be instrumental for sustainable economic growth (Teixeira and Queirós, 2016; Zhu and Li, 2017). Therefore, exploring the explicit elements affecting the relations between export quality, complexity, and economic growth is crucial. Against this backdrop, the current paper explores whether product quality, economic complexity, renewable energy, and institutional quality induce the economic growth of developed countries. The current study is novel in this perspective and it attempts to explore the heterogeneous impacts of export quality and governance indicators on economic growth. Whereas, such indicators represent the overall structural change in the economy.

According to Hausmann and Hidalgo (2011), the developed economies have the highest level of economic complexity, and this could be a major determinant of economic growth. So, with higher capabilities and a complex production structure, the OECD countries can have higher economic growth. The institutional quality (democratic setup, political stability, bureaucratic quality, etc.) is a significant indicator of structural change that can affect technological innovation and productivity. Furthermore, it helps countries critically tackle policies for sustainable development and efficient energy use (Dasgupta and De Cian, 2018).

An increase in the economic complexity improves production capacity through innovation, knowledge accumulation, enhancing capabilities, and trade diversification, all of which are pertinent for economic growth. The second school of thought argues institutional quality moderates economic complexity, therefore, the crucial determining factor of economic growth. According to North (1990), institutions are “the rules of the game in a society, or, more formally, the humanly devised constraints that shape human interaction.” Worthy institutes find expression in property-related rights security, bureaucratic actions, enforcing in contracts, and motivation to invest in human capital formation for innovation and enhancement of productive capacities. Such processes explain the differences in wealth accumulation across the different parts of the globe.

The two channels of research in the extant seam of literature thus have diverse conclusions about economic growth determinants of economic growth. The literature has explored them as separate strands of competing arguments on economic prosperity. This paper enhances the pre-existing layer of literature by joining the two channels of empirical exploration. The study hypothesizes:

I. "Export quality, renewable energy, foreign direct investment, and economic complexity positively influence the economic growth of OECD countries."
II. "Human capital, institutional quality acts as key factors of structural change and impact economic growth".

This research furthers discussion to the growing body of research by delving into the importance of economic complexity as a major driver of prosperity in an economy and sustainability. Furthermore, the study uncovers the role of institutions expressed through bureaucratic quality and democratic accountability as additional drivers of economic growth.

Given the rationale for the research, the study makes two key contributions to academic scholarship. First, the research determines the impacts of economic complexity and export quality on economic progress through the lens of structural change. Second, the current research explores the heterogeneous impacts of institutional quality and human capital on economic growth to draw some novel implications. To the best of the author’s knowledge, the current study uncovers novel conclusions regarding the structural impacts of economic and governance variables on economic growth. Such conclusions further allow us to draw some practical implications in line with the sustainable development goals (SDG-8: decent work and economic growth). In doing so, this research has used panel cointegrating methods to examine the long-term association across the key variables of interest. According to Hsiao (2007), the application of panel estimation techniques has improved over the cross-sectional and time series-based estimation methods. For robustness, we have employed the panel-based quantile regression estimation. Based on comprehensive empirical analysis and discussion, the study attempted to report some novel implications concerning the economic progress and structural change in developed countries. The practical suggestions might be helpful for policymakers of a country to identify the essential prerequisites to enhance the growth and maintain sustainability in energy use.

The rest of the paper is as follows: the subsequent section discusses the literature related to economic complexity, trade openness, energy, and institutional quality and its impact on growth. Section 3 explains the data and methods. Section 4 reports the empirical analysis and results. Section 5 provides discussion and policy suggestions, and Section 6 concludes the research.

2. Literature review

The recent decade has seen growing discussion in the existing seam of literature on a country-level analysis of how economic complexity enhances export competitiveness and economic growth. Furthermore, the existing literature also explores how foreign direct investment, human capital, and institutional quality moderate economic complexity and impact economic growth. According to the study of Erkan and Yildirimci (2015), economic complexity is utilized increasingly in the empirically-based literature to scrutinize the nature of complexity and sophistication of production and its effects on international trade diversification. The studies by Hidalgo and Hausmann (2009) and Lapatinas et al. (2019) argue that the economic complexity-based indicator impacts exports, and countries having a higher economic complexity-based index benefit more from trade.

