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Intellectual and Social Capital, Energy, and Resource Rents as Drivers of Economic Growth in Middle East and North Africa: Evidence from Panel ARDL Analysis

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ABSTRACT

This study examines the short- and long-term effects of intellectual capital (IC), social capital (SC), and natural resource rents, including energy rents, on economic growth in MENA countries. Using a panel ARDL model, the analysis covers knowledge-based assets, social networks, and dependence on natural and energy resources, while incorporating additional IC factors related to demographics, health, and poverty. The results show that IC has a strong positive effect on GDP, while SC alone has little impact. Resource and energy rents reduce growth, highlighting the risks of overreliance on extractive sectors. When IC and SC are combined, their effect on GDP becomes positive and significant, suggesting that social networks can enhance the effectiveness of knowledge-based assets. The study has practical value by pointing to policies that support innovation, skills development, and cooperation while reducing dependence on natural and energy rents. Theoretically, it extends endogenous growth and resource curse frameworks by showing how intangible and social capital jointly shape long-term economic performance in resource-dependent economies.

Keywords: Intellectual Capital, Social Capital, Resource Rents, Resource Curse Theory, Energy, Endogenous Growth Models, Middle East and North Africa
JEL Classifications: O40; O34; Z13; Q32; J24; C33; O53

1. INTRODUCTION

Intellectual capital (IC), encompassing human development, innovation, technology, health, and social capabilities, is increasingly recognized as a key driver of development in both knowledge-based and energy-dependent economies. IC has become central to economic growth and competitiveness, particularly in contexts where diversification beyond oil, gas, and other energy resources is essential for long-term progress. Scholars such as Edvinsson and Malone (1997), Bontis (1998), Pulic (2000), and Bounfour (2003) emphasize that IC, through its components of human, structural, and relational capital, creates value and fosters innovation. More recent studies (e.g., Kianto et al., 2014; Pedro et al., 2018) further highlight its importance for productivity and sustainable economic transition, especially in energy-rich countries facing structural limits to traditional growth. Unlike conventional models that rely heavily on physical and financial resources, IC captures intangible, knowledge-based assets that enhance productivity, competitiveness, and resilience in evolving energy and economic systems.

Saud et al. (2023) explore human capital's role in environmental sustainability in the Middle East and North Africa (MENA), finding that economic complexity reduces CO_2 emissions while natural resource abundance increases them. Cao et al. (2020) demonstrate how tertiary education reduces emissions in OECD countries, illustrating the complex environmental effects of education. At the organizational level, IC enables firms to leverage skills, expertise, and networks to optimize processes, enhance innovation, an(Edvinsson, 2013; Bontis, 2004). In a similar vein, Tran et al. (2022) discover that decreases in the shadow economy are correlated with greater national IC, suggesting that human, structural, and relational capital promote more formalized and responsible economic activity, which may tangentially improve environmental governance.d create value

At the national level, it contributes to economic growth, social inclusion, and environmental stewardship, reflecting the shift toward knowledge-driven development strategies. Several frameworks have sought to formalize IC's structure. The Skandia model (Edvinsson, 2013) and Bontis's national IC measurement system (2004) classify IC into human, market, process, and renewal capital, providing a foundation for understanding IC as a multidimensional construct (Lee et al., 2017; Marcin, 2013). In emerging economies, where structural constraints are more pronounced, IC can be particularly transformative by improving public policy efficiency, supporting technological adoption, and enhancing labor market outcomes.

Despite its growing importance, several challenges limit the development and utilization of IC. Many countries face structural barriers, such as insufficient education systems, low investment in research and development, and weak health infrastructure, which constrain human and social capital accumulation. Measurement of IC also remains inconsistent, as most studies rely on single proxies, such as education or patents, which overlook the multidimensional nature of IC and its systemic effects. Moreover, the links between IC and sustainable development are complex. While IC can enhance productivity and income, it may simultaneously increase ecological footprints or reinforce inequalities if investments are unevenly distributed (Hassan et al., 2019; Zhang et al., 2021 and Danish and Hassan, 2023). In emerging economies, rapid urbanization, industrialization, and trade integration amplify these challenges, making it critical to balance economic growth, social inclusion, and environmental sustainability. Enhancing IC often requires coordinated efforts to strengthen education and skills, incentivize innovation, foster knowledge-sharing networks, and build institutional trust, highlighting the importance of integrated approaches to knowledge-based development.

Research at the institutional and macroeconomic levels illustrates both the promise and challenges of IC. Barajas-Gonzalez et al. (2024) show that firms achieve optimal performance when human capital, social capital, and relational capital are invested at balanced levels, with both over- and under-investment yielding diminishing returns. Consistent with this, Morris et al. (2017) demonstrate that human capital signals firm value, shaping stakeholder perceptions and reinforcing IC's centrality in performance. At the macro level, the evidence is more mixed. Zhang et al. (2021) report that IC can reduce CO_2 emissions in Pakistan but simultaneously increase ecological footprints, revealing a growth-environment trade-off. Danish and Hassan in (2023) find that while economic growth worsens environmental degradation, human-capital-driven IC shows little effect. By contrast, Sun et al. (2023) demonstrate that IC, alongside trade diversification and renewable energy, can reduce the material footprint in BRICST economies, suggesting scope for resource efficiency. These divergent findings highlight the complexity of IC's environmental implications and the importance of measurement choices and model design.

