Gazanfarli, M., & Zhelev, Z. (2025). Dynamic modeling the impact of tax reforms on tax revenue: Evidence from Azerbaijan. *Journal of International Studies, 18*(1), 99-115. doi:10.14254/2071-8330.2025/18-1/6

Journal of International Studies

Centre of Sociological Research

Scientific Papers

Dynamic modeling the impact of tax reforms on tax revenue: Evidence from Azerbaijan

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Abstract. The objective of this study was to ascertain the impact that the implementation of tax reforms has had on tax revenue in Azerbaijan from 2000 to 2022. An Autoregressive Distributed Lag (ARDL) dynamic model was developed to investigate the linkages between tax revenue and tax reforms. Within the framework of developing a new assessment approach, main features of tax reforms were defined and their significance was determined. The analysis incorporated both quantitative and qualitative variables, in particular the influences of technological development and the application of automated systems. The research results demonstrate that the implementation of tax reforms had both short-run and long-run effects on tax revenue in Azerbaijan. Indeed, both qualitative and quantitative variables have been shown to play a crucial role in increasing tax revenues. The findings indicate that tax revenue was positively influenced by the increases in the tax burden rate, the total number of concessions and exemptions, and the application of an automatic tax information system and message service. Conversely, the growing number of tax legislative changes has had an adverse effect. These findings will be of use to the decision-makers responsible for the adoption of national legislation and the drafting of strategy documents.

Received: May, 2024
1st Revision: January, 2025
Accepted: March, 2025

DOI: 10.14254/2071-8330.2025/18-1/6

Keywords: tax policy, tax reforms, econometric modeling, ARDL model, diagnostic analysis

JEL Classification: C5, C54, C87, H2, P11

1. INTRODUCTION

Tax revenues are one of the key indicators characterizing economic development and they are the main financial resource for the revenue side of the state budget. Therefore, increasing tax revenues is one of the main priorities for any state, especially if such growth can be achieved through taxpayers' willing compliance with tax obligations. Indeed, many reforms and measures have been implemented for this purpose. However, while some measures do help to achieve the desired results, others, on the contrary, have negative effects. The investigation and evaluation of these effects are crucial to making accurate forecasts and effective decisions in order to ensure the economic development of the country and increase the social welfare of the population.

Following the regaining of independence by the Republic of Azerbaijan in 1991, a series of significant reforms were initiated in the country. As one of the key attributes of statehood, the tax system attracted significant attention from lawmakers whose principal objective at the time was to ensure its effective functioning. The main goal of the implemented tax reforms was to increase tax revenues, which constituted a substantial share of the state budget. Therefore, it is imperative that the impact of the reforms introduced in the domain of tax revenues is thoroughly investigated and assessed in order to effectively direct the future activities of tax authorities.

The tax system reforms in Azerbaijan over the past two decades have been characterized by a clear focus on modernization, efficiency, and transparency. Indeed, reforms of the tax system in Azerbaijan over the previous 23 years can be summarized as follows:

- "State Program for Improving Tax Administration in the Republic of Azerbaijan" for 2005-2007;
- "Strategic Plan for the Improvement of tax legislation and administration" for 2009-2012;
- "Development concept of services to taxpayers provided by tax authorities" for 2011-2015;
- Administrative reforms planned to be implemented in the "Tax System Development Strategy" from 2013 to 2020";
- "Increasing the efficiency of the tax system" and "Further improvement of tax administration" are priority directions of the "State Program on the expansion of digital payments in the Republic of Azerbaijan for 2018-2020".

These initiatives highlight a strategic progression from improving basic tax administration and legislative frameworks to enhancing taxpayer services and embracing digital transformation with global best practices while adapting to the evolving economic and technological landscape. These reforms emphasize:

- Institutional Strengthening: Building robust administrative systems and capacity for effective tax collection;
- Legislative Development: Refining tax laws to ensure clarity, fairness, and compliance;
- Taxpayer-Centric Approach: Enhancing services to improve accessibility, satisfaction, and voluntary compliance;
- Technological Integration: Leveraging digital solutions to increase efficiency, reduce evasion, and streamline processes.

The analysis of tax rates over the years, the advantages and disadvantages of tax reforms, and the role of the tax burden in various economic sectors in Azerbaijan have been extensively investigated by numerous local and foreign scholars, as well as institutions (Deloitte, 2021; Aslanov, 2015; Khwaja & Iyer, 2014; Zermeño, 2008). However, the existing literature lacks studies that measure the effects of tax reforms on tax revenue in Azerbaijan. Therefore, given the significance of this issue and the existing research gap, our study aims to estimate the impact of tax reforms on tax revenues over the past 23 years in the Republic of Azerbaijan.

This is the first paper that has analyzed and estimated the effect of tax reform on tax revenue in Azerbaijan. The main objective of this research is to investigate the effect of tax reforms on tax revenues in Azerbaijan and identify the key factors influencing tax revenue growth. The secondary objectives include:

– Assessing the ARDL (Autoregressive Distributed Lag) model as a suitable method for modeling tax revenues.

– Conducting a multivariate analysis to examine the behavior of both quantitative (time-series) and qualitative variables related to tax revenues.

– Applying econometric modeling to quantify the impact of tax reforms on tax revenue.

Although tax reforms constitute a major component of state policy, there is surprisingly little scholarly discussion on assessing their impact on tax revenue and overall government revenue in our country. Therefore, this study holds practical significance for the government and theoretical relevance for economic literature.

