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The Impact of Government Size on Output Volatility: Evidence from World Economies

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Abstract: *One of the most important goals of policy-makers is to achieve macroeconomic stability, which could significantly be affected by output volatility. In an effort to provide insights with regard to macroeconomic stability, this study aims to model the volatility of output by using univariate GARCH models and to examine the impact of government size on output volatility by using extensive data set from eight different classifications of world economies for the period between 1960 and 2017. The study also employs the Granger Causality Analysis to determine the direction of this relationship. The results provide strong evidence for a negative relation between government size and output volatility. Output volatility is largely dependent on its own shocks and negatively influenced by outside shock as government size. Moreover, confirming Keynesian Hypothesis, the results show that there is mostly one-way causality from government size to output volatility. The results are robust in terms of different classifications of world economies, different measurements of output volatility, different methodologies and controlling for the effect of different sets of exogenous variables.*

Keywords: Output Volatility, Government Expenditure, Univariate GARCH Model, Granger Causality

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1. Introduction

Achieving macroeconomic stability is vital for policy-makers. One of the most important goals of policy-makers is to achieve a predictable and stable economy, which provides a more reliable environment for economic growth, investment and decision-making. Higher output volatility could have negative effects on macroeconomic stability (Fatás & Mihow, 2001; Down, 2007; Mohanty & Zampolli, 2009). Thus, it is crucial to have a stable or less volatile economy.

Output volatility has been a popular research topic particularly since the *Great Moderation*, a period of decreased macroeconomic volatility starting in the mid-1980s. During this period, the standard deviation of quarterly real GDP declined by half (Stock & Watson, 2002; Turan & İyidoğan, 2017; Debrun et al., 2008). This decline period has brought with it a new area of research: the determinants of output volatility. Numerous studies have shown the effect of different determinants such as government size, trade openness and financial development (Carmignani et al., 2011; Denizer et al., 2002; Cecchetti et al., 2006). For example, Ahmed et al. (2004) argue that a decrease in size and frequency of global shocks is the biggest cause of the

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decline in output volatility in the US. On the other hand, some researchers suggest that monetary policy is more effective than fiscal policy in reducing volatility (Romer, 1999; Clarida et al., 2000; Blanchard & Simon, 2001; Barrell & Gottschalk, 2004). Kent et al. (2005) suggest that a stricter monetary policy and less regulated market decrease output volatility. Romer (1999) also claims that fiscal policies such as income tax and unemployment compensations assist output stability. In addition, Dalsgaard et al. (2002) suggest that the shift from manufacturing to service sector could affect the reduced volatility in developed countries. However, Blanchard and Simon (2001) argue that this shift is not as critical as the goods sector. Other popular explanations for volatility include flawed economy management and degree of liberalization in a country. Hausmann and Gavin (1996) indicate that misconfiguration of macroeconomic policies such as misguided monetary policy cause volatility. Some researchers like Denizer et al. (2002) and Bekaert et al. (2006) advocate that financial openness and development decrease instability. Similarly, Almeida and Ferreria (2002) and Mobarak (2005) show the encouraging effect of democracy on stability.

The relationship between output volatility and unemployment switched sign in the 1980s. Barnichon (2010) states that these variables had a negative relationship until 1983, but unemployment started to increase volatility then. This opinion is also supported by earlier economists (Okun, 1962; Freeman, 2001; Dornbusch et al., 2001). Cecchetti and Ehrmann (1999) suggest that volatility in inflation and inflation targeting increases volatility. With the emergence of real business cycle (RBC) theory in 1980, Nelson and Plosser (1982) introduced that volatility and growth may affect each other. Some researchers suggest that this relationship is a positive one while others argue that it is negative. Black (1987) argues that a major part of business cycle volatility emerges as a result of the preferences of rational investors. Their sensitivity to risk may establish volatile or stable growth. In other words, if people are risk averse in a country, their preferences will be in an industry with stable growth, which affects the economy. Martin and Rogers (1997) advocate that higher unemployment and less human capital in an unfavorable economy depress growth. Stiglitz (1993) associates the negative relationship with the effect of research and development (R&D) volatility. Acemoğlu and Zilibotti (1997) suggest that richer countries have more balanced economies, and they are affected less by unfavorable economic circumstances. Acemoğlu et al. (2003) highlight the significance of institutional problems in analysis and show that government size is not the sole reason of volatility, but weak institutions increase it with the channel of macroeconomic policies. İyigün and Owen (1997) introduce a theoretical and empirical framework for income inequality and growth volatility. Denizer et al. (2002) show how financial development variables affect output, consumption and investment growth volatilities for 70 countries in the 1956-1998 period. Their findings suggest that countries with more developed financial systems have less volatility. Cecchetti et al. (2006) reveal the lowering effect of financial development for volatility of consumption and growth on 13 developed OECD countries. Elgin and Kuzubaş (2013) present the relationship between current account and output volatility on 185 countries in the period between 1950 and 2009. Their findings show that higher current account increases output volatility especially in developing countries.

One of the most important determinants of output volatility is government size, but the literature provides no consensus on the direction of the relationship (Andrés et al., 2008; Debrun et al., 2008; Carmignani et al., 2011). In this context, if we know the existence of a relationship between output volatility and government size, testing the direction of the relationship will be another interesting area.

