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Assessing the Future of African Tertiary Student Mobility: Insights from Forecasting Models on International Education Dynamics

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ABSTRACT

The global education landscape is undergoing a significant transformation in student mobility, with African nations playing a crucial role in international academic exchanges. The mobility of African tertiary students is becoming increasingly important, yet there is a lack of clear scientific insight into future trends. This study assesses future mobility patterns by employing various forecasting models, including statistical, deep learning, and ensemble methods, to provide predictive insights into the dynamics of African tertiary student migration across different regions: Central and Eastern Europe, Central Asia, East Asia and the Pacific, Latin America and the Caribbean, North America and Western Europe, South and West Asia, Sub-Saharan Africa, and the Arab States. Using these forecasting models, historical data on African tertiary student mobility were collected and analyzed to identify key patterns. The results reveal distinct regional variations in mobility trends, with North America and Western Europe remaining the most preferred destinations, whereas regions such as East Asia, the Pacific and the Arab States show increasing growth in African tertiary student enrollments. Additionally, Sub-Saharan Africa exhibits significant intraregional mobility, emphasizing the role of regional academic collaboration. These findings provide valuable insights for higher education institutions and policymakers to anticipate trends, refine recruitment strategies, and implement policies that increase access to global educational opportunities for African tertiary students, thereby promoting knowledge exchange, skill development, and

international academic collaboration.

Keywords: African student mobility, Forecasting models, Global education dynamics, Statistical models, Deep learning in education, Ensemble methods

INTRODUCTION

Student mobility is now a critical component of global education, enabling knowledge exchange, cultural interactions, and international synergy in teaching and research. In recent years, African tertiary students have increasingly participated in international academic mobility, in search of quality education, career advancement, and diverse cultural experiences (Luo et al., 2023). The significance of this mobility goes beyond individual ambitions; it has substantial implications for the global academic community, host institutions, and national policies on education and migration(Gutema et al., 2024; McAlpine et al., 2023; Van Mol et al., 2024a; Yamutuale, 2024).

Despite the increasing number of African tertiary students studying abroad, there is a notable gap in research on future mobility trends. The lack of predictive insights poses challenges for universities, policymakers, and other stakeholders seeking to formulate responsive policies and strategies for student recruitment, funding, and academic support. Understanding these mobility trends is crucial for forecasting educational demands, economic impacts, and potential policy shifts that could influence student movement (Dennis, 2023; Litmeyer et al., 2023; Shah et al., 2024).

This study is guided by the following key research questions:

- What are the historical trends and influencing factors in African tertiary student mobility across different global regions?
- How can statistical, deep learning, and ensemble forecasting models be used to predict future mobility trends?
- What are the projected regional variations in African tertiary student migration, including intraregional mobility within Sub-Saharan Africa?
- What policy implications can be drawn from the forecasted mobility patterns for higher education institutions and governments?

To address the above questions, this study aims to analyze historical trends and influencing factors in African tertiary student mobility across different global regions by employing advanced forecasting models, including statistical methods, deep learning techniques, and ensemble learning approaches. By identifying key patterns and projecting future trends, this study seeks to provide predictive

insights into regional variations in student migration, including intraregional mobility within Sub-Saharan Africa. Furthermore, the findings will inform policy recommendations for higher education institutions and governments to increase global academic collaboration and improve access to international educational opportunities for African students.

LITERATURE REVIEW

Trends in Global Student Mobility

The global landscape of student mobility has evolved significantly over the past few decades, driven by globalization, technological advancements, and increasing demand for higher education. The internationalization of education is a strategic priority for many countries, with emerging and developing nations enhancing their systems to attract talent and promote educational and technological innovation (Cui et al., 2022). The mobility of international students is influenced by a combination of push and pull factors, including the quality of education, visa requirements, academic reputation, and job opportunities in host countries (Gutema et al., 2024). The financial impact of this sector is substantial, generating over USD 500 billion annually, with Asian countries such as China and India leading as major source markets (Simonds et al., 2023). However, challenges such as language barriers, visa policies, and social integration difficulties persist, particularly for students from developing countries (Adamyk & Dyachuk, 2023; Gutema et al., 2024). The COVID-19 pandemic and geopolitical tensions have also reshaped migration policies and economic conditions, prompting a shift toward safer and more stable destinations (Adamyk & Dyachuk, 2023). Additionally, (Mammadova & Allen, 2024) noted that the rise of virtual study abroad programs and initiatives such as Erasmus+ has made international mobility more accessible and user friendly. Furthermore, (Simonds et al., 2023) reported that the landscape of global student mobility is characterized by increasing diversity in student flows, with anglophone countries remaining popular destinations due to their educational offerings and economic opportunities.

