“Tracking changes in economic growth-quality conditions in Armenia: A multidimensional directional diagnostic approach”

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TRACKING CHANGES IN ECONOMIC GROWTH-QUALITY CONDITIONS IN ARMENIA: A MULTIDIMENSIONAL DIRECTIONAL DIAGNOSTIC APPROACH

Abstract

Real GDP growth alone does not reveal whether economic expansion is productive, resilient, inclusive, institutionally grounded, or environmentally sustainable. This study develops a Directional Growth-Quality Conditions Index (DGQCI) for Armenia for 2003–2023. The composite contains 22 indicators in six dimensions: sources of economic growth, macroeconomic stability, human capital, structural transformation and innovation, institutional development, and inclusiveness and sustainability. Six context-dependent series (private and government consumption contributions, the real effective exchange rate, reserves, the current-account balance, and FDI/GDP) remain diagnostics but are excluded from aggregation. Publication requires at least 80% total indicator coverage and at least 50% of the intended indicators within every dimension; a stricter two-thirds rule is tested separately. Real GDP growth and the breadth of favorable growth-quality movements diverge substantially. Human capital has the highest average directional score, while inclusiveness and sustainability have the lowest. Results are highly stable to alternative weights, robust to a constant 16-indicator information set and to reassigning poverty to the inclusiveness dimension, but materially less concordant under magnitude-sensitive scoring. The DGQCI is therefore a directional monitoring tool, not a cardinal measure of welfare, causal policy impact, or the magnitude of socioeconomic progress.

Keywords growth-quality conditions, directional diagnostic index, multidimensional index, structural transformation, human capital, inclusive and sustainable growth, Armenia

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INTRODUCTION

Real GDP growth remains the most widely used indicator of economic performance, but it is not sufficient for evaluating the quality of development. An economy may expand rapidly while its productive structure, institutional capacity, social inclusiveness, environmental sustainability, and macroeconomic resilience remain weak. The international literature therefore increasingly treats growth quality as a multidimensional concept that depends not only on output growth but also on productivity, human capital, stability, institutions, inclusion, structural transformation, and environmental sustainability.

For Armenia, the distinction between the rate and the quality of growth is not merely theoretical. As a small open economy, Armenia is exposed to external demand, remittance cycles, commodity-price movements, geopolitical shocks, and exchange-rate pressures. Periods of rapid expansion have often coexisted with external vulnerability,

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structural imbalances, institutional constraints, and social inequality. This creates a practical measurement problem: policymakers need to know not only how fast the economy grows, but also whether growth is generated by sustainable, productivity-enhancing, inclusive, and institutionally supported sources.

1. LITERATURE REVIEW

Research on the quality of economic growth begins with the limitation of GDP as a sufficient summary of development. Output can rise while productivity, resilience, distribution, institutional capacity, or environmental conditions deteriorate. Thomas et al. (2000) therefore treat the quality of growth as a multidimensional issue involving the sustainability and social consequences of expansion, while the Stiglitz-Sen-Fitoussi Commission argues that economic performance should be assessed jointly with distribution, quality of life, and sustainability rather than inferred from production alone (Stiglitz et al., 2009). This broader perspective is consistent with capability-based approaches to development, in which income is a means rather than the sole end of economic progress (Sen, 1999).

Existing measurement strategies operationalize this broad concept in different ways. Mlachila et al. (2017) construct a Quality of Growth Index that combines intrinsic growth performance with social dimensions, while Navasardyan and Mkrtchyan (2023) distinguish the generation and manifestation of growth quality and combine macroeconomic and social indicators. Other approaches use adjusted welfare measures, multidimensional dashboards, or efficiency frameworks that incorporate undesirable outputs and resource use (Talberth et al., 2007; Ru et al., 2020). These methods differ in whether they measure levels, distances from benchmarks, efficiency, or welfare-adjusted outcomes. The present study is narrower: it does not estimate a cardinal level of growth quality but tracks the annual breadth of favorable and adverse movements.

Composite-indicator methodology also makes clear that aggregation is never purely mechanical. Indicator selection, normalization, missing-data treatment, and weighting can materially affect the resulting index, so transparency and sensitivity analysis are essential (OECD & European Commission Joint Research Centre, 2008). This point is particularly important for a directional index because excluding a missing indicator from a dimension denominator changes the effective weight of the indicators that remain observed. Zgurovsky et al. (2020) likewise emphasize the importance of representative indicator selection for sustainable-development modeling. Accordingly, the DGQCI treats coverage rules, constant-information-set checks, alternative weights, materiality thresholds, and conceptual reclassification as part of the empirical method rather than as optional post-estimation diagnostics.

The productive structure of growth is one major strand of the literature. Structural-change research stresses the reallocation of activity toward higher-productivity uses and the role of diversification in sustaining convergence (McMillan & Rodrik, 2011). Innovation and research capacity provide complementary channels. Giyasova et al. (2025) find dynamic links among R&D expenditure, researchers, and GDP per capita in Hong Kong, reinforcing the importance of innovation and human-capital inputs for longer-run productive performance. At the same time, sectoral shares are not universal welfare rankings: a higher manufacturing share can signal diversification in one context, while high-productivity services can play the same role elsewhere. This motivates treating the DGQCI manufacturing-share direction as an explicit operational convention rather than an unconditional economic law.

Macroeconomic stability is similarly multidimensional and context-dependent. Stable inflation, sustainable public finances, and resilience to shocks can support durable growth, but the desirable movement of individual fiscal indicators depends on initial conditions and the use of public resources. A lower debt ratio may improve fiscal space, yet higher debt can finance productive investment; a higher net-lending balance can indicate consolidation, yet coun-

tercyclical deficits may be appropriate during recessions. The IMF (2014) documents that the growth effect of public investment depends on conditions and implementation. For this reason, the DGQCI does not interpret its debt and fiscal-balance directions as universal welfare judgments; it treats them as transparent monitoring conventions and explicitly tests whether the composite depends on those conventions.

Institutional quality forms another central component of growth-quality research. North (1990), Rodrik et al. (2004), Acemoglu and Robinson (2012), and the World Bank (2017) emphasize that predictable rules, effective government, accountability, and property-rights institutions shape incentives and long-run performance. Tran et al. (2021) find that institutional quality is associated with economic development across Asian countries and identify nonlinear effects. Such results reinforce the need to interpret institutional movements diagnostically rather than as mechanically causal contributions.

