

Article

Historical periodization and potential structural breaks in the fiscal policy–human capital nexus in Azerbaijan

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Abstract

This study examines the historical evolution of the relationship between fiscal policy and human capital formation in Azerbaijan over the period 1991–2024, with particular emphasis on regime changes and potential structural breaks. The analysis is motivated by the fact that Azerbaijan's post-independence development has been characterized by profound economic, institutional, geopolitical, and external shocks that make the assumption of a stable fiscal–human capital relationship unrealistic. A historical-periodization approach is combined with a structural-break-oriented econometric framework to identify distinct phases in the evolution of fiscal capacity, resource revenues, public expenditure, inflation, institutional development, and human capital financing. Eight major periods are distinguished: systemic disruption in 1991–1994; stabilization and institution building in 1995–2004; oil-driven fiscal expansion in 2005–2007; the global financial crisis in 2008–2010; maturation of the oil-financed growth model in 2011–2013; the oil-price shock and macroeconomic adjustment in 2014–2016; fiscal and tax administration reforms in 2017–2019; and the pandemic, conflict, reconstruction, and renewed energy-revenue environment during 2020–2024. The analysis suggests that the transmission of fiscal resources into education, health, and productive capabilities has varied substantially across these regimes. The study proposes the use of Zivot–Andrews, Bai–Perron, CUSUM, ARDL, and NARDL techniques for subsequent empirical verification of the identified structural changes. The findings emphasize that fiscal capacity should not be evaluated solely through aggregate revenue or expenditure ratios, since the composition, institutional quality, macroeconomic environment, and source of public revenues strongly influence their long-term contribution to human capital development.

Keywords: fiscal policy, human capital, structural breaks, oil revenues, public expenditure, Azerbaijan, ARDL, NARDL

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1. Introduction

The importance of using micro-unmanned aerial vehicles (micro-UAVs) for environmental monitoring, precision agriculture, disaster response, infrastructure inspection, border observation, and search-and-rescue operations has been growing. Their small size, mobility and ability to function in areas difficult or dangerous to

humans, make them useful tools in modern engineering and applied science. But, despite these merits, there are a number of limitations associated with micro-UAV systems. They still have challenges with extensive and sustainable use due to limited battery capacity, route inefficiency, environmental uncertainty, communication constraints, and the need for real-time decision making.

The relationship between fiscal policy and human capital formation is rarely stable over long historical periods. Changes in macroeconomic conditions, public institutions, government revenues, inflation, external shocks, and the composition of public expenditure can alter both the scale of fiscal resources and the efficiency with which these resources are transformed into education, health, and productive capabilities.

This issue is particularly relevant in the case of Azerbaijan. Since regaining independence in 1991, the country has experienced a transition from central planning to a market economy, armed conflict and large-scale displacement, macroeconomic stabilization, rapid expansion of hydrocarbon production, an exceptional resource-revenue boom, the global financial crisis, a major decline in oil prices, exchange-rate adjustments, tax and public-finance reforms, the COVID-19 pandemic, the 2020 war, post-conflict reconstruction, and renewed shocks in international energy markets. These developments substantially altered the volume and composition of government revenues, the real value and allocation of public expenditure, private-sector behavior, and the institutional mechanisms through which fiscal resources affected human capital accumulation (Asian Development Bank [ADB], 2020; International Monetary Fund [IMF], 2024; World Bank, 2022).

Consequently, modelling the entire period from independence as a single stable data-generating process may conceal major changes in the underlying fiscal–human capital relationship. A positive long-run association between tax revenues and human capital, for example, may coexist with weak or even negative short-run effects during periods of crisis. Similarly, oil revenues may have high marginal development effects when basic infrastructure is scarce, but their contribution may decline once major physical infrastructure gaps have been reduced and further progress becomes increasingly dependent on institutional quality, education quality, health-system efficiency, innovation, and skills.

Historical periodization therefore has an analytical rather than merely descriptive function. It allows the identification of economic regimes in which the coefficients linking taxation, oil revenues, inflation, government expenditure, institutions, and human capital may differ.

The purpose of this study is to develop a historically grounded framework for analysing structural changes in the fiscal policy–human capital nexus in Azerbaijan between 1991 and 2024. More specifically, the study aims to: identify major fiscal and macroeconomic regimes since independence; assess how the channels linking fiscal capacity and human capital changed across these regimes; identify historically plausible structural-break periods; and develop an econometric strategy through which these breaks can subsequently be formally tested.

The study contributes to the literature by integrating Azerbaijan's resource-based fiscal transformation with human capital analysis and by emphasizing that fiscal capacity is determined not only by the amount of revenue available to the government but also by its source, stability, institutional administration, purchasing power, and allocation.

