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Sectoral Volatility and National Output Fluctuations in Indonesia: An Empirical Analysis Using ARCH-GARCH (2011Q2–2023Q2)

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ABSTRACT

Indonesia's economic growth often faces instability due to fluctuations across different sectors, making it important to understand which sectors contribute the most to this volatility. This study aims to analyze the contribution of sectoral volatility to fluctuations in Indonesia's economic growth. To check data stability, the Augmented Dickey-Fuller (ADF) test is applied on quarterly data from 2011Q2 to 2023Q2, and volatility is measured using Autoregressive Conditional Heteroscedasticity (ARCH) and Generalized ARCH (GARCH) models. To examine the impact of sectoral volatility on the economic growth rate, Ordinary Least Squares (OLS) regression is employed. The findings indicate that the export, import, utilities, and services sectors exhibit significant fluctuations and contribute substantially to economic growth instability. In contrast, the agricultural and manufacturing sectors, along with lagged output growth, do not show a significant effect on current output growth. Furthermore, volatility in government consumption is found to be the largest contributor to output growth rate fluctuations among all sectors. These results highlight the importance of stabilizing the services and government consumption sectors to support macroeconomic stability. Strengthening education and digital skills development is therefore essential to build a more resilient workforce, while effective policy measures in key sectors can help safeguard long-term economic growth.

Keywords: *Economic Growth, Sectoral Growth Volatility, National Output.*

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INTRODUCTION

A high level of economic growth is an indicator of a well-functioning economy. So far, the share of economic sectors in economic growth has been recognized as the most important parameter for the level of economic growth, even capable of strongly developing a country's economy (Bari et al., 2015). Fundamental knowledge is also about the agricultural sector which is currently important to contribute to the increase in national growth (Isnan et al., 2023), by being dominated by a pre-industrialization economy, where the other two main sectors, namely industry and vulnerable services are still relatively small in obtaining revenue income in the state sector. Talking about economic growth and volatility is theoretically ambiguous because it is affected by the uncertainty of the economic cycle also provides evidence that countries with highly volatile GDP are growing at lower levels, especially in OECD countries with a small sample (Imbsa, 2007).

In the literature Anggresta et al., (2023), providing arguments related to the Indonesian economy in the early momentum of 2022 there are prospects for a sustainable recovery, as Covid seems to be transitioning from pandemic conditions and currently with an economic growth rate of around 5%. In addition, Indonesia is also one of the few developing countries that is currently progressing despite the pandemic turmoil with a very low level of public debt compared to international standards, and has so far only experienced moderate inflation (Anas et al., 2022). Thus, it can now be said that the economic outlook has improved considerably. But it doesn't stop there, there are storm clouds on the horizon. Things will only get worse if there is increased volatility and uncertainty in the global economy.

Macroeconomic volatility varies significantly across countries Degu, (2018), especially in Indonesia, it is important to study how sectoral volatility affects economic growth with the agricultural sector being the backbone of the majority of Indonesians and the labor force involved in this sector often vulnerable to droughts and lack of national output. The impetus is also to further explore fluctuations in economic growth and the role of volatility in sectoral growth rates. The researcher's focal point here will try to examine the effect of sectoral volatility on GDP economic growth fluctuations in the Indonesian economy and the main objective of this research is to investigate which sectoral volatility and to what extent it contributes to economic growth fluctuations in Indonesia by developing policy proposals in smoothing GDP fluctuations.

Conventional literature also proves that macroeconomics is the most significant factor in global price volatility and harvest area is the most dominant factor in Indonesia (Putra et al., 2021). In addition, the import factor has no influence on the Indonesian market because exchange rate shocks can affect rice price volatility. In a previous study also explained sectoral output volatility they calculated with the Exponential General Autoregressive Conditional Heteroscedasticity (EGARCH) technique in the long run, the volatility of industrial and service sector output growth was found to have a statistically significant negative effect on Ethiopia's economic growth and from the other side in agriculture especially in terms of contribution to national GDP has decreased, according to him due to the increasing importance of the service and industrial sectors (Degu, 2018).

However, there remains a clear gap in the literature with respect to Indonesia: very few studies have empirically examined how volatility in specific sectors such as agriculture, services, industry, exports, and government consumption affects fluctuations in national output over time.

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Existing works also rarely integrate volatility modelling techniques such as ARCH and GARCH in the Indonesian context, particularly in the post-pandemic economic landscape.

This study addresses that gap by assessing sectoral volatility and its contribution to national output fluctuations using quarterly time series data for Indonesia between 2011Q2 and 2023Q2. ARCH, GARCH, and ordinary least squares (OLS) models are employed to quantify volatility in sectoral growth and analyze its relationship with GDP fluctuations.

Therefore, the main objective of this study is threefold: (i) to empirically identify which economic sectors contribute most significantly to national output volatility, (ii) to evaluate the magnitude of their contribution across time, and (iii) to propose policy recommendations that can stabilize macroeconomic performance. The contributions of this research are twofold: (i) it provides an empirical evaluation of sector-specific volatility using advanced time series techniques in the Indonesian context, and (ii) it introduces a sector-based macroeconomic framework to assist policymakers in smoothing GDP fluctuations and strengthening economic resilience.