The causality relationship between government size and economic performance has been studied frequently since the 1800s in order to provide insights and guidance for macroeconomic stability. There are two important theories for this relationship: Wagner's Law and Keynesian Hypothesis. Wagner's Law argues that there is a significant positive effect of economic performance on the government size, while Keynesian Hypothesis advocates the opposite. In other words, Keynesian Hypothesis argues that if government size increases, the economic growth raises. However, empirical research on the subject has not achieved a consensus on the nature of this relationship (Oxley, 1994; Al-Faris, 2002; Lamartina, 2011; Antonis et. al., 2013).

In an effort to provide insights and more robust empirical evidence, the current study aims to model the volatility of output and examine the impact of government size on output volatility by using extensive dataset and univariate GARCH models. The study also employs the Granger Causality Analysis to determine the direction of this relationship. The relationship between output volatility and government expenditure has been typically analyzed within the framework of OLS or linear panel data estimation model where the standard deviation of the growth rate is regressed on some measure of government size (Galí, 1994; Martin and Rogers, 2000; Fatás, 2002). Our analysis extends this econometric approach by using a univariate GARCH model that permits the presence of volatility clustering to measure uncertainty. Moreover, we consider both its own shocks (as ARCH and GARCH effect) and outside shock (as government size effect) simultaneously in the variance equation of GARCH (1, 1) model. Our results are robust in terms of different classifications of world economies, different measurements of output volatility, different methodologies and controlling for the effect of different sets of exogenous variables such as trade openness, population and inflation.

In the light of these considerations, the current study contributes to the existing literature by presenting strong evidence for a negative relation between government size and output volatility and also by employing the univariate GARCH methodology for modeling output volatility instead of relying on rolling standard deviations. Moreover, confirming Keynesian Hypothesis, the results show that there is mostly one-way causality from government size to output volatility. The following section includes a literature review. Section 3 shows data, methodology and empirical findings. Next, Section 4 presents robustness check and, finally, Section 5 concludes.

2. Literature Review

There are many studies in the literature aiming to guide the macroeconomic stability of a country. For this purpose, the relationship between government expenditure and economic growth has been investigated by numerous studies. The effect of government size on economic growth has been examined in the literature for two main classification areas: the level of growth and the volatility of growth. The first area of research tests the effect of government expenditure on the level of economic growth by using various datasets and methods for many different countries. There is a consensus on the existence of this relationship. However, interestingly, empirical findings provide no consensus on the sign and direction of this relationship (Landau 1983; Landau, 1985; Landau, 1986; Deverajan et al., 1996; Kelly, 1997; Ghali, 1999; Kolluri et al., 2000; Fölster & Henrekson, 2001; Al-Faris, 2002; Wahab, 2004; Loizides & Vamvoukas, 2005; Bose et al., 2007; Cooray, 2009; Gregoriou & Ghosh, 2009; Wu et al., 2010; Lamartina, 2011; Alegre, 2011; Colombier, 2011; Odhiambo, 2015; Çalışkan et al., 2017; Şit & Karadağ, 2018)

The second area of research tests the effect of government expenditure on the output volatility rather than the level of output growth. It is obvious that output volatility may have an effect on macroeconomic stability (Galí, 1994; Virén, 2005; Down, 2007; Mohanty & Zampolli, 2009). Thus, the relationship between government size and output volatility is discussed by both theoretical and empirical research in the literature. To begin with, Galí (1994) highlights the theoretical linkage between government size and growth volatility in the context of a real business cycle (RBC). In addition, Rodrik (1998) shows that large government size helps reduce growth volatility as well as trade openness by using OLS model for 23 OECD countries. In contrast, many political economy models suggest that output volatility causes government expenditures because of inflated spending (Tornell & Lane, 1998). Fatás and Mihow (2001) investigate the relationship among government size, growth volatility and trade openness by using panel regression for 20 OECD countries over the period from 1960 to 1997, and they conclude that government size and trade openness have a significant and negative impact on growth volatility. Bejan (2006) argues that trade openness is the cause of output volatility in both developing and developed countries by using extensive dataset of 111 countries over the period between 1950 and 2000. According to the empirical analysis of Virén (2005), there is a negative relationship between government size and output volatility in OECD countries. Down (2007) uses demand and price volatility as a measurement of growth volatility and shows that government size and trade openness affect the price and demand volatility negatively. Andrés et al. (2008) present evidence for a significant and negative relationship between government size and growth volatility for 20 OECD countries over the period between 1960 and 2004. In other words, they argue that large government size has balance output volatility. Debrun et al. (2008) discuss the relationship between government size and output volatility, and they emphasize that volatility has decreased in small and more closed countries over the last 20 years and that smaller governments had more output volatility until 1997. Empirical analysis of their study suggests that government size has a negative impact on output volatility during the period between 1961 and 2007. The relationship between government size and volatility has decreased after the 1990s and government size began to impact output volatility positively during the period between 1991 and 2007. In a study of the impact of government expenditure share of GDP on output volatility as cyclical fluctuations of GDP/per capita and growth rate of GDP/per capita, Mohanty and Zampolli (2009) argue that government expenditure has a significant and negative impact on output volatility. According to Carmignani et al. (2011), government expenditure and trade openness have a significant and positive effect on output volatility that is measured as a standard deviation of growth for 79 countries over the period between 1970 and 2000 with GMM estimation. Fatás and Mihow (2013) examine the impact of policy volatility (i.e., variance of unforeseen changes in government expenditures), government size (i.e., government general expenditure), output volatility (i.e., standard deviation of output), inflation, and trade openness on growth for 93 countries for the period between 1960 and 2007. They determine that policy volatility, output volatility and inflation have negative effect on growth.