2. Materials and methods

2.1. Research design

The study applies a historical-analytical periodization framework supported by a structural-break-oriented econometric methodology. The period of analysis covers 1991–2024 and corresponds to Azerbaijan's post-independence economic development.

Historical periodization is used to identify episodes during which the mechanisms linking fiscal variables and human capital may have changed materially. The classification is based on major macroeconomic, fiscal, institutional, geopolitical, and external developments affecting Azerbaijan.

The analytical framework focuses on five broad groups of variables:

1. government fiscal capacity, including tax revenues and hydrocarbon-related fiscal resources;
2. public expenditure and its allocation;
3. macroeconomic conditions, particularly inflation and exchange-rate developments;
4. institutional and tax-administration changes; and
5. human capital outcomes and the financing of education and health.

The underlying assumption is that the transmission from fiscal resources to human capital is conditional rather than automatic. An increase in government revenue may produce different outcomes depending on inflation, expenditure composition, administrative capacity, institutional effectiveness, and the stage of economic development.

2.2. Historical periodization

Based on the major economic and institutional transformations observed since independence, the study distinguishes the following analytical regimes:

- **1991–1994:** independence, conflict, economic contraction, and systemic disruption;
- **1995–2004:** macroeconomic stabilization, transition reforms, and institutional development before the full-scale oil boom;
- **2005–2007:** rapid expansion of oil production and fiscal expenditure;
- **2008–2010:** global financial crisis under a resource-revenue-supported fiscal system;
- **2011–2013:** maturation of the oil-boom expenditure model and emerging constraints on oil-led growth;
- **2014–2016:** oil-price collapse, exchange-rate adjustment, inflation, and fiscal adaptation;
- **2017–2019:** stabilization, tax-administration modernization, formalization, and fiscal-rule reforms;
- **2020–2021:** pandemic, war, emergency expenditure, and direct risks to human capital formation;
- **2022–2024:** renewed energy revenues, inflationary pressures, reconstruction expenditure, and changes in the composition of public investment.

These periods are not interpreted as mechanically predetermined econometric break dates. Instead, they provide historically grounded hypotheses that can be compared with statistically estimated structural breaks.

2.3. Identification of structural breaks

Several complementary econometric methods are appropriate for formally evaluating structural instability.

The Zivot–Andrews test allows the unit-root hypothesis to be examined while permitting a single endogenously determined structural break in the intercept, trend, or

both. This is particularly important because conventional unit-root procedures can incorrectly classify a stationary series with a structural break as non-stationary (Zivot & Andrews, 1992).

The Bai–Perron multiple structural-break methodology can be used to identify several unknown break dates in regression coefficients without specifying all breakpoints in advance. Given the annual frequency of Azerbaijani data and the relatively limited sample size, the number of breaks should be restricted and an economically meaningful minimum segment length should be imposed to prevent excessive fragmentation of the sample (Bai & Perron, 2003).

Parameter stability can additionally be evaluated using CUSUM and CUSUMSQ tests. These tests are particularly useful after estimating ARDL or error-correction specifications because they provide evidence on the stability of the estimated coefficients over time.

2.4. ARDL and asymmetric modelling framework

The Autoregressive Distributed Lag approach is suitable when explanatory variables consist of a mixture of $I(0)$ and $I(1)$ processes, provided that none of them is integrated of order two, $I(2)$ (Pesaran et al., 2001).

A general long-run relationship may be represented as:

$$HC_t = f(TAX_t, OIL_t, GEXP_t, INF_t, INST_t)$$

where (HC) represents human capital, (TAX) denotes tax revenues or non-oil tax revenues, (OIL) denotes hydrocarbon-related fiscal resources, (GEXP) represents public expenditure, (INF) denotes inflation, and (INST) represents institutional conditions.

Structural-break dummy variables may subsequently be introduced when theoretically and statistically justified.

Because positive and negative changes in oil revenues and inflation may have different consequences for human capital, the Nonlinear ARDL model provides an additional analytical extension. NARDL decomposes changes in an explanatory variable into positive and negative partial sums and allows the researcher to test whether adverse shocks have different short- and long-run effects from favourable shocks (Shin et al., 2014).

Structural-break controls remain relevant even in a NARDL framework because asymmetry and regime change represent conceptually different forms of nonlinearity.

3. Results

3.1. Systemic disruption and erosion of fiscal capacity, 1991–1994

The first post-independence regime was characterized by the simultaneous collapse of Soviet economic structures, disruption of production and trade networks, severe macroeconomic instability, institutional fragmentation, armed conflict, and displacement.