Since the path-breaking studies of Hidalgo et al. (2007) and Hidalgo and Hausmann (2009), an extensive body of literature has examined the issues on the economic complexity across the globe (Mariani et al., 2015 and Gao and Zhou, 2018). These studies discuss how the network system of economic complexity impacts growth and the future diversification process of the economy.

According to the studies by Rodrik (2005) and Klinger and Lederman (2006), economic complexity plays a crucial role in helping countries to attain economic development. Further, the study by Agosin (2009) argued that trade diversification also impacts economic diversification and enables countries to grow. Economic complexity as a structural change indicator is conducive for economic growth, combating economic challenges, and adapting to technological change. Through economic complexity, technological change occurs, which nurtures innovation and competitiveness and helps economies modernize production processes, which furthermore impacts trade openness and economic growth.

The study by Erkan and Kaya (2015) discussed that economic complexity creates global competitiveness, positively impacting international trade. The study by Canh and Thanh (2020), through panel estimation methods across 70 economies from 1996 to 2014, discussed the interplay of export diversifying, economic-based complexity, and growth of the economy. The study obtained a bidirectional Granger causality between economic complexity and export-related expansion. Furthermore, the study obtained a negative relation of complexity upon growth. Other studies (Can and Gozgar, 2017; Hartmann et al., 2017; Dogan and Saboori, 2019) extensively discussed how economic complexity impacts human capital formation, and impacts environmental sustainability. The studies by Kim et al. (2016), and Carrasco and Garcia (2020) discussed the importance of the external sector and export diversification in impacting economic growth. According to the Global Competitiveness Index, the more complicated goals in the 2030 Agenda are SDG12 (Responsible Production and Consumption), SDG13 (Climate Action), and SDG17 (Sustainable Development) (Peace, Governance & Partnerships). Whereas, SDG9 (Industry, Innovation, and Infrastructure), SDG3 (Health and Wellbeing), SDG7 (cleaner and affordable energy), and SDG-8 (decent work and economic growth) are the most critical goals.

In this perspective, an appropriate strategy for governments might be to follow the sustainable complexity route to fully realize the 2030 Agenda, progressing from less complicated to more complex targets. Finally, future research should be focused on analyzing and identifying how the achievement of one SDG can lead to the achievement (or not) of another SDG using network theory and product-space theory for improving the environmental quality. This predicament could be a side effect of the so-called "Dutch Disease" in economics, which could have an impact on the SDGs' achievement." According to the aforementioned literature, there are several channels whereby export quality and economic complexity affect economic growth, for example, through expanding capital accumulation: spillover effects and skilled labor development, and specialization (Paramati et al., 2022; Shahzad et al., 2022).

The study by Alvarez et al. (2017) discussed the importance of economic-based complexity at the backdrop of energy use and growth. The study explored how government policies promote energy regulation and the adoption of complex energy systems with multifaceted social and environmental impacts. The paper by Dogan et al. (2020c) investigated the interconnections between economic growth, renewable energy usage, non-renewable-based energy consumption patterns, and economic expansion. Furthermore, the study examined the moderating impact of trade openness, complexity, direct foreign investment, and institutional quality upon economic growth. The study covered 32 European countries from 1995 to 2014, concluding that consuming renewably sourced energy has important implications for economic growth.

Likewise, the research of Dogan et al. (2020c) using novel estimation techniques explored how the quality of exports impacts energy intake and carbon dioxide release controlling growth, urbanization, and trade-openness for 63 developed and developing countries. The study suggests important policies which would enhance the direction on achieving the Sustainability Goals of clean energy. The empirical outcomes revealed that climate welfare augments the impact of export quality against climate welfare, reducing economic growth and urbanization. The paper concludes that policymakers should focus on incentivizing export quality to increase the consumption of renewable source-based energy. Such policy strategies would enable the countries to reduce the emission levels. More recently, Shahzad et al. (2020) employed annual data from 1971 to 2014 and examined the impacts of export diversification on carbon dioxide emissions for developing and developed countries. The empirical outcomes based on GMM methods suggest that export diversification has an emission-reducing effect across 63 developing and developed economies.

