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CHANGES IN THE VOLATILITY OF THE BUSINESS CYCLES AND THE ROLE OF FISCAL POLICY: EVIDENCE FROM AZERBAIJAN

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ABSTRACT

This paper investigates the evolution of business cycle volatility in Azerbaijan by analyzing total, oil-gas, and non-oil-gas GDP dynamics, alongside the role of the fiscal policy shocks in shaping non-oil-gas GDP volatility over the past two decades. The results show that the oil boom of the 2000s significantly increased oil-gas GDP volatility, while total and non-oil-gas GDP remained comparatively stable. In the 2010s, volatility in the oil sector declined due to production stabilization, whereas non-oil-gas GDP experienced increased fluctuations driven by fiscal expansion. The COVID-19 pandemic and post-pandemic recovery renewed volatility in the early 2020s, particularly in oil-gas GDP. Structural VAR analysis reveals a substantial reduction in fiscal policy shock variability in recent years, largely due to improved fiscal management and the adoption of fiscal rules. Variance decomposition highlights that while intrinsic sectoral dynamics remain the dominant source of non-oil-gas GDP fluctuations, fiscal expenditure shocks are increasingly influential, making fiscal stabilization a key driver of sustainable non-oil-gas growth.

INTRODUCTION

Business cycle volatility, characterized by fluctuations in economic output, has profound implications for economic stability and growth. Understanding the drivers of these fluctuations is important for designing effective policies that can mitigate adverse impacts and foster sustainable development. In resource-rich countries such as Azerbaijan, business cycle volatility has traditionally been closely tied to fluctuations in global commodity prices, particularly oil prices. However, as Azerbaijan pursues economic diversification and reduces its dependence on oil and gas, understanding the dynamics of the non-oil-gas sector is becoming increasingly important for ensuring long-term economic stability.

Fiscal policy, encompassing government spending and taxation, is one of the most effective tools available to governments for stabilizing economic fluctuations. However, its impact is not always straightforward and depends on factors such as the magnitude and timing of fiscal shocks, private-sector responses, and the broader macroeconomic environment. While fiscal interventions can smooth business cycle volatility, they may also exacerbate it under certain conditions. Understanding these dynamics is particularly critical for Azerbaijan as it transitions toward a more diversified economy.

Azerbaijan's business cycle literature has evolved from documenting high GDP volatility during the oil boom to developing leading indicators for the non-oil-gas sector and applying advanced filtering methods that reveal strong procyclicality and sensitivity to external shocks (Huseynov & Ahmadov, 2014; Mammadov & Adigozalov, 2014; Ahmadova, 2020; Rahmanov, 2023; Hasanli & Rahmanov, 2024). Recent work by Rahmanov (2025) marks a key shift by examining volatility across total, oil-gas, and non-oil-gas GDP over decades and assessing the role of monetary policy shocks. His findings show that while oil-gas volatility fell after the 2000s boom, non-oil-gas volatility rose in the 2010s. However, the variance decomposition analysis based on the structural VAR (SVAR) model shows that the monetary policy shocks explain only a minor share of its fluctuations. This finding points to other drivers like fiscal policy, productivity dynamics, structural reforms, or external forces as potentially more influential in shaping non-oil-gas sector dynamics.

This paper addresses the research gap by examining the role of fiscal policy in explaining changing business cycle volatility of the non-oil-gas sector using a SVAR model with budget expenditure, non-oil-gas taxes, and non-oil-gas GDP for 2001–2024. A decade-by-decade analysis shows that while the mid-2000s oil boom drove large swings in headline GDP, the 2010s saw aggregate volatility decline even as fiscal expansion amplified fluctuations in non-oil-gas output. By the 2020s, stronger fiscal management appears to have moderated spending shocks and enhanced resilience in the non-oil-gas sector. Variance decomposition confirms that fiscal policy has been a significant and at times dominant source of non-oil-gas GDP volatility, reinforcing Rahmanov's (2025) finding that monetary shocks play only a limited role and underscoring the importance of robust fiscal frameworks for Azerbaijan's diversification strategy.

The remainder of this paper is organized as follows. Section 2 summarizes the relevant literature in greater detail. Section 3 outlines the methodology and the SVAR identification strategy. Section 4 describes the data used in this study. Section 5 presents the empirical results. Section 6 concludes with key findings and policy recommendations for strengthening Azerbaijan's fiscal stabilization capacity and supporting sustained, less volatile non-oil-gas growth.

