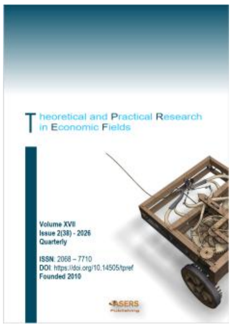
From Complexity to Prosperity: Economic Complexity's Impact on BRICS Economic Wealth



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Abstract: This study examines the impact of technological advancement on economic wealth in BRICS countries over the period 2000–2020. Technological advancement is measured using the Economic Complexity Index (ECI). Economic wealth is measured using a revised Economic Wealth Index (EWI), constructed by excluding GDP, patent applications, and the ECI.Short-run effects are estimated using a panel fixed effects model with Driscoll–Kraay robust standard errors. Long-run relationships are examined through Pedroni cointegration tests and Panel Dynamic Ordinary Least Squares (PDOLS) analysis. Analyses indicate that ECI has a positive and statistically significant effect ($p<0.01$) on EWI in both the short and long run. According to the test results, a one-unit increase in ECI leads to an increase of approximately 1.49 units in EWI in the short term and 1.82 units in the long term. These findings suggest that the level of advanced technology and investments in research and development plays an important role in increasing economic wealth. This study differs from previous studies in the literature by examining both the short- and long-run effects of technological advancement on economic wealth using a revised EWI.

Keywords: BRICS; economic complexity index; economic wealth index; principal component analysis.

JEL Classification: O33; O47; C23; F14.

Introduction

This study brings together technology and economic wealth and examines how high technology, advanced manufacturing capabilities, and complex economic diversification affect economic wealth creation. It is thought that examining the relationship between technology and economic wealth can explain why some economies fail, while others achieve sustainable and desired prosperity.

Despite the growing body of research linking economic complexity to income and growth, the relationship between economic complexity and a broader concept of economic wealth remains underexplored. Existing studies largely rely on GDP-based indicators and do not examine whether structural technological sophistication translates into multidimensional prosperity that also includes social and institutional dimensions. Furthermore, the short- and long-run dynamics of this relationship have not been jointly analyzed within a composite wealth framework.

In light of this gap, this study seeks to address the following research questions:

1. Does economic complexity significantly affect economic wealth in BRICS countries?
2. Is this relationship valid in both the short and long run?
3. To what extent does technological sophistication contribute to a multidimensional measure of economic wealth beyond income-based indicators?

This study utilizes the economic complexity index (ECI), developed by Hidalgo and Hausmann (2009), which shows a nation's technological capacity. However, the core problem addressed is how to measure economic wealth. Traditional indicators such as Gross Domestic Product (GDP), savings rates, and employment figures give only partial insights and ignore critical social, structural, and institutional factors - like the quality of governance, equity, and human capital development - that fundamentally influence real economic wealth. Therefore, this study uses the Economic Wealth Index (EWI) (Öcal, 2025), which provides a more comprehensive composite framework for measuring economic wealth by combining economic, social, and institutional dimensions.

This study extends the literature by examining the short- and long-run effects of economic complexity on economic wealth using a revised ECI. Focusing on BRICS countries over the period 2000–2020, first the EWI was built with Principal Component Analysis (PCA), then the link between EWI and ECI was checked with cointegration tests, and finally panel estimations were carried out.

1. Literature Review

How to measure economic wealth has been debated in economics for several years. Within this debate, the idea of economic complexity appears as a way to look at the structural side of wealth. Based on Hidalgo and Hausmann (2009), ECI shows how well a country can produce and export a wide range of knowledge-based goods. In this sense, ECI links economic wealth not only to capital accumulation but also to productive knowledge.

Many studies in literature have examined the impact of economic complexity on development and growth. Hausmann *et al.* (2007, 2011) found that countries exporting more advanced products tend to grow faster. They argue in their analysis using the ECI that countries with more technologically advanced products that have higher levels of knowledge and skill and complex production structures tend to be richer. In their study Stojkoski and Kocarev (2017) also argue that economic complexity enhances and maintains long-term and sustained high levels of income expansion in Central and Southeastern European nations. Gala *et al.* (2018) suggest that developing countries with higher ECI scores have a higher potential to reach the level of developed countries.