In the same line, Wang et al. (2021) explored the interdependence between carbon-based emissions, growth, use of renewable forms of energy and non-renewable forms of energy, urbanization, export diversification, and economic complexity for economies within the top ten as per the economic complexity index. The period of analysis was 1980–2014. Based on FMOLS, DOLS, and Granger-based causality methods, the empirical results suggested that export diversification and export quality reduce carbon emissions; furthermore, the use of renewably sourced energy mitigates the emission of carbon. Likewise, the study by Shahzad et al. (2021a) explored the role of export diversification for energy demand in ten newly industrializing nations. The empirical results based on FMOLS and DOLS methods suggest that export diversifying techniques significantly lower energy demand. However, economic growth, natural resources, and urbanization raise energy demand. The paper concludes that export diversification unambiguously reduces energy demand which has a climate welfare-enhancing impact. Such empirical outcomes are important for policy prescriptions for sustainable energy demand in the context of the newly industrializing countries.

More recently, Dogan et al. (2021) discussed how structural transformation towards a more sophisticated knowledge-based economy and economic complexity could drive growth in the economy and a cleaner environment. Using panel estimation techniques for 28 countries (OECD) and covering the years 1990 to 2014, the study concluded that complexity and use of renewably sourced energy helped reduce emissions and environmental degradation. Likewise, the study by Bashir et al. (2020) using alternative indicators of export diversification examined its impact on the intensity of carbon dioxide emissions and intensity of energy depletion for 29 OECD countries from 1990 to 2015. Using robust econometric techniques like sequential estimation, panel-quantile regressions, and generalized method of moments (GMM), the paper obtained that the indicators of export diversification have a reducing impact on carbon intensity. The paper further concludes that such empirical outcomes enable policy analysts to envisage strategies on green growth for sustainable development and clean energy use for the OECD economies.

On the same lines, Shahzad et al. (2021b) probed the impacts of export diversification on renewable energy consumption for the G7 and E7 nations covering the data from 1990 to 2017. The empirical outcomes from the study depict a nonlinear association between export diversification and consuming renewable-based energy for the concerned nations. However, the threshold levels of turning points are diverse across the G7 and E7 nations, respectively. Based on newly industrializing countries, Can et al. (2021) reported a bi-direction in causality across the energy use and economic complexity. Such findings have noteworthy policy implications in pursuing the Sustainable Development Goals related to climate welfare and emission reductions. Using a cross-sectional autoregressive distributed lag model, the study obtained that institutional quality improved environment sustainability through the moderating role of economic complexity (Ben Jebli et al., 2020). Furthermore, the study obtained that renewable energy reduced the ecological footprint. The paper concluded that accelerating complexity (economic) and improving institutional quality will reduce the ecological footprint and expand sustainable economic growth.

Recently, a study by Rafique et al. (2021) researched the impacts of economic complexity on renewable energy consumption. The study covered panel data of G7 and E7 nations respectively. The empirical results depicted a significant and positively based impact of complexity on renewable source-based energy consumption patterns. The paper explains that economic complexity is crucial for renewable energy generation. The policy thrust of these countries should be towards improving the complexity (economic) levels in these nations. Such strategies will enable us to move towards green growth and clean energy promotion, as argued by the authors.

There is a comparable growing literature that argues that the quality consciousness of institutions is a major determining factor of economic growth along with interlinkages with economic complexity, human capital formation, foreign direct investment, and trade diversification (Dias and Tebaldi, 2012; Khan et al., 2020). These studies discussed that institutional quality and governance level is essential for enhancing market functioning. Good institutions are revealed in implementing laws and regulations, enforcing property-related rights, and enforcing contracts (Ghazouani et al., 2020). According to Zhu and Li (2017), human capital enhances productive capabilities and economic complexity, and growth. An educated workforce can better produce complex products, which leads to export diversification and foreign-based investment.