LITERATURE REVIEW

The question of whether economic fluctuations have become less volatile over time and why has been widely studied, particularly in advanced economies. Evidence for OECD countries shows a marked decline in output volatility since the mid-1980s that is commonly linked to three broad forces: structural shifts (notably the rising share of services and improvements in inventory/production management), better-designed and more credible macroeconomic policy frameworks, especially monetary policy, and a reduction in the size and frequency of common exogenous shocks (Romer, 1999; Stock & Watson, 2002; Dalsgaard et al., 2002; Cotis & Coppel, 2005; Duran, 2019). Taken together, these developments are often cited as key drivers of the "Great Moderation."

In contrast, evidence from developing economies is more limited but points to a similar pattern, with structural reforms and policy improvements playing central roles in volatility reduction. For example, Burger (2008) documented that South Africa's GDP volatility declined following advancements in monetary policy and financial sector development. Similarly, Zhang & Li (2014) reported a significant reduction in China's output volatility after the 1990s, largely due to smaller external shocks. Krantz (2024) emphasized that fiscal rules, structural reforms, and financial deepening dampen macroeconomic volatility across African economies.

Azerbaijan-specific studies provide a different perspective that reflects the unique challenges of a resource-dependent economy. Early research by Huseynov & Ahmadov (2014) reported that Azerbaijan exhibits exceptionally high real GDP volatility combined with high persistence; private consumption and investment tend to lead the cycle, while trade flows broadly co-move with the output. These findings suggest that demand-side forces, including fiscal policy, may propagate shocks over extended horizons. Complementing these results, Mammadov & Adigozalov (2015) constructed composite leading indicators for the non-oil-gas economy (2000–2014) and successfully identified six turning points with an average lead time of 7.2 months. Their analysis shows expansions lasting approximately 43 months versus 10-month contractions, an asymmetry consistent with episodic policy-driven booms followed by sharp slowdowns. Ahmadova (2020), applying singular spectrum analysis to GDP (1997–2019), identified three distinct subperiod trends (1997–2004, 2005–2014, and 2015–2018) and a strong seasonal structure, as well as a medium-term 43–44 month cyclical component. This timing aligns closely with the expansions observed by Mammadov and Adigozalov (2015).

More recent work further refines the understanding of Azerbaijan's business cycle. Rahmanov (2023), applying an HP filter to 2001Q1–2023Q2 data, finds that household and government consumption, monetary aggregates, exports, and oil prices are broadly procyclical for both total and non-oil-gas cycles, whereas investment and imports appear acyclical. For real non-oil-gas GDP, most associated real variables (except real wages and real total GDP) remain procyclical. Phase-shift analysis suggests that non-oil-gas GDP is influenced by a wide set of leading indicators, which includes monetary and financial aggregates, labor market metrics, and external demand proxies, showing multiple transmission channels through which fiscal and external shocks affect economic activity. Hasanli & Rahmanov (2024) extend this analysis by comparing the HP, Baxter–King, and Christiano–Fitzgerald filters for 2001Q1–2023Q4 data and, together with spectral methods, document high volatility and cycle lengths spanning roughly 4–19 quarters for both total and non-oil-gas GDP. Major global shocks, such as the 2008 financial crisis and COVID-19, underscore Azerbaijan's exposure to external disturbances that often interact with domestic fiscal responses.

Finally, Rahmanov (2025) explicitly examines monetary policy shocks, showing that after peaking around the 2015 devaluation, their volatility declined to historical lows in the 2020s. However, the contribution of the monetary policy shocks to the non-oil-gas GDP variance is very small. This limited monetary pass-through shifts attention toward fiscal mechanisms, structural changes, and productivity dynamics as the primary drivers of non-oil-gas volatility. Building on this literature, the present paper focuses on fiscal policy shocks, captured through budget expenditure and non-oil-gas tax dynamics in a SVAR model designed to assess their evolving influence on the volatility of Azerbaijan's non-oil-gas GDP over the post-2001 period. In doing so, it complements monetary policy–centered studies and deepens the understanding of non-oil-gas sector dynamics.

This research contributes to three strands of work: (1) business cycle characterization in commodity-exporting economies; (2) the stabilization versus amplification role of fiscal policy in emerging markets; and (3) Azerbaijan-specific analyses moving beyond hydrocarbon dependence to the drivers of non-oil-gas sector volatility. For policymakers, the evidence underscores that changing budget expenditure paths and enhancing non-oil-gas revenue mobilization can materially influence macroeconomic stability, particularly when commodity buffers weaken or diversification increases the role of domestic demand.