Further, Bellucci et al. (2021) and Abdallah et al. (2025) stress that IC management cannot be separated from societal and cultural frameworks and advocate for an investigation of IC within larger social contexts. This reflects a growing understanding that IC and SC are overlapping entities rather than distinct domains: market and relational capital directly interact with SC to influence knowledge exchange, innovation processes, and institutional trust. Even with these advancements, research is still dispersed. While SC research frequently overlooks intellectual capital, the majority of IC studies do not include social capital factors. This division makes it impossible to fully comprehend how social frameworks and intangible resources work together to promote sustainable growth. This disparity is especially important for emerging countries, where socio capital dynamics vary by area.

Intellectual capital is also closely tied to income and social outcomes. Gyimah-Brempong and Wilson (2004) estimate that health-related IC accounts for up to 30% of income growth in OECD countries, though the effect decreases over time. Osiobe (2020) shows that IC raises GDP per capita in Latin America and also works indirectly through trade balance, while Olopade et al. (2019) highlight that IC elements—especially education—help reduce poverty in OPEC countries. These studies show that IC can strongly influence development, but its effects differ depending on the context. However, much of the existing research is fragmented, looking at single aspects of IC or focusing only on one country. Few studies explore how IC together shapes growth, poverty reduction, and environmental sustainability—issues that are especially pressing in emerging economies. Al-Mulali and Ozturk (2015) further stress that panel-based studies are needed in regions such as MENA, where energy, trade, urbanization, industrial activity, and political stability interact, pointing to the importance of analyzing IC within a broader, interconnected framework.

Addressing these gaps requires an integrated measure of IC capable of capturing its multidimensional nature and systemic effects. This study develops such a measure using principal component analysis (PCA) applied to a broad set of indicators including demographics, health, poverty, innovation, and technology. By moving beyond single-proxy approaches, it becomes possible to evaluate how IC simultaneously influences economic performance, social inclusion, and environmental pressures. This integrated measure allows for the identification of both synergies and trade-offs, offering insights into how investments in knowledge-based assets can be optimized to support sustainable development.

A broader understanding of intellectual capital (IC) shows how intangible resources shape development trajectories over time. Investments in human and social capital enhance productivity while improving well-being through poverty reduction, better health, and more equitable opportunities. Technological and process-related innovations also support energy efficiency, lower emissions, and promote responsible resource use. Viewed together, these dimensions position IC not merely as an economic input but as a multidimensional driver that connects economic progress with social and environmental advancement. This perspective highlights the need to treat IC as a systemic factor—one that supports balanced growth, social inclusion, and sustainable energy transition.

The analysis presented here contributes to this agenda by providing a comprehensive framework for assessing IC's systemic effects. It highlights how integrated IC investments can strengthen economic performance, foster social inclusion, and support environmental sustainability, while also revealing the trade-offs that might emerge. The findings are intended to guide policymakers, institutions, and businesses seeking to allocate resources effectively, enhance human and social capabilities, and stimulate innovation in ways that promote balanced and sustainable development.

The remainder of this paper is structured as follows. The next section reviews the literature on IC and its relationship with economic, social, and environmental outcomes. This is followed by a description of the methodology used to construct the multidimensional IC measure and analyze its impacts. The results are then presented and interpreted, with a discussion of their implications. The paper concludes by outlining key policy insights and suggesting directions for future research.

2. LITERATURE REVIEW

The foundations of intellectual capital (IC) research can be traced to broader economic growth theories that recognize the role of intangible assets in shaping long-term development. Traditional growth models, such as Solow's (1956) neoclassical framework, largely attributed growth to capital accumulation and labor, treating technological progress as an exogenous factor. However, this framework could not fully explain persistent differences in productivity across countries with similar physical capital endowments. This limitation led to the emergence of endogenous growth theories, which explicitly introduced human capital, innovation, and knowledge as central drivers of growth (Romer, 1986; Lucas, 1988) and development accounting such as Mankiw, et al. 1992. Romer's knowledge spillover model emphasized that investments in research and innovation generate increasing returns to scale, while Lucas's theory highlighted the role of human capital accumulation through education and learning-by-doing. These contributions laid the conceptual groundwork for IC research, shifting attention from tangible resources toward the value of intangible, knowledge-based assets in explaining sustainable development.

