Discover Sustainability

Research

Empirics of convergence in industrialisation and their determinants: global evidence

Charles Shaaba Saba[1] · Nicholas Ngepah[1]

Received: 23 January 2023 / Accepted: 19 April 2023
Published online: 30 May 2023

Abstract
This study examines the convergence club in industrialisation by using an algorithm developed by Phillips and Sul. We used 183 countries for the period between 2000 and 2018. We also investigated the dynamics of the determinants possibly driving the convergence/divergence clubs of the countries. The convergence algorithm results reveal that there is divergence in industrialisation for the overall sample, which implies that less industrialised economies are not catching up with the industrialised economies within the sample period. The club merging algorithm results identified six final clubs of which economic, demographic, governance and geographic variables play a significant role in the likelihood of a country belonging to a particular final club. This study found that globally, the process of convergence in the industrialisation process is yet to echo desirable emanations of industrial/manufacturing policies sharing similar features, but the narrative seems to be different when the algorithm forms clubs.

Keywords Industrialisation convergence · Convergence club determinants · Transition paths · Panel data analysis

JEL Classification C23 · O14 · O50

1 Introduction

In economics, the term "club convergence" refers to a situation where different groups or clubs of countries or regions converge to different steady states or equilibria, rather than all converging to a common equilibrium and vice versa for divergence club. Phillips and Sul [1] propose a new econometric test for club convergence that can identify whether different groups of countries converge to different steady states or to a common steady state. The test is based on a two-step procedure: first, they estimate the number of clubs and the steady state for each club, and second, they test whether there is any evidence of cross-club convergence or divergence. In their paper, Phillips and Sul [1] argue that club convergence is a more realistic way to model economic growth and development than traditional convergence models that assume all countries converge to a single steady state. They show that their club convergence model fits the data better than the traditional models, and they use their model to analyze the convergence patterns of different groups of countries. The two research questions that have motivated this study are: (i) Is there evidence of an industrialisation convergence club at the global level? and (ii) What are the potential factors that could drive the final convergence club in industrialisation? To answer these research questions, we adopted Phillips and Sul [1, 2] convergence club and

✉ Charles Shaaba Saba, sabacharlesshaaba@yahoo.com; Nicholas Ngepah, nngepah@uj.ac.za; nnnbal@yahoo.fr | [1]School of Economics and Econometrics, College of Business and Economics, University of Johannesburg, Auckland Park Kingsway Campus, Johannesburg, 524, South Africa.

multinomial logit econometric approaches to investigate industrialisation convergence club at the global level and the possible likely factors that could drive the final convergence club, respectively. Global convergence in industrialisation implies that countries which are less industrialised are gradually catching-up with the industrialised countries/countries which are moving towards attaining the same level of industrial development. Having insight on this particular theme that has suffered neglect in the literature is still an issue that must be answered empirically. This is because globally, countries are confronted with numerous obstacles that slow down their process of industrialisation. For example, the study of Haraguchi et al. [3] identifies economic, demographic and geographic as drivers/factors that could contribute to successful industrialisation in developing countries. These drivers include education, financial sector development, capital openness, investments, trade management, etc.

Despite these factors at play in the industrial/manufacturing sector, over the years the sector in both developed and less developed countries has experienced some level of enormous change due to the above mentioned and even more drivers. As a result, the sector has made some significant progress [3]. Even though countries have experienced some level of industrialisation, many are still faced with the obstacle of it serving as an engine of economic growth [4, 5]. That is why a continuous investigation into the drivers of successful industrialisation for the purpose of policy direction cannot be over emphasized. This is due to the increasingly unstable economic, demographic, and political conditions across the globe. Due to the sector's importance to economies, researchers/policymakers and the international community/organisations continues to be attracted by it for policy discussion purposes and other related matters meant to promote the sector [6–8]. As a result, Rodrik [9] was motivated to examine the convergence in manufacturing industries for 118 countries.

Given the sector's role in an economy, the question of whether countries are converging/diverging in industrialisation attainment over time, ought to be a cogent matter for policymakers. This is because the industrial/manufacturing sector is a key driver of growth [4, 5]. And that is why the repercussion of some countries being left behind could also mean that they are not catching up with the advanced economies when it comes to growth, which can be dangerous for the economy. For this reason, countries need to make efforts in tackling the impediments to industrial development. The way countries across the globe undertake their industrial development programmes and policies differs. As a result, governments must be aware of those differences/gaps, as well as how well they have succeeded in comparison to others. In addition, identifying and understanding the likely determinants behind a country's convergence/divergence club in industrialisation will inform academicians, the international community, and policymakers to urgently formulate applicable policies that could bridge the gap between industrialised and less industrialised economies. Hence, the rationale for this article using a different approach.

Testing for club convergence in industrialisation is long overdue and important for a variety of reasons. Firstly, it's inference can help to determine whether industrial development aims are being achieved or not. Secondly, it helps to determine factors responsible for disparities in industrialisation convergence among countries. Thirdly, it helps to establish the concept of a security web, which implies that neighbouring countries serve as a source of motivation for other countries to attain industrial development. Therefore, any expansion and development in the industrial sector of a particular country challenges another country that can be either close by or far off. The tendency or potential for taking advantage, for instance, may be diminished in circumstances when countries attempt to compare or benchmark their levels of industrial growth to those of other countries. Studies that focus on convergence in industrialisation are still few in the literature, and different estimation techniques that yield better results are yet to be fully explored. It is based on the above and the following that will contribute to the empirical literature: (i) we utilised the Phillips and Sul (hereafter P and S) [1, 2] club convergence approach given its merits[1] when compared to the study of Rodrik [9] and few others.

(ii) while few studies such as that of Abegaz [15] explore the leaders and latecomer's structural convergence in manufacturing industries, Rodrik [9] examines manufacturing productivity convergence at the international level, while Lemoine et al. [16] utilise a similar approach used by Rodrik [9] to test whether manufacturing convergence also operates in China. Erten and Schwank [17] revisit unconditional convergence within manufacturing by focusing on technology intensity industries; Ortiz and Ruiz [18] investigate convergence of manufacturing (in terms of added manufacturing value) in Sonora; Bénétrix et al. [19] report industrial output growth around the poor periphery, while for the newly industrialised countries, Dong et al. [20] focus on investigating how industrial convergence affects the energy efficiency of the manufacturing sector. To our own knowledge, no study has examined club convergence in industrialisation (defined as manufacturing value added as a percentage share of GDP) at the global level. This is cogent because

[1] For the significance of the method, readers should consult P&S [1, 2] and other studies such as the work of Saba and Ngepah [10], Saba and David [11], Saba [12, 13] and Saba et al. [14] that have used the approach. The advantages of using the method can be found in those studies.

levels of industrial/manufacturing development between countries *could* either widen or contract the existing poverty and social, employment and economic inequalities [21]. Therefore, if less industrialised countries are catching up with the industrialised nations, it means that the levels of industrialisation gaps are steadily closing, and consequently, this could reduce socio-economic challenges facing the countries. Since the data for this study included 183 countries with varying levels of industrialisation, it's possible that none of them converge at the panel level [22], while at the sub-club levels, convergence may be taking place due to spillover issues.

(iii) Based on the convergence club of industrialisation tests, we used a multinomial logit model to investigate the validity of a wide variety of their drivers/determinants. Given that there is an increasingly urgent need for industrialisation convergence across countries, literature on the possible determinants that could contribute to the likelihood of a country belonging to a convergence club is nowhere to be found. Hence, the need for this study. For the possible determinants, we essentially considered the factors that could successfully drive levels of industrialisation, including economic, governance, demographic and geographic factors [3]. The availability of the World Bank dataset assisted us in contributing to the empirical literature on convergence/divergence in industrialisation and its determinants by covering more countries compared to the previous studies of Abegaz [15], Rodrik [9], Lemoine et al. [16], among others. With the World Bank dataset, scholars can obtain results, draw inferences, and conclude and recommend relevant policies.

The remaining aspects of this article are as follows: Sect. 2 brings to light the relevant literature; Sect. 3 focuses on the methodology; Sect. 4 presents the empirical results and a discussion; and Sect. 5 presents the concluding remarks along with policy recommendations.

2 Literature review

The Solow [23] study introduced the convergence hypothesis and was further expanded by the studies of Swan [24], Barro [25], Barro et al. [26], and Barro and Sala-i-Martin [27] among others. The neoclassical growth model serves as a foundation for the concept which states that impoverished nations can catch up with rich nations in terms of per capita income [23]. With the use of various methodologies, the concept has been applied to several fields in economics to date. The beta and sigma convergence types are the two most used in the literature [5, 28, 29]. Beta convergence deals with how fast countries are catching up with one another, while sigma convergence deals with how fast the variance in economic growth is being observed across countries and over time [30].

Other concepts/approaches that followed the above discussed convergence include time-series, stochastic, club convergence, total factor productivity convergence, etc. [31]. While the mentioned concepts/approaches to convergence are popularly applied to income, health, public spending, environmental issues etc., little is known about their applicability to manufacturing/industrial output. Applying the concept to industrial/manufacturing output is important because poor/less industrialised economies may have the tendency to catch up with industrialised ones. To the best of our knowledge, a few studies that have applied the concept include those of Rodrik [9], Bénétrix et al. [19], Erten and Schwank [17], and Dong et al. [20]. Under the context of organised formal parts of manufacturing, Rodrik [9] examined the unconditional convergence in manufacturing over the period 1965 to 2005 for 118 countries. The study used a panel regression approach and found the following: (i) strong evidence of unconditional convergence in manufacturing industries' labour productivity; (ii) sigma-convergence when the countries were divided into smaller samples; and (iii) failure of aggregate convergence in low-income countries and as a result, a small share of manufacturing employment which consequently affected the speed of industrialisation. The Erten and Schwank [17] recent study focuses on technology intensity across industries to re-examine the unconditional convergence within manufacturing, and also used a panel regression approach. The findings from the study reveal that: (i) low- and medium-technology intensive industries witnessed slower convergence for countries in Sub-Saharan Africa and Latin America compared to high-technology intensive countries; and (ii) in developed countries, low-technology industries convergence tends to be slower when compared to the similar rates of convergence that take place in medium- and high-technology industries. The differences in the convergence results obtained from the study was attributed to increased global integration. According to the study, the global integration gave the opportunity to developing countries to compete at the international market.

For the newly industrialised countries, Dong et al. [20] investigated the effect of industrial convergence on energy efficiency in the manufacturing sector by applying a spatial autoregressive combined model. The study found the following: (i) industrial convergence promoted the energy efficiency of the manufacturing sector through the spillover effect that resulted from imitation and learning; and (ii) industrial convergence promoted technological innovation, factor structure optimization, and industrial scale expansion. On the one hand, studies that measured the degree of industrial convergence include those of Fai and Von [28], Xing et al. [32] and Chen et al. [33]. While on the other hand, the studies that investigate the performance of industrial convergence include those of Garcia-Murillo and MacInnes [34], Li et al. [35], Gao and Lu [36], and Cao et al. [37]. The Herfindahl index input–output and coupling evaluation methods of measuring the degree of industrial convergence were used by Fai and Von [28], Xing et al. [32], and Chen et al. [33], respectively.

Studies that focused on the performance of industrial convergence allude to the fact that it positively promotes asset returns [35], metabolic efficiency [36], and local innovation efficiency [36]. The Abegaz [15] study took a different direction by exploring whether there is structural convergence in manufacturing industries between developing and developed countries by using cross-country panel data. The findings of the study reveal that technological penetration and demand appears to produce weak convergence of industrial structures between industrialised and less industrialised countries. Ortiz and Ruiz [18] investigated the convergence of manufacturing in Sonora at the inter-municipal level by considering the role played by state investment. The findings of the study indicate that, while Sonora's rate of municipal convergence in manufacturing value added is quite high, it has been trending downward, and that the state's inability to maximise the use of its resources contributed to the downward trend. Lemoine et al. [16] explored industrial convergence and spatial rebalancing in China by using industrial enterprise surveys that were aggregated to the prefecture-industry level. The findings from the Lemoine et al. study epitomises Rodrik's assertion for the case of China. Previous research on industrial/manufacturing convergence failed to utilise the proposed P and S [1, 2] convergence test. Applying the technique is important because according to P and S [1, 2], "*A convergence club is a group of economies, similar in their structural characteristics, whose initial conditions are near enough to converge toward the same long-term equilibrium*." From an industrial/manufacturing growth context, diversity happens when different patterns of industrial development emerge across country and could be associated with the concept of convergence clubs.

Given that industrialisation/industrial development does not take place without some factors driving it, we also review few of the previous studies that have investigated factors that could influence a successful industrial development. The empirical literature is generally divided into both micro and macro studies. Different micro studies such as Fafchamps et al. [38], Söderbom et al. [39], Söderbom and Teal [40], and Bigsten et al. s [41, 42] studies focused on manufacturing firm's performances, successes, limitations, and survivals in terms of export. While on the contrary, notable macro studies such as Soludo et al. [43], Marti and Ssenkubuge [44], Altenburg [45], Dihn et al. [46], Mijiyawa [47], Haraguchi et al., [3] among others focused on economic, demographic, geographic and governance factors that in countries drive industrialisation/industrial development/manufacturing development. For example, regarding sub-Sahara Africa (SSA), Dihn et al. [46] study explores the opportunities and obstacles facing the development of light manufacturing in the region. The opportunities identified by the study include availability of natural resources, and low-cost of labour etc., required for the supply of raw materials for the industrial, while the obstacles include poor transport infrastructure for trade, access to credit and land, poor human capital and entrepreneurial skills, and input industries. The study recommends that the obstacles to the development of light manufacturing should be properly addressed. Mijiyawa [47] examines the influencing factors of manufacturing development for 53 African countries between 1995 and 2014 by using System GMM estimation technique. The study finds the following: (i) urbanization and FDI does not promote manufacturing development; (ii) GDP per capita and manufacturing share of GDP exhibited U-shape relationship; (iii) Africa's manufacturing sector experienced improvement as a result of the depreciation of exchange rate; (iv) Africa's level of manufacturing development was enhanced due to good governance, government effectiveness and low levels of corruption; and (v) manufacturing share of GDP was positively affected by domestic market size. For the case of developing countries, the recent study of Haraguchi et al. [3] analyses the determinants of successful industrialisation by using two separate periods, 1970–1990 and 1991–2014. The results reveal that factor endowments, demographic, geographic and economic conditions are key to successful industrialisation. The study recommends that policy should focus on institutional stability, investments, financial sector development, education and management of trade and capital openness. It is on the basis of this study that we also chose a range of economic, demographic, geographic and governance factors to investigate how they can contribute to the likelihood of a country belonging to a particular final club.

Due to the characteristics that distinguish this paper from earlier studies, our research differs from them in some ways. Firstly, we used a novel club convergence approach introduced by P and S [1, 2] which previous studies failed to utilise, as mentioned in the previous section. The approach helped us to correctly test the club divergence or club convergence of industrialisation among the selected countries. Secondly, we utilised the multinomial logit regression to investigate the factors that could contribute to countries belonging to different convergence clubs. Even though industrialisation could be a long-term objective, to the best of our knowledge, empirical studies on the factors that drive convergence clubs are nowhere to be found prior to this study. This serves as one of the bases, among others, for this paper.

3 Methodology and data

This section comprises the steps involved in carrying out the convergence clustering algorithm of P and S [1, 2] and the multinomial logit specification for the determinants of the final convergence club classification in industrialisation.