METHODOLOGY

The analysis of the evolution of business cycle volatility usually rests on the analysis of the standard deviation of percentage changes in macroeconomic indicators, mainly GDP, across different sub-periods (Stock & Watson, 2002). A change in the volatility of growth rates signals a change in short-run economic fluctuations. Therefore, to analyze Azerbaijan's business cycle volatility, I compute the annualized growth rates of quarterly output (total GDP, oil-gas GDP, and non-oil-gas GDP) and then the standard deviation of those annualized growth rates over successive decades.

To identify fiscal policy shocks and measure their role in the evolution of Azerbaijan's non-oil-gas business cycle, I estimate a SVAR model a lá Blanchard & Perotti (2002). The focus on the non-oil-gas GDP rather than total GDP is reasonable because oil and gas output is driven by geological conditions of the oil-gas fields and external factors, such as global prices and long-term investment plans, making it unresponsive to short-term fiscal actions. Including oil-gas GDP would mask the true policy effects due to the dominance of exogenous shocks. Regarding identification, I adopt a recursive structure in which budget (government) spending moves first. The decision to allow government expenditure to move first is motivated by both the institutional and structural features of Azerbaijan's fiscal framework. Due to institutional lags, fiscal policy, especially spending, cannot respond contemporaneously to output shocks, as the state budget is pre-approved annually, and mid-year revisions are limited. This fits the Blanchard-Perotti assumption that expenditures are predetermined within the quarter. Additionally, fiscal transmission in Azerbaijan is primarily driven by spending; the main factors affecting non-oil-gas GDP are public investment in infrastructure projects. In contrast, taxes play a more passive role, adjusting indirectly to economic activity and exhibiting minimal countercyclical behavior. Consequently, modeling expenditure as the first-moving variable better reflects the actual fiscal dynamics and provides policymakers with clearer insights into how spending-led interventions affect non-oil-gas economic activity and business cycle volatility.

Formally, the reduced form is:

$$Y_t = A(L, q)Y_{t-1} + u_t \qquad (1)$$

where $Y_t = [G_t, T_t, X_t]'$ is the vector of the logarithms of quarterly budget spending, non-oil-gas taxes, and non-oil-gas GDP, respectively; $u_t = [u_t^g, u_t^t, u_t^x]'$ is the vector of reduced-form residuals. Simply ordering variables in a Cholesky decomposition (recursive structure) would implicitly assume zero contemporaneous feedback, which is unrealistic (e.g., taxes do automatically respond to GDP). By imposing partial restrictions on certain parameters, Blanchard & Perotti (2002) allow for realistic contemporaneous relationships while still achieving identification. The reduced form residuals are combinations of the structural shocks $[e_t^g, e_t^t, e_t^x]'$:

$$\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & -a_1 \\ -c_2 & -c_1 & 1 \end{bmatrix} \begin{bmatrix} u_t^g \\ u_t^t \\ u_t^x \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ a_2 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} e_t^g \\ e_t^t \\ e_t^x \end{bmatrix} \qquad (2)$$

Unexpected movements in budget spending (u_t^g) within a quarter are due to structural shocks to spending (e_t^g). Unexpected movements in non-oil-gas taxes within a quarter are due to unexpected movements in non-oil-gas GDP (u_t^x), structural shocks to budget spending (e_t^g), and structural shocks to non-oil-gas taxes (e_t^t). Unexpected movements in non-oil-gas GDP within a quarter are due to unexpected movements in non-oil-gas taxes (u_t^t), unexpected movements in budget spending (u_t^g), and structural shocks to non-oil-gas GDP (e_t^x).

In this identification scheme, the parameters a_1, a_2, c_1, and c_2 capture the contemporaneous interactions among fiscal variables and output. The parameter a_1 measures the automatic response of tax revenues to changes in non-oil-gas GDP within the quarter, reflecting the built-in elasticity of Azerbaijan's tax system to economic fluctuations; a positive a_1 implies that non-oil-gas taxes move procyclically with non-oil-gas GDP. The parameter a_2 represents the contemporaneous reaction of taxes to government spending, which is typically limited in Azerbaijan due to the reliance on the State Oil Fund transfers rather than immediate tax adjustments; a positive a_2 suggests that an increase in spending is partly financed by higher taxes within the same quarter. The parameters c_1 and c_2 measure the direct effects of non-oil-gas taxes and spending on non-oil-gas GDP, with c_1 capturing the immediate impact of changes in tax burdens (e.g., higher taxes reduce disposable income and consumption) and c_2 reflecting the immediate expansionary effect of increased government spending. Estimating these parameters allows us to disentangle structural fiscal shocks from endogenous responses to economic activities.