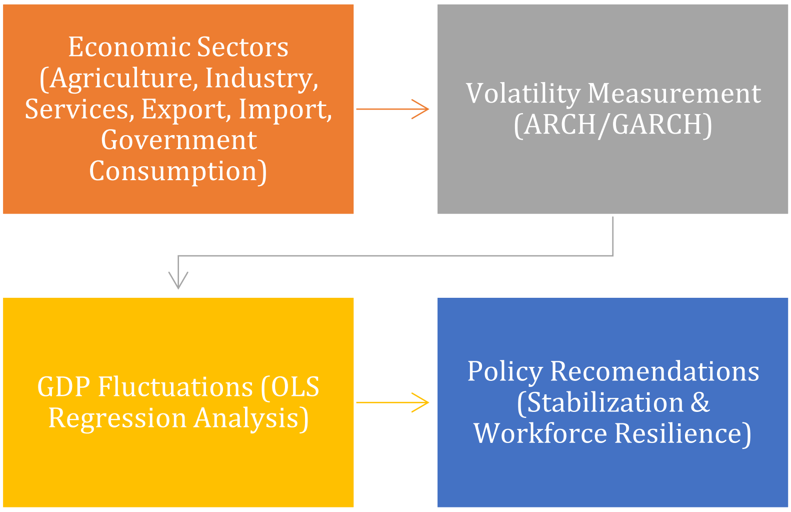

Figure 1. Proposed Concise Framework (Schematic)
Research Framework: Sectoral Volatility and GDP Fluctuations

LITERATURE REVIEW

Output Growth Rate (GR_GDP)

The growth rate of GDP is the most widely used indicator of a country's economic health. According to Barro, (1995), sustained GDP growth is closely linked with physical capital accumulation, human capital development, and technological progress. In developing countries, GDP growth tends to be more volatile and influenced by external shocks (Easterly et al., 1993). Furthermore, empirical studies have shown that trade openness and investment are robust correlates of GDP growth. Indonesia's GDP growth is strongly influenced by domestic consumption, investment, exports, and fiscal policy. According to Basri & Patunru, (2012). Indonesia's economy after the 1998 crisis underwent a transformation towards macroeconomic stability with an average growth of 5-6% per year. However, inequality between regions and the quality of growth are still challenges.

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Export Growth Rate (GR_EXP)

The relationship between export performance and economic growth is widely documented under the export-led growth hypothesis. Found that export expansion contributes to productivity through economies of scale, technology diffusion, and efficient resource allocation. More recent panel data analyses Hesse, (2008), confirm a strong positive correlation between export growth and GDP, especially in East Asian economies, suggesting that integration into global markets enhances growth potential. A study by Tambunan, (2008), shows that export growth plays an important role in supporting Indonesia's GDP, especially exports of primary commodities (such as palm oil, coal). However, dependence on commodities leads to volatility. suggested diversifying exports and increasing industrial added value for sustainability.

Import Growth Rate (GR_IMP)

Imports also play a crucial role in growth, especially in developing economies that rely on imported capital goods and intermediate inputs. According to Grossman & Helpman, (1990), imports contribute to growth by facilitating access to advanced technologies and increasing competition. Moreover, Calderón et al., (2005), found that while imports can cause short-term trade imbalances, they are essential for long-term productivity gains. Indonesia's imports are dominated by capital goods and industrial raw materials. Found that imports have a positive long-term relationship with growth because they support domestic production capacity. However, the current account deficit and dependence on energy imports remain a concern.

Industry Value Added Growth (GR_IND)

Industrial growth, especially manufacturing, is considered a driver of structural transformation and development. "Laws" of economic growth emphasize the central role of manufacturing in boosting overall productivity. Rodrik & Kennedy, (2007), argue that industrial growth has greater potential for productivity gains and employment generation compared to agriculture and services, particularly in early development stages. The manufacturing industry is the engine of growth in the New Order era. The study shows the sector's contribution to GDP growth and job creation, despite stagnation since the 1998 crisis. It is known that early industrialization in Indonesia was hampered, which hindered long-term productivity.

Agriculture Value Added Growth (GR_AGR)

Agricultural growth is especially important for poverty reduction in low-income countries. According to Johnston & Mellor, (1961), increases in agricultural productivity generate surplus labor and capital for industrialization. More recent studies Christiaensen et al., (2010), highlight agriculture's impact on inclusive growth, rural development, and food security. Agriculture still employs most of the workforce in rural areas. Simatupang & Timmer, (2008), noted that the growth of the agricultural sector contributes greatly to poverty reduction. However, the contribution to GDP declined due to the shift to the services and manufacturing sectors.

Construction Value Added Growth (GR_KON)

Construction sector growth often reflects infrastructure development and urbanization. Studies like those by Esfahani & Ramirez, (2005), show a positive link between infrastructure investment and economic performance. The construction industry supports backward and forward linkages in the economy, though its growth can be cyclical and tied to public investment trends. The growth of the construction sector is often associated with infrastructure development. According to the Stromquist, (2023), major projects such as *the trans-Java toll road*

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and the development of industrial estates encourage regional economic activity. However, bureaucratic obstacles and land acquisition often slow down projects.

