

# A spatio-temporal analysis of academic performance at the Basic Education Certificate Examination in Ghana



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## ABSTRACT

Over the last decade, Ghana has more than tripled investment in its basic education system. Consequently, the country has made huge educational gains, primarily in providing universal access to basic education. However, many stakeholders are worried that academic performance is lagging because of disproportional attention to accessing basic education. Discussion of these concerns is hampered by ongoing disagreement about the true trajectory of academic performance at the basic education level and the widespread nature of students' lagging academic performance. In part, this disagreement stems from the failure of empirical studies to comprehensively examine trends in academic performance standards at the basic education level by concurrently considering a geographical and longitudinal perspective. Thus, this study examines the spatio-temporal trends of academic performance at the junior high school level since 2009 by using multilevel growth curve modeling, spatial statistics, and district-level longitudinal data. Results reveal 3 statistically distinct trajectories of academic performance: erratic, accelerating, and decelerating changes. Results also show that rural–urban gaps explain 31% of the performance trajectories, a trend which is expected to persist in the long term. In addition, we find extreme variations in academic performance within rural areas. Given the varying trajectories and geographical variability in academic performance, we suggest a localized approach to addressing challenges of low academic achievement at the basic education level in Ghana.

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## 1. Introduction

Since the late 1980s, Ghana has substantially expanded its educational system and steadily increased investment in education (Akyeampong, Djangmah, Oduro, Seidu, & Hunt, 2007). Public expenditure on education as a share of the country's gross domestic product (GDP) increased more than 600% from 1.8% in 1980 to 8.14% in 2011, which is well above the current average of 5% GDP for Sub-Saharan Africa (UNESCO, 2015). Ghana also embarked on implementing major educational policies and programs, including the free Compulsory Universal Basic Education (fCUBE) policy, Capitation Grant, and the School Feeding Program. The fCUBE pol-

icy has focused primarily on increasing enrollment and improving physical infrastructure at the basic or primary school level that comprises of the first 9 years of formal schooling (Nudzor, 2013). Because of the extent of attention and investment directed toward universal basic school education, the past two decades have witnessed substantial improvement in access to basic education in Ghana (Darvas & Balwanz, 2014). These investments have sought to provide all Ghanaian children with basic education, putting Ghana well on track to achieving its goal of universal access to basic education. This goal is also consistent with the international community's cross-thematic development frameworks such as the Millennium Development Goals (MDGs) and Sustainable Development Goals (SDGs). MDG Goal 2 seeks to ensure that by 2015, all children will be able to complete primary level schooling without respect to their gender or the area or region in which they live. Similarly, the SDGs push for inclusive and quality education for all (United Nations Economic Commission for Africa [UNECA], 2013). Clearly, the improved access to basic education in Ghana is com-

*Abbreviations:* JHS, Junior High School; SHS, Senior High School; BECE, Basic Education Certificate Examination; fCUBE, Free Compulsory Universal Basic Education.

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mendable and deserving of the substantial investments the Ghana government and donor agencies have made.

Despite the goal of the fCUBE policy to improve the access and quality of basic education, improvements in learning outcomes at this level have not kept pace with the remarkable improvement in access (Darvas & Balwanz, 2014; Mettle-Nunoo & Hilditch, 2000). Although stakeholders generally agree that academic performance standards at the basic education level are low and of great concern (Affum-Osei, Asante, & Forkuoh, 2014; Gyan, Mabefam, & Baffoe, 2014), they disagree on the true trajectory of learning outcomes. This issue is clouded by inconsistent claims about whether performance standards are falling, rising, or unchanged. The lack of clarity on the true trajectory of primary level academic achievement is due to, at least in part, most of the assertions being based on snippets of results rather than comprehensive nationwide longitudinal data.

Many in Ghana share the perception that academic achievement is falling (Degue, 2012; Okyerefo, Fiaveh, & Lampsey, 2011). In particular, this perception becomes heightened each year with the release of the annual Basic Education Certificate Examination (BECE) results. BECE is the national standardized examination for students who have completed junior high school (JHS) (i.e., Grade 9). The heightened perception of falling academic achievement is in part because, for instance, 182,000 JHS candidates who sat for the 2013 BECE did not earn a passing grade for at least one core subject, and therefore, did not qualify to enter senior high school. Importantly, some analysts have described this shared perception of a downward trend in academic achievement as a national security threat (Gyasiwaa, 2013).

Many of those who contend that academic achievement is falling have also speculated that the expanded enrollment in the basic education level has come at the cost of the quality of basic education. As noted by Lewin and Akyeampong (2009), "... rapid expansion in enrollments has degraded quality" (p.143). Similarly, the United Nation's 2014 MDG report asserted that Ghana's expanded access to education has steadily weakened the quality of education, and linked the decline in educational quality and student achievement to larger class sizes, the growing number of new schools, and the government's heavy reliance on poorly trained and unqualified teachers (UNECA, 2014). However, significant increase in educational investments does not necessarily have to lead to a trade-off between enrollment (quantity) and learning outcomes (quality). Indeed, data from the late 1980s to the early 2000s support the idea that Ghana's massive investment in education sector in the form of 8000 classroom blocks led to concurrent improvements in enrollment and students' learning outcomes. Why then is there perception that Ghanaian students are on a downward slope of academic achievement?

Simultaneously, many other stakeholders disagree with the assertion that Ghanaian students' academic performance is falling. For instance, even the chief examiners' report of the 2012 BECE suggests that performance trends were mixed (West African Examination Council, n.d.). Other experts and educational scholars contend that the perception of falling performance is false and, not based on data. For instance, Francis Kodzo Amedahe, a professor in educational measurement and statistics at the University of Cape Coast, has contended that "... the issue of falling educational standards in Ghana is a perception rather than a reality" (Ghana News Agency, 2014; para.1). Given conflicting viewpoints on the academic performance trajectory of Ghana, there are important empirical questions that warrant attention. The most pressing unanswered questions include: (a) What are the factual trajectories of academic performance standards at the basic education level? (b) Are the academic performance trajectories generally consistent across Ghana's administrative districts, and are there salient spatial variations in the direction and rate of change in academic perfor-

mance?

This study aims to help fill this empirical gap in academic performance through systematic assessment of the spatio-temporal dynamics of academic achievement in Ghana at the BECE level. We examine 6 years' of local and nationwide BECE data (collected from 2009 through 2014) to address fundamental questions on whether (a) statistically significant trends exist in academic performance, (b) such trends are sloping upwards or downwards, and (c) whether these trends, if any, favor or disadvantage certain geographical areas of the country. Developing a better understanding of the space-time trends of academic achievement in Ghana is critical because determination of the spatial trajectory of academic performance (and potential disparities) in the country will enable education researchers, administrators, and policy makers to better target their energies to areas in need of attention, especially at the basic education level.