Factors influencing African student mobility

Several factors contribute to African student mobility, including economic conditions, scholarship opportunities, language barriers, visa policies, and academic quality (Gao et al., 2024; Odebero et al., 2015). Push factors such as limited access to high-quality education and political instability in home countries often drive students to seek better opportunities abroad. Conversely, pull factors such as favorable immigration policies, cultural proximity, and strong academic reputations attract students to specific regions (Abdulai & Roosalu, 2021; Dago & Barussaud, 2021; Lei et al., 2021). Neoliberal market dynamics significantly shape the internationalization of higher education, often marginalizing African institutions and complicating access to global educational opportunities (Woldegiorgis, 2024). According to (Sun, 2020), the rise of educational partnerships, particularly with countries such as China, presents new avenues for

African students, enhancing their mobility options while also posing unique challenges. These factors form a complex landscape for African student mobility, necessitating a critical understanding of their drive and the barriers they face (Garvik & Valenta, 2024).

Forecasting Student Mobility Trends

Forecasting models have been increasingly applied to predict trends in education and student migration (Oduwaye et al., 2023; Rostovskaya and Zolotareva, 2021). Current advanced models for forecasting student mobility trends across regions include a variety of machine learning and statistical approaches. Notably, the XGBoost algorithm has been employed to increase the accuracy of spatial interaction predictions, particularly for high school graduates transitioning to higher education in Germany, demonstrating its ability to handle complex, nonlinear relationships among variables (Litmeyer et al., 2023). In Taiwan, a hybrid model combining feature selection and support vector regression has been developed to analyze outbound student mobility, achieving high forecasting accuracy (Yang et al., 2020). Furthermore, the layered mobility model architecture (LEMMA) allows for the creation of diverse mobility models through a multiagent microsimulator, facilitating advanced simulations of student mobility patterns (Pelov and Noel, 2009). Finally, a probabilistic CA model has been proposed for medium-term predictions of youth migration flows, integrating various migratory behaviors into a cohesive framework (Shmidt et al., 2022).

Policy implications and institutional strategies

On a global scale, the policy implications for student mobility in higher education institutions (HEIs) are complex, indicating the need for collaboration, sustainability, and security. Effective policies should facilitate international student mobility while addressing challenges such as environmental sustainability and security threats (Suhaili and Ismail, 2023). Additionally, a robust framework for international student mobility (ISM) is essential, as evidenced by the SWOT analysis, indicating that strengths and opportunities in existing ISM policies outweigh weaknesses (Bercasio and Llenaresas, 2021). Furthermore, countries such as India and China are developing strategies to attract international students, highlighting the importance of diversifying recruitment sources to mitigate the risks associated with dependence on specific regions (Pawar, 2024). Notably, the Swedish case illustrates the need for HEIs to adapt to security concerns while maintaining the benefits of international academic networks, emphasizing a balanced approach to policy formulation (Nilsson and Westin, 2024).

The policy implications and institutional strategies for host institutions regarding African student mobility emphasize the need for comprehensive frameworks that facilitate international partnerships and increase the attractiveness of African higher education (Knight, 2023). Institutions are encouraged to adopt measures that support "internationalization at home," fostering an inclusive environment that attracts both local and international students, thereby reversing the trend of student exportation from Africa (Al Laban et al., 2022; Knight, 2023; Nilsson and Westin, 2024). Additionally, the financial

and diplomatic benefits of hosting international students highlight the importance of strategic recruitment efforts by universities, which can significantly increase their internationalization and revenue streams (França and Padilla, 2022). Ultimately, effective policies and institutional strategies can transform intra-Africa mobility into a powerful tool for educational and economic development, addressing the challenges of brain drain and promoting regional collaboration (Agbaje, 2023).

While existing studies have explored factors influencing student mobility, there is limited research on the application of advanced forecasting models to predict African student migration trends. This study contributes to the literature by integrating statistical, deep learning, and ensemble methods to provide a comprehensive and data-driven approach to forecasting student mobility. The findings offer actionable insights for educational institutions, policymakers, and stakeholders seeking to adapt to evolving student migration patterns.