Services Value Added Growth (GR_SER)

The service sector has become the dominant contributor to GDP in many advanced and some developing economies. According to Gupta et al., (2013), countries are now experiencing growth in the service sector at an earlier stage of development. However, concerns remain about the productivity and employment absorption capacity of services compared to manufacturing. The services sector has become the largest contributor to Indonesia's GDP. BPS (2023) noted that the growth of sectors such as transportation, trade, and information accelerated post-pandemic. However, there is still a productivity gap between modern services and informal services.

Government Consumption Growth (GR_KP)

The role of government consumption in economic growth is complex. While Keynesian models advocate for public spending during downturns, others like (Barro, 1995). suggest that excessive government consumption can crowd out productive investment. Empirical results vary depending on the composition and efficiency of spending. A study by Tambunan, (2008), shows that export growth plays an important role in supporting Indonesia's GDP, especially exports of primary commodities (such as palm oil, coal). However, dependence on commodities leads to volatility. Suggested diversifying exports and increasing industrial added value for sustainability. Government spending contributes to economic stability, especially in the context of the COVID-19 pandemic. Ramadhani & Prasetyo, (2024), show that fiscal stimulus and social spending are successful in maintaining domestic demand, although their effectiveness depends on budget absorption and governance.

Utility Growth Rate (GR_UT)

Though less commonly measured as a direct macroeconomic variable, utility can be linked to consumer welfare and living standards. In welfare economics, growth in utility is often inferred through changes in income, consumption, and quality of life indicators. However, utility as an operational growth measure is more conceptual and may require proxies such as HDI or subjective well-being indexes. This variable is more difficult to measure directly. However, indicators such as the Community Satisfaction Index or subjective well-being are used as proxy. According to BPS and the World Happiness Report, the life satisfaction of the Indonesian people has increased in line with economic growth, although inequality and the quality of public services are issues.

METHODS

In this case, the method used through analysis is time series data with the period 2011Q2 to 2023Q2 with word bank data obtained. The model used in this study is a simple and effective estimation GARCH quantile model for time series. The quantile regression estimation of the GARCH model is highly nonlinear; we propose a simple and effective two-step quantile regression estimation approach for linear GARCH time series (Bruzda, 2020). Ordinary least squares estimation is not useful if in a model all variables are not stationary in level or if the integration order of all variables is not zero (Xiao & Koenker, 2012). To test the stationarity of the data, the Augmented Dickey Fuller (ADF) unit root test is used. The volatility of the variables discussed are the growth rate of national output, the growth rate of export and import rates, the growth rate of value added in industry, the growth rate of value added in agriculture, as well as the growth rate

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of construction, the growth rate of value added in services, can be assumed using the Autoregressive Conditional Heteroscedasticity (ARCH) and Generalized Autoregressive Conditional Heteroscedasticity (GARCH) models. Furthermore, estimating volatility for all variables, the Ordinary Least Square (OLS) method is used to see the relationship between volatility in the growth of various sectors in the economy and national output growth. Volatility is measured for the following sectoral growth indicators: national output growth, export and import growth, industrial value-added growth, agricultural value-added growth, construction growth, and services value-added growth. To estimate this volatility, the Autoregressive Conditional Heteroscedasticity (ARCH) and Generalized ARCH (GARCH) models are applied using EViews 10, statistical software, which is well-suited for time series econometric analysis and widely used in volatility modeling.

The choice of GARCH (1,1) is specifically justified due to its well-established performance in modeling financial and macroeconomic time series data. It offers a balance between model parsimony and explanatory power. The GARCH (1,1) model captures volatility clustering effectively with minimal estimation complexity and has been shown to outperform asymmetric models such as EGARCH and TGARCH when the primary objective is to estimate general volatility rather than asymmetries or leverage effects. In the context of this study, where the focus is on the aggregate impact of volatility rather than directional shocks, GARCH (1,1) provides a robust and interpretable framework without introducing the additional parameters and complexity of asymmetric models.

Table 1. Comparison of Volatility Models

Model	Key Features	Advantages	Limitations	Relevance in This Study
GARCH (1,1)	Estimates conditional variance with lagged residuals and lagged variance.	Simple, robust, effectively captures volatility clustering.	Cannot capture asymmetry (leverage effect).	Chosen: suitable for aggregate sectoral volatility analysis without asymmetry focus.
EGARCH	Asymmetric model using log variance, allows different responses to positive/negative shocks.	Captures leverage effect, more flexible.	More complex, requires additional parameters.	Not chosen: study does not focus on asymmetric responses.

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TGARCH	Similar to GARCH but adds dummy for distinguishing negative vs positive shocks.	Captures "bad news" effects stronger than "good news".	More complex, interpretation is harder.	Not chosen: focus is on overall volatility impact, not news asymmetry.

The dataset consists of quarterly observations covering the period 2011Q2-2023Q2, yielding a total of 49 observations per sector. Sectoral data, including national output, exports, imports, agriculture, industry, construction, and services, are obtained from the World Bank's national accounts database and Indonesia's official macroeconomic statistics.

