Ayesu and Boateng
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Estimating the impact of container port throughput on employment: an analysis for African countries with seaports

Enock Kojo Ayesu[1*] and Kofi Ampah Bennin Boateng[2]

*Correspondence: ayesu.enock@yahoo.com; enock.ayesu@knust.edu.gh

[1] Department of Economics, Kwame Nkrumah University of Science and Technology, PMB, Kumasi, Ghana
[2] Carleton University, Ottawa, Canada

Abstract

Ports play a significant role in facilitating international trade and economic development, serving as vital gateways for the movement of goods across the continent and beyond. As global trade volumes continue to rise, efficient port operations hold the potential to not only enhance economic growth but also contribute significantly to job creation across various sectors of the economy. This paper examines the impact of container port throughput on employment in Africa and further tests whether causality runs from employment to container port throughput. To do so, we use a sample of 27 African countries with seaport and data spanning the period from 2010 to 2020 for the analysis. The system- Generalized Method of Moments (SGMM) estimation technique is used as the estimation strategy. We use service, industrial, and total employment percentages of the total population as proxies for employment while annual container throughput measured in Twenty foots Equivalent Units (TEUs) is used as an indicator for port throughput. Based on the empirical results, we establish a positive significant effect of port throughput on employment in Africa. We further show that bidirectional causality exists between port throughput and employment in Africa. Following these findings, we recommend policies that increase port throughput in Africa.

Keywords: Port throughput, Trade, Employment, System-GMM, Africa

Introduction

Globally, ports play a crucial role in facilitating international trade and have a significant impact on employment levels and economic growth worldwide, including in Africa (Bottasso et al. 2013; Seo and Park 2018; Wang and Zhang 2020; Ngepah et al. 2021; Mlambo 2021; Ayesu et al. 2022; Hidalgo-Gallego and Núñez-Sánchez 2023). According to the United Nations Conference on Trade and Development (UNCTACD) (2018), port facilitates approximately 80% of the volume of global merchandise trade worldwide. Hence, ports serve as a catalyst for employment and economic growth prosperity for many economies (Bottasso et al. 2013; Munim and Schramm 2018; Ayesu et al 2023; Lei and Bachman 2020).

The importance of ports to employment and their essential role cannot be overstated, as about 30 million people globally are employed in the port sector directly, with an additional 90 million jobs created in related industries (International Transport Forum [ITF], 2019). It is therefore not startling that the World Bank (2018) estimates that for every direct job created in a port, an additional 3–4 indirect jobs are created in related industries. Port provides employment opportunities in a variety of occupations, including dockworkers, stevedores, truck drivers, and administrative staff (Notteboom and Winkelnmans 2003; Slack and Gouvernal 2015; Rodrigue 2016, 2017). This means that the growth of the port sector can stimulate economic development in surrounding areas, leading to further employment creation (Bottasso et al. 2013; Seo and Park 2018; Ngepah et al. 2023; Hidalgo-Gallego and Núñez-Sánchez 2023).

For African countries, port handle approximately 90% of the continent's trade (African Development Bank [AfDB] 2018a, b), making the sector an important source of employment with many workers employed in a range of occupations across the maritime industry. According to AfDB (2017a, b, 2018a, b), port and related maritime activities account for up to 6% of total employment in some African countries, especially in countries with rapidly growing economies and expanding trade volumes. The sector provides direct employment opportunities in areas such as cargo handling, logistics, shipping, and customs administration, and indirect employment opportunities in industries such as transportation, manufacturing, and tourism (AfDB 2017a, b, 2018a, b; Mlambo 2021).

In this paper, we argue that the contribution of the port sector to employment in various sectors of the economy as indicated above is largely dependent on the port container throughput[1] handled by the port. This is so because an increase in container port throughput generates demand for a range of services, including cargo handling, transportation, warehousing, port administrators, and customs clearance, which create employment opportunities for both skilled and unskilled workers (Bottasso et al. 2013; Seo and Park 2018; Wang and Zhang 2020). It has been well documented in the empirical literature that increasing container port throughput has positive employment benefits (see, for example, Bottasso et al. 2013; Seo and Park 2018; Wang and Zhang 2020; Ngepah et al. 2023; Hidalgo-Gallego and Núñez-Sánchez 2023).

The above is particularly important for African economies plagued by low port throughput (measured in TEUs) compared with other continents (UNCTAD 2020). The reason is that the port sector in Africa faces significant challenges, including poor infrastructure, inadequate investment, and limited regulatory frameworks (AfDB 2017a, b, 2018a, b; World Bank 2018; ITF 2019; Ayesu et al. 2022). Given the significant role container port throughput plays, these challenges can limit the potential of the sector to generate employment opportunities and contribute to economic growth. The study hypothesized that increased seaport throughput (container port throughput) would enhance employment within African countries.

Despite the above, we are only aware of studies by Mlambo (2021) and Ayesu et al. (2023) that focus on port throughput effects on trade performance and economic growth in Africa. With respect to studies examining the impact of container port

[1] Container port throughput refers to the volume of cargo passing through a port measured in Twenty Foots Equivalents Units (TEUs).

throughput on employment in Africa, to the best of the knowledge of the authors, there is no empirical work examining the relationship between container port throughput and employment in the context of African countries. This paper, therefore, becomes the foremost empirical paper using data on African economies to investigate the impact of container port throughput on employment. Another contribution of this paper that has not been explored by previous studies that examined the impact of port throughput on employment in other parts of the world (see, for example, Bottasso et al. 2013; Seo and Park 2018; Ngepah et al. 2023; Hidalgo-Gallego and Núñez-Sánchez 2023) is to examine the causality between port throughput and employment. Precisely, we employ the Dumitrescu and Hurlin (2012) Granger causality approach to test whether causality runs from employment to container port throughput, which has not been studied by past studies to the best of our knowledge. Furthermore, we examine other determinants of employment in Africa, including inflation, population density, income, education, and investment. Achieving the above is crucial as it helps policymakers to design those policies that would enhance the port infrastructure and investment in African countries in the quest to use port throughput as a vehicle towards improving employment in Africa.