Azerbaijan inherited relatively broad education and healthcare systems, high literacy, and considerable technical capacity. However, the fiscal and economic foundations supporting these systems deteriorated sharply.

Declining production reduced the effective tax base, while high inflation eroded the real value of government revenue and expenditure. At the same time, the emerging market economy required the reconstruction of tax administration in an environment

characterized by rapidly changing ownership relations, prices, trade patterns, and enterprise behaviour.

The state also faced substantial extraordinary expenditure pressures related to conflict, internally displaced populations, social protection, and the maintenance of essential public services.

For the fiscal–human capital relationship, this regime represents a period in which the preservation of existing human capital institutions was more important than expansion. Nominal expenditure indicators are therefore unlikely to fully capture the deterioration in real fiscal capacity. (ADB, 2020; World Bank, 2022)

3.2. Stabilization and institutional development, 1995–2004

The period between approximately 1995 and 2004 represents a transition toward macroeconomic stabilization and the construction of institutions required for a market economy.

The 1994 production-sharing agreement commonly known as the “Contract of the Century” established the legal and contractual foundation for large-scale foreign investment in the petroleum sector. However, the full fiscal consequences of large-scale oil production had not yet materialized. Lower inflation improved predictability for budgetary planning, households, and firms. Institutions relating to taxation, customs, treasury management, banking, and public administration were gradually strengthened.

A particularly important development was the establishment of the State Oil Fund of the Republic of Azerbaijan in 1999, which created an institutional mechanism for the accumulation, management, and use of hydrocarbon revenues. Human capital policy during this phase remained constrained by limited fiscal resources. The government simultaneously faced infrastructure shortages, poverty, displacement, administrative restructuring, and the need to maintain education and healthcare systems.

This period consequently provides an important pre-oil-boom benchmark for evaluating whether subsequent resource abundance fundamentally changed the relationship between government fiscal capacity and human capital development. (ADB, 2020; State Oil Fund of the Republic of Azerbaijan [SOFAZ], 2024; World Bank, 2022)

3.3. Oil-driven fiscal expansion, 2005–2007

The mid-2000s represent one of the most important structural transformations in Azerbaijan's post-independence economy.

The completion of the Baku–Tbilisi–Ceyhan pipeline, rapid growth in oil production, and favourable international prices substantially increased export receipts, GDP, government revenue, and public investment.

The resulting expansion fundamentally relaxed the fiscal constraint facing the government. Public infrastructure, regional development, social transfers, and public-sector wages could be financed on a scale that had not been feasible during the 1990s.

From a human capital perspective, higher fiscal revenues created major opportunities for investment in schools, healthcare facilities, information technologies, public-sector remuneration, and targeted social programmes.

However, the speed of fiscal expansion also created absorptive-capacity constraints. The availability of financial resources could increase more rapidly than the supply of qualified administrators, teachers, healthcare workers, contractors, engineers, and project managers. The relationship between expenditure and human capital outcomes may therefore have become increasingly dependent on the quality and efficiency of expenditure rather than its volume alone. (ADB, 2020; SOFAZ, 2024; World Bank, 2022)

3.4. The global financial crisis and fiscal stabilization capacity, 2008–2010

The global financial crisis created external shocks through international demand, financial conditions, and commodity markets. Azerbaijan entered this period with accumulated resource revenues and a substantially stronger fiscal position than during earlier crises. This regime therefore provides an important test of the stabilizing function of resource-based fiscal buffers.

A resource-rich government with accumulated financial reserves can potentially reduce the long-term human capital consequences of a temporary external shock by maintaining expenditure on education, health, public employment, and social protection despite weakening private economic activity. The main analytical difference between this episode and the early 1990s lies in the government's capacity to smooth expenditure across the economic cycle.

Thus, the same external deterioration may produce substantially different human capital effects depending on the fiscal buffers accumulated before the shock. (IMF, 2024; World Bank, 2022)

3.5. Maturation of the oil-financed development model, 2011–2013

The early 2010s constituted a more mature phase of oil-financed development. Public investment remained high and the state continued to possess substantial financial resources.

At the same time, the contribution of the hydrocarbon sector to additional economic growth began to weaken as oil production approached or moved beyond its peak. This phase is important because the marginal development return to additional government investment may have begun to change. When roads, utilities, schools, hospitals, and other basic infrastructure are severely deficient, initial investment can generate substantial social and economic returns. Once major infrastructure gaps have been reduced, however, further improvements increasingly depend on the quality of public services, maintenance, teacher and healthcare-worker performance, institutional reforms, skills, and innovation.