Since the 1800s, the causal relationship between government size and economic performance has been investigated so as to provide insights and guidance for macroeconomic stability. For example, Ram (1987) examines 115 countries over the period between 1950 and 1980 by using cross-section and time-series analysis. Ram (1987) assesses the validity of Wagner’s hypothesis in four different groups with respect to their income levels and presents evidence in favor of Wagner’s Law. Easterly and Rebelo (1993) show that public investment expenditures make a significant positive contribution to growth. Also, Oxley (1994) states that public expenditures and growth have a long-run relationship and there is one-way relationship from growth to expenditures. There seems to be some empirical evidence supporting both Wagner’s Law (Ram, 1987; Oxley, 1994; Lamartina, 2011) and Keynesian Hypothesis (Ghali, 1999; Al-Faris, 2002; Bose et al., 2007). To sum up, consensus is yet to be achieved on the nature of this relationship in the light of empirical research findings. Thus, the current study aims to model the volatility of output and examine the impact of government size on output volatility

3. Data, Methodology and Empirical Findings

This study uses annual data for GDP (constant 2010 US$) as an input for output volatility and general government final consumption expenditure (% of GDP) as a government size. Additional inflation with consumer prices (annual %), trade openness (exports + imports /GDP) and population are used as control variables. All data is derived from World Development Indicators from the World Bank for the available period between 1960 and 2017. The study uses eight different economy classifications for analysis[1] (see Table 1).

The current study employs a univariate GARCH process to model output volatility and tests the impact of government size on it. The first step in the testing procedure involves testing whether all the variables (i.e., government size and output volatility) are stationary by using the Augmented Dickey-Fuller (ADF) unit root test (Dickey and Fuller, 1981). According to Table 2, the null hypotheses of unit root are rejected for all the series[2]. After determining that all the variables are stationary, we model output volatility by estimating univariate GARCH (1,1) models as the following (Bollerslev, 1986):

$$Output_t = \alpha_0 + \alpha_1 Output_{t-1} + z_t \tag{1}$$

where output refers to the logarithmic difference of GDP (constant 2010 US$). Residual derived from mean equation is used in formulating the variance equation (see equation 3). The study estimates the conditional variances of output with the quasi-maximum likelihood method using the GARCH approach by Bollerslev (1986). In order to test the impact of government size on output volatility, we include government size in the variance equation. The following is the general expression of GARCH (1,1) model.

$$z_t = \varepsilon_t \sqrt{h_t}, \qquad \varepsilon_t \sim iid(0,1) \tag{2}$$

$$h_t = \beta_0 + \beta_1 h_{t-i} + \beta_2 z_{t-j}^2 + \beta_3 GS_t + \vartheta_t \tag{3}$$

where h_t is variance of residual derived from *equation (1)*. It also represents current period volatility of output. In other words, h_t is output volatility. B_0 is constant and h_{t-1} represents previous period residual variance or previous period volatility of output. h_t is identified as first order GARCH term. z_{t-1} is previous period's squared residual derived from *equation (1)*, which is identified as first order ARCH term. z_{t-1} represents previous period output information (as growth) about volatility. GS_t is general government final consumption expenditure (% of GDP), which is exogenous or predetermined variable. GS_t indicates variance regressor and shows the contribution of exogenous shock in the volatility of output.

Table 1. Data Definitions

Economy	Code
East Asia & Pacific	EAS
Europe & Central Asia	ECS
Latin America & Caribbean	LCN
Middle East and North Africa	MEA
North America	NAC
South Asia	SAS
Sub-Saharan Africa	SSF
World	WLD

Table 2a. The results of Augmented Dickey Fuller Unit Root Tests for Output Volatility

	Test statistic [x]	Lag [y]	Model[&] [z]	Series [t]
EAS	-6.2030***	1	I+T	L
ECS	-4.2294***	1	I	L
MEA	-3.4264***	1	I	L
NAC	-5.8908***	1	I+T	L
SAS	-6.1947***	7	I	L
SSF	-4.8663***	1	I	L
WLD	-5.0178***	1	I+T	L

[x] MacKinnon critical values for the significance level of 1%, and 5% are -3.55, and -2.91 with (intercept) model, respectively. “*” and “**” represent rejection at the 5% and %1 level of significance, respectively.
[y] Akaike Information Criteria is used for lag order selection
[z] “T”, “I”, and “I+T” represent ADF including the trend, ADF including the intercept, ADF including both the trend and intercept, respectively. None indicates no trend and no intercept case.
[t] L represents Level while F represents 1st difference.
[&] Akaike Information Criteria is used for determining an appropriate deterministic structure of ADF model.