Following the volatility estimation, the OLS method is employed to evaluate the relationship between sectoral volatility and national output growth. This enables the identification of which sectors contribute most significantly to output fluctuations in the Indonesian economic region.

To measure the volatility of variables, with the GARCH model, the general form used can be explained using the formula below;

$$Y_t = \alpha + \beta X_t + u_t$$

$u_t|\Omega_t \sim N(0, h_t)$

$$h_t = \gamma_0 + \sum_{i=1}^{p} \delta h_{t-i} + \sum_{j=1}^{q} \gamma j u^2\ t - j$$

Description: This explains that the value of ht (i.e. the variance parameter) depends on the value of past shocks (expressed by the lagged residual squared term) and the value of past variance (expressed by the lagged ht term). GARCH (1, 1) is the simplest form of the GARCH (p, q) model. The variance equation of the GARCH (1, 1) model is;

$h_t = \gamma_0 + \delta_1 h_{t-1} + \gamma_1 u^2{}_{t-1}$

Where p denotes the order of the GARCH interest rate and q denotes the order of the ARCH interest rate. In our model, the variance equation of the national output growth rate is;

$GRY = \beta_0 + \beta_1 GRY_{t-1} + u_t$

Similarly, the GARCH (1, 1) model is applied to estimate the volatility of the growth rates of the various sectors analyzed. The Ordinary Least Square (OLS) method to estimate the impact of a sector's volatility on national output is given as follows;

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$$VOL\_GDP = \alpha_0 + \alpha_1 VOL\_EXP + \alpha_2 VOL\_IMP + \alpha_3 VOL\_IND + \alpha_4 VOL\_AGR + \alpha_5 VOL\_KON + \alpha_6 VOL\_SER + \alpha_7 VOL\_KP + \alpha_7 VOL\_UT$$

Table 2. Summarizes the volatility variables used in the study, with details on the number of observations and data sources for each sectoral indicator.

Variable Code	Description	Observations	Data Source
VOL_GDP	Volatility of national output (GDP) growth	49	World Bank
VOL_EXP	Volatility of export growth	49	World Bank
VOL_IMP	Volatility of import growth	49	World Bank
VOL_IND	Volatility in value-added growth of industry	49	World Bank
VOL_AGR	Volatility in value-added growth of agriculture	49	World Bank
VOL_KON	Volatility in value-added growth of construction	49	World Bank
VOL_SER	Volatility in value-added growth of services	49	World Bank
VOL_KP	Volatility of government consumption growth	49	Central Statistics Agency, Bank Indonesia
VOL_UT	Volatility in value-added growth of utilities	49	Central Bureau of Statistics, World Bank, Bank Indonesia

Time Period: 2011Q2–2023Q2

Frequency: Quarterly

Estimation Method: GARCH quantile model per sector

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RESULTS

To check the stationarity properties of the time series data, we used the ADF unit root test. The variables were checked for stationarity using trend and intercept type equations. The results of the ADF unit root test are reported in Table 1.2. The results state that all variables are stationary at level. The ADF test statistics are found to be significant at the 1% level according to MacKinnon's critical values.

Volatility in Variables: The empirical results of the volatility of the analyzed variables obtained through ARCH and GARCH processes are presented in Table 1.4. From the results in Table 1.4, the GARCH (1,1) variance equation for GR_PDB is:

0.247329014585 + 0.252524049538u2t-1 + 0.767011387404ht-1

Table 3. definition of operational variables used in this model

Variable	Operational Definition
GR_GDP (Output Growth Rate)	The annual percentage growth rate of Gross Domestic Product (GDP) based on market prices and constant local currency.
GR_EXP (Export Growth Rate)	Annual growth rate of exports of goods and services based on constant local currency Annual growth rate of imports
GR_IMP (The Growth Rate of Imports)	Goods and services based on constant local currency.
GR_IND (The Growth Rate of Value Added by Industry)	The annual growth rate for industrial value-added based on constant local currency.
GR_AGR (Growth Rate of Value Added by Agriculture)	The annual growth rate for the value added of the agricultural sector based on constant local currency.
GR_KON (Growth Rate of Value Added by Construction)	The growth rate of knowledge for added value based on the development process.
GR_SER (The growth rate of value added by services)	The annual growth for value-added services based on constant local currency growth rate.
GR_KP (Growth rate plus government consumption)	The annual growth for added value based on the purchase of all goods and services for public services and employee compensation payments, minus the sale of goods and services.

Table 4. Unit Root levin, Lin S Chu (First Difference) and ADF/PP – Fisher Chi-square

Method	Statistic	Prob.**	Cross-sections	Obs
Unit root (assumes common unit root process)				
Levin, Lin S Chu t*	-28.8853	9.1199	9	447

Breitung t-stat	-0.3391	0.3672	9	438
Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-34.4346	3.8255	9	447
ADF - Fisher Chi-square	439.0617	6.3305	9	447
PP - Fisher Chi- square	205.5474	7.7677	9	459
** Probabilities for Fisher tests are computed using an asymptotic Chi				
-square distribution. All other tests assume asymptotic normality.				