## 2. Rural–urban differences

Spatial inequality in Ghana is not a new phenomenon. However, concerns are growing among many scholars and practitioners that the extent of spatial inequality in education and other social indicators is widening despite the country's economic growth, investment in socioeconomic development, and falling poverty levels (Annim, Mariwah, & Sebu, 2012; Aryeetey, Owusu, & Mensah, 2009). Like many sub-Saharan African countries (Michaelowa, 2004), significant rural–urban differences exist in Ghana in terms of access to educational resources and the resultant outcomes of these resources. More often than not, the rural–urban gaps in educational outcomes favor urban areas because they have disproportionately more education resources (e.g., good classrooms and school furniture) and favorable living conditions such as good road and accommodation (Ansong, Ansong, Ampomah, & Adjabeng, 2015; Kimosop, Otiso, & Ye, 2015; Senadza, 2012).

Despite the urban advantage, the caveat is that the rural–urban differences may not always be a clear dichotomy. The educational discourses in Ghana often presume that the problem of spatial disparities in educational outcomes is more acute in rural than urban areas (Tsikata & Seini, 2004). However, in the absence of adequate empirical evidence from a contextualized and spatial perspective, this presumption may be an over-simplification of the problem. Although a great deal is known about rural–urban inequalities regarding access to education and related resources, little is known about these inequalities in terms of specific educational outcomes (e.g., academic performance) given the scant nationwide empirical assessment of any such potential spatial disparities. Empirical studies are yet to clarify the temporal nature of academic performance in rural versus urban areas. One of the few studies to have examined the spatial dimension of learning outcomes used data from a random sample of 6000 junior high-school students from across Ghana (Ansong & Chowa, 2013). The study found regional variations in educational performance when measured by math and English scores, but such variations favored predominantly rural areas such as the western and northern regions. However, because the study focused on limited subject areas (i.e., only math and English subjects) and used cross-sectional data, its findings do not offer a holistic overview of the country's space-time trends in academic performance.

The absence of such a holistic overview is not unusual, and the data used to shape conversations on growing spatial inequality are often incomprehensive, non-longitudinal, and inadequately scrutinized. To a large extent, public concerns about falling academic standards at the basic education level have been driven by media reports of the abysmal BECE performance of primary level students. Although these reports are important in initiating conversations about measures for addressing inequalities in learning

outcomes, the external validity of such reports is often assumed rather than verified. For instance, in 2012, media reports claimed that more than two-thirds of the 840 candidates who sat for the BECE in the Sissala West District failed the exam (Farouq, 2012). The Ghana News Agency (2010) also reported that not a single candidate from more than a dozen public and private schools in the Agona West Municipality scored high enough (i.e., aggregate scores 6 to 30) on the 2012 BECE examination to qualify for placement in a second-cycle institution (i.e., senior high, vocational, and technical schools). While such media reports focus on select schools or school districts, they tend to skew public perception of the state of basic education performance in Ghana. From a policy and research standpoint, it is critical to assess empirically whether the problem of low academic performance of the BECE is ubiquitous in Ghana or is confined to specific schools and regions.

Thus far, given what is known about educational outcomes by location, enrollment, and educational progression, there is reason to believe that substantial spatial variations exist in district-level trajectories of academic performance. For instance, Akyeampong et al. (2007) found that the education system favors students living in urban districts. Specifically, Akyeampong and colleagues, found children from urban areas were not only more likely than rural children to pass the BECE and transition to senior high school, but that the rural–urban gap in school enrollment and progression was widening. Moreover, the rural–urban gap also manifests in other ways that can affect educational outcomes. For example, the disparity in the “educational climate” between rural and urban areas was revealed by the 2010 Population and Housing Census, which showed that whereas 1 out of 7 urban residents had never attended school, that proportion was significantly higher in rural areas at 1 out of 3 (Ghana Statistical Service, 2012). Further rural–urban disparities exist in the quality of available school facilities and education offered. Thus, rural residents’ access to quality education is severely limited by poor infrastructure and the low numbers of qualified teachers (Poku-Boansi & Amoako, 2014). Rural schools often have inadequate classrooms, outdated or insufficient numbers of textbooks, and poorly trained or untrained teachers—all of which exacerbate the relatively poor quality of education in these areas (Ansong et al., 2015; Atuahene & Owusu-Ansah, 2013). Because the Ghanaian society is socially, culturally, and economically heterogeneous (Avendal, 2011), it is reasonable to assume that academic performance trajectories vary across the country. However, compared to existing knowledge on access to education and educational resources in Ghana, little is known about spatial variations in academic performance.

### 3. Inter-rural differences

Inter-rural variability (i.e., variations between rural areas) is a largely unexplored spatial dimension of rural deprivation in Ghana. Historically, the rural–urban dichotomy has been emphasized in development theory and practice (Gough, Agergaard, Fold, & Moller-Jensen, 2009). However, even though rural Ghana is disproportionately disadvantaged and has lower achievement outcomes, the dynamics of rural deprivation and the associated learning outcomes are more intricate and nuanced than portrayed by the traditional rural–urban divide literature. Further, the lack of understanding of variability among rural areas has been perpetuated by the many research studies on rural Ghana that have aggregated all rural areas into a homogeneous category (Atuahene & Owusu-Ansah, 2013; Mettle-Nunoo & Hilditch, 2000).

The vast literature on rural challenges in Ghana notwithstanding, questions remain about whether educational disadvantage in rural areas is more acute in certain regions than others. Although rural Ghana shares many qualities, it also varies considerably in the type and extent of deprivation experienced. For instance, most in-

dicators of human development (e.g., health, education, economic well-being) suggest that the three northern regions of Ghana have a more severe level of deprivation than either the middle or southern regions (Otiso & Owusu, 2008; Seini, 2000). Given these regional disparities and the structure of the educational system, with rural districts nested within regions, a particularly challenging question remains to be answered: Compared with the middle and southern regions of Ghana, do distinct clusters of low-performing rural districts exist in the north? If so, how have these clusters evolved and changed over time and space? While it may be reasonable to infer that all rural areas are disadvantaged, especially those in the northern regions (Poku-Boansi & Amoako, 2014), few empirical analyses have been conducted on national space-time trends in academic performance. Thus, it is unclear whether, academic trajectories of the northern regions are unique or similar to those of the nation as a whole. To help fill this knowledge gap, this paper uses multilevel growth curve modeling and spatial analysis to examine, (a) the 6-year (2009–2014) trajectory of academic achievement as measured by performance on the national junior high school examinations; (b) whether any such academic achievement trajectory is influenced by the rural/urban status of the district, and if so, how such influence is manifested; and (c) whether inequalities exist among rural districts in Ghana. The benefit of combining multilevel growth curve modeling with spatial analysis in this study is the ability to measure change over time in the BECE results at both the national and district levels and at the same time geographically visualize the changes over time and variations across different areas of the country.