3.1 Log t convergence test

P and S [1, 2] suggested $logX_{it}$ which has different parts, namely: μ_t, δ_{it} and ε_{it}. Where μ_t, δ_{it} and ε_{it} is common factor, idiosyncratic factor loading and error terms, respectively. In this study, we define variable $X_{it}(MGDP)$ *as* $i = 1, \ldots, N$ *and* $t = 1, \ldots, T$ *where N and T* refer to the number of countries and the panel sample, respectively. The two of them are assumed to be time variant in nature, while the μ_t predisposes the common MGDP path according to what we have below:

$$logX_{it} = \delta_{it}\mu_t + \varepsilon_{it} \tag{1}$$

Equation (1) helps to determine whether the factor loading δ_{it} is converging/diverging. In order to achieve this, P and S [1] came up with the panel relative transition coefficient/parameter, h_{it}, as:

$$h_{it} = \frac{logX_{it}}{\frac{1}{N}\sum_{i=1}^{N} logX_{it}} = \frac{\delta_{it}}{\frac{1}{N}\sum_{i=1}^{N}\delta_{it}} \tag{2}$$

According to P and S [1] "*Eq. (2) helps to measure the coefficient of the factor loading δ_{it} in relation to the average panel series of the transition path for the country i. The relative transition coefficients h_{it} is estimated from Eq. (2) and then used to plot the relative transition curves*". Please note that $logt$ test employs the transition coefficient h_{it} in testing the convergence of the factor loading coefficient. Convergence then implies that an individual unit approaches the sample average over time. Therefore, according to P and S [1] the following holds: "*(1) $\delta_{it} \to \delta$ for all i as $t \to \infty$ implies that the transition coefficient δ_{it} converges toward δ as $t \to \infty$; (2) $h_{it} \to 1$ for all i as $t \to \infty$ implies that the equivalent to convergence of the relative transition coefficient h_it toward unity $ast \to \infty$;(3)$H_t = \frac{1}{N}\sum_{i=1}^{N}(h_{it} - 1)^2 \to 0$for all i as $t \to \infty$implies that the cross sectional variance of h_{it}, H_t, converges toward zero as $t \to \infty$*"

P and S [1] put forward the below semiparametric specification which is meant to account for nonstationary panel transition behaviour that may be induced by a reduction in a sample's cross-sectional variance, even when there is an absence of panel convergence and only the presence of local convergence within subgroups. Below is the semiparametric specification:

$$\delta_{it} = \delta_i + ß_i Ш_{it} Z(t)^{-1} t^{-\tau} \tag{3}$$

where δ_{it} is the time-invariant part of the country-specific factor loading δ_i, *Z(t)* is a variant slowly increasing function (with $Z(t) \to \infty ast \to \infty$), τ is the decay rate (i.e. the speed of convergence), and $Ш_{it}$ is a weakly autocorrelated random error variable ($Ш_{it}$ is *iid*(0,1)). Based on Eq. (1), P and S (2007) proposed the following hypothesis: "H_0: *Convergence for all i* $H_0 : \delta_i = \delta$ *and* $\tau \geq 0$ *vs*: H_1: *No convergence for all i* $H_1 : \delta_i \neq \delta$ *and* $\tau < 0$"

The testing procedure involves the following three steps:

1. To determine the cross-sectional variance ratio as captured by the ratio of the hypotheses: H_1/H_t (From point 3 above).
2. Estimation of the following OLS regression:

$$\log\left(\frac{H_1}{H_t}\right) - 2logZ(t) = \hat{\varphi} + \hat{b}logt + \hat{\mu}_t, fort = [jT], [jT] + 1, \ldots, T \text{ for some } j > 0 \tag{4}$$

3. One-side *t* test for $\tau \geq$ using $\hat{b}(\hat{b} = 2\hat{\tau})$ and HAC standard error. *j* (*j* ∈ *(*0, 1*)*) is a truncation parameter that shortens the regression by a certain fraction of the first observations. Monte Carlo simulations by P&S [1] suggest the use of *j* = 0.3 and *Z(t)* = $logt$ for samples up to *T* = 183. The standard critical value to reject/accept the null hypothesis of convergence is at the 5% level if $t_{\hat{b}} < -1.65$. Where $\hat{b} is equal to 2\hat{\tau}$ and j indicates the fraction of the sample that needs to be discarded for the regression analysis.

3.2 Club clustering and merging algorithms

According to the P and S [1] approach, the steps explain the club clustering algorithm procedures to identify the divergent/convergent clubs and they include *"Step 1: order the N members of the panel according to the last observation; Step 2: Use the k highest members (from Step 1) for all different values of k(i.e. $2 \leq K < N$). They then estimate a sequence of $logt$ regression by choosing the highest generated convergence t-statistic $t_{\hat{b},k}$ (where $t_{\hat{b},k} > -1.65$ so that convergence was ensured for the corresponding club). The corresponding club then forms the core convergence club; Step 3: add one country at a time to the core club (if $t_{\hat{b}} > c^*$) and run the $logt$ regression; and Step 4: the second convergence club is formed (if $t_{\hat{b}} > c^*$) after running the $logt$ regression for all the countries that diverges in the previous step. In case it was rejected, the algorithm repeated steps 1–3 for the remaining countries to determine whether the group itself could be subdivided into convergence clusters. If there was no k in step 2 for which $t_{\hat{b}} > -1.65$, we concluded that the remaining countries displayed divergent behaviour."* We used the P&S [2] technique to test the robustness of our analysis, because, according to P and S (2009), the P and S (2007) approach has a tendency to overstate the number of clubs compared to the actual number that it ought to be. The application of the P and S [2] approach is therefore essential to prevent inaccurate results and analysis.[2]

3.3 Multinomial logit specification approach

The study used a multinomial logit regression technique to determine the possible drivers of industrialisation final club convergence. The details of the explanatory variables (that is, the conditioning vector of variables) are found in Table 1, and are the likely variables that drive countries belonging to different final club convergence. Let Z_i represent a variable that shows whether ith country belongs to a specific final club, while $Prob\left(Z_i = v\right)$ reveals the probability that ith country belongs to the vth final club. Let B_i be the $Kx1$ conditioning vector of variables which determines ith country to belong to a particular final club. Let Ω_v be the $Kx1$ parameter vector where v takes on the values of 1, 2, J. While J stands for the number of the final clubs. Therefore, the probability that ith country will belong to vth final club is as follows:

$$Prob\left(Z_i = v\right) = \frac{\exp(B_i'\Omega_v)}{\sum_{k=1}^{J}(B_i'\Omega_k)} \tag{5}$$

For recognition purposes, there is a need to place a coefficient restriction on the base outcome (which is the reference class) Υ as $\Omega_\Upsilon = 0$. Therefore, the $\log$ odds ratio can be obtained as:

$$log\left(\frac{Prob\left(Z_i = v\right)}{Prob\left(Z_i = \Upsilon\right)}\right) = B_i'\left(\Omega_v - \Omega_\Upsilon\right) = B_i'\Omega_v \tag{6}$$

Ω_v is the parameter estimate based on the final club referent's values, therefore, we draw inference from the multinomial logit regression by making use of the explanatory variables. Putting other explanatory variables on hold, the logit of the final club v relative to the referent final club Υ is predicted to change by its respective parameter estimate. The study used final club 5 as the base outcome for the models below:

$$log\left(\frac{Prob\left(Z_i = 1\right)}{Prob\left(Z_i = 5\right)}\right) = \Omega_{1,1} + \Omega_{2,1}\sum_{i=1}^{n=17} W_i \tag{7}$$

$$log\left(\frac{Prob\left(Z_i = 2\right)}{Prob\left(Z_i = 5\right)}\right) = \Omega_{1,2} + \Omega_{2,2}\sum_{i=1}^{n=17} W_i \tag{8}$$

$$log\left(\frac{Prob\left(Z_i = 3\right)}{Prob\left(Z_i = 5\right)}\right) = \Omega_{1,3} + \Omega_{2,3}\sum_{i=1}^{n=17} W_i \tag{9}$$

[2] The details of this methodology can be found in P&S [2], Saba and Ngepah [10], Du [48], among others. We used the updated STATA code provided by Du [48].

Table 1 Variable description and sources

Variables	Description	Sources
Economic variables		
MGDP	Manufacturing, value added (% of GDP)	WDI database
AGRI	Agriculture, value added (% of GDP)	WDI database
GDPC	GDP per capita (constant 2010 US$) proxy for the levels of income	WDI database
GFCF	Gross fixed capital formation (% of GDP)	WDI database
FDV	Domestic credit to private sector (% of GDP) proxy for financial development	WDI database
FDI	Foreign direct investment, net inflows (% of GDP)	WDI database
REX	Real effective exchange rate index (2010 = 100)	WDI database
FLA	Inflation, GDP deflator (annual %)	WDI database
TRD	Trade (% of GDP)	WDI database
MNR	Mineral rents (% of GDP)	WDI database
HUM	School enrollment, secondary (% gross) proxy for human capital endowments	WDI database
LFP	Labor force participation rate, total (% of total population ages 15 +) (modeled ILO estimate)	WDI database
ICT	ICT penetration is captured by a composite index of ICT indicators (which comprises of three indicators) by applying principal components method/analysis (PCA). These indicators include: (i) Mobile-cellular telephone subscriptions per 100 inhabitants (penetration of connected mobile lines); (ii) Fixed-telephone subscriptions per 100 inhabitants (penetration of connected fixed lines); and (iii) Percentage of Individuals using the Internet (percentage of population with access to the internet)	ITU database
Geographic variables		
LAN	Land area (sq. km)	WDI database
Demographic variable		
POP	Population, total	WDI database
Governance indicators		
CRR	Control of Corruption	WGI database
POL	Political stability and absence of violence/terrorism	WGI database
GEF	Government effectiveness	WGI database
REGQ	Regulatory quality	WGI database
RUL	Rule of law	WGI database
VCA	Voice and accountability	WGI database

Note: WDI represents World Bank's World Development Indicators. ITU represents International Telecommunication Union database. WGI represents World Bank's World Governance Indicators. We had the problem of missing data for some variables, but this was handled by means of interpolation and extrapolation of data (Studies that have used these techniques include those of Saba & Ngepah [115, 116, 131–134], Saba and David [11, 135], Saba [136–141] and Saba and Biyase [142].)

$$log\left(\frac{Prob\left(Z_i = 4\right)}{Prob\left(Z_i = 5\right)}\right) = \Omega_{1,4} + \Omega_{2,4}\sum_{i=1}^{n=17} W_i \quad (10)$$

where W_i is a vector of explanatory variables for the drivers of final club convergence in industrialisation, which can be found in Table 1. Where $\Omega_{1,1}, \Omega_{1,2}, \Omega_{1,3}$ *and* $\Omega_{1,4}$ in Eq. 7, 8, 9, 10 are the constant parameters; and $\Omega_{2,1}, \Omega_{2,2}, \Omega_{2,3}$ *and* $\Omega_{2,4}$ are the estimated parameters. $Prob$ stands for probability. In statistics, estimated parameter refers to a value that is obtained from a sample and is used to estimate an unknown panel parameter. Constant parameters in this study are fixed values that do not change in a given model or equation.

Based on the above approaches we test the following hypotheses:

Null hypothesis There is no evidence of industrialisation convergence club at the global level.

Alternative hypothesis There is evidence of industrialisation convergence club at the global level.

Null hypothesis There are no significant factors that could drive the final convergence club in industrialisation.

Alternative hypothesis There are significant factors that could drive the final convergence club in industrialisation.

3.4 Data and variables description

This study utilised an annual panel data for 183 countries between 2000 and 2018. We drew data for the series from three main sources, namely the International Telecommunication Union (ITU), the World Bank's World Development Indicators (WDI), and the World Governance Indicators (WGI) databases. The time span and the countries used were selected based on the data availability, and therefore, we could not extend the data to include the years 2019, 2020 and 2021, when writing this article. Hence, future studies should consider including the mentioned years. We log-transformed the variables, excluding those with negative values. ICT variables were obtained from the highlighted indicators in Table 1 through the utilisation of PCA see, for example, [21, 22, 49–51]. The role that ICT plays in the industrialisation process cannot be over emphasized because according to Prakash [52], *"industrialisation supported by ICT could be a chosen pathway for regional growth/development, and the integration into global markets for goods and services."* Hence, the need for the use of the ICT variable in this study. ICT plays a significant role in the industrialisation process of countries. ICT is not only a tool for improving productivity and efficiency but also a driver of innovation and growth. It has transformed the way industries operate and has enabled the creation of new industries, such as the software and electronics industries. ICT could positively impact on the industrialisation process in several ways. Firstly, it improves the efficiency of production processes, reducing costs and increasing productivity. ICT allows for the automation of processes and the use of advanced robotics, which can perform complex tasks with high precision and speed. Secondly, ICT enables the creation of new products and services through innovation. It provides a platform for collaboration and knowledge sharing, allowing businesses to work together and share information to develop new technologies and products. This has led to the creation of new industries and the growth of existing ones. Finally, ICT plays a vital role in improving the competitiveness of industries. By using ICT tools and technologies, businesses can better understand market trends and customer needs, allowing them to develop products and services that are more tailored to their customers' requirements. One study by Rasel [53] found that the adoption of ICT had a positive effect on the productivity of German manufacturing firms. Another study by Hwang and Kim [54] found that ICT had a positive impact on the innovation and growth of Korean manufacturing firms. Therefore, it is important to examine its role in the process of industrialisation club convergence since it is an essential factor in the industrialisation process of countries. As for the determinants of final club convergence for industrialisation, the variables used in earlier studies were adopted as potential deciding factors that could contribute to the probability of a country belonging to a particular group convergence/divergence. All the control variables used in this study are possible factors that could also drive industrialisation, either in a positive or negative direction. These variables can generally be grouped into economic/macroeconomic, financial, demographic and governance variables.

Beginning with GDP per capita (GDPC), this variable could serve two purposes, which include: (i) proxy for level of income [55]; and (ii) measuring differences in the levels of development across countries [3]. According to the Gui-Diby and Renard [55] study, this variable could serve as a household's potential real purchasing power. Haraguchi et al. [3] allude to the fact that less industrialised countries have the probability of catching up with industrialised countries. This is because their low levels of economic development will trigger them to pursue long-term industrialisation patterns. This is possible because poor countries can achieve unconditional convergence with the technological frontier as a result of higher productivity growth rates that they record in the manufacturing sector [9]. The relationship between income levels and industrialisation process is a topic of ongoing debate in the field of development economics. While some argue that higher levels of income are a necessary precondition for successful industrialisation, others contend that industrialisation itself can lead to increased income levels. One school of thought suggests that higher levels of income are necessary for industrialisation to occur. According to this view, countries must first achieve a certain level of income in order to have the financial resources and technological capabilities necessary to invest in industrialisation. For example, in his book "*The End of Poverty*," economist Jeffrey Sachs argues that "the preconditions for sustained growth include a minimally adequate level of education, health, infrastructure, and social stability, as well as a sufficiently dynamic and diversified economy" [56]. On the other hand, some scholars argue that industrialisation itself can lead to increased income levels, as industrialisation creates jobs, stimulates economic growth, and increases productivity. According to this view, countries do not necessarily need to achieve a certain level of income before embarking on the industrialisation process. For example, economist Ha-Joon Chang argues that "the experience of successful late industrializers such as South Korea, Taiwan, and China shows that the link between industrialisation and income growth is bidirectional—industrialisation leads to income growth, and income growth facilitates further industrialisation" [49]. Therefore, the relationship between income levels and industrialisation process is complex, and different scholars have different views on the matter. While some argue that higher levels of income are necessary for successful industrialisation, others contend that industrialisation itself can lead to increased income levels.

To keep an eye on how crucial investment is in the convergence/divergence process of the countries, we used gross fixed capital formation (% of GDP) (GFCF). Increased investments in the economy are the backbone for increasing productive capacities and aggregate demand, hence leading to industrialisation [3, 57]. Investment is widely considered to be a critical factor in the industrialisation process. Investment can create a conducive environment for industrialisation and support sustainable economic growth. Some studies have shown that investment plays a crucial role in the industrialisation process. For example, a study by Kniivilä [58] and Amsden [59] found that investment was a key determinant of industrial growth in developing countries. Investment can also create spillover effects that contribute to industrialisation. For instance, investment in research and development can lead to technological advances that increase productivity and competitiveness in industrial sectors. In addition, investment in education and training can improve the skills of the workforce, which is critical for the adoption and implementation of new technologies in the industrial sector. As a result, investment is a critical component of the industrialization process and its role in the industrialisation process needs to be explore in this study.

Human capital (HUM) is important for industrialisation, just has it is for economic growth. The reason being that in growth theories, investment in human capital contributes to innovative capabilities; new technological adaptation; and it does not allow returns on capital to easily fall [3, 60]. Therefore, this is obviously important for industrialisation as well. This variable is measured by school enrolment, secondary, (% gross) following the previous studies of David [61], Saba and Ngepah [62], among others. Furthermore, human capital, defined as the knowledge, skills, and abilities possessed by individuals, is an essential factor in the industrialisation process. A well-educated and skilled workforce is crucial for the adoption and implementation of new technologies, the development of innovation, and the production of high-quality goods and services. Several studies have emphasized the role of human capital in the industrialisation process. For example, a study by Lucas [63] argues that human capital is an important determinant of economic growth, as it influences the ability of workers to learn and adopt new technologies. Similarly, a study by Benhabib and Spiegel [64] shows that investment in human capital can lead to long-term economic growth. In addition to the importance of general education and skills, specialised skills and technical knowledge are also essential for industrialisation. For example, in the manufacturing sector, specialised skills are necessary for the design and production of complex products, and technical knowledge is essential for the maintenance and operation of industrial machinery and equipment. Therefore, human capital is a critical component of the industrialisation process, and investing in education, skills development, and specialised training is essential for promoting sustainable economic growth and industrialisation.

Financial development is a critical factor in the industrialisation process, as it can provide the necessary funding for investment in technology, infrastructure, and human capital. Financial development includes the development of financial institutions such as banks, insurance companies, and stock markets, as well as the establishment of legal and regulatory frameworks that facilitate investment and capital flows. Several studies, among others have emphasized the role of financial development in the industrialisation process. For example, a study by Beck et al. [65] found that financial development facilitates access to funding for investment and improved the efficiency of capital allocation in the economy. Similarly, a study by Rajan and Zingales [66] showed that financial development played a crucial role in promoting the growth of manufacturing industries in India. In addition to providing funding for investment, financial development can also promote innovation and entrepreneurship. For example, a well-developed venture capital industry can provide funding and support for entrepreneurs and start-ups, which can lead to the development of new technologies and industries. As a result, financial development is a critical component of the industrialisation process, and policies that promote financial sector development can contribute to sustainable economic growth and industrialisation. To account for the levels of financial development of the countries, we measured it by domestic credit to private sector (% of GDP) (FDV). Schumpeter is among the scholars that first established how important the financial sector is in the production process of an economy. The financial sector supports individuals, entrepreneurs, and firms within the industrial/manufacturing sector with the high probabilities of achieving innovative products and carrying out innovative processes [3, 67]. Domestic credit to private sector (% of GDP) will be employed given that it is a common indicator used in studies *inter alia*: [40, 57, 58].

