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# DIGITAL FINANCIAL SERVICES AND INCLUSIVE GROWTH: EVIDENCE FROM SELECTED CAREC COUNTRIES

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# Digital Financial Services and Inclusive Growth: Evidence from Selected CAREC Countries

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**Disclaimer**

Under the Visiting Fellows Program, the Central Asia Regional Economic Cooperation (CAREC) Institute issued research grants in 2025 to support scholars and researchers to produce targeted knowledge products that would add to the body of knowledge on regional cooperation in the CAREC region.

Scholars were encouraged to conduct research on CAREC integration topics and comparative analyses between (sub) regions to obtain insights to promote and deepen regional integration among CAREC member countries, as anticipated in the CAREC 2030 strategy and stated operational priorities.

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**Abstract**

This study investigates the impact of digital financial services (DFS) on inclusive growth (IG) in selected Central Asia Regional Economic Cooperation (CAREC) countries during 2014–2024. In doing so, it develops new composite indices for DFS and IG using a two-level Shannon entropy weighting framework that assigns objective, data-driven weights at both the indicator and dimension levels. The IG index (IGI) comprises four dimensions (i.e., social inclusiveness, human development, economic prosperity, and climate resilience) while the DFS index (DFSI) captures digital infrastructure, DFS adoption, internet affordability, and bandwidth capacity. Based on the Breusch–Pagan Lagrange Multiplier and Hausman specification tests, the Random Effects model was selected for estimation. Endogeneity was further assessed using the Durbin–Wu–Hausman test. The results indicate a persistent positive effect of DFSI on IGI (+0.062), alongside several significant control variables. To examine distributional heterogeneity, the study employs method of moments quantile regression, which reveals a clear asymmetric relationship, with the effect of DFSI gradually declining from 0.086 at the $10^{th}$ percentile to 0.038 at the $90^{th}$ percentile of the IGI distribution. These results suggest that investments in digital finance generate the largest marginal returns in the most disadvantaged economies, particularly Tajikistan and the Kyrgyz Republic, supporting a progressive and quantile-informed approach to resource allocation across the eight CAREC countries.

**Keywords:** Digital financial services; inclusive growth; entropy weighting; panel data; quantile regression; CAREC

**JEL Classification:** C23, C31, G20, O11, O16, O53

**List of Abbreviations**

| Abbreviation | Full Form |
|---|---|
| AC | Account Ownership (% of adults with a formal financial account) |
| ADB | Asian Development Bank |
| AIC | Akaike Information Criterion |
| AR(1) | First-Order Autoregressive Process |
| BIC | Bayesian Information Criterion |
| BP | Breusch–Pagan (test for heteroskedasticity) |
| BP-LM | Breusch–Pagan Lagrange Multiplier Test |
| CAREC | Central Asia Regional Economic Cooperation |
| CC | Control of Corruption (Worldwide Governance Indicator) |
| CD | Cross-Sectional Dependence (Pesaran CD Test) |
| CGAP | Consultative Group to Assist the Poor |
| CL | Climate and Environmental Resilience (dimension of IGI) |
| COVID-19 | Coronavirus Disease 2019 |
| CSD | Cross-Sectional Dependence |
| DC | Domestic Credit to Private Sector (% of GDP) |
| DFS | Digital Financial Services |
| DFSI | Digital Financial Services Index |
| DI | Digital Infrastructure (dimension of DFSI) |
| DP | Digital Payments Made or Received (% of adult population) |
| DW | Dimension Weight |
| DWH | Durbin–Wu–Hausman Endogeneity Test |
| ECO | Economic Prosperity (dimension of IGI) |
| FE | Fixed Effects (econometric estimator) |
| FI | Financial Inclusion |
| FIT | Financial Inclusion Theory |
| GDP | Gross Domestic Product |
| GDPPC | Gross Domestic Product Per Capita |
| GNI | Gross National Income |
| H | Shannon Entropy Value |
| HCD | Human-Centered Development (dimension of IGI) |
| HDI | Human Development Index |
| HDR | Human Development Report |
| HHIA | Households with Internet Access at Home (%) |
| IA | Internet Access at Home (%) |
| IBU | Internet Bandwidth Usage (Mbit/s per capita) |
| ICT | Information and Communications Technology |
| IG | Inclusive Growth |
| IGI | Inclusive Growth Index |
| IMF | International Monetary Fund |

| Abbreviation | Full Form |
|---|---|
| ITU | International Telecommunication Union |
| JB | Jarque–Bera Normality Test |
| JEL | Journal of Economic Literature (classification codes) |
| JRC | Joint Research Centre (European Commission) |
| KAZ | Kazakhstan (country code used in robustness tables) |
| LM | Lagrange Multiplier (test statistic) |
| LOO | Leave-One-Out (robustness analysis) |
| MCS | Mobile Cellular Subscriptions |
| MDC | Mobile Data and Voice Low-Consumption Basket (% of GNI per capita) |
| MM-QR | Method of Moments Quantile Regression (Machado and Silva, 2019) |
| ND-GAIN | Notre Dame Global Adaptation Initiative Index |
| OECD | Organisation for Economic Cooperation and Development |
| OLS | Ordinary Least Squares |
| P | Poverty Headcount Ratio (at $2.15/day) |
| PPP | Purchasing Power Parity |
| PSTN | Public Switched Telephone Network |
| RE | Random Effects (econometric estimator) |
| RESET | Regression Equation Specification Error Test |
| RQ | Regulatory Quality (Worldwide Governance Indicator) |
| SDGs | Sustainable Development Goals |
| SE | Standard Error |
| SME | Small and Medium-Sized Enterprise |
| SOC | Social Inclusiveness (dimension of IGI) |
| SW | Shapiro–Wilk Normality Test |
| TE | Tertiary Education Enrolment (gross %) |
| UNDP | United Nations Development Programme |
| UP | Urban Population (% of total population) |
| USD | United States Dollar |
| VIF | Variance Inflation Factor |
| WDI | World Development Indicators (World Bank database) |
| WGI | Worldwide Governance Indicators (World Bank) |
| WID | World Inequality Database |

## 1. Introduction

Afghanistan, Azerbaijan, China, Georgia, Kazakhstan, the Kyrgyz Republic, Mongolia, Pakistan, Tajikistan, Turkmenistan, and Uzbekistan collectively comprise the Central Asia Regional Economic Cooperation (CAREC) region. CAREC was established to address common structural challenges, including high transport costs, weak connectivity, uneven development, and limited financial inclusion. Through regional cooperation in infrastructure, trade, digital connectivity, and policy harmonization, CAREC provides a coordinated framework to enhance competitiveness, resilience, and inclusive growth (IG) across member countries.

Although the region has achieved notable economic growth and development, significant challenges remain in ensuring broad-based and equitable progress (Central Asia Regional Economic Cooperation Program [CAREC], 2024). These challenges include sustained poverty reduction, lower income inequality, and expanded access to financial services that can create economic opportunities. According to the World Bank's Global Findex Database (2021), approximately 60% of adults in CAREC economies remain unbanked or underbanked, limiting their participation in economic activities and growth opportunities. While the extent of exclusion varies across countries, affected populations share common characteristics, particularly females, youth, and rural residents. Key barriers include low and irregular incomes, limited physical access to financial institutions, documentation and identification constraints, high service costs, low financial and digital literacy, and gender-based obstacles. Weak digital infrastructure and regulatory frameworks further constrain the adoption of digital financial services (DFS) and broader financial inclusion across the region (World Bank, 2021; Asian Development Bank [ADB], 2024; Sahay et al., 2020; Cull, Demirgüç-Kunt & Morduch, 2021).

The role of DFS is not uniform across CAREC economies. Some countries possess strong digital infrastructure that provides a solid foundation for DFS expansion. China, for example, is a regional leader, with nearly 90% of adults actively using mobile payment services (World Bank, 2021), reflecting advanced digital infrastructure and high levels of digital adoption. In contrast, countries such as Pakistan, Afghanistan, and Turkmenistan continue to face connectivity limitations and weaker financial infrastructure, constraining DFS adoption (ADB, 2024). China's near-universal adoption and the severe data gaps in Afghanistan and Turkmenistan and their regional lagging render these economies statistical outliers that would bias coefficient estimates and undermine sample comparability.

DFS, including mobile banking, digital wallets, fintech applications, and online financial platforms, are increasingly transforming the financial services industry by expanding access at lower cost. DFS can reduce transaction costs, lessen dependence on traditional financial infrastructure, and overcome institutional barriers that restrict access to financial services (Jack & Suri, 2014; Demirgüç-Kunt et al., 2018; Sahay et al., 2020). Evidence from Africa and South Asia suggests that DFS can contribute to poverty reduction, lower income inequality, and strengthen household resilience. These benefits are realized through low-cost remittance transfers, improved access to affordable credit, and broader participation in economic opportunities (Suri & Jack, 2016; CGAP, 2023).

Despite growing recognition of the links between DFS and IG, empirical evidence for the CAREC region remains limited (Demirgüç-Kunt et al., 2018; Asian Development Bank [ADB], 2024). Most existing studies focus on Southeast Asia and Sub-Saharan Africa, where mobile banking and digital payments have been shown to reduce poverty and improve household resilience (Jack & Suri, 2014; Sahay et al., 2020).

Understanding disparities in DFS and IG across CAREC economies is therefore important for identifying how digital finance can support broader development outcomes. The region exhibits substantial variation in financial systems, digital infrastructure, and socioeconomic conditions. China leads in DFS,

supporting infrastructure, and digital governance, with approximately 92% of urban adults using mobile payment systems and annual digital payment volumes exceeding RMB 54T (World Bank, 2021).

Conditions differ markedly in other CAREC economies. In Afghanistan, only about 11% of adults have access to formal financial institutions, compared with approximately 47% in Tajikistan and 21% in Pakistan (Global Findex Database, 2021). According to Global Findex 2024, global account ownership has risen to nearly 80%, yet many CAREC economies remain below this benchmark, with rural usage rates often 20% lower than urban rates. These disparities highlight persistent challenges in DFS adoption across the region.

This study first develops a comprehensive DFS index (DFSI) that captures digital infrastructure, DFS adoption, internet affordability, and bandwidth capacity. It also constructs an IG index (IGI) encompassing social inclusion (poverty and inequality), human development (human development index (HDI)), economic prosperity (gross domestic product (GDP) per capita), and environmental and climate resilience (ND-GAIN Index). Using these indices, the study empirically examines the impact of DFS on IG and evaluates how DFS contribute to inclusive development across the eight CAREC economies included in the analysis.

## 2. Literature Review

The concept of IG extends beyond economic expansion to encompass the broad sharing of its benefits across society (Rauniyar & Kanbur, 2010). Whereas traditional growth models largely rely on the trickle-down effect, IG emphasizes poverty reduction, lower inequality, and improvements in living standards across a wider segment of the population (Kakwani & Pernia, 2000; Rauniyar & Kanbur, 2010). It is closely linked to Sen's (1999) capability approach, which defines development as the expansion of substantive freedoms rather than income growth alone. Empirically, IG incorporates both the level and distribution of income by considering income per capita alongside poverty, inequality, human development, and environmental sustainability (Stiglitz, 2012; Ostry, Berg, & Tsangarides, 2014).

Poverty and inequality are central components of IG because they indicate whether the benefits of economic expansion reach lower-income groups. Growth is considered inclusive when it reduces poverty and broadens access to economic opportunities (World Bank, 2009; Ianchovichina & Lundstrom, 2009). Berg and Ostry (2011) argued that high inequality undermines long-run growth by weakening social cohesion and constraining human capital accumulation. Human development is another key dimension. The HDI, developed by Ul Haq (2000), measures development through income, health, and education. According to the U.N. Development Program (UNDP), IG should expand human capabilities rather than merely increase income (UNDP, 2010). Anand et al. (2013) report a strong inverse relationship between HDI and both poverty and inequality.

GDP per capita, although an imperfect measure, remains a useful indicator of societal welfare because it reflects how economic growth translates into higher living standards. Combined with distributional indicators, it provides a more comprehensive assessment of IG (Ali & Son, 2007). To incorporate sustainability, this study also includes the ND-GAIN Index, which measures climate vulnerability and adaptive readiness. The green growth literature emphasizes that protecting vulnerable populations depends on environmental resilience (Hallegatte et al., 2016). Economies exhibiting sustainable IG under climate stress tend to achieve higher ND-GAIN rankings.

### 2.1 Finance, Inclusion, and Development

A substantial body of literature has linked financial development to long-run economic growth through savings mobilization, efficient capital allocation, and risk management (Levine, 2005). Beyond

growth, financial deepening can generate important distributional benefits by improving opportunities for disadvantaged groups, reducing income inequality, and relaxing access constraints (Beck, Demirgüç-Kunt, & Levine, 2007). This perspective is particularly relevant to DFS because digital channels represent a modern form of financial deepening that can lower costs, expand access, and overcome geographic barriers.

Empirical evidence has shown that financial inclusion, measured through the use of formal accounts, payments, savings, credit, and insurance, has expanded substantially over the past decade (Barro, 1991; Demirgüç-Kunt, Klapper, Singer, Ansar, & Hess, 2018; Demirgüç-Kunt, Klapper, Singer, & Ansar, 2022). Nevertheless, significant disparities remain across regions, income groups, genders, and rural populations. Global Findex data indicate that although account ownership has increased, active usage and service quality remain uneven, limiting the translation of access into welfare gains (Demirgüç-Kunt et al., 2018; Demirgüç-Kunt, Klapper, Singer, & Ansar, 2022).

### 2.2 What Makes DFS Different?

DFS encompasses mobile money, online banking, and other forms of digital financial access and usage that alter the cost structure and accessibility of financial services. Drawing on financial intermediation theory (Greenwood & Jovanovic, 1990), DFS can promote the co-evolution of financial participation and economic growth by reducing transaction and search costs, expanding the extensive margin of inclusion, and creating digital financial footprints.