Blanchard & Perotti (2002) impose restrictions on the parameters a_1, c_1, and c_2 to identify structural fiscal shocks from the reduced-form residuals of the VAR. Without such restrictions, the system of equations linking observed innovations (u_t^g, u_t^t, u_t^x) to the structural shocks (e_t^g, e_t^t, e_t^x) would be underdetermined, meaning we could not uniquely separate exogenous fiscal shocks (policy-driven) from endogenous movements (automatic responses to the economy).

In this paper, the contemporaneous coefficients a_1, c_1, and c_2 are obtained outside the SVAR and equal 1.02, −0.02, and 0.61, respectively; the remaining parameter a_2 is then estimated within the SVAR system. The tax–output elasticity $a\,1$ is calibrated by a simple OLS regression of log real non-oil–gas taxes on log real non-oil–gas GDP (both in levels so that the slope is directly an elasticity). OLS is suitable in this context because we are typically interested in the immediate proportional reaction of revenues to the tax base. Taxes are directly connected to current income through the statutory framework, and considering the quarterly frequency and institutional context, the likelihood of reverse causality from unexpected tax administration changes affecting the same quarter's GDP is minimal. Incorporating dynamics would not alter the elasticity interpretation but would reduce the degrees of freedom.

In contrast, the impact coefficient c_1 is proxied from an autoregressive distributed lag (ARDL) specification of log non-oil–gas GDP on current and one lag of log real non-oil–gas taxes (lag length chosen by AIC). An ARDL rather than simple OLS in levels is used here because the potential simultaneity between current taxes and current output would bias a contemporaneous OLS slope, output adjustment to tax innovations is plausibly distributed over time rather than purely instantaneous, and including the lagged tax term helps separate the predetermined (exogenous with respect to current output) variation required to identify the structural elasticity; the coefficient on the first lag of taxes is therefore taken as the empirical proxy for c_1.

The spending impact coefficient c_2 is again obtained via OLS by regressing log real non-oil–gas GDP on log real budget expenditure. This approach is justified because institutional lags in Azerbaijan's budget process render expenditure predetermined within the quarter, mitigating simultaneity and allowing for a parsimonious contemporaneous elasticity estimate. The positive a_1 and c_2, together with the near-zero c_1, imply that non-oil-gas taxes co-move strongly with non-oil-gas output, government spending exerts a meaningful immediate expansionary effect, and the contemporaneous contractionary effect of tax shocks on output is weak.

DATA DESCRIPTION

For the analysis of business cycle volatility, I use the total GDP, oil-gas GDP, and non-oil-gas GDP quarterly time series from 2001:1 to 2024:3 from the National Accounts Statistics of the State Statistical Committee of Azerbaijan. The oil-gas GDP series is proxied by mining and quarrying, while the non-oil-gas GDP series is proxied by subtracting mining and quarrying and net taxes from the total GDP. The series are in 2005 prices and were seasonally adjusted using the X11 procedure. For the analysis, the series were transformed into annual growth rates.

For the structural VAR model, in addition to the non-oil-gas GDP data, I use data on budget expenditure and non-oil-gas tax revenues from 2004:1 to 2024:3, which come from the reports of the Ministry of Finance of Azerbaijan. Both series are seasonally adjusted using the X11 procedure, converted into real terms using the non-oil-gas GDP deflator, and transformed into the logarithmic form.