The agricultural sector can play a critical role in the industrialisation process by providing the necessary resources, such as raw materials and labor, for industrial production. In addition, the development of the agricultural sector can contribute to overall economic growth by increasing rural incomes, promoting food security, and reducing poverty. Several studies have emphasized the importance of the agricultural sector in the industrialisation process. For example, a study by Diao et al. [68] found that the development of the agricultural sector was an essential precondition for industrialisation in many countries, as it provided the necessary resources and labor for industrial production. In addition to providing resources and labor for industrial production, the agricultural sector can also contribute to technological innovation and knowledge transfer. For example, the development of agricultural research and extension systems can lead to the development of new technologies and practices that can be applied in other sectors. Therefore, the agricultural sector can play a critical role in the industrialisation process, and policies that promote agricultural development can contribute to sustainable economic growth and industrialisation. Agriculture, value added (% of GDP) (AGRI) is included because the contraction (expansion) of one sector could possibly correspond to the contraction (expansion) of another [29, 55]. As structural change (that is, reallocation of factors of production from the agrarian sector to the industrial/manufacturing sector [50, 51, 69–71]), is gradually becoming part of every economy, there is a need to investigate the role AGRI played in the probability of countries belonging to a club. In addition, the countries have some level of agricultural activities taking place in their economy, which makes this variable relevant.

Foreign direct investment (FDI) can play a critical role in the industrialisation process by providing the necessary funding, technology, and expertise for industrial development. FDI can also stimulate competition and innovation, which can lead to increased productivity and growth. Some studies have emphasized the importance of FDI in the industrialisation process. For example, a study by Blomström and Kokko [72] showed that FDI played a crucial role in the development of the electronics industry in Southeast Asia. In addition to providing funding and technology, FDI can also promote the development of local supply chains and linkages with other industries. For example, multinational corporations can provide a market for local suppliers, which can stimulate the development of local industries and increase employment opportunities. Therefore, FDI can play a critical role in the industrialisation process, and policies that promote FDI can contribute to industrialisation. Therefore, it is important to examine the role it has played in the industrialisation club convergence. Foreign direct investmentnet inflows (% of GDP) (FDI) can promote industrialisation since foreign investors are known to bring both financial and knowledge assets to an economy. Theoretically, the Rodrıguez-Clare [73] and Markusen and Venables [74] studies have demonstrated that FDI could act as a stimulant for industrialisation. Trade (% of GDP) proxy for trade openness (TRD) could serve as a channel of technological spillovers, which can boost production and, as a result, catalyse industrialisation [75–77]. Trade openness exposes firms and businesses to the latest goods/technologies and also presents the opportunity to acquire them [78].

The real effective exchange rate (REX) can play an important role in the industrialisation process by influencing the competitiveness of domestic industries in the international market. A competitive REX can make domestic industries more competitive, while an overvalued REX can make domestic industries less competitive and hinder industrial development. Some studies have emphasized the importance of REX in the industrialisation process. For example, a study by Rodríguez and Rodrik [79] found that a competitive REX was a crucial precondition for successful industrialisation, as it provided the necessary incentives for domestic firms to invest in productive activities. Similarly, a study by Lederman and Maloney [80] showed that an overvalued REX was associated with lower levels of manufacturing exports in Latin America and the Caribbean. In addition to influencing the competitiveness of domestic industries, REX can also affect the inflow of foreign investment and the availability of external financing. For example, an overvalued REX can discourage foreign investment and make external financing more expensive, which can hinder industrial development. As, the REX can play an important role in the industrialisation process, and policies that promote a competitive and stable REX can contribute to sustainable economic growth and industrialisation. A competitive and stable exchange rate, according to Haraguchi et al. [3], plays an important role in the tradable/productive sector. This is because economies that are characterised by labour intensive industries, have infant domestic manufacturing sectors that usually enjoy protection. This article used the real effective exchange rate (REX).

Governance indicators can play an important role in the industrialisation process by providing a favorable environment for investment, innovation, and productivity growth. Sound governance institutions can reduce corruption, enhance the rule of law, and promote political stability, which can create a favorable environment for industrial development. Some studies have emphasized the importance of governance indicators in the industrialisation process. For example, a study by Asiedu [81] showed that better governance was associated with higher levels of manufacturing exports in Africa. In addition to promoting good governance can also facilitate the development of a skilled workforce and technological capabilities, which are essential for successful industrialisation. Similarly, a study by Janz et al. [82] showed that better governance was associated with higher levels of firm innovation in developing countries. Therefore, governance indicators can play an important role in the industrialisation process, and policies that promote good governance can contribute to sustainable industrialisation. Industrial/manufacturing sector activities do take place in the absence of governance or an institutional environment. Hence, it is pertinent to examine the role they play in the convergence club of global industrialisation. The stability of governance/institutional indicators is crucial for the smooth running of both public and private sectors and is key to industrial/economic development [6]. They are also key to the successful execution of short and long-term industrial policies [3]. We used six governance indicators, which can be found in Table 1.

Mineral rents, which are the profits derived from the extraction and sale of minerals, can play an important role in the industrialization process. However, the relationship between mineral rents and industrialisation is complex, and the impact of mineral rents on industrialisation can vary depending on a variety of factors such as the structure of the economy, the quality of governance, and the level of technological development. Some studies have investigated the relationship between mineral rents and industrialisation. For example, a study by Matsuyama [7] found that mineral rents can promote industrialisation by providing the necessary capital for investment in infrastructure and industrialisation projects. Similarly, a study by Sachs and Warner [8] found that mineral-rich countries tend to have higher levels of industrialisation than mineral-poor countries, although this relationship is not always straightforward. However, other studies have found that mineral rents can actually hinder industrialisation by creating a "resource curse" that leads to overreliance on the mining sector and neglect of other industries [83, 84]. Additionally, mineral rents can lead to political instability, corruption, and conflict, which can undermine the industrialisation process [85]. The impact of mineral rents on industrialisation is complex and context-specific. While mineral rents can provide important resources for investment in industrialisation, they can also create challenges and risks that can undermine the process. We added mineral rents (% of GDP) (MNR) to capture the important features and endowments of the countries, while considering the Dutch disease debate about the possible negative impacts of high natural resource rents on the manufacturing sector's development, and the cyclical fluctuations it may cause in the national income [86, 87].

Land is an important factor in the industrialisation process as it provides the space for building factories, warehouses, and other industrial facilities. However, the importance of land in industrialisation can vary depending on the nature of the industry and the level of technological development. In addition, access to land can be a challenge for some countries, particularly in densely populated areas where land is scarce. Some studies have examined the importance of land in industrialisation. For example, a study by Buhaug and Gates [81] found that countries with more land suitable for agriculture tend to have higher levels of industrialisation, as agriculture provides a source of income that can be used to finance industrialisation projects. Similarly, a study by Ranis and Stewart [88] found that access to land can be an important factor in the development of small and medium-sized enterprises (SMEs), which can be an important driver of industrialisation. However, other studies have highlighted the challenges associated with land acquisition for industrialisation. In some cases, land acquisition can be costly and time-consuming, particularly if the land is owned by multiple parties or if there are legal disputes over ownership [89]. In addition, land acquisition can be a source of conflict between industrial developers and local communities, particularly if the land is seen as having cultural or spiritual significance [90]. The importance of land in the industrialisation process depends on a variety of factors, including the nature of the industry, the level of technological development, and the availability and accessibility of land. While land can provide important resources for industrialisation, it can also create challenges and conflicts that need to be addressed. Therefore, exploring its role in industrialisation convergence cannot be overemphasized.

Population is a crucial factor in the industrialisation process, as it provides the labor force necessary for the production and operation of industrial facilities. The size and skill level of the population can have a significant impact on the level of industrialisation in a country. However, the relationship between population and industrialisation is complex, and the impact of population on industrialisation can vary depending on a variety of factors such as the level of education, the quality of governance, and the availability of resources. Some studies have investigated the relationship between population and industrialisation. For example, a study by Lucas [63] found that a larger labor force can promote industrialisation by allowing for the specialisation of labor and the development of economies of scale. Similarly, a study by Acemoglu and Johnson [91] found that population density can promote industrialisation by increasing the efficiency of production and lowering the cost of transportation. However, other studies have highlighted the challenges associated with population growth for industrialisation. In some cases, population growth can lead to increased competition for resources and labor, which can drive up wages and make industrialisation more expensive [92]. In addition, rapid population growth can put pressure on social and environmental systems, which can undermine the sustainability of industrialisation [93]. The impact of population on industrialisation is complex and context-specific. While a large and skilled labor force can promote industrialisation, population growth can also create challenges and risks that need to be addressed.

Previous empirical studies have put forward the fact that geographic factors (such as land area (LAN) and total population (POP)) are essential for the industrialisation process [32, 40, 86]. For example, population could create demand and determine the size of the domestic market for industrial/manufactured products [94]. In the literature, an increase in population size is expected to increase the demand for manufactured goods, and as a result,

Table 2 Principal component and correlation matrix results

Component	Eigenvalue	Difference	Proportion	Cumulative
Panel (A): Principal component results				
Component 1	2.358	1.818	0.786	0.786
Component 2	0 .540	0.438	0.180	0.966
Component 3	0.102		0.034	1.000
Panel (B): Principal components eigenvectors results				
Variable	Component 1	Component 2	Component 3	Unexplained
Fixed-telephone	0.521	0.807	0.278	0.359
Mobile-telephone	0.578	− 0.574	0.581	0.212
Internet access	0.628	− 0.142	− 0.765	0.071
Panel (C): Correlation matrix results				
Variables				
Fixed-telephone	1.000			
Mobile-telephone	0.477*** (0.000)	1.000		
Internet access	0.688*** (0.000)	0.855*** (0.000)	1.000	

Source: Author's computation

***$p < 0.01$

**$p < 0.05$

*$p < 0.1$, p-value in parentheses

the manufacturing firms lower the cost of production per unit, thereby generating economies of scale [95]. The connection of railways, transportation network, communication lines, pipelines, power lines etc. requires land (LAN). And that is why land is needed for all these infrastructures that usually connect urban and manufacturing/industrial cores [96]. Chandra [97] "defines industrialisation as the increase of the manufacturing value-added share of GDP", while Echaudemaison [98] "defines industrialisation as an increasing share of the secondary sector in terms of employment and GDP". The two indicators must show a significant increase or improvement over time before we can say that there is industrialisation taking place in an economy. However, due to data problems, we could not use the latter but mainly focused on using manufacturing value added as a percentage share of GDP (MGDP), which serves as a proxy for industrialisation. Its popularity in the literature as a proxy for industrialisation and due to availability of data for MGDP, caused us to use it [26, 31, 39, 40, 56, 68]. Manufacturing value added is considered a useful proxy for measuring industrialisation because it represents the value of goods produced by a country's manufacturing sector, net of the costs of inputs. Industrialisation is typically characterized by an increase in the size and output of a country's manufacturing sector, which is often accompanied by an increase in the share of manufacturing value added in the country's gross domestic product (GDP). Manufacturing value added as a share of GDP (MGDP) is a widely used proxy for measuring industrialization in an economy, and it is supported by empirical evidence that shows a positive correlation between manufacturing value added and measures of economic growth and development, as well as other indicators of industrialisation [99–101]. Since the variable used to obtain the results of the final clubs was manufacturing value added (% of GDP), the final clubs are considered as the dependent variable in the multinomial logit analysis. The reason is that they contain information about the manufacturing value added (% of GDP).

4 Empirical results and discussion

4.1 Descriptive statistics, correlation matrix and principal component results analysis

Table 2 presents the principal component approach and correlation matrix results for the ICT variable. We first started by testing whether there is some degree of association between the indicators of ICT. The results revealed that the indicators are strongly correlated (see Panel C), hence, we proceeded to the estimation of the PCA given that the condition of the indicators being correlated was filled [102]. For the ICT variable, in summary, given that the first factor or principal component explains the highest percentage of the total variation, the first principal component

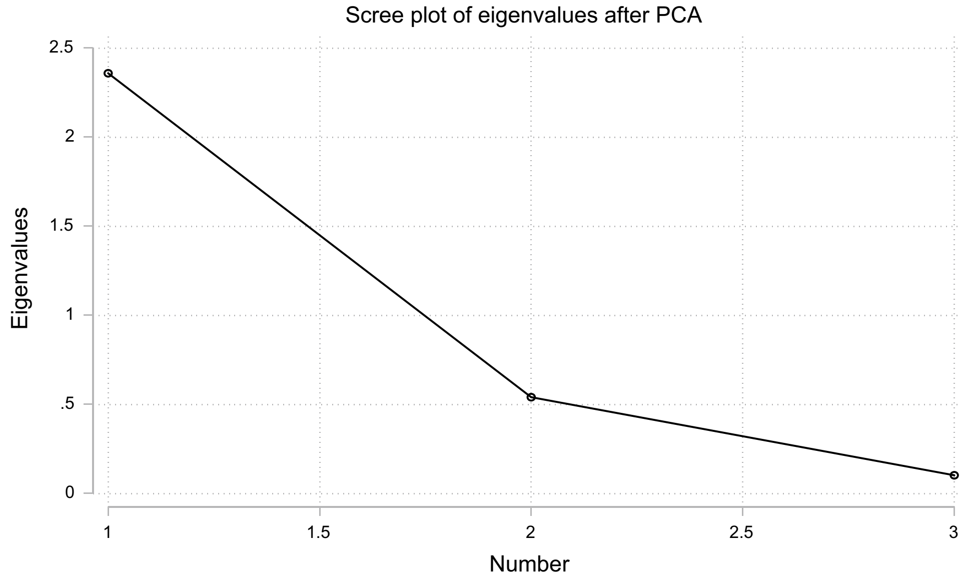


Fig. 1 Scree plot of the eigenvalues

was chosen for making a composite index. We chose the first component because its eigenvalue accounted for 2.36% which explains the highest percentage of the total variation. The results in Table 2 are further supported by the scree plots in Fig. 1.

Table 3 presents the descriptive statistics results. The descriptive statistics provided for the variables under review include the mean (or median) values for each variable. The mean represents the average value of a variable, while the median represents the middle value of a variable when all values are arranged in ascending or descending order. Looking at the mean (or median) values provided, we can see that the variable with the highest value is POP, which has a mean value of 16.796 (or median value of 16.855). This suggests that the population at the global level is quite large. The variable with the lowest value is MNR, which has a mean value of − 2.829 (or median value of − 2.521). This suggests that the globe may not have a significant amount of mineral resources. AGRI has a mean value of 1.506 (or median value of 1.364), which suggests that the globe may have a significant agricultural sector. ICT has a mean value of 0.667 (or median value of 1.135), which suggests that the globe has some level of information and communications technology infrastructure. A similar interpretation holds for other variables. The maximum and minimum values for the variables are between 280.132 and − 58.323, respectively. Table 3 presents the standard deviations (SD) for the variables. Standard deviation is a measure of how spread out the data is from the mean (average) value. A larger standard deviation indicates that the data is more spread out, while a smaller standard deviation indicates that the data is more clustered around the mean. The values listed after each variable name are the standard deviations calculated for each of these variables. For example, the standard deviation for MGDP is 0.432, while the standard deviation for AGRI is 1.077. It's also worth noting that some of the variables have relatively large standard deviations compared to others, such as FDI and LAN with standard deviations of 19.842 and 7.837, respectively. This indicates that the values for these variables has a higher degree of variation compared to the other variables. The series with the negative value of skewness shows a negatively skewed distribution for the variables, while the series with the negative value of skewness shows the negatively skewed distribution. Furthermore, the Jarque–Bera statistics shows that the variable's normality distribution differs at least at the 10% significance level.

4.2 Convergence analysis

Table 4 presents the results for the panel level, and reveals the absence of panel convergence since the $t_{\hat{b}} < -1.65$, that is, − 118.151 < − 1.65 (this means that it will reject the null hypothesis as stipulated in Sect. 3). The point estimate result is negative (since $\hat{b} = 2\hat{\sigma} = \hat{\sigma} = \hat{b}/2 = -1.143/2$),[3] which implies that the countries at the panel level are experiencing a slow divergence process in industrialisation. This outcome confirms that industrial development levels among countries

[3] According to P&S [1], the sign of the point estimate is also a way of evaluating convergence patterns.