METHOD

This study employs a data-driven approach to forecast African tertiary students' mobility trends via historical data and advanced machine learning techniques. This section outlines the data collection methodology and the modeling approaches utilized for predictive analysis.

Data collection

The dataset utilized in this study was sourced from the UNESCO database (UNESCO, 2025), covering the period from 2008--2022. The dataset captures the outbound mobility of internationally mobile tertiary students from Sub-Saharan Africa and North Africa, categorized by their regions of destination, including Central and Eastern Europe, Central Asia, East Asia and the Pacific, Latin America and the Caribbean, North America and Western Europe, South and West Asia, Sub-Saharan Africa (intraregional mobility), and the Arab States. The dataset encompasses the total outbound student population without disaggregating data by gender.

Model Description

Predicting future trends is a critical challenge across the sciences, engineering, technology, education, and humanities, with real-world applications. While traditional statistical models have been valuable, they often struggle to capture complex relationships within data. This study aims to increase the forecasting accuracy by integrating advanced techniques that learn from extensive historical information. Rather than relying solely on simple trend analysis, which may overlook complicated patterns, a combination of statistical, deep learning, and aggregated models is employed to improve predictive performance. A key component of this aggregated approach is the weighted ensemble model, which functions like a panel of experts, combining predictions from multiple models to generate a more accurate and robust forecast.

Specifically, the AutoGluon framework (Fakoor et al., 2020; Shchur et al., 2023) was utilized to increase time series forecasting accuracy by integrating a diverse set of models across statistical, deep learning, and tabular approaches. Classical statistical models, including AutoETS and Dynamic Optimized Theta, were employed to capture seasonality and trend dynamics, whereas the Non-Parametric Time Series Model (NPTS) provided a flexible, data-driven approach to forecasting.

Advanced deep learning architectures, such as the deep autoregressive model (DeepAR), patching time series transformer (PatchTST), temporal fusion transformer (TFT), and time series dense encoder (TiDE), were incorporated to model complex temporal dependencies and nonlinear relationships. The forecasting pipeline included state-of-the-art models such as Chronos Zero-Shot and Chronos Fine-Tuned, which leverage pretrained time series representations for improved generalization.

Additionally, tabular approaches such as the direct tabular and recursive tabular methods were included, using structured data representations for enhanced predictive performance. The seasonally naïve model served as a baseline for benchmarking, whereas the weighted ensemble method aggregated predictions from multiple models to improve forecast accuracy and robustness.

Mathematical Representations of the Models

Here, the mathematical representations of the models are given below:

i. *Chronos Zero-Shot and Chronos Fine-Tuned*

Chronos models are pretrained deep learning models that leverage transformer-based architectures. They do not have a fixed explicit mathematical formulation but rely on sequence-to-sequence learning with attention mechanisms:

$$\dot{y}_t = f(y_{t-1}, y_{t-2}, \dots, y_{t-k}; \theta) \quad (1)$$

where $\dot{y}_t$ is the predicted value at time t, $y_{tk}, \dots, y_{t-1}$ are past observations and where θ represents the model parameters learned from the data.

ii. *Seasonal Naïve Model*

The seasonally naïve model predicts the future value on the basis of the value from the previous seasonal cycle:

$$\dot{y}_t = y_{t-m} \quad (2)$$

where m is the seasonal period and where y_{tm} is the observed value from the previous season.

iii. *Recursive Table and Direct Table*

Tabular models use machine learning techniques such as decision trees and gradient boosting. The general formulation is as follows:

$$\dot{y}_t = f(X_t; \theta) \quad (3)$$

where X_t is a set of features derived from past time steps, f is a machine learning model (e.g., XGBoost, random forest), and θ are model parameters learned from training data.

iv. *Temporal Fusion Transformer (TFT)*

TFT uses an attention mechanism to weigh different parts of the time series:

$$\hat{y}_t = \sum_{i-1}^{k} \alpha_i y_{t-i} \quad (4)$$

where α_i are learned attention weights and where y_{t-i} are past values.

v. Dynamic Optimized Theta Model

The Theta model decomposes the time series into trend and seasonal components:

$$y_t = \alpha + \beta t + \gamma S_t + \epsilon_t \quad (5)$$

where α is the level, β is the trend coefficient, S_t is the seasonal component and ϵ_t is the error term.

vi. Deep Autoregressive Model (DeepAR)

