect of inflation volatility is controlled. To satisfy this objective, we estimate a regression of economic growth on volatilities of inflation rate and output along with a set of three control variables. We estimate this regression using a fixed effect estimator, consistent with the results of the Hausman test and the Likelihood ratio test. We also do sensitivity analysis to check the robustness of our results. For this, we changed the model's specification or dropped extreme observations. Moreover, consistent with somewhat old literature we also estimate the effects of the inflation rate and business cycle, instead of their volatilities, on economic growth.

The results of our main regression are given in Table 1. The GDP growth rate has been regressed on the inflation rate and output volatilities along with three control variables. We find interesting results. First, inflation volatility has a negative effect on output growth and the effect is statistically significant at a 1% significance level. This result is consistent with the existing empirical literature and is aligned with the economic theory. Second, we find a negative effect of

output volatility on economic growth; this effect too is statistically significant at a 1% significance level. The result is consistent with our main hypothesis that output volatility hurts economic growth even if the negative effect of inflation volatility is controlled. It means that if the monetary policy stabilizes the inflation rate without putting due weight on output stabilization, then it cannot provide an enabling environment for long-run sustained economic growth. The state of the economy, at any particular point in time, represents business opportunities and future prospects. If output remains volatile, especially when recessions are more frequent, then businesses are reluctant to invest in the economy. The lack of investment further deteriorates the business situation and puts a drag on economic growth.

Third, we find positive effects of investment to GDP ratio and labor force growth rates on GDP growth rate; both effects are consistent with economic theory and empirical literature on growth. The results are also statistically significant at a 1% level of significance. Fourth, we find the insignificant effect of trade openness on economic growth. The possible reason for this insignificant effect can be the time period that we consider in our study. The fast-growing economies mostly grew at fast rates before 1990 while their openness was also increasing at that time. During our sample period, newly industrialized countries were experiencing declining growth rates along with high trade openness. On the other hand, other emerging economies were experiencing high growth rates along with increasing trade openness. The combination of these two different trends makes the effect of trade openness insignificant.

R square value is almost 60% which shows the goodness of fit of our model. The F statistics and its probability value show the appropriateness of the overall model. The results of the Huisman test indicate the appropriateness of using a fixed effect estimator. The probability value in the Huisman test is less than 0.001 means that the null hypothesis is rejected, so the random effect estimator is inconsistent. Then we use the likelihood ratio test, which is used for different versions of the fixed effect model, i.e. whether it should be cross-section fixed, time fixed, or both. As the probability values of the three versions of the test are less than 1%, so the flexible model is relevant for our estimation.

Consistent with the empirical literature on economic growth we also estimate the same regression including initial GDP as an additional regressor. This is to capture the convergence effect. For this specification, we use only the time-fixed effect as countries' fixed effects are perfectly collinear with initial GDP. Our results show that there is a negative effect of initial GDP on the growth rate, which shows the validity of the convergence hypothesis. The results are statistically significant (table 1). The important take from this specification is that our main result of negative effects of the inflation rate and output volatilities on economic growth remains robust to this change in specification.

Table 1

Effect of Inflation and Output Volatilities On Economic Growth

	Specification 1		Specification 2	
Variables	Coefficient	SE	Coefficient	SE
Constant	6.444***	1.284	11.521***	2.014
Investment	16.897***	2.686	13.655***	1.918
Labor Growth	0.532***	0.117	0.355***	0.087
Trade Openness	0.009	0.010	-0.007*	0.004
Inflation Volatility	-0.002***	0.000	0.002***	0.000
Output Volatility	-28.440***	3.014	-21.870***	2.850
Initial Output			-0.203	0.067
R-squared	0.589		0.414	
F-statistics	6.126		25.450	
Prob Value	0.000		0.000	
Hausman Stats	18.601		19.099	
Prob Value	0.000		0.000	
Cross-section F	2.250			
Prob Value	0.000			