The remaining sections of the paper are organized as follows. Sect. "Related literature" discusses the related theoretical and empirical literature that underpins the study. Specifically for the empirical literature, we structure it in four sub-sections namely seaport throughput and employment, seaport transport infrastructure and employment, seaport throughput and macroeconomic variables, and other drivers of employment. Sect. "Methodology" discusses the methodology used in the paper as well as stylized facts on the performance of container port throughput in Africa. The empirical results are presented and discussed in Sect. "Results and Discussion". Sect. "Concluding remarks" concludes the paper and provides key policy suggestions based on the study's findings.

Related literature

This section of the paper is into two parts. The first part is devoted to the theory that guides the study and a conceptual linkage between port activity and employment. The second part reviews some related empirical works that are related to the study.

Theoretical review and conceptual linkage between port activity and employment

According to the agglomeration hypothesis, transportation infrastructure like seaports stimulates economic expansion by fostering agglomeration economies. In the context of container port throughput and employment, this hypothesis is particularly pertinent. Because port function as entry points for international trade and are crucial nodes in supply chains and the movement of containerized products worldwide (Bottasso et al. 2013; Seo and Park 2018; Mlambo 2021; Ayesu et al. 2022; Hidalgo-Gallego and Núñez-Sánchez 2023). The proximity of businesses to the port encourages the sharing of information and ideas, lowers transaction costs, and improves the pooling of labor markets, which creates job opportunities for the public. Additionally, the presence of seaport draws industries that profit from port-related operations, such as logistics and transportation firms, and results in the development of industrial clusters which in turn creates more jobs in the economy (Bottasso et al. 2013; Yap and Ho 2023; Seo and Park 2018). In

light of the agglomeration theory, we contend that container port throughput is essential for explaining the employment levels in Africa.

The conceptual linkage between port activity and employment could be direct or indirect. The direct impact is because ports are labor-intensive facilities, requiring a workforce for cargo handling, equipment operation, maintenance, and administrative tasks (Bottasso et al. 2013; UNCTAD 2018; Seo and Park 2018; Mudronja et al. 2020; Hidalgo-Gallego and Núñez-Sánchez 2023). The level of direct employment is related to the scale of port operations and the volume of cargo handled (Seo and Park 2018; Hidalgo-Gallego and Núñez-Sánchez 2023). The indirect mechanism could be explained by increased trade activities and labour market effects (Bottasso et al. 2013; Shan et al. 2014; Park et al. 2019; Mudronja et al. 2020; Özer et al. 2021; Yap and Ho 2023). Increased trade activity fosters indirect employment opportunities in related industries such as transportation, warehousing, and manufacturing. These sectors benefit from the demand for services and goods generated by port operations that result in employment effects (Mudronja et al. 2020; Özer et al. 2021; Yap and Ho 2023). Also, port activity can influence the overall labor market dynamics of a region or country by creating direct and indirect jobs leading to reduced unemployment rates, increased household income, and improved standards of living (Bottasso et al. 2013; Shan et al. 2014; Park et al. 2019; Yap and Ho 2023). Apart from the aforementioned, the type of port activity influences the required skill levels of the workforce. For example, containerized ports may demand more specialized skills compared to bulk cargo ports. Therefore, adequate training programs and skill development initiatives are essential to match the workforce with the specific needs of port operations, and the consequence is an increase in employment.

Empirical review

Here, we review studies that have examined the impact of seaport throughput on employment, the influence of seaport transport infrastructure on employment, the relationship between seaport throughput and macroeconomic variables, and other factors driving employment.

Seaport throughput and employment

Few studies to the best of the knowledge of the authors have been conducted on the impact of seaport throughput on employment (local and urban employment) in developed and developing countries (Bottasso et al. 2013; Seo and Park 2018; Ngepah et al. 2023; Hidalgo-Gallego and Núñez-Sánchez 2023). These studies have measured seaport throughput using the container port throughput handled by the port measured in TEUs while the system- Generalized Method of Moments, fixed and random effects, and the Tobit estimation strategies have been used in analyzing the relationship between container port throughput and employment in developed countries. While the studies by Bottasso et al. (2013), Seo and Park (2018), Fageda and Gonzalez-Aregall (2017), and Ngepah et al. (2023) found a significant positive impact of seaport throughput on local (regional) employment, Hidalgo-Gallego and Núñez-Sánchez (2023) found a significant positive impact of seaport throughput on urban employment.

Seaport transport infrastructure and employment

The impact of seaport transport infrastructure on employment has also been examined in the literature. For example, Sobieralski et al. (2021), Ngepah et al. (2023), Wang and Zhang (2020), and Fageda and Gonzelez-Aregall (2017) measured seaport transport infrastructure using the total amount of traffic of each port on employment and concluded that seaport transport infrastructure has a significant positive direct impact on employment. These studies used various estimation techniques such as the system generalized method of Moments, fixed and random, effects, spatial analysis, and ordinary least squares as their estimation methods.