In consistence with the existing literature (Grier and Perry, 2000; Fountas and Karanasos, 2006; Lee, 2010), we include one GARCH term and one ARCH term in the variance equation, so we call the model as a univariate GARCH (1,1) model. We estimate mean equation (see equation 1) and variance equation (see equation 3) simultaneously by using the quasi-maximum likelihood method. Under the student-t distribution, if the ARCH term is significant, it means that previous year output (i.e., growth) data can influence current year output volatility (i.e., h_t in equation 3). Under the distribution, if the GARCH is also significant, it means that the previous year output volatility will influence current period output volatility. In this case, we could suggest that output volatility is influenced by its own shocks (i.e., its own ARCH and/or GARCH factors). If the size is also significant, it means that outside shock (as government general expenditure) will influence output volatility.

Table 2b. The results of Augmented Dickey Fuller Unit Root Tests for Government Size

	Test statistic [x]	Lag [y]	Model[&] [z]	Series [t]
EAS	-6.6022***	1	None	L
ECS	-2.9414**	1	I	L
MEA	-8.3830***	1	I+T	F
NAC	-4.8826***	1	None	F
SAS	-5.9771***	1	None	L
SSF	-5.8186***	1	None	F
WLD	-6.5033***	1	I+T	F

[x] MacKinnon critical values for the significance level of 1%, and 5% are -3,55, and -2,91 with (intercept) model, respectively. “*” and “**” represent rejection at the 5% and %1 level of significance, respectively.

[y] Akaike Information Criteria is used for lag order selection

[z] “T”, “I”, and “I+T” represent ADF including the trend, ADF including the intercept, ADF including both the trend and intercept, respectively. *None* represents no trend and no intercept case.

[t] L represents Level and F represents 1st difference.

[&] Akaike Information Criteria is used for determining an appropriate deterministic structure of ADF model.

The results are presented in Table 3. The study additionally employs all diagnostic test as Lagrange Multiplier test for ARCH effect, Ljung-Box Q test for autocorrelation, and Jarque-Bera test for normality. All the estimations are consistent. There is no serial correlation and no ARCH effect in the residuals, and the residuals are normally distributed. These results suggest that all the models pass standard specification tests and all the estimators are consistent.

As can be seen Table 3, under the student-t distribution, the ARCH term is significant for all the classifications except for North America. This implies that previous year output (growth) information can influence current year output volatility for related economies. Under the distribution, the GARCH is also significant for Latin America & Caribbean, Middle East and North Africa, North America, South Asia and Sub-Saharan Africa. This implies that the previous year output volatility will influence current period output volatility for related economies. In this case, we could suggest that output volatility is influenced by its own shocks (its own ARCH and/or GARCH factors).

Moreover, the government size is also negatively significant for East Asia & Pacific, Europe & Central Asia, Middle East and North Africa, South Asia, Sub-Saharan Africa, World; while it is positively significant for North America. It means that outside shock (as government general expenditure) will commonly have a negative effect on the output volatility. The results support the theoretical models suggesting that a larger government increases economic stability. In other words, output volatility is largely dependent on its own shocks and negatively influenced most by outside shock as government size.

This study aims to model the volatility of output and to test the factors affecting the volatility of output. We can conclude that output volatility is largely dependent on its own shocks and it is also influenced by outside shock as government size.

Table 3a. Estimated GARCH Models for Output Volatility

	EAS	**ECS**	**LCN**	**MEA**	**NAC**
	Mean Equation				
c	0.04371*** (19.306)	0.02493*** (8.296)	0.02876*** (4.082)	0.03312*** (6.0346)	0.03786*** (10.650)
Output$_{t-1}$	0.42736*** (3.795)	0.53697*** (4.136)	0.55394*** (4.507)	0.1115 (0.7502)	0.42728*** (3.837)
	Variance Equation				
c	0.00171*** (74.716)	0.00316*** (71.059)	0.00029 (0.980)	0.00121*** (28.724)	-0.01227*** (-5.369)
ARCH(-1)	1.08424** (2.457)	0.95481*** (2.664)	-0.10623** (-2.306)	-0.08433*** (-9.023)	-0.00021 (-0.007)
GARCH(-1)	0.01947 (0.275)	0.11100 (0.938)	0.90971*** (5.050)	0.9829*** (41.103)	-0.90249*** (-8.383)
Log(GS)	**-0.0006***** **(-153.117)**	**-0.00105***** **(-63.434)**	**-0.00008** **(-0.794)**	**-0.000398***** **(-38.597)**	**0.005***** **(5.394)**
Log-lik.	152.5	134.4	137.4	100.6	147.6
ARCH[a] (2)	1.02562 (0.599)	3.84484 (0.146)	3.20703 (0.201)	1.1465 (0.5636)	0.55606 (0.757)
ARCH (4)	1.67470 (0.795)	6.14364 (0.189)	3.40523 (0.492)	1.1492 (0.8864)	2.71677 (0.606)
ARCH (6)	3.08797 (0.798)	7.26709 (0.297)	4.065403 (0.668)	1.4775 (0.9611)	8.18015 (0.225)
ARCH (8)	6.64607 (0.575)	6.98312 (0.539)	6.01110 (0.646)	1.6772 (0.9895)	13.87027 (0.085)
Q(2)[b]	1.7898 (0.181)	3.4572 (0.063)	1.052 (0.305)	4.2336 (0.0402)	0.4032 (0.525)
Q(4)	2.9049 (0.407)	3.6584 (0.301)	1.9235 (0.588)	4.7173 (0.194)	0.9615 (0.811)
Q(6)	3.4156 (0.636)	5.189 (0.393)	4.6573 (0.459)	6.5492 (0.256)	2.4311 (0.787)
Q(8)	4.3938 (0.733)	8.9729 (0.255)	7.1825 (0.410)	7.6837 (0.361)	3.422 (0.843)
JB[c]	3.090 (0.213)	5.334 (0.069)	4.228 (0.121)	3.160 (0.205)	0.935 (0.626)

t-values are given in parentheses.