Building on these theoretical foundations, empirical studies began to highlight the strong relationship between human capital and growth. For example, Barro (1991) demonstrated through cross-country regressions that educational attainment significantly improves economic performance, while Benhabib and Spiegel (1994) emphasized that human capital not only raises productivity directly but also facilitates the adoption and diffusion of new technologies. Together, these studies illustrate that growth trajectories cannot be understood solely in terms of physical capital investment; rather, knowledge accumulation, education, innovation, skill formation, and institutional quality are indispensable components (Sanders and Ter Weel, 2000, Neycheva, 2010). This recognition directly informed the development of IC as a distinct field of research, emphasizing how intangible resources underpin productivity, competitiveness, and welfare beyond the explanatory reach of neoclassical models.

A nation's physical capital, labor force, natural resources, energy reserves, and knowledge-based assets collectively shape productivity and growth. Natural resources—including land, minerals, and water—alongside energy reserves such as oil, gas, coal, and electricity, are vital for industrial development and economic activity. However, according to the Resource Curse theory, an abundance of resources and energy reserves can hinder the accumulation of human and physical capital, constraining long-term growth. Empirical studies by Sachs and Warner (1999; 2001) and Leamer et al. (1999) show that resource- and energy-rich economies often experience slower technological advancement and weaker institutional development. Conversely, Stijns (2005) emphasizes that natural resources and energy reserves present both opportunities and risks, noting that the resource curse primarily affects oil and gas sectors. Thus, while tangible and intangible capitals jointly contribute to economic progress, overdependence on resources and energy reserves can undermine innovation and knowledge accumulation—key mechanisms through which intellectual capital enhances long-term economic performance.

As intellectual capital research evolved, scholars sought to conceptualize and measure IC systematically, giving rise to a range of frameworks that continue to inform the literature. A pioneering contribution came from Edvinsson and Malone (1997). The Skandia Navigator introduced one of the first comprehensive models for assessing IC within organizations. Their framework distinguished between human capital (employees' knowledge, skills, and abilities) and structural capital (organizational routines, databases, and processes), while also incorporating relational capital to capture the value of external networks and stakeholder relationships. This model highlighted that firms create value not only through physical and financial assets but also by leveraging intangible resources embedded in people, processes, and relationships.

Pulic (2000) further advanced measurement practices with the value added intellectual coefficient (VAIC™), which quantified the efficiency of human, structural, and capital employed resources in generating value. While the VAIC approach became widely used for empirical research due to its reliance on accounting data, it also faced criticism for oversimplifying IC and failing to capture its multidimensional, dynamic character (Ståhle et al., 2011). Nonetheless, Pulic's work was instrumental in moving IC from a largely conceptual discussion toward quantifiable metrics that could be applied across firms and countries.

Other key frameworks broadened the scope of IC analysis. Bontis (1998; 2004) was among the first to extend IC studies beyond the organizational level to the national level, proposing that IC contributes to macroeconomic competitiveness and national wealth creation. His measurement system classified IC into four dimensions—human, market, process, and renewal capital—providing a holistic lens for assessing how intangible resources drive development at different scales. More recently, scholars such as Kianto et al. (2014) and Pedro et al. (2018) emphasized the link between IC and sustainable development, showing how IC supports productivity, innovation, and adaptability in contexts where traditional growth models face structural limits. These later contributions underscore that IC is not merely a management tool for firms but also a national and global asset that determines resilience, competitiveness, and long-term sustainability.

Human capital remains a central pillar in understanding both economic growth and societal well-being, as evidenced by numerous empirical studies across regions and time periods. Gyimah-Brempong and Wilson (2004) highlighted that health-related human capital explains a substantial portion of per capita income growth, approximately 22% in Sub-Saharan Africa and 30% in OECD countries, underscoring the critical role of investment in education and healthcare. Importantly, their analysis also suggested diminishing returns at higher levels of health capital, implying that incremental improvements matter most in regions with low baseline health outcomes.

Beyond health, human capital broadly encompasses education, skills, and professional capabilities, which drive both productivity and innovation. Osiobe (2020) examined 14 Latin American countries from 1950 to 2014 and found that a 1% increase in human capital raised GDP per capita by 0.21%. The study further revealed significant indirect effects through trade balance, highlighting the complex channels through which skills, knowledge, and labor market dynamics influence growth. Similarly, Olopade et al. (2019) analyzed 12 OPEC countries, demonstrating that both education and health expenditures reduce poverty, with education being the more influential factor. These findings underscore the necessity of prioritizing human capital development for achieving sustainable socio-economic outcomes.

Recent studies have refined human capital measurements by integrating qualitative and demographic variables. Yu and Liu (2021) and Knapińska and Siński (2022) examined Polish regions, assessing indicators such as population size, working-age proportion, employment in larger firms, professional activity, school enrollment rates, and cultural participation. They found that high-quality human capital significantly promotes regional economic growth and local well-being, though they also emphasized the need for further research on environmental factors, particularly in the post-COVID-19 context. Their work aligns with the International National Intellectual Capital Index (INIC), which substitutes government spending on education and secondary/postsecondary enrollment as proxies for human capital quality, linking education policy directly to regional development outcomes.