Human capital links current economic performance to longer-run productive capacity through health, skills, participation, and productivity (World Bank, 2018; OECD, 2019). Giyasova et al. (2025) highlight the interaction between R&D and skilled research capacity. These studies support treating human capital as more than an education variable, while also cautioning against interpreting individual annual movements without institutional and social context.

Distributional outcomes create an important conceptual overlap between human capital and inclusiveness. Poverty can constrain health, education, labor-market participation, and productive capacity, but it is also directly an inclusion outcome. Sen (1999), Stiglitz (2012), Piketty (2014), and Das et al. (2013) emphasize that deprivation and inequality concern both capabilities and the distribution of opportunities. Because either classification can be defended, the baseline DGQCI retains poverty in the human-capital dimension for continuity with the productive-capacity interpretation, but a sensitivity specification reassigns poverty to inclusiveness and sustainability to test whether the dimensional architecture drives the composite result.

Environmental sustainability adds an intergenerational dimension that conventional growth measures omit. The Brundtland framework defines sustainable development in terms of meeting present needs without compromising future capacity (World Commission on Environment and Development, 1987), while the IPCC (2023) documents the economic relevance of climate-related risks. The World Bank (2012) links inclusive green growth to resource efficiency, resilience, and social inclusion. This literature supports combining environmental and distributional diagnostics while recognizing that their relative weight is itself a modeling choice.

Taken together, the literature identifies three unresolved measurement problems relevant to Armenia. First, multidimensional growth-quality frameworks differ substantially in conceptual coverage and aggregation, so any composite requires explicit assumptions. Second, many empirical studies estimate causal or level relationships, whereas policymakers also need a transparent annual monitoring device that can be updated with limited data. Third, data availability changes over time, creating a comparability problem if missing observations alter effective indicator weights. The DGQCI addresses these issues by using a direction-only scoring rule, explicit missing-data and within-dimension coverage criteria, a constant-information-set robustness check, alternative weighting and magnitude specifications, and conceptual sensitivity tests. Its contribution is therefore not to replace established welfare, productivity, or causal measures, but to provide an auditable annual diagnostic of how broadly conditions associated with growth quality move in favorable or adverse directions in Armenia.

This paper aims to construct and empirically apply a multidimensional directional diagnostic index for Armenia. The study addresses three questions: 1) How can annual changes in conditions associated with growth quality be organized in a transparent composite framework? 2) How did those conditions move in Armenia over the comparable 2003–2023 period? 3) Which dimensions most consistently supported or constrained the composite score?

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2. METHOD

The study applies a directional composite-index methodology to annual Armenian data. The method defines the conceptual dimensions, the 22 indicators retained in aggregation, the six contextual-only series, predefined indicator-specific rules for assigning a score of +1, transformations, missing-data rules, coverage criteria, dimension weights, and robustness tests. Observations from 2000–2024 are used where available to construct year-on-year movements, while the comparable main DGQCI series covers 2003–2023.

The DGQCI is a directional diagnostic rather than a measure of the level of growth quality. Its six dimensions are sources of economic growth, macroeconomic stability, human capital development, structural transformation and innovation, institutional development, and inclusiveness and sustainability. The dimensions overlap conceptually and are used for diagnostic transparency, not as mutually exclusive causal channels or a decomposition of GDP or welfare.

Indicator selection follows four criteria: conceptual relevance, availability of comparable annual series, a transparent transformation, and an operational direction that can be stated before observing the annual score. If a variable's sign depends too strongly on financing, starting conditions, or composition, we retain it only as contextual information. Private- and government-consumption contributions, REER, reserves, the current-account balance, and FDI/GDP are therefore excluded from aggregation and reported separately in Supplementary File S1 (Mkrtchyan et al., 2026).

Table 1 lists the 22 composite indicators. Poverty remains in human capital in the baseline because deprivation can constrain health, education, labor-market attachment, and productive capacity; however, because poverty is also a direct inclusiveness outcome, a sensitivity specification reassigns it to inclusiveness and sustainability. Four retained directions (lower government debt, a higher net-lending/net-borrowing balance, higher labor-force participation, and a higher manufacturing share) are explicitly treated as operational monitoring conventions rather than universally favorable welfare judgments. Their influence is tested through leave-one-out sensitivity checks.

The growth-source indicators require a further distinction. For manufacturing and gross exports, the study computes a growth-contribution proxy:

$$P_{j,t} = \frac{g_{j,t} \cdot s_{j,t-1}}{100}, \quad (1)$$

where $g_{j,t}$ is the real growth rate of component j in year t and $s_{j,t-1}$ is its share of GDP in the preceding year. The manufacturing proxy is production-side, whereas the gross-export proxy is derived from the expenditure side. They are not additive components of one national-accounts decomposition and are never summed to reconstruct GDP growth. The export proxy measures gross-export growth and is not a net-exports contribution because import growth is not subtracted. The same arithmetic identity is used for the two consumption diagnostics, which remain outside the composite.

The source database contains annual observations from 2000 through 2024 where available. Because scoring compares year t with year $t - 1$, both transformed observations are required. Missing comparisons are recorded as NA and excluded from the relevant dimension denominator; 0 is reserved for an exactly unchanged observed transformed value. Supplementary File S1 (Mkrtchyan et al., 2026) reports the annual input series and transformed values, indicator scores, dimension denominators, coverage decisions, and all robustness specifications.

To test temporal comparability under a stable information set, a separate constant-panel specification uses only the 16 indicators with valid directional scores in every year from 2003 through 2023: two source indicators, two macroeconomic indicators, four human-capital indicators, all three structural indicators, all three institutional indicators, and two inclusiveness/sustainability indicators. The baseline dimension weights are retained so that this exercise isolates the effect of changing indicator availability rather than changing the weighting architecture.

