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#### Article

# Revisiting the volatility-growth relationship: Some cross country evidence, 1978-2017

**Cogent Economics & Finance** 

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*Suggested Citation:* Raju, Y. N.; Acharya, Debashis (2020) : Revisiting the volatility-growth relationship: Some cross country evidence, 1978-2017, Cogent Economics & Finance, ISSN 2332-2039, Taylor & Francis, Abingdon, Vol. 8, Iss. 1, pp. 1-23, https://doi.org/10.1080/23322039.2020.1826655

This Version is available at: https://hdl.handle.net/10419/269984

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**Cogent Economics & Finance** 

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/oaef20

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To cite this article: Y N Raju & Debashis Acharya | (2020) Revisiting the Volatility- Growth relationship: Some cross country evidence, 1978–2017, Cogent Economics & Finance, 8:1, 1826655, DOI: 10.1080/23322039.2020.1826655

To link to this article: https://doi.org/10.1080/23322039.2020.1826655

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Received: 15 June 2020 Accepted: 17 September 2020

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Reviewing editor: Aviral Tiwari, Finance and Economics, Rajagiri Business School, India

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## GENERAL & APPLIED ECONOMICS | RESEARCH ARTICLE Revisiting the Volatility- Growth relationship: Some cross country evidence, 1978–2017

Y N Raju<sup>1</sup> and Debashis Acharya<sup>2</sup>\*

**Abstract:** This paper attempts a re-examination of the relationship between the output volatility and economic growth using an annual data set for select 67 countries for the period 1978 to 2017 spanning over 40 years. Towards this objective cross section and panel, regressions are estimated for different country groups namely developing, industrial, high financially integrated (HFI) and low financially integrated (LFI) country groups. Overall, the results indicate that output volatility as a proxy of macroeconomic volatility has negative effect on economic growth. The results appear to be stronger when we include other control variables as part of an information set. The panel regression results support the negative relationship between economic growth and volatility for the developing countries. The financial development indicator indicates significant relation with growth for industrial economies.

Subjects: Macroeconomics; International Economics; Development Economics

Keywords: economic growth; growth volatility; financial development; HP filter Jel Classification: C1; C3; F15; F36; F41; F43; G24

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#### PUBLIC INTEREST STATEMENT

In the last few decades, different economies have been relatively more integrated financially preceded by their integration with trade. In this backdrop macroeconomic volatility namely in terms of output volatility has been a major concern for the economies all over the world. Output volatility is found to have an effect on growth in different economies. This paper revisits this debate and finds some contrasting evidence in volatility growth nexus for the developing, high and low financially integrated economies.





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#### 1. Introduction

The debate on the volatility and growth relationship gained momentum in the literature in the last two and half decades. We find both theoretical and empirical studies examining this link attributing different sources to volatility. As regards the sources of volatility, Turnovsky Stephen and Chattopadhyay (2003) summarize three key sources of volatility. A negative link between volatility and growth is found by Ramey and Ramey (1995), evidenced in his cross-country exercise. Specifically, the study finds adverse relation between mean output growth rates and their volatility. Later, this work is extended by Fatas (2002), Hnatkovska (2005) among others, wherein the general finding points to volatility in reducing the magnitude of economic growth in general and particularly, in those countries that are financially and institutionally underdeveloped. In terms of business cycle, the relationship is found positive if volatility is associated with occurrence of recession. Recession in turn leads to higher research and development (R&D) or say destruction of least productive firms in Schumpeter's words (Loayza et al. (2007)<sup>1</sup>. This whole process generates higher economic growth alongside higher volatility; see Grier and Tullock (1989), Caporale and McKiernan (1996), and Kormendi and Meguire (1985). Inclusion of other volatility measures yield insignificant impact on output, though positive (Gavin and Hausman, 1995). The second strand of literature investigates the relationship between policy instruments' volatility and growth. Aizenman and Marion (1993) examine the effect of policy uncertainty on economic growth in the endogenous growth framework with investment irreversibility. First, the investors' behaviour towards uncertainty about the future affects the long-term growth. Due to uncertainty, firms get wrong signal and tend to invest in a wrong project. Increase in volatility can also lead to reduced investment if the investment is characterised by irreversibility. The authors confirm that policy fluctuations could lead to lower economic growth. Kormendi and Meguire (1985) and Aizenman and Marion (1993) deal with volatility of monetary and fiscal policies affecting output growth. Some of the external sources of volatility such as terms of trade and real exchange rate affecting growth is the engagement in the third strand of literature(Mendoza, 1994, Gavin and Hausman, 1995), but the results are inconclusive on the direction of the relationship.

A few other studies examine the role of financial integration while studying the said growth volatility relationship and related issues. For instance, Mendoza (1994) by applying a stochastic dynamic business cycle model finds that financial integration has little impact on output and consumption volatility. He also notices that volatility rises when the shocks are large and persistent. A few others use dynamic stochastic sticky-price model<sup>2</sup> to explain the importance of monetary and fiscal shocks on output and consumption volatility. In the presence of monetary and or fiscal policy shocks, the change in output volatility and the change in consumption volatility depend on the degree of financial integration (Sutherland, 1996 and Senay, 1998). Aghion and Saint-pual (1998) find that in recession, the cost involved in innovation decreases, which tends to improve productivity and therefore, yield higher economic growth. Further, Grier and Perry (2000) apply bivariate GRACH-M model to examine the link between uncertainty, inflation, and output growth for United States over the period of 1948 to 1996 and they find no evidence to support the relationship.