The study by Gala (2020), using the economic complexity indicator for 210 countries, investigated how complexity and human capital formation impacted the economy (Nakhli et al., 2022). The study concluded that economic complexity and capital (human) formation impacted the economy's growth both in the short-run and the long term. There is a growing unanimity in the literature that good institutions offer inducements for entrepreneurial events, human capital formation, and innovation. Thus, institutional quality provides the horizon and facilitation for innovating and creating complex production structures, essential for economic prosperity. Recently, Nouira and Saafi's (2021) documented the nonlinear nexus between export diversification and economic growth. The results concluded that export diversification could impact economic growth significantly if certain threshold conditions apropos human capital and institutional quality are satisfied.

The preceding discussion deliberates extensively on the most difficult and interesting questions. "Why do some countries grow faster and are hence more affluent than some others?" As evident from the literature, the line of inquiry is through two-pronged conduits. The first school of thought explored how economic complexity helps identify trade diversification patterns, foreign direct investment, ecological footprint, and economic development (Hidalgo and Hausmann, 2009; Hausmann et al., 2014; Santoalha and Boschma, 2020). These studies conclude that robust growth and environmental sustainability are seen in those countries whose production processes are geared towards sophistication and economic complexity. The central argument from these studies is that complexity (economic) sets up a robust measure of the concerned country's innovation and trade diversification.

3. Data, model specification, and methodology

3.1. Data and model specification

The prime objective of this study is to explore the role of export product quality, economic complexity, and institutional quality as key indicators of structural change for the economic progress of OECD countries. The on-hand research consists of a panel data set of 28 OECD countries, comprising the period 1990 to 2019. The authors attempt to explore the impacts of economic complexity, institutional quality, export quality on economic growth for the developed OECD countries. In doing so, authors gather the data for GDP, representing economic growth, export quality (EQ), the economic complexity index (ECI), renewable energy consumption (REC), trade (Trade), the financial development index (FD), the Human capital index (HC), urbanization level (urban), the democratic accountability index (DAI), and the bureaucratic quality index (BQI). The authors gather the data on renewable energy, trade, Human development, urbanization, and institutional indicators from (World Bank, 2021). Data for institutional indicators was accessed from (ICRG, 2022), whereas the human capital data is sourced from Penn World Table 9.0. The data for export product quality and financial development was obtained from (International Monetary Fund, 2022) database. Finally, the economic complexity data was obtained from the (Observatory of Economic Complexity, 2022).

The baseline models are represented in Eqs. (1), (2), and (3), respectively.

Model 1:

$$GDP_{it} = EQ_{it} + ECI_{it} + REC_{it} + Trade_{it} + FD_{it} + \varepsilon_{it} \quad (1)$$

Model 2:

$$GDP_{it} = EQ_{it} + ECI_{it} + REC_{it} + HC_{it} + DAI_{it} + \varepsilon_{it} \quad (2)$$

Model 3:

$$GDP_{it} = EQ_{it} + ECI_{it} + REC_{it} + urban_{it} + BQI_{it} + \varepsilon_{it} \quad (3)$$

In all models, i stands for the country and t for time, ε is the error term. The empirical methodology applied will be presented next, following all the steps, including robustness check methodologies applied.