EMPIRICAL RESULTS

Figure 1 reports the sample standard deviation of total GDP, oil-gas GDP, and non-oil-gas GDP by decade (the last decade includes only four years). The standard deviation of each decade is shown in relation to the overall sample standard deviation, with values below one indicating a period of comparatively low volatility. Total GDP and non-oil-gas GDP were less volatile, but oil-gas GDP was more volatile in the 2000s than over the full sample. The high volatility in the oil-gas GDP is due to the oil boom that Azerbaijan's economy experienced in the mid-2000s. In the 2010s, the relative standard deviations of total GDP and oil-gas GDP were less volatile than in the 2000s. The decline in volatility was due to the stabilization of oil and natural gas production. The non-oil-gas GDP instead had an increase in volatility in the same period, which can be explained by fiscal expansion, which accelerated the growth of the non-oil-gas sector. In the early 2020s, during the COVID and post-COVID periods, the volatility of total GDP and oil-gas GDP increased relative to that of the 2010s. The increase in the magnitude of fluctuations is linked to the increase in the volatility of hydrocarbon production. Overall, the data show a trend toward reduced volatility over time in total GDP, which is due to the stabilization of oil-gas GDP. The non-oil-gas sector shows consistent stability, positioning it as a more resilient part of the economy.

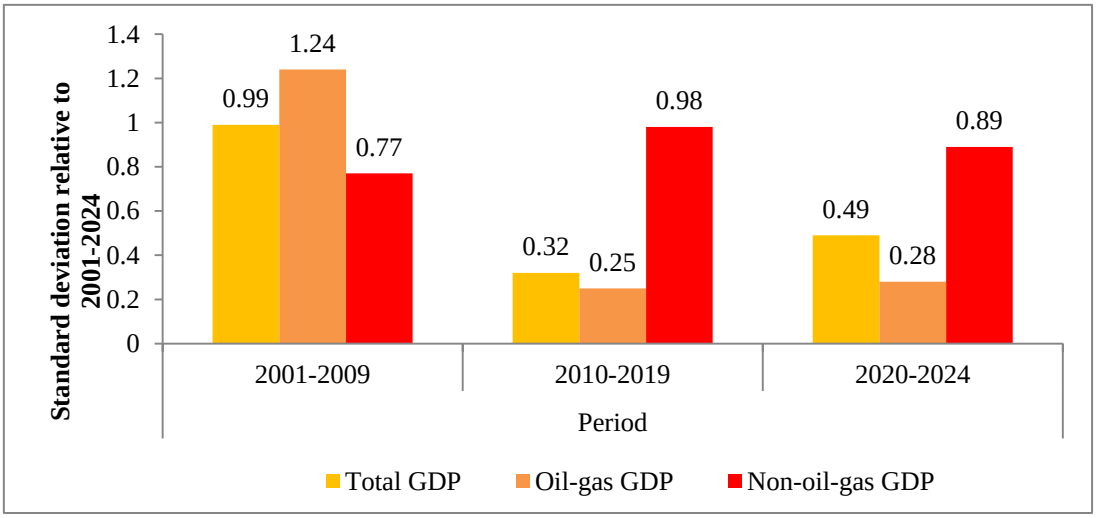

Fig. 1 Standard deviations of annual growth rates, by decade

Figure 2 reports the standard deviation of fiscal policy shocks obtained from the structural VAR model by decade relative to the standard deviation for the entire period. The results suggest a notable increase in the variability of fiscal policy shocks in 2010-2019. Meanwhile, the recent period has witnessed a substantial decrease in the volatility of fiscal shocks, which reached historically low levels. The causes behind the decline in the volatility of fiscal policy shocks include the improvement in fiscal policy management driven by the lessons learnt in 2015-2016 and the implementation of the fiscal rule.

Azerbaijan's fiscal rules legally mandate ceilings on the non-oil budget deficit and state debt, expressed as percentages of GDP. Specifically, the consolidated budget's non-oil-gas primary deficit must not exceed a set limit relative to non-oil-gas GDP, and total public debt must remain below a ceiling relative to overall GDP. These ceilings are determined by the relevant executive authority body (as per Article 11-1 of the Budget System Law) and are calculated based on projected crude oil export prices. Presidential Decree No. 1950 (2022) established concrete medium-term targets: a 17.5% ceiling for the non-oil deficit ratio (25% specifically for end-2023) and a 30% ceiling for the public debt ratio. If the rules are suspended under specific circumstances, these ceilings must be recalculated and reset for the subsequent medium-term periods.