Seaport throughput and macroeconomic variables

The empirical literature on seaport throughput (container port throughput) and macroeconomic variables such as economic growth and trade performance have extensively been researched in both developed and developing countries. Regarding studies that have investigated the impact of container port throughput on economic growth, Bottasso et al. (2013), Shan et al. (2014), Feng et al. (2018), Park et al. (2019), Han et al. (2019), Özer et al. (2021), Mudronja et al. (2020), Freire-Seoane et al. (2020), Fratila et al. (2021), Wang et al. (2021), Ayesu et al. 2023) established a positive significant impact of container port throughput on economic growth. The studies aforementioned employed varied estimation techniques such as the system-generalized Method of Moments, Autoregressive Distributed Lag Model, Fixed and Random Effects, Fully Modified Ordinary Least Squares, and Vector Error Correction Model for the analysis of results. For container port throughput and trade performance, Mlambo (2021) proxied port performance using the container port throughput and found a positive significant effect on trade performance in African countries.

Other drivers of employment

In examining the relationship between container port throughput, seaport transport infrastructure and employment, significant variables such as income, population density, and education served as control explanatory variables. For instance, Sobieralski (2021), Wang and Zhang (2020), Fageda and Gonzalez-Aregall (2017), Seo and Park (2018), and Johnson et al. (2017) found a positive significant impact of population density on employment, while Hidalgo-Gallego and Núñez-Sánchez (2023) and Kassouri (2024) established a negative significant impact of population density on employment. As regards education's effect on employment, Sobieralski (2021), Wang and Zhang (2020), Fageda ad Gonzalez-Aregall (2017), and Seo and Park (2018) found a positive effect on education on employment. With respect to income and employment, Kassouri (2024), Hidalgo-Gallego and Núñez-Sánchez (2023), Seo and Park (2018), and Bottasso et al. (2013) found a positive significant effect of income on employment. Other strands of the literature have reported a positive impact of investment on employment (see, Kassouri 2024; Yap and Ho, 2023). Regarding the impact of inflation on employment, Kassouri (2024) reported a negative relationship.

It is evident from the theoretical and empirical literature reviewed that port throughput is crucial for employment growth and economic growth. However, as pointed out earlier, to the best of our knowledge, no empirical study exists in the context of

African countries that examines the impact of container port throughput on employment. Additionally, no study has considered whether causality runs from employment to port throughput. To this end, this study becomes the foremost empirical evidence of the impact of container port throughput on employment in Africa and is the first to examine the causality between container port throughput and employment in the port throughput and employment literature.

Methodology

This section is devoted to the methods used in achieving the objective of the study. Specifically, it delineates the empirical model specification, data, estimation strategy employed, and model diagnostics.

The empirical model specification

In examining the impact of container port throughput on employment amongst other potential determinants of employment, we specify a panel dynamic model as stated in Eq. (1) for estimation:

$$\begin{aligned} EMP_{it} = \eta + \phi EMP_{it-1} + \theta PTP_{it} + \tau INF_{it} + \beta PDN_{it} + \nu INC_{it} \\ + \vartheta EDU_{it} + \delta INV_{it} + \mu_i + \gamma_t + \varepsilon_{i,t} \end{aligned} \tag{1}$$

for I = 1,2,3…, N, and t = 1,2,3…, T.

Where EMP represents employment outcomes, including total employment (measured using the total employment to population ratio), employment in the service sector (expressed as percentage of the total population), and employment in the industry sector (expressed as percentage of the total population). Additionally, the variables container port throughput (PTP), inflation (INF), population density (PDN), income (INC), education (EDU) and investment (INV) are included in the model specification for analysis. Also, μ_i and γ_t are respectively country-specific and time-specific effects; and ε_{it} is the disturbance term. The coefficient EMP_{it-1} denotes previous years' employment. The parameter θ is our coefficient of interest which measures the impact of port throughput on indicators of employment; η is the constant term.

With respect to the a priori expectations, container port throughput is expected to have a positive relationship with employment as documented in the port literature (see, Bottasso et al. 2013; Shan et al. 2014; Feng et al. 2018; Park et al. 2019; Özer et al. 2021). Income is expected to have either a positive or negative impact on employment. Thus, a rise in income for individuals and households enables them to increase consumer demand for goods and services. This increase in demand prompts businesses to produce more goods and services, leading to higher demand for labour and, subsequently, higher employment rates (Bottasso et al. 2013; Seo and Park 2018; Kassouri 2024). However, the negative relationship between income and employment could be attributed to the fact that as technology improves, some jobs may be replaced by machines, leading to a potential decrease in employment opportunities for certain types of labour (Bottasso et al. 2013; Seo and Park 2018). The coefficient of investment and employment is expected to be positive since governments' investment in human capital can lead to a more skilled and adaptable workforce, resulting in better employment prospects (Kassouri 2024).

The coefficient of population density is expected to be positive. The reason is that in densely populated urban areas, there tends to be a more extensive concentration of economic activities, industries, and services creating a positive impact on employment opportunities, as urban areas often attract businesses due to a larger consumer base, better infrastructure, and proximity to a diverse labour pool (Fageda and Gonzalez-Aregall 2017; Seo and Park 2018; Wang and Zhang 2020; Sobieralski 2021). Regarding the expected sign for education, studies have shown that higher levels of education are associated with higher employment rates and lower rates of unemployment (Fageda and Gonzalez-Aregall 2017; Seo and Park 2018; Wang and Zhang 2020; Sobieralski 2021). Therefore, a positive relationship between education and employment is expected since a more educated workforce is typically better equipped with the skills and knowledge required to meet the demands of the modern job market. Finally, the study expects inflation to have a positive relationship with employment. The reason is that when inflation rises, the purchasing power of money decreases, leading to higher prices for goods and services. As a result, businesses may experience increased revenue and may expand production to meet the higher demand, leading to a decrease in unemployment as more workers are hired to meet the increased production needs.

Data

This study focuses on 27 African countries with seaport, covering the period 2010 to 2020. The choice of countries and periods chosen is due to data availability constraints. Table 6 in the Appendix contains the list of sample countries used for the analysis.