The structure of this paper includes an Introduction, a Literature review, Research objectives, and a Methodology section that outlines the selection of indicators and the methodological approach. The Empirical Analysis section presents statistical and econometric analyses along with their results. Finally, the Conclusion and Recommendations section summarizes the key findings of the research and provides policy suggestions.

2. LITERATURE REVIEW

To examine the importance of this issue and identify an effective solution, it is crucial to investigate and analyze the existing literature including both foreign and local research. The impact of reforms which shape taxation policies and contribute to economic development, has been assessed using economic-mathematical methods by economists and organizations based on various countries and indicators. The influence of various tax policy changes was evaluated in an International Monetary Fund (IMF) paper (Amaglobeli et al., 2022), which analyzed a sample of 21 emerging and advanced market economies. The key findings of this study suggest that the revenue impact of tax policy changes varies significantly depending on the type of tax instrument used (e.g., value-added tax or personal income tax) and the nature of the change (i.e., rate or base) (Amaglobeli, et al., 2022). Van Der Wielen W. (2019) is among the economists who have studied the effects of tax reforms. His research evaluated the macroeconomic impact of tax policy changes in the European Union from 2000 to 2016, focusing on income tax, social insurance contributions, and corporate income tax. The findings provide evidence of asymmetry between the effects of revenue-increasing and decreasing measures within the EU (Van Der Wielen, 2019). Since the tax systems vary across countries, the impact of implemented tax reforms on tax revenue has been analyzed separately for different states. Studies conducted in Nigeria (Oriakhi & Ahuru, 2014), Sub-Saharan Africa (Ngoma & Krsic, 2017), and Ghana (Kamasa, et al., 2022) concluded that tax reforms had significant and positive impacts on tax revenue generation. Additionally, research on tax administration reforms in Togo from 1990 to 2018 found an accumulated gain in the tax-to-GDP ratio, averaging approximately 2.8% annually. After nearly nine years of reform implementation, Togo demonstrated a remarkable improvement in tax performance(Bayale, et al., 2022).

An analysis of existing studies reveals that most of them focus on measuring the relationship between tax revenues and tax rates based on the Laffer curve theory (Liapis, et al., 2020; Guis, 2017). Related research has also identified the maximum or optimal tax rate for VAT for Greece, Portugal, and Slovakia, as well as optimal direct tax rates for the majority of the Eurozone countries. This study, based on panel data from 1995 to 2011, utilized the Seemingly Unrelated Regression (SUR) econometric model (Ferreira-Lopes, et al., 2020).

Since tax revenues form a fundamental financial pillar of the state and serve as a key macroeconomic indicator of economic development and social welfare, it is essential to examine not only taxation-related factors but also broader social and economic determinants. These include governance quality, institutional efficiency, demographic dynamics, technological advancements, financial sector development, and sectoral transformations, all of which play a critical role in shaping a country's tax revenue performance and fiscal sustainability (Ho, et al., 2023; Gnangnon, 2021; Loganathan, et al., 2020; Basheera, et al., 2019; Ufuk & Ebru, 2018; Loganathan, et al., 2014; Zeng, et al., 2013; Bakija & College, 2013; Taha, et al., 2011).

The onset of the Fourth Industrial Revolution has accelerated the development and implementation of automated control systems across various fields. This transformation has had a significant impact on taxation as well. The digitization of tax processes plays an indispensable role in facilitating taxpayer compliance by reducing financial and time-related burdens while enhancing transparency and accountability through improved accessibility to tax authorities. Undoubtedly, these advancements are also reflected in tax revenues. Given the significance of this issue, numerous scholars have examined the impact of automated tax processes on tax revenues(Adegbie, et al., 2022; Hötte, et al., 2022; Masunga, et al., 2020; Mukuwa & Phiri, 2020; Madegwa, et al., 2018; Allahverdi, et al., 2017).

The studies analyzed above indicate that the vast majority focus on assessing the interaction between tax revenues and one or two influencing factors. However, it is essential to recognize that tax administration, as a mechanism for managing tax relations between tax authorities and taxpayers, aims to mobilize a country's economic potential into the state budget. In other words, it seeks to increase tax revenues by establishing effective tax relations. Some studies have proposed analytical models to evaluate the effectiveness of tax administration based on its influencing factors and have emphasized the importance of considering these indicators collectively. (Gazanfarli, 2020; Musayev & Gazanfarli, 2020a; b).

3. METHODOLOGY

This section examines the methods and tools necessary for conducting the research. However, before proceeding, it is essential to define the key factors that characterize tax reform in Azerbaijan.

An investigation and analysis of adopted legislation, as well as various programs and development strategies, reveal significant changes in several areas. These include reductions in tax rates, the development of an automated tax management system, the introduction of tax concessions and exemptions, and improvements in the quantity and quality of taxpayer services provided by tax authorities. Consequently, these indicators can serve as characteristics of tax reform. The changes in quantitative indicators, such as tax burden rate, the number of legislative amendments, and the total number of concessions and exemptions, are documented in various statistical platforms and reports. However, some reforms, particularly those involving qualitative changes, lack systematically recorded annual data. For example, the application of e-services represents a significant qualitative improvement in tax administration. Taxpayer compliance begins with registration, and one of the most critical innovations in this regard was the implementation of the "Automated tax information system" in 2006. This system significantly enhanced the efficiency and accuracy of tax compliance processes. During 2007-2008, several key digital services were introduced under ATIS, including e-application, e-declaration, one-stop-shop, online integration service with banks, etc. These innovations enabled taxpayers to fulfill their obligations, such as submitting tax returns, preparing tax declarations, and providing input on declaration forms, electronically, minimizing administrative burdens, time costs, and financial losses. Such advancements play a crucial role in reducing tax evasion and enhancing transparency.