## 4. Methods

### 4.1. Data and analyses

The present study uses six waves of data (2009–2014) drawn from the BECE results of junior high school students in Ghana. These longitudinal data are aggregated at the school district level with varying sample sizes: 142 districts in 2009, 138 in 2010, 154 in 2011, 156 in 2012, 169 in 2013 and 166 in 2014. These sample sizes vary by year because of the creation of new districts during the study period and non-availability of BECE data from a few districts in 2010. Using two rigorous approaches—multilevel growth curve modeling and spatial statistics analysis—the data were examined to determine the spatio-temporal curves of BECE pass rates in Ghana.

#### 4.1.1. Multilevel growth curve modeling

The use of repeated measures data make multilevel growth curve models an invaluable statistical tool in educational research because this technique estimates changes in student outcomes more accurately by taking into account the hierarchical nature of the data (i.e., nesting of repeated measures within individual units) (Hox & Stoel, 2005). Moreover, as compared with traditional approaches for analysis of longitudinal data, multilevel growth curve modeling offers the advantage of being able to easily and efficiently handle unbalanced data, such as the varying sample sizes in our data (Luke, 2004). We used multilevel growth curve modeling to model the process of change in BECE pass rates over time, and to assess rural and urban differences in the initial status and growth rates. The time variable is the academic year (*Year*), which indicates the measurement occasion for each of the six BECE results starting from 2009. The variable *academic achievement* is measured as the percentage of candidates who earned an aggregated score between 6 and 30, which is considered a passing score for admission to a senior high school (Mereku, 2012). To test for rural–urban variation in BECE pass rates, we included a binary measure of whether a district is predominantly rural or urban.

Fig. 1 presents a plot of the mean BECE pass rate over 6 consecutive years, starting from 2009. The figure depicts a nonlinear growth curve; the percentage of candidates passing the BECE decreased from 2009 to 2010 and then increased between 2010 and 2012 before decreasing again between 2012 and 2014. Because of these nonlinear trends in BECE results over time as shown in Fig. 1, we modeled quadratic ( $Year^2$ ) and cubic slopes ( $Years^3$ ) (Shek & Ma, 2011) to account for potential nonlinear individual growth trajectories in the way in which districts in Ghana perform at the BECE over time.

Based on the recommended analytical strategy for longitudinal data analysis (Singer & Willett, 2003) we tested five nested models, starting with the most restrictive and progressing to the least restrictive model. Model 1, the unconditional means model, examined possible differences across all districts in the mean percentage of candidates who passed the exam, regardless of the exam year. This model also assessed average district level variations in the BECE pass rate and the amount of variance accounted for by the inter-district differences as well as differences between years. The intra-class correlation (ICC) was .49 [i.e.,  $208.06/(208.06 + 215.87)$  see Table 1], suggesting that inter-district differences explained 49% of the variability in the BECE pass rate. The ICC is greater than the recommended cutoff of .25, which further supports the need to use individual growth curve modeling (Kreft, 1996).

Next, we modeled an unconditional linear growth curve model (Model 2) to examine the existence of any significant differences in the districts' trajectory over time. Because the time variable was statistically significant in Model 2 (i.e., the baseline model) we proceeded to examine two higher-order change trajectories. First, we added a quadratic term ( $Year^2$ ) to test for higher-order change trajectories over time. The resulting model (Model 3) was needed to examine whether the individual rate of change accelerated or decelerated over time. In the next test for higher-order change trajectory (Model 4) we added a cubic term ( $Year^3$ ) to capture the rate of acceleration or deceleration over a long period of time. Model 5, the last in the five-step modeling process, tested the potential moderation role of a district's status as either predominantly rural or urban. In other words, this model tested whether the change trajectories were statistically the same for rural and urban districts. Because we did not expect the rural–urban designation of districts to change significantly over the observation period, we examined the rural–urban status as a time-invariant phenomenon. The model is estimated as follows:

$$Y_{ij} = \gamma_{00} + \gamma_{01}(\text{Rural})_j + \gamma_{10}(\text{Year})_{ij} + \gamma_{11}(\text{Rural})_j(\text{Year})_{ij} + \gamma_{20}(\text{Year}^2)_{ij} + \gamma_{21}(\text{Rural})_j(\text{Year}^2)_{ij} + \gamma_{30}(\text{Year}^3)_{ij} + \gamma_{31}(\text{Rural})_j(\text{Year}^3)_{ij} + u_{1j}(\text{Year})_{ij} + u_{0j} + r_{ij}$$

where  $Y_{ij}$  is the BECE pass rate of year  $i$  for district  $j$ ,  $\gamma_{00}$  is the adjusted average BECE rate across all districts,  $\gamma_{01}$  to  $\gamma_{31}$  are the

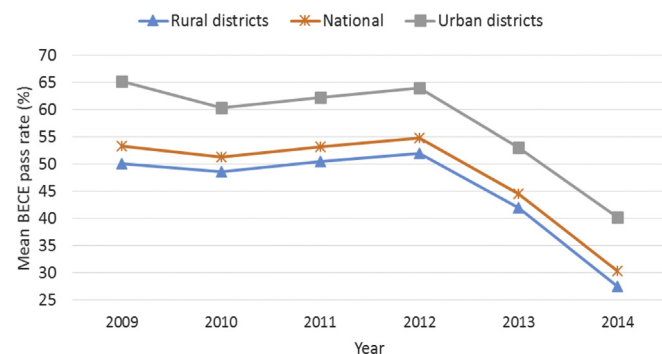


Fig. 1. Mean BECE pass rate profiles of districts from 2009 to 2014.

fixed effects,  $u_{1j}$  and  $u_{0j}$  are the two random effects (or error terms at Level 2) of district  $j$  on BECE pass rate and  $r_{ij}$  is the error term at Level 1.

To determine which model best fits the data, we compared the fit indices ( $-2 \log$  likelihood  $[-2LL]$  and the Akaike information criterion [AIC]) of the two models with the lowest AIC values, that is, the cubic growth (Model 4) and predictor effect models (Model 5) (Kuha, 2004; Shek & Ma, 2011). A pairwise comparison indicated a statistically significant difference between the two models:  $\chi^2(4) = 7434.42 - 7412.63 = 21.79$ ,  $p < .001$ . The AIC difference between the lowest AIC model (predictor effect model AIC = 7436.63) and all other models (unconditional linear growth curve, Model 2 AIC = 7651.19; quadratic growth curve Model 3 AIC = 7493.28; cubic growth curve Model 4 AIC = 7450.42) were greater than the recommended cutoff of 10 (Burnham & Anderson, 2002). This AIC difference means that among all the nested models, only the predictor effect model (Model 5) explained any substantial variation in the data. Thus, Model 5 (predictor effect) was retained as the final and best fitting model.