[a] ARCH-LM(n): Lagrange Multiplier test for ARCH effect for *n*th lag. Numbers are the corresponding *p*-values.

[b] Q(n): Ljung-Box Q test statistic for *n*th lag. Numbers are the corresponding *p*-values.

[c] JB: Jarque-Bera test for normality. Numbers are the corresponding *p*-values.

****, **, and * represent 1%, 5% and 10% significance levels, respectively

Table 3b. Estimated GARCH Models for Output Volatility

	SAS	**SSF**	**WLD**
		Mean Equation	
C	0.05509*** (18.004)	0.02052* (1.724)	0.02970*** (8.815)
Output$_{t-1}$	0.15671 (1.521)	0.77554*** (6.940)	0.53904*** (4.445)
		Variance Equation	
C	0.00073 (3.233)	0.00043*** (2.951)	0.00347*** (131.591)
ARCH(-1)	-0.10710** (-2.016)	-0.24617*** (-97.803)	0.84468*** (2.781)
GARCH(-1)	1.03764*** (20.910)	1.04881*** (10.589)	0.03840 (0.327)
Log(GS)	**-0.00030***** **(-3.118)**	**-0.00015***** **(-2.757)**	**-0.00122***** **(-114.206)**
Log-lik.	135.9	104.5	161
ARCH^{a} (2)	1.67843 (0.432)	3.71305 (0.156)	0.18316 (0.912)
ARCH (4)	3.17264 (0.529)	6.09243 (0.192)	1.88611 (0.757)
ARCH (6)	4.11235 (0.661)	7.56952 (0.271)	3.28998 (0.772)
ARCH (8)	5.2261 (0.733)	7.99363 (0.434)	5.60251 (0.692)
Q(2)^{b}	0.1523 (0.696)	0.0673 (0.795)	1.5136 (0.219)
Q(4)	1.7435 (0.627)	1.378 (0.711)	1.5914 (0.661)
Q(6)	3.9137 (0.562)	4.1903 (0.522)	3.0671 (0.690)
Q(8)	7.5545 (0.324)	6.3852 (0.496)	6.4407 (0.489)
JB^{c}	2.094 (0.351)	2.529 (0.282)	4.708 (0.095)

t-values are given in parentheses.

^{a} ARCH-LM(n): Lagrange Multiplier test for ARCH effect for *n*th lag. Numbers are the corresponding *p*-values.

^{b} Q(n): Ljung-Box Q test statistic for *n*th lag. Numbers are the corresponding *p*-values.

^{c} JB: Jarque-Bera test for normality. Numbers are the corresponding *p*-values.

****, **, and * represent 1%, 5% and 10% significance levels, respectively

In addition to detecting a significant relationship between output volatility and government size, the current study also tests whether there is any causality between output volatility and government size or not. We use Granger causality to investigate a possible relationship between output volatility (OV) and government size (GS). The model is as follows:

$$OV_t = \beta_0 + \sum_{j=1}^{z} \beta_{1,j} OV_{t-1} + \sum_{j=1}^{z} \beta_{2,j} GS_{t-1} + e_t$$

$$GS_t = \alpha_0 + \sum_{j=1}^{z} \alpha_{1,j} GS_{t-1} + \sum_{j=1}^{z} \alpha_{2,j} OV_{t-1} + \upsilon_t$$

Here, *t* (1,…,T) denotes the time period and *z* denotes the lag number. e_t and υ_t are white noise errors. $OV_{i,t}$ denotes output volatility while $GS_{i,t}$ denotes government size.

The basic idea of Granger Causality is that if past values of GS are significant predictors of the current value of OV even when past values of OV have been included in the model, then GS exerts a causal influence on OV. Using the above equation, one might easily test whether the GS is said to have a predictive power for OV based on an F-test with the following null hypothesis ($H_{0,1}$):

$$H_{0,1} = \beta_{2,1} = \beta_{2,2} = \cdots = \beta_{2,m} = 0$$

On the other hand, we test whether the OV is Granger cause for GS and the corresponding null hypothesis ($H_{0,2}$) is:

$$H_{0,2} = \alpha_{2,1} = \alpha_{2,2} = \cdots = \alpha_{2,m} = 0$$

where $GS_{i,t}$ and $OV_{i,t}$ are the observations of two stationary variables for economies in period *t*.

If $H_{0,1}$ is rejected, it indicates that causality from GS to OV exists. It can be tested for causality in the other direction as well, and it is possible to detect whether the existence of causality for testing $H_{0,2}$. If $H_{0,2}$ is rejected, one can conclude that causality from OV to GS exists.

The correct choice of lag length is important in terms of avoiding non-trustable results on Granger-causality. Thus, the study uses Akaike Information Criteria (AIC) to determine optimal lag. The Granger-causality results are presented in Table 4.