Table 1. Components and indicators included in the directional growth-quality conditions index (DGQCI)

Indicator	Unit of measurement	Operational +1 convention	Source
1. Sources of Economic Growth			
Manufacturing growth contribution proxy	Real growth rate × lagged GDP share / 100	Increase	World Bank Database; our calculations
Gross-export growth contribution proxy	Real growth rate × lagged GDP share / 100	Increase	World Bank Database; our calculations
Energy-use efficiency	Value added per unit of energy consumed	Increase	World Bank Database; our calculations
2. Macroeconomic Stability			
Absolute inflation-target deviation	Absolute deviation from inflation target, percentage points	Decrease	Global Inflation Database, IMF; our calculations
Inflation volatility	Standard deviation of monthly 12-month CPI inflation	Decrease	Global Inflation Database, IMF; our calculations
General government gross debt	Percent of GDP	Decrease	International Monetary Fund (IMF) Database; our calculations
General government net lending/borrowing	Percent of GDP	Increase	International Monetary Fund (IMF) Database; our calculations
3. Human Capital Development			
Life expectancy	Years	Increase	World Bank Database; our calculations
Unemployment among tertiary-educated workers	Percent	Decrease	World Bank Database
Employment with advanced education	Percent	Increase	World Bank Database; our calculations
Labor productivity (real GDP per person employed)	Constant PPP dollars per person employed	Increase	World Bank Database; our calculations
Labor-force participation rate	Percent	Increase	World Bank Database; our calculations
Poverty headcount ratio	Percent	Decrease	World Bank Database; our calculations
4. Structural Transformation and Innovation			
Manufacturing share of GDP	Percent of GDP	Increase	World Bank Database; our calculations
ICT service exports	Percent of service exports, BoP	Increase	World Bank Database; our calculations
R&D expenditure	Percent of GDP	Increase	World Bank Database
5. Institutional Development			
Rule of law	WGI estimate	Increase	Worldwide Governance Indicators (WGI)
Control of corruption	WGI estimate	Increase	Worldwide Governance Indicators (WGI)
Government effectiveness	WGI estimate	Increase	Worldwide Governance Indicators (WGI)
6. Inclusiveness and Sustainability			
Gini index	Index points	Decrease	World Bank Database
Per-capita CO_2 emissions	Metric tons per capita	Decrease	European Commission (EC)
Renewable-energy share	Percent of total final energy use	Increase	World Bank; International Energy Agency (IEA)

Note: The main publication rule now combines overall and within-dimension coverage. A year is reported only when at least 18 of 22 indicator scores are available (≥80% overall coverage) and at least 50% of the intended indicators are observed in every dimension. This prevents a dimension from carrying its full composite weight on the basis of a single observed score. The rule retains 2003–2023 and suppresses 2001, 2002, and 2024. As a stricter coverage sensitivity, the minimum within-dimension requirement is raised to two-thirds, which retains 2007–2023.

The baseline materiality threshold is zero. For an increase-convention indicator, $s_{i,t} = +1$ when $\Delta x_{i,t} > 0$, $s_{i,t} = 0$ when $\Delta x_{i,t} = 0$, and $s_{i,t} = -1$ when $\Delta x_{i,t} < 0$; the signs are reversed for decrease-convention indicators. If either observation required for the comparison is unavailable, $s_{i,t}$ = NA. Absolute inflation-target deviation is transformed as $|\pi_t - \pi \times t|$ and is coded favorably when it narrows. The fiscal series is IMF general-government net lending (+)/net borrowing (–), percent of GDP, and a numerical increase is the stated operational convention.

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For dimension d in year t,

$$D_{d,t} = 100 \cdot [\Sigma i \in \frac{A_{d,t} \cdot s_{i,t}}{n_{d,t}}], \quad (2)$$

where $A_{d,t}$ is the set of available scored indicators in that dimension and $n_{d,t}$ is its size. Indicators are equally weighted within a dimension. The fixed-weight composite is

$$DGQCI_t = \Sigma d \cdot w_d \cdot D_{d,t}, \quad (3)$$

with baseline weights of 15% for sources of growth, 10% for macroeconomic stability, 25% for human capital, 20% for structural transformation and innovation, 15% for institutions, and 15% for inclusiveness and sustainability. These are transparent policy-priority weights, not estimated structural parameters.

Robustness analysis separates changes within the directional framework from changes in the measurement concept. Weight robustness uses equal dimension weights, alternative policy weights of 15/15/20/20/15/15, and equal indicator weights. Materiality robustness treats movements within 10% and 25% of the indicator-specific sample standard deviation of annual transformed changes as neutral. A bounded magnitude-sensitive specification instead uses standardized annual changes clipped to [–1, +1], thereby changing the index from direction-only breadth toward a magnitude-sensitive concept.

Additional robustness tests address the new aggregation and classification concerns. The constant 16-indicator panel holds the information set fixed over 2003–2023. The poverty-reassignment specification moves only the poverty indicator from human capital to inclusiveness and sustainability. Four leave-one-out specifications separately exclude government debt, the net-lending/net-borrowing balance, labor-force participation, and manufacturing share. Exclusion rather than sign reversal is used because reversing a convention would simply impose the opposite universal normative judgment.

The DGQCI is constructed in five auditable steps: define included and contextual series; transform each included indicator and state its operational direction; compute the year-on-year score; average available scores within each dimension subject to the coverage rule; and aggregate eligible dimension scores with fixed weights. Directional scaling keeps annual signs traceable but treats small and large movements alike. Supplementary File S1 (Mkrtchyan et al., 2026) therefore reports the calculation chain from annual inputs to the composite and all sensitivity tests. Robustness is interpreted according to what changes: weights alter aggregation of the same directional information, the constant panel changes the information set, poverty reassignment changes dimensional architecture, leave-one-out tests examine normative conventions, and magnitude-sensitive scoring changes the measurement concept itself.

3. RESULTS

The empirical application shows substantial annual variation in Armenia's directional growth-quality conditions over the comparable 2003–2023 period. Figure 1 compares the DGQCI with real GDP growth, while Table 2 reports the composite, the six unweighted dimension scores, and total indicator coverage. Every published year satisfies both the ≥ 80% overall coverage rule and the minimum 50% within-dimension coverage rule.

The principal empirical result is the divergence between real GDP growth and the breadth of favorable growth-quality movements. Real GDP grew by about 10.5% in 2004 and 13.2% in 2006, while the DGQCI was –19.17 and –15.00; by contrast, the DGQCI reached 53.33 in 2013 when real GDP growth was 3.5%, and 18.33 in 2016 when growth was only 0.2%. The two series therefore capture distinct empirical objects.

Across the main sample, the DGQCI is positive in most years, negative in 2004, 2006, 2009, 2014, and 2015, and exactly zero in 2020. The highest annual directional score is 53.33 in 2013, followed by 40.00 in 2011 and 37.92 in 2003. These values indicate the weighted balance of favorable and adverse directions; differences between adjacent values are not interpreted as differences in the magnitude of growth quality.