Table 3 Descriptive statistics

	MGDP	LAGRI	GDPC	GFCF	FDV	REX	TRD	MNR	HUM	ICT	LFP	FLA	LAN	POP	CRR	POL	GEF	REGQ	RUL	VCA	FDI
Mean	2.606	1.506	9.175	3.046	3.949	4.590	4.239	− 2.829	4.428	0.667	4.096	5.643	12.604	16.796	0.358	− 0.024	0.447	0.451	0.345	0.374	5.749
Median	2.620	1.364	9.274	3.067	4.072	4.603	4.213	− 2.521	4.557	1.135	4.112	3.174	12.632	16.855	0.218	0.143	0.447	0.526	0.418	0.635	2.662
Maximum	3.913	4.099	11.626	3.783	5.542	5.563	5.973	2.819	5.057	1.741	4.411	80.755	16.612	21.014	2.470	1.755	2.354	2.089	2.100	1.784	280.132
Minimum	0.495	− 1.397	5.351	1.373	0.973	3.100	3.031	− 16.697	2.345	− 5.455	3.722	− 16.909	7.796	12.418	− 1.453	− 2.810	− 1.772	− 1.720	− 1.821	-1.843	−58.323
Std. Dev	0.432	1.077	1.424	0.231	0.895	0.133	0.478	2.933	0.406	1.134	0.125	7.837	1.707	1.481	1.075	0.983	0.995	0.954	1.057	0.949	19.842
Skewness	− 0.819	0.133	− 0.623	− 0.850	− 0.577	− 0.194	0.403	− 0.810	− 2.195	− 1.827	− 0.390	3.119	0.087	− 0.111	0.273	− 0.620	− 0.103	− 0.308	− 0.004	−0.514	9.305
Kurtosis	6.729	2.444	2.816	7.761	2.598	9.320	3.818	3.864	8.654	6.447	3.905	19.884	3.148	3.1607	1.913	2.680	1.997	2.045	1.798	2.054	107.946
Jarque–Bera	522.439	11.969	49.989	805.113	47.073	1262.950	41.560	106.171	1614.082	794.788	44.959	10,205.66	1.638	2.377	46.633	51.664	33.020	40.657	45.540	61.549	357,839.6
Prob	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.441	0.305	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Obs	756	756	756	756	756	756	756	756	756	756	756	756	756	756	756	756	756	756	756	756	756

Source: Author's computation

Table 4 Convergence in industrialisation and final club classification results (club merging)

<table>
<tr><th>Sample</th><th>Countries</th><th>$\hat{b}Coeff$</th><th>SE</th><th>$t - Stat$</th></tr>
<tr><td>Full sample</td><td>All 183 countries used for the study</td><td>– 1.143*</td><td>0.001</td><td>– 118.151</td></tr>
<tr><td>Club 1</td><td>| Armenia | Aruba | Barbados | Central African Rep, | Djibouti | Equatorial Guinea | Eritrea | Gabon | Ireland | Myanmar | Puerto Rico | Uganda | Uzbekistan |</td><td>0.464</td><td>0.144</td><td>3.213</td></tr>
<tr><td>Club 2</td><td>| Algeria | China | Czech Republic | Eswatini | Guinea | Korea, Rep. | North Macedonia | Senegal |</td><td>0.388</td><td>0.061</td><td>6.372</td></tr>
<tr><td>Club 3</td><td>| Angola | Austria | Bahrain | Bangladesh | Belarus | Bosnia and Herzegovina | Brunei Darussalam | Cameroon | Congo (Rep. of the) | Dem. Rep. of the Congo | Egypt, Arab Rep. | Germany | Ghana | Guinea-Bissau | Haiti | Hungary | Japan | Jordan | Kyrgyz Republic | Lithuania | Malaysia | Mexico | Mongolia | Nicaragua | Paraguay | Poland | Romania | Saudi Arabia | Slovak Republic | Slovenia | Turkey|</td><td>– 0.036</td><td>0.077</td><td>– 0.469</td></tr>
<tr><td>Club 4</td><td>| Cambodia | Cuba | El Salvador | Honduras | India | Indonesia | Morocco | Pakistan | Philippines | Sri Lanka | Tunisia |</td><td>0.223</td><td>0.059</td><td>3.775</td></tr>
<tr><td>Club 5</td><td>| Denmark | Ecuador | Estonia | Guatemala | Italy | Namibia | Oman | Singapore | Sudan | Suriname | Venezuela, RB |</td><td>0.105</td><td>0.096</td><td>1.094</td></tr>
<tr><td>Club 6</td><td>| Albania | Argentina | Belgium | Bolivia | Burundi | Colombia | Costa Rica | Cote d'Ivoire | Dominican Republic | Fiji | Finland | Greece | Guyana | Iceland | Iran, Islamic Rep. | Israel | Kazakhstan | Latvia | Lesotho | Mauritius | Moldova | Netherlands | Peru | Portugal | Russian Federation | Serbia | South Africa | Spain | Sweden | Ukraine | United States | Uruguay | Vietnam | Zimbabwe |</td><td>0.133</td><td>0.048</td><td>2.757</td></tr>
<tr><td>Club 7</td><td>| Bhutan | Brazil | Burkina Faso | Chile | France | Iraq | Jamaica | Kuwait | Malawi | New Zealand | Nigeria | Sao Tome and Principe | Tanzania |</td><td>0.033</td><td>0.054</td><td>0.607</td></tr>
<tr><td>Club 8</td><td>| Benin | Cabo Verde|Canada | Georgia | Kenya | Lao PDR | Lebanon | Niger | Qatar | Saint Kitts and Nevis | Tajikistan | United Arab Emirates | United Kingdom |</td><td>0.515</td><td>0.080</td><td>6.427</td></tr>
<tr><td>Club 9</td><td>| Afghanistan | Antigua and Barbuda | Belize | Botswana | Ethiopia | Faroe Islands | Gambia | Malta | Mauritania | Mozambique | Norway | Panama | Rwanda | Saint Vincent and the Grenadines | Samoa | Togo | Tonga | Yemen, Rep. | Zambia |</td><td>0.422</td><td>0.118</td><td>3.573</td></tr>
<tr><td>Club 10</td><td>| Australia | Azerbaijan | Bahamas | Chad | Kiribati | Nepal | Seychelles | Turkmenistan |</td><td>0.436</td><td>0.194</td><td>2.247</td></tr>
<tr><td>Club 11</td><td>| Cyprus | Grenada | Luxembourg |</td><td>0.182</td><td>0.071</td><td>2.550</td></tr>
<tr><td>Club 12</td><td>| Greenland | Mali | Montenegro | Vanuatu |</td><td>0.186</td><td>0.025</td><td>7.410</td></tr>
<tr><td>Club 13</td><td>| Liberia | Libya | New Caledonia | Sierra Leone | Syrian Arab Republic</td><td>– 0.040</td><td>0.930</td><td>– 0.043</td></tr>
<tr><td>Club 14</td><td>| Bermuda | Dominica | Hong Kong SAR, China | Macao SAR, China | Madagascar | Maldives | Micronesia, Fed. Sts. | Timor-Leste | Tuvalu |</td><td>1.448</td><td>2.114</td><td>0.685</td></tr>
<tr><td>Club 15</td><td>| Thailand |</td><td colspan="3">Not convergent</td></tr>
<tr><td>Club merging</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Club 1 + 2</td><td></td><td>0.517</td><td>0.131</td><td>3.946</td></tr>
<tr><td>Club 2 + 3</td><td></td><td>0.002</td><td>0.072</td><td>0.034</td></tr>
<tr><td>Club 3 + 4</td><td></td><td>0.000</td><td>0.077</td><td>0.005</td></tr>
<tr><td>Club 4 + 5</td><td></td><td>– 0.043</td><td>0.074</td><td>– 0.584</td></tr>
<tr><td>Club 5 + 6</td><td></td><td>0.028</td><td>0.050</td><td>0.568</td></tr>
<tr><td>Club 6 + 7</td><td></td><td>– 0.065</td><td>0.046</td><td>– 1.411</td></tr>
<tr><td>Club 7 + 8</td><td></td><td>0.107</td><td>0.055</td><td>1.932</td></tr>
<tr><td>Club 8 + 9</td><td></td><td>0.140</td><td>0.076</td><td>1.836</td></tr>
<tr><td>Club 9 + 10</td><td></td><td>0.150</td><td>0.123</td><td>1.219</td></tr>
<tr><td>Club 10 + 11</td><td></td><td>0.429</td><td>0.188</td><td>2.281</td></tr>
<tr><td>Club 11 + 12</td><td></td><td>– 0.097**</td><td>0.029</td><td>– 3.315</td></tr>
<tr><td>Club 12 + 13</td><td></td><td>– 2.044**</td><td>0.265</td><td>– 7.728</td></tr>
<tr><td>Club 13 + 14</td><td></td><td>– 7.581**</td><td>2.339</td><td>– 3.241</td></tr>
</table>

Table 4 (continued)

<table>
<tr><th>Sample</th><th>Countries</th><th>$\hat{b}Coeff$</th><th>SE</th><th>$t-Stat$</th></tr>
<tr><td>Club 14+15</td><td></td><td>– 7.890**</td><td>1.559</td><td>– 5.062</td></tr>
<tr><td>Final club classifications</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Final Club 1</td><td>| Albania | Algeria | Angola | Argentina | Armenia | Aruba |Austria | Bahrain | Bangladesh | Barbados | Belarus | Belgium | Bolivia | Bosnia and Herzegovina | Brunei Darussalam |Burundi | Cambodia | Cameroon | Central African Rep, | China |Colombia | Congo (Rep. of the) | Costa Rica | Cote d'Ivoire | Cuba | Czech Republic | Dem. Rep. of the Congo | Denmark |Djibouti | Dominican Republic | Ecuador | Egypt, Arab Rep. | El Salvador | Equatorial Guinea | Eritrea | Estonia |Eswatini | Fiji | Finland | Gabon | Germany | Ghana | Greece |Guatemala | Guinea | Guinea-Bissau | Guyana | Haiti | Honduras |Hungary | Iceland | India | Indonesia | Iran, Islamic Rep. |Ireland | Israel | Italy | Japan | Jordan | Kazakhstan |Korea, Rep. | Kyrgyz Republic | Latvia | Lesotho | Lithuania |Malaysia | Mauritius | Mexico | Moldova | Mongolia | Morocco |Myanmar | Namibia | Netherlands | Nicaragua | North Macedonia |Oman | Pakistan | Paraguay | Peru | Philippines | Poland |Portugal | Puerto Rico | Romania | Russian Federation | Saudi Arabia | Senegal | Serbia | Singapore | Slovak Republic |Slovenia | South Africa | Spain | Sri Lanka | Sudan | Suriname |Sweden | Tunisia | Turkey | Uganda | Ukraine | United States |Uruguay | Uzbekistan | Venezuela, RB | Vietnam | Zimbabwe |</td><td>– 0.088</td><td>0.065</td><td>– 1.363</td></tr>
<tr><td>Final Club 2</td><td>| Afghanistan | Antigua and Barbuda | Belize | Benin | Bhutan |Botswana | Brazil | Burkina Faso | Cabo Verde | Canada | Chile |Ethiopia | Faroe Islands | France | Gambia | Georgia | Iraq |Jamaica | Kenya | Kuwait | Lao PDR | Lebanon | Malawi | Malta |Mauritania | Mozambique | New Zealand | Niger | Nigeria |Norway | Panama | Qatar | Rwanda | Saint Kitts and Nevis |Saint Vincent and the Grenadines | Samoa |Sao Tome and Principe | Tajikistan | Tanzania | Togo | Tonga |United Arab Emirates | United Kingdom | Yemen, Rep. | Zambia |</td><td>– 0.007</td><td>0.054</td><td>– 0.130</td></tr>
<tr><td>Final Club 3</td><td>| Australia | Azerbaijan | Bahamas | Chad | Cyprus | Greenland | Grenada | Kiribati | Luxembourg | Mali | Montenegro | Nepal |Seychelles | Turkmenistan | Vanuatu |</td><td>0.255</td><td>0.149</td><td>1.702</td></tr>
<tr><td>Final Club 4</td><td>| Liberia | Libya | New Caledonia | Sierra Leone |Syrian Arab Republic |</td><td>– 0.040</td><td>0.930</td><td>– 0.043</td></tr>
<tr><td>Final Club 5</td><td>| Bermuda | Dominica | Hong Kong SAR, China | Macao SAR, China |Madagascar | Maldives | Micronesia, Fed. Sts. | Timor-Leste |Tuvalu |</td><td>1.448</td><td>2.114</td><td>0.685</td></tr>
<tr><td>Final Club 6</td><td>| Thailand |</td><td>Not convergent</td><td></td><td></td></tr>
</table>

The countries that in bold fonts are the industrialised economies, while the countries that are not in the bold fonts are the countries that are less industrialised

* and ** respectively indicate rejection of the null hypothesis of convergence and club convergence merging at the 5% level

is not the same, and suggests that an effort by global governments could help the less industrialised countries to catch up with the industrialised ones.

Figure 2A presents the panel relative transition curves for the countries at the global level, to show how the countries behave over time, and compared to the panel average spanning the study period. According to P and S [1, 2], for countries to demonstrate convergence, the must indicate that the countries tend towards unity. A visual examination of the curves for the countries suggests that some exhibited both divergence and convergence at different points. This is because some of the countries exhibited both transition paths above 1 and below 1. But towards the end of the time period, the conclusion was that the countries demonstrated divergence. This concurs with the results in Table 4. The panel result and the transition graph suggest that at one point or another, world governments appear to have chosen both similar and dissimilar paths for their manufacturing/industrial development policy measures. One of the reasons that could be attributed to the nonconvergence in industrialisation is that the global industrial/manufacturing sector has, and is still undergoing, a shortage of lending, currency volatility, recalibrating supply networks/chains, downward pressure on prices, increased competition in the sector etc. [103].

Given that the *log t* parameter is − 118.151, the overall sample suggests that there is no indication of conditional or relative convergence towards the average. The countries can be categorized into 13 clubs according to the P and S [1] technique, but we cannot completely rely on the approach given as it could sometimes overestimate the number of clubs. Therefore, we proceeded to execute the P and S [2] club convergence merging technique in order to obtain the true number of clubs. After the execution of the P and S [2] approach, we had 6 clubs instead of 13 clubs. The club convergence merging algorithm results shows that clubs 1 + 2, 2 + 3, 1 + 2, 2 + 3, 3 + 4, 4 + 5, 5 + 6, 6 + 7, 7 + 8, 8 + 9, 9 + 10 and 10 + 11 can be merged because the $t_{\hat{b}}$ > − 1.65 (that is, 3.9462 > -1.65, 0.0338 > − 1.65, 0.0053 > − 1.65, − 0.5840 > − 1.65,

A: Transition paths for the World

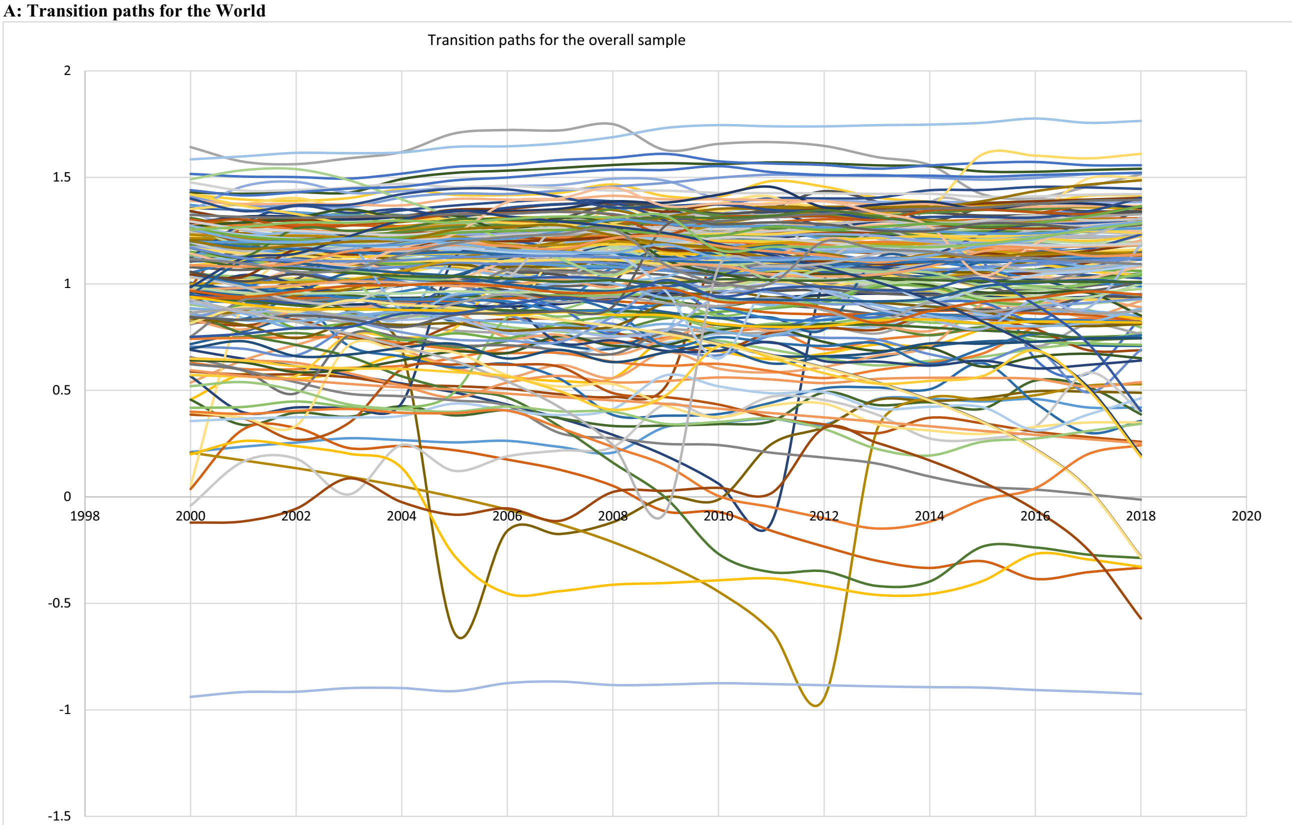


Fig. 2 **A** Transition paths for the World; **B** Transition paths for final club 1; **C** Transition paths for final club 2; **D** Transition paths for final club 3; **E** Transition paths for final club 4; **F** Transition paths for final club 5; **G** Transition paths for final club 6