In 2012, Tacchella *et al.* (2012) studied on a new nonlinear "fitness" model to measure countries' production and complexity capacity and they showed that growth depends not only on the goods produced but also on the complexity and knowledge intensitivity level of the production structure. Similar results have been reached later in several studies. For example, Poncet and De Waldemar (2013) showed a positive correlation between higher export complexity and stronger economic development. Hartmann *et al.* (2017) also demonstrated that income inequality is lower in more complex economies.

Recent empirical studies further supports the social dimension of economic complexity. Subekti (2024), using a dynamic panel approach for G20 countries, finds that higher economic complexity significantly reduces income inequality. These findings suggest that economic complexity may influence not only growth but also distributive outcomes, reinforcing its broader socio-economic implications.

Emerging research highlights the heterogeneous social effects of economic complexity. Kumar *et al.* (2025), examining 32 Asian countries, find that the impact of economic complexity on income inequality varies across income distribution quantiles, suggesting that complexity may reduce inequality at lower levels while exacerbating disparities at higher levels. These findings underline the nuanced and multidimensional implications of economic complexity beyond aggregate income measures.

Some studies have examined how complexity is related to stability and structural changes. Güneri (2019) showed that higher complexity is linked to lower output volatility. Country-specific work also supports this idea. O'Clery (2016) showed that Ireland's drop in export diversity was followed by a decrease in its ECI score. Camargo and Gala (2017) noted that low complexity may help explain the "Dutch disease" patterns observed in resource-dependent economies.

Contemporary research continues to emphasize the role of economic complexity in structural transformation and sustainable growth dynamics. For instance, Mellini and da Silva (2024) links economic complexity to improvements in Thirlwall's elasticity ratio, highlighting its importance for long-term growth patterns and balance-of-payments sustainability.

Additional evidence extends the scope of economic complexity research beyond income-based measures. Hamdi *et al.* (2025), using a buffered panel threshold regression for a large sample of countries, demonstrate that economic complexity significantly affects human development, with heterogeneous effects depending on institutional quality and resource dependence.

Current studies show that economic complexity is related to many outcomes such as growth, inequality, and economic stability. However, most of these studies relied on income-based measures. Recent evidence also indicates that the effects of economic complexity are multidimensional and context-dependent, varying across institutional and socio-economic settings. Nevertheless, only a few studies have examined whether complexity affects economic wealth, which reflects a broader form of prosperity that also includes social and institutional aspects.

The literature does not offer a single or widely agreed-upon definition of economic wealth. However, many studies agree that economic wealth is a broad and integrated concept that combines economic, social, and institutional factors. When discussing economic wealth, it should not be understood that it is related only to economic and financial indicators. Economic wealth also reflects a country's ability to create and sustain prosperity, distribute wealth fairly, and ensure that institutions operate transparently and effectively, free from disruptive factors that undermine the economy and social order, such as bribery and corruption (Öcal, 2025).

Barbier's (2015) research shows four key dimensions of economic wealth: physical infrastructure and equipment that form produced capital; education, skills, and health that compose human capital; environmental resources like land and forests that are natural capital; and the monetary holdings, stocks, and bonds that constitute financial assets. Similarly, Chikviladze (2023) contends that a nation's economic wealth shows cumulative competencies, including both intangible assets and human capabilities, which shape its sustained productive potential over time. These studies show that economic wealth is a dynamic phenomenon that has evolved. It isn't a static collection of assets and resources.

Stiglitz, Sen, and Fitoussi (2009) state that seeing GDP as the sole measure of economic performance is insufficient, because relying solely on GDP does not account for what is produced, who benefits from it, and the methods used in production. This may indicate that economic wealth is shaped by both the size of economic output and its structure and distribution among people. Similarly, Ofori-Sasu *et al.* (2024) state that national wealth reflects the combined value of key resources under a country's control.

Overall, the literature has shown that economic complexity is associated with growth, inequality, and economic stability, yet most empirical evidence relies on income-based indicators. Although the concept of economic wealth has been discussed in broader terms, the relationship between economic complexity and a multidimensional composite measure of economic wealth has received limited empirical attention. This study contributes to the literature by linking economic complexity to a revised Economic Wealth Index and addressing this gap.