Baily et al. (2021) contributed to the understanding of returns to human capital in advanced economies. Using the Mincer model, they linked education to wages in the U.S., Germany, and Japan, highlighting the persistent effects of job tenure, skill level, and gender on income distribution. Their findings revealed that although higher education improves earnings, systemic disparities remain, suggesting that investments in human capital must be complemented by labor market reforms to realize full potential. Collectively, these studies demonstrate that human capital shapes economic performance not only directly through productivity gains but also indirectly by influencing trade, innovation, and social inclusion, reinforcing its central role in both national and regional growth strategies.

Innovation represents a critical conduit through which IC translates into economic growth, productivity gains, and competitiveness. Phusavat et al. (2011) provided early evidence from Thailand, showing that all IC components—human, market, process, and renewal capital, positively impact GDP. Similarly, Popkova et al. (2015) highlighted the contribution of creativity, skills, and risk-taking to technological revolutions in advanced economies. These findings reinforce the notion that IC not only supports routine productivity but also facilitates the development and adoption of new technologies, creating sustainable competitive advantages. Using proxies including cross-border R&D, licensing, and subsidiary inventions. Li, Li, and Shapiro (2012) connected renewal capital to multinational companies' capacity to take use of local skills in emerging economies. Their analysis of Chinese businesses revealed that while geographical, cultural, and institutional barriers diminish investment, host-country technical advantages, investment experience, GDP growth, per capita income, and the existence of Chinese businesses abroad boost it.

Ståhle et al. (2015) extended these insights by proposing the ELSS framework, which emphasizes human, process, market, and renewal capital as interdependent drivers of total factor productivity (TFP). Their results suggest that market and renewal capital have the strongest effects on GDP through innovation networks, while human and process capital demonstrate weaker or context-dependent impacts. Gashe et al. (2024) further corroborated this by examining 29 countries from 1990 to 2020, constructing an IC index and finding a strong positive correlation between IC and TFP. Their study underscores the importance of R&D, human capabilities, and organizational innovation in explaining cross-country productivity differences, suggesting that policy interventions should simultaneously promote technological and social innovation to bridge productivity gaps.

The regional and national heterogeneity in IC's impact is also evident. Radenovic et al. (2021) found that in EU countries, high-tech exports, mobile subscriptions, and researchers in R&D positively influence growth, whereas government education and R&D spending exhibited ambiguous effects, reflecting challenges in IC absorption and efficiency. Kuzkin et al. (2019) and Stevanović et al. (2018) similarly highlight that renewal and innovation capital matter most in middle-income transition economies, whereas structural capital influences all income groups. Roze (2021) analyzed Russian regions, demonstrating that human capital consistently drives IC indices, while structural and relational components show significant regional variability. Sánchez Trujillo et al. (2020) examined Mexico and reported nuanced relationships between intellectual capital proxies like:

Education, patents, FDI, and trade openness—and regional GDP, indicating that the benefits of IC are highly context-specific.

The interplay between IC and external competitiveness is further demonstrated by Lin and Yeh-Yun, (2022), who showed that national intellectual capital (human, market, process, renewal, and financial capital) enhances inward FDI, with developed countries leveraging human and renewal capital, while developing countries rely more on market and process capital. Szafran, and Curie-Skłodowska (2015) emphasized renewal capital as a signal of future potential for foreign investors, while Saini and Singhania (2018) noted that poor infrastructure, governance, and corruption limit IC's positive effect on attracting investment. These studies collectively illustrate that IC is not only an internal productivity driver but also a strategic determinant of international competitiveness and integration into global value chains.

Recent and theoretically studies highlight the nuanced role of social capital (SC) in economic growth (Putnam, 1993). Hauser et al. (2007) and Muringani et al. (2021) analyzed 120 European regions using an index of bridging and bonding capital, with proxies like neighborhood participation and group memberships. Bonding capital can negatively affect GDP, while bridging capital has a positive impact; higher education mitigates bonding capital's negative effects, showing complex interactions with human capital. Ruiz et al. (2011) argue GDP overlooks intangibles and propose the National Index of Knowledge Capital (NIKC), including human capital (skills, knowledge), structural capital (processes, R&D, social/environmental factors), and non-explicit capital (tacit knowledge, culture). Xue et al. (2025) meta-analyzed 993 estimates from 81 studies, categorizing SC into cognitive (trust), structural (association membership), and others, with GDP growth or income as outcomes. They found small-to-medium positive effects, slightly stronger for cognitive capital. These findings show SC's impact is context-dependent, varies by type and proxies, and interacts with human capital, emphasizing careful measurement in research and policy.

The environmental and energy dimension of IC highlights the complex interplay between human, innovation, and institutional factors in shaping sustainability outcomes. Zhang et al. (2021) investigated Pakistan from 1985 to 2018 using Dynamic ARDL simulations, finding that human capital reduces CO_2 emissions but increases the ecological footprint. This suggests a trade-off between energy efficiency in production and broader resource consumption. Danish and Hassan in (2023), also examining Pakistan, found that economic growth raises the ecological footprint in both the short and long run, while biocapacity has a mitigating effect. Human capital in this context showed no significant influence, underscoring the need to integrate environmental and energy awareness into growth strategies.