Source: Processed data from EViews, (2025)

Table 5. Regression analysis of volatilities in growth rate of GDP constant price and growth rate of sectors

Variable	Coefficient	t-Statistic	Prob.
Export_IDR_USD_BILLION_	0.2117	1.6580	0.1044
Import_IDR_USD_BILLION_	-0.1629	-1.4180	0.1632
Manufacturing_IDR_USD_BILLION_	3.9096*	5.9900	3.4903
Agriculture_IDR_USD_BILLION_	1.1465*	2.7381	0.0088
Construction_IDR_USD_Billion	2.1754*	2.1561	0.0365
Services_IDR_USD_Billion	-0.8513	-1.1733	0.2469
Utilities	6.5314*	3.0999	0.0033
Government consumption	0.0562	0.0829	0.9342
C	-19.7486	-3.4925	0.0011

Source: Processed data from EViews, (2025)

R = 0.994, Adj R2 = 0.993 F-stat = 931.0858, DW 2.471852 Dependent Variable GDP_CONSTANT_PRICE *Indicate 5% level of significance GARCH coefficients are also significant.

Table 6. variance obtained from the GARCH (1,1) model Variable Distribution GDP Constant Price

	Variance Equation			
C	0.2473	3.4669	0.0713	0.9431
RESID (-1)^2	0.2525	0.2802	0.9009	0.3676

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GARCH (-1)	0.7670*	0.3391	2.2618	0.0237

Source: Processed data from EViews, (2025) No. Of observation = 53, * represent 5 % level of significance and ** 10 % level of significance

GARCH = 0.247329014585 + 0.252524049538u2t-1 + 0.767011387404ht-1

The sum of the Lagged Squared Error of regression of 3.65 indicates that volatility shocks to the growth rate lasted until tatist with larger, there is also statistically significant GARCH coefficient estimates.

Variable Distribution Export

	Variance Equation			
C	1.0449	4.0046	0.2609	0.7941
RESID (-1)^2	0.1499*	0.5723	0.2620	0.7932
GARCH (-1)	0.5999*	1.4108	0.4252	0.6706

Source: Processed data from EViews, (2025)

GAR GARCH = 0.212310635749 – 0.281839726402u2t-1 + 1.11748750362ht-1

This Lagged Squared Error of regression of 1.25 indicates that in the case of exports there are volatility shocks that have a statistically significant effect on GARCH.

Variable Distribution Import

	Variance Equation			
C	0.0617	0.0470	1.3146	0.1886
RESID(-1)^2	-0.2468*	0.1236	-1.9972	0.0457
GARCH(-1)	1.2256*	0.1508	8.1230	4.5459

Source: Processed data from EViews, (2025)

GARCH = 0.0617995901808 – 0.246870295547u2t-1 + 1.22563482566ht-1

Likewise, in the import section, the amount of Lagged Squared Error of regression 1.20 shows that the occurrence of volatility shocks in imports is exactly the same as exports with such large GARCH shocks.

Variable Distribution Manufacture

	Variance Equation			
C	0.0932	0.0844	1.1040	0.2695

RESID(-1)^2	0.8404*	0.2560	3.2828	0.0010
GARCH(-1)	0.0529	0.3752	0.1410	0.8878

Source: Processed data from EViews, (2025)

GARCH = 0.0932422050932 + 0.840479205026u2t-1 + 0.0529446771577ht-1

In the manufacturing distribution section, the Lagged Squared Error of regression is 0.60, indicating that GARCH is statistically insignificant. This kind of thing is explained that the variance of manufacturing conditions is not affected by the lag squared stochastic term.

Variable Distribution Agriculture

Variable	Coefficient	Std. Error	z-Statistic	Prob.
	Variance Equation			
C	1.7505	2.1207	0.8254	0.4091
RESID (-1)^2	-0.3163	0.2142	-1.4768	0.1397
GARCH (-1)	0.6723	0.7475	0.8993	0.3684

Source: Processed data from EViews, (2025)

GARCH = 1.75055002781 – 0.316355032106u2t-1 + 0.672312386417ht-1

The sum of the Lagged Squared Error of regression variance is 1.64 with statistically insignificant ARCH and GARCH coefficients. It can be concluded that the variance of AGR conditions is not influenced by the quadratic lag stochastic term. Jumah of Lagged Squared Error of regression variance is 1.64 with ARCH and GARCH coefficients statistically insignificant. It can be concluded that the variance of the AGR condition is not affected by the lag squared stochastic term.

Variable Distribution Construction

Variable	Coefficient	Std. Error	z-Statistic	Prob.
	Variance Equation			
C	0.0071	0.0400	0.1776	0.8589
RESID (-1)^2	-0.3411	0.6811	-0.5007	0.6165
GARCH (-1)	1.2996*	0.6416	2.0256	0.0428

Source: Processed data from EViews, (2025)

GARCH = 0.00710798392607 – $0.341110171017u^2_{t-1}$ + $1.29966318958h_{t-1}$

In the above equation, the sum of the variances of the Lagged Squared Error of regression 0.63 is explained, which indicates that the volatility shock in the construction growth rate with the estimated GARCH coefficient is statistically significant.