The fiscal-human capital transmission mechanism consequently becomes more complex as an economy moves from infrastructure accumulation toward quality-intensive development. (World Bank, 2022)

3.6. Oil-price shock, devaluation, and fiscal adjustment, 2014–2016

The decline in global oil prices beginning in 2014 created another major structural episode. Lower hydrocarbon revenues weakened Azerbaijan's external and fiscal position. Exchange-rate adjustments in 2015 increased the domestic-currency cost of imported goods and contributed to inflationary pressures. The shock revealed an important distinction between resource-supported fiscal abundance and sustainable non-oil fiscal capacity.

Government expenditure commitments had expanded during the high-revenue period, while financing conditions changed rapidly following the deterioration in the external environment. The implications for human capital operated through several channels. Currency depreciation increased the domestic cost of imported pharmaceuticals, laboratory equipment, educational technologies, scientific materials, and other inputs. Inflation reduced the purchasing power of households and the real value of nominal government expenditure. Weaker economic activity and stress in the

financial system could also negatively affect employment and private expenditure on education and healthcare.

The period therefore represents a strong candidate for structural-break testing in fiscal, inflation, exchange-rate, and human-capital-related series. (IMF, 2024; World Bank, 2022)

3.7. Stabilization and improvement in fiscal administration, 2017–2019

The post-devaluation period was characterized by stabilization and increasing emphasis on non-oil growth, fiscal discipline, formalization, and administrative reform. Digital tax administration, electronic invoicing, online cash registers, formalization initiatives, and changes in revenue administration were intended to improve compliance and expand the non-oil tax base. (ADB, 2025a; IMF, 2024)

These developments are analytically important because they potentially represent a qualitative rather than purely quantitative change in fiscal capacity. Even when the aggregate tax-to-GDP ratio changes gradually, the underlying revenue system can become more predictable, transparent, and information-intensive. Digitalization improves the government's ability to observe transactions, cross-check declarations, identify compliance risks, and target enforcement. The introduction of a fiscal rule in 2019 represented another institutional development aimed at constraining the use of oil revenues and strengthening medium-term fiscal sustainability. (ADB, 2025a; IMF, 2024)

Consequently, fiscal capacity during this period should not be evaluated exclusively through aggregate revenue ratios. Improvements in revenue administration may influence the long-run sustainability of public financing even before substantial changes become visible in headline tax indicators. (ADB, 2025a; IMF, 2024)

3.8. Pandemic, war, and direct human capital shocks, 2020–2021

The COVID-19 pandemic represented a simultaneous health, education, economic, and fiscal shock. The demand for public health expenditure and social assistance increased while restrictions disrupted economic activity, employment, education, and service delivery. Unlike many previous fiscal shocks, the pandemic directly affected the mechanisms through which human capital is accumulated. (Betthäuser et al., 2023; World Bank, 2024a, 2024b)

School closures and the transition toward distance education created risks of learning losses, particularly among students with limited access to digital devices, reliable internet connectivity, and household educational support. Although previous investments in digital infrastructure and public-sector capacity supported continuity, unequal access and the limitations of remote pedagogy remained significant concerns. The healthcare system simultaneously faced extraordinary demands while routine medical services and preventive programmes risked disruption. Declining household income could also affect nutrition, healthcare utilization, and private educational expenditure. In addition, the 2020 war created extraordinary fiscal requirements and altered subsequent public-expenditure priorities. The combined nature of these shocks makes 2020–2021 an especially important period when evaluating parameter stability in models of fiscal policy and human capital. (Betthäuser et al., 2023; World Bank, 2024a, 2024b)

3.9. Reconstruction, renewed energy revenues, and changing expenditure composition, 2022–2024

The post-pandemic period was characterized by renewed hydrocarbon revenues, inflationary pressures, non-oil economic activity, and large-scale reconstruction expenditure.

Higher energy prices strengthened the external and fiscal position, demonstrating once again the importance of commodity-price cycles for Azerbaijan's public finances. At the same time, the composition of public expenditure changed substantially.

Reconstruction in Karabakh and Eastern Zangezur required expenditure on transport networks, utilities, housing, public administration, schools, healthcare facilities, digital infrastructure, and security. (ADB, 2025b; IMF, 2025)

These investments may positively affect regional development and long-term human capital formation. However, newly created infrastructure also generates recurrent expenditure obligations associated with staffing, service delivery, maintenance, and administration. The development impact of reconstruction expenditure therefore depends not only on initial capital investment but also on the capacity to finance and manage the resulting public-service networks over the longer term. (ADB, 2025b; IMF, 2025)

4. Discussion

The historical evidence indicates that the relationship between fiscal policy and human capital formation in Azerbaijan cannot reasonably be assumed to have remained constant between 1991 and 2024. At least four broad transformations are particularly important. First, Azerbaijan moved from severe fiscal scarcity in the early independence period to substantial resource-based fiscal abundance during the oil boom. This transformation changed the binding constraint on human capital policy. During the 1990s, the central challenge was maintaining essential systems under severe resource constraints. During the oil-boom period, the challenge increasingly shifted toward efficient allocation and absorptive capacity.