Sun et al. (2023) extended the analysis to BRICST countries (Brazil, Russia, India, China, South Africa, Turkey) over 1990-2019, focusing on trade diversification, IC, renewable energy transition, and GDP effects on material footprint. Using Method of Moments Quantile Regression (MMQR), they found that IC and trade diversification reduce material footprint by promoting efficient resource use, while renewable energy transitions lower resource intensity through substitution away from fossil fuels. Conversely, GDP growth increases resource consumption. Wang et al. (2024) confirmed the Environmental Kuznets Curve (EKC) in a dynamic GMM model, showing that CO_2 emissions initially rise with income but decline beyond a certain threshold, with human capital and energy use having heterogeneous effects across countries.

These studies collectively highlight that IC's environmental impact is multidimensional. Human and renewal capital can promote sustainable practices through knowledge diffusion, technological adoption, and innovation. However, without complementary policies—such as energy efficiency, resource management, and regulatory enforcement—economic growth fueled by IC may exacerbate environmental pressures. The findings underscore the importance of context-specific strategies that integrate IC development with environmental stewardship, especially in emerging and developing.

3. METHODOLOGY

3.1. Data Selection

The first two sections of this study investigates the relationship between intellectual capital (IC), social capital (SC), and economic growth (GDP) using secondary data (2005-2022) from sources like the World Bank, World Value Surveys (WVS), European Value Surveys (EVS). IC is calculated as a weighted sum of human, renewal, market, and process capital, while SC is analyzed separately using a PCA-based index. Focusing on 8 countries, including MENA countries, the study investigates the distinct impacts of IC and SC on GDP and controls for resource rent, following prior research (Radenovic et al., 2021; Bowlus et al., 2022; Dasci Sonmez and Cemaloglu, 2021; Mačerinskienė and Aleknavičiūtė, 2017; Bontis, 2004).

$$REALGDP = C + \beta 1\ IC + \beta 2\ SC + \beta 3\ R\_rent + \mu i \quad (1)$$

In this case, ui represent unobservable factors that vary across units according to the flat method proposed by Bowlus et al in 2022. Ultimately, Equation (1) transforms into a new model for real GDP per capita, where real GDP is expressed as a function of a nation's overall ability to implement technological, social, organizational, ecological and marketing innovations. GDP per capita is transformed into logarithm form for simple calculation.

$$LnGDP = f\ (IC, SC)$$

3.2. Principal Component Analysis (PCA)

This study calculates the intellectual capital index using PCA in R-Studio to reduce variables and identify patterns. PCA creates uncorrelated linear combinations of variables (Smith, 2002), with the first principal component (PC1) explaining the most variance and subsequent components (PC2, PC3, etc.) explaining decreasing variance (Vyas and Kumaranayake, 2006). The "eigenvalues above 1" criterion determines the number of components, with weights summing to 1. For each country and year, the components are combined to form indices, as illustrated below:

$$PC_1 = a_{11}x_1 + a_{12}x_{12} + \ldots + a_{1n}x_n$$

$$PC_m = a_{m1}x_1 + a_{m2}x_2 + \ldots a_{mn}x_n$$

$$IC = (\sigma i^2).(PC1) + (\sigma i^2).(PC^2) + (\sigma i^2).(PC3) \quad (2)$$

$$IC = (\sigma i^2).(HC) + (\sigma i^2).(PC) + (\sigma i^2).(MC)) + (\sigma i^2).(RC)$$

Here, σi^2 represents the variance explained by each principal component.

3.3. Panel ARDL Model

This study utilized the ARDL Simulations model, building on the methodologies established by earlier researchers (Saud et al., in 2023; Dasci Sonmez and Cemaloglu, 2021; Radenovic et al., 2021). The data show significant cross-sectional heterogeneity, making a panel model the most suitable approach. We assessed stationarity using panel unit root tests, including Levin et al. (1992) for homogeneous panels and Im et al. (1997) for cross-sectional variation.

Our model results show a mix of I(0) and I(1) data sets. Stationarity was assessed using Augmented Dickey-Fuller, and the best ARDL model was selected via AIC. Panel Kao Fisher co-integration tests confirmed the suitability of the Panel ARDL model (Kao et al., 1999).

We applied the pooled least squares (OLS) model in equation (3)

$$LnGDP_{it} = \beta_0 + \beta_1 IC_{it} + \beta_2 SC_{it} + \beta_3 R\_rent_{it} + \mu_{it}* \quad (3)$$

And then, ARDL model as it is widely used in panel time series analysis as flexible alternatives to multivariate models (Verma, 2007). ARDL models dynamic variable interactions without structural restrictions, handling mixed-order variables I(0) and I(1)or I(1), making it ideal for this study. Following prior research (Dasci Sonmez and Cemaloglu, 2021; Radenovic, 2021; Bontis, 2004), the model links human capital dimensions with economic growth (equation 5). The study first explored the long-run relationship between endogenous variables with GDP growth as the response variable, to confirm long-term link.