#### 4.1.2. Spatial pattern analysis

Spatial pattern analysis was the second analytical approach we used to examine the data. This method is a nontraditional statistical tool for mapping and quantifying statistically significant trends and clusters in geographically referenced data. Specifically, we generated thematic maps and conducted grouping analyses. The benefits of the spatial analyses include the ability to (a) validate results from the multilevel growth curve models, (b) map and visualize identifiable growth trajectories, and (c) highlight inter-rural, inter-urban, and rural–urban variations.

First, we used the Grouping Analysis tool, a relatively new exploratory method in ArcGIS, to identify distinct groups of districts based on the trajectories of the BECE pass rate. To avoid prejudging the number of distinct trajectories, we used the Calinski–Harabasz pseudo F-statistic to determine the maximum number of geographically diverse trajectories that exist in the data (Calinski & Harabasz, 1974). Lastly, we used six consecutive choropleth maps to reveal the spatio-temporal variations that exist within Ghana's rural areas based on the percentage of candidates who passed the BECE from 2009 to 2014. To make the map easy to interpret without excessive loss of detail, we used graded colors with a five-level equal interval classification scheme—that is, 20%, 40%, 60%, 80%, and 100%—for each wave of data. This visualization scheme is based on the recommended four to six classes used in most maps (Yang, 2005). We also computed and mapped out the annual changes in BECE pass rates across rural areas.

## 5. Results

The mean academic performance profiles for rural and urban districts and the national average are displayed in Fig. 1. Overall, the downward direction of the trend for both rural and urban districts is similar to the national trend. The fairly parallel profile for rural and urban districts suggests no interaction between district type and time. In other words, rural districts did not catch up with the urban districts during the 6-year observation period nor did the urban ones fall to the level of the rural areas.

Fig. 2 builds on Fig. 1 by illustrating the rural–urban gaps and their statistical significance at the national level from 2009 to 2014. The extent of this gap remained statistically significant at the .01 and .001 significance levels over the six-year period. Although the rural–urban gap narrowed marginally after 2009, the average performance of urban districts in subsequent years remained significantly higher than rural districts. As Fig. 2 shows, the largest differences between the rural and urban districts occurred in 2009 ( $\Delta 15.07\%$ ,  $t = 4.42$ ,  $p < .001$ ) followed by 2014

**Table 1**  
Results of multilevel growth curve models.

	Model 1 Unconditional mean model <i>b</i> (SE)	Model 2 Unconditional linear growth curve model <i>b</i> (SE)	Model 3 Quadratic growth curve model <i>b</i> (SE)	Model 4 Cubic growth curve model <i>b</i> (SE)	Model 5 Predictor effect model <i>b</i> (SE)
<b>Fixed effects</b>					
Intercept ( $\gamma_{00}$ )	47.76(1.21)***	63.26(1.51)***	44.73(2.02)***	62.58(3.29)***	80.56(6.97)***
Year ( $\gamma_{10}$ )		-4.24(.26)***	9.35(1.03)***	-12.93(3.42)***	-21.04(7.20)**
Year <sup>2</sup> ( $\gamma_{20}$ )			-1.92(.13)***	5.38(1.08)***	7.52(2.26)**
Year <sup>3</sup> ( $\gamma_{30}$ )				-.69(.10)***	-.86(.21)***
Rural ( $\gamma_{01}$ )					-23.15(7.88)**
Year × Rural ( $\gamma_{11}$ )					10.37(8.18)
Year <sup>2</sup> × Rural ( $\gamma_{21}$ )					-2.73(2.57)
Year <sup>3</sup> × Rural ( $\gamma_{31}$ )					.22(.24)
<b>Random effects</b>					
Residual ( $r_{ij}$ )	215.87(11.11)***	143.65(8.49)***	106.59(6.34)***	99.10(5.89)***	98.47(5.86)***
Intercept ( $u_{0j}$ )	208.06(27.29)***	228.85(43.25)***	264.62(42.97)***	273.27(43.03)***	244.33(39.73)***
Year ( $u_{1j}$ )		2.31(1.48)	6.38(1.69)***	6.67(1.66)***	6.80(1.67)***
<b>Model Fit</b>					
-2LL	7904.53	7639.19	7479.28	7434.42	7412.63
AIC	7910.53	7651.19	7493.28	7450.42	7436.63
AICc	7910.56	7651.28	7493.40	7450.57	7436.97
BIC	7925.02	7680.17	7527.09	7489.05	7494.59

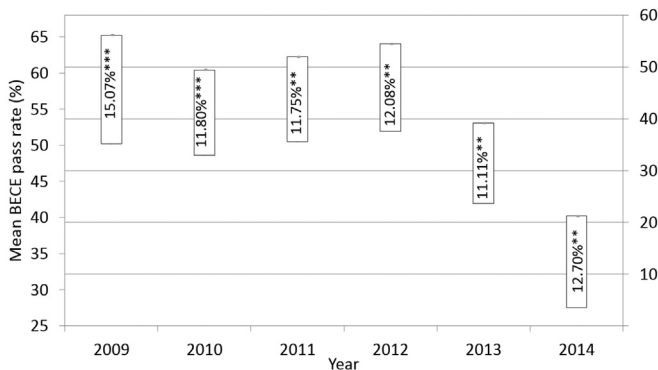
Note. -2LL = -2 log likelihood; Akaike information criterion; AICc = corrected Akaike information criterion; BIC = Bayesian information criterion.  
\*\*\* $p < .001$ , \*\* $p < .01$ , \* $p < .05$ .

( $\Delta 12.70\%$ ,  $t = 3.88$ ,  $p < .001$ ). The smallest difference occurred in 2013 ( $\Delta 11.11\%$ ,  $t = 2.99$ ,  $p < .01$ ).

5.1. Multilevel growth curve modeling results

Results of the final model presented in Table 1 show that the intercept ( $b = 80.56$ ,  $p < .001$ ) and linear growth parameter ( $b = -21.04$ ,  $p < .001$ ) were both highly statistically significant. This suggests that the initial status and the linear growth rate of the BECE pass rate changed over time. This finding means that the estimated initial average BECE pass rate decreased after 2009. The quadratic effect was positive and statistically significant ( $b = 7.52$ ,  $p < .01$ ) but the cubic effect was negative and statistically significant ( $b = -.85$ ,  $p < .001$ ). These results, which are consistent with the mean profiles in Fig. 1, show that the pass rate initially decreased in 2010, increased in 2011, and then decreased again in 2013 and 2014. However, the rate of deceleration gradually slowed down over time.