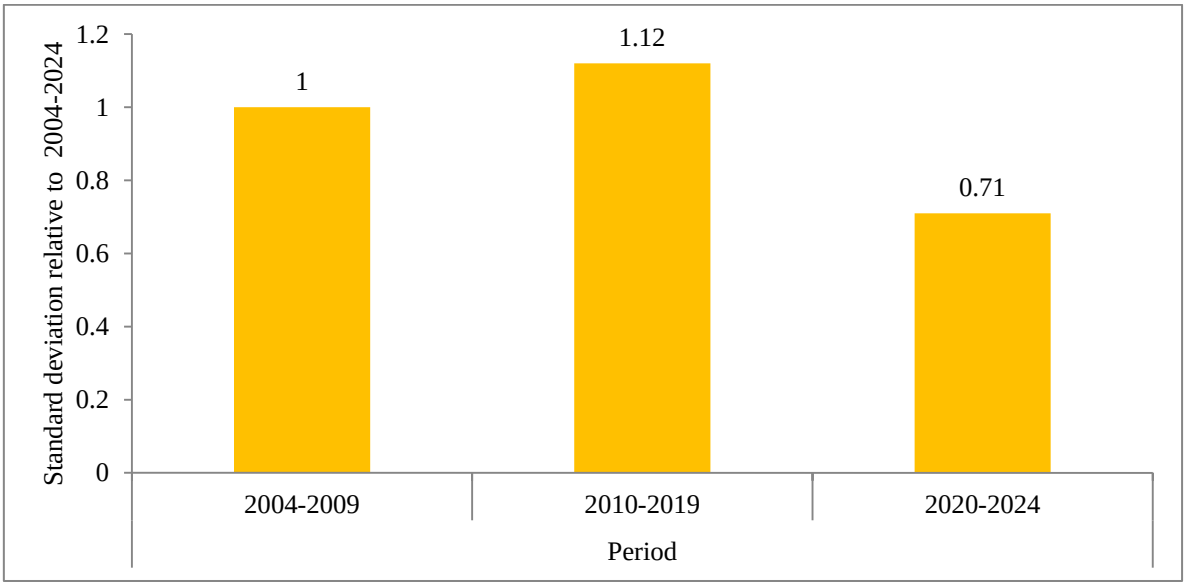

Fig. 2 Changes in the standard deviations of budget spending shocks, by decade

However, the reduction in the fluctuations of fiscal policy shocks should not necessarily explain the moderation in the volatility of the non-oil-gas GDP. Whether the reductions in the variances of the fiscal policy shocks are responsible for the decline in the volatility of the non-oil-gas output depends on the importance of these shocks in determining non-oil-gas GDP growth. The variance decomposition of non-oil-gas GDP indicates that its own shocks remain the dominant driver of fluctuations, accounting for 73.5% in Q1 and gradually declining to 71.8% by Q12 (Figure 3). This highlights that internal dynamics, such as sector-specific productivity, private demand, or external non-fiscal shocks, are the primary sources of short- to medium-term volatility. Budget expenditure shocks show a steadily increasing contribution, rising from 26.5% in Q1 to 28.2% in Q12, suggesting that fiscal spending plays an increasingly important role in shaping non-oil-gas economic fluctuations over time. In contrast, non-oil-gas tax shocks

contribute very little throughout the horizon, peaking at 0.08% in Q4 and declining to 0.04% by Q12, reflecting their limited influence on the volatility of non-oil-gas GDP. This finding implies that the reduction in fiscal policy volatility, primarily due to the improved management of budget expenditures and the enforcement of fiscal rules, has played a significant role in moderating the volatility of non-oil-gas GDP observed in the last decade. In essence, when government spending patterns became less volatile and more predictable, the non-oil economy responded with greater stability. This is particularly relevant for Azerbaijan, where fiscal policy is a key driver of the non-oil-gas sector due to the state's substantial involvement in public investment projects, infrastructure development, and social spending.

In practical terms, this means that maintaining a stable fiscal stance is not merely a matter of budgetary discipline but a vital tool for smoothing business cycle fluctuations in the non-oil-gas economy. If fiscal expenditures fluctuate widely, they directly transmit volatility to the non-oil-gas sector, given their dependency on public investment and transfers. Conversely, when fiscal rules and medium-term expenditure frameworks are effectively implemented, they reduce the uncertainty faced by private firms and households, encouraging consistent investment and consumption patterns. Therefore, the experience of the last decade suggests that sustained fiscal stabilization, which is achieved through prudent budget management and adherence to fiscal rules, remains essential for ensuring steady non-oil-gas GDP growth, especially in an economy where oil revenues indirectly shape the dynamics of the non-oil-gas sector.