Figure 2 decomposes the composite into weighted dimension contributions. Human capital has the

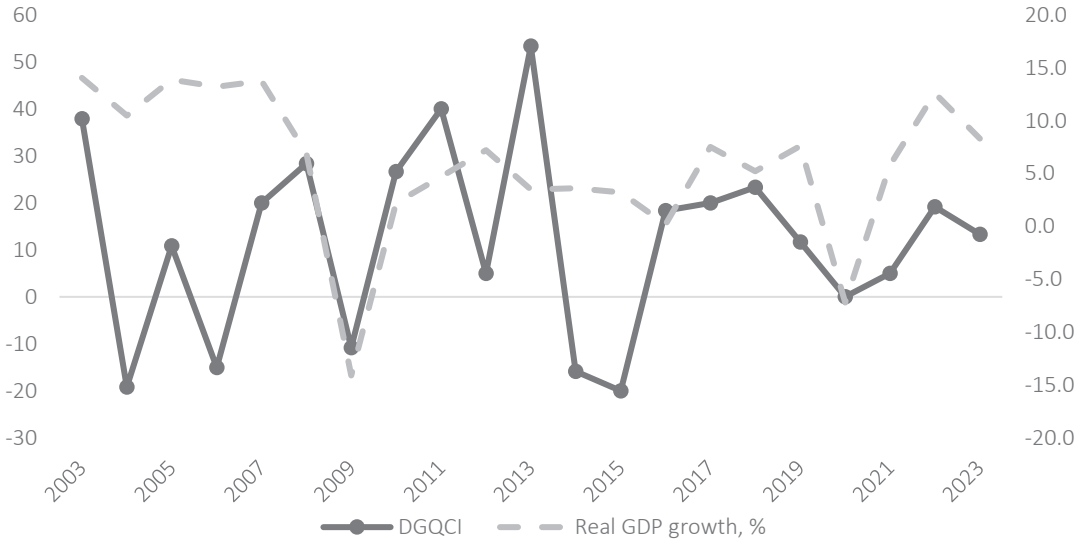


Figure 1. Directional growth-quality conditions index and real GDP growth in Armenia, 2003–2023

Table 2. Annual DGQCI values, dimension scores, and total indicator coverage; Armenia, 2003–2023

Year	DGQCI	Sources	Macro	Human	Structural	Institutions	Incl./Sust.	Coverage
2003	37.92	33.3	100.0	25.0	33.3	33.3	33.3	18/22
2004	–19.17	–33.3	0.0	50.0	–33.3	–33.3	–100.0	18/22
2005	10.83	33.3	0.0	50.0	–33.3	33.3	–33.3	18/22
2006	–15.00	–33.3	100.0	0.0	–100.0	–33.3	33.3	18/22
2007	20.00	100.0	66.7	100.0	–33.3	–33.3	–100.0	19/22
2008	28.33	–33.3	0.0	66.7	33.3	100.0	–33.3	21/22
2009	–10.83	–33.3	–66.7	–50.0	–33.3	33.3	100.0	21/22
2010	26.67	100.0	66.7	33.3	33.3	–100.0	33.3	21/22
2011	40.00	–33.3	33.3	100.0	33.3	100.0	–33.3	21/22
2012	5.00	–33.3	50.0	100.0	–100.0	100.0	–100.0	22/22
2013	53.33	100.0	–50.0	66.7	33.3	100.0	33.3	22/22
2014	–15.83	–100.0	0.0	50.0	33.3	–100.0	–33.3	22/22
2015	–20.00	–100.0	–100.0	33.3	33.3	–100.0	33.3	22/22
2016	18.33	100.0	–50.0	–33.3	33.3	33.3	33.3	22/22
2017	20.00	100.0	0.0	33.3	33.3	33.3	–100.0	22/22
2018	23.33	–33.3	50.0	66.7	33.3	100.0	–100.0	22/22
2019	11.67	33.3	50.0	33.3	–33.3	33.3	–33.3	22/22
2020	0.00	–100.0	–50.0	0.0	100.0	33.3	–33.3	22/22
2021	5.00	100.0	0.0	0.0	–100.0	100.0	–33.3	22/22
2022	19.17	100.0	50.0	0.0	33.3	–100.0	50.0	19/22
2023	13.33	–100.0	–50.0	100.0	–33.3	100.0	0.0	18/22

Note: Dimension scores range from −100 to +100 and are calculated from available +1/0/−1 indicator scores. Coverage reports the number of available composite-indicator scores out of 22. The published main series satisfies ≥ 80% overall coverage and at least 50% coverage within every dimension. A stricter two-thirds within-dimension rule is reported as a sensitivity.

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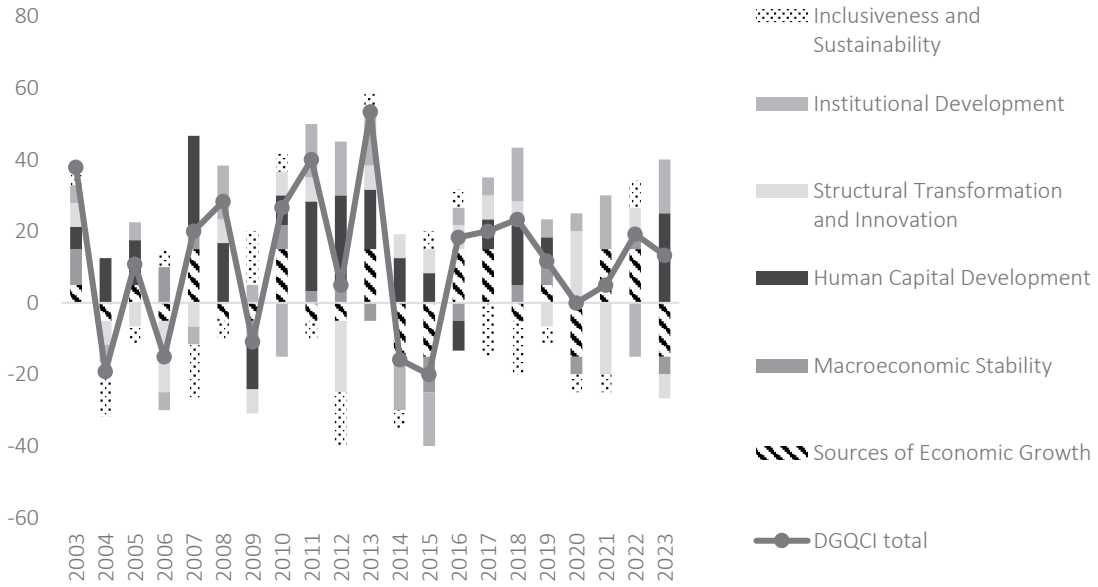


Figure 2. DGQCI in Armenia by weighted dimension contributions

highest average directional score over 2003–2023 (39.29) and is positive in 15 of 21 years. Institutional development also records frequent favorable movements, with an average directional score of 20.63 and positive scores in 14 years. Macroeconomic stability is more mixed, averaging 9.52, while the sources dimension averages 7.94.