DeepAR predicts future values by learning a probabilistic recurrent model:

$$p(y_t \mid y_{t-1}, y_{t-2}, \ldots, y_{t-k}; \theta) = \mathcal{N}(\mu_t, \sigma_t^2) \quad (6)$$

where μ_t and σ_t^2 are the mean and variance predicted by the recurrent network, respectively.

vii. Time-Series Dense Encoder (TiDE)

TiDE uses dense layers to capture temporal dependencies:

$$\hat{y}_t = f(WX_t + b) \quad (7)$$

where W is the weight matrix, X_t is the input feature vector and b is the bias term.

viii. AutoETS (Exponential Smoothing)

The ETS model is represented as:

$$y_t = (l_{t-1} + b_{t-1})s_{t-m} + \epsilon_t \quad (8)$$

where l_t is the level component, b_t is the trend component, s_t is the seasonal component, and m is the seasonal period.

ix. Patching Time Series Transformer (PatchTST)

PatchTST splits time series into patches and applies self-attention:

$$\hat{y}_t = \sum_{i-1}^{k} \alpha_i W y_{t-i} \quad (9)$$

where W are learned weights from self-attention.

x. Non-Parametric Time Series Model (NPTS)

NPTS estimates the conditional probability of future values given past values:

$$p(y_t \mid y_{t-1}, \ldots, y_{t-k}) = \sum_{i=1}^{N} w_i K(y_t - y_i) \quad (10)$$

where K is a kernel function and where w_i are weights.

xi. Weighted Ensemble Model

The ensemble model combines multiple forecasts:

$$\hat{y}_t = \sum_{i=1}^{n} w_i \hat{y}_{t,i} \quad (11)$$

where w_i are weights assigned to each model's prediction and where $\hat{y}_{t,i}$ is a prediction from the i^{th} model.

RESULTS

Analysis of African Tertiary Students' Mobility Trends and Future Projections

Figures 1 and 2 present historical trends and forecasts of African students' mobility to various global regions. The data illustrate the number of African students studying in different destinations over time, with observed data (blue lines) and forecasted projections (red lines). The shaded confidence intervals represent forecast uncertainty, with the pink and gray areas indicating 80% and 90% confidence levels, respectively.

North America and Western Europe: The number of African tertiary students has consistently increased, with a sharp increase in recent years. The forecast suggests continued growth, with a relatively tight confidence interval, indicating a high level of certainty in the trend. Universities in these regions should continue expanding scholarship programs, streamlining visa policies, and strengthening partnerships with African institutions to sustain this upward trend.

South and West Asia: African student mobility to this region initially increased rapidly but has appeared to have stabilized in recent years. The forecast suggests modest growth but with a gradually widening confidence interval, implying potential uncertainties in future student mobility trends. The stabilization of student mobility suggests that universities must innovate recruitment strategies to maintain growth. Increasing affordability, increasing targeted outreach, and offering specialized programs in high-demand fields could attract more African students. Governments might also consider improving work-study opportunities to increase a region's appeal.

Sub-Saharan Africa: The mobility trend is highly volatile, with significant fluctuations in student numbers. The forecast shows continued variability, reflected in the wider confidence intervals, suggesting that uncertainties may be linked to economic, social, or policy-driven factors. Universities in this region should focus on improving local education quality to retain students while collaborating with international institutions to create exchange programs. Policies that provide financial aid and reduce tuition burdens could also enhance stability.