ΔLn(GDPt)=C+ρ·REALGDPt−1+θ·ICt−1+θ·SCt−1+i=1∑p−1ϕi·ΔGDPt−i+i=0∑qπi·ΔICt−I+i=0∑qπi·ΔSCt−i+R_Rent+Ut

(4)

4. EMPIRICAL RESULTS AND DISCUSSION

This section presents results from descriptive statistics, Pearson correlation for variable relationships, and VIF tests for multicollinearity. Due to panel co-integration, serial correlation, and heteroskedasticity, Panel ARDL estimation was applied.

4.1. Empirical Results

4.1.1. Descriptive statistics

The results in Table 1 above show a positive and significant relationship between IC and GDP per capita (0.337***), indicating that higher intellectual capital is associated with economic growth. In contrast, SC is strongly negatively correlated with GDP per

Table 1: Descriptive statistics

Variables	Mean (SD)	IC	SC	R_rent	Ln (GDP)
IC	0.06 (2.80)	1	−0.404***	0.255***	0.337***
SC	0.39 (1.84)	−0.404***	1	0.051	−0.692***
R_rent	0.81 (0.30)	0.255***	0.051	1	−0.186
Ln (GDP)	12,635.65 (21,759.41)	0.337***	−0.692***	−0.186	1

Source: R-studio. ***, **, * indicate significance at the 1%, 5%, and 10% levels respectively. SD: Standard deviation

Table 2: Varimax factor loading

Variable name	MR1	MR4	MR2	MR3	Source
Scientific and technical journal articles	0.621	0.734		−0.146	World Bank
Government expenditure on education (% of GDP)		−0.451	0.234	0.585	World Bank
Current health expenditure (% of GDP)		0.363	0.548	0.411	World Bank
Hospital beds (per 1,000 people)	0.744		−0.209	−0.123	World Bank
ICT expenditure		−0.252		0.798	World Bank
Physicians (per million people)			−0.805	−0.288	World Bank
Primary pupils		0.238	0.892	−0.131	World Bank
Tertiary pupils	0.87	−0.332	0.194	−0.137	World Bank
R&D expenditure (% of GDP)	0.78		−0.392	0.206	World Bank
R&D expenditure in millions	0.327	0.289	−0.255	0.765	World Bank
Primary school enrollment		0.148	0.128	0.205	World Bank
Secondary school enrollment	0.342		−0.566		World Bank
Tertiary school enrollment	0.906	0.33			World Bank
Income share of top 10%	0.726	0.15	−0.129		World Bank
Infant mortality rate		−0.361	0.807		World Bank
Trade (% of GDP)	−0.468	−0.282	−0.497	0.572	World Bank
Patent applications		0.976	0.193		World Bank
High-technology exports (% of total exports)	−0.316		0.235	0.793	World Bank
Age dependency ratio (%)	−0.5		0.71	0.219	World Bank

Source: Author's calculation

Table 3: Intellectual capital operational variables

IC dimension	Variable name
Human capital (HC)	Hospital beds (per 1,000 people)
	Tertiary pupils
	R&D expenditure (% of GDP)
	Tertiary school enrollment
	Income share of top 10%
	Age dependency ratio (%)
Renewal capital (RC)	Scientific and technical journal articles
	Government expenditure on education (% of GDP)
	Patent applications
Process capital (PC)	Current health expenditure (% of GDP)
	Physicians (per million people)
	Primary school enrollment
	Secondary school enrollment
	Infant mortality rate
	Trade (% of GDP)
Market capital (MC)	ICT expenditure
	R&D expenditure in millions
	High-technology exports (% of total exports)

Source: Author's calculation

capita (−0.692***), suggesting potential structural or regional disparities. R_Rent has a weak negative correlation with GDP per capita (−0.186), showing a slight inverse relationship. Additionally, the negative correlation between IC and SC (−0.404***) highlights potential trade-offs between these two forms of capital. These findings reflect the complex interplay between economic, social, and environmental factors.

4.2. Principal Component Analysis

The intellectual capital index was constructed through several steps. First, the proportion of variance was calculated, followed by the selection of variables using Varimax rotation. Eigenvalues were then computed across years, countries, and variables to derive the index. The resulting eigenvalues show that the principal components account for 80% of the total variance, indicating that four factors capture nearly two-thirds of the relationships among the proxy variables. The rotated Varimax component matrix corresponds closely with the theoretical framework described earlier, with the fourth component predominantly representing the four key indicators of intellectual capital. The Table 2 presents the variables selected based on their Varimax factor loadings.