2. Method

The study covers the period 2000–2020, for which complete data are available for all components of the EWI, allowing the implementation of PCA. This period was chosen not only because it ensures data integrity but also because it represents a period of accelerated capital flows and strengthened global economic ties within economies (Özatay, 2015). At the same time, BRICS countries have undergone rapid transformation over the last two decades and constitute a suitable sample for studying the impact of technology on economic wealth.

Technological advancement was measured using ECI. The ECI data were obtained from the Atlas of Economic Complexity (Harvard Growth Lab, 2024). To measure economic wealth, the EWI (Öcal, 2025) was employed after removing patent applications, and ECI from its components. These variables were excluded to avoid conceptual overlap with the explanatory variable and to ensure that economic wealth was measured independently fom technological indicators.

Table 1. Indicators and Data Sources Used for the Reconstruction of EWI

Indicator	Dimension	Source	Years
GDP per capita	Economic	World Bank, WDI	2000 - 2020
Gross Fixed Capital Formation (% of GDP)	Economic	World Bank, WDI	2000 - 2020
Savings Rate (% of GDP)	Economic	World Bank, WDI	2000 - 2020
Economic Freedom Index	Economic	Heritage Foundation	2000 - 2020
Employment Rate (% of total population)	Social	World Bank, WDI	2000 - 2020
GINI Index	Social	World Bank, UNU-WIDER (WIID)	2000 - 2020
Human Capital Index	Social	Penn World Table	2000 - 2020
Control of Corruption	Institutional	World Governance Indicators	2000 - 2020

Source: calculated by the authors

GDP was also removed, because GDP per capita was already included in the index. Following these adjustments, the EWI constructed in this study consisted of economic, social, and institutional components. Economic indicators included GDP per capita, gross fixed capital formation, the savings rate, and economic freedom. Social indicators included the employment rate, the GINI index, and human capital. Institutional indicator was represented by control of corruption. Table 1 shows the EWI indicators, their sources, and the years of the data used.

To build the EWI for each country, PCA was used to combine the selected variables under a single composite measure. PCA was chosen to allow the relative importance of the indicators to be determined from the data itself, rather than assigning equal or arbitrarily chosen weights. The suitability of the data for PCA was confirmed by acceptable test results (KMO > 0.6; Bartlett's test of sphericity, $p < 0.001$). The first principal component was used as the EWI for each country and year. This procedure yielded a single economic wealth score for each country and year.

To explore the link between economic complexity and economic wealth, the following model was used:

$$ECI_{it} = \beta_0 + \beta_1 EWI_{it} + e_{it} \quad (1)$$

Here, ECI_{it} is the economic complexity value for country *i* in year *t*, EWI_{it} is the economic wealth measure, and e_{it} is the error term.

After setting up the model, the analysis started with stationarity and cointegration tests to see whether the variables moved together in the short and long run.

In the short run, the link between ECI and EWI was estimated with a fixed-effects model using the Driscoll–Kraay standard errors. In the long run, Pedroni's panel cointegration tests and Panel Dynamic Ordinary Least Squares (PDOLS) were used to explore dynamic relationships.

Before estimating the short-run relationship, the Hausman specification test was applied to determine the appropriate estimator. The test results supported the use of a fixed-effects model. Second, diagnostic tests were employed and indicated the presence of heteroskedasticity and serial correlation in the panel structure. Since these violations render conventional fixed-effects standard errors inconsistent, the short-run model was estimated using Driscoll–Kraay corrections, which correct for heteroskedasticity, autocorrelation and cross-sectional dependence issues and are suitable for panels with a small number of cross-sections and a relatively long-time dimension.

Before estimating the long-run coefficients, the Pedroni (2004) panel cointegration test was applied to examine whether a stable long-run relationship exists between ECI and EWI. Given the evidence of cointegration, the long-run coefficient was estimated using the PDOLS method, which accounts for serial correlation, endogeneity, and dynamic adjustments through lead–lag terms.