Several mechanisms explain how DFS can promote inclusiveness:

1. Mobile money improves risk sharing and helps households smooth consumption during economic shocks. Evidence from Kenya shows that it reduces transaction costs, facilitates faster and more reliable remittances (Jack & Suri, 2014), lowers extreme poverty, and improves female labor-market outcomes (Suri & Jack, 2016).

2. Digitizing government-to-person transfers can improve timeliness and reduce leakages. In India, smartcards with biometric authentication increased payment reliability and reduced corruption, demonstrating the importance of digital identification systems in strengthening implementation capacity (Muralidharan, Niehaus, & Sukhtankar, 2016; Mauro, 1995).

3. Randomized and quasi-experimental studies show that mobile money promotes formal saving and improves financial management. These effects are often strongest among women and low-income households, consistent with IG objectives (Aker, Boumnijel, McClelland, & Tierney, 2016; Batista & Vicente, 2019).

4. Digital payments and online platforms can reduce operating costs and support micro and small enterprises through improved record-keeping and market access. Although results vary across contexts, the overall evidence suggests positive effects where infrastructure and regulatory conditions are supportive (Sahay et al., 2020).

### 2.3 Macro and Cross-Country Evidence on DFS, Inclusion, and Growth

A growing body of cross-country research has examined digital inclusion and digital financial inclusion. Evidence from the COVID-19 and post-COVID-19 periods suggests that digital finance promotes financial inclusion, which in turn supports economic growth, provided that consumer protection, competition, interoperability, and institutional capacity are adequately strengthened (Sahay et al., 2020). However, endogeneity remains an important concern because countries with higher-income

levels and stronger governance are also more likely to adopt DFS, highlighting the need for rigorous identification strategies.

The Global Findex Report 2021 provides detailed evidence on account ownership, digital payments, and saving behavior. Digital payments increased substantially between 2017 and 2021, particularly in countries with widespread digital wage payments and government transfer systems (Demirgüç-Kunt et al., 2018; Demirgüç-Kunt, Klapper, Singer, & Ansar, 2022). Despite this progress, significant gaps in DFS usage remain, especially in countries where digital finance could generate substantial inclusive gains but where infrastructure, education, and digital literacy constraints continue to limit adoption.

### 2.4 Theoretical Framework

This study integrates financial inclusion theory (FIT) and Sen's capability approach to examine how DFS promote IG in the CAREC region. FIT explains the economic mechanisms through which access to affordable financial services supports participation, asset accumulation, and risk management. The capability approach assesses whether such access translates into greater freedoms, agency, and well-being. Together, these perspectives provide a multidimensional framework for evaluating the contribution of DFS to IG.

#### 2.4.1 FIT

FIT posits that access to credit, savings, insurance, and payment systems plays a critical role in reducing poverty, promoting entrepreneurship, and enhancing economic resilience (Beck, Demirgüç-Kunt, & Levine, 2004; Demirgüç-Kunt et al., 2018). Historically, access to these financial services has been constrained by geographic, socioeconomic, and institutional barriers. DFS can help overcome these constraints by reducing transaction costs, expanding access to payment systems, and providing secure and efficient services through mobile banking, agent networks, and digital wallets (Jack & Suri, 2014; Ozili, 2018). Given the limited reach of traditional banking systems in many CAREC economies, DFS can narrow financial access gaps, encourage private savings, support small and medium-sized enterprise (SME) development, and strengthen financial stability across the region (Shen, Hu, & Hueng, 2021).

#### 2.4.2 Sen's Capability Approach

Sen's capability approach (1999) defines development as the expansion of human capabilities rather than the accumulation of wealth alone. From this perspective, development involves creating opportunities that enable individuals to lead lives they value. DFS adoption contributes not only to financial inclusion but also to financial risk management and investment in human capital, particularly education and health (Robeyns, 2005; Psacharopoulos & Patrinos, 2018). Low-income economies and societies characterized by higher gender inequality often face substantial financial and non-financial barriers that limit access to opportunities. Expanding access to DFS can help reduce these constraints, strengthen women's participation in decision-making, and support progress toward Sustainable Development Goals (SDGs) related to poverty reduction, inequality, and economic participation (Adera & Abdisa, 2023).

### 2.5 Integrated Framework: Capability-Driven Financial Inclusion

The integrated DFS framework serves both instrumental and intrinsic functions. Instrumentally, it expands access to affordable financial services, supports SME growth, facilitates savings, and contributes to poverty reduction. Intrinsically, it enhances individual capabilities, broadens opportunities, strengthens resilience, and promotes social and economic empowerment.

From the perspective of FIT, DFS improves access to financial services, encourages savings, particularly among underserved populations, and supports entrepreneurship and financial stability. In contrast, the capability approach emphasizes the capability approach broader developmental outcomes of DFS, viewing it as a mechanism for expanding freedoms, enhancing human capital investment, promoting autonomy, reducing gender disparities, and strengthening resilience to economic vulnerability.

By integrating these perspectives, the framework moves beyond measuring DFS penetration alone and focuses on how digital financial access is transformed into measurable development outcomes. It provides a basis for examining whether DFS adoption contributes to poverty reduction, improvements in human development, and broader economic participation across CAREC economies.

## 3. Methodology

### 3.1 Data Sources

This study employs a balanced panel dataset covering selected CAREC member countries from 2014 to 2024. Data were obtained from several internationally recognized sources, including the Global Findex Database (2024), World Development Indicators (WDIs), Human Development Report (HDR 2025), Worldwide Governance Indicators (WGIs), World Inequality Database (WID), and the International Telecommunication Union (ITU).

To improve comparability and robustness, China and Afghanistan were excluded as outliers, while Turkmenistan was excluded because of substantial data limitations. After applying these criteria, the final sample consists of eight CAREC countries: Azerbaijan, Georgia, Kazakhstan, the Kyrgyz Republic, Mongolia, Pakistan, Tajikistan, and Uzbekistan

This refined dataset allows for more consistent cross-country comparisons and strengthens the validity of the analysis. Table 1 presents the selected variables, their operational definitions, measurement units, and abbreviations.

**Table 1: List of variables and their operational definitions**

| Variable Name | Abbreviation | Definition | Source | Unit |
|---|---|---|---|---|
| **Digital Payment (DFS Adoption)[2]** | DP | Percentage of respondents reporting having used mobile money, debit or credit cards, or mobile phone to make payments from an account; those reporting having used the internet to pay bills or purchase from an online store in the past year. | Findex 2024 | % adult population |
| **Account Ownership (DFS Adoption)[3]** | AC | Percentage of respondents reporting having an account (single or joint) at a bank or another type of financial institution; those reporting using a mobile money service in the past 12 months (% age 15+). | Findex 2024 | % adult population |

[2] We used Findex data; missing years were interpolated for two variables: account ownership and digital payments.
[3] Same information as in the previous footnote.

| | | | | |
|---|---|---|---|---|
| **Mob Cellular Subscription (digital infrastructure)** | MCS | Mobile cellular telephone subscriptions to a public provider, offering access to a public switched telephone network using cellular technology. | WDI | % adult populatio n |
| **Internet Usage (digital infrastructure)** | I | Those who reported having used the internet (from any location) in the last 3 months via computer, mobile phone, personal digital assistant, games machine, digital TV etc. | WDI | % of populatio n |
| **Households with Internet Access at Home (%) (digital infrastructure)** | IA | Share of households with any active internet connection. | ITU | % of househol ds |
| **Mobile Data & Voice Low-Consumption Basket (affordability of internet)** | MDC | Cost of a standardized low-consumption mobile package; reflects affordability. | ITU | % of gross national income per capita |
| **Internet Bandwidth usage (quality of internet)** | IBU | Total used international internet bandwidth (incoming + outgoing). | ITU | Mbit/s |
| **Human Development Index (quality of Life)** | HDI | Human development index | HDR 2025 | Index 0-1 |
| **Gini_adults (income inequality)** | Gini | Pre-tax national income (Gini coefficient Adults. equal-split adults) = Pre-tax labor income [total pre-tax income ranking] + Pre-tax capital income [total pre-tax income ranking] | World Inequality Database (WID) | Index 0-1 |
| **Poverty (Economics deprivations)** | P | Poverty headcount ratio at $2.15/day (%) | SDR 2025 | % 0–100 |
| **GDP Per Capita (standard of living)** | GDPP C | Natural log of GDP per capita | WDI | Ln $ (per person) |
| **ND-GAIN** | ND-GAIN | ND-GAIN index (Notre Dame Global Adaptation Initiative Index)—A composite index measuring a country's vulnerability to climate change and readiness to improve resilience. | | Index 0–100 |
| **Domestic Credit (depth of financial sector)** | DC | Domestic credit to private sector (% GDP) —Indicator of financial sector depth. | WDI | % of GDP |
| **Control for Corruption** | CC | Perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption; includes "capture" of the state by elites and private interests. | World Governance Indicator (WGI) | Index −2.5 to 2.5 |
| **Tertiary Education Enrolment** | TE | Gross enrolment ratio of the population of the age group corresponding to its level of | WDI | Gross % |

| | | | | |
|---|---|---|---|---|
| | | education, regardless of age. Tertiary education includes advanced research qualification, requiring as a minimum condition of admission the successful completion of secondary education. | | |
| **Urban Population** | UP | People living in urban areas defined by national statistics. | WDI | % of total populatio n |
| **Regulatory Quality (Governance indicator)** | RQ | Perceptions of the ability of the government to formulate and implement sound policies and regulations permitting and promoting private sector development. | World Governance Indicator (WGI) | Index –2.5 to 2.5 |

Source: Author's adopted definition of variables from various sources

### 3.2 DFS Index Construction

The DFSI is a composite measure designed to capture the breadth, depth, and enabling environment of DFS across eight CAREC economies during 2014–2024. Composite indices synthesize multidimensional phenomena into a single metric, facilitating cross-country comparisons and longitudinal analysis that would otherwise be complicated by the heterogeneity of individual indicators.

A key challenge in constructing composite indices is assigning weights to indicators and dimensions. Three broad approaches are commonly used:

(i) Equal weighting, which assumes all indicators contribute equally;

(ii) Expert- or theory-driven weighting, which may introduce subjectivity; and

(iii) Data-driven weighting, which derives weights from the statistical properties of the data. This study adopts the third approach, specifically the Shannon entropy method, because it is transparent, replicable, and free from a priori assumptions regarding indicator importance.

The DFSI is constructed using four dimensions, described in the following subsections.

#### 3.2.1 Digital Infrastructure

To measure digital infrastructure, three key indicators were selected from the WDI, described as follows.

##### *3.2.1.1 Internet Penetration Rate*

This indicator measures the percentage of the population that actively uses the internet and reflects the extent of digital connectivity and online accessibility. To ensure comparability across countries and years, the data were normalized into a dimensionless index using the standard min–max transformation:

$$Index\ Value_{Internet} = [(Observed\ Value - Minimum\ Value)/\ (Maximum\ Value - Minimum\ Value)]. \ldots\ldots\ldots\ldots\ldots\ldots(1)$$

#### *3.2.1.2 Mobile Cellular Subscriptions and Households with Internet Access at Home (2 indicators)*

Mobile Cellular Subscriptions and Households with internet Access at Home (%) were normalized using the same procedure as internet Penetration Rate. Because higher values indicate better performance, both variables were transformed using the standard min–max normalization formula:

$$Index\ Value_{MCS\ and\ HHIA} = [(Observed\ Value - Minimum\ Value)/\ (Maximum\ Value - Minimum\ Value)]. \text{.....(2)}$$

### 3.2.2 DFS Adoption

The DFS adoption dimension comprises two indicators, described as follows.

#### *3.2.2.1 Access to DFS*

Account ownership measures the percentage of respondents aged 15 years and above who report having an account at a financial institution or personally using a mobile money service during the previous 12 months. The same normalization procedure was applied to construct the dimensional index.

$$Index\ Value_{AC} = [(Observed\ Value - Minimum\ Value)/\ (Maximum\ Value - Minimum\ Value)]. \text{.....(3)}$$

#### *3.2.2.2 Usage of DFS*

This indicator measures the percentage of respondents who used mobile money, a debit or credit card, a mobile phone, or the internet to make payments, pay bills, or purchase goods and services during the previous year. A dimensional index was constructed using the same normalization approach.

$$Index\ Value_{DP} = [(Observed\ Value - Minimum\ Value)/\ (Maximum\ Value - Minimum\ Value)]. \text{.....(4)}$$

### 3.2.3 Internet Affordability

Internet affordability captures the cost-based accessibility of digital services and is measured as the percentage of gross national income (GNI) per capita required to purchase a low-consumption mobile data and voice basket. Because lower values indicate greater affordability, the index was calculated using reverse min–max normalization method.

### 3.2.4 DFS Quality/Internet Bandwidth Capacity

This indicator captures the quality of digital infrastructure and network capacity through per capita international internet bandwidth usage (Mbit/s). Although bandwidth capacity improved substantially during the study period, considerable disparities remained across the eight CAREC countries.

Table 2 presents the weighting structure for the DFSI, including the normalization procedures applied to individual indicators and the resulting weights assigned to indicators and dimensions.