3.2. Methodology

As stated previously, we add to the extant literature by exploring the relationship between economic complexity, export product quality, institutional quality, and energy use. In doing so, we employ panel cointegration techniques to examine these variables' long-run relationships. We first make a preliminary analysis of the descriptive statistics. The empirical exercise begins with the Pesaran (2015) cross-sectional dependence (CD) test to examine cross-sectional dependence occurs in the panel data. To deal with the problems associated with cross-sectional dependence, the study adopts the second-generation panel estimation techniques robust to panel heterogeneity and cross-sectional dependence. Panel unit root tests are also employed. After obtaining the order of integration of the time series observations, both the Westerlund panel cointegration and Pedroni panel cointegration tests are applied to explore the variables' long-run associations. The fully modified least square (FMOLS) model and the dynamic least square model (DOLS) are used to estimate long-run elasticities. Lastly, the authors employ a robustness check on the model specifications by employing the panel quantile regression estimation.

a. Preliminary analysis

We begin our empirical analysis with Pesaran's (2015) CD-test for weak cross-sectional dependence in panel context. It is a method of investigation of the mean correlation between panel data. The null hypothesis in Pesaran (2015) is of weak dependence, provided the null hypothesis of cross-sectional independence of Pesaran (2004) is very strong and unlikely to be met in a large panel. Pesaran's (2015) null hypothesis of cross-section independence, having CD $\sim$ N (0,1), and p-values lower than 5%, indicate that data are correlated across the panel. The weak dependence means that when N or T converges to infinity in the limit, the cross-sectional dependence (weak relations) disappears, turning the estimator consistent. The strong dependence assumption poses real problems like that of omitted variable bias.

After checking for weak cross-section dependency, we apply the panel unit root tests. The first one was the CIPS-test developed by Pesaran (2007) to be applied in heterogeneous panels in the presence of cross-section dependence. The cross-sectional Im, Pesaran, and Shin (CIPS) by Pesaran (2007) has a nonstandard distribution, even with large N (Im et al., 2003). The second used test of panel unit-roots was that of the CADF test (covariate augmented Dickey-Fuller) developed in Hansen (1995) and proposed in Pesaran (2007).

Once cross-sectional correlations are detected, we need panel unit root tests accounting for data stationarity. To this end, we employ the second-generation tests (CIPS and CADF). Both CIPS and CADF tests rely on the factor structure approach. The CADF test is based on the mean of individual Dickey-Fuller t-statistics of each unit in the panel, parallel to the CIPS test (Im et al., 2003). The null hypothesis of the CADF test assumes that all series are nonstationary, as does the null of the CIPS test.

Moving forward, panel cointegration tests were executed. These are necessary when time series are nonstationary to determine if they have stable long-run relationships. However, sometimes, not even doing so will turn them stationary (which is the situation in the present article. Provided nonstationary time series tend to

Table 6(b)
Robustness Check with Panel Quantile Regressions (model-2).

Variables	Pooled OLS	Quantile 10th	Quantile 25th	Quantile 50th	Quantile 75th	Quantile 90th
Export quality	4.582*	5.737***	3.477***	6.798***	7.278***	4.271***
	(2.645)	(0.599)	(0.882)	(0.992)	(0.893)	(0.866)
Complexity	0.593**	0.0930	0.450***	0.542***	0.412***	0.685***
	(0.217)	(0.0766)	(0.113)	(0.127)	(0.114)	(0.111)
Renewable energy	0.349***	0.210***	0.257***	0.361***	0.358***	0.372***
	(0.0269)	(0.0124)	(0.0183)	(0.0205)	(0.0185)	(0.0179)
Human capital	−3.068***	−3.179***	−3.060***	−4.359***	−2.322***	−2.014***
	(0.721)	(0.402)	(0.591)	(0.665)	(0.598)	(0.580)
Democratic accountability	−0.137***	0.00832	−0.148***	−0.165***	−0.134**	−0.0240
	(0.0494)	(0.0371)	(0.0546)	(0.0614)	(0.0553)	(0.0536)
Constant	17.38***	18.00***	19.87***	16.15***	14.85***	16.77***
	(1.592)	(0.565)	(0.832)	(0.935)	(0.842)	(0.817)
Observations	840	840	840	840	840	840
R-squared	0.516	0.2281	0.1980	0.2771	0.3951	0.4603

Notes: Standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$. Pooled OLS is applied with Driscoll-Kraay standard errors. Panel quantile regression is applied at conditional quantiles.