3. Research Results

3.1 Construction of the Economic Wealth Index (EWI)

The PCA results indicated that the data were suitable for factor extraction. The Kaiser–Meyer–Olkin (KMO) measure exceeded the acceptable threshold (KMO>0.6), and Bartlett's test of sphericity was statistically significant ($p<0.001$), confirming the appropriateness of PCA. Based on the first principal component, annual EWI scores were computed for each BRICS country over the period 2000–2020. The resulting EWI values are reported in Table 2.

Table 2. Annual EWI Scores for BRICS (2000–2020)

Year	Brazil	Russia	India	China	South Africa
2000	0.98815	-1.85841	-1.46514	-0.79093	1.55832
2001	1.03664	-1.80184	-1.53112	-1.43343	1.43979
2002	1.12631	-1.21341	-1.45367	-1.23238	1.41662
2003	1.12741	-1.23319	-1.31106	-1.04148	1.47476
2004	1.06441	-1.024	-1.25492	-0.9334	1.14816
2005	0.84741	-1.01909	-0.51489	-0.70364	0.8184
2006	0.75127	-0.71744	-0.37051	-0.6087	0.69557
2007	0.47937	-0.15661	-0.259	-0.76304	0.41487
2008	0.53582	0.15052	-0.05055	-0.54746	0.18215
2009	0.223	0.45439	-0.02362	-0.30895	0.16855

Year	Brazil	Russia	India	China	South Africa
2010	0.30452	0.27037	0.11649	-0.41226	-0.25418
2011	0.29731	0.29184	-0.27947	-0.12575	-0.66131
2012	0,11335	0.51981	0.20492	0.0532	-0.88203
2013	-0.08229	0.73149	0.38234	0.48197	-0.85217
2014	-0.56554	0.8113	0.64433	0.6399	-0.73708
2015	-0.89824	0.65641	0.76551	0.75166	-0.82185
2016	-1.08025	0.80023	1.15586	0.82508	-0.83411
2017	-1.50065	1.1152	1.02862	1.16073	-0.85971
2018	-1.47489	0.92997	1.32957	1.37829	-0.93133
2019	-1.44244	1.04171	1.33994	1.52174	-1.2592
2020	-1.85067	1.25075	1.54639	2.08884	-1.22423

Source: calculated by the authors

3.2 Short-run Estimation Results

Before estimating the short-run model, the Hausman specification test was applied. The results are reported in Table 3.

Table 3. Hausman Specification Test Results

Estimator	Coefficient
Fixed Effects (b)	1.488
Random Effects (B)	0.368
Difference (b − B)	1.120
Test Statistic	Value
Chi-square (1 df)	9.86
p-value	0.0017

Source: calculated by the authors

The null hypothesis assumes that the random-effects estimator is consistent. Since $p < 0.01$, the null hypothesis is rejected, indicating that the fixed-effects model is the appropriate specification for short-run estimation.

The short-run estimation results based on the fixed-effects model with Driscoll–Kraay corrections are presented in Tables 4 and 5.

Table 4. Fixed-Effects Model Regression Results with Driscoll–Kraay Standard Errors for the Short-Run

Dependent Variable : EWI					
Variable	Coefficient	Std. Error	t-stat	p-value	95% CI
ECI	1.488	0.415	3.59	0.001	[0.665 – 2.312]
Constant	-0.413	0.147	-2.80	0.001	[-0.706 – -0.121]

Source: calculated by the authors

Table 5. Model Diagnostics for the Short-Run Fixed-Effects Estimation

Model Diagnostics			
R-squared (Within)	0.1149	R-squared (Between)	0.1061
F-statistic	12.85	Prob > F	0.0005
ρ (fraction of variance due to u_i)	0.3179		

Source: calculated by the authors

The fixed-effects regression results, corrected for heteroskedasticity and serial correlation using Driscoll–Kraay standard errors, indicate that ECI in BRICS economies has a positive and statistically significant coefficient on EWI. Specifically, a one-unit increase in ECI raises EWI by approximately 1.49 points ($p < 0.01$).

3.3 Long-run Estimation Results

Before estimating the long-term coefficients, the Pedroni (2004) panel cointegration test was applied. Table 6 reports the results of the Pedroni (2004) panel cointegration test for ECI and EWI.