Apart from the empirical strands discussed above, the theoretical literature on risk-outputgrowth relationship is also remarkably diverse. These studies include price volatility and investment relationship (Abel Andrew, 1983) and Caballero's (1991) negative volatility-investment relationship. The stochastic general equilibrium growth class of models refers to an aggregate risk-growth tradeoff. In these models growth is related to different sources of exogenous risk affecting the economy and interaction with policy variables to derive macro equilibrium; see Grinols and Turnovsky (1994, 1998), Maurice (1994), and Turnovsky Stephen and Chattopadhyay (2003). In view of this ambiguous and mixed evidence on the volatility and growth relationship, the present study is motivated to revisit the issue. Specifically, this paper attempts to examine the effects of output volatility on economic growth for a set of 67 countries (including industrial and developing countries) for the period, 1978 to 2017. The rest of the paper is organized as follows; Section 2 presents the details of data used and the methodology employed. The empirical results are discussed in Section 3 and finally, Section 4 offers some concluding remarks.

#### 2. Data and methodology

The empirical analysis attempted in this paper heavily draws upon the idea of Ramey and Ramey (1995) to re-examine the volatility and output growth relationship. Two different methods are applied for a set of 67 countries (40 developing and 27 industrial counties given in Table A1) over an annual data set spanning over 1978–2017. The selection of the country grouping is based on the MSCI (Morgan Stanley Capital International) global investable markets index or stock markets index. The index categorizes countries into industrial, high financial integrated (HFI) and low financial integrated (LFI) countries. The recent global index, approved in April 2017, is used here.<sup>3</sup>

The measure of volatility is taken to be overall output volatility as a proxy of macroeconomic volatility. Both simple standard deviation of per capita GDP growth and standard deviation of output gap are employed to measure output volatility. These measures are employed by most of the empirical studies on volatility wherein standard deviation of per capita GDP growth is calculated for each country over the sample time period (i.e. realized volatility, measuring the standard deviation of the concerned variable based on the past information; see Aghion et al., 1999). Then, the average growth rate of per capita GDP is regressed on macroeconomic volatility. Growth is taken as the dependent variable and its volatility is taken as the main explanatory variable. The alternative is based on real business cycle (RBC) literature, which considers the standard deviation of per capita GDP gap. First, the trend GDP is obtained. Finally, the standard deviation of the gap series is calculated. This can be estimated by applying HP filter developed by Hodrick and Prescott (1997). The standard deviation of the output gap may underestimate macroeconomic volatility. Hodrick and Prescott (1997) filter decomposes the series into a non-stationary trend component ( $y^{p}_{t}$ ) and stationary cyclical component ( $y^{c}_{t}$ )

$$y_t = y_t^p + y_t^c$$
,  $T = 1, 2, 3, 4....t$  (1)

$$\left\{ y^{pt} \right\}_{t=1}^{T^{mim}} \left| \sum_{t=1}^{T} \left( Y_t - Y_t^p \right)^2 + \lambda \sum_{t=2}^{T-1} \left( \Delta^2 Y_t^p \right)^2 \right|$$
(2)

Here,  $\lambda$  is the smoothing parameter. In Equation (2) the first term implies minimizing the variance in the cycle component  $(y^c{}_t)$  and the second term shows smoothing the change in the trend component. The HP filter identifies the cyclical component  $(y^c{}_t)$  from  $(y_t)$ . As  $\lambda$  approaches to infinity  $(\lambda \to \infty)$  the variance in the growth of the trend component approaches to zero and the trend component  $(y^p{}_t)$  becomes simple linear trend. On other extreme, if  $\lambda = 0$  the filter series is equivalent to the original series. The choice of the value of  $\lambda$  is arbitrary. As proposed by Hodrick and Prescott (1997)  $\lambda = 100$  is taken for the annual data series.

The first model estimated is cross-sectional using data averaged over the period 1978 to 2017, such that one observation is obtained for each country (especially country averages over full sample and decadal average in some places). To examine the relationship between growth and volatility, a simple regression of per capita GDP growth on each of the two measures of

macroeconomic volatility as defined above is carried out. This is done for the full sample of countries as well as for MSCI country groupings.

The following model is estimated by ordinary-least-squares (OLS).

$$Gr_i = \beta_{\alpha_+} \beta_1 vol_{i+} e_i \tag{3}$$

Where,  $Gr_i$  represents average growth rate of per capita GDP over time for the *i*<sup>th</sup> country as a dependent variable, "vol<sub>i</sub>" is a measure for volatility, and *e* is the residual.

To further strengthen the model an additional conditional information set is included. First, a simple conditional variable set usually applied in growth literature say X<sub>i</sub> including initial level of per capita income (to explain transitional convergence effect), the average investment as share of GDP and initial human capital (average years of total schooling, age 25 plus total) is added. The model is specified as

$$Gr_i = \beta_0 + \beta_1 vol_i + \beta_2 X_i + e_i \tag{4}$$

Secondly, the other policy conditional information set includes, government consumption expenditure ratio of GDP (Govtexp) to measure the size of the government, rate of inflation (Inf) to measure price stability. Third, the full conditional information set includes trade openness index (Tradeopen) and proxy for i.e. credit to private sector as % of GDP(PrivatCD).<sup>4</sup>

#### 3. Results and discussion

The descriptive statistics for the sample of 67 countries is presented in Table 1. The average per capita GDP growth is 2.2% for full sample and it ranges between 8.5% and -0.32%. This implies huge difference in per capita GDP growth across countries. The mean of output growth volatility is 2.9% and investment to GDP ratio is 23% for the full sample. Mean of trade openness is between 5.9% and 3%. measured by Private Credit % of GDP shows an average of 3.9% and it ranges from 5.1% to 2%. The correlation matrix indicates positive relationship between economic growth and investment to GDP ratio, human capital, trade openness and private credit. On the contrary, output volatility, inflation, and government consumption expenditure are negatively correlated with growth.