The rural-urban status of the districts was a significant predictor of the initial BECE pass rate ( $b = -23.15$ ,  $p < .01$ ) but not the linear ( $b = -10.37$ ,  $p = .21$ ), quadratic ( $b = -2.73$ ,  $p = .29$ ), or cubic ( $b = -23.15$ ,  $p = .37$ ) changes in the BECE pass rate. That



\*\*\*  $p < .001$ , \*\*  $p < .01$

Fig. 2. Illustration of statistically significant annual differences in BECE pass rate between rural and urban districts from 2009 to 2014.

is, rural and urban districts had a statistically similar quadratic and cubic rate of change in the BECE results. The rural-urban status of districts explained 31% [ $(143.65-98.47)/143.65 = .3145$ ] of the inter-district variations in the BECE pass rate. The negative correlation between the intercept and the linear growth parameter ( $b = -17.54$ ,  $p < .01$ ) means that districts with high BECE scores had a slower linear decrease, whereas districts with low BECE scores had a faster decrease in their linear growth over time. Thus, the situation of the low scoring districts got worse over time.

5.2. Spatial grouping analysis results

The parallel box plot in Fig. 3 illustrates the optimal distinct trajectories in the BECE results from 2009 to 2014. The Calinski-Harabasz pseudo F-statistic for the grouping analysis revealed three geographically-diverse trajectories (pseudo  $F = 74.87$ ). These three trajectories are analogous to accelerating, decelerat-

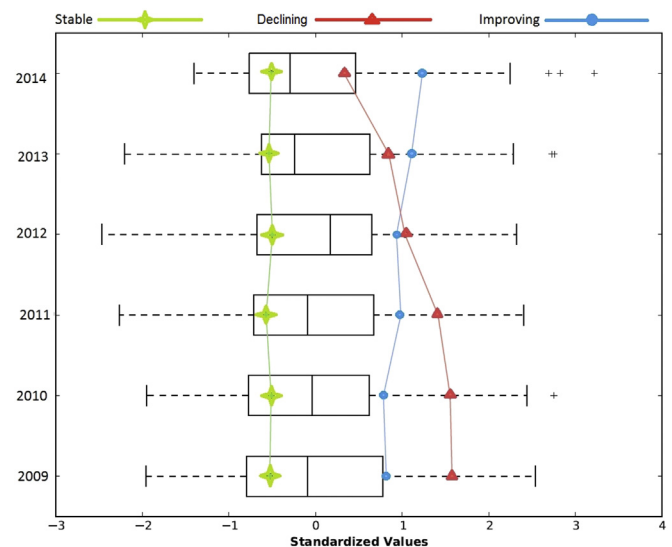


Fig. 3. A parallel box plot summarizing the global trajectories in BECE results from 2009 to 2014.

ing, and erratic changes. The first statistically distinct trajectory, illustrated with a star–green line, reflects districts whose BECE results are neither improving nor declining consistently. Although this group had relatively steady results over the years, their group mean hovered below the global mean throughout the 6-year observation period. The second statistically distinct trajectory is illustrated with a triangular point red line. The line shows districts whose BECE pass rates have decreased consistently since 2009. Although still above the global mean, this group's mean fell below the global upper quartile for the first time in 2014. The last statistically significant trajectory is illustrated with a circular point blue line that shows districts whose results increased steadily during the 6-year period.

Throughout the study period, the BECE pass rate scores for this group (i.e., districts with steady increases over time) were greater than the global mean and global upper quartile. The parallel box plot also shows that the number of outliers increased over time; meaning that the number of districts with exceptionally good results increased over the 6 years.

Fig. 4 presents the localized results of the grouping analysis, and shows the three statistically significant unique trajectories identified using the ArcGIS Grouping Analysis tool. The green districts have relatively stable trajectories. One noticeable result from the map is that majority of districts in the northern regions are neither improving nor declining in their BECE performance. The red districts experienced steady decreases in BECE pass rates over the study period. A disproportionate number of districts with declining trajectories were located in the southern regions. The blue districts experienced steady improvement in the BECE pass rates over the 6-year study period, and were located in the southern regions, especially in southwest Ghana. The unshaded white areas indicate districts with growth trajectories that did not fit any statistically distinguishable pattern for growth trajectories.

Overall, Fig. 4 shows that most districts in northern and eastern Ghana are neither improving nor declining compared to those in southwest Ghana. The southern region is the most diverse because its districts have a noticeable variety of trajectories. Specifically, the Ashanti Region in the south is the most promising region in terms of the number of districts with an accelerating growth trajectory or improving performance. In contrast, the Western Region is the worst performing region given its high number of districts with a declining BECE performance trajectory.

### 5.3. Inter-rural spatial variability

Fig. 5 shows the spatial distribution of Ghanaian rural districts by academic performance from 2009 to 2014. Each panel, particularly before 2014, illustrates the dynamic nature of the BECE pass rates, which suggests some rural areas outperform others. The spatial distribution shows a wide but shrinking inter-rural variation in the BECE pass rate over time. In other words, the differences that exist between rural districts have narrowed over time. However, the results show that the primary reason for the narrowing gap between rural districts is due largely to the fact that many districts that used to perform well on the BECE have experienced gradual decline in their BECE results. That is, the darker shades have progressively gotten lighter, which suggests worsening trends in rural areas.

Fig. 6 shows the annual changes in rural area performance from 2009 to 2014. Panels *a* through *e* show that some rural districts experienced yearly increases in their pass rates (blue shades) while others experienced declines (red shades). The five panels show clear patterns or clusters, thereby confirming variability within rural areas. The maps also confirm results from Fig. 5 that the narrowing inter-rural gap is not because low-performing districts have improved, but rather well-performing districts have declined in

their performance on the BECE.

### 5.4. Inter-urban spatial variability

Trends in the inter-rural comparison is similar to trends in the inter-urban comparison. As panels *a* through *f* in Fig. 7 show, the spatial distribution of academic performance in Ghanaian urban districts varies. The spatial distribution shows moderate inter-urban variations in the BECE pass rate during the study period. Panels *e* and *f* in Fig. 7 show that the inter-urban differences have also narrowed over time, but there is still a fair amount of inter-urban variation compared to the inter-rural variation.

Fig. 8 shows the pattern of annual changes in the BECE pass rate in Ghana's urban areas. Panels *a* through *c* show that the urban areas of Ghana experienced a mix of improvement and decline in their BECE results from 2009 through 2012. However, the extent of inter-urban variation shrunk from 2012 to 2014 largely because more urban districts experienced decline in their BECE result during the last two years of the study period. This trend is similar to the trends observed among rural districts.

### 5.5. Rural–urban spatial variability

There are rural–urban similarities and differences in BECE pass rates. Results from Fig. 9 show that both rural and urban districts have representation of the three statistically distinct trajectories of BECE pass rate in Ghana: improving, declining, and stable trends. In addition, both rural (31%) and urban (32%) areas have equivalent proportions of districts whose trajectories are not statistically unclassified. On the other hand, there are many rural–urban differences in Ghana's BECE pass rate. First, most of the rural districts are located in the northern and middle sectors of the country, whereas nearly all the urban districts are located in the south of the country. Second, as evident in panels *a* and *b* of Fig. 9, rural districts are largely neither improving nor declining (58%) compared to urban districts (41%). Third, a higher proportion of urban districts showed consistent signs of improvement (24%) during the study period compared to a handful of rural districts (5%). Another important rural–urban difference in performance at the BECE is that the declining districts, though few, are somewhat spread out among rural districts in the south, middle, northern Ghana, while those of the urban districts are clustered in the south, particularly the southwestern part.