Data on employment is measured in three ways, thus total employment (measured using the total employment to population ratio), employment in the service sector percentage of the total population, and employment in industry employment percentage of the total population. The motivation for using three measures of employment is to ensure the robustness of our estimates and explain the impact of port throughput on each of the employment sectors.

Container port throughput is measured using container traffic measured in TEU handled by a country's seaport. The use of container traffic measured in TEU as an indicator for port throughput is vital as it reflects the performance of seaport, which have significant added value in the goods and service market and stimulate employment (that is services and industrial sector employment) as revealed by Bottasso et al. (2013), Seo and Park (2018), and Hidalgo-Gallego and Núñez-Sánchez (2023). Inflation, population density, income, education, and investment are the other potential determinants of employment considered in this paper as control variables. Except for port throughput data, which is obtained from the UNCTAD 2022 database, data on employment, income, inflation, investment, and population density are sourced from the World Bank's WDI (2022) database. Tables 1 and 2, provide a short definition of all variables, data sources, and summary statistics of the variables.

Table 1 A brief definition of variables and data sources

Variables	Definition	Notations	Data source(s)
Dependent variables			
Total Employment	Total employment to total population ratio	TEM	WDI, 2022
Service Employment	Employment in the service sector percentage of the total population	SEM	WDI, 2022
Industry Employment	Employment in the industry percentage of the total population	IEM	WDI, 2022
Variable of interest			
Port throughput	Container volume measured in Twenty foot's equivalent units (TEUs)	PTP	UNCTAD, 2022
Other determinants			
Inflation	Annual consumer price index	INF	WDI, 2022
Population density	Population density (per sq. km of land area)	PDN	WDI, 2022
Income	GDP per capita growth annual percentage	INC	WDI, 2022
Education	Tertiary education enrolment (Gross)	EDU	WDI, 2022
Investment	Gross fixed capital formation percentage of GDP	INV	WDI, 2022

WDI denotes World Development Indicators, and UNCTAD is United Nations Conference on Trade

Source: Authors

Table 2 Summary statistics of variables

Variable	Obs	Mean	Std. Dev	Minimum	Maximum
Total Employment	297	55.582	13.658	34.53	85.866
Service Employment	297	30.035	71.796	5.36	433.189
Industry Employment	297	44.177	14.285	5.782	72.41
Population density	292	94.659	117.969	2.549	623.517
Education	238	18.263	13.302	1.957	61.090
Investment	297	26.221	11.1488	11.801	79.401
Port throughput	297	1,009,770	1,598,808	33,842.01	7,896,000
Inflation	297	159.0367	212.361	100	3364.820
Income	297	1.022	4.102	-22.488	17.660

Source: Authors

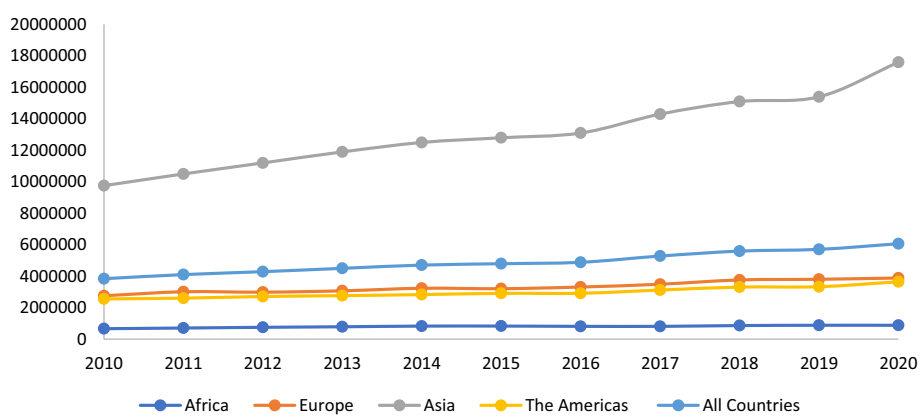

Fig. 1 Average port throughput (measured using TEU) performance for African countries compared with other continents. *Source:* Authors based on data from UNCTAD Statistics, 2022

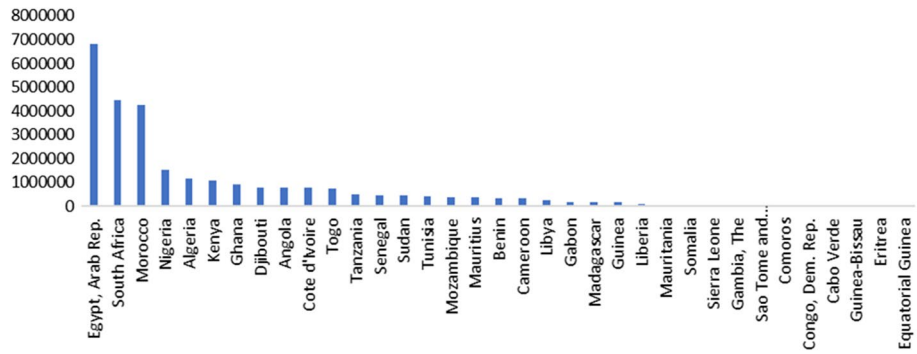

Fig. 2 Average port throughput (measured using TEU) performance for African countries. *Source:* Authors based on data from UNCTAD Statistics, 2022