Variables were retained in the factor analysis if their loadings were ≥0.4, as this threshold reflects a moderate to strong association with the factor. Loadings below 0.4 are considered weak and are typically excluded (Guadagnoli and Velicer, 1988). The components of intellectual capital were then organized according to prior literature and the author's judgment, as presented in the Table 3.

The subsequent step involved calculating indices using the selected variables ($PC1$, $PC2$,…, PCm) across all countries, years, and variables. The socio-capital index, following the approach of Hauser et al. (2007) and Muringani et al. (2021), was constructed using PCA and incorporated both bridging and bonding components. This index was computed as a weighted average of the relevant indicators, with data sourced from the world values survey (WVS) and the european values study (EVS) (Table 4).

4.3. Model Identification

The PCA-derived indexes were regressed on Ln (GDP), controlling for resource rent (R_rent), following unit root and co-integration tests to select the best panel analysis method. Stationarity was tested using the Augmented Dickey-Fuller (ADF) test, with results in Table 5.

The Table 5 shows that all variables are either I(0) or I(1), supporting the use of the ARDL model. ADF tests indicate that IC, SC, R_rent, and GDP per capita become stationary after first differencing (I[1]). This confirms the data are suitable for analyzing long-term relationships and ensures reliable results for the model.

4.4. Panel Estimation

Table 6 presents the panel least squares (PLS) estimation results. The constant (C) has a coefficient of 8.89 (t-statistic: 75.05), significant at the 1% level. Intellectual Capital (IC) positively affects the dependent variable, with a coefficient of 0.09 (t-statistic: 5.61), significant at 1%. Social capital (SC) shows a negative coefficient of −0.01 (t-statistic: −1.43), but it is not statistically significant (P = 0.15). Resource rents (R_rent) negatively impact the dependent variable, with a coefficient of −0.43 (t-statistic: −2.91, significant at 1%).

The Panel EGLS (cross-section random effects) results support these findings. The constant (C) remains highly significant (coefficient: 8.81, t-statistic: 23.16, P < 0.01). IC (0.09) and SC (−0.01) maintain similar effects as in the PLS model, with SC again not significant (P = 0.13). R_rent continues to negatively affect growth (coefficient: −0.42, t-statistic: −2.89, significant at 1%).

The Pesaran CD test for cross-sectional dependence is significant (P = 0.000), confirming residual correlation across countries and suggesting attention to potential model specification and time-series autocorrelation.

The Kao Residual Cointegration Test in Table 7, was used to check whether resource rent, LN(GDP), IC, and SC move together in the long run. The ADF (Augmented Dickey-Fuller) statistic is −1.81 with a P = 0.035, which is below 0.05 (Kao et al., 1999 and Pedroni 1999). This indicates that we can reject the null hypothesis of no co-integration, meaning these variables are co-integrated. Based on this result, the Panel ARDL model was applied to analyze their long-term relationships.

The initial ARDL model showed insignificance, serial correlation, and cross-sectional dependence. The below ARDL model will provide the effect of IC and SC as one index computed using factor analysis on ln(GDP) in the Tables 8a and b.

According to the method of Kao et al., 1999 and Pedroni, 1999, the Panel ARDL Cointegration and Long-Run results indicate that in the short run, a 1% increase in the combined Intellectual

Table 4: Socio capital operational variables

WVS variables	
Socio capital	• Bonding social capital: Proxy: Measured through individuals' participation in political parties, local political action groups, and trade unions. • Bridging social capital: Calculated through the share of the population in different types of voluntary associations, such as cultural, religious, and human rights organizations.

Source: Author's calculation

Table 5: Unit root test

Variable	At level	At first difference
Ln (GDP)	0.1274	0.000*
IC	0.2343	0.000*
SC	0.4868	0.000*
R_rent	0.4015	0.000*

Source: R-studio. ***, **, * indicate significance at the 1%, 5%, and 10% levels respectively

Table 6: Panel estimation

Model/variable	Coefficient	t-statistic	P-value
Panel OLS			
C	8.894	75.05	<2e−16***
IC	0.085	5.61	0.000***
SC	−0.011	−1.43	0.155
R_rent	−0.428	−2.91	0.004***
Jarque-Bera test			0.000***
Panel EGLS (cross-section random effects)			
C	8.806	23.16	<2e−16***
IC	0.087	5.77	0.000***
SC	−0.011	−1.52	0.132
R_rent	−0.423	−2.89	0.005***
Cross-sectional dependence			
Pesaran CD test			0.000***

Source: R-studio. ***, **, * indicate significance at the 1%, 5%, and 10% levels respectively

Table 7: Cointegration test

Kao Residual Cointegration Test	t-statistic	Probability
ADF	−1.807	0.0354***
Residual variance	0.00122	
HAC variance	0.00131	

Source: R-studio. ***, **, * indicate significance at the 1%, 5%, and 10% levels respectively

Table 8a: Panel ARDL model

Variable	Coefficient	Standard error	t-statistic	P-value
Cointegrating form (short run)				
D (IC/SC)	1.115	0.115	9.66	0.000***
CointEq(−1)	−0.118	0.04	−2.95	0.004**
Long-run coefficients				
IC/SC	0.549	0.221	2.48	0.014**
Constant (C)	8.506	0.256	33.26	0.000***

Source: R-studio. ***, **, * indicate significance at the 1%, 5%, and 10% levels respectively

Table 8b: Diagnostic tests

Diagnostic statistics tests	P-values	Results
Ramsey RESET test (F-statistic)	0.0644	Model is likely correctly specified at 5%.
Breusch-godfrey serial correlation LM test	0.4927	Serial correlation does not exist.
Heteroskedasticity test: ARCH	0.1407	Heteroskedasticity does not exist.