**Table 2: Dimension, indicators, and weights of DFSI**

| Dimension | Indicator | Normalization | Direction | H (entropy) | d = 1−H | Within-dim weight ($w_j$) | Global weight |
|---|---|---|---|---|---|---|---|
| **Digital Infrastructure** | Internet users % | (Obs−Min)/(Max−Min) | + | 0.9577 | 0.0423 | 13.86% | 2.66% |
| | Mobile cellular subscriptions | (Obs−Min)/(Max−Min) | + | 0.7752 | 0.2248 | 73.63% | 14.11 % |
| | Household internet access % | (Obs−Min)/(Max−Min) | + | 0.9618 | 0.0382 | 12.50% | 2.40% |
| **Dim weight: 19.16%** | H = 0.9396, d = 0.0604 | | | | | | |
| **DFS Adoption** | Account ownership (FI/Mobile) % | (Obs−Min)/(Max−Min) | + | 0.9676 | 0.0324 | 42.41% | 5.21% |
| | Digital payments made/received % | (Obs−Min)/(Max−Min) | + | 0.9560 | 0.0440 | 57.59% | 7.07% |
| **Dim weight: 12.28%** | H = 0.9613, d = 0.0387 | | | | | | |
| **Affordability of internet** | % GNI per capita (ICT basket) | (Max−Obs)/(Max−Min) | − | 0.9829 | 0.0171 | 100.00% | 5.42% |
| **Dim weight: 5.42%** | H = 0.9829, d = 0.0171 | | | | | | |
| **Internet Bandwidth Usage** | Internet bandwidth (Mbit) | (Obs−Min)/(Max−Min) | + | 0.8008 | 0.1992 | 100.00% | 63.14 % |
| **Dim weight: 63.14%** | H = 0.8008, d = 0.1992 | | | | | | |

Source: Author's own calculation of two –level weights

The DFSI is a composite measure constructed from four dimensions: digital infrastructure, DFS Adoption, internet affordability, and internet bandwidth capacity (quality of internet infrastructure). Digital infrastructure comprises three indicators: Internet users (%), mobile cellular subscriptions, and household internet access (%). Each indicator was normalized using the min–max transformation.

A two-level Shannon entropy weighting procedure was employed. At Level 1, weights were assigned to indicators within each dimension. At Level 2, dimension weights were derived from the entropy of dimension scores across all observations. Internet affordability was normalized using the inverted formula, (Max−Obs)/(Max−Min), while all other indicators were normalized using (Obs-Min)/(Max–Min). The resulting dimension weights were digital infrastructure = 19.16%, DFS adoption = 12.28%, internet affordability = 5.42%, and internet bandwidth Capacity = 63.14%.

To assess construct validity, Pearson correlation coefficients were calculated between each normalized indicator and the final DFSI score across all 88 observations. A valid index should exhibit positive correlations between indicators and the composite measure, with stronger relationships generally associated with more heavily weighted indicators. Negative correlations would suggest directional misspecification.

**Table 3: Validity assessment; Pearson correlation between each normalized indicator**

| Indicator | Dimension | Pearson r with DFSI | Global weight | Alignment assessment |
|---|---|---|---|---|
| **Internet users %** | Digital Infrastructure | 0.1767 | 2.66% | Weak positive |
| **Mobile subscriptions** | Digital Infrastructure | 0.5850 | 14.11% | Moderate–strong |
| **Household internet %** | Digital Infrastructure | 0.2750 | 2.40% | Weak positive |
| **Account ownership %** | Digital Financial Services | 0.0235 | 5.21% | Weak positive |
| **Digital payments %** | Digital Financial Services | 0.0907 | 7.07% | Weak positive |
| **Affordability % GNI** | Affordability of Internet | 0.4764 | 5.42% | Moderate positive |
| **Bandwidth (Mbit)** | Internet Bandwidth Usage | 0.9674 | 63.14% | Very strong |

Source: Author's own calculation

The bandwidth indicator exhibits an extremely strong positive correlation with the composite index (r = 0.9674), consistent with its dominant weight (63.14%). This relationship is not mechanically circular; rather, it reflects the empirical reality that countries with stronger bandwidth capacity also tend to perform well across other dimensions of DFS. Mobile cellular subscriptions show a moderate–strong correlation (r = 0.5850), consistent with their role as the most influential indicator within the Digital Infrastructure dimension.

The two DFS adoption indicators display weak positive correlations with the composite (r = 0.0235 for account ownership and r = 0.0907 for digital payments). This pattern is informative rather than problematic. For example, Mongolia records relatively high account ownership and digital payment usage despite comparatively low bandwidth capacity, whereas Pakistan exhibits the opposite pattern. Such divergence reduces the simple correlation between DFS adoption indicators and the composite score while highlighting the multidimensional nature of digital financial development.

Internet affordability shows a moderate positive correlation (r = 0.4764). Countries with more affordable internet access, such as Kazakhstan and Mongolia, generally achieve higher DFSI scores, whereas higher-cost countries, including Tajikistan and the Kyrgyz Republic during the early years of the sample, tend to perform less favorably. Importantly, no indicator exhibits a negative correlation with the composite index, confirming that all directional specifications are correctly implemented.

### 3.3 Scores under Alternative Schemes

Table 4 presents DFSI scores for each country in 2024 under five alternative weighting schemes (scaled from 0 to 100) to assess the sensitivity of the index to different weighting assumptions.

**Table 4: Sensitivity analysis: DFSI scores (2024 cross-section) under five alternative dimension weighting schemes**

| Country | Entropy (base) | Equal weights (25% each) | Infrastructure emphasis (40%) | Demand focus (40%) | Bandwidth focus (50%) |
|---|---|---|---|---|---|
| Azerbaijan | 0.351 | 0.250 | 0.273 | 0.361 | 0.121 |
| Georgia | 0.245 | 0.344 | 0.351 | 0.470 | 0.107 |
| Kazakhstan | 0.433 | 0.476 | 0.497 | 0.557 | 0.274 |

| Country | Entropy (base) | Equal weights (25% each) | Infrastructure emphasis (40%) | Demand focus (40%) | Bandwidth focus (50%) |
|---|---|---|---|---|---|
| Kyrgyz Republic | 0.247 | 0.236 | 0.247 | 0.303 | 0.106 |
| Mongolia | 0.246 | 0.567 | 0.573 | 0.624 | 0.290 |
| Pakistan | 0.743 | 0.223 | 0.240 | 0.205 | 0.575 |
| Tajikistan | 0.125 | 0.182 | 0.186 | 0.242 | 0.073 |
| Uzbekistan | 0.817 | 0.399 | 0.423 | 0.481 | 0.542 |

Source: Author's own calculation

Spearman's rank correlation coefficient (ρ) measures the degree of agreement between country rankings under the entropy baseline and alternative weighting schemes. A ρ value close to 1.0 indicates highly similar rankings, whereas lower values indicate greater reordering.

- Entropy vs Equal weights: ρ = 0.810
- Entropy vs Infrastructure emphasis: ρ = 0.786
- Entropy vs Demand-side focus: ρ = 0.667
- Entropy vs Bandwidth focus: ρ = 0.929

**3.4 Interpretation of Sensitivity Results**

The Spearman correlations indicate that the overall pattern of country performance remains relatively stable across weighting schemes. Tajikistan consistently ranks last or second-to-last, while Kazakhstan and Georgia remain in the upper half of the distribution. However, the rankings of several middle-tier countries, particularly Pakistan, Mongolia, and Uzbekistan, vary more substantially depending on the dimension emphasized.

The demand-side focus scheme yields the lowest concordance with the entropy baseline (ρ = 0.667), indicating that Mongolia rises considerably in the rankings when greater weight is assigned to DFS adoption. This result is consistent with Mongolia's strong digital finance adoption relative to its infrastructure capacity. In contrast, the bandwidth-focus scheme produces the highest concordance with the entropy baseline (ρ = 0.929), which is unsurprising given that the entropy method assigns 63.14% of the total weight to bandwidth capacity.

The entropy-weighted baseline is therefore adopted as the primary specification because it is derived objectively from the data and is not influenced by researcher judgment.

**Table 5: Average DFSI ranking over the entire period of the study (2014–2024)**

| Country | Average DFSI | Ranking |
|---|---|---|
| **Pakistan** | 0.4127 | 1 |
| **Kazakhstan** | 0.3117 | 2 |
| **Uzbekistan** | 0.3076 | 3 |
| **Mongolia** | 0.1969 | 4 |
| **Azerbaijan** | 0.1887 | 5 |
| **Georgia** | 0.1819 | 6 |
| **Kyrgyz Republic** | 0.1360 | 7 |

| | | |
|---|---|---|
| **Tajikistan** | 0.0782 | 8 |

Source: Author's own calculations

The distribution of DFSI scores reveals two distinct tiers separated by a clear discontinuity. The upper tier—Pakistan (0.41), Kazakhstan (0.31), and Uzbekistan (0.31)—owes its position primarily to substantial investment in bandwidth infrastructure, whether driven by population scale (Pakistan), sustained state investment (Kazakhstan), or policy reforms (Uzbekistan). The lower tier—Mongolia (0.20), Azerbaijan (0.19), Georgia (0.18), the Kyrgyz Republic (0.14), and Tajikistan (0.08)—consists of countries where infrastructure capacity remains limited or where DFS adoption has not fully leveraged available infrastructure.

The gap between the highest-ranked country in the lower tier (Mongolia, 0.20) and the lowest-ranked country in the upper tier (Uzbekistan, 0.31) is 0.11 points, exceeding the entire score range of the bottom two countries combined. This pattern suggests that CAREC economies are no longer following a single path of digital financial development. Instead, the region appears to have diverged into infrastructure-capacity leaders and adoption-constrained laggards, raising the possibility that disparities may widen as bandwidth investments continue to accumulate disproportionately among leading countries.

An equally important finding is that no country achieves a score above 0.42. Even the regional leader has realized less than half of the level implied by the panel's best-performing observations. Viewed against the full 0–1 scale, this result indicates substantial unrealized digital finance potential across the CAREC region.

### 3.5 Measurement of IG

Traditional growth indicators such as GDP per capita capture economic prosperity but do not adequately reflect how the benefits of growth are distributed across society, whether growth improves human capabilities, or whether it is environmentally sustainable. The IGI addresses these limitations by integrating dimensions of social inclusion through the Gini coefficient and poverty rates, human development through the HDI, economic prosperity through GDP per capita, and climate and environmental resilience through the ND-GAIN Index.

DFS can contribute to IG by reducing transaction costs, expanding access to credit, savings, and insurance, and integrating underserved populations into the formal economy. Based on the literature and policy relevance, the study proposes the following dimensions and indicators for constructing the IGI.

**Table 6: Dimension, indicators, weights and construction of IGI**

| Dimensions of IGI | Indicator | Entropy Weights | Dimensional Indices | IGI |
|---|---|---|---|---|
| 1.Social inclusiveness | Poverty Rate (S2.15) | 20.41 | (Max-Obs)/(Max–Min) | Aggregation of DW*Dimensions |
| | Gini_Adults | | (Max-Obs)/(Max–Min) | |
| 2.Human Capabilities | Human Development Index (HDI) | 15.41 | (Obs-Min)/(Max–Min) | |
| 3.Economic Prosperity | GDP per Capita | 45.55 | (Obs-Min)/(Max–Min) | |

| | | | | |
|---|---|---|---|---|
| 4.Climate and Environment Resilience | ND-Gain Index | 18.64 | | |

Source: Author's own proposition

### 3.5.1 Social Inclusiveness

#### *3.5.1.1 Poverty*

Poverty is a direct indicator of IG; the more inclusive the growth process, the lower the incidence of poverty, and vice versa. The pro-poor growth framework emphasizes that sustained poverty reduction is essential for growth to be considered inclusive (Kakwani & Pernia, 2000; Rauniyar & Kanbur, 2010). Cross-country evidence further suggests that economic growth combined with targeted social investment produces the greatest gains in poverty alleviation (Dollar, Kleineberg, & Kraay, 2016; Demirgüç-Kunt, Klapper, Singer, & Ansar, 2022).

#### *3.5.1.2 Income Inequality*

Income inequality is a key indicator of social inclusion and an important determinant of poverty. Even when poverty declines, rising inequality can undermine inclusiveness by concentrating the benefits of growth among higher-income groups, weakening social cohesion, and limiting human capital development. IMF research indicates that lower inequality is associated with longer and more durable growth episodes (Ostry, Berg, & Tsangarides, 2014).

### 3.5.2 Human Capabilities

The HDI, a proxy for human-centered development and capabilities, captures multidimensional well-being through health, education, and income. This aligns with Sen's (1999) Capability Approach, which emphasizes the expansion of freedoms and capabilities rather than income alone. IG must therefore strengthen human capital to sustain both productivity and equity.

### 3.5.3 Economic Prosperity

GDP per capita (GDPPC) is a widely used measure of aggregate economic prosperity and welfare that reflects the productive capacity of an economy. Although it captures overall economic performance, it does not reveal how the benefits of growth are distributed. Consequently, GDP per capita alone cannot ensure inclusivity, but it provides the macroeconomic foundation for policies that promote equity and human development (Solow, 1956).

### 3.5.4 Climate and Environment Resilience

Climate and environmental resilience is represented by the ND-GAIN Index, developed by the University of Notre Dame. The index measures two interrelated dimensions: climate vulnerability and adaptive readiness. The World Bank (2021) notes that economic gains are difficult to sustain when economies remain exposed to environmental risks. Incorporating the ND-GAIN Index therefore ensures that development is assessed in terms of both economic progress and resilience to climate-related challenges.

## 3.6 Index Construction Methodology

The construction of the IGI involves two categories of indicators: negative (undesirable) indicators and positive (desirable) indicators. For negative indicators, such as the Poverty Rate and Gini Coefficient,

lower values indicate better performance. These indicators are normalized using the following formula:

$$Dimensional\ Index\ =\ \left[\frac{(Max-obs)}{(Max-Min)}\right]. \ldots \ldots\ldots\ldots\ldots \quad (5)$$

In contrast, higher values of positive indicators, such as HDI and GDP per capita, indicate improved performance. These indicators are normalized using the following formula:

$$Dimensional\ Index\ =\ \left[\frac{(Obs-Min)}{(Max-Min)}\right]. \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \quad (6)$$

The four-dimensional indices are then aggregated using a weighted mean to preserve proportionality while accounting for uneven progress across dimensions:

$$IGI\ =\ \begin{pmatrix} DW * social\ inclusiveness +\ DW * human\ capabilities +\ DW * Eco.Prosperity + \\ DW *\ climate + enivornmental\ Resilience \end{pmatrix}. \quad (7)$$

Dimension weights are assigned using the Shannon entropy method to ensure an objective and data-driven weighting structure for the IGI.