Legend for the World

Fig. 2 (continued)

B: Transition paths for final club 1

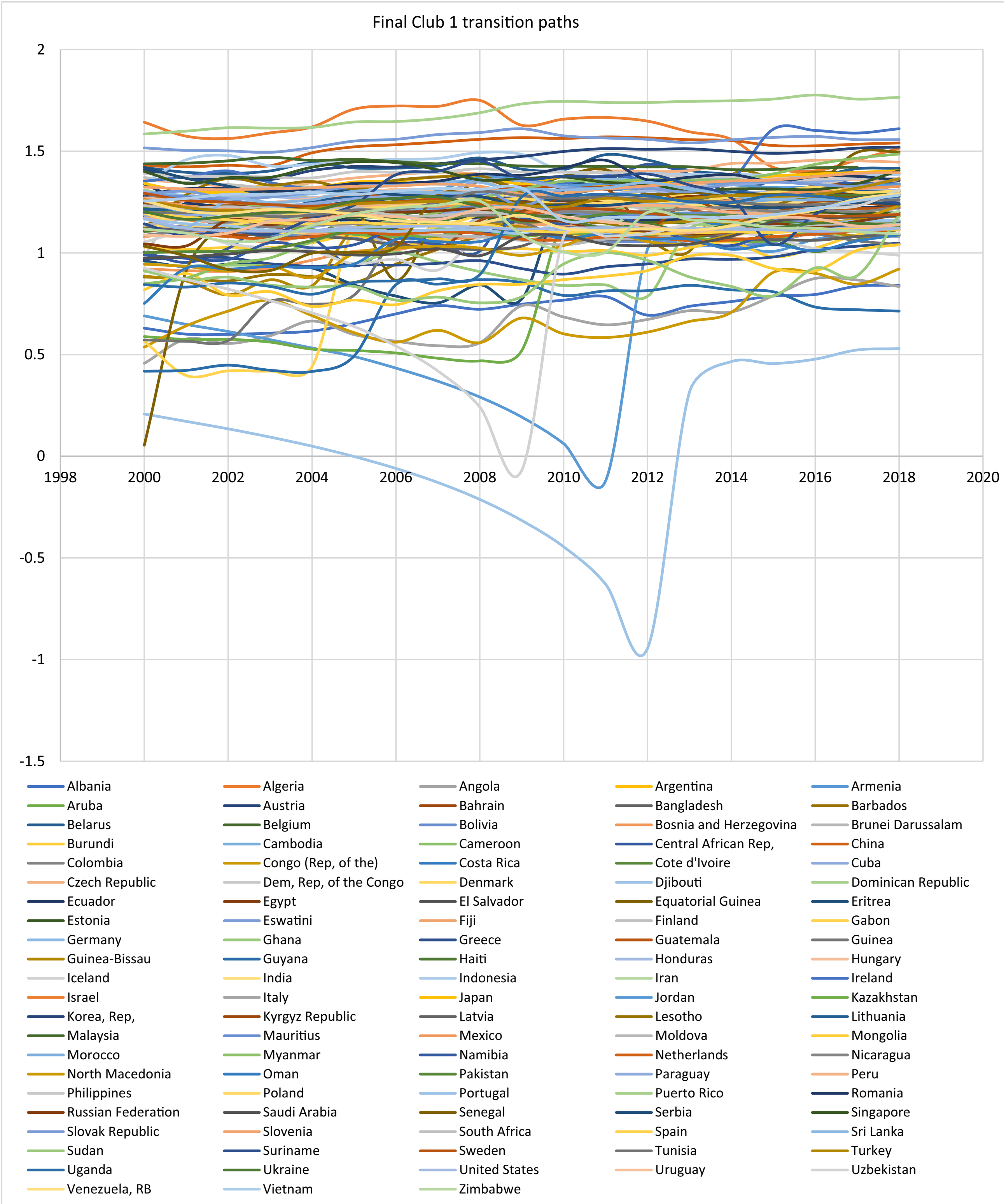


Fig. 2 (continued)

C: Transition paths for final club 2

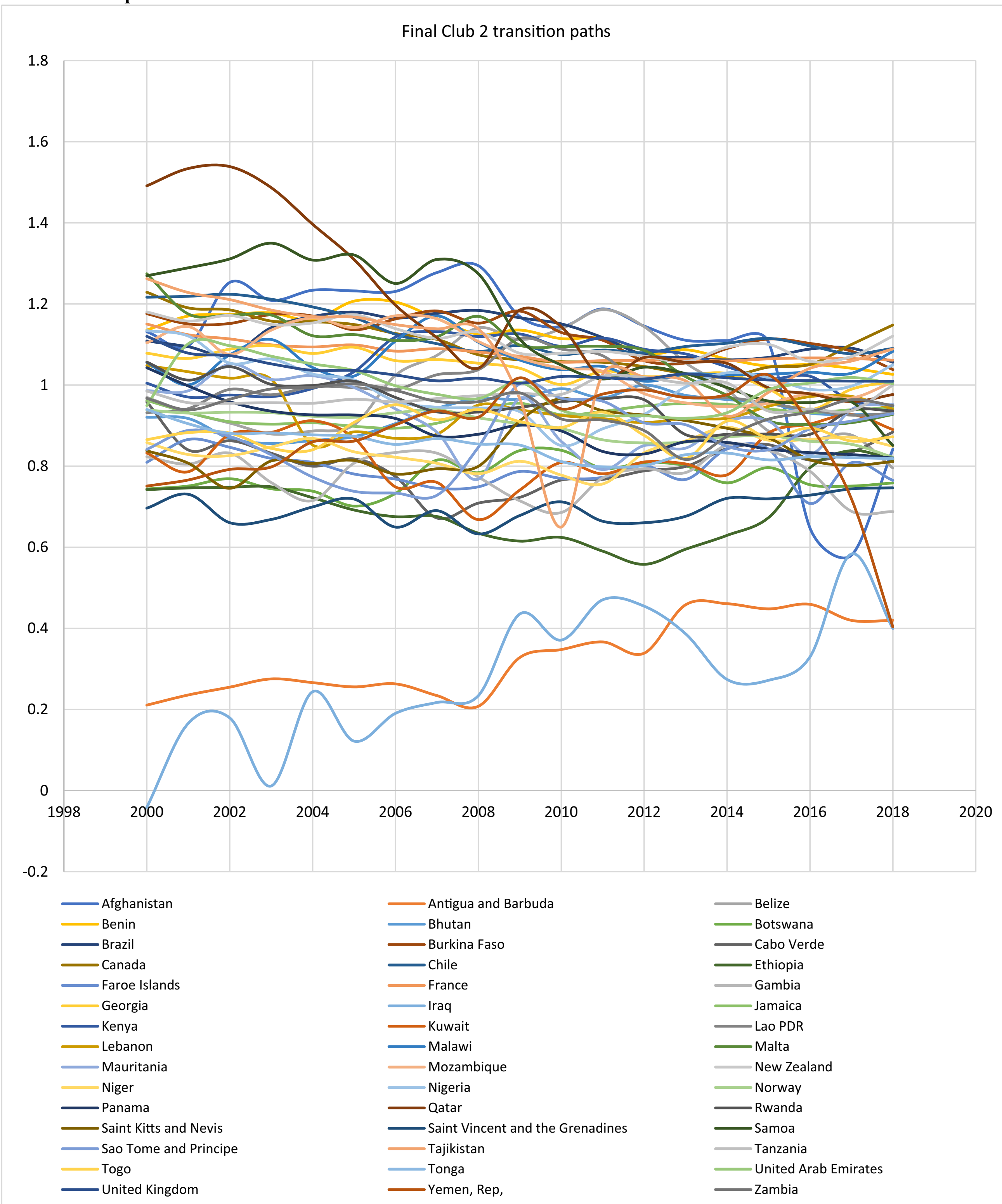


Fig. 2 (continued)

D: Transition paths for final club 3

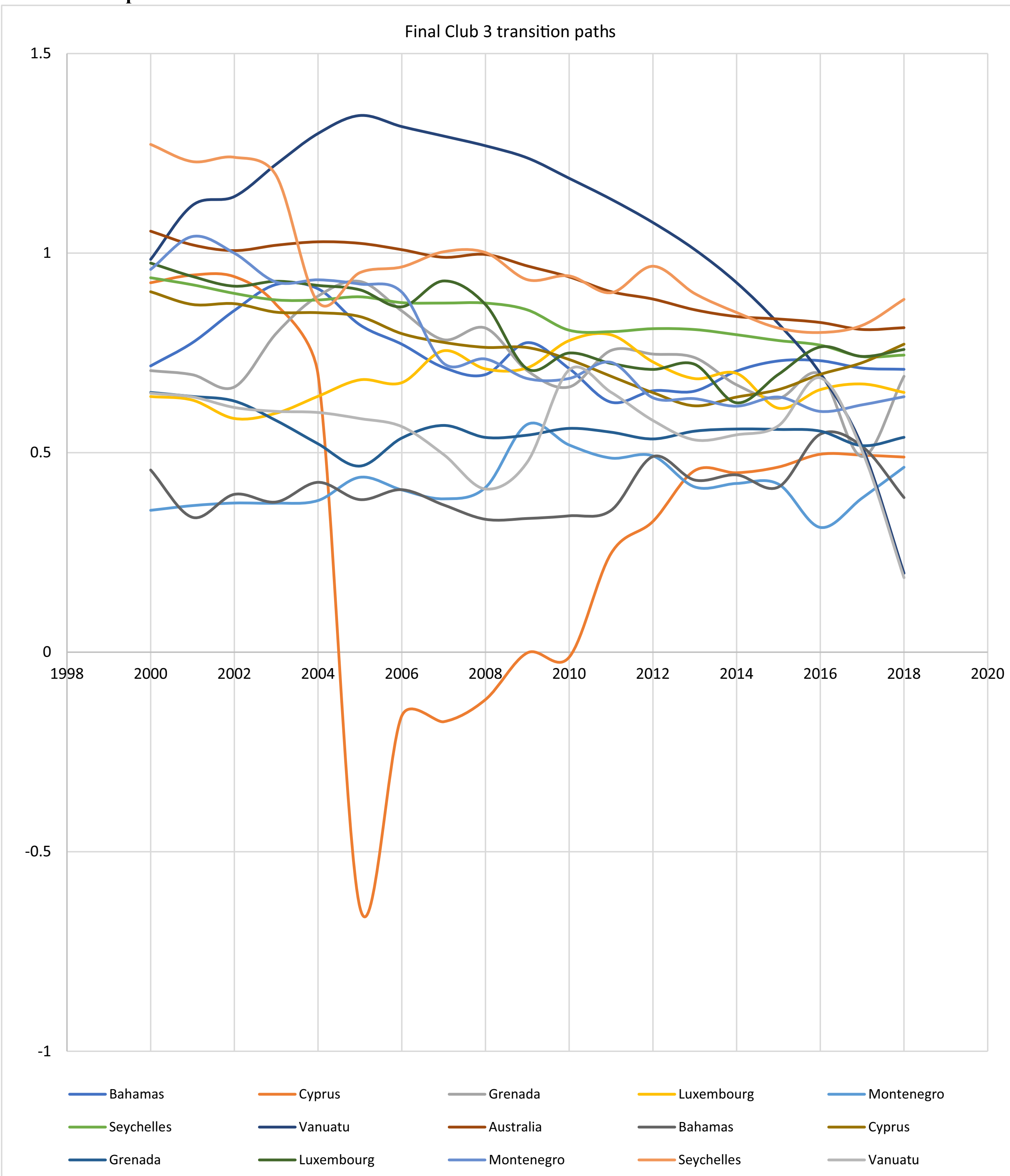


Fig. 2 (continued)

E: Transition paths for final club 4

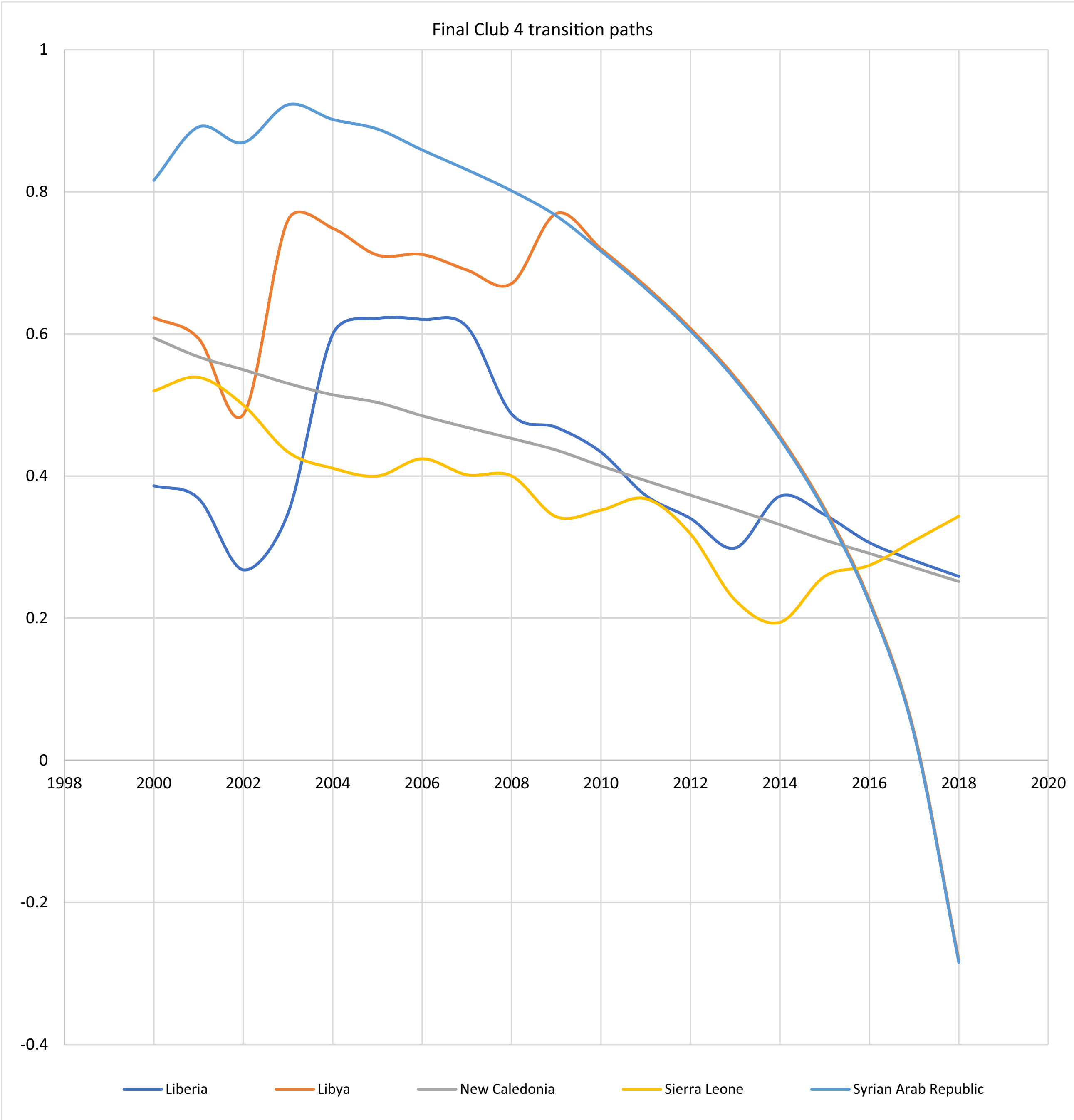
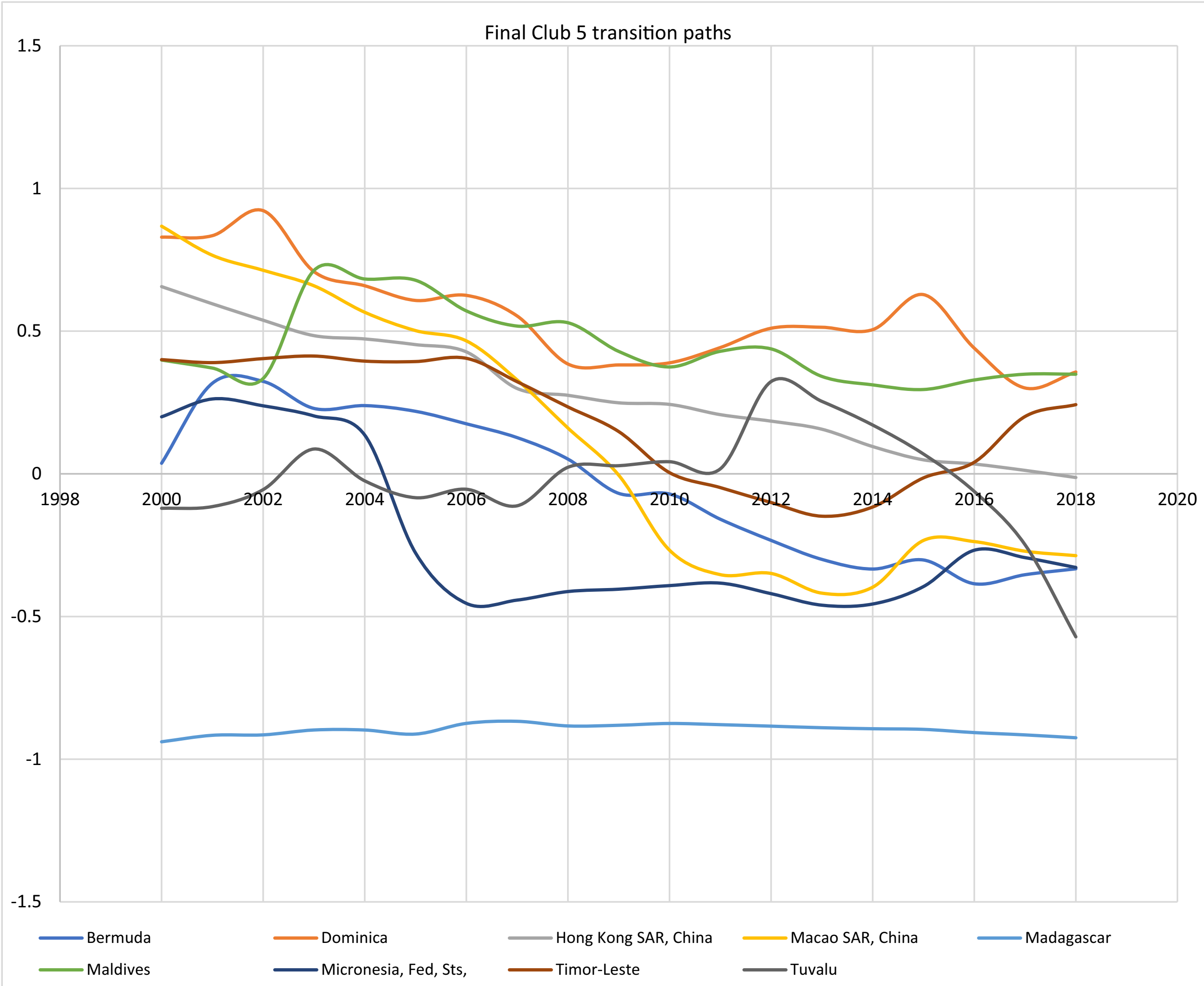