Table 2 presents the cross-sectional mean at level and volatility (standard deviation) of per capita output growth, including five other macroeconomic variables over the past four decades (Bugamelli and Paterno, 2009). Here, we calculate cross-sectional mean growth of GDP per capita at level and volatility of its growth rate and of five other macroeconomic variables i.e. export, import, investment, government consumption and private consumption. The macroeconomic volatility measured by the standard deviation of growth rate of each variable for each country over the corresponding sample period is also presented. One finds that output growth is on average the highest in industrial countries followed by HFI and LFI economies. As regards, volatility, the picture is just the opposite. The industrial economies face less output volatility compared to HFI and LFI countries. Overall, the LFI country groups face high volatility and low economic growth.

Further, this is confirmed by the scatter plot of GDP per capita growth with volatility. The figure for full sample of countries is presented in Figure 1(a,b). A negative growth-volatility relationship is seen across all the countries for both the measures of volatility, i.e. standard deviation of per capita GDP growth and standard deviation of output gap. But a positive relationship between

Table 1. Descr	iptive statistics	: (1978 to 2017	6						
Panel A	Growth	Volatility	LNinitial GDP	Investment	Human capital	GovtExp	Trade open	PrivateCD	Inflation
Mean	2.196	2.937	9.075	23.085	7.538	16.343	4.171	3.892	10.06
Median	1.846	2.578	9.108	22.365	7.822	16.32	4.124	4.103	4.92
Stdv	1.385	1.159	1.458	3.538	2.748	4.904	0.57	0.643	16.51
Max	8.543	5.771	11.172	35.478	12.661	26.893	5.865	5.175	110.89
Min	-0.32	1.399	5.93	13.166	0.954	4.918	3.028	2.08	1.149
Observations	67	67	67	67	67	67	67	67	67
<b>Correlation Matr</b>	ix								
Panel B	Growth	Volatility	Initial GDP	Investment	Human capital	GovtEXp	Tradeopen	PrivateCD	Inflation
Growth	1.00								
Volatility	0.0221	1.00							
LNinitial GDP	-0.091	-0.4187	1.00						
Investment	0.6717	0.1317	0.1271	1.00					
Human capital	0.0104	-0.3793	0.8744	0.1415	1.00				
GovtExp	-0.366	-0.2583	0.559	-0.1014	0.5082	1.00			
Tradeopen	0.159	0.3394	0.1701	0.2819	0.1734	0.1104	1.00		
PrivateCD	0.229	-0.2366	0.7374	0.4625	0.656	0.412	0.4009	1.00	
Inflation	-0.134	0.1137	-0.0718	-0.2278	-0.1094	-0.0474	-0.3454	-0.3303	1.00

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Countries	Full		Dec	ade		Full		Dec	ade	
groups	sample 1978–2017	1978-1987	1988–1997	1998-2007	2008-2017	sample 1978–2017	1978–1987	1988–1997	1998–2007	2008-2017
(1) Per capita	Output growth						(1) General Go	vernment consu	umption growth	
Industrial Economies	2.04	2.4	2.37	2.35	0.95	2.39	3.17	2.16	2.64	1.58
Developing Economies*	1.90	1.41	1.81	2.33	2.06	3.61	3.34	2.41	4.36	4.25
HFI** Economies	2.33	1.61	2.87	2.72	2.11	3.70	3.83	3.46	3.75	3.60
LFI*** Economies	1.48	1.21	0.75	1.94	2.04	3.35	3.04	1.36	4.96	4.74
Output volatili	ty						General Gover	ment consump	otion volatility	
Industrial Economies	2.55	2.35	2.36	1.90	2.46	2.35	2.40	2.45	1.61	1.60
Developing Economies*	3.83	4.55	3.29	2.72	2.29	7.39	7.11	8.35	6.22	4.58
HFI** Economies	3.58	4.22	2.75	2.88	2.35	4.70	5.41	4.29	3.96	2.77
LFI*** Economies	60.4	4.89	3.84	2.56	2.24	10.08	8.81	12.42	8.48	6.38
(1) Private co	nsumption grow	vth					(4)	Investment Gro	wth	
Industrial Economies	5.29	2.76	2.88	3.08	1.62	2.91	2.46	4.02	3.76	1.36
Developing Economies*	3.79	3.41	3.78	4.22	3.74	4.01	1.22	5.24	4.54	4.35
HFI** Economies	3.94	3.64	4.64	4.06	3.36	4.05	3.80	6.59	3.73	2.82
LFI*** Economies	3.64	3.18	2.88	4.38	5.35	3.97	1.36	3.89	5.35	5.89
										(Continued)

Table 2. (Cor	tinued)									
Countries	Full		Dec	ade		Full		Dec	ade	
groups	sample 1978–2017	1978–1987	1988–1997	1998–2007	2008-2017	sample 1978–2017	1978–1987	1988–1997	1998–2007	2008-2017
Private consun	nption volatility						Inv	restment Volatil	ity	
Industrial Economies	2.48	2.40	2.45	1.61	1.60	7.74	7.97	7.94	5.26	7.38
Developing Economies*	5.48	6.18	5.43	4.21	3.88	14.37	14.38	12.55	15.26	9.56
HFI** Economies	3.74	4.22	3.22	3.22	2.22	11.63	9.67	11.07	7.16	2.35
LFI*** Economies	7.21	8.13	5.12	5.12	4.55	17.91	17.14	15.43	19.45	11.96
*Develoning eco	nomies (HET+1 ET)	**HFT (Hinh finand	rint interrated) ar	14 *** I FT (I nw fir	uncial integrated					

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## Figure 1. (a) Full sample of countries. (b) Full sample of countries.









growth and volatility among the industrial economies (Figure 2) is seen, whereas for developing countries the relationship is negative (Figure 3). It is also seen that the relationship between growth and volatility is strongly negative for LFI economies (Figure 5) and the same is positive for the HFI economies (Figure 4). Therefore, we may say that the poor countries are somewhat more volatile in nature compared to the developed ones.