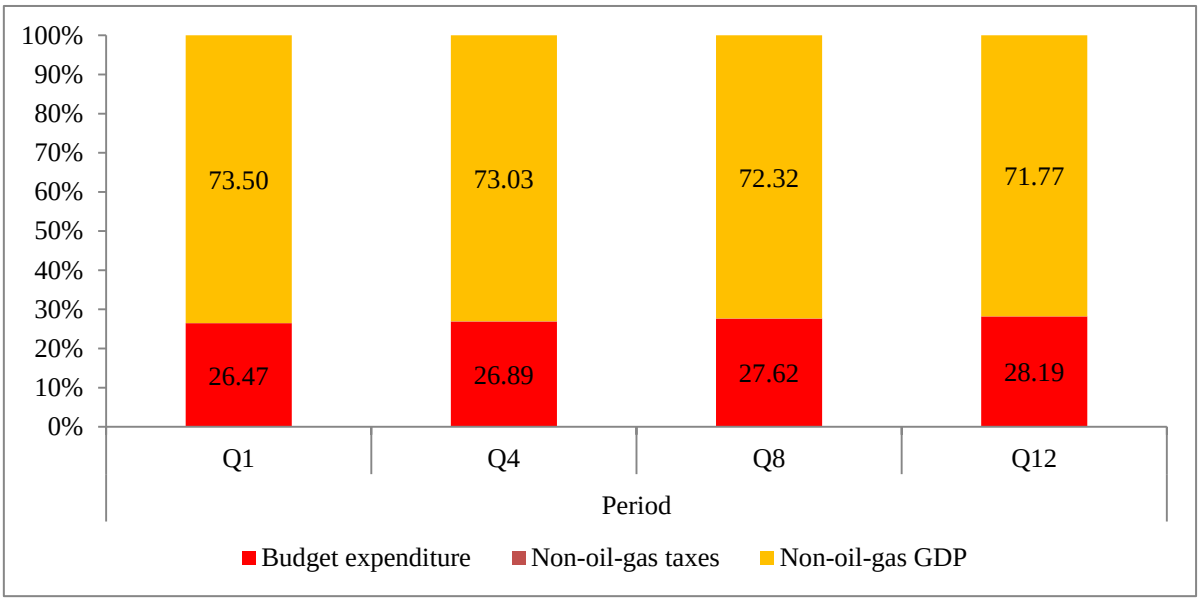

Fig. 3 Variance decomposition of the non-oil-gas GDP, %

Conclusions

The empirical findings of this paper highlight significant changes in the volatility patterns of Azerbaijan's economy over the past two decades, with distinct dynamics between the oil-gas and non-oil-gas sectors. While the oil-gas sector experienced high volatility during the mid-2000s due to the oil boom, the stabilization of hydrocarbon production in the 2010s contributed to an overall decline in total GDP volatility. In contrast, the non-oil-gas sector exhibited rising volatility during the same decade, primarily driven by fiscal expansion aimed at accelerating growth. The COVID-19 pandemic and post-pandemic period have once again increased fluctuations in total and oil-gas GDP owing to an increase in hydrocarbon production, primarily natural gas. Despite

these variations, the non-oil-gas sector has shown greater resilience and stability over time, underscoring its potential to act as a stabilizing force in Azerbaijan's economy.

The analysis of fiscal policy shocks using the SVAR model reveals that fiscal volatility was relatively high in the 2010s but has since decreased to historically low levels due to improved fiscal management and the implementation of fiscal rules. These rules, particularly the ceilings on the non-oil budget deficit and state debt, have fostered greater predictability and discipline in public finances. Variance decomposition results further indicate that while non-oil-gas GDP fluctuations are largely driven by their own internal shocks, budget expenditure shocks have become increasingly influential over time, whereas non-oil-gas tax shocks play a negligible role. This underscores the importance of fiscal spending as a key driver of non-oil-gas economic dynamics.

Overall, the results suggest that the reduction in fiscal policy volatility has played a meaningful role in moderating non-oil-gas GDP volatility, particularly in the last decade. A stable fiscal stance, supported by well-designed fiscal rules and medium-term expenditure frameworks, is a critical policy instrument for smoothing economic fluctuations in the non-oil-gas sector. This is especially important for Azerbaijan, where fiscal policy is the primary transmission channel between oil-gas revenues and non-oil-gas economic performance. Future research could extend this analysis by assessing the role of foreign shocks, structural reforms, and private sector development in enhancing the resilience of the non-oil-gas economy.

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