Fig. 2 (continued)

F: Transition paths for final club 5



G: Transition paths for final club 6

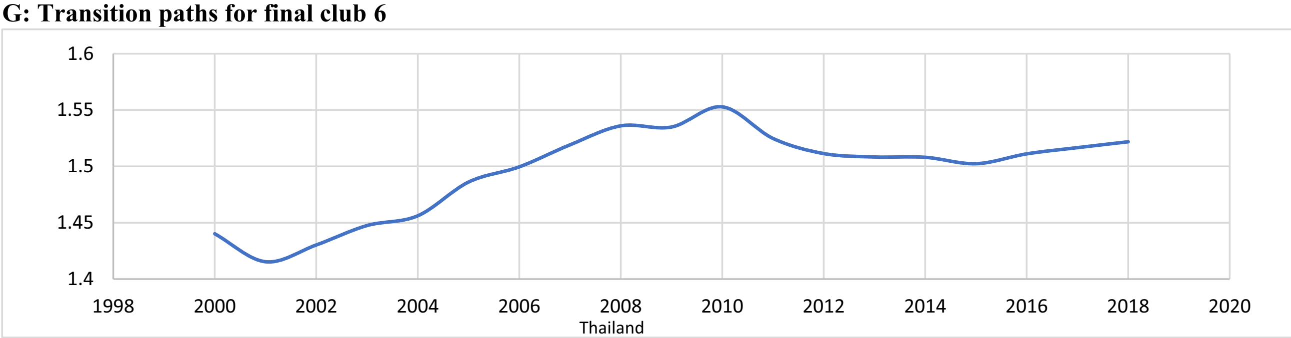


Fig. 2 (continued)

0.5680 > − 1.65, − 1.4110 > − 1.65, 1.9323 > − 1.65, 1.8355 > − 1.65, 1.2185 > − 1.65 and 2.2807 > − 1.65). While clubs 11 + 12, 12 + 13, 13 + 14 and 14 + 15 cannot be merged because the $t_{\hat{b}}$ < − 1.65 (that is, − 3.3149 < − 1.65, − 7.7277 < − 1.65, − 3.2409 < − 1.65 and − 5.0616 < − 1.65). Therefore, our clubs reduced from 13 to 6 clubs, as mentioned earlier. Following the rule of thumb, we concluded that final clubs 1, 2, 3, 4 and 5 converge (since their $t_{\hat{b}}$ is greater than − 1.65), while club 6 diverges. Although there is a possible difference in the countries degrees of industrial/manufacturing development, the results clearly suggest that final clubs 1, 2, 3, 4 and 5 are headed towards convergence, with different speeds of adjustment. The speed of adjustment for final clubs is -0.088, and − 0.007, 0.255, − 0.040 and 1.448. The highest speed of convergence is seen in final club 5, which is an interesting observation, further suggesting that less industrialised countries in that club are gradually catching-up with countries like Bermuda, Hong Kong, Macao, SAR, and China.

Final clubs 1, 2, 3, 4, 5 and 6 panel relative transition paths can be found in Fig. 2B–G, respectively. These graphs depict how the six final clubs' industrialisation processes behaved in relation to the panel average. The trajectories of each country's industrialisation route in relation to the sample average can be seen by inspecting the curves. In summary, a visual examination of the curves for the countries in each graph suggests that some of the countries exhibited both divergence and convergence at different points. This is because some of the countries exhibited both transition paths above 1 and those below 1. But towards the end of the time period, the countries panel transition paths demonstrated convergence. This also agrees with the results in Table 4.

It is evident from the results that there is no convergence for the overall sample (in other words, at the global level). This suggests that less industrialised nations are not catching up with a faster speed with the industrialised ones. This could be attributed to several reasons such as inadequate sharing and spreading of new industrial approaches and know-how from industrialised nations to the less industrialised ones. Since the industrial/manufacturing sector is seen as one of the primary drivers of growth, the absence of convergence in the overall sample may also be reflecting the gap in economic growth between the industrialised and less industrialised economies [4, 5]. Although the overall sample result suggests an absence of convergence; nevertheless, the results at the final club level suggest that the less industrialised countries with their numerous challenges and incapacities are still making efforts to catch up with the industrialised ones. The catch-up speed for the final clubs cannot be generalised, hence, less industrialised countries in final club 1, 2 and 4 (See Table 4) need to double their efforts to be able to catch-up with the industrialised countries that are in the same group with them. Readers should note that the industrialised economies according to the World Bank classification are in bold font. Finally, for this section, since the algorithm does not give insight on the likely drivers that help countries to form clubs, it is on this note that we move to the next estimations and analysis.

4.3 The results and analysis of the application of multinomial logit regression

The possible drivers of the final club convergence of the above analysis were identified by the application of multinomial logit regression. Beginning with Eq. (7), final club 5 serves as our reference class club because it has the highest speed of convergence. Table 5 presents the multinomial logit regression results which are interpreted at the10% significance level. On the one hand, other things held constant, the results in Column 1 show that AGRI, FDV, FDI, LAN, CRR, REGQ and VCA played a positive role in a significant way for the likelihood of countries to belong to the final club 1, while the opposite holds for variables like MNR, POL and GEF for the same club. This implies that the larger the values of the coefficient of the variable with positive value, the more likely countries will belong to final convergence club 1, when compared to final club 5. On the other hand, the higher the percentage of MNR, POL and GEF, the less likely countries will belong to final club 1 when compared to final club 5.

Looking at the estimation result of Eq. (8), other things held constant, the results in Column 2 show that AGRI, FDV, LAN, CRR, REGQ and VCA played a positive role in a significant way for the likelihood of countries to belong to the final club 2, while the opposite holds for variables like REX, MNR, POL and GEF for the same club. This implies that the larger the values of the coefficient of the variable with positive value (that is, AGRI, FDV, LAN, CRR, REGQ and VCA) the more likely countries will belong to final convergence club 2 when compared to final club 5. The higher the percentage of REX, MNR, POL and GEF, the less likely countries will belong to final club 2 when compared to final club 5.

Thus, the estimation results in Eq. (9, 10) with final clubs 3 and 4 respectively, will basically follow the same line of interpretation as what we have in Eq. (8, 7). That is, for a particular country, larger values of GDPC, FDV, FDI and REGQ make it more likely for countries to be part of final club 3 than to final club 5. In a similar way, higher REX, LFP, POP, RUL and VCA makes it less likely for countries to be part of final convergence club 3 than to final convergence club 5. And lastly, for a particular country, larger values of AGRI, FDI, REX, POP and RUL make it more likely for countries to be part of final club 4 than t final club 5. In a similar way, higher FDV, FLA, TRD, MNR, LFP, CRR and REGQ makes it less likely to

Table 5 Multinomial logistic regression results for the final clubs

	(1)	(2)	(3)	(4)
(Reference class = Final club 5)				
Variables	Final club 1	Final club 2	Final club 3	Final club 4
AGRI	0.880***	1.266***	0.199	7.112**
	(0.338)	(0.361)	(0.889)	(2.807)
GDPC	0.417	− 0.556	3.256**	− 1.609
	(0.418)	(0.482)	(1.519)	(1.808)
GFCF	− 0.196	− 0.125	− 1.089	1.858
	(0.604)	(0.597)	(2.714)	(1.887)
FDV	0.529**	0.655***	3.152***	− 4.170**
	(0.229)	(0.248)	(0.776)	(1.681)
FDI	0.040**	0.003	0.027**	0.049*
	(0.016)	(0.004)	(0.013)	(0.026)
REX	− 0.561	− 2.166*	− 17.925***	7.602***
	(1.298)	(1.145)	(3.071)	(1.604)
FLA	− 0.006	− 0.017	0.034	− 0.256***
	(0.020)	(0.024)	(0.072)	(0.084)
TRD	0.286	0.215	− 0.123	− 2.926**
	(0.388)	(0.384)	(0.899)	(1.391)
MNR	− 0.188***	− 0.405***	− 0.081	1.042**
	(0.056)	(0.060)	(0.277)	(0.409)
HUM	− 0.857	0.329	0.798	4.531
	(0.672)	(0.662)	(2.220)	(3.405)
ICT	− 0.400*	− 0.166	1.017	− 0.799
	(0.214)	(0.233)	(1.313)	(0.598)
LFP	0.197	1.443	− 13.771*	− 10.792***
	(1.002)	(1.129)	(7.747)	(4.093)
LAN	0.442***	0.944***	1.207*	− 1.886
	(0.162)	(0.177)	(0.621)	(1.183)
POP	− 0.353*	− 0.471**	− 3.089***	1.382**
	(0.213)	(0.229)	(1.179)	(0.589)
CRR	1.656***	1.446***	0.626	− 1.796*
	(0.465)	(0.524)	(1.280)	(1.001)
POL	− 0.874***	− 0.972***	0.415	2.098
	(0.263)	(0.291)	(1.439)	(2.353)
GEF	− 2.695***	− 2.657***	2.306	2.291
	(0.619)	(0.796)	(2.467)	(4.480)
REGQ	1.571***	1.603**	11.145***	− 3.358***
	(0.531)	(0.646)	(2.741)	(1.186)
RUL	0.362	1.390	− 12.556***	10.154*
	(0.743)	(0.847)	(3.005)	(5.873)
VCA	0.865**	0.765*	− 2.579***	1.085
	(0.373)	(0.438)	(0.997)	(0.884)
Constant	− 4.939	− 5.711	119.291***	− 1.995
	(11.504)	(12.879)	(36.063)	(23.346)
Observations	756	756	756	756

Robust standard errors in parentheses

***$p < 0.01$

**$p < 0.05$ɯ

*$p < 0.1$

belong to final convergence club 4 than to final convergence club 5. In conclusion, combining the estimation results of Eq. (7, 8), we can say that larger values of AGRI, FDV, LAN, CRR, REGQ and VCA raise the likelihood of countries to be part of a final convergence club, while larger values of MNR, POL and GEF make it less likely for countries to be part of a final convergence club in industrialisation.

The results indicate that the agricultural sector makes a significant and positive contribution to industrialisation, which is consistent with the findings of some studies, including Henneberry et al. [104] Hye [105], Adenomon and Oyejola [106] Rakhmetullina et al. [107] and Aguwamba et al. [108]. This suggests that the agricultural sector plays a crucial role in the industrialisation convergence of countries in final club 1, 2, and 4. Conversely, the agricultural sector's insignificant contribution to industrialisation for countries in final club 3 implies that more needs to be done to improve agricultural development, particularly in developing countries that are lagging behind in the club. This will enable the agricultural sector to make a significant contribution to industrialisation convergence. The significant and positive contribution of financial development to industrialisation is consistent with the findings of Teranishi [109], Efobi et al. [110], Shahbaz [111], amongst others. When financial development positively contributes to industrialisation, it implies that an increase in financial resources and services, such as credit, savings etc. leads to an increase in investment, particularly in the manufacturing sector, which in turn drives the growth of industrial production and output. Financial development can also help to overcome market failures, such as information asymmetry, and improve the efficiency of resource allocation. Therefore, the result reveals that financial development has contributed to the industrialisation convergence of the countries in final club 1, 2, and 3 (except in final club 4). The result suggests that financial development is an important driver of industrialization. By providing firms with access to financial resources and services, financial development can promote investment in the manufacturing sector, which is a key component of industrialisation.

The significant and positive contribution of FDI to industrialisation is consistent with the findings of Gui-Diby and Renard [55], Lim and Pang [112], Kang and Lee [113] and Anwar and Sun [114]. This implies that as FDI provide access to new technologies, capital, managerial expertise etc., it has contributed to industrialisation convergence of the countries in the different final clubs. The research conducted by Gui-Diby and Renard [55] supports the idea that higher income levels can have a positive impact on industrialisation, which is evident in the countries belonging to final club 3. However, for other countries belonging to the rest of the final clubs, particularly those classified as developing countries, several obstacles may hinder the contribution of income levels to industrialisation convergence. These include, among others, unequal income distribution, limited access to finance, weak infrastructure, and poor governance, as noted by various sources [115, 116]. The research conducted by Deng et al. [117] Erb et al. [118], Tian [119] and Yin et al. [120] supports the idea that land area can positively contribute to industrialisation, as it can support industrial development by providing the physical space needed for factories, infrastructure, and urbanisation. Therefore, the positive contribution of land area to industrialisation convergence in final club 1, 2 and 3 is worth noting given that the countries are not equally endowed when it comes to land area.

The effectiveness of the contribution of control of corruption, regulatory quality and voice & accountability to industrialisation convergence in this study also aligns with the studies conducted by Muhammad and Abdullahi [121], Totouom et al. [122] and Osei-Assibey [123]. Firstly, this is important because for example, corruption can create a business environment that is unpredictable and unstable, with rules and regulations that are not consistently enforced. This can lead to uncertainty and discourage investment in industries, as investors may be hesitant to invest in a country where corruption is rampant. Secondly, corruption can increase the cost of doing business, as companies may need to bribe officials to obtain permits or contracts, or may be forced to pay "protection" money to criminal organisations. These costs can make it more difficult for companies to compete in the market and can reduce the profitability of investments in industrial sectors. Therefore, it is important for both developing and developed countries that are members of the final clubs to closely pay attention to the six governance indicators used in this study for sustainable industrialisation convergence. Regarding external policies, the results presented in Table 4 suggest that countries belonging to final club 2 and 3 benefited from an exchange rate regime that enhanced the competitiveness of their domestic sector, thereby promoting their industrialisation convergence process. By keeping their exchange rates under control, these countries were able to stimulate their tradable sector and it further supports the idea of an effective tool for industrial policy, as stated by Rodrik [124]. This agrees with the findings of Haraguchi et al. [3] and Rodrik [124].