Further, a decadal analysis of the macroeconomic fluctuations over the sample period is attempted. The results are presented in Table 2. It is found that the average output growth in the industrial economies has been declining over the four decades. Though, the output volatility declined in first three decades, it increased again in the fourth decade. This decline in macro-economic fluctuations is also seen in the study by Stock and Watson (2002), in which they confirm that from 1970s to 2000s, the industrial countries witness steady decline in output volatility and steady rise in output growth rate. In the developing country sample both, HFI and LFI countries notice a decrease in average output growth in the decades of the 1980s and 1990s. The growth rebounds in 2000s and 2010s with an average increase of two points. Both the HFI and LFI

![](_page_10_Figure_2.jpeg)

#### Figure 2. Industrial countries.

![](_page_10_Figure_4.jpeg)

![](_page_10_Figure_5.jpeg)

economies experience high output volatility, which is more than its output growth in the 1980s and 1990s. It is found that there is substantial rise in volume of international trade and financial flows to the developing countries from the industrial economies during mid-1980s to 1990s (Kose et al., 2003a). Private capital also has moved from developed economies to developing nations between these periods. Further, the HFI and LFI ones show high average government consumption growth as well as high volatility in average government consumption compared to the industrial economies.

The results for average private consumption growth and volatility show a similar pattern for HFI and LFI countries. They have the highest average private consumption growth rate compared to industrial economics and at the same time these countries experience the highest volatility.

![](_page_11_Figure_2.jpeg)

![](_page_11_Figure_3.jpeg)

![](_page_11_Figure_4.jpeg)

Figure 5. Low financial integreted (LFI).

Moreover, the LFI economies witness higher volatility, i.e. two times greater than its average growth followed by HFI and industrial countries. The industrial economies show the highest average private consumption growth and the lowest volatility in 1980s and 1990s. Towards the end of the 2010, the growth rate of private consumption for industrial countries decrease to 1.62. Overall, volatility decrease for all the three groups of the countries studied here.

The results for levels and volatility of investment growth reported in Table 2 also show that the average investment growth, increase for the industrial economies in the 1990s and 2000s, followed by a decline in 2010s. Coming to the developing countries average investment growth see a slowdown in the 1980s and an increase from the 1990s. Further, investment growth in HFI and LFI increase since 1990s. Interestingly, the volatility of investment growth also increases in 2000 for both LFI and industrial economies. But for HFI economies both investment growth and volatility decline.<sup>5</sup>

In case of import and export reported in Table 3, growth and volatility relationship differs across all the three groups of countries. Over the full sample period, the highest average export growth and lowest volatility are seen in HFI economies, followed by industrial economies and LFIs. The highest average import growth and highest volatility is seen in LFI economies, followed by HFI and industrial countries. During the 1990s, HFI countries experience the highest average export growth and lowest volatility in developing country group. Towards the end of 2010, LFI economies witness high level of average export growth with high volatility in the developing country group.

To further the growth-volatility analysis, cross-sectional regressions are run between output growth and its volatility in line with Ramey and Ramey (1995). The regression results are reported for the full sample of 67 countries, and sub samples of 27 industrial countries, 20 high financial integrated economies and 20 low financial integrated economies over the period of 1978-2017. The cross-sectional regression results with GDP per capita as dependent variable and output volatility as explanatory variable are presented in Tables 4 and 5.<sup>6</sup> The estimated coefficient for the full sample yields a negative and significant association between economic growth and volatility implying one-standard deviation increase in macroeconomic volatility results in an average decline of 0.31% point of annual per-capita growth of the economy. It is also evident that countries with higher volatility in growth rates tend to have systematically lower growth rates<sup>7</sup> (Figure 1(a,b)). In case of different country groups, the 27 industrial economies yield a positive coefficient of 0.23 but not significantly different from zero at 5% level. This is contrast to Ramey and Ramey (1995), where the relationship is found to be negative and significant for 24 OECD economies. One of the potential reasons for this difference could be that the positive association between output volatility and output arowth among industrial economies might have become stronger over time. In case of developing country groups, the relationship between growth and volatility is negative and highly significant. Further, one standard deviation increase in output volatility leads to a decline of 0.5 percent in the growth rate. Coming to the HFI and LFI economies, the results indicate that HFI economies witness positive but insignificant relationship between economic growth and volatility. However, LFI economies show negative and statistically significant effect of output volatility on economic growth.

Next, the cross-section models are augmented with additional control variables taken from growth literature. The possible control variables are investment to GDP ratio, initial log GDP per capita (to account for transitional convergence effect), initial human capital (to account the human capital investment). In addition to this, variables such as government consumption expenditure as % of GDP, trade openness index and indicator<sup>8</sup> are also employed as control variables (Levine & Renelt, 1992; Barro & Lee., 2001; Aizenman and Marion, 1999). The results with the full set of control variables presented in Tables 6 and 7 yield a negative and statistically significant coefficient of -0.31 for the full sample. In the case of developing country sample, the coefficient is -0.39 and statistically significant. In both the cases, the inclusion of full set of controls results in lower negative coefficient of output volatility. This implies that the significant effect of additional control variables on growth-volatility relationship.