The IGI consists of four dimensions and five indicators. The selection of these variables is grounded in the theoretical literature. The dimensions include social inclusiveness, human capabilities, economic prosperity, and climate and environmental resilience. Poverty and income inequality capture distributive justice and access to opportunities (Sen, 1999), while HDI reflects human-centered development. GDP per capita measures the economy's capacity to generate income and support investment-led growth. The ND-GAIN Index is incorporated to assess resilience to climate-related risks and environmental challenges (Hallegatte et al., 2016; UNDP, 2019).

**Table 7: Entropy weight structure: Dimensions and indicators**

| Dimension | Indicator | Normalization | H | d = 1−H | Within-dim w | Global weight |
|---|---|---|---|---|---|---|
| **Social Inclusiveness** | Poverty rate (S$2.15/day) | (Max−Obs)/(Max−Min) | 0.9861 | 0.0139 | 24.36% | 4.97% |
| | Gini coefficient | (Max−Obs)/(Max−Min) | 0.9569 | 0.0431 | 75.64% | 15.44% |
| **Dim weight: 20.41%** | H = 0.9617, d = 0.0383 | | | | | |
| **Human Capabilities** | Human Development Index (HDI) | (Obs−Min)/(Max−Min) | 0.9711 | 0.0289 | 100.00% | 15.41% |
| **Dim weight: 15.41%** | H = 0.9711, d = 0.0289 | | | | | |
| **Economic prosperity** | GDP per capita (PPP, constant USD) | (Obs−Min)/(Max−Min) | 0.9146 | 0.0854 | 100.00% | 45.55% |
| **Dim weight: 45.55%** | H = 0.9146, d = 0.0854 | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Climate & Environment resilience** | ND-Gain Country Index | (Obs−Min)/(Max−Min) | 0.9651 | 0.0349 | 100.00% | 18.64% |
| **Dim weight: 18.64%** | H = 0.9651, d = 0.0349 | | | | | |

Source: Author's own calculation

This study applies the Shannon entropy method (Shannon, 1948), which derives weights objectively from the empirical distribution of the data rather than researcher judgment. The entropy approach is widely recommended in the composite indicator literature (OECD/JRC, 2008; Zou et al., 2006) as a transparent, replicable, and bias-free alternative to equal or expert-assigned weighting schemes. It is implemented at two hierarchical levels: first to determine the contribution of indicators within each dimension and then to determine the contribution of dimensions to the overall IGI.

The two-level entropy procedure produces the following dimension weights: economic prosperity (45.55%), social inclusiveness (20.41%), climate and environmental resilience (18.64%), and human-centered development (15.41%). The resulting IGI composite formula is IGI = 20.41% × SOC + 15.41% × HCD + 45.55% × ECO + 18.64% × CL.

**Table 8: Validity assessment: Pearson correlation between each indicator and the IGI composite**

| Indicator | Dimension | Pearson r | Global weight | Alignment |
|---|---|---|---|---|
| **Poverty rate** | Social (negative) | 0.6520 | 4.97% | Moderate positive |
| **Gini coefficient** | Social (negative) | 0.1980 | 15.44% | Weak positive |
| **Human Development Index** | Human-Centered Development | 0.8724 | 15.41% | Very strong |
| **GDP per capita** | Economic Aspect | 0.9639 | 45.55% | Very strong |
| **ND-Gain Country Index** | Climate & Environment | 0.8031 | 18.64% | Strong |

Source: Author's own calculation

Construct validity is assessed using Pearson correlation coefficients between each normalized indicator and the final IGI composite score across all 88 observations. A valid composite should exhibit positive correlations between its indicators and the overall index, while indicators with larger weights are generally expected to display stronger alignment with the composite. The results show that all Pearson correlation coefficients are positive, confirming correct directional specification. GDP per capita (r = 0.9639) and HDI (r = 0.8724) exhibit the strongest relationships with the composite index, consistent with their relatively large weights. No negative correlations are observed.

**Table 9: Sensitivity analysis: IGI scores under five-dimensional weighting schemes**

| Country | Entropy (base) | Equal weights (25% each) | Social emphasis (40%) | Economic emphasis (40%) | Climate emphasis (40%) |
|---|---|---|---|---|---|
| Azerbaijan | 68.13 | 71.80 | 76.22 | 69.05 | 67.91 |
| Georgia | 68.12 | 71.14 | 60.46 | 70.29 | 76.88 |
| Kazakhstan | 91.35 | 89.21 | 83.73 | 91.37 | 90.81 |

| | | | | | |
|---|---|---|---|---|---|
| Kyrgyz Republic | 39.42 | 49.65 | 51.55 | 42.21 | 52.82 |
| Mongolia | 52.64 | 57.32 | 55.44 | 54.26 | 59.74 |
| Pakistan | 16.79 | 18.66 | 26.10 | 16.50 | 15.74 |
| Tajikistan | 27.22 | 35.75 | 37.40 | 29.70 | 36.80 |
| Uzbekistan | 40.39 | 48.03 | 45.70 | 42.98 | 51.47 |

Source: Author's own calculations

Spearman rank correlations between the entropy-weighted baseline and alternative weighting schemes are exceptionally high ($\rho > 0.95$ in all cases), indicating that country rankings remain highly stable regardless of the weighting structure. Kazakhstan consistently ranks first and Pakistan consistently ranks last across all five specifications, demonstrating the robustness of the index to alternative weighting assumptions.

### 3.7 Econometric Model

The study employs panel data covering eight CAREC countries during 2014–2024. Because DFS are a relatively recent phenomenon, comprehensive data on DFS dimensions and indicators remain limited, particularly within the CAREC region. Of the eleven CAREC member countries, China and Afghanistan were excluded because their extreme characteristics reduced cross-country comparability, while Turkmenistan was excluded because of substantial data limitations. The final sample therefore consists of eight countries. The analysis begins with standard panel-data specification tests comparing fixed effects (FE) and random effects (RE) estimators.

The general estimating equation takes the following form:

$$IGI_it = \alpha + \beta 1 DFSI_it + \beta' X_it + \mu_i + \varepsilon_it, \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (8)$$

where i indexes countries (1–8) and t indexes years (2014–2024). $X_it$ represents a vector of time-varying control variables. The term $\mu_i$ captures unobserved country-specific heterogeneity and is treated either as fixed effects in FE models or as random effects in RE models. Standard errors are clustered at the country level to account for within-country serial correlation.

**Table 10: Estimates across the seven potential models**

| Variable | M1 RE Baseline | M2 FE Baseline | M3 FE Gov.Ch. | M4 FE Fin.Dep. | M5 FE Labor | M6 FE Interact. | M7 RE Parsim. ★ |
|---|---|---|---|---|---|---|---|
| Constant | +43.340*** (7.720) | +43.200*** (5.850) | +40.630*** (6.100) | +43.060*** (5.910) | +49.600*** (4.470) | +39.770*** (5.750) | +47.620*** (7.470) |
| DFSI | **+0.060*** (0.020)** | **+0.062* (0.033)** | **+0.070** (0.027)** | **+0.064** (0.032)** | **+0.092*** (0.026)** | **+0.261** (0.117)** | **+0.062** (0.022)** |
| Governance (composite) | +7.220*** (2.370) | +6.950** (3.340) | — | +6.690* (3.440) | +7.360** (3.130) | +0.649 (5.764) | +8.291** (2.550) |
| Govt. effectiveness | — | — | +5.310** (2.180) | — | — | — | — |
| Regulatory quality | — | — | +3.580 (2.650) | — | — | — | — |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Rule of law | — | — | –4.360 (4.400) | — | — | — | — |
| DFSI × Governance | — | — | — | — | — | +0.257 (0.159) | — |
| Tertiary Education | +0.127** (0.056) | +0.124 (0.105) | +0.069 (0.091) | +0.111 (0.104) | +0.060 (0.080) | +0.067 (0.055) | +0.115** (0.057) |
| Gross capital formation (% GDP) | +0.139** (0.056) | +0.138** (0.052) | +0.169*** (0.063) | +0.137*** (0.050) | +0.121*** (0.042) | +0.136** (0.063) | — |
| Domestic credit (% GDP) | — | — | — | +0.026 (0.026) | — | — | — |
| Population growth (%) | –3.584** (1.477) | –3.529** (1.397) | –3.172** (1.526) | –3.722*** (1.394) | –3.547*** (1.289) | –2.945** (1.344) | –3.190** (1.536) |
| Unemployment rate (%) | — | — | — | — | –0.543 (0.385) | — | — |
| $R^2$ within | 0.5780 | 0.5780 | 0.5980 | 0.5800 | 0.6020 | 0.6240 | 0.5490 |
| $R^2$ between | 0.3260 | 0.3200 | 0.3020 | 0.3160 | 0.3040 | 0.2790 | 0.3210 |
| $R^2$ overall | 0.5650 | 0.5780 | 0.5980 | 0.5800 | 0.6020 | 0.6240 | 0.5320 |
| Estimator | **RE** | **FE** | **FE** | **FE** | **FE** | **FE** | **RE** |
| **N (obs)** | 88 | 88 | 88 | 88 | 88 | 88 | 88 |

Source: Author's own calculations

The results from all seven panel specifications consistently indicate that DFS, as measured by the DFSI, exert a positive and statistically significant effect on IG across the eight CAREC economies. This relationship remains robust across alternative estimators, governance specifications, additional financial and labor-market controls, and interaction effects. Specification tests support the RE estimator as the preferred approach, with Model 7 serving as the recommended policy model. Additional justification for selecting the RE specification is provided in the subsequent diagnostic tests.

Three policy implications emerge from these findings. First, expanding DFS adoption represents a measurable pathway to promoting IG in the CAREC region, distinct from traditional financial deepening. Investments in digital infrastructure, mobile money adoption, and internet affordability can generate inclusive-growth benefits beyond those associated with credit expansion alone. Second, institutional quality—particularly government effectiveness and policy implementation capacity—emerges as a critical structural determinant of IG. The magnitude of its effect substantially exceeds that of DFSI, suggesting that digital finance reforms are likely to yield greater benefits in stronger governance environments. Governance improvements should therefore complement digital finance initiatives. Third, population growth exerts a consistently negative effect on IG across all specifications, highlighting the importance of investments in education, family planning, and productive employment alongside digital and governance reforms. This finding is supported by the World Bank report, 2013 which shows that effective job creation and productive employment can support IG.

**Table 11: Model specification and post-estimation test summaries**

| Test | Statistic / Result | Verdict | Implication for M7 |
|---|---|---|---|
| **[A1] VIF Multicollinearity** | All VIF < 6 (DFSI = 1.07, governance = 5.89) | PASS | No harmful multicollinearity; coefficients estimable |
| **[A2] Pesaran CD Test** | CD = 1.784, p = 0.074 | PASS (marginal) | No significant CSD; clustering SEs is sufficient correction |
| **[A5] Regressor Correlations** | Max \|r\| = 0.805 (governance–pg) | PASS | No perfect multicollinearity; governance–pg correlation monitored |
| **[B1] Breusch–Pagan LM** | LM = 382.73, p<0.0001 | PASS | Panel effects highly significant; RE strongly preferred over Pooled OLS |
| **[B2] Hausman Test** | chi2(4) = 0.051, p = 0.9997 | PASS | RE is consistent & efficient; no endogeneity between effects & regressors |
| **[B3] F-test (FE effects)** | F = 23.02, p<0.0001 | PASS | Country effects jointly significant; panel structure essential |
| **[C1] Normality of Residuals** | JB p = 0.203, SW p = 0.104; skew = 0.46 | PASS | Residuals approximately normal; inference valid |
| **[C2] Heteroskedasticity (BP)** | BP-LM = 16.27, p = 0.003 | MANAGED | Heteroskedasticity present but corrected by robust SEs throughout |
| **[C3] Serial Correlation** | Mean AR(1) rho = 0.655; 7/8 countries significant | MANAGED | Serial correlation present but corrected by clustered/robust SEs |
| **[C4] RESET (panel-corrected)** | F = 0.437, p = 0.648 (within-demeaned) | PASS | No functional form misspecification in panel-appropriate test |
| **[C5] DWH Endogeneity (DFSI)** | First-stage F = 247.1; vhat t = −0.863, p = 0.391 | PASS | DFSI is exogenous; OLS/RE estimates are consistent |
| **[C6] Outliers / Cook's D** | Stud.resid>2: 3 obs; Cook's D>4/n: 4 obs | PASS | No highly influential outliers distorting estimates |
| **[LOO] Leave-One-Out** | DFSI significant in 6/7 sub-panels | PASS | Results not driven by any single country; robust to exclusion |
| **[AIC/BIC] Info. Criteria** | M7: AIC = 400.6, BIC = 413.0 (lowest BIC) | PASS | Parsimonious model confirmed by information criteria |

Note: Table 11 summarizes fourteen diagnostic tests. Tests are classified as PASS (assumption satisfied) or MANAGED (violation detected but appropriately corrected). Overall, the results provide strong support for Model 7. All major assumptions are either satisfied or adequately addressed, while endogeneity—the most serious threat to causal inference—is not found to be a significant concern.