	Specification 1		Specification 2	
Variables	Coefficient	SE	Coefficient	SE
Period F	25.20		19.739	
Prob Value	0.000		0.000	
Cross-Section/Period F	3.673			
Prob Value	0.000			

Dependent variable: Real GDP Growth Rate

*Note: ***, **, * represent significance at 1%, 5%, 10%, respectively. SE represents the standard error of coefficient estimate*

Next, we do a sensitivity analysis to check the robustness of the results. In the first step, we estimate the same regression but with per capita GDP growth rate as the dependent variable. In this case, investment to GDP ratio and trade openness are the two control variables. Results of this specification (table 2) are consistent with those found in Table 1; the effects of inflation rate and output volatilities on economic growth are negative and statistically significant. The effect of control variables also remains stable to change in specification. The Hausman test and likelihood ratio test also justify the specification used in the model.

Table 2

Effect of Inflation and Output Volatilities On Per Worker GDP Growth Rate

	Specification 1		Specification 2	
Variables	Coefficient	SE	Coefficient	SE
Constant	5.469***	1.284	5.041***	1.928
Investment	16.346***	2.74	12.700***	2.038
Trade Openness	0.007	0.01	-0.006	0.004
Inflation Volatility	-0.007***	0.00	-0.00***	0.000
Output Volatility	-27.547**	3.01	-21.87***	2.998
Initial Output			-0.20	0.07
R-squared	0.535		0.281	
F-statistics	4.998		15.542	
Prob Value	0.000		0.000	
Hausman Stats	17.913		18.087	
Prob Value	0.000		0.001	
Cross-section F	2.687			
Prob Value	0.000			
Period F	22.158		13.149	
Prob Value	0.000		0.000	
Cross-Section/Period F	3.673			
Prob Value	0.00			

Dependent variable: Real Per Worker Growth Rate

*Note: ***, **, * represent significance at 1%, 5%, 10%, respectively. SE represents the standard error of coefficient estimate*

In the second step of sensitivity analysis, we estimate our initial regression but ignore extreme values of inflation rate volatility. In our sample, the fluctuation of the inflation rate is much higher; the inflation rate ranges from single digits to five digits. These extreme values may have an influential effect on our main results. Therefore, we drop extreme values and re-estimate the regression. The threshold value used to drop observations is set at 100 for the standard deviation of the inflation rate; only those countries' years are used for which the standard deviation of the inflation rate is less than 100. Results in Table 3 show the robustness of our main results. Both inflation rate and output volatilities have negative effects on economic growth in specifications with and without initial GDP. The results of control variables also remain the same as found in the initial regression. This shows our results are robust to extreme observations.

Table 3

Effect of Inflation and Output Volatilities On Economic Growth (Inflation Outliers have been dropped)

	Specification 1		Specification 2	
Variables	Coefficient	SE	Coefficient	SE
Constant	6.444***	1.284	11.521***	2.014
Investment	16.897***	2.686	13.655***	1.918
Labor Growth	0.532***	0.117	0.355***	0.087
Trade Openness	0.009	0.010	-0.007*	0.004
Inflation Volatility	-0.002***	0.000	0.002***	0.000
Output Volatility	-28.440**	3.014	-21.870**	2.850
Initial Output			-0.203	0.067
R-squared	0.589		0.414	
F-statistics	6.126		25.450	
Prob Value	0.000		0.000	
Hausman Stats	18.601		19.099	
Prob Value	0.002		0.001	
Cross-section F	2.245			
Prob Value	0.000			
Period F	29.199		19.739	
Prob Value	0.000		0.000	
Cross-Section/Period F	3.615			
Prob Value	0.000			

Dependent variable: Real GDP Growth Rate

*Note: ***, **, * represent significance at 1%, 5%, 10%, respectively. SE represents the standard error of coefficient estimate*