Among the control variables, average investment as % of GDP is positive and highly significant, initial per capita income is negative and significant and human capital is positive but insignificant. The convergence is found to be slow in view of the low coefficient of initial per capita income. Similarly, the coefficients of human capital indicate a weak positive association. The policy variable, government consumption expenditure shows negative and significant impact on growth for full sample and developing countries. But for industrial economies, it is negative and insignificant. Government consumption expenditure is negative and statistically significant for LFI economies. This may be because in developing countries most of the government expenditure may have been

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Countries	Full		Dec	ade		Full		Dec	ade	
groups	sample 1978–2017	1978–1987	1988–1997	1998–2007	2008-2017	sample 1978–2017	1978–1987	1988–1997	1998–2007	2008-2017
(5) Export Grow	ţħ							1) Import Growt	£	
Industrial Economies	5.18	5.11	7.11	5.26	2.90	5.01	4.42	6.83	6.07	2.74
Developing Economies*	5.49	5.81	6.50	6.25	3.53	4.91	2.43	6.88	6.10	4.23
HFI** Economies	588	5.63	7.38	7.17	2.87	5.59	3.46	9.38	6.42	3.11
LFI*** Economies	5.11	6.00	5.16	5.35	4.18	4.23	1.41	4.37	5.79	5.35
Export volatility								Import volatility		
Industrial Economies	5.56	5.19	4.35	4.90	6.26	6.49	2.35	2.36	1.90	2.46
Developing Economies*	11.98	15.52	8.72	6.25	9.38	12.84	15.56	11.98	10.11	10.32
HFI** Economies	9.25	11.41	6.48	7.17	8.20	12.10	14.11	10.09	10.65	10.33
LFI*** Economies	14.72	19.63	10.96	5.35	10.57	13.57	17.02	13.87	9.56	10.30
*Developing ecor	nomies (HFI+LFI) **	'HFI (High financial	integrated) and **	** LFI (Low financio	al integrated)					

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Independent variable	Full sample	Industrial	Developing	HFI	LFI
		Economies	Economies	Economies	Economies
Constant	-3.03 (<.001) ***	-3.95 (0.01) **	-2.97 (0.002) ***	-3.59 (0.007) ***	-0.61 (0.64)
Volatility	-0.318 (0.005)***	0.232 (0.19)	-0.50 <.001***	-0.32 (0.16)	-0.45 (0.009)***
Average investment percentage of GDP	0.255 <.001***	0.15 (0.01)***	0.28 <.001***	0.34 <.001***	0.13 (0.04)**
Secondary Education (as human capital)	0.15 (0.2)	0.23 (0.03)**	0.19 (0.02)**	-0.20 (0.89)	0.31 (0.004)***
Initial per capita GDP	-0.0007 <.001***	-0.00022 (0.25)	-0.00001 <.001***	-0.000000 *(000)	-0.00011 (0.001)***
Number of observations	67	27	40	20	20
Adjusted R-squared	0.58	0.32	0.72	0.8	0.63
Notes: GDP per capita growth rat "10',"5','1' per cent level of signi	:e used as a dependent variable. A ficance.	ll regressions run including intercer	pt. Standard errors are presented	in brackets are p-values and the	character "*" "**" "**" indicates

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Table 5. Cross-section reg	ression GDP per capita gro	wth and volatility (1978–2	017) (Volatility as standaı	d deviation of output gap H	Ρ λ-100)
Independent variable	Full sample	Industrial Economies	Developing Economies	HFI Economies	LFI Economies
Constant	-3.13 <.001***	-3.92 (0.01)**	-3.18 (0.001)***	-3.78 (0.005)***	-0.82 (0.54)
Volatility	-0.31 (0.01)**	0.32 (0.14)	-0.57 (0.001)***	-0.33 (0.24)	-0.51 (0.02)**
Average investment percentage of GDP	0.25 <.001***	0.15 (0.008)***	0.28 <.001***	0.33 <.001***	0.14 (0.05)**
Secondary Education (as human capital)	0.14 (0.02)**	0.21 (0.03)**	0.16 (0.05)**	-0.04 (0.74)	0.28 (0.01)**
Initial per capita GDP	-0.00006 <.001***	-0.00019 (0.37)	-0.00009 (0.001)***	-0.000006 (0.12)	-0.0001 (0.003)***
Number of observations	67	27	40	20	20
Adjusted R-squared	0.57	0.33	0.71	0.79	0.60
Notes: GDP per capita growth rat "10',"5','1' per cent level of signif	e used as a dependent variable. <i>I</i> icant.	All regressions run including interc	ept. Standard errors are present	ed in brackets are p-values and the	character "*" "**" "**" indicates

Table 6. Cross-section regres	sion GDP per capita grow	th and its volatility (1978-	-2017): (volatility as SD of ou	utput growth) (Including po	olicy variables and variable)
Independent variable	Full sample	Industrial Economies	Developing Economies	HFI Economies	LFI Economies
Constant	-2.33	-6.73	-1.64	-1.89	-1.02
	(0.02)**	(0.003)***	(0.15)	(0.44)	(0.49)
Volatility	-0.31	0.12	-0.39	-0.28	-0.37
	(0.01)**	(0.47)	(0.006)***	(0.31)	(0.02)**
Average investment	0.22	0.05	0.25	0.31	0.13
percentage of GDP	<.001**	(0.36)	<.001**	(0.001)**	(0.05)**
Secondary Education (as	0.16	0.23	0.17	-0.03	0.26
human capital)	(0.01)**	(0.01)**	(0.04)**	(0.87)	(0.01)**
Initial per capita GDP	-0.0006 <.001***	-0.00003 (0.07)*	-0.00008 (0.01)**	-0.000001 (0.50)	-0.00011 (0.07)*
Trade openness (in log)	0.06	0.60	-0.39	-0.67	0.38
	(0.78)	(0.02)**	(0.25)	(0.26)	(0.45)
(Private credit % of GDP)	0.23 (0.41)	0.82 (0.03)**	0.54 (0.14)	0.68 (0.52)	0.16 (0.7)
Government expenditure (%	-0.08	-0.20	-0.10	-0.80	-0.12 (0.01)**
of GDP)	(0.005)***	(0.51)	(0.02)**	(0.65)	
Number of observations	67	27	40	20	20
Adjusted R-squared	0.66	0.55	0.76	0.76	0.78
Notes: GDP per capita growth rate u	sed as a dependent variable. A	ll regressions run including intel	rcept. Dummy variables taken for c	:ountry group developed HFI	
and LFI. Standard errors are present	ed in brackets are p-values an	d the character "*" "**" "**" ind	licates "10',"5','1' per cent level of	significance.	