Given the importance of both qualitative and quantitative indicators in evaluating the effects of tax reforms, it is necessary to incorporate each type for a comprehensive analysis.

Taking all these factors into account, the following indicators have been identified to assess the impact of tax reforms on tax revenues:

Tax burden; the number of legislative changes; total number of concessions and exemptions; automated tax information system; one-stop and online integration with banks services; messages and SMS services.

The relationship between tax revenues and reforms implemented in the country can be expressed through the following function:

$$TR_t = f(LC_t, TB_t, CE_t, MSS_t, ATIS_t, OSOI_t) \tag{1}$$

Where,

Tax revenue (TR) – A continuous variable representing the total tax revenues collected by the state, measured in local currency

The number of legislative changes (LC) – A discrete variable representing the count of significant tax-related legislative amendments introduced within a given period.

Tax burden (TB) – A continuous variable representing the overall tax rate or the ratio of total tax revenue to GDP, expressed as a percentage.

Total number of concessions and exemptions (CE) – A discrete variable representing the number of tax incentives, deductions, or exemptions granted by the government within a specific timeframe.

Messages and SMS services (MSS) – A binary variable (1 = implemented; 0 = not implemented) indicating whether tax authorities use SMS and messaging services for taxpayer communication and compliance facilitation.

Automated tax information system (ATIS) – A binary variable (1 = implemented; 0 = not implemented) representing the presence of an automated tax information system aimed at improving tax administration efficiency.

One-stop and online integration with bank services (OSOI) – A binary variable (1 = applied; 0 = not applied) indicating whether integrated tax payment and reporting services are available through online platforms and banking systems.

The empirical specifications of the model can be expressed as follows:

$$TR_t = \alpha_0 + \alpha_1 LC_t + \alpha_2 TB_t + \alpha_3 CE_t + \alpha_4 MSS_t + \alpha_5 ATIS_t + \alpha_6 OSOI_t + \varepsilon_t \tag{2}$$

Herein,

TR_t −explained variable; $LC_t, TB_t, CE_t, MSS_t, ATIS_t, OSOI_t$ − explanatory variables in the t year;
ε_t − unobservables (error term); $\alpha_1, \alpha_2, \alpha_3, \alpha_4, \alpha_5, \alpha_6$ − slope parameters (elasticities).

3.1. Stationarity

To determine the appropriate method for measuring the effects, it is essential to first check the stationarity of the time series. Optimal lag selection is a challenging yet crucial aspect of unit root testing which has been extensively examined by researchers over the years (Maddal & Kim, 2007; Wu, 2010; Cavaliere, et al., 2012; Agunloye, et al., 2013). Many techniques can be used for lag selection including the Akaike information criterion (AIC) (Akaike, 1969), Final Prediction Error (FPE), Bayesian information criterion (BIC) (Schwarz, 1978), and Hannan-Quinn information criterion (HQIC) (1979).

The stationarity of the time series refers to the condition where its mean, variance, and autocorrelation structure remain constant over time.

Several tests are commonly applied to check the stationarity, including the Dickey-Fuller test (ADF), Philipse-Perron (PP), Kwiatkowski Phillips Schmidt and Shin (KPSS), Dickey-Fuller GLS, Zivot-Andrews tests.

The Null and alternative Hypotheses for the two most commonly used tests: the Augmented Dickey-Fuller (ADF) test (Dickey & Fuller, 1981) and Phillips-Perron (PP) (Phillips & Perron, 1988), are based on the following autoregressive model (2):

H_0: The process has a unit root; H_1: The process does not have a unit root.

3.2. ARDL model

If time series data is stationary (or no trend), in this case, ordinary least square (OLS) or vector autoregressive (VAR) models can be used to obtain unbiased estimates. If all underlying variables are non-stationary, Vector Error Correction Model (VECM - Johansen Approach ECM) (Johansen S., 1988) can be applied to analyze the relationships between the variables. However, if variables used in the analysis are of mixed type, i.e., some are stationary and others are non-stationary then Autoregressive Distributed Lag (ARDL) (Albert, et al., 1963; Almon, 1965) model is more appropriate for estimation.

Equation (2) can be expressed in ARDL form as below:

$$TR_t = \alpha_0 + \sum_{i=1}^{m} \beta_i TR_{t-i} + \sum_{j=0}^{m} \alpha_{1j} LC_{t-j} + \sum_{j=0}^{m} \alpha_{2j} TB_{t-j} + \sum_{j=0}^{m} \alpha_{3j} CE_{t-j} + \\ + \sum_{j=0}^{m} \alpha_{4j} MSS_{t-j} + \sum_{j=0}^{m} \alpha_{5j} ATIS_{t-j} + \sum_{j=0}^{m} \alpha_{6j} OSOI_{t-j} + \varepsilon_t \quad (3)$$

Where, α_0 is the intercept, m is the lag order, ε_t is the error term,

TR_t is the dependent variable while $LC_t, TB_t, CE_t, MSS_t, ATIS_t,\ OSOI_t$ are independent (explanatory) variables, α_{vj}, ($v = \overline{1,6}$ express the coefficients of explanatory variables, $j = \overline{0,m}$) and β_i, ($i = \overline{1,m}$) are the coefficients (elasticities), m is the lag order. While considering both $I(0)$ and $I(1)$ variables in the same estimation, the ARDL model is more robust and suitable for the small sample size.