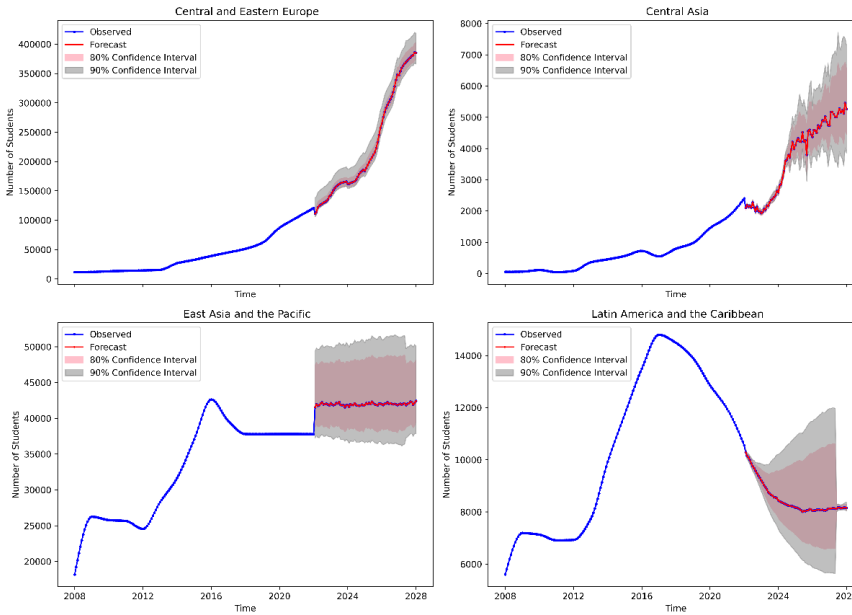
The Arab States: The trend has exhibited steady growth, with African student numbers rising consistently. The forecast predicts continued expansion but at a slower rate, possibly due to changing economic conditions, visa policies, or shifting student preferences. The steady growth but slowing pace suggests that HEIs should prioritize student support services, including cultural integration programs and career opportunities postgraduation. Governments could adjust visa and funding policies to sustain momentum and ensure long-term attractiveness for African students.

Central and Eastern Europe: The number of African tertiary students has increased significantly over time. The forecast suggests continued growth but at a slower pace, indicating that this region remains an attractive destination but may face saturation in the future. While African student numbers have grown, potential saturation suggests that universities should diversify their offerings and focus on

long-term engagement with African education institutions. Policy interventions that promote dual-degree programs or research collaborations could help maintain steady inflows of students.

Figure 1

Historical trends and forecasts of African student mobility to Central and Eastern Europe, Central Asia, East Asia and the Pacific, and Latin America and the Caribbean.

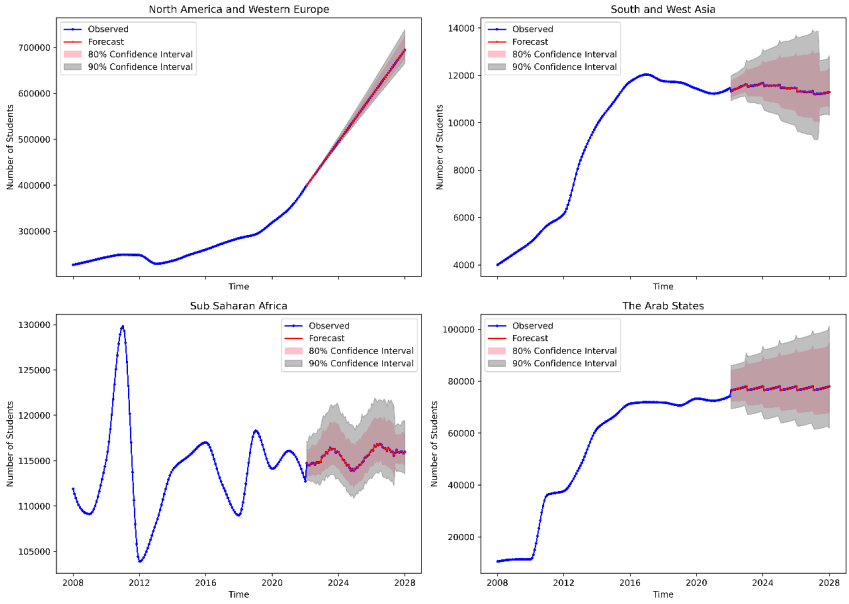


Central Asia: The trend shows a steady rise in African tertiary students, with projections indicating continued growth. However, the widening confidence intervals suggest some uncertainty, possibly due to changing policies or economic fluctuations in these host countries. The uncertainty in mobility trends suggests that tertiary institutions should strengthen recruitment networks in Africa while ensuring policy stability regarding student visas and scholarships. Host governments may need to increase economic incentives or create pathways for students to transition into the workforce after graduation.

East Asia and the Pacific: African student mobility shows a sharp rise followed by fluctuations, with the forecast indicating stabilization but within a broad confidence range, suggesting uncertainty in future trends. The fluctuating trends indicate a need for universities to stabilize their recruitment efforts by offering long-term financial aid packages, improving international student support systems, and establishing academic collaborations with African

institutions. Clearer policies on work opportunities for students could also make the region more attractive.

Figure 2
Historical trends and forecasts of African Tertiary student mobility to North America and Western Europe, South and West Asia, Sub-Saharan Africa, and the Arab States.