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Table 7. Cross-section reg depth variable)	ression GDP per capita grov	vth and its volatility (1978	8–2017): (volatility as SD ou	tput gap) (Including polic	y variables and financial
Independent variable	Full sample	Industrial Economies	Developing Economies	HFI Economies	LFI Economies
Constant	-2.31 (0.02)**	-0.68 (0.002)***	-1.76 (0.13)	-2.20 (0.36)	-1.03 (0.53)
Volatility	-0.30 (0.03)**	0.19 (0.37)	-0.41 (0.02)**	-0.24 (0.45)	-0.38 (0.08)*
Average investment percentage of GDP	0.22 <.001***	0.05 (0.34)	0.25 <.001***	0.31 (0.001)***	0.14 (0.05)**
Secondary Education (as human capital)	0.16 (0.02)**	0.21 (0.01)**	0.15 (0.08)*	-0.003 (0.98)	0.26 (0.03)**
Initial per capita GDP	-0.0006 <.001***	-0.00027 (0.09)*	-0.00006 (0.03)**	-0.000005 (-0.53)	-0.00006 (0.01)**
Trade openness (in log)	0.02 (0.91)	0.56 (0.04)**	-0.41 (0.25)	-0.69 (0.28)	0.34 (0.55)
(Private credit % of GDP)	0.23 (0.43)	0.87 (0.02)**	0.51 (0.20)	0.56 (0.56)	0.05 (0.90)
Government expenditure (% of GDP)	-0.08 (0.006)***	-0.17 (0.59)	-0.10 (0.03)**	-0.06 (0.74)	-0.12 (0.01)**
Number of observations	67	27	40	20	20
Adjusted R-squared	0.60	0.55	0.74	0.77	0.70
Notes: GDP per capita growth rat and LFI. Standard errors are pres	e used as a dependent variable. A ented in brackets are p-values an	ll regressions run including inter d the character "*" "**" indi	cept. Dummy variables taken for c icates "10',"5','1' per cent level of s	ountry group developed HFI significance.	

per capita growth rate used as a dependent variable. All regressions run including intercept. Dummy variables taken for country group developed HFI	andard errors are presented in brackets are p-values and the character "*" "**" indicates "10',"5','1' per cent level of significance.	
:: GDP per capita growth rate used as	FI. Standard errors are presented in b	

on unproductive projects. The trade openness index shows a positive and significant relationship between trade and economic growth. But the relationship is not clear in case of developing countries. The reason may be import of more capital goods, export of primary goods and insufficient trade share to balance the budget in case of these countries(Kose et al., 2003a). The indicator bears the expected sign implying that works smoothly in industrial economies compared to the developing economies (the coefficients are positive but not significant), as shown in Levine and Renelt (1992), Ramey and Ramey (1995), and Fatás and Mihov (2003) hypotheses. The regressions, when re-estimated using volatility of output gap do not show any difference compared to the regressions with standard deviation of output-measuring volatility.

Next, the panel regression results are presented considering the change of growth-volatility relationship over time within a country group. Following some of the past studies, five-year non-overlapping annual averages of the variables, i.e. maximum of eight observations for each country are used in the panel data estimation. The panel data set up accounts for both time-invariant country-specific effects and country-invariant time-specific effects. The obvious advantage of panel data lies in eliminating omitted-variable bias as well as getting more degrees of freedom and more efficiency in estimation. The following model is estimated for three different country groups.

$$Gr_{it} = \beta_0 + \beta_1 vol_{it} + \beta_2 X_{it} + \partial_i + \gamma_t + \varepsilon_{it}$$
(5)

where 'i' denotes country and "t" denotes time,  $\partial_i$  stands for unobserved country-specific effect,  $\gamma_t$  is time-fixed effect and  $\varepsilon_{it}$  is the error term. Hausman's (1978) test is used to choose between fixed and random effect specification. The null hypothesis in Hausman's test is that the chosen model is random effects against the alternative of fixed effects. The approach basically tests whether the errors u<sub>i</sub> are correlated with the regressors. For completeness sake, pooled, fixed effect and random effect regressions are run and the best model is selected based on the Hausman's test. The results from the pooled, fixed, and random effect regressions presented in Table 8, show a statistically significant negative contemporaneous relationship between economic growth and output volatility for the full sample of 67 countries. The above regressions are then augmented with full set of control variables. Three out of six control variables namely log of initial income, investment as a percentage of GDP and government expenditure as percentage of GDP are statistically significant with theoretically expected signs across the pooled, fixed, and random effects regressions. It may be noted that among the other control variables private credit as percentage of GDP and human capital bear-mixed signs and significance, vielding ambiguous relationship with economic growth across all the three specifications. Hence, the association between growth and volatility become stronger once we include a set of control variables. These results are like results obtained in some of the previous studies by Ramey and Ramey (1995). Levine and Renelt (1992), and Kose et al. (2006).