## 6. Discussion

The goal of this study was to model changes in the percentage of candidates who passed the BECE over a 6-year period and to determine whether the pattern of change over time differed based on the urban or rural status of Ghana's administrative districts. At the national level, the BECE performance trends suggest that the initial results followed a fluctuating pattern until the last 3 years when they declined consistently. The recent trend at the national level, lends credence to concerns expressed by Degue (2012), Lewin and Akyeampong (2009), and others on the falling BECE performance and academic standards in Ghana. Our results are also consistent with Ghana's poor performance at several international schooling rankings. For instance, in a 2015 global report on math and science education published by the Organization for Economic Co-operation and Development (OECD), Ghana placed last behind other African countries such as Tunisia, Morocco, Botswana, and South Africa (Darko, 2015). Ghana has also consistently lagged behind other peer African countries, including South Africa, Morocco, Botswana, and Egypt in the 2003, 2007, and 2011 editions of the Trends in International Math and Science Study (TIMSS) (Abukari, 2010; Etsey et al., 2009).

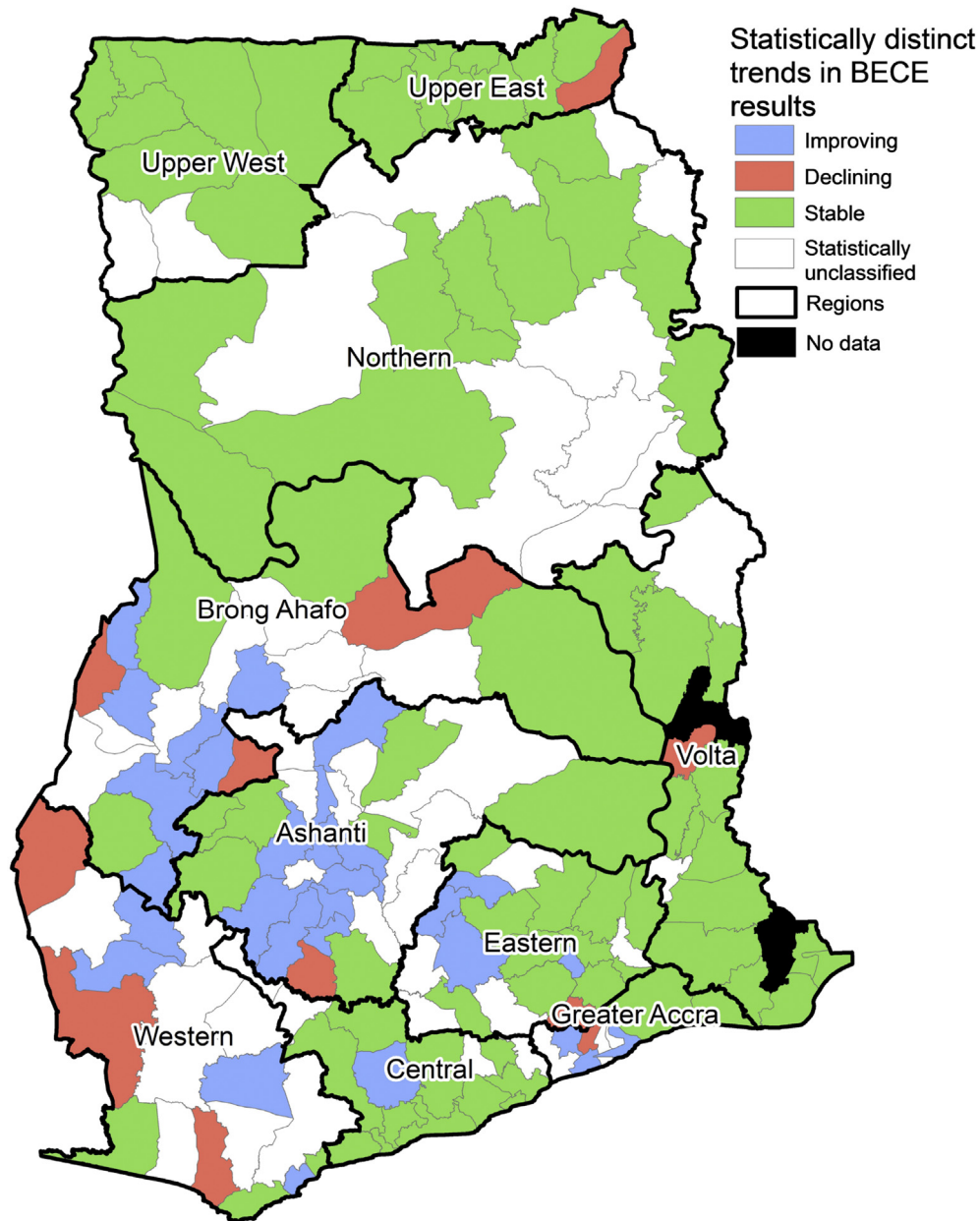


Fig. 4. Results of grouping analysis showing spatial variability in the growth trajectories in BECE results from 2009 to 2014.

The clear implication of our findings and those of other studies is that the Ghanaian government and other education stakeholders should worry about the trajectory of the country's academic performance. The results of our spatial grouping analysis demonstrate that of the 120 districts statistically classified into distinct groups, a significant majority (66%) experienced neither consistent improving nor declining BECE performance. Moreover, these districts consistently performed below the national average during the study period. In other words, this group, which dominates the districts in most of the regions in Ghana (Upper East = 90%, Upper West = 78%, Northern = 60%, Volta = 70%, Eastern = 56%, and Central = 79%), has not experienced meaningful, steady improvement in BECE performance since 2009. This finding confirms the widely held view that academic standards at the basic education level in Ghana remain low (Gyan et al., 2014). Moreover, this finding is alarming because the districts in the stable group represent nearly two-thirds of districts in Ghana and have a large number of the country's junior high school students. While internal migration

may be a predictive factor for the observed trends, emigration of students from low-performing districts may not possibly be a dominant reason why low-performing areas continue to do poorly because internal migration between rural and urban areas in Ghana is not highly skewed in one direction (Anarfi, Kwankye, Ababio, & Tiemoko, 2003; Castaldo, Deshingkar, & McKay, 2012). In fact, data from the fifth round of the Ghana Living Standards Survey (GLSS 5) show that majority of internal migrants move largely towards rural areas (Ghana Statistical Service, 2008). Certainly, this persistent poor performance at the BECE points to persistent weaknesses in Ghana's efforts to improve its basic education system.