Table 6. Pedroni Panel Cointegration Test Results for ECI and EWI

Test Statistic	Panel	Group
Panel-t	-2.253	-
Group-t	-	-2.337
Panel-ADF	-0.5196	-
Group-ADF	-	0.8956

Source: calculated by the authors

In Pedroni's tests, large negative t-statistics ($|t| > 1.96$) indicate rejection of the null of no cointegration. Accordingly, among the within- and between-dimension measures, the panel and group t-statistics are significant at the 5% level, indicating the presence of cointegration between the two variables. These results suggest that ECI and EWI move together in the long run.

Given the evidence of cointegration, the long-run coefficient was estimated using the PDOLS method, which accounts for serial correlation, endogeneity, and dynamic adjustments through lead–lag terms. The PDOLS long-run estimation results are reported in Table 7.

Table 7. PDOLS Long-Run Coefficient Estimates: Impact of ECI on EWI

Panel PDOLS estimation details:		
no. of panel units : 5	lags and leads : 2	
number of obs : 80	avg obs. per unit : 16	
data points were time-demeaned.		
Variables	Beta	t-stat
ECI_td	1.822	3.226

Source: calculated by the authors

The estimated coefficient of ECI is approximately 1.82, and the associated t-statistic ($t = 3.226$) exceeds the 1% critical value, indicating significance at the 1% level ($p < 0.01$). These results indicate that economic complexity has a positive and statistically significant long-run relationship with economic wealth in BRICS countries.

5. Discussions

The empirical results show that, in the near term, economic complexity affects economic wealth in BRICS economies in a positive and statistically significant way. Therefore, it can be argued that even in short periods as economic complexity increases, economic wealth also increases, and countries with higher technological levels and intensive knowledge production structures can achieve stronger economic wealth levels in the short run.

The long-term estimation results also indicate the ECI and EWI tend to move together and there is a positive and stable relationship between them. Therefore, it can be argued that high technology contributes to the sustainable increase in the economic wealth of countries in the long run.

Recent global developments between 2021 and 2026 have further underscored the importance of economic complexity in shaping long-term prosperity. The COVID-19 pandemic, supply chain disruptions, geopolitical tensions, and the acceleration of digital and green transformations have altered global production structures. In this evolving environment, countries with diversified and technologically advanced production capabilities appear better positioned to adapt to external shocks and structural changes, thereby strengthening the structural foundations of economic wealth. For emerging economies, including BRICS countries, strengthening productive capabilities and institutional quality have become increasingly critical for sustaining economic wealth beyond income-based growth.

These developments reinforce the relevance of the complexity–wealth nexus identified in this study and suggest that future research incorporating post-2020 data may provide additional insights into the evolving structural dynamics of global economies.

This study offers three main contributions to literature. First, it extends the economic complexity literature beyond income-based outcomes by linking ECI to a multidimensional composite measure of economic wealth. Second, it introduces a revised EWI framework that avoids conceptual overlapping with technological indicators. Third, it jointly examines short- and long-run dynamics using panel cointegration and PDOLS techniques, offering a more comprehensive understanding of the complexity–wealth nexus.

Conclusions and Further Research

The findings of this study point to several important conclusions. First, high technology and a high-technology-based production structure affect not only the growth process but also the capacity to create wealth. Second, given that ECI positively impacts economic wealth, it is fair to say that R&D investments in high technology and technological infrastructure positively impact not only on the economy but also employment, income distribution, human capital development, and the more transparent and reliable operation of institutions. Therefore, to achieve sustainable and desirable economic wealth, countries should prioritize technology, increase R&D spending, and strive to develop high-technology/knowledge-based production capabilities.

Future studies could expand this study to other countries or longer time periods and search for which components of economic wealth are most sensitive to changes in economic complexity.

Declarations

Credit Authorship Contribution Statement: Both authors made equal contributions to the study, covering all stages from the development of the research idea to the final evaluation of the findings.

Declaration of Competing Interest: The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Declaration of Use of Generative AI and AI-Assisted Technologies: The authors declare that generative AI and AI-assisted technologies were used solely for language editing and improving readability. These tools were not used for content generation, data analysis, or interpretation of results.

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