3.3. ARDL model specification to cointegration test

Cointegration is a technique used to identify possible long-term correlations between time series processes. The concept of cointegration was first introduced by Granger (Granger, 1983; Granger & Weiss, 1983). Several cointegration tests exist, including the Engle and Granger test (Engle & Granger, 1987), the Johansen test (1988a; b), the Autoregressive Distributed Lag (ARDL) cointegration technique or bound cointegration testing technique (Pesaran & Shin, 1999; Pesaran, et al., 2001).

ARDL approach to cointegration offers several crucial advantages as highlighted below (Nkoro & Uko, 2016):

- This approach allows the identification of cointegrating vectors, even when there are multiple cointegrating vectors;
- The Error Correction Model (ECM) which integrates short-run adjustments with long-run equilibrium without losing long-run information, can be derived from the ARDL model through a simple linear transformation.

ARDL Cointegration form of ARDL model can be expressed as follows:

$$\Delta TR_t = \alpha_0 + \sum_{i=1}^{m} \beta_i \Delta TR_{t-i} + \sum_{j=1}^{m} \alpha_{1j} \Delta LC_{t-j} + \sum_{j=1}^{m} \alpha_{2j} \Delta TB_{t-j} + \sum_{j=1}^{m} \alpha_{3j} \Delta CE_{t-j} + \\ + \sum_{j=1}^{m} \alpha_{4j} \Delta MSS_{t-j} + \sum_{j=1}^{m} \alpha_{5j} \Delta ATIS_{t-j} + \sum_{j=1}^{m} \alpha_{6j} \Delta OSOI_{t-j} + \delta_1 TR_{t-1} + \delta_2 LC_{t-1} + \delta_3 TB_{t-1} + \\ + \delta_4 CE_{t-1} + +\delta_5 MSS_{t-1} + \delta_6 ATIS_{t-1} + \delta_7 OSOI_{t-1} + \varepsilon_t \quad (4)$$

Where α_0 is the intercept, m is the maximum lag order, ε_t is the error term (white noise errors), and Δ is the first difference operator.

Expressions from δ_1 to δ_7 correspond to the long-run relationships, while α_{vj}, ($v = \overline{1,6}$, $j = \overline{0,m}$) and β_i, ($i = \overline{1,m}$) depicts the short-run dynamics of the model.

F-statistics is used to test the long-run equilibrium relationship between explained and explanatory variables. Following the study (Pesaran, et al., 2001), the calculated F-statistic is compared with two critical values: the lower and upper bounds. These critical values are used to determine the existence of cointegration.

The null hypothesis of *no cointegration* between dependent and independent variables that are given in equation (2) is:
$H_0: \delta_1 = \delta_2 = \delta_3 = \delta_4 = \delta_5 = \delta_6 = \delta_7 = 0$ (the long run relationship does not exist)

And against the alternative hypothesis is:
$H_1: \delta_1 \neq \delta_2 \neq \delta_3 \neq \delta_4 \neq \delta_5 \neq \delta_6 \neq \delta_7 \neq 0$ (the long run relationship exists)

If there is a cointegration between the variables, then the Error Correction Model (ECM) model can be utilized. The result of ECMs calculation expresses the speed at which a dependent variable returns to equilibrium after a change in other variables. This is expressed as follows:

$$\Delta TR_t = \alpha_0 + \sum_{i=1}^{m} \theta_i \Delta TR_{t-i} + \sum_{j=0}^{m} \gamma_{1j} \Delta LC_{t-j} + \sum_{j=0}^{m} \gamma_{2j} \Delta TB_{t-j} + \sum_{j=0}^{m} \gamma_{3j} \Delta CE_{t-j} + \\ + \sum_{j=0}^{m} \gamma_{4j} \Delta MSS_{t-j} + \sum_{j=0}^{m} \gamma_{5j} \Delta ATIS_{t-j} + \sum_{j=0}^{m} \gamma_{6j} \Delta OSOI_{t-j} + \vartheta ECM_{t-1} + \varepsilon_t \quad (5)$$

Herein, θ and γ are the short-run dynamic coefficients of the model and ϑ is the speed of adjustment.

3.4. Data

The assessment will be conducted using statistical yearly data covering the period from 2000-2022 (23 observations). The data will include information on the tax burden, the number of legislative changes, the total number of concessions and exemptions, as well as data related to the implementation of e-application, e-declaration, one-step shop, online integration services with banks, application of SMS and messaging services for taxpayers during these years. The major components of the database were obtained from the State Tax Service under the Ministry of the Economy through a formal request.

4. EMPIRICAL ANALYSIS

4.1. Statistical analysis of variables

Table 1 represents the descriptive analysis of quantitative variables. The results of the Jarque-Bera test and corresponding p-values indicate that except for the tax burden (TB), all variables accept the null hypothesis at a 5% level p-value, so they are normally distributed. It is no coincidence that the use of dummy variables may introduce multicollinearity. Correlation analysis reveals that two categorical (binary) variables, namely the Automated Tax Information System (ATIS) and One-Stop and Online Integration (OSOI), exhibit a high correlation while the remaining variables show normal correlation patterns (Fig. 1). Since multicollinearity can compromise the reliability of statistical inferences, the Variance Inflation Factor (VIF) was also examined. The results indicate that OSOI has a VIF greater than 10, signaling severe multicollinearity (Table 2). To ensure the robustness of the model, the highly correlated independent variable (OSOI) will be removed, allowing for more reliable and statistically significant results.