As a final sensitivity test, we check the effect of output and inflation rate volatilities on economic growth separately for boom and recession periods. We categorize a time as a boom (recession) period if the average value of de-trended GDP is found positive (negative) in 5-year windows. We construct dummy variables for boom and recession and then find a product of these dummy variables with the output volatility, which is then used as a regressors. This specification gives separate estimates of output volatility in boom and recession. Results in Table 4 show the robustness of our main findings. Output volatility not only has a negative effect on economic growth in the presence of inflation volatility, but the effect is also the same in two different regimes of the business cycle. It means that output volatility is harmful to economic growth matter the economy is booming or recession. Results of all other variables are also robust to this change in specification.

Table 4

Effect of Inflation and Output Volatilities On Economic Growth In Boom And Recession

	Specification 1		Specification 2	
Variables	Coefficient	SE	Coefficient	SE
Constant	6.283***	1.286	11.332***	2.010
Investment	17.138***	2.686	13.833***	1.914
Labor Growth	0.541***	0.117	0.355***	0.087
Trade Openness	0.008	0.010	-0.007*	0.004
Inflation Volatility	-0.002***	0.000	-0.002***	0.000
Output Volatility positive	-28.415***	3.008	-21.980**	2.840
Output Volatility negative	-27.795**	3.038	-21.184	2.862
Initial Output			-0.201	0.067
R-squared	0.591		0.420	
F-statistics	6.099		23.800	
Prob Value	0.000		0.000	
Hausman Stats	19.563		20.257	
Prob Value	0.000		0.020	

	Specification 1		Specification 2	
Variables	Coefficient	SE	Coefficient	SE
Cross-section F	2.218			
Prob Value	0.000			
Period F	24.391		19.209	
Prob Value	0.000		0.000	
Cross-Section/Period F	3.544			
Prob Value	0.000			

Dependent variable: Real GDP Growth Rate

*Note: ***, **, * represent significance at 1%, 5%, 10%, respectively. SE represents the standard error of coefficient estimate*

As mentioned in the introduction of this section, we also estimate the relationship between the growth rate and average values of the inflation rate and de-trended GDP. This is consistent with somewhat old empirical literature in the framework of the Phillips curve that shows the trade-off between average values of inflation rate and economic activity. Results in Table 5 show that the inflation rate and de-trended GDP both have a negative effect on the GDP growth rate. This shows that not only inflation rate volatility is harmful to economic growth the higher values of the inflation rate do the same. The same is the case with business cycle fluctuations; higher fluctuations lead to less output growth. All other results are the same as those found in the main regression. Moreover, the results of the inflation rate, business cycle fluctuation, and control variables remain the same in specifications with and without initial GDP.

Table 5

Effect of Inflation and Output on Economic Growth

	Specification 1		Specification 2	
Variables	Coefficient	SE	Coefficient	SE
Constant	-2.691***	0.947	2.868***	1.774
Investment	20.185***	2.895	14.351***	2.012
Labor Growth	0.622***	0.126	0.454***	0.09
Trade Openness	0.005	0.011	-0.009*	0.090
Average Inflation	0.009***	0.001	0.007***	0.001
B.Cycle	-1.609***	1.836	-1.151***	1.908
Initial Output			-0.122	0.069
R-squared	0.520		0.360	
F-statistics	4.638		20.226	
Prob Value	0.000		0.000	
Hausman Stats	38.900		26.511	
Prob Value	0.000		0.000	
Cross-section F	1.692			
Prob Value	0.001			
Period F	6.768		8.086	
Prob Value	0.000		0.000	
Cross-Section/Period F	2.178			
Prob Value	0.000			

Dependent variable: Real GDP Growth Rate

*Note: ***, **, * represent significance at 1%, 5%, 10%, respectively. SE represents the standard error of coefficient estimate*

In the final step, we estimate separate effects of business cycle fluctuations on economic growth in boom and recession. All other variables are the same as those in the last specification. As shown in Table 6, our main results are also robust to this change in specification. Inflation rate and business cycle fluctuations have negative effects on economic growth. More importantly, we find that the negative effects of the business cycle are more pronounced in a recession as compared to that in a boom. This shows that though the business cycle fluctuations are harmful to economic growth in both regimes the effect is much higher in recessions. This shows the importance of output stabilization along with price

stability and policy response to output fluctuations is much more needed in recessions.