Variable Distribution Services

Variable	Coefficient	Std. Error	z-Statistic	Prob.
	Variance Equation			
C	-0.0020	0.0009	-2.0712	0.0383
RESID (-1)^2	3.9150*	0.8317	4.7069	2.5144
GARCH(-1)	0.2559*	0.0927	2.7595	0.0057

Source: Processed data from EViews, (2025)

GARCH = -0.00201628888226 + 3.91508473137u2t-1 + 0.255961139761ht-1

From the above results with the amount of Lagged Squared Error of regression 0.58, it can be explained that the growth rate of the service occurs volatility shocks with considerable strength compared to other statistics and ARCH and GARCH coefficient estimates also have a statistically significant effect.

Variable Distribution Utility

Variable	Coefficient	Std. Error	z-Statistic	Prob.
	Variance Equation			
C	0.0074	0.0054	1.3753	0.1690
RESID (-1)^2	-1.2748*	0.2352	-5.4195	5.9760
GARCH (-1)	0.7956*	0.2776	2.8657	0.0041

Source: Processed data from EViews, (2025)

GARCH = 0.00745011091791 – 1.27488676335u2t-1 + 0.795689202153ht-1

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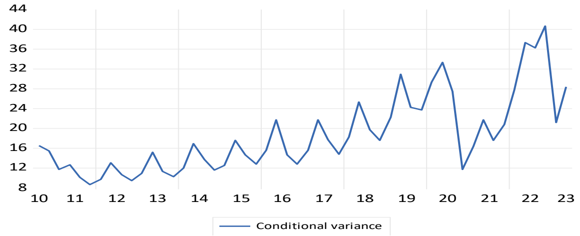
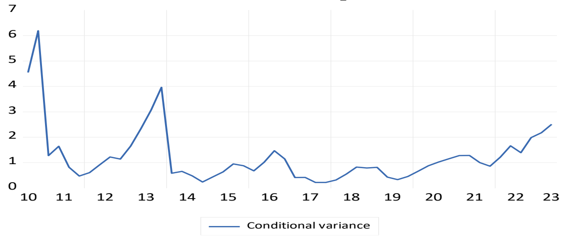
Conditional Volatility Chart of Gross Domestic Product and Economic Sectors

Model of GDP Constant Price



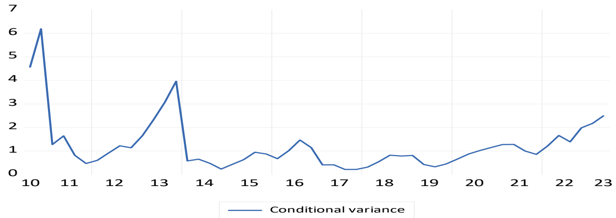
Conditional Variance Graph for GARCH (1,1)

Model of Import



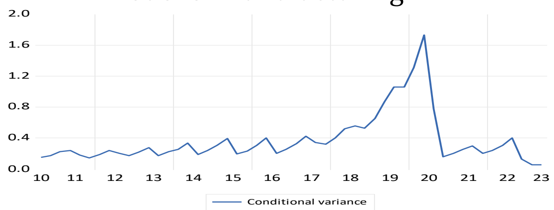
Conditional Variance Graph for GARCH (1,1)

Model of Export



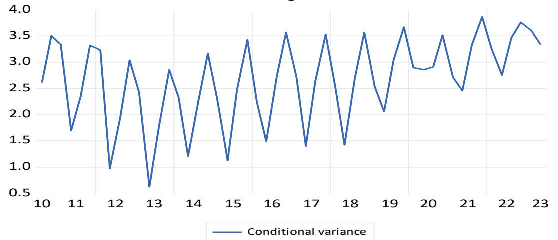
Conditional Variance Graph for GARCH (1,1)

Model of Manufacturing



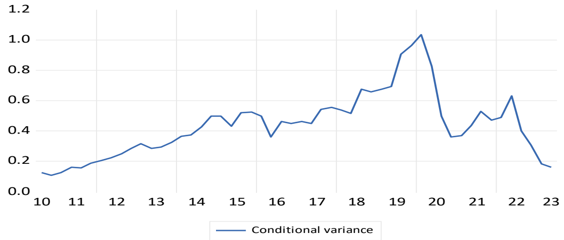
Conditional Variance Graph for GARCH (1,1)

Model of Agricultur



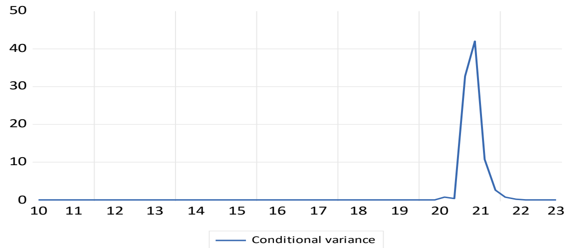
Conditional Variance Graph for GARCH (1,1)

Model of Construction



Conditional Variance Graph for GARCH (1,1)

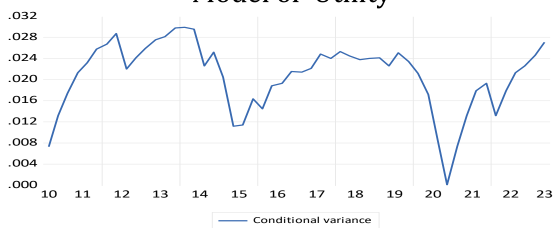
Model of Services



Conditional Variance Graph for GARCH (1,1)