Table 6(c)
Robustness Check with Panel Quantile Regressions (model-3).

Variables	Pooled OLS	Quantile 10th	Quantile 25th	Quantile 50th	Quantile 75th	Quantile 90th
Export quality	5.019***	7.437***	6.569***	5.163***	4.692***	2.195***
	(0.866)	(0.438)	(0.310)	(0.319)	(0.489)	(0.703)
Complexity	−0.00632	−0.0467	−0.158***	−0.0353	0.0936	0.152
	(0.0828)	(0.0621)	(0.0440)	(0.0452)	(0.0693)	(0.0996)
Renewable energy	0.111***	0.106***	0.108***	0.104***	0.106***	0.104***
	(0.00551)	(0.0109)	(0.00772)	(0.00793)	(0.0122)	(0.0175)
Urbanization	0.833***	0.895***	0.879***	0.859***	0.811***	0.751***
	(0.0111)	(0.0206)	(0.0146)	(0.0150)	(0.0230)	(0.0331)
Bureaucratic quality	0.275***	0.263***	0.336***	0.287***	0.167***	0.155**
	(0.0296)	(0.0380)	(0.0269)	(0.0276)	(0.0424)	(0.0610)
Constant	5.068***	1.477***	2.567***	4.605***	6.319***	10.08***
	(0.584)	(0.522)	(0.370)	(0.380)	(0.583)	(0.838)
Observations	840	840	840	840	840	840
R-squared	0.910	0.6679	0.6975	0.7261	0.7287	0.7232

Notes: Standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$. Pooled OLS is applied with Driscoll-Kraay standard errors. Panel quantile regression is applied at conditional quantiles.

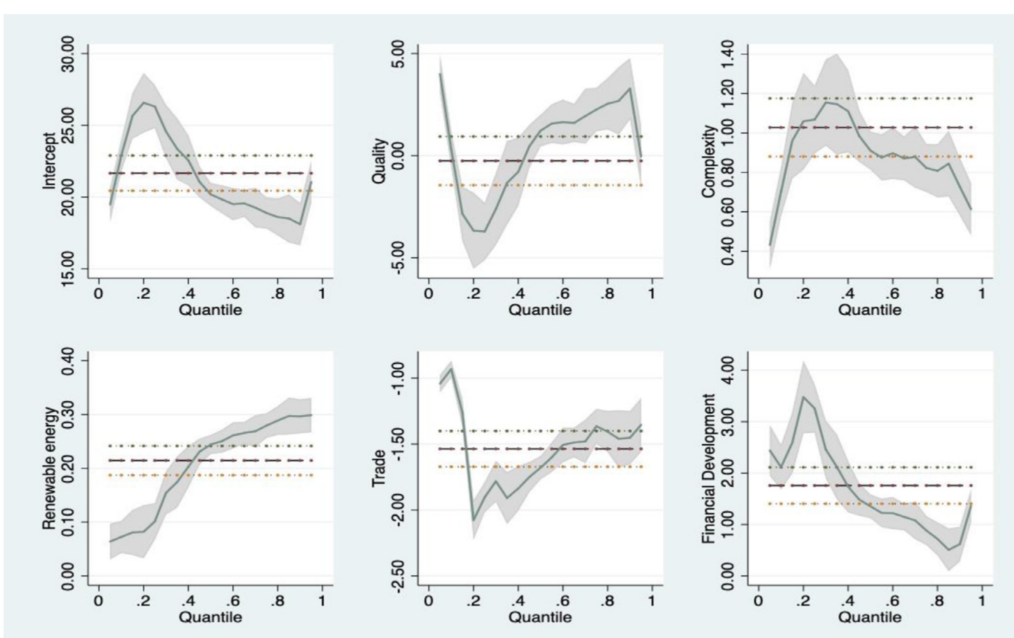

Fig. 1. (a): Quantile plot of model-1 estimates, Fig. 1(b): Quantile plot of model-2 estimates, Fig. 1(c): Quantile plot of model-3 estimates.