Table 6

Effect of Inflation and Output on Economic Growth In Boom And Recession

	Specification 1		Specification 2	
Variables	Coefficient	SE	Coefficient	SE
Constant	-2.715***	0.957	2.642***	1.813
Investment	20.157**	2.904	14.338***	2.014
Labor Growth	0.625***	0.127	0.466***	0.092
Trade Openness	0.005	0.011	-0.009*	0.004
Inflation	-0.009***	0.001	0.007***	0.001
B.cycle positive	-0.867	4.350	0.690	3.569
B. cycle negative	-2.146	3.392	-2.433	2.837
Initial Output			-0.116	0.070
R-squared	0.520		0.360	
F-statistics	4.566		18.542	
Prob Value	0.000		0.000	
Hausman Stats	23.717		25.759	
Prob Value	0.000		0.000	
Cross-section F	1.675			
Prob Value	0.001			
Period F	6.612		7.798	
Prob Value	0.000		0.000	
Cross-Section/Period F	2.138			
Prob Value	0.000			

Dependent variable: Real GDP Growth Rate

*Note: ***, **, * represent significance at 1%, 5%, 10%, respectively. SE represents the standard error of coefficient estimate*

Conclusion

According to previous studies, a lot of research has been done on the relationship between inflation and growth, the effect of inflation volatility on economic growth, and the effect of output volatility on growth but no study has estimated the effect of one volatility controlling the effect of the other. In practice, central banks in the modern world put more weight on inflation volatility due to which the output becomes more volatile. We estimate growth regression in a panel of 68 countries and a time span of 190 to 2020 with both inflation rate and output volatilities as regressors. Our results show that both volatilities are harmful to economic growth. The negative effect of output volatility on economic growth is observed even after controlling the effect of inflation rate volatility. This result is robust to different specifications of the empirical model and drops extreme observations.

Our results have clear policy implications. Central banks of developing countries should maintain a balance between output stabilization and price stability. If they put more weight on price stability then output remains volatile, especially against supply shocks. Thus, price stability that is achieved at the cost of output volatility does not remain fruitful for long-term growth.

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Appendix

S.No	Country Name	S.No	Country Name
1	Albania	35	Sri Lanka
2	Armenia	36	Madagascar
3	Azerbaijan	37	Mexico
4	Burundi	38	Mali
5	Benin	39	Mongolia
6	Burkina Faso	40	Malaysia
7	Bangladesh	41	Namibia
8	Bulgaria	42	Niger
9	Brazil	43	Nicaragua
10	Botswana	44	Nepal
11	Central African Republic	45	Oman
12	Cote d'Ivoire	46	Pakistan
13	Cameroon	47	Panama
14	Congo	48	Peru
15	Colombia	49	Philippines
16	Dominican Republic	50	Paraguay
17	Ecuador	51	Russian Federation
18	Egypt	52	Rwanda
19	Gabon	53	Sudan
20	United Kingdom	54	Senegal
21	Ghana	55	El Salvador
22	Guinea	56	Swaziland
23	Gambia	57	Chad
24	Guinea- Bissau	58	Togo
25	Guatemala	59	Thailand
26	Honduras	60	Tunisia
27	India	61	Turkey
28	Iran	62	Tanzania,
29	Jamaica	63	Uganda
30	Jordan	64	Ukraine
31	Japan	65	Uruguay
32	Kazakhstan	66	United States
33	Kenya	67	South Africa
34	Lebanon	68	Zimbabwe