The extended sensitivity analysis (Table 3) separates weighting robustness from conceptual and data-composition robustness. Alternative dimension and indicator weights remain very close to the baseline (correlations 0.962–0.988; exact sign agreement 95.2%). The 10% and 25% materiality thresholds also preserve the baseline sign in 95.2% of years, although correlations fall to 0.897 and 0.854. By contrast, the magnitude-sensitive specification is substantially less concordant (correlation 0.721; sign agreement 71.4%). This difference is substantive: conclusions are robust to how the same directional information is weighted, but considerably less robust when the underlying measurement concept is changed from direction-only breadth to magnitude-sensitive scoring.

The new coverage and classification checks lead to a similar but more qualified conclusion. Under the stricter two-thirds within-dimension rule, the eligible window becomes 2007–2023; human capital still has the highest average directional score (41.18),

Table 3. Sensitivity of the DGQCI, Armenia, 2003–2023

Specification	Correlation with baseline	Exact sign agreement	Mean absolute deviation
Equal dimension weights	0.962	95.2%	5.34
Alternative policy weights	0.988	95.2%	2.80
Equal indicator weights	0.966	95.2%	4.14
10% SD materiality threshold	0.897	95.2%	6.92
25% SD materiality threshold	0.854	95.2%	8.21
Magnitude-sensitive scoring	0.721	71.4%	11.55
Constant 16-indicator panel	0.919	90.5%	8.33
Poverty reassigned to Incl./Sust.	0.985	100.0%	3.73
Operational-convention leave-one-out range	0.922-0.981	90.5–95.2%	2.86-6.67

Note: Correlation and mean absolute deviation are calculated against the 2003–2023 baseline. The constant-panel specification retains the 16 indicators observed in every year. Poverty reassignment moves only P3_POV to Inclusiveness/Sustainability. The operational-convention row reports the range across four leave-one-out tests. The magnitude-sensitive specification changes the measurement concept by incorporating standardized magnitude.

institutions remains positive on average (25.49), and inclusiveness/sustainability retains the lowest average directional score (–18.63). The constant 16-indicator panel over 2003–2023 correlates 0.919 with the baseline and has 90.5% exact sign agreement; only 2012 and 2020 change sign category, both involving a baseline value at or close to zero. Reassigning poverty to inclusiveness/sustainability yields a correlation of 0.985 and 100% sign agreement. Excluding the four convention-sensitive indicators one at a time produces correlations of 0.922–0.981 and sign agreement of 90.5–95.2%.

Figure 3 presents the three indicators retained in the sources dimension: the manufacturing growth contribution proxy, the gross-export growth contribution proxy, and energy-use efficiency. The first two are constructed from different sides of the national accounts and are not an additive decomposition of GDP growth; the export proxy refers to gross exports rather than net exports. Private and government consumption contributions remain contextual-only because their desirability depends on import intensity, financing, and expenditure composition.