Second, the source of fiscal revenue matters. Hydrocarbon revenues can finance large public investments without requiring a corresponding expansion of domestic taxation. However, resource revenues are highly exposed to global commodity-price cycles. Non-oil taxation, by contrast, can provide a more stable connection between domestic economic activity and government revenue.

Consequently, aggregate government revenue may conceal substantial differences in fiscal sustainability. Third, the real value of fiscal resources is influenced by inflation and exchange-rate movements. The 2014–2016 episode illustrates how nominal expenditure can provide a misleading picture of actual fiscal support for human capital when currency depreciation increases the cost of imported medical, educational, technological, and scientific inputs.

Fourth, the institutional quality of fiscal management may modify the effects of taxation and expenditure even in the absence of major changes in headline fiscal ratios. Digital tax administration and formalization policies introduced during the later 2010s potentially increased the predictability and information content of non-oil revenues. These observations have important econometric implications. Potential structural breaks are unlikely to occur at identical dates for every variable. Oil revenues may exhibit breaks associated with the expansion of production, the 2014 oil-price decline, the pandemic, or subsequent energy-price shocks. Non-oil tax revenues may instead show changes around major tax-administration and formalization reforms.

Government expenditure may change when the scale of oil-fund transfers or reconstruction commitments changes. Inflation and exchange-rate series are likely to be especially sensitive to the macroeconomic stabilization of the 1990s and the

exchange-rate adjustments of 2015. An additional measurement issue arises when tax revenues are expressed as a percentage of total GDP. During an oil boom, rapid expansion of nominal GDP may reduce the observed tax-to-GDP ratio even when nominal tax collections increase. Conversely, the ratio can move mechanically during a recession.

The ratio of non-oil tax revenues to non-oil GDP may therefore provide a more informative supplementary indicator of domestic fiscal capacity. The proposed econometric sequence should consequently begin with unit-root tests allowing for structural change, followed by endogenous break identification. ARDL specifications can then estimate short- and long-run relationships, while CUSUM-type diagnostics can evaluate parameter stability.

If strong asymmetries are expected for oil revenues or inflation, NARDL models can test whether negative shocks generate different consequences from positive shocks. The historical periodization developed in this study should not substitute for econometric breakpoint estimation. Its function is instead to provide an economically meaningful interpretation of statistically identified breaks and to prevent purely data-driven breakpoint estimates from being interpreted without institutional context.

5. Conclusion

This study develops a historical framework for analysing the changing relationship between fiscal policy and human capital formation in Azerbaijan over the period 1991–2024.

The analysis identifies several fundamentally different fiscal regimes, beginning with the severe economic and institutional disruption of the early independence period and progressing through macroeconomic stabilization, the emergence of hydrocarbon revenues, rapid fiscal expansion, external crises, the oil-price shock, fiscal-administration reforms, the COVID-19 pandemic, conflict, reconstruction, and renewed energy-related fiscal revenues.

The central conclusion is that the fiscal policy–human capital nexus in Azerbaijan should be treated as structurally unstable over the full post-independence period. The scale of government revenue alone is insufficient to explain changes in human capital outcomes. The source and volatility of revenue, expenditure composition, inflation, exchange-rate dynamics, institutional capacity, tax administration, and the stage of infrastructure development all affect the efficiency with which fiscal resources are transformed into education, health, and productive capabilities.

The historical evidence identifies the mid-2000s oil expansion, the 2014–2016 oil-price and exchange-rate shock, the 2017–2019 fiscal-administration reform period, and the 2020–2021 pandemic and conflict episode as particularly important candidates for formal structural-break analysis. Future empirical analysis should test these historically motivated regimes using Zivot–Andrews and Bai–Perron procedures and should incorporate statistically supported break variables into ARDL and NARDL specifications.

Such an approach would allow the analysis to distinguish between temporary shocks, persistent structural changes, and asymmetric fiscal effects.

For Azerbaijan, this distinction is particularly important because long-term human capital development increasingly depends not on the simple expansion of fiscal resources but on the stability, quality, productivity, and institutional effectiveness of public finance.

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