The ineffective contribution of mineral rent to industrialisation convergence for countries in final club 1, 2 and 4 points to the fact that increased reliance on natural resources raises the likelihood of negative performance in the long run and tends to amplify cyclical fluctuations in national income [125]. And that was why, Sachs and Warner [87] used the Dutch disease argument to highlight the possible harmful impacts of high mineral/natural resource rents on the growth of the manufacturing sector, to be more precise. The ineffective contribution of trade openness to industrialisation convergence for countries in final club 1, 2 and 3 suggest that trade openness may benefit certain sectors/countries of an economy while leaving others behind. As a result, some sectors/countries may experience deindustrialisation, leading to a decrease in their economic activity and output. This also suggest that developing countries in the final clubs may lack the technological capabilities required to take advantage of trade openness. Without the necessary technology, these countries may be unable to compete with more advanced economies and may struggle to develop their manufacturing sector. Countries in the final clubs that rely heavily on primary commodity exports may face difficulties in industrializing. These countries may be subject to the volatility of commodity markets, which can lead to fluctuations in revenue and hinder their ability to invest in the industrial sector. Our research findings suggest that industrialisation is not closely linked with human capital endowments, as measured by school enrollment, secondary (percentage gross). This result is not consistent with our expectation, and therefore, there is need for more investment in human capital to meet the increasing demand of the industries, and to upgrade the workforce's skills as industries make efforts to move up the value chain. The result related to human capital is not consistent with Haraguchi et al. s study [3]. This difference in results may be due to variations in sample size, time span, methodology, and other factors. The significant and negative contribution of labor force participation rate to industrialisation convergence in final club 3 and 4 suggests that more labor-intensive industries are needed most especially for the developing countries [126]. Overall, these findings are relatively and generally consistent with past research when it comes to the final clubs. On the relationship between AGRI, FDI, GDPC, LAN, REX, POL, MNR, FDV and TRD with industrialisation, see for example, Gui-Diby and Renard [55], Mijiyawa [47], Haraguchi et al. [3], Aslam et al. [127], and Müller [128].

5 Concluding remarks and policy recommendations

There are few studies in the literature that offer insight on industrialisation convergence. The modest body of empirical literature on industrialisation convergence is thus expanded by this paper. Using a novel approach developed by P&S [1, 2], the paper explores the club convergence in industrialisation for 183 countries between 2000 and 2018. We also classified and examined the possible drivers (grouped into economic, demographic, and geographic factors) that influence the convergence clubs of the countries. This is cogent for policy implication purposes, hence, this paper makes some contributions to the literature on convergence in industrialisation, which is as follows: (i) the absence of panel convergence unveiled by the approach shows that the countries are at different levels of industrial development; (ii) the algorithm test results reveal 5 clubs that were converging at different speeds, of which club 5 has the highest speed; and (iii) the results demonstrate that the determinants play a critical role in countries belonging to final clubs that are either converging or diverging.

Specifically, for economic variables: (i) agriculture value added as a percentage share of GDP, financial development and mineral rents as a percentage share of GDP played a significant role in the probability of countries belonging to final club 1, 2 and 4; (ii) real GDP per capita (proxy for levels of income) played a significant role in the probability of countries belonging to final club 3; (iii) foreign direct investment played a significant role in the probability of countries belonging to final club 1, 3 and 4; (iv) real effective exchange rate played a significant role in the probability of countries belonging to final club 2, 3 and 4; (v) inflation and trade openness played a significant role in the probability of countries belonging to final club 4; (vi) ICT played a significant role in the probability of countries belonging to final club 1; (vii) labor force participation rate played a significant role in the probability of countries belonging to final club 3 and 4; and (viii) gross fixed capital formation as a percentage share of GDP (proxy for investment) and human capital did not play a significant role in the probability of countries belonging to the final clubs. For the geographic variable, land area played a significant role in the probability of countries belonging to final club 1, 2 and 3. For the demographic variable, population played a significant role in the probability of countries belonging to final club1, 2, 3 and 4. While for governance indicators: (i) control of corruption played a significant role in the probability of countries belonging to final club 1, 2 and 4; (ii) government effectiveness and political stability and absence of violence/terrorism played a significant role in the probability of countries belonging to final club 1 and 2; (iii) regulatory quality played a significant role in the probability of countries belonging to final club 1, 2, 3 and 4; (iv) rule of law quality played a significant role in the probability of countries belonging to final club 3 and 4; (v) voice and accountability played a significant role in the probability of countries belonging to final club 1, 2 and 3. Final club 5 serves as the reference class in the multinomial regression. A country is more likely to belong to a particular final club if the values of the drivers are higher and it is important to also note that these drivers have varying degrees of influence depending on the final club one is focusing on.

The divergence in industrialisation at the panel level suggests that idiosyncratic/distinctive factors influence the industrialisation process globally. The implication of this result is that, since the industrial sector drives growth, the absence of industrialisation convergence would have contributed to the different levels of economic growth for the countries. Since our study consists of both industrialised and less industrialised economies, the findings reveal that less industrialised economies are not catching up with industrialised economies. It thus raises an awareness of the reality that less industrialised economies must be ready to bear all the possible costs that are needed to catch up with the industrialised ones. The slow rate of convergence indicates the need for greater effort by the less industrialised nations to catch up with the industrialised ones. As a result, industrialised nations need to provide assistance to the less industrialised countries in catching up, by working in conjunction with them and implementing policies that facilitate the process of rapid industrialisation. The divergence result at the panel level is proof that the idea of a security web concept does not hold at the global level. This suggests that, on a global scale, some countries may occasionally not perceive the progress of their neighbours' industrial growth as a danger. The narrative appears to differ at the club levels, which indicate that countries occasionally perceive the progress of their neighbours' industrial growth as a danger. Hence, this usually create rivalry between the countries.

In terms of policy direction, this analysis concludes that: (i) priority should be given by policymakers to determinants that negatively influenced the final clubs and which had little or no impact; (ii) policies that will promote a faster rate of convergence should be implemented for final clubs 1, 2, and 4, where the rate of convergence is slow; (iii) policies that will make the transfer of technology/training easy within the industrial sector for the purpose of closing industrialisation gaps should be implemented, while multilateral industrial cooperation efforts between countries that are within the same final club should be encouraged; (iv) in order to maintain and accelerate the speed of convergence through the effective operation of their industrial sector, the governments in final clubs 1, 2, 3, 4 and 5 must review policies surrounding the determinants on a regular basis; (v) policymakers should use transition paths for the countries to gather information on how countries have behaved in past times, and how they should better plan the use of available resources to further their industrialisation process for sustainable growth. More specifically, given that FDI that is focused on natural resource extraction or low-skill assembly activities may not lead to sustainable industrialisation [129]. Therefore, based on the result from this study it is important for host countries that are less industrialised to design policies that attract FDI that is aligned with their development objectives and that can contribute to sustainable industrialisation. Since the relationship between levels of income and industrialisation is not always a straightforward one, therefore, policies that promote real GDP per capita and provide targeted support to industries with high growth potential are critical for fostering industrialisation in developing countries. Promoting industrialisation in less industrialised countries requires the implementation of policies that support investment in key sectors of the economy. Some of the best policies on investment to promote industrialisation in less industrialised countries include, among others, investment in infrastructure. The governments should invest by building modern infrastructure such as roads, ports, airports, and railways that can create a conducive environment for industrialisation. This is because infrastructure reduces the cost of doing business, making it easier for firms to transport goods and services. Human capital is one of the essential factors that can influence industrialisation in any country, therefore, the insignificant contribution of human capital to the convergence process calls for policies that promote radical investment in the educational system of less industrialised countries. Education is one of the key drivers of human capital development. Thus, investing in education policies that ensure access to quality education and skills development can help promote industrialisation in less industrialised countries. According to the World Bank, investment in education can increase productivity and promote innovation, which are critical drivers of industrialisation [130].

The caveat from this study is that relevant stakeholders should amend and constantly review policies around economic and governance variables that are not industrially friendly towards the attainment of industrial development at the global level, since our results reveal panel nonconvergence of industrialisation. Given that the industrial/manufacturing sector contributes to the process of economic growth and development of a nation, it is therefore crucial to align as much as possible different countries industrial policy directives with the aim of tackling major factors that might prevent the sector from contributing effectively to local, national, and international development. Further research should consider extending the dataset, the time span, and apply the same methodology to the different regions of the world. This will further reveal the level of regional industrialisation convergence at the regional levels of the globe.

Author contributions CSS and NN conceptualized the study idea, drafted the paper, collected data, analyzed data, wrote the introduction section, organized the literature review, drafted the methodology section, interpreted the results, and provided the discussions, concluded the study with policy implications and organized the reference list. All author(s) read and approved the final manuscript.

Funding The author(s) received no financial support for the research, authorship, and/or publication of this article.

Data availability The data relevant to this research is publicly available from the World Bank's World Development Indicator and International Telecommunication Union (ITU) databases or obtained from the authors by making a reasonable request.

Declarations

Ethics approval and consent to participate This article does not contain any studies with human participants or animals performed by any of the author(s).

Consent for Publication This manuscript is an original work of the authors which has not been submitted elsewhere and we give our full consent for its publication in the Discover Sustainability journal.

Competing interests The authors declare no competing interests.

References

1. Phillips PC, Sul D. Transition modeling and econometric convergence tests. Econometrica. 2007;75(6):1771–855.
2. Phillips PC, Sul D. Economic transition and growth. J Appl Econom. 2009;24(7):1153–85.
3. Haraguchi N, Martorano B, Sanfilippo M. What factors drive successful industrialization? Evidence and implications for developing countries. Struct Chang Econ Dyn. 2019;49:266–76.
4. Kaldor N. Causes of the slow rate of growth of the United Kingdom. Cambridge: Cambridge University Press; 1966.
5. Kaldor N. Strategic factors in economic development Cornell University. New York: New York State School of Industrial and Labor Relations; 1967.
6. Xu LC. The effects of business environments on development: surveying new firm-level evidence. Wor Bank Res Obs. 2011;26(2):310–40.
7. Matsuyama K. Agricultural productivity, comparative advantage, and economic growth. J Econ Theory. 1992;58(2):317–34.
8. Sachs, J. D, and Warner, A. M. Natural resource abundance and economic growth (No. w5398). National bureau of economic research. https://www.nber.org/system/files/working_papers/w5398/w5398.pdf.Accessed on 11th Mar 2023. 1995.
9. Rodrik D. Unconditional convergence in manufacturing. Quart J Econ. 2013;128(1):165–204.
10. Saba CS, Ngepah N. Military expenditure and security outcome convergence in African regional economic communities: evidence from the convergence club algorithm. Pea Econ Pea Sci Pub Pol. 2020;26(1):20190014. https://doi.org/10.1515/peps-2019-0014.
11. Saba CS, David OO. Convergence patterns in global ICT: fresh insights from a club clustering algorithm. Tel Pol. 2020;44(10): 102010.
12. Saba CS. Convergence or divergence patterns in global defence spending: further evidence from a nonlinear single factor model. Peace Econ: Peace Sci. Publ. Pol; 2020. https://doi.org/10.1515/peps-2020-0012.
13. Saba CS. Convergence and transition paths in transportation: fresh insights from a club clustering algorithm. Tran Pol. 2021;112(2021):80–93. https://doi.org/10.1016/j.tranpol.2021.08.008.
14. Saba CS, Ngepah N, Odhiambo NM. Analysis of convergence in transport infrastructure: a global evidence. Eur J Tran Infra Res. 2021;21(2):137–60.
15. Abegaz B. Structural convergence in manufacturing industries between leaders and latecomers. J Dev Stud. 2002;38(4):69–99.
16. Lemoine F, Poncet S, Ünal D. Spatial rebalancing and industrial convergence in China. China Econ Rev. 2015;34:39–63. https://doi.org/10.1016/j.chieco.2015.03.007.
17. Erten B, Schwank O. Rethinking unconditional convergence in manufacturing in the age of new technologies. J Glob Dev. 2021. https://doi.org/10.1515/jgd-2020-0011.
18. Ortiz Ávalos L, Ruiz Ochoa W. Inter-municipal Convergence of Manufacturing in Sonora: the role of state investment. Frontera Norte. 2010;22(44):79–107.
19. Bénétrix AS, O'Rourke KH, Williamson JG. The spread of manufacturing to the poor periphery 1870–2007. Op Econ Rev. 2015;26(1):1–37.
20. Dong F, Li Y, Zhang X, Zhu J, Zheng L. How does industrial convergence affect the energy efficiency of manufacturing in newly industrialized countries? Fresh evidence from China. J Clean Prod. 2021;316: 128316.
21. Saba CS, Ngepah N. ICT diffusion industrialisation and economic growth nexus: an international cross-country analysis. J Know Econ. 2021. https://doi.org/10.1007/s13132-021-00795-w.
22. Abramovitz M. Catching up, forging ahead, and falling behind. J Econ Hist. 1986;46(2):385–406.

23. Solow RM. A contribution to the theory of economic growth. Quart J Econ. 1956;70(1):65–94.
24. Swan TW. Economic growth and capital accumulation. Econ Rec. 1956;32(2):334–61.
25. Barro RJ. Economic growth in a cross section of countries. Quar J Econ. 1991;106(2):407–43.
26. Barro RJ, Sala-i-Martin X, Blanchard OJ, Hall RE. Convergence across states and regions. Brook Papers Econ Act. 1991. https://doi.org/10.2307/2534639.
27. Barro RJ, Sala-i-Martin X. Convergence. J Pol Econ. 1992;100(2):223–51.
28. Fai F, Von Tunzelmann N. Industry-specific competencies and converging technological systems: evidence from patents. Struct Chang Econ Dyn. 2001;12(2):141–70.
29. de Souza JPA. Evidence of growth complementarity between agriculture and industry in developing countries. Struct Chang Econ Dyn. 2015;34:1–18. https://doi.org/10.1016/j.strueco.2015.05.001.
30. Rey SJ, Montouri BD. US regional income convergence: a spatial econometric perspective. Reg Stud. 1999;33(2):143–56.
31. Islam N. What have we learnt from the convergence debate? J Econ Surv. 2003;17(3):309–62.
32. Xing W, Ye X, Kui L. Measuring convergence of China's ICT industry: an input–output analysis. Tel Pol. 2011;35(4):301–13.
33. Chen W, Huang X, Liu Y, Song Y. Does industry integration improve the competitiveness of china's electronic information industry?—evidence from the integration of the electronic information industry and financial industry. Sust. 2019;11(9):2695.
34. Garcia-Murillo MA, MacInnes I. FCC organizational structure and regulatory convergence. Tel Pol. 2001;25(6):431–52.
35. Li X, Chen H, Zhang X. Research on the performance of the integration of information industry and manufacturing industry. Based on the data of Zhejiang Province. Chin Soft Sci. 2017;2:21–31 (**(in Chinese)**).
36. Gao Z, Lu Z. The impact of industrial convergence on innovation efficiency of equipment manufacturing industry. Based on the perspective of converged development of equipment manufacturing industry and high-tech service industry. Cont Econ Res. 2018;8:71–81 (**(in Chinese)**).
37. Cao L, Li L, Wu Y, Zeng W. Does industrial convergence promote regional metabolism? Evidence from China. J Clean Prod. 2020;273:123010. https://doi.org/10.1016/j.jclepro.2020.123010.
38. Fafchamps M, El Hamine S, Zeufack A. Learning to export: evidence from moroccan manufacturing. J Afri Econ. 2008;17(2):305–55.
39. Söderbom M, Teal F, Harding A. The determinants of survival among African manufacturing firms. Econ Dev Cult Chang. 2006;54(3):533–55.
40. Söderbom M, Teal F. Are manufacturing exports the key to economic success in Africa? J Afri Econ. 2003;12(1):1–29.
41. Bigsten A, Collier P, Dercon S, Fafchamps M, Gauthier B, Gunning JW, Oduro A, Oostendorp R, Patillo C, Söderbom M, Teal F. Credit constraints in manufacturing enterprises in Africa. J Afri Econ. 2003;12(1):104–25.
42. Bigsten A, Collier P, Dercon S, Fafchamps M, Gauthier B, Willem Gunning J, Oduro A, Oostendorp R, Pattillo C, Söderbom M, Teal F. Do African manufacturing firms learn from exporting? J Dev Stud. 2004;40(3):115–41.
43. Soludo CC, Ogbu MO, Chang HJ, editors. The Politics of trade and industrial policy in Africa: forced consensus? Trenton: Africa World Press; 2004.
44. Marti, D.F. and Ssenkubuge, I, 2009. Industrialisation and industrial policy in Africa: is it a policy priority? South Centre Research Paper no. 20. https://www.econstor.eu/bitstream/10419/232138/1/south-centre-rp-020.pdf.
45. Altenburg, T. Industrial policy in developing countries: Overview and lessons from seven country cases. German Development Institute Discussion Paper No. 4/2011. German Development Institute: Bonn. 2011.
46. Dihn, H. T, Palmade, V, Chandra, V. and Coassar, F. 2012 Light Manufacturing in Africa: Targeted policies to enhance private investment and create jobs. A co-publication of Agence Franc aise de De´veloppement and the World Bank. Paris
47. Mijiyawa AG. Drivers of structural transformation: the case of the manufacturing sector in Africa. Wor Dev. 2017;99:141–59. https://doi.org/10.1016/j.worlddev.2017.07.007.
48. Du K. Econometric convergence test and club clustering using Stata. Stat J. 2017;17(4):882–900.
49. Chang HJ. Kicking away the ladder: Infant industry promotion in historical perspective. Oxf Dev Stud. 2003;31(1):21–32.
50. Carmignani F, Mandeville T. Never been industrialized: a tale of African structural change. Struct Chang Econ Dyn. 2014;31:124–37.
51. McMillan, M., Rodrik, D, and Sepulveda, C. Structural change, fundamentals and growth: a framework and case studies. No. w23378. National Bureau of Economic Research. 2017.
52. Prakash, A. The role of industrialisation and ICT in Africa's growth and integration into global value chains. At Economic Research Institute for ASEAN and East Asia. 2019. http://hdl.handle.net/11540/10871.
53. Rasel F. ICT and global sourcing–evidence for German manufacturing and service firms. Econ Innov New Technol. 2017;26(7):634–60.
54. Hwang, W. S, and Kim, H. S. Does the adoption of emerging technologies improve technical efficiency? Evidence from Korean manufacturing SMEs. Small Business Econ. 2021 1–17.
55. Gui-Diby SL, Renard MF. Foreign direct investment inflows and the industrialization of African countries. Wor Dev. 2015;74:43–57. https://doi.org/10.1016/j.worlddev.2015.04.005.
56. Sachs J. The End of Poverty: Economic Possibilities for Our Time. London: Penguin Books; 2005.
57. Weiss, M, Clara, M, UNIDO: Vienna 2016. Unlocking domestic investment for industrial development Department of Policy. Research and Statistics Working Paper 12/2016.
58. Kniivilä M. Industrial development and economic growth: Implications for poverty reduction and income inequality Industrial development for the 21st century. Sustain Develop Persp. 2007;1(3):295–333.
59. Amsden AH. The rise of "the rest: Challenges to the West from late-industrializing economies. Oxford: Oxford University Press; 2001.
60. Romer D. Advanced macroeconomics. New York: McGraw-Hill; 1996.
61. David OO. Powering economic growth and development in Africa: telecommunication operations. Appl Econ. 2019;51(33):3583–607.
62. Durlauf S, Quah DT. The new empirics of economic growth. In: Taylor J, Woodford M, editors. Handbook of macroeconomics (Part A). North Holland: Elsevier; 1999. p. 235–308.
63. Lucas RE. On the mechanics of economic development. J Monet Econ. 1988;22(1):3–42.
64. Benhabib J, Spiegel M. The role of human capital in economic development: evidence from aggregate cross-country data. J Monet Econ. 1994;34(2):143–73.
65. Beck T, Demirgüç-Kunt A, Levine R. Law and finance: why does legal origin matter? J Comp Econ. 2003;31(4):653–75.