In the face of such poor performance at the BECE, reassessment of the current education programs is warranted. The BECE itself may need to be evaluated on whether it is currently the optimal assessment tool for academic performance at the JHS level. A cross-country assessment between Ghana and other West African countries such as Gambia, Liberia, and Sierra Leone that use the equivalent of the BECE as an assessment tool would be useful to

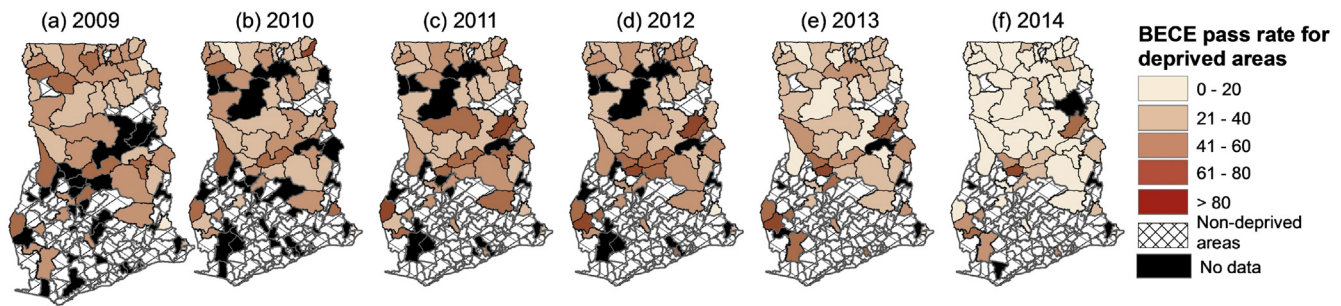


Fig. 5. Variability in percentage of candidates in deprived areas that earned a pass grade at the BECE from 2009 to 2014.

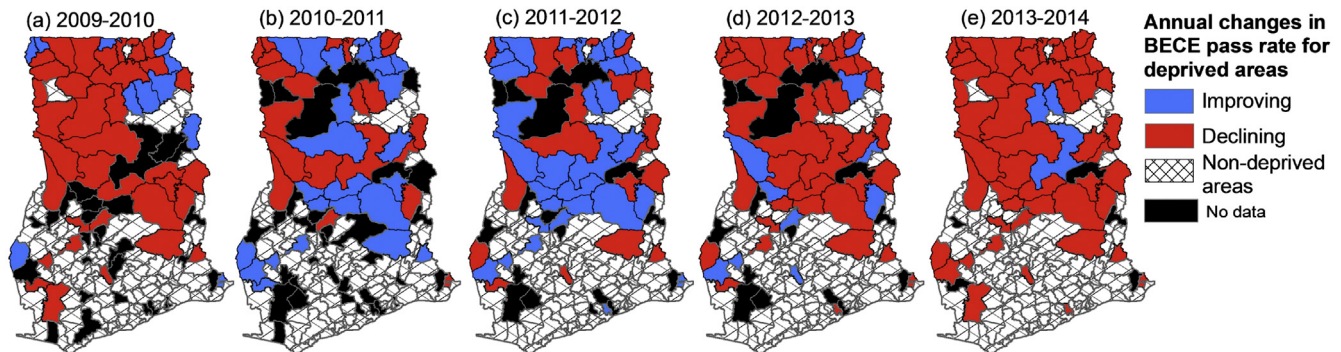


Fig. 6. Annual changes in BECE pass rates in deprived areas from 2009 to 2014.

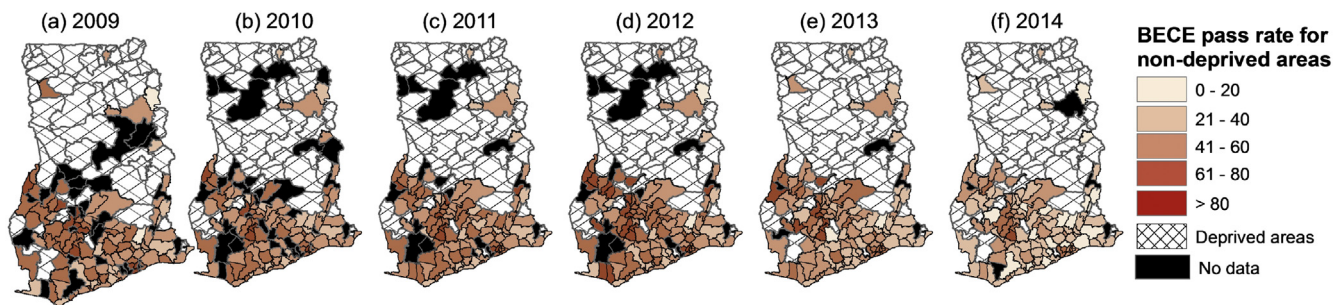


Fig. 7. Variability in percentage of candidates in non-deprived areas that earned a pass grade at the BECE from 2009 to 2014.

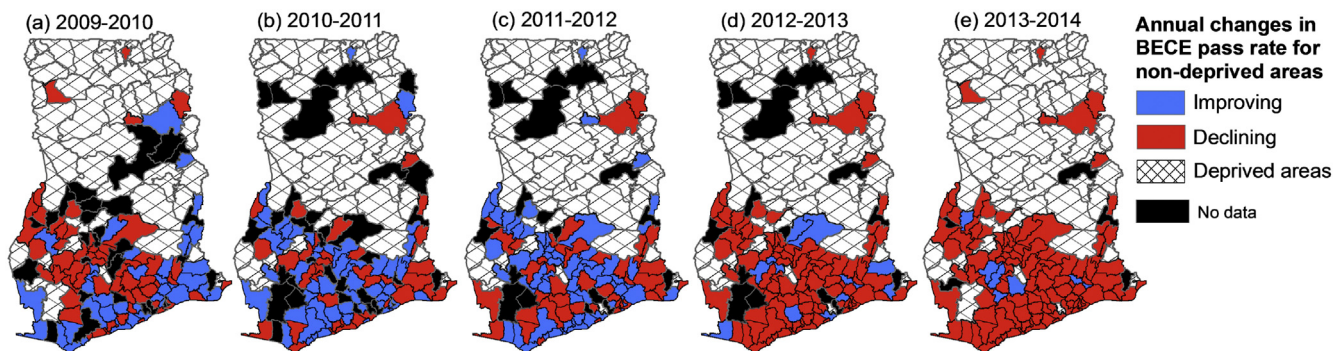


Fig. 8. Annual changes in BECE pass rates in non-deprived areas from 2009 to 2014.

determine whether the problem of low performance at the JHS level is largely peculiar to Ghana or is a problem with the assessment format. Education stakeholders and administrators of examinations in Anglophone countries of West Africa already recognize that external examination should not be the only measure of learning outcomes at the JHS level; thus, they reformed the BECE nearly a decade after its inception to take into account teachers' continuous assessment of students' in-class performance (Akyeampong,