Table 1

Descriptive analysis of variables

	TR	TB	CE	LC
Mean	5185.1	11.65	110.6	72.52
Median	5696.4	11.4	99.0	61.00
Std. Dev.	3530.9	2.03	36.6	63.58
Minimum	510.40	9.20	71.0	0.0
Maximum	15541.5	17.9	187.0	209.0
Count	23	23	23	23
Jarque-Bera	2.336	12.103	5.697	2.575
Probability	0.311	0.002*	0.057	0.275

*Rejection of the null hypothesis at 5 % p-value

Source: Author's calculations, 2024

Table 2

VIF results

With OSOI		After eliminating OSOI	
Variable	VIF	Variable	VIF
TR (mln m)	8.676854	TR (mln m)	8.059178
LC	1.824899	LC	1.794028
TB (%)	3.016770	TB (%)	1.788418
CE	5.226851	CE	5.001175
MSS	3.918885	MSS	3.885887
ATIS	10.343621	ATIS	3.581578
OSOI	12.456191		

Source: Author's calculation, 2024

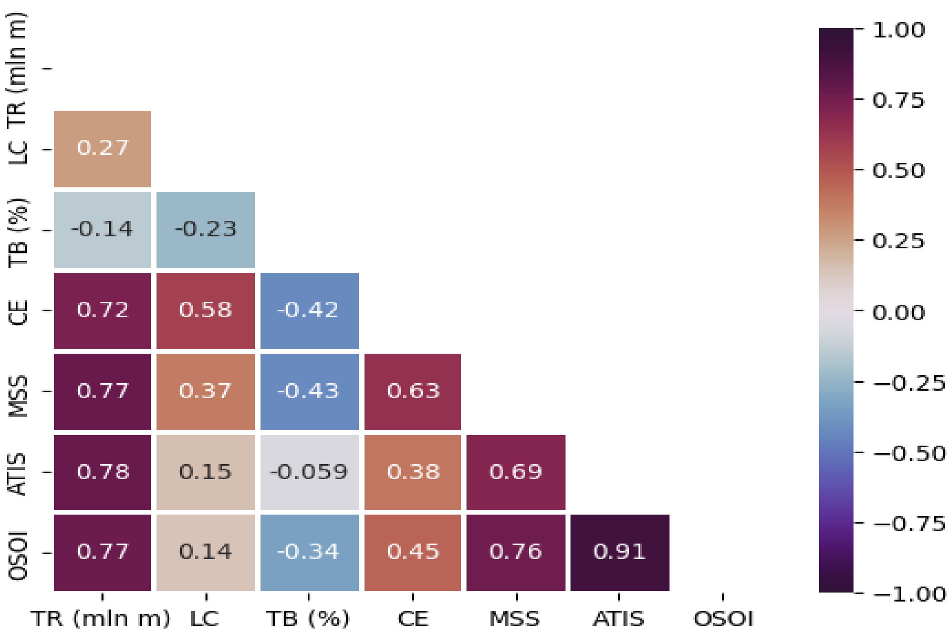


Figure 1. Correlation analysis, including observations 23

Source: Author's calculation, 2024

4.2. Testing stationarity

As mentioned earlier, determining the optimal lag length plays a significant role in the application of different unit root tests. Table 3 depicts the results of the lag order selection, demonstrating the association among endogenous variables. As seen from Table 3, optimal lag length is determined to be 2 ensuring that the model effectively captures the underlying dynamics of the variables.

Table 3

VAR Lag Order Selection Criteria.

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-389.186	NA	4.69e+10	41.5985	41.8968	41.649
1	-303.517	108.214	3.13e+08	36.3702	38.4579	36.724
2	-169.914	84.381*	54297.5*	26.0962	29.9733	26.752
3	2890.71	0.0000	NA	-292.29*	-286.62*	-291.33*

* Indicates lag order designated by the criterion

Endogenous variables: TR TB LC CE ATIS; Included observations: 21

Source: Author's calculation, 2024

To examine the stationarity of the time series Augmented Dickey-Fuller test (ADF) (Dickey & Fuller, 1981) test was employed(Table 4). Based on the ADF test results, 3 variables including tax revenue (TR), and the total number of concessions and exemptions (CE), were found to be non-stationary at level and 1st difference (C&T) but became stationary 1st difference (C). However, the tax burden (TB) and the number of legislative changes (LC) are stationary at level and 1st difference. Additionally, the P-P unit root test was conducted, and the results were consistent with those obtained from the ADF results.

Table 4

Augmented Dickey-Fuller (ADF) Unit root test results.