Latin America and the Caribbean: The mobility trend peaked and then declined, and the forecast suggests further decreases before stabilization. This decline could be due to economic challenges, language barriers, or changes in scholarship opportunities for African students in these regions. The declining trend suggests that universities need to reassess their strategies, possibly by addressing economic barriers and language constraints through scholarship programs and targeted English- or French-taught courses. Governments could explore new agreements with African nations to revive student interest and exchange opportunities.

Model performance

The time series forecasting model was configured with a high-quality preset to optimize the predictive performance. The evaluation metric used was the mean absolute scaled error (MASE), and the model utilized a rolling window validation approach with two validation windows to improve generalizability. A six-year prediction was conducted via probabilistic forecasting, with quantile levels ranging from 0.1--0.9. Model refitting was performed at every window iteration,

and the entire training process was constrained to a maximum runtime of 3000 seconds to manage computational resources effectively. All computations and analyses in this study were conducted via Google Colab, a cloud-based platform that provides an interactive environment for executing Python code and leveraging GPU acceleration.

Table 1
Training Time (in seconds) for Forecasting Models Across Different Regions for Student Mobility Prediction

REGION	TRAINING TIME
Central and Eastern Europe	2652.9 s
Central Asia	2784.5 s
East Asia and the Pacific	2793.9 s
Latin America and the Caribbean	2794.4 s
North America and Western Europe	2800.5 s
South and West Asia	2787.7 s
Sub Saharan Africa	2742.8 s
The Arab States	2776.8 s

Table 1 presents the training times for forecasting models across different regions, highlighting variations in computational requirements. The longest training time is observed for North America and Western Europe (2800.5 s), indicating potentially more complex patterns or larger datasets in this region. Conversely, Sub-Saharan Africa (2742.8 s) has the shortest training time, suggesting either simpler patterns or a smaller dataset. Other regions, such as Latin America and the Caribbean (2794.4 s) and East Asia and the Pacific (2793.9 s), have comparable training durations, indicating similar computational demands. The variation in training time across regions suggests differences in data complexity, seasonality, and forecasting challenges specific to each geographic location.

Table 2 outlines the test scores across different forecasting models and regions, indicating varying levels of predictive accuracy, with lower values representing better performance. The weighted ensemble model consistently achieves the lowest error rates across all regions, suggesting its effectiveness in integrating multiple models for enhanced accuracy. The weighted ensemble model is the most reliable forecasting method because it combines the strengths of multiple models, reducing the limitations of any single approach. By assigning different weights to each model on the basis of their performance, it optimally balances predictions, leading to higher accuracy and robustness. AutoETS and recursive tabular (RT) methods also performed well in most regions, particularly in sub-Saharan Africa (SSA), North America and Western Europe (NAWE), where they presented relatively low error values.

Table 2
Test Scores of Forecasting Models Across Different Regions for Student Mobility Predictions

MODEL	TEST SCORES BY REGIONS (MEAN ABSOLUTE SCALED ERROR)							
	CEE	CA	EAP	LAC	NAWE	SWA	SSA	AS
AutoETS	03.89	2.84	6.10	5.59	1.48	2.44	0.42	02.71
CFT	20.64	3.60	2.32	5.65	6.22	9.78	0.73	11.93
CZS	09.27	6.12	0.82	0.42	5.63	0.35	0.34	01.65
DeepAR	11.39	4.96	0.78	3.45	6.80	6.91	0.27	08.90
DT	17.12	11.28	4.76	6.82	7.79	6.54	0.29	06.28
DOT	06.16	3.16	2.98	2.83	5.31	3.36	0.38	02.79
NPTS	16.38	9.77	4.09	6.27	7.53	4.34	0.31	03.60
PatchTST	13.43	4.70	3.98	5.74	7.58	5.23	0.47	07.24
RT	09.42	5.07	1.75	1.50	1.85	2.20	1.83	03.10
Seasonal Naïve	10.39	5.61	0.94	1.42	6.20	0.37	0.38	00.35
TFT	00.66	3.70	0.28	1.97	5.74	1.50	1.09	01.79
TiDE	09.21	4.17	2.89	4.89	7.68	4.60	2.61	15.10
Weighted Ensemble	00.54	2.23	0.22	0.42	1.48	0.16	0.24	00.14

Deep learning models such as the temporal fusion transformer (TFT) and Chronos ZeroShot (CZS) have shown competitive performance, especially in East Asia, the Pacific (EAP), Latin America and the Caribbean (LAC). However, models such as direct tabular (DT) and NPTS yielded higher test scores, indicating suboptimal performance in forecasting student mobility trends. Notably, TiDE exhibited high error values in South Asia and West Asia (SWA) and Asia (AS), suggesting challenges in capturing patterns in these regions. In summary, the weighted ensemble approach outperformed individual models, demonstrating the advantage of combining diverse forecasting techniques for improved prediction accuracy.