### 3.7.1 Robustness Check: Leave-One-Country-Out Analysis

To verify that the results are not driven by any single country, the preferred model was re-estimated repeatedly, excluding one country at a time. The DFSI coefficient remains positive and statistically significant (at the 1–10% level) in six of the seven sub-panels. The only exception occurs when Pakistan is exclude, in which case the DFSI coefficient becomes small (0.017) and statistically insignificant (P=0.709)

**Table 12: Leave-one-country-out analysis summary**

| Excluded country | DFSI coef | SE | p-value | Assessment |
|---|---|---|---|---|
| Azerbaijan (excl.) | 0.0677 | 0.0213 | 0.002*** | Effect strengthens; AZE's fast DFSI growth not the driver |
| Georgia (excl.) | 0.0982 | 0.0178 | 0.000*** | Largest increase in DFSI coef; GEO moderates the effect slightly |
| Kazakhstan (excl.) | 0.0461 | 0.0227 | 0.046** | Remains significant; KAZ's high-performance trajectory not essential |
| Kyrgyz Republic (excl.) | 0.0645 | 0.0229 | 0.006*** | Stable; Kyrgyz Republic is not an outlier driver |
| Mongolia (excl.) | 0.0506 | 0.0223 | 0.027** | Stable; Mongolia's unique DFS structure does not distort |
| Pakistan (excl.) | 0.0165 | 0.0439 | 0.709 | Loses significance; Pakistan's high-BW / low-DFS contrast is key identifier |
| Tajikistan (excl.) | 0.0564 | 0.0248 | 0.026** | Stable; Tajikistan's laggard status is not mechanically driving results |
| Uzbekistan (excl.) | 0.0770 | 0.0203 | 0.000*** | Strengthens; Uzbekistan's recent reform period validates the effect |

Source: Author's own calculation

### 3.8 Method of Moments Quantile Regression (MM-QR)

The study also examines whether the impact of DFS varies across different levels of IG. To address this question, it employs the method of moments quantile regression (MM-QR) approach. MM-QR allows the effects of explanatory variables to differ across the distribution of the dependent variable while remaining robust to outliers, heteroskedasticity, and unobserved heterogeneity.

The most important distributional finding is the monotonically declining DFSI coefficient, which decreases from 0.086 at $\tau = 0.10$ to 0.038 at $\tau = 0.90$, with statistical significance disappearing beyond $\tau = 0.80$. Countries located in the lower tail of the IG distribution (IGI ≈ 15.8), represented primarily by Tajikistan and Pakistan during the early years of the sample, experience an estimated effect of 0.086 for each unit increase in DFSI. This effect is nearly 1.4 times larger than the average panel estimate (0.062) and more than twice the effect observed at $\tau = 0.90$. The results are consistent with a diminishing-returns mechanism, whereby DFS generate larger welfare gains in environments characterized by severe financial exclusion, thinner markets, and limited digital connectivity.

**Table 13: MM-QR estimation results across all quantiles**

| Variable | τ = 0.10 | τ = 0.20 | τ = 0.25 | τ = 0.30 | τ = 0.40 | τ = 0.50 | τ = 0.60 | τ = 0.70 | τ = 0.75 | τ = 0.80 | τ = 0.90 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| DFSI | **0.086*** (0.026)** | **0.078*** (0.022)** | **0.075*** (0.020)** | **0.073*** (0.019)** | **0.068*** (0.019)** | **0.060*** (0.019)** | **0.056*** (0.021)** | **0.052** (0.023)** | **0.049* (0.025)** | **0.045* (0.027)** | **0.038 (0.032)** |
| Governance (composite) | 5.495 (3.684) | 5.968* (3.119) | 6.109** (2.947) | 6.247** (2.808) | 6.594** (2.546) | 7.042*** (2.401) | 7.289*** (2.358) | 7.516*** (2.420) | 7.716*** (2.490) | 7.955*** (2.591) | 8.423*** (3.002) |
| Tertiary Education | 0.049 (0.062) | 0.074 (0.052) | 0.081 (0.050) | 0.088* (0.050) | 0.106* (0.054) | 0.129** (0.062) | 0.141** (0.071) | 0.153* (0.081) | 0.163* (0.088) | 0.176* (0.096) | 0.200* (0.116) |
| Gross capital formation (% GDP) | 0.072 (0.072) | 0.093 (0.063) | 0.100 (0.060) | 0.106* (0.058) | 0.122** (0.055) | 0.142** (0.055) | 0.153*** (0.056) | 0.164*** (0.059) | 0.173*** (0.061) | 0.183*** (0.065) | 0.205*** (0.075) |
| Population growth (%) | –3.125** (1.364) | –3.256** (1.310) | –3.295** (1.317) | –3.333** (1.328) | –3.429** (1.402) | –3.553** (1.527) | –3.622** (1.672) | –3.684** (1.825) | –3.740* (1.923) | –3.806* (2.044) | –3.936* (2.338) |
| Constant | 45.248*** (4.735) | 44.584*** (4.348) | 44.386*** (4.266) | 44.193*** (4.259) | 43.706*** (4.452) | 43.077*** (4.826) | 42.730*** (5.320) | 42.411*** (5.886) | 42.130*** (6.226) | 41.796*** (6.657) | 41.138*** (7.785) |
| q(τ) — quantile of std. residuals | –1.5372 | –1.0380 | –0.8897 | –0.7447 | –0.3786 | 0.0943 | 0.3546 | 0.5942 | 0.8050 | 1.0564 | 1.5507 |
| N (observations) | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 |
| Estimator | **MM-QR (FE)** | **MM-QR (FE)** | **MM-QR (FE)** | **MM-QR (FE)** | **MM-QR (FE)** | **MM-QR (FE)** | **MM-QR (FE)** | **MM-QR (FE)** | **MM-QR (FE)** | **MM-QR (FE)** | **MM-QR (FE)** |
| Std. errors | Bootstrap (B = 500) | Bootstrap (B = 500) | Bootstrap (B = 500) | Bootstrap (B = 500) | Bootstrap (B = 500) | Bootstrap (B = 500) | Bootstrap (B = 500) | Bootstrap (B = 500) | Bootstrap (B = 500) | Bootstrap (B = 500) | Bootstrap (B = 500) |

Source: Author's own calculations

The governance coefficient increases monotonically from 5.50 at τ = 0.10 (statistically insignificant) to 8.42 at τ = 0.90 (significant at the 1% level). This pattern suggests that countries with higher levels of IG, such as Kazakhstan and Georgia, derive greater benefits from marginal improvements in government effectiveness, regulatory quality, and the rule of law. In contrast, governance exerts a weaker and statistically insignificant effect among lower-performing countries, where structural constraints such as limited infrastructure, lower income levels, and population pressures appear to be more binding than institutional quality, persistent with the findings of Kaufmann, Kraay & Mastruzzi (2010).

Gross capital formation exhibits a similar pattern, increasing from 0.072 (insignificant) at τ = 0.10 to 0.205 (significant at the 1% level) at τ = 0.90. This finding suggests that investment becomes more productive in countries that already possess stronger foundations in governance, connectivity, and financial infrastructure. Tertiary education follows the same trend, rising from 0.049 (insignificant) at the lower quantiles to 0.200 (significant at the 10% level) at the upper quantiles persistent with the findings of Psacharopoulos & Patrinos, 2018. Population growth, by contrast, exerts a consistently negative effect across the entire distribution.

## 4. Policy Implications

The findings support a four-tier policy framework that reflects the differing stages of digital financial development and the varying policy priorities across CAREC economies.

**Table 14: Policy framework: Four-tier recommendations by country group and priority**

| Priority | Target countries | Recommended actions |
|---|---|---|
| Tier 1: Digital infrastructure investment | Tajikistan, Kyrgyz Republic | Subsidized broadband expansion; reduce ICT basket cost below 3% GNI (currently 2.19–6.49%); public–private partnerships for last-mile connectivity; regional bandwidth-sharing agreements under CAREC Digital Strategy 2030. |
| Tier 2: DFS demand activation | Pakistan, Azerbaijan | Mobile money regulatory sandboxes; financial literacy programs targeting rural and unbanked populations; government-to-person digital transfer payments to anchor adoption; interoperability mandates across payment platforms. |
| Tier 3: Governance and institutional deepening | All countries, priority for lower-middle tier | Strengthen government effectiveness (most significant WGI pillar in Model 3); regulatory quality improvements for FinTech licensing; rule-of-law reforms for digital contract enforcement; anti-corruption measures that reduce transaction costs for digital financial services. |
| Tier 4: Coordinated regional approach | All 8 CAREC economies | Cross-border digital payment systems; shared FinTech regulatory frameworks; regional digital identity infrastructure; coordinated spectrum policy to reduce country-level barriers to cross-border digital finance. |

Source: Author's own calculations

## 5. Conclusion

This study examined the role of DFS in promoting IG across CAREC economies by constructing two composite measures: the DFSI and the IGI. Using panel data covering 2014–2024, the analysis identified a statistically significant positive relationship between DFS and IG. The findings suggest that DFS constitutes an important driver of inclusive development within the CAREC region.

The results further indicate that CAREC economies are progressing along different digital development trajectories. A group of countries, including Kazakhstan, Uzbekistan, and Pakistan, has developed relatively strong infrastructure and institutional foundations that support continued digital expansion. In contrast, countries such as Tajikistan and the Kyrgyz Republic continue to face substantial infrastructure and adoption constraints. These findings suggest that the CAREC Digital Strategy 2030 should prioritize concessional investment in digital infrastructure, regulatory capacity building, and regional digital payment systems to accelerate progress among the region's lower-performing economies.

Although the study contributes by developing the DFSI and IGI for selected CAREC countries, several limitations should be acknowledged. The exclusion of China and Afghanistan because of their extreme characteristics, together with the exclusion of Turkmenistan due to data limitations, reduces the regional generalizability of the findings. In addition, the 2014–2024 panel may be insufficient to fully capture the long-run developmental effects of DFS. Finally, while the entropy method provides an objective weighting procedure, the resulting weights are determined by statistical variation rather than theoretical importance, which may produce weighting structures that are not always fully aligned with conceptual priorities.

The DFSI-IGI relationship loses significance when Pakistan is excluded from the panel while reliance on two interpolated Findex indicators are the limitations of the study.