Variables		**Level**		**1st level**	
		C	**C&T**	**C**	**C&T**
TR	t-statistic	-0.766130	-2.708415	-4.152329	-4.104531
	P-value	0.8081	0.2436	0.0051***	0.0226**
TB	t-statistic	-2.70834	-3.40797	-4.26143	-4.44078
	P-value	0.0901*	0.0785*	0.0041***	0.0119**
CE	t-statistic	0.86661	-0.43471	-3.45214	-2.49819
	P-value	0.9928	0.9786	0.0211**	0.3246
LC	t-statistic	-4.6858	-5.42026	-6.60543	-6.47860
	P-value	0.0014***	0.0014***	0.0000***	0.0002***

Note: ***, ** and * denote statistical significance at 1%, 5%, and 10%, respectively

Source: Author's calculation, 2024

Testing stationarity reveals that the variables used in the analysis are mixed, with some being stationary while others are non-stationary. Therefore, the ARDL model is appropriate to estimate the impacts of defined independent variables on the tax revenue. Since the ARDL approach is particularly suited for models containing a mix of I(0) and I(1) variables**,** this method was chosen to test for cointegration. To identify the best model specification, the Akaike Information Criterion (AIC) was utilized, leading to the selection of the ARDL (2, 2, 2, 2, 2, 2). Therefore, the general ARDL output based on equation (3) is as follows:

$$TR = -0.797831635463 * TR(-1) - 0.726140706209 * TR(-2) + 262.353627286 * TB - 455.715113194 * TB(-1) + 550.648609547 * TB(-2) + 40.1839991993 * CE + 38.1309924401 * CE(-1) + 18.89363838 * CE(-2) - 12.7952331767 * LC - 17.3404096848 * LC(-1) - 7.18437126073 * LC(-2) + 5527.35839208 * ATIS + 3437.05128843 * ATIS(-1) - 1701.12144054 * ATIS(-2) + 348.587471556 * MSS + 3948.09840132 * MSS(-1) + 1971.80874578 * MSS(-2) - 8241.67214267$$

4.3. ARDL Bounds test to Cointegration

If the calculated F-statistic goes above the upper bound, then:

- the null hypothesis of no cointegration between TB, CE, LC, ATIS, MSS, and TR is rejected;

If it goes less than the lower bound, then:

- the null hypothesis of no cointegration between variables cannot be rejected.

If F-statistic is between the lower and the upper bounds, then:

- the null hypothesis of no cointegration-appropriate variables becomes inconclusive.

The results of the cointegration analysis confirm that the null hypothesis is rejected, indicating that the variables are cointegrated (Table 5). Consequently, both short-run as well as long-run models can be specified.

Table 5

ARDL bounds test

Null Hypothesis: No levels of relationship				
Test Statistic	Value	**Significance level.**	**I(0) Bound**	**I(1) Bound**
F-statistic	66.876	10%	2.08	3
k	5	5%	2.39	3.38
		2.5%	2.7	3.73
		1%	3.06	4.15

Source: Author's calculation, 2024

ARDL cointegration test based on equation (2) is expressed as below:

$$EC = TR - (141.5575 * TB + 38.5141 * CE - 14.7862 * LC + 2877.7210 * ATIS + 2483.5829 * MSS - 3265.3576)$$

The coefficient of ECM depicts the speed adjustment towards equilibrium. By analyzing the cointegration coefficient (-2.523972) and p-value (0.0005) presented in Table 6, it can be proved that long-run adjustment would be possible.

Table 6

Cointegrating form of variables (Long-run and short-run estimations)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Long run estimation				
TB	141.5575**	19.06079	7.426630	0.0177
CE	38.51414***	1.751140	21.99376	0.0021
LC	-14.78622**	1.747282	-8.462412	0.0137
ATIS	2877.721***	60.29872	47.72441	0.0004
MSS	2483.583***	61.86759	40.14352	0.0006
C	-3265.358	189.9471	-17.19088	0.0034
Short run estimation				
D(TR(-1))	0.726141***	0.030845	23.54188	0.0018
D(TB)	262.3536***	6.366661	41.20741	0.0006
D(TB(-1))	-550.6486***	13.98627	-39.37066	0.0006
D(CE)	40.18400***	0.955645	42.04908	0.0006
D(CE(-1))	-18.89364***	1.236291	-15.28252	0.0043
D(LC)	-12.79523***	0.207135	-61.77230	0.0003
D(LC(-1))	7.184371***	0.323534	22.20591	0.0020

D(ATIS)	5527.358***	91.50965	60.40192	0.0003
D(ATIS(-1))	1701.121***	63.86447	26.63643	0.0014
D(MSS)	348.5875**	35.64490	9.779449	0.0103
D(MSS(-1))	-1971.809***	93.99245	-20.97837	0.0023
CointEq(-1)*	-2.523972	0.058327	-43.27288	0.0005

R-squared	0.999249	Mean dependent var	397.4800
Adjusted R-squared	0.998217	S.D. dependent var	721.8194
S.E. of regression	30.47668	Akaike info criterion	9.955510
Sum squared resid	7430.625	Schwarz criterion	10.55295
Log likelihood	-87.55510	Hannan-Quinn criter.	10.07214
Durbin-Watson stat	2.574397		

Note: ***, ** and * denote statistical significance at 1%, 5%, and 10%, respectively
Source: Author's calculation, 2024.

4.4. Long-run and short-run analysis

Several tests were conducted to assess the qualitative adequacy of the model, confirming its validity for both **short-term and long-term** periods. For long-run relationships analysis, ARDL Long Run Form and Bounds Test was performed (Table 6). The results show that in the long run, all the explanatory (independent) variables are statistically significant: tax burden (TB), total number of concessions and exemptions (CE), applying of automated management system and message service (MSS) have positive effects on tax revenues, while numbers of legislative changes (LC) has a negative impact.