DISCUSSION

African student mobility trends show varied patterns across global regions, with North America and Western Europe experiencing continuous growth, whereas South Asia, West Asia and Central and Eastern Europe exhibit stabilization and slower increases. Sub-Saharan Africa remains highly volatile, and Latin America and the Caribbean face declining numbers, whereas Central Asia, East Asia and the Pacific, and the Arab States show continued growth but with uncertainties tied to economic and policy factors. These trends emphasize the need for targeted policies to sustain educational exchanges and address emerging uncertainties in key destination regions.

a. *Growth in Student Mobility:* The steady rise in African tertiary student mobility to North America, Western Europe, and Central Asia highlights their attractiveness as study destinations, driven by factors such as academic prestige, scholarship opportunities, and favorable immigration policies. The

relatively tight confidence intervals in forecasts suggest predictability in student flows, which may be attributed to stable funding mechanisms, well-structured exchange programs, and policies that facilitate student visas and poststudy opportunities. Research by (OECD, 2022) emphasized that scholarship availability and funding schemes play critical roles in shaping international student mobility patterns, particularly for students from Africa. Similarly, (Choudaha, 2017) and (Van Mol et al., 2024b) noted that host countries with clear and supportive policies for international students tend to experience sustained growth in student enrollment. The increasing trend in these regions suggests that African students continue to seek high-quality education and global career opportunities, reinforcing the long-term appeal of North America, Western Europe, and Central Asia as study destinations.

b. *Fluctuations:* Fluctuations in African tertiary student mobility to Sub-Saharan Africa, East Asia and the Pacific suggest underlying challenges such as uncertain educational opportunities, political instability, and inconsistent funding mechanisms. In Sub-Saharan Africa, economic disparities and political unrest have historically disrupted student mobility, limiting access to higher education opportunities both within the region and abroad (Teferra & Altbachl, 2004). Similarly, East Asia and the Pacific, despite offering attractive academic programs, have seen volatility in African student enrollments, possibly due to shifting scholarship policies, language barriers, and changing diplomatic relations (Gutema et al., 2024). To address these instabilities, regional collaborations should be strengthened to enhance student mobility through structured exchange programs, harmonized education policies, and increased financial support. The African Union's Agenda 2063 emphasizes the need for intra-African academic mobility and partnerships with global institutions to create sustainable pathways for student exchanges (African Union, 2015). By investing in stable and well-funded educational initiatives, governments can reduce volatility and ensure that African students have consistent access to international learning opportunities.

c. *Declining Trend:* The declining trend in African tertiary student mobility to Latin America and the Caribbean suggests that the region is becoming less attractive due to language barriers, economic constraints, and reduced scholarship opportunities. Unlike English-speaking destinations such as North America and Western Europe, Spanish- and Portuguese-speaking environments in Latin America present linguistic challenges that may discourage African students (Knight, 2012). Furthermore, economic downturns in several Latin American countries have led to budget cuts in education and scholarship programs, limiting funding opportunities for international students (De Wit, 2005). The reduction in government-sponsored scholarships, such as those previously provided by Brazil and Cuba for African students, has further contributed to this decline (Dafouz & Smit, 2020). To counteract this trend, bilateral agreements between African and Latin American governments should be strengthened, promoting more exchange programs, scholarship schemes, and language support initiatives.

Programs such as the PROAFRICA in Brazil have demonstrated that structured academic cooperation and targeted funding can significantly increase African student enrollment in the region (UNESCO, 2020).

d. *Uncertainty in Future Trends:* The uncertainty in future trends for African tertiary student mobility in Sub-Saharan Africa, South Asia, West Asia, and Central Asia is evident in the wider confidence intervals, indicating greater unpredictability. This variability can be attributed to several factors, including policy changes, visa restrictions, economic downturns, and shifting educational preferences (De Wit & Altbach, 2021). For example, the tightening of visa policies in countries such as India and Kazakhstan has affected the ease of mobility for African students (Lomer, 2018). Additionally, economic instability in Sub-Saharan Africa has created financial barriers, making it difficult for students to afford tuition and living costs abroad (De Wit & Altbach, 2021). As geopolitical and economic factors continue to evolve, regional educational agreements, financial aid programs, and diplomatic efforts will be essential in ensuring sustainable student mobility patterns for African students.