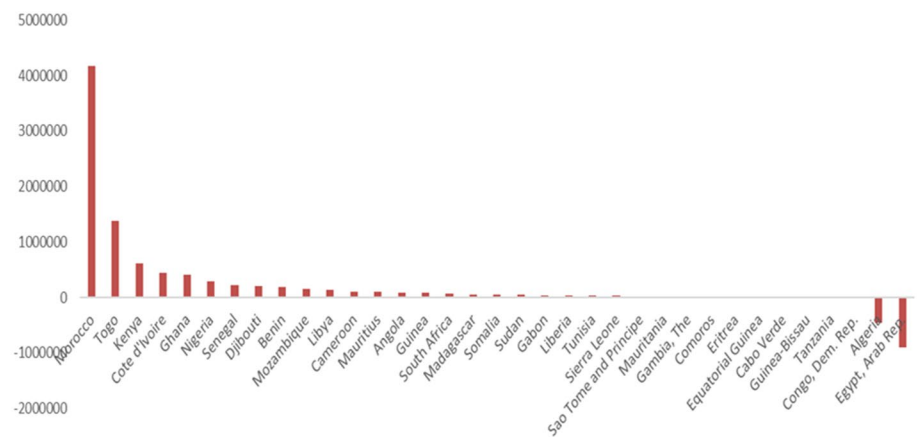

Fig. 3 Change in port throughput (measured using TEU) performance for African countries. *Source:* Authors based on data from UNCTAD Statistics, 2022

Stylized facts on the performance of container port throughput in Africa

This section presents stylized facts that describe the performance of container port throughput in Africa, comparing it with other regions such as Asia, Europe, and The Americas from 2010 to 2020. The analysis and the findings are visualized in Figs. 1, 2, 3. We conduct this analysis based on the availability of data for a sample of 27 African countries and compare this with the performance of other parts of the world, which is 31 in Asia, 32 in Europe, and 31 in The Americas for the period 2010 to 2020. Furthermore, a brief discussion of the best and worst-performing African countries based on the average and changes in the value of port throughput from 2010 to 2020 is provided.

Figure 1 illustrates the container port throughput performance of Africa in comparison to other regions. It reveals that African countries generally exhibit lower container port throughput performance than their counterparts in Asia, Europe, and The Americas. Specifically, Asia stands out as the best performer in this indicator, surpassing both Europe and Africa. This discrepancy raises concerns and demands attention from African policymakers to enhance container port throughput levels, thereby reaping the positive impacts on employment and economic growth.

Figure 2 focuses on the average container port throughput for African countries during the 2010 to 2020 period. The three countries with the highest performance in this category are Egypt, South Africa, and Morocco, owing to factors such as improved port infrastructure, high liner shipping connectivity scores, and greater trade volumes within their regions. Conversely, Comoros, Congo Democratic Republic, and Cabo Verde exhibit the lowest container port throughput performance due to issues like port congestion resulting from inadequate infrastructure, low port calls, and limited shipping connectivity.

Figure 3 examines the changes in container port throughput between 2010 and 2020 for African countries. Morocco, Togo, and Kenya recorded the highest increases in container port throughput during this period. These outcomes can be attributed to their efforts in expanding port facilities to accommodate growing trade volumes within their regions and internationally. For example, Morocco and Togo's direct large vessel calls and provision of transshipment to smaller regional ports have contributed to increased container port throughput.

In conclusion, while certain African countries have demonstrated encouraging performance in container port throughput, policies aimed at boosting container port throughput volumes are essential for the continent to fully benefit from international trade activities. Addressing issues related to infrastructure, port calls, and shipping connectivity is crucial in improving container port throughput performance and harnessing its positive effects on African economies.

Estimation technique

The dynamic nature of the model specified in Eq. (1) underscores the importance of avoiding estimators such as ordinary least squares, fixed effects, random effects, and autoregressive distributed lag models employed in past studies such as Feng et al. (2018), park et al. (2019), Özer et al. (2021), and Freire-Seoane et al. (2020) as they may result in biased and inconsistent parameter estimates. A major issue encountered in the specification of such nature is potential endogeneity, reverse causality, and simultaneity bias. The issue of endogeneity arises from the possibility that the correlation between container port throughput and employment may be spurious. This could occur if a common unobserved factor drives both variables and if causality runs from employment to port throughput. Further, the inclusion of the lagged value of employment serves as a feedback effect and this is likely to be correlated with the unobserved country-specific effects that are absorbed in the disturbance term. Additionally, there is a likely reverse causality[2] between port throughput and employment. We postulate employment levels might drive changes in port throughput. For instance, higher employment in a region may result in increased demand for goods, leading to greater imports and exports through the port increasing container port throughput. On the other hand, an increase in container port throughput leads to increased employment since activities at the port, such as handling

[2] Reverse causality refers to a situation where the assumed cause-and-effect relationship between two variables is actually the opposite of what is commonly believed. In other words, instead of one variable causing the other, it is possible that the second variable is influencing the first. For the purpose of this study, we posit that while an increase in container port throughput can lead to increased employment, the reverse is also true-employment can lead to an increase in container port throughput..

more cargo, create a demand for labor, thus boosting employment. There is also the possibility of simultaneity bias, arising among the explanatory variables being studied. For example, inflation can affect port throughput as during periods of high inflation, consumer demand may decrease, leading to a reduction in trade volume. This can directly impact container port throughput, as there is less cargo moving through the port. Similarly, container port throughput can affect inflation via an increase in the cost of port operations such as an increase in labor, fuel, and maintenance expenses.