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**Appendices**

**Appendix-1.1: DFSI dimensions**

| Country | Year | Digital payments_% | Accounts own | Individuals using the internet % | Household access to internet_% | Affordability %GNI | Mobile cellular subscription | Internet bandwidth Mbit |
|---|---|---|---|---|---|---|---|---|
| Azerbaijan | 2014 | 20.42 | 20.42 | 75.00 | 76.20 | 6.23 | 10,552,500 | 187,000 |
| | 2015 | 21.80 | 21.80 | 77.00 | 76.70 | 5.44 | 10,697,100 | 260,000 |
| | 2016 | 23.19 | 23.19 | 78.20 | 77.40 | 3.89 | 10,189,000 | 260,000 |
| | 2017 | 24.58 | 24.58 | 79.00 | 77.75 | 2.73 | 10,127,000 | 360,000 |
| | 2018 | 29.07 | 29.07 | 79.80 | 78.20 | 1.39 | 10,339,700 | 414,000 |
| | 2019 | 33.56 | 33.56 | 81.10 | 79.10 | 1.12 | 10,750,300 | 485,050 |
| | 2020 | 38.05 | 38.05 | 84.60 | 84.80 | 0.92 | 10,344,300 | 688,000 |
| | 2021 | 42.55 | 42.55 | 86.00 | 81.37 | 1.86 | 10,817,100 | 692,122 |
| | 2022 | 45.56 | 45.56 | 88.00 | 89.31 | 1.48 | 11,068,100 | 1,090,000 |
| | 2023 | 48.58 | 48.58 | 89.00 | 88.57 | 1.08 | 11,111,300 | 2,420,000 |
| | 2024 | 51.59 | 51.59 | 90.00 | 88.57 | 1.14 | 11,323,000 | 2,420,000 |
| Georgia | 2014 | 23.58 | 39.67 | 49.10 | 41.03 | 1.90 | 5,400,770 | 187,223 |
| | 2015 | 33.37 | 61.23 | 47.57 | 45.14 | 1.40 | 5,550,730 | 197,239 |
| | 2016 | 43.16 | 51.83 | 58.46 | 70.05 | 1.40 | 5,531,880 | 217,823 |
| | 2017 | 52.95 | 61.23 | 59.71 | 70.70 | 1.47 | 5,502,400 | 250,525 |
| | 2018 | 55.26 | 62.51 | 62.72 | 75.80 | 2.87 | 5,459,240 | 322,205 |
| | 2019 | 57.56 | 64.06 | 68.85 | 79.26 | 2.29 | 5,382,060 | 343,273 |
| | 2020 | 59.86 | 65.61 | 72.53 | 83.84 | 1.86 | 5,100,100 | 519,785 |
| | 2021 | 62.17 | 70.47 | 76.44 | 86.12 | 1.89 | 5,552,600 | 587,266 |
| | 2022 | 64.57 | 69.24 | 78.71 | 88.38 | 0.78 | 5,844,480 | 603,817 |
| | 2023 | 66.98 | 71.31 | 81.88 | 88.99 | 0.66 | 5,911,130 | 731,794 |
| | 2024 | 69.38 | 78.82 | 81.88 | 88.99 | 0.60 | 6,138,030 | 731,794 |
| Kazakhstan | 2014 | 46.74 | 53.91 | 66.00 | 82.00 | 0.90 | 28,595,600 | 469,346 |
| | 2015 | 49.11 | 58.70 | 70.83 | 82.22 | 0.60 | 26,309,300 | 850,695 |
| | 2016 | 51.49 | 60.16 | 74.59 | 84.38 | 0.40 | 25,534,800 | 1,130,000 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Kazakhstan | 2017 | 53.87 | 61.87 | 76.43 | 84.85 | 0.70 | 26,693,300 | 800,000 |
| | 2018 | 59.89 | 67.14 | 78.90 | 87.59 | 1.15 | 26,065,600 | 950,000 |
| | 2019 | 65.90 | 72.40 | 81.88 | 90.34 | 0.72 | 25,717,700 | 1,180,000 |
| | 2020 | 71.91 | 77.66 | 85.94 | 92.40 | 0.60 | 24,293,900 | 1,580,000 |
| | 2021 | 77.93 | 81.11 | 90.92 | 94.45 | 1.04 | 24,471,000 | 1,940,000 |
| | 2022 | 80.29 | 84.96 | 92.30 | 96.17 | 0.95 | 25,171,800 | 2,240,000 |
| | 2023 | 82.66 | 86.99 | 92.88 | 96.81 | 0.99 | 25,842,600 | 2,740,000 |
| | 2024 | 85.02 | 84.20 | 93.39 | 97.06 | 1.11 | 26,170,100 | 2,740,000 |
| Kyrgyz Republic | 2014 | 15.09 | 18.47 | 28.30 | 13.80 | 5.80 | 7,563,440 | 39,680 |
| | 2015 | 22.08 | 38.28 | 30.25 | 16.50 | 4.70 | 7,579,440 | 77,323 |
| | 2016 | 29.07 | 37.74 | 40.50 | 18.76 | 3.70 | 7,613,530 | 81,310 |
| | 2017 | 36.06 | 44.06 | 50.80 | 21.11 | 3.61 | 8,467,970 | 112,580 |
| | 2018 | 36.90 | 44.15 | 62.80 | 70.06 | 2.86 | 8,735,250 | 148,520 |
| | 2019 | 37.74 | 44.24 | 64.10 | 83.40 | 2.86 | 8,622,570 | 203,229 |
| | 2020 | 38.59 | 44.34 | 72.00 | 87.80 | 2.83 | 7,315,900 | 345,212 |
| | 2021 | 39.43 | 40.97 | 77.12 | 72.79 | 3.11 | 7,377,830 | 426,631 |
| | 2022 | 48.77 | 53.44 | 82.60 | 77.58 | 2.73 | 7,437,540 | 762,392 |
| | 2023 | 58.12 | 62.45 | 88.47 | 80.64 | 1.74 | 7,681,220 | 906,504 |
| | 2024 | 67.46 | 69.96 | 88.47 | 80.64 | 1.24 | 7,724,410 | 906,504 |
| Mongolia | 2014 | 72.27 | 91.82 | 19.94 | 22.52 | 0.90 | 3,027,240 | 10,000 |
| | 2015 | 76.60 | 92.97 | 22.50 | 22.43 | 0.80 | 3,068,160 | 15,000 |
| | 2016 | 80.93 | 89.60 | 22.27 | 22.99 | 0.80 | 3,367,570 | 15,500 |
| | 2017 | 85.27 | 93.27 | 23.71 | 43.30 | 0.86 | 3,886,170 | 16,540 |
| | 2018 | 88.30 | 94.95 | 47.13 | 46.72 | 2.95 | 4,222,040 | 20,675 |
| | 2019 | 91.34 | 96.63 | 51.08 | 77.60 | 2.95 | 4,418,920 | 63,042 |
| | 2020 | 94.37 | 98.32 | 62.50 | 80.03 | 2.57 | 4,363,920 | 93,300 |
| | 2021 | 97.41 | 98.17 | 81.61 | 81.10 | 2.57 | 4,687,300 | 256,000 |
| | 2022 | 96.57 | 99.64 | 82.17 | 81.78 | 1.12 | 4,835,520 | 387,000 |
| | 2023 | 95.74 | 99.27 | 83.02 | 81.40 | 0.92 | 4,841,940 | 390,000 |
| | 2024 | 94.91 | 98.22 | 83.02 | 81.61 | 0.69 | 4,889,040 | 390,000 |
| Pakistan | 2014 | 9.45 | 8.71 | 10.00 | 15.68 | 2.00 | 1.36E+08 | 145,227 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Pakistan | 2015 | 12.20 | 18.05 | 11 | 19 | 1.8 | 1.26E+08 | 403,253 |
| | 2016 | 14.95 | 23.61 | 11.00 | 19.00 | 1.80 | 1.36E+08 | 493,435 |
| | 2017 | 17.69 | 25.69 | 12.39 | 22.14 | 2.00 | 1.45E+08 | 672,453 |
| | 2018 | 17.67 | 24.92 | 13.78 | 11.79 | 2.19 | 1.54E+08 | 922,729 |
| | 2019 | 17.66 | 24.16 | 15.34 | 21.47 | 2.43 | 1.65E+08 | 2,650,000 |
| | 2020 | 17.64 | 23.39 | 17.07 | 34.13 | 2.43 | 1.76E+08 | 3,170,000 |
| | 2021 | 17.62 | 16.29 | 18.93 | 32.77 | 1.96 | 1.89E+08 | 4,670,000 |
| | 2022 | 19.96 | 24.63 | 21.41 | 35.78 | 2.27 | 1.93E+08 | 5,990,000 |
| | 2023 | 22.30 | 26.64 | 24.21 | 36.83 | 1.51 | 1.89E+08 | 6,740,000 |
| | 2024 | 24.64 | 18.28 | 27.38 | 36.73 | 1.71 | 1.93E+08 | 6,740,000 |
| Tajikistan | 2014 | 8.75 | 11.46 | 17.49 | 7.23 | 5.80 | 7,999,100 | 5,800 |
| | 2015 | 20.48 | 47.02 | 18.98 | 8.77 | 4.70 | 8,489,000 | 3,530 |
| | 2016 | 32.20 | 40.87 | 20.47 | 10.31 | 3.71 | 9,400,000 | 4,367 |
| | 2017 | 43.93 | 51.93 | 21.96 | 26.68 | 3.60 | 9,904,000 | 4,400 |
| | 2018 | 41.23 | 48.48 | 23.50 | 26.93 | 6.49 | 10,000,000 | 4,150 |
| | 2019 | 38.53 | 45.03 | 25.11 | 27.10 | 6.49 | 10,995,000 | 5,500 |
| | 2020 | 35.83 | 41.58 | 27.54 | 27.18 | 3.73 | 6,072,130 | 6,400 |
| | 2021 | 33.13 | 38.90 | 49.84 | 24.69 | 3.02 | 6,387,540 | 7,800 |
| | 2022 | 38.53 | 43.20 | 53.11 | 39.45 | 2.94 | 6,500,760 | 8,200 |
| | 2023 | 43.93 | 48.27 | 56.79 | 41.72 | 2.66 | 7,918,680 | 8,950 |
| | 2024 | 49.33 | 52.47 | 56.79 | 44.34 | 2.19 | 7,918,680 | 9,600 |
| Uzbekistan | 2014 | 38.37 | 40.71 | 35.50 | 58.10 | 2.30 | 21,639,200 | 16,460 |
| | 2015 | 36.99 | 37.09 | 42.80 | 75.19 | 2.60 | 21,783,300 | 26,390 |
| | 2016 | 35.60 | 44.27 | 46.79 | 79.70 | 1.39 | 23,265,400 | 80,000 |
| | 2017 | 34.22 | 42.22 | 48.70 | 79.86 | 0.66 | 24,265,500 | 160,000 |
| | 2018 | 36.10 | 43.35 | 55.20 | 80.40 | 1.59 | 23,226,200 | 459,034 |
| | 2019 | 37.97 | 44.47 | 70.40 | 81.15 | 1.81 | 33,380,000 | 950,034 |
| | 2020 | 39.85 | 45.60 | 71.10 | 93.55 | 1.68 | 33,387,000 | 1,200,000 |
| | 2021 | 41.72 | 44.13 | 76.59 | 95.05 | 1.14 | 35,069,000 | 2,010,000 |
| | 2022 | 44.44 | 49.11 | 83.90 | 95.53 | 1.02 | 36,850,700 | 2,310,000 |
| | 2023 | 47.16 | 51.50 | 89.01 | 96.15 | 0.95 | 38,106,900 | 7,090,000 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Uzbekistan | 2024 | 49.88 | 59.66 | 90.00 | 96.15 | 1.20 | 40,177,000 | 8,090,000 |

**Appendix 1.2: Dimensional indices of DFSI**

| Country | Year | Digital Infrastructure Index (DI) | Digital Financial Services Index (DFS) | Affordability Index (AF) | Bandwidth Index (BW) | DFSI (composite) |
|---|---|---|---|---|---|---|
| Azerbaijan | 2014 | 0.23 | 0.17 | 0.04 | 0.02 | 0.08 |
| | 2015 | 0.24 | 0.19 | 0.17 | 0.03 | 0.10 |
| | 2016 | 0.24 | 0.20 | 0.43 | 0.03 | 0.11 |
| | 2017 | 0.24 | 0.20 | 0.62 | 0.04 | 0.13 |
| | 2018 | 0.24 | 0.26 | 0.84 | 0.05 | 0.16 |
| | 2019 | 0.25 | 0.31 | 0.88 | 0.06 | 0.17 |
| | 2020 | 0.26 | 0.35 | 0.91 | 0.08 | 0.20 |
| | 2021 | 0.26 | 0.39 | 0.76 | 0.09 | 0.19 |
| | 2022 | 0.28 | 0.43 | 0.82 | 0.13 | 0.24 |
| | 2023 | 0.28 | 0.46 | 0.89 | 0.30 | 0.35 |
| | 2024 | 0.28 | 0.50 | 0.88 | 0.30 | 0.35 |
| Georgia | 2014 | 0.12 | 0.24 | 0.75 | 0.02 | 0.11 |
| | 2015 | 0.13 | 0.40 | 0.84 | 0.02 | 0.13 |
| | 2016 | 0.18 | 0.42 | 0.84 | 0.03 | 0.15 |
| | 2017 | 0.18 | 0.53 | 0.82 | 0.03 | 0.16 |
| | 2018 | 0.19 | 0.55 | 0.59 | 0.04 | 0.16 |
| | 2019 | 0.21 | 0.58 | 0.69 | 0.04 | 0.17 |
| | 2020 | 0.22 | 0.60 | 0.76 | 0.06 | 0.20 |
| | 2021 | 0.23 | 0.64 | 0.76 | 0.07 | 0.21 |
| | 2022 | 0.24 | 0.64 | 0.94 | 0.07 | 0.22 |
| | 2023 | 0.24 | 0.67 | 0.96 | 0.09 | 0.24 |
| | 2024 | 0.25 | 0.72 | 0.97 | 0.09 | 0.24 |
| Kazakhstan | 2014 | 0.30 | 0.46 | 0.92 | 0.06 | 0.20 |
| | 2015 | 0.30 | 0.50 | 0.97 | 0.10 | 0.24 |
| | 2016 | 0.30 | 0.52 | 1.00 | 0.14 | 0.26 |
| | 2017 | 0.31 | 0.54 | 0.95 | 0.10 | 0.24 |
| | 2018 | 0.32 | 0.60 | 0.88 | 0.12 | 0.26 |
| | 2019 | 0.32 | 0.67 | 0.95 | 0.15 | 0.29 |
| | 2020 | 0.33 | 0.73 | 0.97 | 0.20 | 0.33 |
| | 2021 | 0.34 | 0.79 | 0.89 | 0.24 | 0.36 |
| | 2022 | 0.35 | 0.82 | 0.91 | 0.28 | 0.39 |
| | 2023 | 0.35 | 0.85 | 0.90 | 0.34 | 0.43 |
| | 2024 | 0.35 | 0.85 | 0.88 | 0.34 | 0.43 |
| Kyrgyz Republic | 2014 | 0.06 | 0.09 | 0.11 | 0.00 | 0.03 |
| | 2015 | 0.06 | 0.22 | 0.29 | 0.01 | 0.06 |
| | 2016 | 0.08 | 0.27 | 0.46 | 0.01 | 0.08 |
| | 2017 | 0.11 | 0.34 | 0.47 | 0.01 | 0.10 |
| | 2018 | 0.20 | 0.35 | 0.60 | 0.02 | 0.12 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Kyrgyz Republic | 2019 | 0.23 | 0.36 | 0.60 | 0.04 | 0.15 |
| | 2020 | 0.22 | 0.35 | 0.56 | 0.05 | 0.15 |
| | 2021 | 0.24 | 0.47 | 0.62 | 0.09 | 0.20 |
| | 2022 | 0.25 | 0.57 | 0.78 | 0.11 | 0.23 |
| | 2023 | 0.25 | 0.67 | 0.86 | 0.11 | 0.25 |
| | 2024 | 0.23 | 0.36 | 0.60 | 0.04 | 0.15 |
| Mongolia | 2014 | 0.04 | 0.80 | 0.92 | 0.00 | 0.16 |
| | 2015 | 0.04 | 0.83 | 0.93 | 0.00 | 0.16 |
| | 2016 | 0.04 | 0.85 | 0.93 | 0.00 | 0.16 |
| | 2017 | 0.08 | 0.89 | 0.92 | 0.00 | 0.18 |
| | 2018 | 0.12 | 0.92 | 0.58 | 0.00 | 0.17 |
| | 2019 | 0.17 | 0.95 | 0.58 | 0.01 | 0.19 |
| | 2020 | 0.19 | 0.97 | 0.64 | 0.01 | 0.20 |
| | 2021 | 0.23 | 0.99 | 0.64 | 0.03 | 0.22 |
| | 2022 | 0.23 | 0.99 | 0.88 | 0.05 | 0.24 |
| | 2023 | 0.23 | 0.99 | 0.91 | 0.05 | 0.25 |
| | 2024 | 0.23 | 0.98 | 0.95 | 0.05 | 0.25 |
| Pakistan | 2014 | 0.53 | 0.00 | 0.74 | 0.02 | 0.15 |
| | 2015 | 0.49 | 0.07 | 0.77 | 0.05 | 0.18 |
| | 2016 | 0.54 | 0.11 | 0.74 | 0.06 | 0.20 |
| | 2017 | 0.56 | 0.14 | 0.71 | 0.08 | 0.22 |
| | 2018 | 0.61 | 0.13 | 0.67 | 0.11 | 0.24 |
| | 2019 | 0.68 | 0.13 | 0.67 | 0.33 | 0.39 |
| | 2020 | 0.72 | 0.13 | 0.74 | 0.39 | 0.44 |
| | 2021 | 0.78 | 0.09 | 0.69 | 0.58 | 0.56 |
| | 2022 | 0.80 | 0.15 | 0.82 | 0.74 | 0.68 |
| | 2023 | 0.79 | 0.17 | 0.78 | 0.83 | 0.74 |
| | 2024 | 0.80 | 0.15 | 0.84 | 0.83 | 0.74 |
| Tajikistan | 2014 | 0.03 | 0.01 | 0.11 | 0.00 | 0.01 |
| | 2015 | 0.04 | 0.25 | 0.29 | 0.00 | 0.05 |
| | 2016 | 0.05 | 0.30 | 0.46 | 0.00 | 0.07 |
| | 2017 | 0.07 | 0.43 | 0.47 | 0.00 | 0.09 |
| | 2018 | 0.08 | 0.40 | 0.00 | 0.00 | 0.06 |
| | 2019 | 0.08 | 0.36 | 0.00 | 0.00 | 0.06 |
| | 2020 | 0.07 | 0.33 | 0.45 | 0.00 | 0.08 |
| | 2021 | 0.10 | 0.30 | 0.57 | 0.00 | 0.09 |
| | 2022 | 0.13 | 0.35 | 0.58 | 0.00 | 0.10 |
| | 2023 | 0.14 | 0.41 | 0.63 | 0.00 | 0.11 |
| | 2024 | 0.15 | 0.47 | 0.71 | 0.00 | 0.12 |
| Uzbekistan | 2014 | 0.19 | 0.34 | 0.69 | 0.00 | 0.12 |
| | 2015 | 0.22 | 0.32 | 0.64 | 0.00 | 0.12 |
| | 2016 | 0.24 | 0.34 | 0.84 | 0.01 | 0.14 |
| | 2017 | 0.25 | 0.32 | 0.96 | 0.02 | 0.15 |
| | 2018 | 0.26 | 0.34 | 0.80 | 0.06 | 0.17 |
| | 2019 | 0.32 | 0.36 | 0.77 | 0.12 | 0.22 |
| | 2020 | 0.34 | 0.37 | 0.79 | 0.15 | 0.25 |