66. Rajan RG, Zingales L. The great reversals: the politics of financial development in the twentieth century. J Financ Econ. 2003;69(1):5–50.
67. Rajan RG, Zingales L. Power in a theory of the firm. Quart J Econ. 1998;113(2):387–432.
68. Diao X, McMillan M, Wangwe S. Agricultural labour productivity and industrialisation: lessons for Africa. J Afr Econ. 2018;27(1):28–65.
69. Botta A. A structuralist North-South model on structural change, economic growth and catching-up. Struct Chang Econ Dyn. 2009;20(1):61–73.
70. Diao, X, McMillan, M, and Rodrik, D. The recent growth boom in developing economies: a structural change perspective. No. w23132. National Bureau of Economic Research. 2017.
71. Lewis WA. Economic development with unlimited supplies of labour. Man Sch Econ and Soc Stud. 1954;22:139–91.
72. Blomström M, Kokko A. Multinational corporations and spillovers. J Econ Surv. 1998;12(3):247–77.
73. Rodriguez-Clare, A,. Multinationals linkages, and economic development. Am. Econ. Rev. 1996 852–873.
74. Markusen JR, Venables AJ. Foreign direct investment as a catalyst for industrial development. Eur Econ Rev. 1999;43(2):335–56.
75. Christiaans T. International trade and industrialization in a non-scale model of economic growth. Struct Chang Econ Dyn. 2008;19(3):221–36.
76. Kaya Y. Globalization and industrialization in 64 developing countries, 1980–2003. Soc For. 2010;88(3):1153–82.
77. Rowthorn, R and Ramaswamy R. 1997. Deindustrialization: causes and implications. IMF working paper no. 97/42. International Monetary Fund.
78. Keller W. International trade, foreign direct investment, and technology spillovers. Elsevier: In Handbook of the economics of innovation; 2010.
79. Rodríguez F, Rodrik D. Trade policy and economic growth a skeptic's guide to the cross—national evidence. In: Bernanke B, Rogoff K, editors. NBER Macroeconomics Annual. Cambridge: MIT Press; 2000.
80. Lederman D, Maloney WF. Does what you export matter? In search of empirical guidance for industrial policies. World Bank Res Observer. 2012;27(1):26–57.
81. Asiedu E. Foreign direct investment in Africa: The role of natural resources, market size, government policy, institutions, and political instability. World Econ. 2006;29(1):63–77.
82. Janz, N, Lööf, H, and Peters, B. Firm level innovation and productivity-is there a common story across countries? ZEW Discussion Paper No. 03–26. 2003. https://doi.org/10.2139/ssrn.416444. https://ssrn.com/abstract=416444. Accessed on 11th of Mar 2023.
83. Auty, R. Sustaining development in mineral economies: the resource curse thesis. routledge. 2002. Accessed on 11 Mar 2023.
84. Collier, P, and Goderis, B. Commodity prices, growth, and the natural resource curse: Reconciling a conundrum. 2008. https://doi.org/10.2139/ssrn.1473716. https://ssrn.com/abstract=1473716. Accessed on 11 Mar 2023.
85. Ross ML. The political economy of the resource curse. World Politics. 1999;51(2):297–322.
86. Rodriguez F, Sachs JD. Why do resource-abundant economies grow more slowly? J Econ Grow. 1999;4(3):277–303.
87. Sachs JD, Warner AM. The curse of natural resources. Eur Econ Rev. 2001;45(4–6):827–38.
88. Ranis, G, and Stewart, F. Economic growth and human development in Latin America. Cepal Review. 2002. https://hdl.handle.net/11362/10904. Accessed on 11 Mar 2023.
89. Davis KF, D'Odorico P, Rulli MC. Land grabbing: a preliminary quantification of economic impacts on rural livelihoods. Popul Environ. 2014;36:180–92.
90. Temper L. From boomerangs to minefields and catapults: dynamics of trans-local resistance to land—grabs. J Peasant Stud. 2019;46(1):188–216.
91. Acemoglu D, Johnson S. Disease and development: the effect of life expectancy on economic growth. J Polit Econ. 2007;115(6):925–85.
92. Malthus TR. An essay on the principle of population (1798) the works of Thomas Robert Malthus. London: Pickering & Chatto Publishers; 1986.
93. Boserup E. The conditions of agricultural growth: the economics of agrarian change under population pressure, vol. 4. London: Earthscan; 1965.
94. Guadagno, F, 2016. The determinants of industrialisation in developing countries, 1960–2005 (MERIT Working Papers 2016–031). United Nations University-Maastricht Economic and Social Research Institute on Innovation and Technology (MERIT). https://www.merit.unu.edu/publications/wppdf/2016/wp2016-031.pdf.
95. Mensah, E.B. Is sub-Saharan Africa deindustrializing? (Maastricht economic and social research institute on innovation and Technology (UNU-MERIT). UNU-MERIT Working Papers 2020–045). 2020. file:///C:/Users/PC/Downloads/wp2020–045%20(1).pdf
96. Zhang X, Mount TD, Boisvert RN. Industrialization, urbanization and land use in China. J Chin Econ Bus Stud. 2004;2(3):207–24.
97. Chandra R. Industrialization and development in the third World. London: Routledge; 2003.
98. Echaudemaison C-D. Dictionnaire d'économie et de sciences sociales. 6e ed. Paris: Nathan; 2003.
99. Hausmann R, Rodrik D. Economic development as self-discovery. J Dev Econ. 2003;72(2):603–33.
100. Szirmai A, Verspagen B. Manufacturing and economic growth in developing countries, 1950–2005. Struct Chang Econ Dyn. 2015;34:46–59.
101. World Bank. Manufacturing value added (% of GDP). 2022. https://data.worldbank.org/indicator/NV.IND.MANF.ZS. Accessed on 11th Mar 2023.
102. Chen IJ. Financial crisis and the dynamics of corporate governance: evidence from Taiwan's listed firms. Int Rev Econ Finance. 2014;32:3–28.
103. Thornton PK. Livestock production: recent trends, future prospects. Phil Trans of Royal Soc B Biol Sci. 2010;365(1554):2853–67.
104. Henneberry SR, Khan ME, Piewthongngam K. An analysis of industrial–agricultural interactions: a case study in Pakistan. Agric Econ. 2000;22(1):17–27.
105. Hye QMA. Agriculture on the road to industrialization and sustainable economic growth: an empirical investigation for Pakistan. Int J Agric Econ Rural Develop. 2009;2(2):1–6.
106. Adenomon MO, Oyejola BA. impact of agriculture and industrialization on GDP in Nigeria: evidence from VAR and SVAR models. Int J Anal Appl. 2013;1(1):40–78.
107. Rakhmetullina, S, Isiksal, A. Z. and Chimezi, J. O. Economic growth, agriculture and industrialization in nigeria: an ardl bound testing approach. Int J Econ Persp. 11(2). 2017.

108. Aguwamba, C. A, Paul, N L, and Student, E. J. C. P. D. Effect of agriculture on industrialization of Nigerian economy (1981–2018). IN AFFILIATION WITH UNIVERSITY OF NIGERIA, NSUKKA, 101. 2020. https://www.alvanikoku.edu.ng/wp-content/uploads/2020/11/Jounal-of-School-of-Arts-and-Social-Sciences-vol.-8-no-1-Sept.-2020.pdf#page=114. Accessed 11 Mar 2023.
109. Teranishi, J. Financial system and the industrialisation of Japan 1900–1970. PSL Quarterly Review, 43(174). 1990.
110. Efobi, U, Asongu, S, Okafor, C, S Tchamyou, V, and Tanankem B. Diaspora remittance inflow, financial development and the industrialisation of Africa. African Governance and Development Institute WP/16/037. 2016. https://doi.org/10.2139/ssrn.2846249. https://ssrn.com/abstract=2846249. Accessed on 11 Mar 2023.
111. Shahbaz, M, Bhattacharya, M, and Kumar M. Financial development, industrialisation, urbanisation and the role of institutions: a comparative analysis between India and China. 2017. https://mpra.ub.uni-muenchen.de/81609/1/MPRA_paper_81609.pdf. Accessed on 11 Mar 2023.
112. Lim L. Y and Pang, E. F. Foreign direct investment and industrialisation in Malaysia, Singapore Taiwan, and Thailand. 1991. https://ink.library.smu.edu.sg/lkcsb_research/240. Accessed on 11 Mar 2023.
113. Kang SJ, Lee H. Foreign direct investment and de-industrialisation. World Econ. 2011;34(2):313–29.
114. Anwar S, Sun S. Foreign direct investment and export quality upgrading in China's manufacturing sector. Int Rev Econ Financ. 2018;54:289–98.
115. Saba CS, Ngepah N. Nexus between telecommunication infrastructures defence and economic growth a global evidence. Netnom Econ Res Electron Netw. 2022;2(3):139.
116. Saba CS, Ngepah N. Convergence in renewable energy sources and the dynamics of their determinants: an insight from a club clustering algorithm. Energy Rep. 2022;8:3483–506.
117. Deng X, Huang J, Rozelle S, Uchida E. Growth, population and industrialization, and urban land expansion of China. J Urban Econ. 2008;63(1):96–115.
118. Tian L. Land use dynamics driven by rural industrialization and land finance in the peri-urban areas of China: "the examples of Jiangyin and Shunde." Land Use Policy. 2015;45:117–27.
119. Erb KH, Gingrich S, Krausmann F, Haberl H. Industrialization, fossil fuels, and the transformation of land use: an integrated analysis of carbon flows in Austria 1830–2000. J Ind Ecol. 2008;12(5–6):686–703.
120. Yin J, Zhao X, Zhang W, Wang P. Rural land use change driven by informal industrialization: evidence from fengzhuang village in China. Land. 2020;9(6):190.
121. Muhammad GB, Abdullahi A. Corruption, governance, and the politics of de-industrialization in Nigeria. Int J Phys Soc Sci. 2013;3(4):1–13.
122. Totouom, A, Kaffo, H. F and Sundjo, F. Structural transformation of Sub-Saharan Africa Does the quality of institutions matter in its industrialization process? Région et Développement Number. 50–2019. 2019. Accessed on 11 Mar 2023.
123. Osei-Assibey, E. Is China's growing interest in Africa a blessing or a curse for the continent's industrialization drive? In designing integrated industrial policies volume II (pp. 183–202). For inclusive development in Africa and Asia. Edited by Shigeru Thomas Otsubo, Christian Samen Otchia. Routledge. 2020 https://doi.org/10.4324/9781003020240.Accessed on 11 Mar 2023.
124. Rodrik, D. Normalizing Industrial Policy Commission on Growth and Development Working Paper No. 3. © World Bank, Washington. DC. 2008. Accessed on 11 Mar 2023.
125. Rodriguez F, Sachs JD. Why do resource-abundant economies grow more slowly. J Econ Growth. 1999;4:277–303.
126. Tran, T and Doan, T. 2010. Industrialization, economic and employment structure changes in vietnam during economic transition. Accessed 11 Mar 2023. https://mpra.ub.uni-muenchen.de/26996/1/MPRA_paper_26996.pdf.
127. Aslam B, Hu J, Shahab S, Ahmad A, Saleem M, Shah SSA, Javed MS, Aslam MK, Hussain S, Hassan M. The nexus of industrialization GDP per capita and CO2 emission in China Tech. Inn Env. 2021. https://doi.org/10.1016/j.eti.2021.101674.
128. Müller P. Impacts of inward FDIs and ICT penetration on the industrialisation of Sub-Saharan African countries. Struct Chang Econ Dyn. 2021;56:265–79. https://doi.org/10.1016/j.strueco.2020.12.004.
129. United Nations Conference on Trade and Development (UNCTAD) 2020. World Investment Report 2020. Accessed on 13 Mar 2023. https://unctad.org/system/files/official- document/wir2020_overview_en.pdf.
130. World Bank. Building human capital. https://doi.org/10.1596/978-1-4648-1328-3_ch3.2018 Accessed on 14 Mar 2023.
131. Saba CS, Ngepah N. Empirical analysis of military expenditure and Industrialisation Nexus: a regional approach for Africa. Int Econ J. 2019;34(1):1–27.
132. Saba CS, Ngepah N. A cross-regional analysis of military expenditure, state fragility and economic growth in Africa. Qual Quantity. 2019;53(6):2885–915.
133. Saba CS, Ngepah N. Convergence in military expenditure and economic growth in Africa and its regional economic communities: evidence from a club clustering algorithm. Cogent Econ Financ. 2020;8(1):1832344.
134. Saba CS, Ngepah N. Nexus between defence spending economic growth and development evidence from a disaggregated panel data analysis. Econ Change Restruct. 2020;55(1):109.
135. Saba CS, David OO. Identifying convergence in telecommunication infrastructures and the dynamics of their influencing factors across countries. J Knowl Econ. 2022. https://doi.org/10.1007/s13132-022-00967-2.
136. Saba CS. Military expenditure and security outcome convergence in Africa: an application of the club clustering approach. African Secur. 2020;13(3):260–95.
137. Saba CS. Security as an outcome for promoting economic prosperity in the regional economic communities of Africa: evidence from a panel data analysis. African Secur Rev. 2020;4(376):400.
138. Saba, C. S. Defence spending and economic growth in South Africa Evidence from cointegration and co-feature analysis. Pea Econs Pea Sci Pub Pol. 2021a. 10. 1515/peps- 2021a- 0017
139. Saba CS. An investigation of security outcome convergence and the dynamics of their influencing factors in Africa. Afri Sec Rev. 2021;4(473):494.
140. Saba CS. Nexus between CO2 emissions, renewable energy consumption, militarisation, and economic growth in South Africa: evidence from using novel dynamic ARDL simulations. Renew Energy. 2023. https://doi.org/10.1016/j.renene.2023.01.070.

141. Saba CS. CO2 emissions-energy consumption-militarisation-growth nexus in South Africa: evidence from novel dynamic ARDL simulations. Environ Sci Pollut Res. 2022. https://doi.org/10.1007/s11356-022-23069-7.
142. Saba CS, Biyase M. Determinants of renewable electricity development in Europe: do governance indicators and institutional quality matter? Energy Rep. 2022;8:13914–38.

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.