According to Table-4, GS is Granger cause of OV for all the country classifications except for Sub-Saharan Africa[3] while we only capture other way causality from OV to GS for East Asia & Pacific. Thus, we can conclude that there is a one-way causality from GS to OV mostly, confirming Keynesian Hypothesis.

Table 4. Granger Causality Test Results ($OV \nrightarrow GS$)

	EAS		
$OV \nrightarrow GS$		$GS \nrightarrow OV$	
Lags	1	*Lags*	1
Chi-Sq	5.148	*Chi-Sq*	15.188
p-value	0.0233^{**}	*p-value*	0.0001^{***}
	ECS		
$OV \nrightarrow GS$		$GS \nrightarrow OV$	
Lags	2	*Lags*	2
Chi-Sq	0.790	*Chi-Sq*	31.498
p-value	0.6736	*p-value*	0.0000^{***}
	MEA		
$OV \nrightarrow GS$		$GS \nrightarrow OV$	
Lags	1	*Lags*	1
Chi-Sq	0.0141	*Chi-Sq*	1.4694
p-value	0.9053	*p-value*	0.2254
	NAC		
$OV \nrightarrow GS$		$GS \nrightarrow OV$	
Lags	1	*Lags*	3
Chi-Sq	0.0656	*Chi-Sq*	7.1902
p-value	0.9956	*p-value*	0.0661^{*}

Table 4. Granger Causality Test Results ($OV \nrightarrow GS$) (Continued)

	SAS		
$\underline{OV \nrightarrow GS}$		$\underline{GS \nrightarrow OV}$	
Lags	1	*Lags*	1
Chi-Sq	2.467	*Chi-Sq*	9.588
p-value	0.1162	*p-value*	0.0020**
	SSF		
$\underline{OV \nrightarrow GS}$		$\underline{GS \nrightarrow OV}$	
Lags	1	*Lags*	1
Chi-Sq	2.222	*Chi-Sq*	0.1961
p-value	0.1360	*p-value*	0.6578
	WLD		
$\underline{OV \nrightarrow GS}$		$\underline{GS \nrightarrow OV}$	
Lags	3	*Lags*	3
Chi-Sq	2.007	*Chi-Sq*	23.970
p-value	0.5709	*p-value*	0.0000***

3.1. Robustness Check

There are many different measurements of output volatility that may lead to inconsistent results. The current study estimates the same model by using different output volatility measurements as volatility in the business cycle as a robustness check. The study uses the Hodrick-Prescott filter (Hodrick & Prescott, 1997) in order to compute volatility in the business cycle component from de-trended real GDP. All empirical part replicate using new measurement of output volatility with growth volatility measurement[4]. The empirical results do not differ according to volatility calculations (see Table 5a and 5b)

The study classifies countries based on income classifications as high income, middle income, and low income. The results are presented in Table 6, which shows that the ARCH term is significant for high-income and middle-income under the student-t distribution. It means that previous year output (growth) information can influence current year output volatility for these income groups. Under the distribution, the GARCH is also significant for middle-income and low-income. Furthermore, the government size has significantly negative impact for middle-income. It means that outside shock (as government general expenditure) will have a negative effect on the output volatility for these income levels. The results indicate that a larger government increases economic stability. In other words, output volatility is dependent on both of its own shocks and it is negatively influenced by outside shock as government size over middle-income levels. The results are robust in terms of controlling for different income level of country classifications.

To investigate the relationship between output volatility and government size, the study also uses a set of exogenous variables in the variance equation as control variables, trade openness, population and inflation. For brevity, we could not report empirical results of our estimates here, but they are available on request. The results are robust in terms of controlling for the effect of different sets of exogenous variables.

4. Conclusions

Achieving macroeconomic stability is one of the most important objectives of policy-makers. Theoretical models rely on the fact that a large government yields more macroeconomic stability. Interestingly, however, reviews of empirical literature suggest that the relationship between government size and output volatility is controversial. Thus, in order to get more robust empirical evidence, the current study aims to model the volatility of output and examine the impact of government size on output volatility by using eight different classifications of world economies and univariate GARCH models. The study additionally uses the Granger Casualty Analysis to determine the direction of this relationship.

The results suggest a negative relationship between government size and output volatility for East Asia & Pacific, Europe & Central Asia, Middle East and North Africa, North America, South Asia, Sub-Saharan

Africa, and World. According to empirical evidence, we can conclude that a larger government increases economic stability. It is obvious that output volatility is largely dependent on its own shocks and negatively influenced by outside shock as government size. Moreover, according to Granger causality, there is one-way causality from GS to OV for Europe & Central Asia, North America, South Asia, and World while there is two-way causality between GS and OV only for East Asia & Pacific. Thus, we could confirm Keynesian Hypothesis for capturing mostly one-way causality from government size to output volatility.

For robustness check, the study uses another output volatility measurement as volatility in the business cycle. The study also applies Fourier ADF unit root test (Lee and Enders, 2012) to model structural break as an endogenous process. Moreover, the study applies same model for different classifications of world economies. These results demonstrate the robustness of our empirical findings.