Further, panel regressions are estimated for the full sample as well as for the four country groups i.e. developing, industrial, HFI, and LFI. The results are reported in Table 9, where Hausman's test favours the fixed effect model for full sample, developing and industrial countries. The output volatility has positive and significant effect on economic growth for the full sample. Thus, higher the growth rate, higher is the output volatility. To be precise, one standard deviation increase in output volatility leads to 0.29% increase in average GDP growth the full sample. For the developing and industrial countries, the coefficients are -0.31 and 0.26. These results are like the findings of Kormendi and Meguire (1985), and Grier and Tullock (1989), where higher standard deviation of GDP growth is associated with greater economic growth, due to aggregate trade-off between risk and returns. Similarly, the coefficient of volatility bears negative sign and is statistically significant for developing economies. However, in case of industrial countries, one standard deviation increase in 0.26% increase in economic growth.

After including control variables as mentioned above one finds that the estimated coefficient on initial per capita GDP is negative as expected for the developing countries. Thus, a significant convergence effect is confirmed for developing economies. One percent increase in initial per capita GDP

Table 8. Panel regression (fixed vs. random effect) GDP per capita growth and volatility (1978 2017)			
Independent variable	Pooled OLS	Fixed effect	Random
	Full sample	Full sample	Full sample
Constant	4.80	11.22	4.82
	(<.001***)	(0.002)***	(<.001***)
Volatility	-0.28	-0.29	-0.28
	(<.001***)	(<.001***)	(<.001***)
Average investment percentage of GDP	0.16	0.13	0.15
	(<.001***)	(<.001***)	(<.001***)
Secondary Education (as	0.04	-0.18	-0.03
human capital)	(0.44)	(0.07)*	(0.63)
Initial per capita GDP	-0.55	-0.79	-0.40
	(<.001***)	(0.10)*	(0.008)***
Trade openness (in log)	0.006	0.009	-0.005
	(<.001***)	(0.04)**	(0.003)***
Financial depth	0.22	-0.17	0.09
(Private credit % of GDP)	(0.17)	(0.51)	(0.63)
Government expenditure	-0.07	-0.13	-0.08
(% of GDP)	(0.001)***	(0.001)***	(0.001)***
Number of observations	536	536	536
Adjusted R-squared	0.34	0.17	0.34
Hausman test			0.0000***

Notes: GDP per capita growth rate used as a dependent variable. All regressions run including intercept. Dummy variables taken

For country group developed HFI and LFI. Standard errors are presented in brackets are p-values and the character

Indicates "10',"5','1' per cent level of significance.

Table 9. Fixed-effect estimations of GDP per capita growth and volatility (1978–2017)			
Independent variable	Full sample	Industrial	Developing
Constant	11.22	7.84	12.01
	(0.002)***	(0.34)	(0.003)***
Volatility	0.29	0.26	-0.31
	(<.001***)	(0.001)***	(<.001***)
Average investment percentage of GDP	0.13	0.02	0.15
	(<.001***)	(0.51)	(<.001***)
Secondary Education (as human capital)	-0.18	-0.29	0.11
	(0.07)*	(0.04)**	(0.42)
Initial per capita GDP	-0.79	0.62	-1.16
	(0.10)*	(0.47)	(0.05)**
Trade openness (in log)	0.009	0.002	-0.10
	(0.04)**	(0.62)	(0.19)
Financial depth	-0.17	-0.50	-0.14 (0.72)
(Private credit % of GDP)	(0.51)	(0.12)	
Government expenditure	-0.13	-0.38	-0.08
(% of GDP)	(0.001)***	<.001***	(0.11)
Inflation	-0.01	0.01	-0.02
	(<.001***)	(0.11)	(<.001***)
Number of observations	536	216	320

(Continued)

Independent variable	Full sample	Industrial	Developing
Adjusted R-squared	0.17	0.15	0.25
Hausman test	0.0000***	0.0000***	0.0001***

Notes: GDP per capita growth rate used as a dependent variable. All regressions run including intercept. Dummy variables taken

for country group developed HFIs and LFIs. Standard errors are presented in brackets are p-values and the character "\*" "\*\*\*"

Indicates "10',"5','1' per cent level of significance.

leads to 1.16% decline in economic growth. Further, the coefficients of trade openness show negative but insignificant effect on growth. Among other control variables, government expenditure as percentage of GDP is negative for both developing and industrial country groups. But the effect is significant only for industrial counties. The reasons underlying such results may be that higher taxes induce more government spending. But inefficient allocation of resources and unexpected economic fluctuations can reduce the output growth level (Kormendi & Meguire, 1985). Inflation has significant and negative effect on economic growth for developing countries as expected. The evidence goes against the Mundell-Tobin hypothesis.<sup>9</sup> But it supports that of Stockman's (1981), i.e. at higher rates of inflation, money being relatively costly to hold, net return from investment becomes lower. As a result, steady state capital stock also declines due to lower investment. This implies reduction in investment, lower capital stock and lower economic growth (Kormendi & Meguire, 1985). Finally, the proxy of i.e. private credit as percentage of GDP shows negative but insignificant relationship between economic growth and. Hence, the above results confirm that developing countries are highly volatile in nature compared to industrial countries. It may be noted that the industrial countries are highly capable in stabilising their economy compared to the developing ones. The results in Table 10 with random effect regressions as favoured by the Hausman test for HFI and LFI yield that volatility coefficients are negative and significant with all the control variables. However, the HFI yield coefficients of higher magnitude compared to the LFI. The coefficients of control variables vary dramatically across the two subsamples. Investment as percentage of GDP explains economic growth better for both the country groups. While the government expenditure percentage of GDP and Inflation is negative and significant for HFI,