Implications

The results highlight key trends in African tertiary student mobility, emphasizing the continued growth of migration to North America, Western Europe, and Central Asia due to scholarship opportunities, immigration policies, and academic prestige. However, fluctuations in Sub-Saharan Africa and East Asia and the Pacific indicate challenges such as political instability and inconsistent funding, necessitating stronger regional collaboration and financial aid programs. The decline in African tertiary student mobility to Latin America and the Caribbean is attributed to language barriers and reduced scholarships, suggesting a need for bilingual programs and targeted funding. Additionally, the unpredictable trends in Sub-Saharan Africa, South Asia, West Asia, and Central Asia call for proactive policy interventions, including streamlined visa processes and enhanced academic cooperation. The findings also suggest significant intraregional mobility within Africa, highlighting the importance of strengthening African higher education institutions through improved infrastructure, research collaboration, and student-friendly policies to retain talent and foster regional academic growth.

Recommendations

To sustain the growth of African tertiary student mobility to North America, Western Europe, and Central Asia, expanding scholarships and student exchange programs is essential, with both African governments and host nations increasing financial aid opportunities to support this trend. Moreover, addressing instability in Sub-Saharan Africa, East Asia and the Pacific requires investment in regional educational infrastructure to enhance local universities and reduce dependence on foreign education, whereas strengthening partnerships with host institutions in East Asia and the Pacific can create more structured student pathways.

Additionally, to revitalize interest in Latin America and the Caribbean, African and Latin American countries should expand bilateral agreements, introduce more scholarships and language training programs, and encourage African embassies in Latin America to actively promote educational opportunities in the region. Given the uncertainties in student mobility trends, particularly in Sub-Saharan Africa, Central Asia, and South and West Asia, governments and institutions should improve data collection and use advanced forecasting models to develop data-driven policies that ensure sustainable and predictable mobility patterns for African students.

CONCLUSION

This study provides a comprehensive analysis of African student mobility trends across global regions, using advanced time series forecasting models to examine historical data and predict future patterns. The integration of statistical, deep learning and ensemble approaches through the AutoGluon framework has enabled accurate forecasts, highlighting key trends, variations, and uncertainties in student flows. The results reveal continuous growth in African student mobility to North America, Western Europe, and Central Asia, suggesting that these regions remain highly attractive destinations due to their academic prestige, funding opportunities, and favorable immigration policies. Conversely, student mobility to Latin America and the Caribbean is on a declining trajectory, potentially due to economic constraints, language barriers, and reduced scholarships.

The fluctuations observed in Sub-Saharan Africa, East Asia and the Pacific emphasize the impact of socioeconomic and political instability on student mobility. Additionally, significant uncertainties in future trends, particularly in South and West Asia, Sub-Saharan Africa, and Central Asia, emphasize the need for data-driven policy interventions to sustain student mobility growth. The study also shows the effectiveness of ensemble forecasting methods in capturing complex temporal patterns and improving predictive accuracy across diverse regions.

To address challenges and sustain student mobility growth, policy recommendations include expanding scholarships and financial aid, enhancing regional educational infrastructure, fostering bilateral agreements between African and host country governments, and utilizing advanced forecasting models for informed decision-making. These strategies can play a crucial role in ensuring sustained access to high-quality education for African students on a global scale, thereby advancing the principal objectives of knowledge dissemination, capacity building, and the promotion of international academic cooperation. While the study identifies key factors influencing African students' mobility, a more in-depth analysis of their interactions, evolving dynamics, and underlying cultural, social, and individual motivations would provide a valuable direction for future research.

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In the preparation of this manuscript, we utilized artificial intelligence (AI) tools for content creation with the following capacity:

☐x Some sections, with extensive editing

This article incorporates content generated by artificial intelligence (AI) tools. The sections where AI tools were employed are the table analyses. The use of AI tools complied with ethical standards and guidelines for academic integrity. The final content has been thoroughly reviewed and edited to ensure accuracy, relevance, and adherence to academic standards.

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