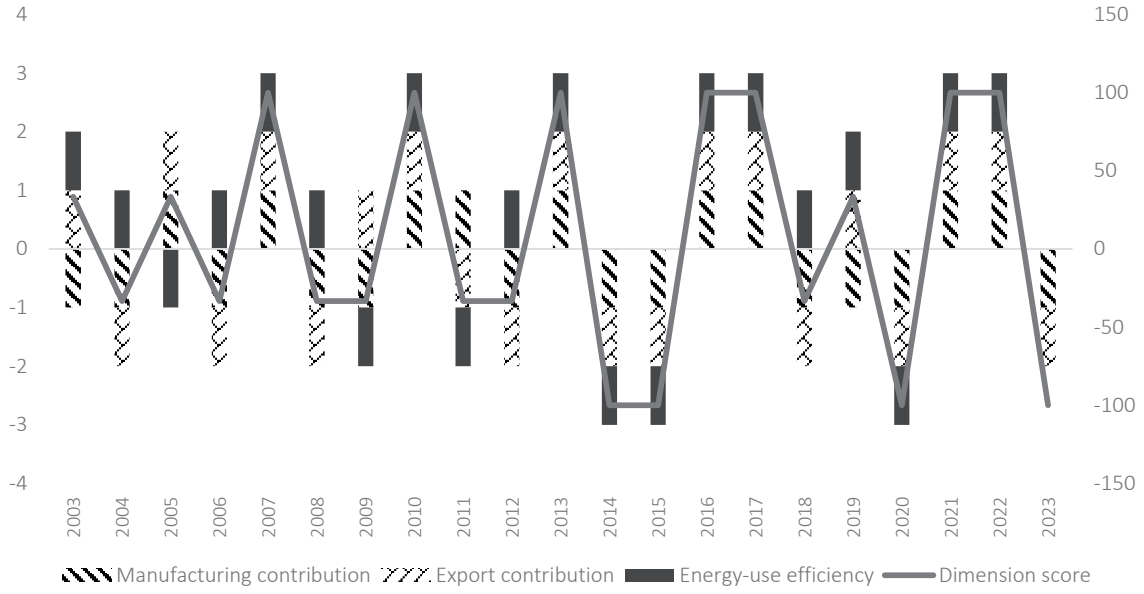


Figure 3. DGQCI first dimension: Sources of economic growth

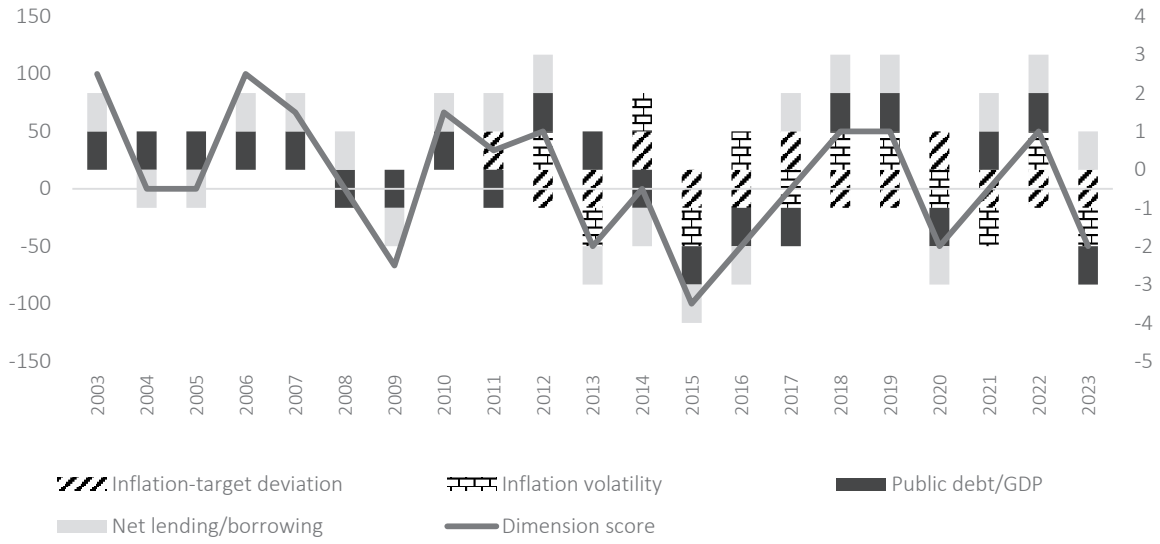


Figure 4. DGQCI second dimension: Macroeconomic stability

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The macroeconomic-stability dimension contains absolute inflation-target deviation, inflation volatility, general-government gross debt/GDP, and general-government net lending/borrowing/GDP. A decrease in the first two is coded +1. Lower debt and a higher fiscal balance are retained as explicit monitoring conventions rather than universal welfare judgments; the leave-one-out tests show that omitting either produces high concordance with the baseline. REER, reserves, the current account, and FDI/GDP remain contextual diagnostics.

The macroeconomic dimension is positive in nine of 21 comparable years, negative in six, and exactly neutral in six, with an average directional score of 9.52. Negative values indicate that adverse directional scores outnumber favorable ones under the stated conventions; they do not establish that the macroeconomic policy stance was inappropriate in those years.

The human-capital dimension includes life expectancy, unemployment among tertiary-educated workers, employment with advanced education, labor productivity, labor-force participation, and poverty. Coverage is lower in the early years and in 2022–2023, but every published year satisfies the revised within-dimension minimum. Higher labor-force participation is an operational convention and is tested through a leave-one-out specification (Figure 5).

Human capital is the most consistently favorable dimension in directional terms: it is positive in 15 of 21 years, negative in two, and neutral in four, with an average score of 39.29. Favorable labor-productivity movements are a recurring contribution, supplemented in different years by health, labor-market, educational-employment, and poverty movements. Reassigning poverty to inclusiveness/sustainability leaves the sign of the annual composite unchanged in all 21 years.

The structural-transformation and innovation dimension contains manufacturing share of GDP, IT-services exports, and R&D expenditure as a share of GDP (Figure 6). We use a higher manufacturing share as an Armenia-focused structural-upgrading convention rather than a universal sector ranking, and we test its influence by excluding it from the composite in a sensitivity specification.

The dimension alternates between positive and negative values throughout 2003–2023. It is positive in 12 years and negative in nine, with an average directional score close to zero (–1.59). The result indicates that favorable annual movements across manufacturing share, IT-services exports, and R&D have not been consistently synchronized.

The institutional dimension comprises annual movements in rule of law, control of corruption,