To the short-run estimations, the tax burden has constructive and positive influences on tax revenue at the t and $(t-2)$ while this effect is negative at the $(t-1)$. The different directions of the impacts immediate positive and lagged negative effects can be explained by considering the economic mechanisms, behavioral responses, and adjustment processes that occur over time. CE and applying of ATIS have a positive and statistically significant (at 5% level) effect on the tax revenue while the impacts of LC are negative at the moment of t, $(t-1)$ and $(t-2)$. The application of MSS also has a positive effect, however the result is significant at the $(t-1)$.

The Wald test was used to determine the significance of the coefficients in the short-run period (Table 7). Thus, in the short run, the significance of the coefficients on the application of tax burden (262.3536), C_E (40.18400), electronic services (5527.358), and message services (348.5875) was confirmed at 5% level (with 95% accuracy), and LC (-12.79523) with at 10% level (with 90% accuracy).

Table 7

Wald Test results

Test Statistic	Value	df	Probability
Null Hypothesis: C(1)=C(2)=0			
F-statistic	24.77248	(2, 2)	0.0388
Chi-square	49.54495	2	0.0000
Null Hypothesis: C(3)=C(4)=C(5)=0			
F-statistic	58.41165	(3, 2)	0.0169
Chi-square	175.2350	3	0.0000
Null Hypothesis: C(6)=C(7)=C(8)=0			
F-statistic	21.50797	(3, 2)	0.0448
Chi-square	64.52391	3	0.0000
Null Hypothesis: C(9)=C(10)=C(11)=0			
F-statistic	16.61102	(3, 2)	0.0573
Chi-square	49.83307	3	0.0000

Null Hypothesis: C(12)=C(13)=C(14)=0			
F-statistic	48.94564	(3, 2)	0.0201
Chi-square	146.8369	3	0.0000
Null Hypothesis: C(15)=C(16)=C(17)=0			
F-statistic	85.45621	(3, 2)	0.0116
Chi-square	256.3686	3	0.0000

Source: Author's calculation, 2024.

4.5. Diagnostic analysis of the ARDL model

To ensure the **robustness and reliability** of the estimated model, several diagnostic and stability tests were conducted:

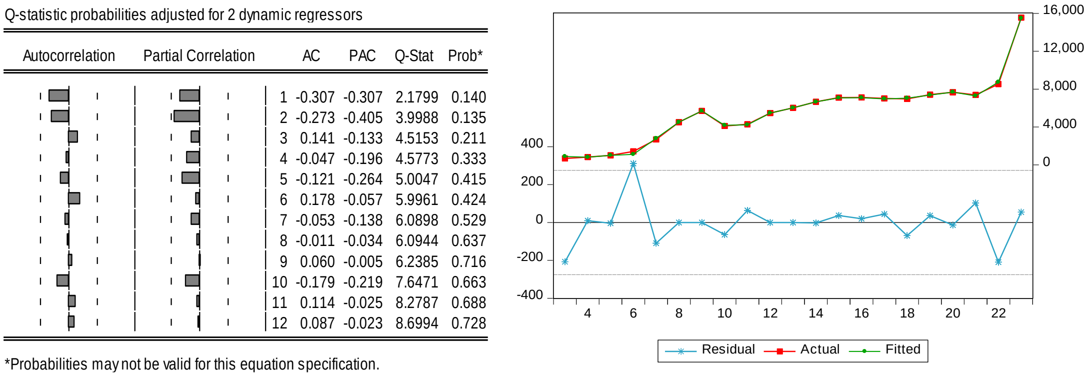
- The Breusch-Pagan-Godfrey and Glejser tests were used to check for heteroscedasticity of residuals (Table 8);
- The Jarque-Bera test was used to verify that the residuals distributed normally and proved by accepting H_0 (null hypothesis) at the 5% significant level residuals are multivariate normally distributed (Table 8);
- Breusch-Godfrey Serial Correlation LM test and Correlogram of residuals – Q statistics, were used to check for serial correlation(no autocorrelation) (Table 8), (Fig. 2a). Results indicate that H_0 (null hypothesis) is accepted at the 5% significant level, so model free from serial correlation,
- To further assess models' performance, actual and fitted values and residuals, were analyzed (Fig. 2b).

Table 8

Diagnostic analysis

Heteroskedasticity Tests:			
		Glejser	Breusch-Pagan-Godfrey
F-statistic		0.965562	0.317680
Prob. F(17,2)		0.6237	0.7298
Prob. Chi-Square(1)		0.3998	0.4445
Prob. Chi-Square(6)		1.0000	1.0000
Breusch-Godfrey Serial Correlation LM Test:			
F test		0.205658	
Obs*R-squared		3.411553	
Prob. F(1,1)		0.7290	
Prob. Chi-Square(1)		0.0647	
Jarque-Bera test (checking normality)		3.289257	
Prob.		0.193084	
R-squared	0.999940	Mean dependent var	5131.335
Adjusted R-squared	0.999430	S.D. dependent var	2553.734
S.E. of regression	60.95336	Akaike info criterion	10.55551
F-statistic	1961.709	Durbin-Watson stat	2.574397
Prob(F-statistic)	0.000510		

Source: Author's calculations, 2024.



a) Correlogram of residuals – Q statistics b) Actual and fitted values and residual

Figure 2. Residual analysis correlogram and plots

Source: Author's calculations, 2024

Note: All estimations including graphical and tabular representations were realized by the author using Python programming language and EViews-2010 software.