End Notes

1. *The data is single time-series for a specific group of countries. Thus, the GARCH models are not aggregated into country sub-samples. The series itself also aggregated for a group of classifications as a single time-series by the World Bank.*
2. *The study also applies Fourier ADF unit root test (Lee and Enders, 2012) for modeling structural break as an endogenous process (see Table 2c and 2d). These results demonstrate the robustness of our results.*
3. *The study applies Granger Causality Test only for the economies that have a significant relationship between output volatility and government size. See Table 3 for details.*
4. *There are two different measurements of output. The first one is logarithmic reel GDP, and the second one is cycle component of logarithmic GDP. The cycle component is calculated by using the Hodrick-Prescott filter (Hodrick & Prescott, 1997). We use output as an input for univariate GARCH estimation model to get output volatility. The differences between two calculations are based on output calculation.*

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Appendix

Table 2c. The Results of Fourier Augmented Dickey Fuller Unit Root Tests for Output Volatility

	Test statistic [x]	Lag [y]	Series [t]
WLD	-5.3363352**	1	L
MEA	-7.3891786***	1	D
NAC	-7.3891786***	1	L
SAS	-7.3891786***	4	L
SSF	-5.0411616**	1	L
LCN	-4.6542207*	1	L
EAS	-5.7038319**	2	D
ECS	-4.3421734*	1	L

[x] *, **, and *** represent the 10%, 5% and 1% significance levels, respectively. In the model with the constant and the trend, the critical values for the F statistics are 4.162, 4.972 and 6.873 for 10%, 5% and 1% significance levels, respectively.

[y] Akaike Information Criteria are used for lag order selection

[t] L represents Level and D represents the difference of series.

Table 2d. The Results of Fourier Augmented Dickey Fuller Unit Root Tests for Government Size

	Test statistic [x]	Lag [y]	Series [t]
WLD	-5.1895386**	4	D
MEA	-7.2991035***	1	D
NAC	-4.2915365*	5	L
SAS	-4.9325627*	1	L
SSF	-7.6880085***	1	D
LCN	-4.3062010*	6	D
EAS	-5.2629122**	4	D
ECS	-6.5155696**	1	L

[x] *, **, and *** represent the 10%, 5% and 1% significance levels, respectively. In the model with the constant and the trend, the critical values for the F statistics are 4.162, 4.972 and 6.873 for 10%, 5% and 1% significance levels, respectively.

[y] Akaike Information Criteria are used for lag order selection

[t] L represents Level and D represents the difference of series.

Table 5a. Estimated GARCH Models for Output Volatility in the Business Cycle

	EAS	**ECS**	**LCN**	**MEA**	**NAC**	**SAS**	**SSF**	**WLD**
	Mean Equation							
C	-0.00489 (-1.262)	-0.00132 ((-0.314)	-0.00711 (-1.255)	**-0.00510** **(-0.628)**	0.00135 (1.049)	0.00082 (0.736)	0.00273** (2.250)	0.00183 (0.724)
AR(1)	0.51879* (4.286)	0.60236* (0.121)	0.44796** (2.234)	0.45469* (3.137)	-0.07453** (-2.096)	0.11479 (0.498)	0.20069 (1.118)	0.32974 (1.853)
AR(2)				0.13508 (0.904)			-0.32940* (-8.155)	
MA(1)	0.35122** (2.206)	0.24786 (3.754)	0.30484 (1.471)		0.78391* (50.574)	0.42890** (2.089)	0.71973* (3.845)	0.39332 (2.169)
MA(2)							0.27588** (2.560)	
	Variance Equation							
β_0	4.81079 (0.907)	-2.03518 (-0.547)	-12.55599 (-1.449)	-4.61349 (-0.650)	-8.38646* (-10.535)	0.92819* (12161.26)	-4.33364* (-21.803)	0.42198 (1.011)
β_1	1.10654** (2.269)	-0.24836 (-0.536)	0.85040 (1.475)	0.98160*** (1.875)	-1.86206* (-3.604)	-0.33261* (-38.102)	-3.21520* (-4042.794)	-0.34682 (-0.885)
β_2	0.42931 (1.343)	0.57415* (2.592)	-0.01809 (-0.084)	-0.17322 (-0.582)	0.55322** (2.189)	0.12663 (0.926)	-0.19263*** (-1.690)	0.51738** (2.448)
β_3	0.43796 (1.587)	0.82886* (4.396)	-0.49255 (-1.098)	0.92144* (3.970)	0.24504* (5.435)	0.95202* (863.187)	-0.24235* (-2.960)	0.83314* (25.514)
Log(GS)	-4.10468** (-2.064)	0.20637 (0.165)	-0.22819 (-0.063)	1.05297 (0.540)	1.11288* (3.964)	-0.46173* (-219.029)	-1.68542* (-4.793)	-0.6117* (-14.764)
Log-lik.	171.5	144.5	157.4	116.9	175.0	159.4	117.4	187.0
ARCH^a (2)	0.13149 (0.936)	1.19328 (0.551)	3.13090 (0.209)	0.61313 (0.736)	0.02019 (0.990)	0.20924 (0.901)	3.44590 (0.179)	1.93840 (0.379)
ARCH (4)	2.53001 (0.639)	1.10652 (0.893)	6.41724 (0.170)	2.16401 (0.706)	0.04433 (1.000)	1.32917 (0.856)	3.44590 (0.179)	4.90597 (0.308)
ARCH (6)	4.24005 (0.644)	2.99796 (0.809)	9.41262 (0.152)	3.12140 (0.794)	0.23950 (1.000)	1.99185 (0.920)	7.77520 (0.255)	5.01418 (0.542)
ARCH (8)	9.39089 (0.310)	4.45664 (0.814)	12.33877 (0.137)	2.76516 (0.948)	1.12034 (0.997)	3.81023 (0.874)	8.68602 (0.370)	8.11662 (0.422)
Q(2)^b	1.7154 (0.190)	1.0047 (0.316)	1.9849 (0.159)	3.5865 (0.056)	6.9870 (0.08)	0.7933 (0.402)	5.181 (0.025)	1.6665 (0.197)
Q(4)	1.7238 (0.422)	1.6879 (0.430)	4.0277 (0.133)	3.9600 (0.138)	7.4151 (0.025)	3.1828 (0.204)	6.3832 (0.041)	1.9010 (0.387)
Q(6)	1.9975 (0.736)	5.9964 (0.199)	8.4836 (0.075)	5.2050 (0.267)	7.7052 (0.103)	3.5679 (0.468)	7.5828 (0.055)	9.3441 (0.053)
Q(8)	2.4363 (0.876)	9.3704 (0.154)	9.4575 (0.149)	6.5796 (0.361)	8.4225 (0.209)	3.6103 (0.729)	7.8447 (0.097)	0.077 (0.102)
JB^c	3.545	0.566	1.439	2.061	417.7	0.223	1.755	1.133