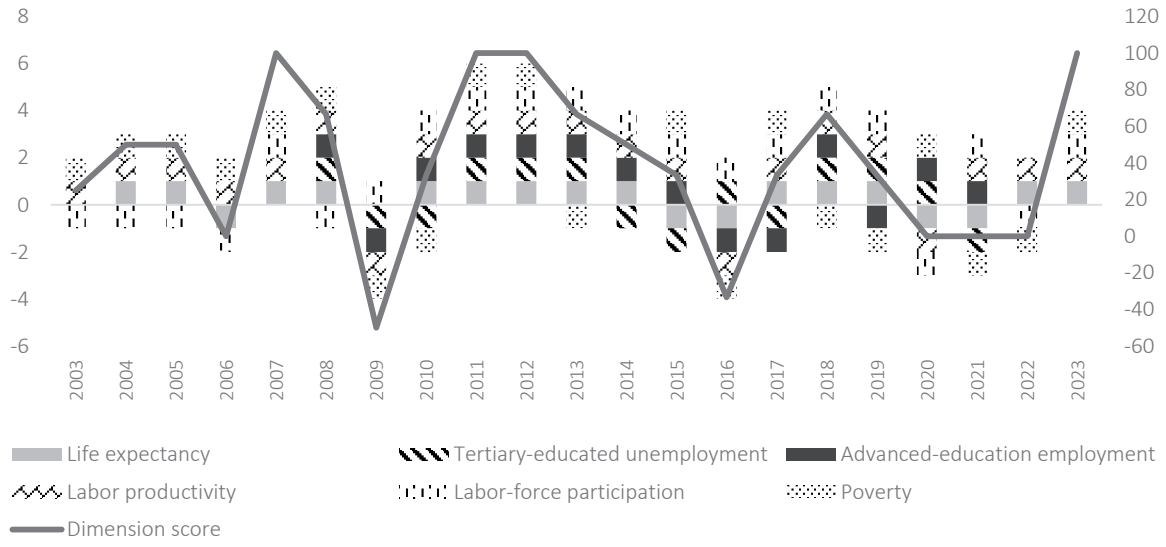


Figure 5. DGQCI third dimension: Human capital development

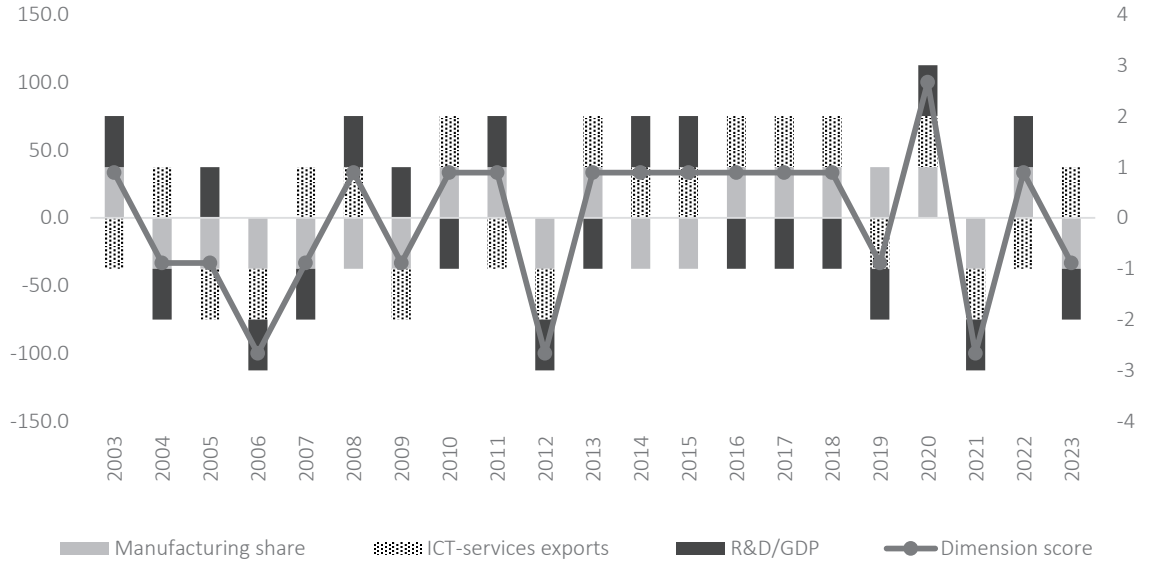


Figure 6. DGQCI fourth dimension: Structural transformation and innovation

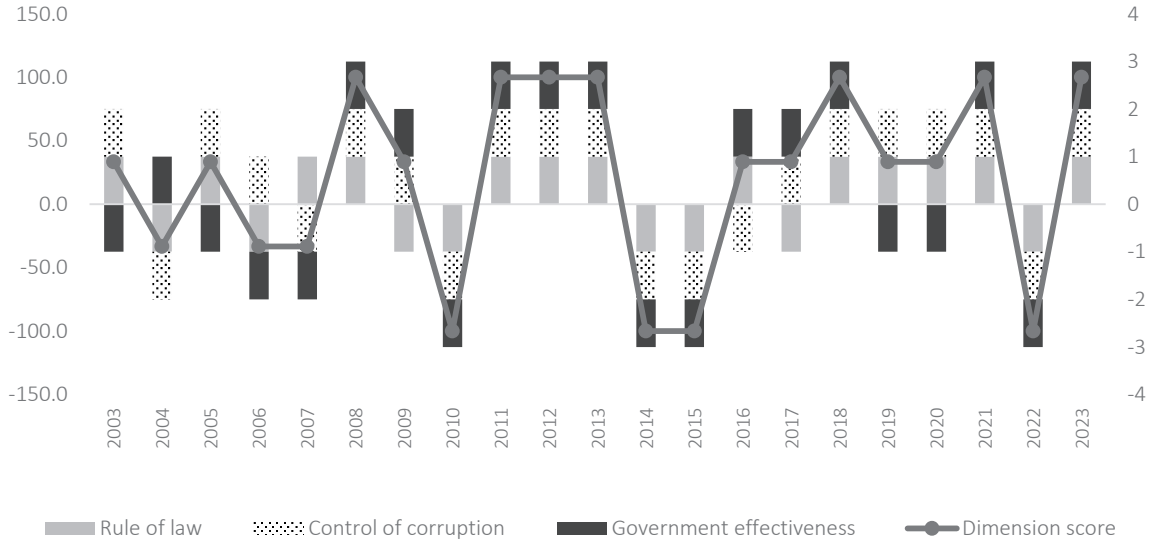


Figure 7. DGQCI fifth dimension: Institutional development

and government effectiveness. All three indicators are observed throughout the 2003–2023 main sample (Figure 7).

Institutional scores are positive in 14 of 21 years and negative in seven, with an average directional score of 20.63. Positive values are especially frequent in the later part of the sample, although the three governance indicators do not always move in the same direction.

The baseline inclusiveness and sustainability dimension combines the Gini index, per-capita CO_2 emissions, and renewable-energy share (Figure 8). A decline in the Gini index or CO_2 emissions is coded +1, while an increase in renewable-energy share is coded +1. Because this baseline composition gives two of three within-dimension positions to environmental indicators, the poverty-reassignment sensitivity adds poverty to this dimension and removes it from human capital.

Under the baseline classification, inclusiveness/sustainability has the lowest average directional score in the sample (–18.25): it is negative in 12 years, positive in eight, and zero in one. When

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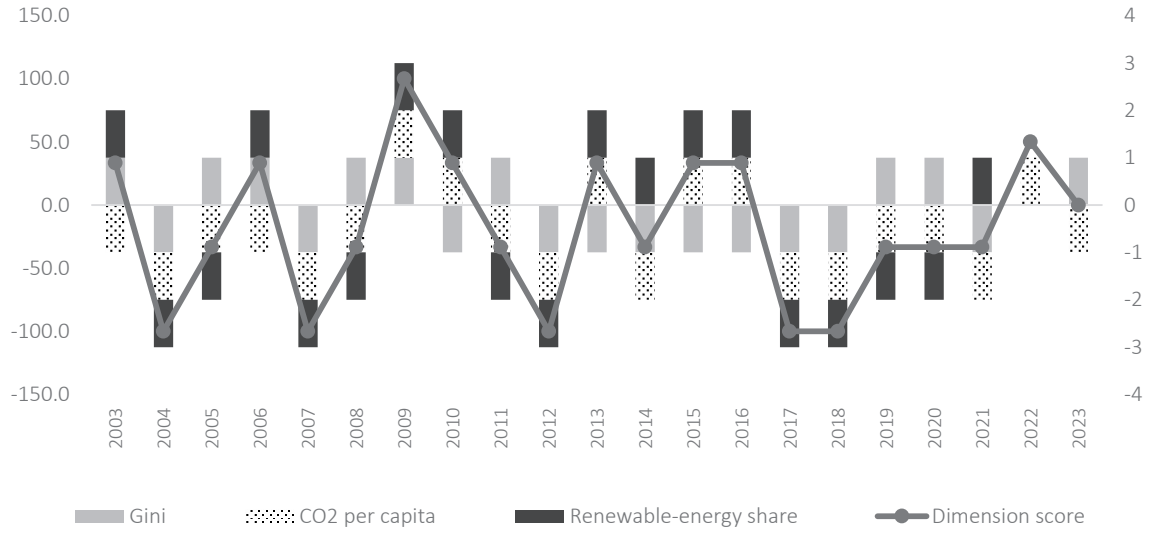


Figure 8. DGQCI sixth dimension: Inclusiveness and sustainability

poverty is reassigned to this dimension, its average directional score becomes less negative, while the annual DGQCI sign remains unchanged in every year. This confirms that the dimension's internal interpretation is sensitive to composition even though the composite direction is not.