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|---|---|---|---|---|---|---|
| Uzbekistan | 2021 | 0.36 | 0.38 | 0.88 | 0.25 | 0.32 |
| | 2022 | 0.38 | 0.42 | 0.90 | 0.29 | 0.35 |
| | 2023 | 0.39 | 0.45 | 0.91 | 0.88 | 0.73 |
| | 2024 | 0.40 | 0.50 | 0.87 | 1.00 | 0.82 |

**Appendix 2: Data on IGI indicators**

| Country | Year | Inequality | HDI | gdppc | poverty | ND_Gain |
|---|---|---|---|---|---|---|
| Azerbaijan | 2014 | 0.43 | 0.77 | 20709.20 | 0.30 | 47.27 |
| | 2015 | 0.43 | 0.77 | 20678.75 | 0.30 | 48.15 |
| | 2016 | 0.41 | 0.77 | 19822.41 | 0.31 | 49.31 |
| | 2017 | 0.43 | 0.77 | 19659.00 | 0.32 | 48.54 |
| | 2018 | 0.43 | 0.78 | 19781.85 | 0.31 | 48.85 |
| | 2019 | 0.43 | 0.78 | 20101.49 | 0.31 | 49.81 |
| | 2020 | 0.43 | 0.76 | 19126.10 | 0.33 | 48.63 |
| | 2021 | 0.43 | 0.77 | 20111.38 | 0.31 | 49.62 |
| | 2022 | 0.43 | 0.78 | 21051.24 | 0.30 | 48.82 |
| | 2023 | 0.43 | 0.79 | 21310.74 | 0.29 | 48.33 |
| | 2024 | 0.43 | 0.79 | 22072.11 | 0.29 | 48.33 |
| Georgia | 2014 | 0.56 | 0.80 | 14475.31 | 6.35 | 57.30 |
| | 2015 | 0.56 | 0.81 | 14936.84 | 5.23 | 56.52 |
| | 2016 | 0.58 | 0.81 | 15442.96 | 5.17 | 56.37 |
| | 2017 | 0.59 | 0.82 | 16237.62 | 6.03 | 58.17 |
| | 2018 | 0.58 | 0.82 | 17228.68 | 5.78 | 58.51 |
| | 2019 | 0.58 | 0.83 | 18186.88 | 5.39 | 57.36 |
| | 2020 | 0.58 | 0.82 | 17031.14 | 6.13 | 58.10 |
| | 2021 | 0.58 | 0.82 | 18915.65 | 5.91 | 58.63 |
| | 2022 | 0.58 | 0.84 | 20966.53 | 4.50 | 58.53 |
| | 2023 | 0.58 | 0.84 | 22590.53 | 3.93 | 58.61 |
| | 2024 | 0.58 | 0.84 | 25000.63 | 3.41 | 58.61 |
| Kazakhstan | 2014 | 0.47 | 0.81 | 30986.44 | 0.65 | 54.67 |
| | 2015 | 0.44 | 0.82 | 30893.76 | 0.68 | 54.17 |
| | 2016 | 0.49 | 0.82 | 30758.32 | 0.77 | 55.46 |
| | 2017 | 0.50 | 0.82 | 31524.44 | 0.69 | 56.07 |
| | 2018 | 0.50 | 0.83 | 32330.23 | 0.65 | 56.86 |
| | 2019 | 0.50 | 0.83 | 33298.21 | 0.65 | 57.79 |
| | 2020 | 0.50 | 0.83 | 32011.55 | 0.64 | 57.32 |
| | 2021 | 0.50 | 0.82 | 32945.85 | 0.62 | 57.83 |
| | 2022 | 0.50 | 0.83 | 33506.26 | 0.61 | 58.15 |
| | 2023 | 0.50 | 0.84 | 34703.23 | 0.58 | 58.03 |
| | 2024 | 0.50 | 0.84 | 35905.44 | 0.57 | 58.03 |
| Kyrgyz Republic | 2014 | 0.43 | 0.69 | 5513.75 | 1.65 | 48.27 |
| | 2015 | 0.46 | 0.70 | 5600.21 | 2.62 | 47.59 |
| | 2016 | 0.45 | 0.70 | 5715.01 | 1.61 | 49.82 |
| | 2017 | 0.47 | 0.70 | 5861.22 | 1.82 | 50.37 |
| Kyrgyz Republic | 2018 | 0.47 | 0.71 | 5951.83 | 1.34 | 51.30 |
| | 2019 | 0.50 | 0.71 | 6087.60 | 1.26 | 51.48 |
| | 2020 | 0.50 | 0.70 | 5537.80 | 1.87 | 50.86 |
| | 2021 | 0.50 | 0.70 | 5736.48 | 1.34 | 51.17 |
| | 2022 | 0.50 | 0.72 | 6139.78 | 1.10 | 51.06 |

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|---|---|---|---|---|---|---|
| | 2023 | 0.50 | 0.72 | 6575.78 | 1.03 | 51.18 |
| | 2024 | 0.50 | 0.72 | 7046.31 | 0.98 | 51.18 |
| Mongolia | 2014 | 0.55 | 0.75 | 13943.43 | 0.99 | 49.33 |
| | 2015 | 0.54 | 0.75 | 13974.60 | 1.04 | 49.09 |
| | 2016 | 0.53 | 0.76 | 13898.15 | 1.28 | 49.79 |
| | 2017 | 0.53 | 0.76 | 14401.54 | 1.33 | 51.44 |
| | 2018 | 0.54 | 0.77 | 15230.24 | 1.22 | 51.70 |
| | 2019 | 0.53 | 0.76 | 15790.70 | 1.03 | 52.52 |
| | 2020 | 0.53 | 0.74 | 14801.34 | 0.96 | 52.12 |
| | 2021 | 0.53 | 0.73 | 14792.25 | 0.97 | 52.35 |
| | 2022 | 0.53 | 0.74 | 15310.43 | 0.88 | 51.71 |
| | 2023 | 0.53 | 0.75 | 16222.86 | 0.84 | 52.02 |
| | 2024 | 0.53 | 0.75 | 16801.31 | 0.81 | 52.02 |
| Pakistan | 2014 | 0.50 | 0.52 | 4520.24 | 6.02 | 37.21 |
| | 2015 | 0.51 | 0.53 | 4645.29 | 5.64 | 37.36 |
| | 2016 | 0.50 | 0.54 | 4886.61 | 5.51 | 37.01 |
| | 2017 | 0.50 | 0.54 | 5031.56 | 5.52 | 37.30 |
| | 2018 | 0.49 | 0.54 | 5255.06 | 5.52 | 37.27 |
| | 2019 | 0.49 | 0.54 | 5295.95 | 4.83 | 37.70 |
| | 2020 | 0.49 | 0.54 | 5135.02 | 5.77 | 38.69 |
| | 2021 | 0.49 | 0.54 | 5367.27 | 4.37 | 38.76 |
| | 2022 | 0.49 | 0.54 | 5526.28 | 3.52 | 38.64 |
| | 2023 | 0.49 | 0.54 | 5439.18 | 3.85 | 37.89 |
| | 2024 | 0.49 | 0.54 | 5531.00 | 3.72 | 37.89 |
| Tajikistan | 2014 | 0.50 | 0.66 | 2943.09 | 6.11 | 41.91 |
| | 2015 | 0.50 | 0.66 | 3041.45 | 9.95 | 42.40 |
| | 2016 | 0.52 | 0.66 | 3169.97 | 7.28 | 44.31 |
| | 2017 | 0.52 | 0.67 | 3312.71 | 6.85 | 44.87 |
| | 2018 | 0.52 | 0.67 | 3479.69 | 6.56 | 45.94 |
| | 2019 | 0.52 | 0.67 | 3649.88 | 6.17 | 46.23 |
| | 2020 | 0.52 | 0.66 | 3724.75 | 5.99 | 45.91 |
| | 2021 | 0.52 | 0.67 | 3985.91 | 5.66 | 46.03 |
| | 2022 | 0.52 | 0.69 | 4213.76 | 4.99 | 45.82 |
| | 2023 | 0.52 | 0.69 | 4472.32 | 4.32 | 45.87 |
| | 2024 | 0.50 | 0.66 | 2943.09 | 6.11 | 41.91 |
| Uzbekistan | 2014 | 0.55 | 0.70 | 7145.11 | 5.37 | 44.37 |
| | 2015 | 0.55 | 0.71 | 7529.76 | 4.24 | 44.56 |
| | 2016 | 0.54 | 0.71 | 7839.98 | 3.67 | 46.68 |
| | 2017 | 0.55 | 0.72 | 8047.05 | 3.49 | 46.89 |
| | 2018 | 0.55 | 0.73 | 8348.96 | 3.14 | 48.62 |
| Uzbekistan | 2019 | 0.55 | 0.73 | 8755.13 | 2.95 | 49.02 |
| | 2020 | 0.55 | 0.72 | 8727.41 | 3.06 | 49.00 |
| | 2021 | 0.55 | 0.73 | 9247.64 | 2.63 | 50.18 |
| | 2022 | 0.55 | 0.74 | 9607.56 | 2.29 | 50.76 |
| | 2023 | 0.55 | 0.74 | 10007.69 | 2.11 | 51.12 |

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|---|---|---|---|---|---|---|
| | 2024 | 0.55 | 0.74 | 10450.21 | 1.96 | 51.12 |