t-values are given in parentheses. The models come from E-Garch Estimation

^{a} ARCH-LM(n): Lagrange Multiplier test for ARCH effect for *n*th lag. Numbers are the corresponding *p*-values.

^{b} Q(n): Ljung-Box Q test statistic for *n*th lag. Numbers are the corresponding *p*-values.

^{c} JB: Jarque-Bera test for normality. Numbers are the corresponding *p*-values.

***, **, and * represent 1%, 5% and 10% significance levels, respectively

$$\log(h_t) = \beta_0 + \beta_1 \log h_{t-1} + \beta_2 \frac{|\varepsilon_{t-1}|}{\sqrt{h_{t-1}}} + \beta_3 \frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}_{\,t}} + \beta_4 \log(GS)$$

Table 5b. Granger Causality Test Results ($OV \nrightarrow GS$) for Output Volatility in the Business Cycle

	$OV \nrightarrow GS$			$GS \nrightarrow OV$		
	Chi-sq.	**df**	**Prob.**	**Chi-sq.**	**df**	**Prob.**
Area						
EAS	2.01049	2	0.366	26.3877*	2	0.000
ECS	5.87793***	2	0.053	29.2205*	2	0.000
LCN	1.48906	3	0.685	10.24812**	3	0.0166
MEA	0.064412	1	0.800	0.53593	1	0.464
NAC	2.28252	2	0.319	37.5249*	2	0.000
SAS	7.79418**	2	0.020	9.82292*	2	0.007
SSF	2.07898	2	0.354	1.65020	2	0.438
WLD	6.58909**	2	0.037	39.3524*	2	0.000

Table 6. Estimated GARCH Models for Output Volatility

	HIC	**MIC**	**LIC**
		Mean Equation	
c	0.02894*** (6.419)	0.04763*** (14.580)	0.04715*** (8.758)
Output$_{t-1}$	0.55055*** (4.704)	0.58008*** (5.046)	0.47649*** (3.483)
		Variance Equation	
c	0.00106 (0.485)	0.00124*** (3.231)	0.00018*** (2.784)
ARCH(-1)	0.46047* (1.750)	0.18082*** (3.809)	-0.71234 (-0.953)
GARCH(-1)	0.15731 (0.446)	-1.10395*** (-9.557)	1.15761*** (2.994)
Log(GS)	-0.00034 (-0.444)	-0.00033*** (-2.702)	-0.00004 (-0.743)
Log-lik.	155.2	164.2	72.8
ARCH^{a} (2)	0.860539 (0.650)	1.50850 (0.470)	2.750374 (0.253)
ARCH (4)	4.14352 (0.387)	4.87839 (0.300)	2.610489 (0.625)
ARCH (6)	7.59667 (0.269)	6.18336 (0.403)	5.268891 (0.510)
ARCH (8)	13.20629 (0.105)	6.61734 (0.578)	8.524916 (0.384)
Q(2)^{b}	0.5444 (0.461)	0.125 (0.724)	1.808 (0.179)
Q(4)	1.4028 (0.705)	1.7993 (0.615)	2.3475 (0.503)
Q(6)	1.8744 (0.866)	2.8691 (0.720)	4.0095 (0.548)
Q(8)	4.7567 (0.690)	4.4754 (0.724)	5.7235 (0.572)
JB^{c}	3.505 (0.173)	1.019 (0.601)	2.111 (0.348)

t-values are given in parentheses.

[a] ARCH-LM(n): Lagrange Multiplier test for ARCH effect for *n*th lag. Numbers are the corresponding *p*-values.

[b] Q(n): Ljung-Box Q test statistic for *n*th lag. Numbers are the corresponding *p*-values.

[c] JB: Jarque-Bera test for normality. Numbers are the corresponding *p*-values.

****, **, and * represent 1%, 5% and 10% significance levels, respectively.