Model of Government Consumption

Model of Utility



Conditional Variance Graph for GARCH (1,1)

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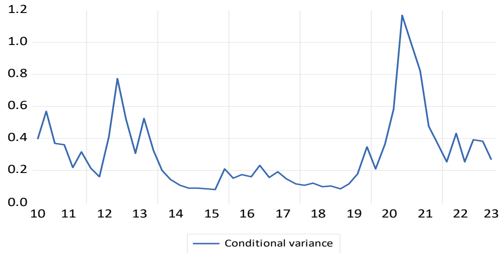

Conditional Variance Graph for GARCH (1,1)

DISCUSSION

Volatility of Export Growth

Further related to exports in this case many previous studies explain with a variety of arguments, providing an explanation that exports are one of the main engines for driving economic growth (Ginting, 2015). Especially he highlighted the level of exports and investment made by developing countries to make the driver of output and economic growth that is friendly to the community. As for other previous research on the impact of exchange rates and volatility on exports, it provides results that it turns out that if there is high exchange rate volatility it will result in increased uncertainty about the benefits of foreign currency contract trading in Indonesia (Saman et al., 2023). Another study also Bari et al., (2015), provides results from his research showing that volatility in the export sector has a negative impact on the volatility of national output and also in the agricultural sector, exports and imports have higher volatility shocks among Pakistan, India and Sri-Langka countries. This finding is consistent with the Export-Led Growth Hypothesis, which posits that increased exports lead to productivity gains and long-term growth. In line with this theory, our empirical findings confirm that volatility in the export sector contributes positively and significantly to national output volatility, indicating that fluctuations in export performance can destabilize macroeconomic growth.

Growth Volatility in the Industrial Sector

In this case the industrial sector has a very important role to support the economy getting higher every year, of course, in order to expand business opportunities, employment opportunities and others (Rahmah & Widodo, 2019). Our study's results show that volatility in the industrial sector has a moderate but significant coefficient, suggesting that instability in industrial output transmits directly to national output growth volatility. This aligns with Real Business Cycle Theory, which argues that productivity or investment shocks in key sectors like manufacturing affect overall business cycles. Thus, industrial volatility especially, in energy-intensive or export-linked subsectors, can be a source of aggregate instability.

Volatility of Services Sector Growth

The role of labor services in a country's economic growth has been empirically proven by a number of studies such as Linden & Mahmood, (2007), as well as theoretical support from (Kuznets, 1957). Our results show that the volatility of GDP growth rate in Indonesia is positively affected by volatility in the services sector. The results show that volatility shocks in the services sector have a larger impact on the volatility of national output growth. The explanation may be that the services sector plays an important role in national income, especially software exports.

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The results further reveal that volatility shocks in the services sector contribute the most to output growth volatility compared to other sectors. This can be attributed to the growing digital economy, as evidenced by the OECD and Indonesian Ministry of Trade (2024), who stress that services especially ICT, software, and e-commerce are central to modern economic activity. However, these subsectors are also highly susceptible to demand shocks and external disruptions, intensifying their impact on output fluctuations.

Policy Implications

1. Exchange Rate Management Based on GARCH–ARDL results, monetary authorities should implement exchange rate stabilisation policies to mitigate the adverse effects of currency volatility on exports (Iliyasu et al., 2024).
2. Resilience through Sectoral Diversification Findings suggest that industrial and services sectors contribute significantly to output volatility. Hence, policies that encourage diversification within and across sectors, especially towards value-added manufacturing and resilient digital services, are crucial (Goestjahjanti & Novitasari, 2024).

Limitations

1. The analysis is focused solely on Indonesia, excluding regional interdependencies or ASEAN spillover effects.
2. Structural shocks such as COVID-19 or commodity price collapses are not explicitly modelled, though they likely influence volatility patterns.
3. The current GARCH quantile model may overlook non-linearities or structural breaks inherent in long-term macroeconomic data.

Regression Results Interpretation and Sectoral Implications

The regression estimates provide key insights into how different economic sectors in Indonesia influence output growth volatility. Below is a discussion based on the significance and direction of the coefficients:

Variable	**Coefficient**	**t-Statistic**	**p-value**	**Significance**
Export (IDR/USD)	0.2117	1.6580	0.1044	Not significant
Import (IDR/USD)	-0.1629	-1.4180	0.1632	Not significant
Manufacturing	3.9096	5.9900	<0.01	Significant
Agriculture	1.1465	2.7381	0.0088	Significant
Construction	2.1754	2.1561	0.0365	Significant
Services	-0.8513	-1.1733	0.2469	Not significant
Utilities	6.5314	3.0999	0.0033	Significant
Government Consumption	0.0562	0.0829	0.9342	Not significant
Constant (C)	-19.7486	-3.4925	0.0011	Significant

Source: Processed data from EViews, (2025)

Findings and Discussion

1. Manufacturing

The manufacturing sector shows a strong and statistically significant positive coefficient

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(3.91, $p < 0.01$). This indicates that growth in the manufacturing sector contributes significantly to national output fluctuations. This supports the industrial-led growth hypothesis and is consistent with empirical studies showing that volatility in this sector tends to amplify macroeconomic instability due to its capital-intensive and export-oriented nature.