A dimension value of –100 means that all available indicators in that dimension moved adversely in that year; it does not imply a 100% deterioration. Likewise, a favorable Gini, poverty, or renewable-energy score indicates only the direction of annual movement.

Taken together, the six dimensions confirm that similar composite values can arise from different indicator combinations; Supplementary File S1 (Mkrtchyan et al., 2026) therefore reports the full score matrix, denominators, coverage decisions, and sensitivity specifications needed for interpretation.

4. DISCUSSION

The Armenian results reinforce the distinction between output growth and the broader conditions associated with growth quality emphasized by Thomas et al. (2000), Mlachila et al. (2017), and the beyond-GDP literature. Years of rapid output growth do not consistently coincide with favorable movements across productive, macroeconomic, human-capital, institutional, distributional, and environmental indicators. The DGQCI makes this divergence visible without interpreting the composite as a welfare function or a causal policy-effect estimate.

Human capital has the highest average directional score, and institutional development also records favorable movements relatively often. This pattern is consistent with evidence that skills, health, research capacity, and institutional quality are central to longer-run development (World Bank, 2018; Giyasova et al., 2025; Tran et al., 2021). The result is nevertheless descriptive: the index shows that favorable annual directions were more frequent in these dimensions, not that their economic effects were stronger in magnitude.

The baseline inclusiveness/sustainability dimension has the lowest average directional score, but the reviewer's classification concern is substantively important. Poverty is both a productive-capacity constraint and an inclusion outcome. Reassigning it from human capital to inclusiveness/sustainability raises the latter dimension's average directional score and produces a 0.985 correlation and 100% annual sign agreement with the baseline composite. Thus, the overall DGQCI direction is not driven by poverty's baseline location, although interpretation of the two affected dimensions should acknowledge this conceptual overlap.

The new aggregation checks qualify the claim of temporal comparability. The revised publication rule requires at least half of each dimension's in-

tended indicators in addition to ≥80% overall coverage, and the stricter two-thirds rule retains 2007–2023 while preserving the main dimensional pattern. More importantly, the constant 16-indicator panel produces a correlation of 0.919 and 90.5% sign agreement with the baseline. This is supportive but not perfect concordance, indicating that changing information availability matters for a small number of borderline years. Accordingly, annual values close to zero should be interpreted more cautiously than persistent positive or negative runs.

The operational-direction issue also remains a genuine conceptual limitation rather than a problem that can be eliminated by notation. Lower debt, a higher fiscal balance, higher labor-force participation, and a higher manufacturing share are reasonable monitoring conventions in the stated framework, but their desirability depends on initial conditions, financing, labor-market quality, demographic structure, and sectoral productivity. The leave-one-out tests show that the annual composite remains highly correlated with the baseline when these indicators are excluded separately, but the paper therefore avoids describing the conventions as universally favorable economic states.

Finally, the sensitivity analysis shows a clear hierarchy of robustness. Changing weights within the directional framework has little effect on the annual pattern, and poverty reassignment or convention exclusions also leave the broad series highly concordant. The constant information set produces somewhat larger differences but remains strongly correlated. In contrast, magnitude-sensitive scoring reduces correlation to 0.721 and sign agreement to 71.4%. This is evidence that the substantive conclusions are much more robust to weighting choices than to changing the underlying measurement concept. Future work should therefore examine alternative magnitude transformations, state-contingent direction rules, richer inclusion indicators, and harmonized data panels before extending the framework to cross-country comparisons or causal applications.

CONCLUSION

This paper develops and applies a Directional Growth-Quality Conditions Index for Armenia over 2003–2023. The composite contains 22 indicators in six dimensions, while six context-dependent demand-side and external-position series remain diagnostics outside aggregation.

The method is deliberately transparent. Missing comparisons are coded NA, exact observed non-change is coded 0, and the main series requires at least 80% total indicator coverage together with at least 50% coverage within every dimension. A stricter two-thirds rule, a constant 16-indicator panel, alternative weights, materiality thresholds, poverty reassignment, and leave-one-out tests for four normative operational conventions are used to assess robustness.

The principal empirical finding is that real GDP growth and the breadth of favorable growth-quality movements do not move together mechanically. Human capital has the highest average directional score and the most frequent favorable annual readings, institutional development is also favorable relatively often, structural transformation is mixed, and inclusiveness/sustainability has the lowest average directional score under the baseline classification.

The sensitivity evidence narrows the interpretation. The annual pattern is highly robust to alternative weights, and reassigning poverty to inclusiveness/sustainability leaves the composite sign unchanged in all years. A constant information set remains strongly correlated with the baseline, although a small number of borderline years change sign category. Operational-convention leave-one-out tests also remain highly concordant.

The magnitude-sensitive specification is different: its correlation with the baseline is 0.721 and exact sign agreement is 71.4%. The DGQCI should therefore not be treated as a magnitude measure. Its most

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defensible use is as a first-stage directional diagnostic that identifies where favorable and adverse movements are concentrated and where deeper indicator-level or causal analysis is required.

The study also clarifies that the manufacturing and gross-export indicators are contribution proxies drawn from different national-accounts perspectives; they are not an additive decomposition of GDP growth, and the export proxy is not a net-exports contribution. Similarly, debt, fiscal balance, labor-force participation, and manufacturing share are explicit monitoring conventions rather than universal welfare rankings.

Overall, the DGQCI complements rather than replaces sectoral, distributional, environmental, and causal analysis. Its contribution lies in making annual direction, data coverage, aggregation assumptions, and sensitivity to alternative specifications auditable for Armenia.

AUTHOR CONTRIBUTIONS

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Project administration: Tatul Mkrtchyan.
Resources: Tatul Mkrtchyan, Garik Petrosyan, Knarik Vardanyan, Gayane Avagyan, Narine Petrosyan.
Software: Garik Petrosyan.
Supervision: Tatul Mkrtchyan, Garik Petrosyan, Narine Petrosyan.
Validation: Tatul Mkrtchyan, Garik Petrosyan, Knarik Vardanyan, Gayane Avagyan, Narine Petrosyan.
Visualization: Garik Petrosyan.
Writing – original draft: Tatul Mkrtchyan, Garik Petrosyan, Knarik Vardanyan, Gayane Avagyan, Narine Petrosyan.
Writing – review & editing: Tatul Mkrtchyan, Garik Petrosyan, Narine Petrosyan.

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