Given the above, the standard way to address issues is the use of reliable instruments for port throughput indicators. However, finding exogenous and good instruments is often challenging in empirical research. Therefore, to ensure a consistent estimate of the parameters in Eq. (1), we employ the system Generalized Method of Moments (GMM) estimation technique for the regression analysis (Arellano and Bond 1991; Roodman 2009). The system-GMM is used because it can deal with the possible issues that come up when estimating a dynamic relationship by eliminating unobservable individual-specific effects, and inherent omitted variable bias as well as deal effectively with the issues of reverse causality. Therefore, using the system GMM will result in consistent estimates of the parameters and can resolve the issue of difficulty in obtaining a reliable instrument for estimation as suggested by Arellano and Bond (1991) and Roodman (2009). Additionally, in assessing the validity of our estimates, the Arellano and Bond (1991) test for second-order serial correlation is employed to verify the consistency of our estimator. Also, to ensure the validity of the instruments used, the Hansen J test for over-identifying restriction is employed. Finally, as noted by Roodman (2009) the system-GMM is often prone to using 'too many instruments' and raises concerns about the power of the Hansen J test. In addressing this concern, we use the Roodmans stata routine to collapse all the internally generated instruments.

Concerning the analysis, we provide the short- and long-run impacts of the explanatory variables. The estimated short-run coefficients measure the impacts of the explanatory variable. To estimate the long-run effects, the study follows the method proposed by Papke and Wooldridge (2005) by dividing the coefficients obtained for the short run by one minus the coefficients of the lagged dependent variable. These long-run coefficients provide important insights for policy-making purposes. In addition, we employ the Dumitrescu and Hurlin (2012) Granger causality method to estimate the direction of causality between employment and port throughput which has not been studied in the port literature.

Results and discussion

This section of the paper reports and discusses the interpretation of the estimated coefficients obtained from the system-Generalized Method of Moments estimation technique in two parts. The first part focuses on the economic interpretation of the short and long results, and the second part presents the analysis of the causality test results.

Short-run and long-run analysis

Here, we present and interpret the short-run and long-run impact of port throughput on employment in Africa using the Generalized Method of Moments estimation technique. In addition, we briefly highlight the findings of other determinants of employment in

Table 3 The short-run impact of port throughput on employment in Africa

Variables	Model 1	Model 2	Model 3
lnEMP (− 1)	0.943***	0.967***	0.966***
	(0.0205)	(0.0146)	(0.00619)
lnPTP	0.00751**	0.00902**	0.00500**
	(0.00285)	(0.00380)	(0.00232)
lnEDU	− 0.0187**	0.0104	0.00265
	(0.00786)	(0.0103)	(0.00250)
lnPDN	0.00803**	− 0.00535***	0.00295
	(0.00341)	(0.00173)	(0.00207)
lnINF	− 0.0152**	− 0.0213***	− 0.00622*
	(0.00692)	(0.00380)	(0.00316)
lnINV	− 0.00323	0.00442	0.0111
	(0.00558)	(0.00935)	(0.00854)
INC	− 0.000220	− 0.00363	0.00192*
	(0.000819)	(0.00226)	(0.00108)
Constant	0.227**	0.0688	0.0494
	(0.105)	(0.0541)	(0.0289)
Number of observations	173	173	173
Number of groups	26	26	26
Number of instruments	22	22	23
AR2[*p*-value]	0.289	0.243	0.279
Hansen[*p*-value]	0.415	0.156	0.348

Standard errors in parentheses $p < 0.10$, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: Authors

Table 4 The long-run impact of port throughput on employment in Africa

Variables	Model 1	Model 2	Model 3
lnPTP	0.1320**	0.2773**	0.1454***
	(0.0648)	(0.2167)	(0.0501)
lnEDU	− 0.3286***	0.3196*	0.0771
	(0.0446)	(0.1928)	(0.0765)
lnPDN	0.1412***	− 0.1644*	0.0858
	(0.0491)	(0.0841)	(0.0619)
lnINF	− 0.2676**	− 0.6555*	− 0.1809**
	(0.1169)	(0.3526)	(0.0834)
lnINV	− 0.0568	0.1357	0.3241
	(0.1077)	(0.2601)	(0.2223)
INC	− 0.0038	− 0.1116	0.0558
	(0.0138)	(0.1000)	(0.0381)
Constant	3.9948	2.114216	1.4361
	0.7528	(1.4983)	(0.9367)

Note: Standard errors in parentheses $p < 0.10$, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Source: Authors

Africa. These results (short- and long-run) are reported in Tables 3 and 4. It must be noted that, in each of the results tables, three estimation models are presented. While models 1 and 2 present the results for total and industry employment, model 3 reports

the results for service employment, respectively. Before proceeding to the interpretation of the results, it is important to note that the validity of our estimated results depends on the model diagnostics. Specifically, our estimates rely on the absence of second-order autocorrelation and the validity of the instruments used. The last part of Table 3 indicates that none of our three models exhibit second-order autocorrelation, and the instruments used in our analysis are valid as confirmed by the Hansen J test's p-values.

Regarding the coefficients of the variable of interest, the results in Table 3 and 4 clearly show that the estimated coefficients measuring the impact of port throughput on total employment (model 1), industry employment (model 2), and service employment (model 3) are positive and statistically significant as expected, suggesting that improvements in port throughput hold significant potential for enhancing employment outcomes in Africa. The magnitude of the coefficients shows that for every 1% increase in port throughput, total employment increases by 0.007% (0.132%), industry employment increases by 0.009% (0.277%), and services employment increases by 0.005% (0.050%) in both the short-run (long-run). These coefficients are all statistically significant at the conventional levels of 1% and 5%. These outcomes obtained are in line with the positive impact of port throughput on employment revealed by Bottasso et al. (2013), Seo and Park (2018), and Hidalgo-Gallego and Núñez-Sánchez (2023).