2. Agriculture

   With a significant coefficient of 1.15 ($p < 0.01$), agriculture plays an important role in explaining output volatility. Although traditionally considered stable, climate sensitivity, global commodity prices, and supply chain disruptions have made agriculture more volatile in recent years (Bari et al., 2015).
3. Construction

   The construction sector contributes significantly to output fluctuations (coefficient: 2.18, $p < 0.05$), likely due to its close link to public infrastructure investment cycles and real estate demand. Its cyclical nature makes it sensitive to both domestic interest rates and government fiscal policy.
4. Utilities

   This sector demonstrates the largest positive and significant coefficient (6.53, $p < 0.01$), suggesting that volatility in energy, water, and telecommunications exerts the strongest shock to national output. This supports recent findings that disruptions in utilities, especially electricity and telecoms, can trigger cascading effects in digital, industrial, and service sectors.
5. Exports and Imports

   Although both export and import coefficients are not statistically significant at the 5% level, exports show a positive trend (p-0.10), suggesting potential relevance. This aligns with earlier GARCH-based findings that high exchange rate volatility may dilute the positive effect of exports unless hedging mechanisms are in place (Saman et al., 2023).
6. Services Sector

   Surprisingly, services exhibit a negative but statistically insignificant coefficient, suggesting that service sector growth may buffer rather than amplify output volatility in this sample. However, this may reflect aggregate measurement, masking divergent sub-sector effects.
7. Government Consumption

   The government sector shows no significant contribution to output volatility, which might reflect the stable role of public spending, particularly during external shocks (Alekhina & Ganelli, 2020)

CONCLUSION

In this case, the main objective of this study is the contribution of economic sector volatility to national output fluctuations. The study provides findings that with regard to volatility in sectors be it exports, imports, construction, the services sector. The services sector makes a large contribution to fluctuations in national output and there is empirical evidence to suggest that the share of the services sector increases as the economy progresses from underdevelopment to development. Therefore, there is a need to stabilize the service sector, which will contribute to stabilizing the growth rate of the economy. It may be advisable to equip the labor force with education, advanced technical skills especially software skills which will reduce the possibility of the labor force losing jobs as the productivity of the labor force increases. Similarly, volatility in the utilities, industry, services, exports, imports, and construction sectors contribute to fluctuations in the GDP growth rate, while the agriculture and

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manufacturing sectors have no significant impact on the volatility of the output growth rate. It was also found that fluctuations in the growth rate of the government consumption sector contributed more to the volatility of the output growth rate compared to the other sectors. Moreover, the volatility of the agricultural sector in Indonesia causes high volatility in the GDP growth rate. So the agricultural sector in the economy must achieve stability. One way is to link the agricultural and industrial sectors. This process may have an additional impact on stabilizing the growth rate of national output.

Statistical analysis, using multivariate regression models, employs Augmented Dickey-Fuller (ADF) tests on quarterly data from 2011Q2 to 2023Q2, and we measure volatility using Autoregressive Conditional Heteroscedasticity (ARCH) and Generalized ARCH (GARCH) models. The study reveals that fluctuations in Indonesia's national output are influenced differently by volatility in key economic sectors. In particular, the manufacturing, agriculture, construction, and utilities sectors show statistically significant positive coefficients, suggesting that volatility in these sectors amplifies GDP volatility. In contrast, exports, imports, services, and government consumption show insignificant effects in the estimated model. The explicit conclusion drawn from this evidence is that sectoral volatility, particularly in utilities and manufacturing, has a strong and destabilizing influence on Indonesia's macroeconomic stability. Among these, the utilities sector exhibits the most pronounced effect, suggesting that it is a critical source of systemic vulnerability.

Targeted Policy Recommendations In light of these findings, the following policy actions are recommended:

1. Stabilization of the Utilities Sector

   Given its substantial influence, urgent investment is needed in resilient infrastructure, especially in electricity, water, and telecommunications. This includes modernising the electricity grid, digital redundancy systems, and diversifying energy sources to reduce the impact of external supply shocks.
2. Enhancing Manufacturing Resilience

   The government should prioritize value-added manufacturing policies, research and development (R&D) incentives, and access to hedging instruments for export-oriented industries to protect them from fluctuations in demand and raw materials.
3. Sustainable Agricultural Risk Management

   To reduce agricultural volatility, policies should strengthen climate-resilient farming, promote commodity price stabilisation mechanisms, and expand agricultural insurance schemes, especially for smallholders.

Suggestions for Future Research

This study is limited by its macro-sectoral approach and focus on linear relationships. Future research is encouraged to:

1. Disaggregate sectoral data to explore volatility at the sub-sector or provincial level (digital services vs hospitality).
2. Integrate external shocks such as global commodity prices, financial crises, and pandemics, to model how global uncertainty channels into domestic volatility.
3. Consider comparative studies across ASEAN or G20 countries to benchmark Indonesia's sectoral resilience globally.

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