**Appendix 2.1: IGI indicator indices**

| Country | Year | N_HDI | N_gdppc | N_ND_Gain | N_Ineqlity | N_Poverty |
|---|---|---|---|---|---|---|
| Azerbaijan | 2014 | 0.758 | 0.539 | 0.475 | 0.879 | 0.999 |
| | 2015 | 0.773 | 0.538 | 0.515 | 0.927 | 0.999 |
| | 2016 | 0.776 | 0.512 | 0.569 | 1.000 | 0.998 |
| | 2017 | 0.783 | 0.507 | 0.533 | 0.919 | 0.997 |
| | 2018 | 0.786 | 0.511 | 0.548 | 0.919 | 0.998 |
| | 2019 | 0.801 | 0.521 | 0.592 | 0.919 | 0.998 |
| | 2020 | 0.730 | 0.491 | 0.538 | 0.919 | 0.996 |
| | 2021 | 0.755 | 0.521 | 0.583 | 0.919 | 0.998 |
| | 2022 | 0.814 | 0.549 | 0.546 | 0.919 | 0.999 |
| | 2023 | 0.829 | 0.557 | 0.524 | 0.919 | 1.000 |
| | 2024 | 0.829 | 0.580 | 0.524 | 0.919 | 1.000 |
| Georgia | 2014 | 0.870 | 0.350 | 0.938 | 0.147 | 0.373 |
| | 2015 | 0.885 | 0.364 | 0.902 | 0.143 | 0.489 |
| | 2016 | 0.891 | 0.379 | 0.895 | 0.044 | 0.495 |
| | 2017 | 0.913 | 0.403 | 0.979 | 0.000 | 0.406 |
| | 2018 | 0.938 | 0.433 | 0.994 | 0.039 | 0.432 |
| | 2019 | 0.957 | 0.462 | 0.941 | 0.017 | 0.472 |
| | 2020 | 0.932 | 0.427 | 0.975 | 0.017 | 0.395 |
| | 2021 | 0.922 | 0.485 | 1.000 | 0.017 | 0.418 |
| | 2022 | 0.981 | 0.547 | 0.995 | 0.017 | 0.564 |
| | 2023 | 1.000 | 0.596 | 0.999 | 0.017 | 0.623 |
| | 2024 | 1.000 | 0.669 | 0.999 | 0.017 | 0.677 |
| Kazakhstan | 2014 | 0.904 | 0.851 | 0.817 | 0.688 | 0.963 |
| | 2015 | 0.922 | 0.848 | 0.793 | 0.823 | 0.960 |
| | 2016 | 0.925 | 0.844 | 0.853 | 0.537 | 0.950 |
| | 2017 | 0.938 | 0.867 | 0.881 | 0.523 | 0.959 |
| | 2018 | 0.950 | 0.892 | 0.918 | 0.505 | 0.963 |
| | 2019 | 0.969 | 0.921 | 0.961 | 0.505 | 0.963 |
| | 2020 | 0.944 | 0.882 | 0.939 | 0.505 | 0.964 |
| | 2021 | 0.913 | 0.910 | 0.963 | 0.505 | 0.966 |
| | 2022 | 0.960 | 0.927 | 0.977 | 0.505 | 0.967 |
| | 2023 | 0.978 | 0.964 | 0.972 | 0.505 | 0.970 |
| | 2024 | 0.978 | 1.000 | 0.972 | 0.505 | 0.971 |
| Kyrgyz Republic | 2014 | 0.525 | 0.078 | 0.521 | 0.873 | 0.859 |
| Kyrgyz Republic | 2015 | 0.537 | 0.081 | 0.489 | 0.729 | 0.759 |
| | 2016 | 0.553 | 0.084 | 0.592 | 0.791 | 0.863 |
| | 2017 | 0.565 | 0.089 | 0.618 | 0.687 | 0.842 |
| | 2018 | 0.578 | 0.091 | 0.661 | 0.654 | 0.891 |
| | 2019 | 0.578 | 0.095 | 0.669 | 0.483 | 0.900 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | 2020 | 0.553 | 0.079 | 0.640 | 0.483 | 0.836 |
| | 2021 | 0.565 | 0.085 | 0.655 | 0.483 | 0.891 |
| | 2022 | 0.606 | 0.097 | 0.650 | 0.483 | 0.916 |
| | 2023 | 0.615 | 0.110 | 0.655 | 0.483 | 0.923 |
| | 2024 | 0.615 | 0.124 | 0.655 | 0.483 | 0.929 |
| Mongolia | 2014 | 0.702 | 0.334 | 0.570 | 0.225 | 0.928 |
| | 2015 | 0.717 | 0.335 | 0.559 | 0.299 | 0.922 |
| | 2016 | 0.736 | 0.332 | 0.591 | 0.305 | 0.898 |
| | 2017 | 0.736 | 0.348 | 0.667 | 0.310 | 0.892 |
| | 2018 | 0.761 | 0.373 | 0.680 | 0.295 | 0.904 |
| | 2019 | 0.733 | 0.390 | 0.717 | 0.329 | 0.923 |
| | 2020 | 0.680 | 0.360 | 0.699 | 0.329 | 0.931 |
| | 2021 | 0.637 | 0.359 | 0.709 | 0.329 | 0.930 |
| | 2022 | 0.683 | 0.375 | 0.680 | 0.329 | 0.939 |
| | 2023 | 0.699 | 0.403 | 0.694 | 0.329 | 0.943 |
| | 2024 | 0.699 | 0.420 | 0.694 | 0.329 | 0.946 |
| Pakistan | 2014 | 0.000 | 0.048 | 0.009 | 0.499 | 0.407 |
| | 2015 | 0.016 | 0.052 | 0.016 | 0.467 | 0.446 |
| | 2016 | 0.040 | 0.059 | 0.000 | 0.493 | 0.460 |
| | 2017 | 0.047 | 0.063 | 0.013 | 0.511 | 0.459 |
| | 2018 | 0.050 | 0.070 | 0.012 | 0.531 | 0.459 |
| | 2019 | 0.056 | 0.071 | 0.032 | 0.531 | 0.530 |
| | 2020 | 0.043 | 0.066 | 0.078 | 0.531 | 0.433 |
| | 2021 | 0.047 | 0.074 | 0.081 | 0.531 | 0.578 |
| | 2022 | 0.068 | 0.078 | 0.075 | 0.531 | 0.666 |
| | 2023 | 0.068 | 0.076 | 0.041 | 0.531 | 0.631 |
| | 2024 | 0.068 | 0.079 | 0.041 | 0.531 | 0.645 |
| Tajikistan | 2014 | 0.419 | 0.000 | 0.227 | 0.479 | 0.398 |
| | 2015 | 0.422 | 0.003 | 0.249 | 0.505 | 0.000 |
| | 2016 | 0.432 | 0.007 | 0.337 | 0.409 | 0.276 |
| | 2017 | 0.447 | 0.011 | 0.363 | 0.381 | 0.321 |
| | 2018 | 0.460 | 0.016 | 0.413 | 0.377 | 0.351 |
| | 2019 | 0.469 | 0.021 | 0.427 | 0.377 | 0.391 |
| | 2020 | 0.441 | 0.024 | 0.412 | 0.377 | 0.410 |
| | 2021 | 0.466 | 0.032 | 0.417 | 0.377 | 0.444 |
| | 2022 | 0.512 | 0.039 | 0.408 | 0.377 | 0.513 |
| | 2023 | 0.525 | 0.046 | 0.410 | 0.377 | 0.583 |
| | 2024 | 0.525 | 0.055 | 0.410 | 0.377 | 0.638 |
| Uzbekistan | 2014 | 0.562 | 0.127 | 0.340 | 0.221 | 0.474 |
| | 2015 | 0.575 | 0.139 | 0.349 | 0.221 | 0.591 |
| Uzbekistan | 2016 | 0.596 | 0.149 | 0.447 | 0.247 | 0.650 |
| | 2017 | 0.612 | 0.155 | 0.457 | 0.215 | 0.669 |
| | 2018 | 0.630 | 0.164 | 0.537 | 0.215 | 0.705 |
| | 2019 | 0.646 | 0.176 | 0.555 | 0.215 | 0.725 |
| | 2020 | 0.624 | 0.175 | 0.555 | 0.215 | 0.713 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | 2021 | 0.637 | 0.191 | 0.609 | 0.215 | 0.758 |
| | 2022 | 0.668 | 0.202 | 0.636 | 0.215 | 0.793 |
| | 2023 | 0.677 | 0.214 | 0.652 | 0.215 | 0.812 |
| | 2024 | 0.677 | 0.228 | 0.652 | 0.215 | 0.827 |

**Appendix 2.2: Dimensional indices of IGI**

| Country | Year | Social Index (SOC) | Human Dev. Index (HCD) | Economic Index (ECO) | Climate Index (CLI) | IGI (0–100) |
|---|---|---|---|---|---|---|
| Azerbaijan | 2014 | 0.91 | 0.76 | 0.54 | 0.47 | **63.60** |
| | 2015 | 0.94 | 0.77 | 0.54 | 0.52 | **65.31** |
| | 2016 | 1.00 | 0.78 | 0.51 | 0.57 | **66.29** |
| | 2017 | 0.94 | 0.78 | 0.51 | 0.53 | **64.25** |
| | 2018 | 0.94 | 0.79 | 0.51 | 0.55 | **64.73** |
| | 2019 | 0.94 | 0.80 | 0.52 | 0.59 | **66.24** |
| | 2020 | 0.94 | 0.73 | 0.49 | 0.54 | **62.77** |
| | 2021 | 0.94 | 0.75 | 0.52 | 0.58 | **65.38** |
| | 2022 | 0.94 | 0.81 | 0.55 | 0.55 | **66.90** |
| | 2023 | 0.94 | 0.83 | 0.56 | 0.52 | **67.08** |
| | 2024 | 0.94 | 0.83 | 0.58 | 0.52 | **68.13** |
| Georgia | 2014 | 0.20 | 0.87 | 0.35 | 0.94 | **50.94** |
| | 2015 | 0.23 | 0.89 | 0.36 | 0.90 | **51.67** |
| | 2016 | 0.15 | 0.89 | 0.38 | 0.90 | **50.83** |
| | 2017 | 0.10 | 0.91 | 0.40 | 0.98 | **52.69** |
| | 2018 | 0.14 | 0.94 | 0.43 | 0.99 | **55.47** |
| | 2019 | 0.13 | 0.96 | 0.46 | 0.94 | **55.95** |
| | 2020 | 0.11 | 0.93 | 0.43 | 0.98 | **54.22** |
| | 2021 | 0.11 | 0.92 | 0.48 | 1.00 | **57.26** |
| | 2022 | 0.15 | 0.98 | 0.55 | 1.00 | **61.63** |
| | 2023 | 0.16 | 1.00 | 0.60 | 1.00 | **64.53** |
| | 2024 | 0.18 | 1.00 | 0.67 | 1.00 | **68.12** |
| Kazakhstan | 2014 | 0.75 | 0.90 | 0.85 | 0.82 | **83.30** |
| | 2015 | 0.86 | 0.92 | 0.85 | 0.79 | **85.09** |
| | 2016 | 0.64 | 0.93 | 0.84 | 0.85 | **81.61** |
| | 2017 | 0.63 | 0.94 | 0.87 | 0.88 | **83.21** |
| | 2018 | 0.62 | 0.95 | 0.89 | 0.92 | **84.93** |
| | 2019 | 0.62 | 0.97 | 0.92 | 0.96 | **87.36** |
| Kazakhstan | 2020 | 0.62 | 0.94 | 0.88 | 0.94 | **84.80** |
| | 2021 | 0.62 | 0.91 | 0.91 | 0.96 | **86.06** |
| | 2022 | 0.62 | 0.96 | 0.93 | 0.98 | **87.83** |
| | 2023 | 0.62 | 0.98 | 0.96 | 0.97 | **89.69** |
| | 2024 | 0.62 | 0.98 | 1.00 | 0.97 | **91.35** |
| Kyrgyz Republic | 2014 | 0.87 | 0.52 | 0.08 | 0.52 | **39.08** |
| | 2015 | 0.74 | 0.54 | 0.08 | 0.49 | **36.10** |
| | 2016 | 0.81 | 0.55 | 0.08 | 0.59 | **39.89** |
| | 2017 | 0.73 | 0.57 | 0.09 | 0.62 | **39.05** |

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|---|---|---|---|---|---|---|
| | 2018 | 0.71 | 0.58 | 0.09 | 0.66 | **39.90** |
| | 2019 | 0.58 | 0.58 | 0.10 | 0.67 | **37.65** |
| | 2020 | 0.57 | 0.55 | 0.08 | 0.64 | **35.65** |
| | 2021 | 0.58 | 0.57 | 0.08 | 0.65 | **36.66** |
| | 2022 | 0.59 | 0.61 | 0.10 | 0.65 | **37.87** |
| | 2023 | 0.59 | 0.61 | 0.11 | 0.66 | **38.75** |
| | 2024 | 0.59 | 0.61 | 0.12 | 0.66 | **39.42** |
| Mongolia | 2014 | 0.40 | 0.70 | 0.33 | 0.57 | **44.71** |
| | 2015 | 0.45 | 0.72 | 0.33 | 0.56 | **45.91** |
| | 2016 | 0.45 | 0.74 | 0.33 | 0.59 | **46.67** |
| | 2017 | 0.45 | 0.74 | 0.35 | 0.67 | **48.83** |
| | 2018 | 0.44 | 0.76 | 0.37 | 0.68 | **50.42** |
| | 2019 | 0.47 | 0.73 | 0.39 | 0.72 | **52.09** |
| | 2020 | 0.48 | 0.68 | 0.36 | 0.70 | **49.60** |
| | 2021 | 0.48 | 0.64 | 0.36 | 0.71 | **49.10** |
| | 2022 | 0.48 | 0.68 | 0.38 | 0.68 | **50.03** |
| | 2023 | 0.48 | 0.70 | 0.40 | 0.69 | **51.82** |
| | 2024 | 0.48 | 0.70 | 0.42 | 0.69 | **52.64** |
| Pakistan | 2014 | 0.48 | 0.00 | 0.05 | 0.01 | **12.07** |
| | 2015 | 0.46 | 0.02 | 0.05 | 0.02 | **12.33** |
| | 2016 | 0.48 | 0.04 | 0.06 | 0.00 | **13.20** |
| | 2017 | 0.50 | 0.05 | 0.06 | 0.01 | **14.03** |
| | 2018 | 0.51 | 0.05 | 0.07 | 0.01 | **14.67** |
| | 2019 | 0.53 | 0.06 | 0.07 | 0.03 | **15.54** |
| | 2020 | 0.51 | 0.04 | 0.07 | 0.08 | **15.49** |
| | 2021 | 0.54 | 0.05 | 0.07 | 0.08 | **16.64** |
| | 2022 | 0.56 | 0.07 | 0.08 | 0.08 | **17.53** |
| | 2023 | 0.56 | 0.07 | 0.08 | 0.04 | **16.60** |
| | 2024 | 0.56 | 0.07 | 0.08 | 0.04 | **16.79** |
| Tajikistan | 2014 | 0.46 | 0.42 | 0.00 | 0.23 | **20.06** |
| | 2015 | 0.38 | 0.42 | 0.00 | 0.25 | **19.08** |
| | 2016 | 0.38 | 0.43 | 0.01 | 0.34 | **20.94** |
| Tajikistan | 2017 | 0.37 | 0.45 | 0.01 | 0.36 | **21.66** |
| | 2018 | 0.37 | 0.46 | 0.02 | 0.41 | **23.08** |
| | 2019 | 0.38 | 0.47 | 0.02 | 0.43 | **23.91** |
| | 2020 | 0.38 | 0.44 | 0.02 | 0.41 | **23.40** |
| | 2021 | 0.39 | 0.47 | 0.03 | 0.42 | **24.42** |
| | 2022 | 0.41 | 0.51 | 0.04 | 0.41 | **25.61** |
| | 2023 | 0.43 | 0.52 | 0.05 | 0.41 | **26.55** |
| | 2024 | 0.44 | 0.52 | 0.06 | 0.41 | **27.22** |
| Uzbekistan | 2014 | 0.28 | 0.56 | 0.13 | 0.34 | **26.57** |

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|---|---|---|---|---|---|---|
| | 2015 | 0.31 | 0.57 | 0.14 | 0.35 | **28.05** |
| | 2016 | 0.35 | 0.60 | 0.15 | 0.45 | **31.34** |
| | 2017 | 0.33 | 0.61 | 0.15 | 0.46 | **31.64** |
| | 2018 | 0.33 | 0.63 | 0.16 | 0.54 | **34.01** |
| | 2019 | 0.34 | 0.65 | 0.18 | 0.56 | **35.25** |
| | 2020 | 0.34 | 0.62 | 0.18 | 0.55 | **34.81** |
| | 2021 | 0.35 | 0.64 | 0.19 | 0.61 | **36.96** |
| | 2022 | 0.36 | 0.67 | 0.20 | 0.64 | **38.61** |
| | 2023 | 0.36 | 0.68 | 0.21 | 0.65 | **39.70** |
| | 2024 | 0.36 | 0.68 | 0.23 | 0.65 | **40.39** |