These findings imply that the effect of port throughput on employment outcomes can be seen from the fact that an increase in port throughput generates demand for a range of services, including cargo handling, transportation, warehousing, port administrators, and customs clearance, which create employment opportunities for both skilled and unskilled workers (Bottasso et al. 2013; Seo and Park 2018; Wang and Zhang 2020). In addition, the Port serves as a gateway for the facilitation of imports and exports, leading to increased trade and economic activity. This can result in the creation of more jobs in various sectors, including transportation, logistics, and manufacturing. Furthermore, port throughput reflects the revenue/income generated by port authorities to the state (government) which would be used to stimulate economic activities and bolster the government's ability to employ the citizenry in various sectors of the economy (Bottasso et al. 2013; Shan et al. 2014; Seo and Park 2018; Hidalgo-Gallego and Núñez-Sánchez (2023). The AfDB (2018a, b) report indicates that ports have the potential to serve as catalysts for industrialization in Africa, while the highlighted the need for policies to support the formalization of port-related services in Africa, to promote decent work and employment growth, given the positive employment benefit to be derived from port operations.

Interestingly, we find the impact of port throughput to be greater in terms of the size of the coefficient in the industry employment model compared to the total and service employment models. A similar finding was revealed by Bottasso et al. (2013). The greater effect of port throughput on industry employment could be due to an increase in demand for raw materials and intermediate goods, stimulating the growth of manufacturing industries. This can result in the creation of jobs in the manufacturing sector, which is typically associated with industry employment.

Regarding the results of the other potential determinants of employment, interesting outcomes were obtained. The impact of inflation on total employment, industry, and service employmentwas found to be negative and statistically significant in both

the short and long run. The potential explanation is that high inflation rates can create uncertainty and instability in the economy, which can discourage investment and reduce business confidence. This can lead to reduced economic activity and job creation. Additionally, high inflation rates can affect the cost of borrowing and access to credit, further impacting business investment and job creation. This finding is in line with the study by Kassouri (2024) who reported a negative impact of inflation on employment.

The study also finds a positive significant effect of population density on total employment while the impact of population density on employment in the industrial sector was negative and significant. The positive impact of population density on total employment may be due to the increase in demand for goods and services and the potential for economies of scale in Africa. Thus, while several potential factors may explain this relationship, one possible explanation is that a larger population can create increased demand for goods and services, which in turn can generate more job opportunities. Furthermore, as the population grows, businesses may have greater opportunities to achieve economies of scale, leading to increased employment. Investments in infrastructure and public services can also contribute to job creation. The result obtained are consistent with the studies by Sobieralski (2021), Wang and Zhang (2020), Fageda and Gonzalez-Aregall (2017), Seo and Park (2018), and Johnson et al. (2017). On the contrary, the negative impact of population density on industrial employment could stem from the fact that in densely populated areas, land becomes scarce and expensive. This means industrial companies may struggle to find affordable space for factories, warehouses, or other facilities. The high cost of land can deter new industrial ventures or force existing ones to relocate, leading to a decrease in industrial employment opportunities. This outcome confirms the study by Kassouri (2024), and Hidalgo-Gallego and Núñez-Sánchez (2023), which found a negative effect of population density on employment.

The results obtained for education effect on total employment were positive and significant while it enters negatively and significantly for industrial employment. The implication of the positive impact of education on employment is that education fosters critical thinking, problem-solving, and creativity—essential skills in today's rapidly changing job market. Well-educated individuals are better equipped to adapt to new technologies, industries, and job requirements, making them more resilient to economic fluctuations and technological advancements. Consequently, they have a higher likelihood of gaining employment easily. The positive significant effect of education on total employment obtained in this study is in line with those obtained by Sobieralski (2021), Wang and Zhang (2020), Fageda ad Gonzalez-Aregall (2017), and Seo and Park (2018). The possible explanation for the negative impact of education on industrial employment could be that higher levels of education may lead to increased awareness of labor rights, workplace safety regulations, and environmental concerns among industrial workers. While these are generally positive developments, they can also impose additional costs and administrative burdens on industrial employers. Compliance with regulations may require investments in training, safety equipment, and environmental controls, which can increase operational expenses and potentially reduce employment levels in the short term. Studies that have reported a negative impact of education on employment include Sobieralski (2021).

For the case of income and investment, though a positive and negative relationship was revealed based on how employment was measured, the effect is not statistically significant for investment on all the measures of employment used while the impact is only positive and statistically significant in the short run for income and service employment. The result obtained by Kassouri (2024), Hidalgo-Gallego and Núñez-Sánchez (2023), Seo and Park (2018), and Bottasso et al. (2013) is in line with the positive significant effect of income on service employment revealed in this paper. The positive impact of income on service employment is multifaceted and can be explained through several means. For instance, Higher income levels generally lead to greater disposable income for individuals. As people have more money to spend on non-essential goods and services, there is an increased demand for services such as dining out, travel, entertainment, personal care, and luxury goods. This heightened demand creates opportunities for service providers to expand their operations and hire more employees to meet the needs of consumers. Though insignificant, the positive relationship between investment and employment (industrial and service employment) revealed in this study is not surprising as overall, investment stimulates economic growth, fosters innovation, and creates job opportunities across both service and industrial sectors. By promoting business expansion, enhancing productivity, supporting technological innovation, developing infrastructure, and empowering SMEs, investment initiatives contribute to sustainable employment generation and economic development. This outcome is in tandem with the study by Kassouri (2024) regarding the positive impact of investment on employment. The negative effect of investment on total employment revealed in this study suggests that, over the years, investment in African countries has not contributed positively to employment creation within the continent.