Source: R-studio. ***, **, * indicate significance at the 1%, 5%, and 10% levels respectively

and Social Capital (IC/SC) leads to an immediate 1.12% increase in GDP, which is highly significant ($t = 9.66$, $P < 0.01$). The error correction term, CointEq(−1), has a coefficient of −11.8% ($t = −2.95$, $P < 0.01$), showing that about 12% of the short-term deviation from the long-term equilibrium is corrected each period. In the long run, a 1% increase in IC/SC is associated with a 0.55% increase in GDP, indicating a positive and statistically significant effect ($t = 2.48$, $P < 0.05$), while the constant term represents the baseline GDP level (8.506). These results support prior findings that intellectual capital contributes to economic growth, especially when supported by social capital networks (Al-Mulali and Ozturk, 2015; Bellucci et al., 2021; Sun et al., 2023; Barajas-Gonzalez et al., 2024).

$$\Delta Ln(GDP) = 1.1148 - 0.1185 \cdot CointEq(t-1) + 0.5494 \cdot IC/SC + 8.5060$$

The results show that intellectual capital (IC) has a positive and statistically significant effect on economic growth in both the short and long run, consistent with studies that emphasize the contribution of human, renewal, and knowledge assets to productivity and development (Edvinsson and Malone, 1997; Bontis, 2004; Ståhle et al., 2015; Gashe et al., 2024). In contrast, social capital (SC) appears with a negative and insignificant coefficient, reflecting earlier findings that its impact can vary depending on network structures, institutional quality, and context (Hauser et al., 2007; Bellucci et al., 2021; Barajas-Gonzalez et al., 2024; Abdallah et. al. 2025). Resource rents show a negative association with growth, aligning with resource-curse arguments that stress the challenges of rent dependence without adequate reinvestment (Rahim et al., 2021). The Kao cointegration test suggests a long-term equilibrium relationship among GDP, IC, SC, and resource rents, while the ARDL model captures significant short-run dynamics and a gradual adjustment toward equilibrium. Diagnostic tests indicate that the model is correctly specified and free of serial correlation, confirming discussions of Zhang, 2021, Sun et al., 2023 and Wang et al., 2024, tests were developed by Bera & Higgins in 1993, Ramsey in 1969 and Breusch-Godfrey in 2015.

5. CONCLUSION

This study examined the relationship between intellectual capital (IC), social capital (SC), energy resource rents, and economic growth in MENA countries using panel and ARDL approaches. The results consistently show that IC plays a significant and positive role in driving GDP growth, while SC on its own is statistically insignificant. However, when IC and SC are combined into a single index, their joint effect becomes positive and significant, suggesting that social networks can strengthen the contribution of knowledge-based assets to economic performance. Energy and resource rents, in contrast, exhibit a negative effect on growth, consistent with the "resource curse" hypothesis, highlighting how heavy reliance on oil, gas, and other extractive revenues constrains diversification and knowledge-driven development in resource-abundant economies (Al-Mulali and Ozturk, 2015; Bellucci et al., 2021; Abdallah et al. 2025).

From a policy standpoint, these findings emphasize the need for governments to diversify growth strategies beyond resource rents by investing in intangible assets. Strengthening IC and SC can be achieved through innovation incentives, vocational and higher education reforms, and policies that encourage collaboration between firms, research institutions, and civil society. On a practical level, managers can leverage these findings by fostering knowledge-sharing, employee development, and cross-departmental collaboration, which not only enhance firm-level competitiveness but also contribute to broader macroeconomic development (Barajas-Gonzalez et al., 2024).

Despite these insights, the study has several limitations. First, the analysis relies on secondary data, which may constrain the accuracy and depth of measurement for IC and SC indicators. Second, the model focuses on aggregate effects in MENA countries and does not account for sectoral or institutional heterogeneity, which could shape the dynamics of IC and SC differently across industries.

Finally, future research should address these limitations by employing longitudinal and sector-specific analyses to better capture the dynamic interactions between IC, SC, and economic growth. In addition, examining other forms of intangible assets, such as organizational culture, digital transformation, and environmental sustainability practices, could provide a more comprehensive understanding of the drivers of growth in knowledge-based economies. By highlighting the complementary role of IC and SC and the risks of overreliance on resource rents, this study contributes to ongoing debates on sustainable development strategies in the MENA region.

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