Table 10. Random-effect estimations of GDP per capita growth and volatility (1978–2017)			
Independent variable	Low financial integrated (LFI)	High financial integrated (HFI)	
Constant	6.18 (0.002)***	5.82 (0.03)***	
Volatility	-0.19 (0.01)**	-0.53 (<.001***)	
Average investment percentage of GDP	0.17 (<.001***)	0.13 (<.001***)	
Secondary Education (as human capital)	0.18 (0.10)*	-0.19 (0.16)	
Initial per capita GDP	-0.97 (0.004)***	-0.41 (0.18)	
Trade openness (in log)	0.01 (0.13)	0.001 (0.87)	
Financial depth (Private credit % of GDP)	0.02 (0.93)	0.75 (0.09)*	
Government expenditure (% of GDP)	0.005 (0.93)	-0.14 (0.006)***	

able 10. Random-effect estimations of GDP per capita growth and volatility (1978–2017)

(Continued)

Table 10. (Continued)			
Independent variable	Low financial integrated (LFI)	High financial integrated (HFI)	
Inflation	-0.01 (0.22)	-0.009 (0.02)**	
Number of observations	160	160	
Adjusted R-squared	0.34	0.52	
Hausman test	0.073	0.053	

Notes: GDP per capita growth rate used as a dependent variable. All regressions run including intercept. Dummy variables taken

for country group developed HFIs and LFIs. Standard errors are presented in brackets are p-values and the character "\*" "\*\*"

"\*\*\*" indicates "10',"5','1' per cent level of significance.

the same is insignificant for LFI. The coefficients on Private credit percentage of GDP are positive and significant only for HFI countries. These results are consistent with Levine and Renelt (1992) and Kose et al. (2003a), and Easterly and Stiglitz (2000).

#### 4. Conclusion

This paper attempts a re-examination of the relationship between output volatility as a proxy of macroeconomic volatility and economic growth for a select sample of 67 countries (40 developing and 27 industrial counties) over an annual data set spanning, 1978 to 2017. The main conclusion of this paper is that output volatility has negative effect on economic growth, and it is confirmed by both crosssection and panel regression results. Further, the negative output volatility and growth relationship is found to be stronger for the developing countries. These results support the theoretical insights given by Martin and Rogers (2000), Fatás and Mihov (2003), Hnatkovska,, & Norman, L. (2003), and Loayza et al. (2007). For industrial countries, we find a positive and significant relationship between growth-volatility, which contrasts with Ramey and Ramey (1995), but resonates findings of Kormendi and Meguire (1985), Grier and Tullock (1989), Caporale and McKiernan (1998), and Ramey and Ramey (1995) find negative and significant effect of output volatility on growth for 24 OECD countries and the underlying reason may be different time period of the study. The results regarding the control variables in this study are consistent with growth theory, except human capital and trade openness. As a robustness check, we estimate the models for HFI and LFI groups separately. We find a negative and significant relationship between output volatility and economic growth. This might be due to the intermediate stage of financial market development or maybe due to poor institutional setups resulting in poor management of unpredictable shocks. Overall, the results suggest a bit of ambiguity except the clear negative relationship found for developing countries. The results of different samples of HFIs and LFIs speak of the role financial integration plays in defining growth volatility relationship. However, further research in future may focus on the channels causing such negative relationship in the presence of financial integration. To substantiate the role of financial integration in bringing out the changing nature of volatility growth relationship, one may examine the impact of different types of financial flows.

#### Funding

The authors received no direct funding for this research.

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#### **Citation information**

Cite this article as: Revisiting the Volatility- Growth relationship: Some cross country evidence, 1978–2017, Y N Raju & Debashis Acharya, *Cogent Economics & Finance* (2020), 8: 1826655.

#### Notes

- 1. Schumpeter's (1939) idea of "creative destruction"
- 2. Redux model of Maurice and Rogoff (1995)
- The HFI (high financial integrated) countries are also called "emerging markets" according to the methodology used by MSCI GIMI (global investable markets index). Next LFI (less financial integrated) countries are

called as "Frontier market". The methodology used to construct the MSCI Frontier Markets Indexes is similar, but not identical, to the construction of the indexes for Developed and Emerging Markets. One of the prime differences is that the Frontier Markets are divided into size (Large, Small) and liquidity (Average, Low, and Very Low) categories (MSCI Global Investable Market Indexes Methodology, 2017).

- 4. All conditional variables include period dummies to control for time-varying factors and country-specific dummies to arrest the effect of structural variables that does not change over time.
- 5. Kose et al. (2003a) find that industrial countries have high investment growth in 1980s and 1990s compare to HFIs and LFIs with less volatility.
- 6. The GDP per capita and its volatility are averages over 1978–2017.
- 7. We find the similar results when we used standard deviation of output gap as volatility.
- 8. We dropped population growth and inflation in this due to large outliers
- 9. Mundell (1963) and Tobin (1965) argued that higher inflation leads to shifts away from real money balance to real capital assets, therefore higher investment and higher economic growth.

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#### Appendix A

Table A1. List of sample countries (67)			
Industrial countries	High Financial Integrated (HFI)	Low Financial Integrated (LFI)	
Australia	Chile	Malta	
Belgium	Greece	Jordan	
Canada	Korea, Rep.	Mauritius	
Denmark	Brazil	Sri Lanka	
Finland	China	Bangladesh	
France	Colombia	Kenya	
Germany	Malaysia	Morocco	
Hong Kong SAR, China	Mexico	Senegal	
Ireland	Peru	Tunisia	
Israel	South Africa	Sierra Leone	
Italy	Thailand	Niger	
Japan	Turkey	Тодо	
Netherlands	Egypt, Arab Rep.	Belize	
New Zealand	India	Benin	
Norway	Indonesia	Bolivia	
Portugal	Pakistan	Cameroon	
Singapore	Philippines	Congo, Rep.	
Spain	El Salvador	Gabon	
Sweden	Gambia	Malawi	
Switzerland	Iran, Islamic Rep.	Central African Republic	
United Kingdom			
United States			
Panama			
Jamaica			
Uruguay			
Luxembourg			
Fiji			

![](_page_24_Picture_2.jpeg)

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