Results of causality analysis

As earlier indicated in the introduction and estimation technique sections, another important contribution of the paper is to establish whether causality runs from employment to port throughput. To do so, we employ the Dumitrescu and Hurlin (2012) Granger causality method in assessing the direction of causality between employment and port throughput. It must be noted that the null hypothesis of Dumitrescu and Hurlin's (2012) Granger causality test states that there is no causality between port throughput and employment, while the alternative states that there is a causality between port throughput and employment. The rule of thumb is that if the P-value of Dumitrescu and Hurlin's (2012) test is insignificant at the 5% level, then the null hypothesis is accepted, and the conclusion is that there is no causality between port throughput and employment. However, if the p-value is significant at the 5% level, then we fail to reject the alternative hypothesis and conclude that there is a causality between port throughput and employment. The analysis of this is presented in Table 5.

According to the results of Dumitrescu and Hurlin's (2012) Granger causality test presented in Table 5, based on the p-value, we established a bi-directional causal relationship between measures of employment that is total, service, and industry employment and port throughput in Africa.

Table 5 Dumitrescu and Hurlin (2012) Granger causality test results

Variable	Total employment	Industry employment	Service employment	port throughput
Total employment				0.000
Industry employment				0.000
Service employment				0.000
port throughput	0.000	0.000	0.000	

p-values are reported at a 5% significance level. Also, the *p*-values reported are that of the Z-bar

Source: Authors

The possible explanation for the bi-directional causal relationship between port throughput and total employment is that increased port throughput can lead to increased economic activity, which can create job opportunities and stimulate employment growth. At the same time, increased employment can lead to increased demand for goods and services, which can drive up port throughput as more goods are imported and exported. This relationship is supported by Gossling and Scott (2015), who found that port throughput is positively associated with economic growth and job creation in developing countries, including those in Africa. Another report by the AfDB (2017a, b), and World Bank (2018) showed that investments in port infrastructure can stimulate economic growth and job creation by facilitating international trade and attracting foreign investment. On the other hand, increased employment can also lead to increased demand for goods and services, which can lead to increased port throughput.

Concerning the implication for the bi-directional relationship between port throughput and service employment and port throughput in Africa, the reason could be that increased port throughput can lead to increased economic activity, which can create job opportunities in the service sector, such as logistics, transportation, and warehousing. At the same time, increased service employment can lead to increased demand for port services, such as cargo handling and customs clearance as postulated by Sánchez-Soriano et al. (2018), and Song et al. (2018).

As far as the bi-directional causal relationship between industry employment and port throughput is concerned, it could be that increased port throughput can lead to increased economic activity, which can create job opportunities in industries such as manufacturing, construction, and mining. At the same time, increased industry employment can lead to increased demand for port services, such as shipping and logistics. This relationship is supported by Kramberger et al. (2019).

In sum, the bi-directional causal relationship between measures and port throughput revealed in this study highlights the importance of investing in port infrastructure and promoting job creation in the service and industrial sectors to drive economic growth and development in Africa.

Concluding remarks

This paper adds to the discussion on ways African countries can improve maritime trade to boost their economic development, especially the level of employment. With the implementation of the African Continental Free Trade Area, we anticipate that

increased port activities will unlock the full potential benefits of maritime trade in African countries. Hence, the paper examined the impact of container port throughput on employment in Africa within the framework of the system-Generalized Method of Moment estimation technique that addresses the problem of endogeneity concerns. The study further examines the causality between port throughput and employment with the aid of Dumitrescu and Hurlin's (2012) Granger causality test approach. Panel data on 27 countries with seaports in Africa, for the period 2010–2020 was used for the analysis. The empirical results obtained suggest that port throughput is a crucial determinant of employment in Africa in both the short run and long run. Our findings also revealed the existence of bi-directional causality between port throughput and all the measures of employment (i.e., total employment, service employment, and industry employment). Finally, with respect to the other potential determinants of employment, our results indicate that inflation, population density, education, income, and investment are important drivers of employment in Africa.

Based on these findings, it will be prudent for policy makers to aim at those policies that would increase port throughput in Africa. This is important because of the low level of port throughput in Africa when compared with other regions of the world. Furthermore, stakeholders in Africa should promote regional cooperation and integration in trade and transport corridors since it can enhance connectivity and reduce trade barriers, making it easier for landlocked nations to access international markets thereby leading to an improved container port throughput in neighboring coastal communities. It is also recommended that macroeconomic policies ensuring price stability within the continent be strengthened. Thus, setting and adhering to clear inflation targets by Central Banks in Africa can provide certainty to businesses and households, thereby promoting investment and consumer spending, which can positively impact employment. To leverage the positive impact of population density on employment, policymakers could consider developing targeted employment programs that focus on industries or sectors that can benefit from a dense population, such as retail, hospitality, healthcare, and professional services. These programs can include job training initiatives, incentives for business startups, and support for small and medium-sized enterprises (SMEs).

While these findings provide valuable insights, it's important to acknowledge the limitations of this study. We relied on aggregate employment and container port throughput data to explore the impact on employment in Africa. For a more nuanced understanding and to better inform policy, it would have been beneficial to have data on port throughput segmented by cargo type, and employment data focused on the municipal or provincial level rather than aggregating both employment and container port throughput. Unfortunately, due to data constraints, we couldn't pursue this approach. Therefore, it is crucial that future research delves into this relationship using port employment data at the municipal or provincial level, along with segmented container port throughput data per cargo type. This approach will provide insights into which cargo segments most significantly influence port employment and identify the provinces or municipalities that benefit most from port employment, aiding in more effective policy formulation.

Appendix

See Table 6.

Table 6 List of countries

Algeria	Egypt, Arab Rep	Morocco	Tanzania
Angola	Gambia, The	Mozambique	Togo
Benin	Ghana	Namibia	Tunisia
Cabo Verde	Guinea	Nigeria	
Cameroon	Kenya	Senegal	
Comoros	Madagascar	Sierra Leone	
Congo, Rep	Mauritania	South Africa	
Cote d'Ivoire	Mauritius	Sudan	

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Declarations

Competing interest
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