5. DISCUSSION

The primary objective of this research is to investigate the impacts of tax reform on the tax revenue in the Republic of Azerbaijan over the past 23 years by using the ARDL cointegration approach. The results show that implemented tax reforms affect tax revenue both in short-run and long-run periods. The Short-run analysis reveals a strong and significant relationship between tax revenue and implemented tax reforms. Consequently, the interpretation of results which describe the influences of main indicators characterizing the tax reform on tax revenue in Azerbaijan during 2000-2022 is provided in Table 9 below.

Table 9

Interpreting of short-run estimations

	(t)	t-1 (1-year lag effect)	t-2 (two-year lag effect)
1% increase in tax burden	₼ 262.3536 ($154.33) increase	₼ 455.7151 ($268.07) decrease	₼ 550.6486 ($323.91) increase
A unit increase in the total number of concessions and exemptions	₼ 40.18400 ($23.64) increase	₼ 38.13099 ($22.43) increase	₼ 18.89364 ($11.11) increase
A unit increase in the number of legislative changes	₼ 12.79523 ($7.53) decrease	₼ 17.34041 ($10.2) decrease	₼ 7.184371 ($4.23) decrease

Note: ₼ - AZN, the national currency of the Azerbaijan Republic

Source: Author's calculations

However, a 1% increase in tax burden results in an increase of $83.27 (₼141.5575) in tax revenue, while a unit increase in the total number of concessions and exemptions leads to an increase of $22.66 (₼38.51414). Conversely, a unit increase in the number of legislative changes results in a decrease of $8.7 (₼14.78622) in tax revenue in the long run.

The influences of qualitative variables are positive in both short and long-run periods. The results indicate that implementation of the automated tax information system and messages services contribute approximately $1692.78 (₼2877.721) and $1460.93 (₼2483.583) for increasing the amount of tax revenue in the long run, respectively. Furthermore, the application of an automated tax information system is beneficial for tax revenue, contributing$3251.39 (₼5527.358) in the short run. Although the impact of the application of messages service application is positive, the result is not statistically significant at the 5% level.

The results of the research show that the effects of tax reform in the short run are more pronounced than in the long run, especially in terms of tax burden. It is evident that raising additional tax revenues without harming economic growth is one of today's most essential challenges. The negative effect of the tax burden, which depends on lag distributions (t and t-1), further supports this. Therefore, an optimal tax burden rate must be defined to provide both increased tax revenue and economic growth. The application of numerous concessions and exemptions to taxpayers has contributed to the rise in tax revenue over the previous 23 years. This can be explained in two ways: first, these measures help taxpayers (especially entrepreneurs) to restore their business activities and fulfill their tax liabilities. Second, concessions and exemptions attract both individuals and legal entities to comply with their tax liabilities, thereby increasing tax revenue by reducing tax evasion or avoidance. Unfortunately, frequent legislative changes can create the perception that the tax system is unstable, which may encourage tax evasion.

Additionally, enhancing technological services within the tax system can improve the efficiency of both tax authorities and taxpayers by providing a more effective and transparent tax system.

6. CONCLUSION

The findings of this study offer valuable insights into the effects of tax reform on tax revenue in Azerbaijan, aligning with existing research while providing a unique contribution to the field. The results indicate that the tax burden is a key determinant of tax revenue in both the short-run and long-run. This conclusion is consistent with the theory outlined by Auerbach and Hines (2002), who suggest that while raising taxes can yield immediate revenue gains, there is a limit to how much additional tax burden can be absorbed by taxpayers before it begins to undermine economic performance. This finding highlights the importance of determining an optimal tax rate that maximizes revenue without stifling economic growth.

Moreover, the study found that concessions and exemptions had a moderate positive impact on tax revenue. This result supports the argument made by Alm and Torgler (2006), who suggest that providing targeted concessions can encourage compliance by reducing the perceived burden on taxpayers. In Azerbaijan's case, these concessions have helped maintain business activity, particularly among entrepreneurs, by offering relief during periods of economic strain. However, similar to Alm and Torgler's findings, excessive exemptions may lead to inefficiencies in the tax system by shrinking the tax base.

On the other hand, frequent legislative changes were found to have a negative impact on tax revenue, particularly when they introduce uncertainty or instability into the tax system. Consistent with Tanzi and Zee (2000), the research suggests that a stable and predictable tax system is critical for fostering taxpayer trust and compliance. Frequent changes may signal instability and make it harder for businesses and individuals to adapt to new regulations, ultimately undermining tax compliance efforts.

Furthermore, the study highlights the significant role of technology in improving tax administration. The implementation of automated tax information systems and messaging services led to significant increases in tax revenue. This finding is consistent with the research of Pomeranz (2015), which demonstrates that technology can reduce tax evasion by increasing transparency and simplifying tax compliance. Automated systems improve the efficiency of tax collection, minimize errors, and facilitate greater taxpayer engagement, thus increasing overall compliance and revenue generation.

In summary, the empirical analysis of this study provides the following key conclusions for the Republic of Azerbaijan:

- The tax burden is a major determinant of tax revenue, with significant implications for both short-run and long-run fiscal policy;
- Concessions and exemptions have moderate positive impacts, whereas frequent legislative changes are negatively associated with tax revenue;
- Both qualitative and quantitative variables play a crucial role in the increasing of tax revenue.

DECLARATION

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors. "Declarations of interest: none"

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