1997). The ratio of the external exam to the continuous assessment, which started from 60:40, is now 70:30, and there are recommendations to change to a 50:50 ratio (Dery & Addy-Lamprey, 2010). There is similar ongoing debate in several African countries about the appropriate weighting system for the continuous assessment and external examination (Kapambwe, 2010; Kellaghan & Greaney, 2003; Pudaruth et al., 2013). It is important that the ensuing decisions to replace or augment the one-shot external ex-



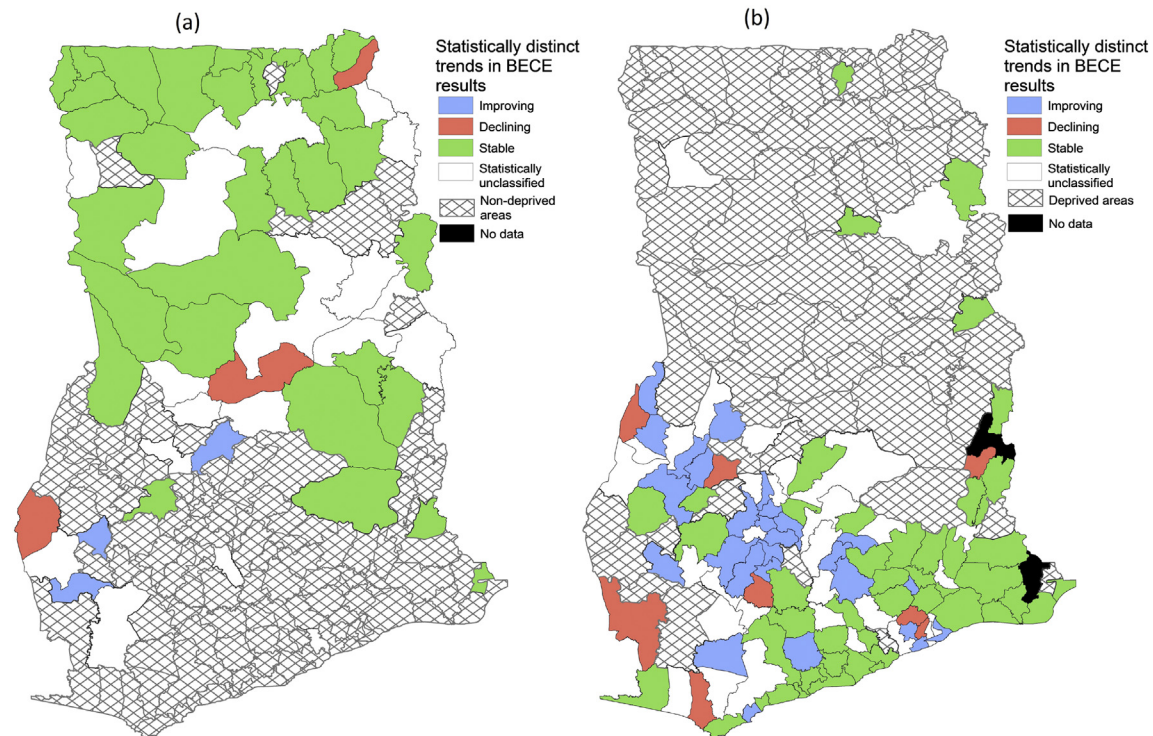


Fig. 9. Rural–urban spatial variability in the BECE results based on grouping analysis (a) Rural (b) Urban.

aminations with more classroom and school-based assessments do not overlook the fact that the inter-rural, inter-urban, and rural–urban disparities in teaching and infrastructural (i.e., classroom and school) conditions could have implications on performance at the BECE across different geographical areas.

Besides the need to reassess the BECE weighting format, additional government actions may be needed to address the problem of low performance at the BECE and the rural–urban differences. It is not as though government and stakeholders have completely ignored the problem in the past decade. In fact, government expenditure on basic education has tripled in the past decade, yet learning outcomes at the junior high school level have not improved (Darvas & Balwanz, 2014). Perhaps, the government’s education investment choices have targeted the access-challenges to the detriment of academic quality concerns. Notably, the introduction of major educational initiatives in Ghana such as the Free Compulsory Universal Basic Education (FCUBE) policy in 1996, the Capitation Grant Scheme in 2004, and the Ghana School Feeding Program in 2005, and free school uniforms in 2009 have had significant impact on universal access to basic education (CREATE, 2008). It is however, not clear the extent to which these programs have directly affected the lagging performance standards. It is essential that government, policy makers, and stakeholders focus adequate attention on performance standards, similar to the efforts directed at investments in access basic education.

Another key finding of this study is the varying space-time patterns of academic performance at the BECE in the 2009–2014 period. In contrast to the national trends, in-depth district-level analysis shows more nuanced variations in BECE results than the global trends suggest. Significant geographical variations exist in performance trends, which is likely due to spatial disparities in access to pedagogical resources and infrastructure (Ansong et al., 2015). For some districts, mostly in the central, eastern, Volta, northern, and upper regions of Ghana, the proportion of candidates passing the BECE remained relatively stable over the 6-year study period. Other districts, most of which are in the Ashanti (southern) region,

have consistently experienced annual increases. The Ashanti region houses Ghana’s second largest city and a network of urban centers (Otiso & Owusu, 2008), hence the region is well-endowed with education resources, such as a high proportion of trained teachers, which is critical for learning outcomes (Ministry of Education, 2013). In contrast, another group of districts mostly in the western (i.e., Nzema East, Aowin-Suaman, and Bia) and Brong Ahafo regions (i.e., Tano South, Pru, and Jaman South) experienced steady decline over the 6-year study period. The only glimmer of hope for the academic performance of these downward-trending districts is that they have not yet fallen below the national average. This optimistic assessment gives local authorities a window of opportunity to thoroughly explore localized, targeted interventions to reverse their decline in BECE performance.

We also found that some districts, the majority of which are in southern Ghana, did not fit any of the three distinct profiles. These districts are not in the blue, red, or green zones of Figs. 4 and 9, which means they have not consistently experienced declines, improvements, nor stability in their BECE performance. This finding does not mean that the statistically unclassified districts do not have academic performance challenges. Rather, those districts have unpredictable trajectories and this uncertainty can hamper effective educational planning. The fact that those districts do not have an upward trajectory (i.e., do not show consistent improvement) require attention because their BECE performance does not seem to be commensurate with increased education investment. Noticeably, most of the statistically unclassified districts in southern Ghana (i.e., 76% in Fig. 4) are adjacent to blue-shaded districts (i.e., districts with ideal growth trajectories). Because of data limitations, our study is not able to offer insights into the reasons for contrast between contiguous districts. It will be important for future studies to investigate the reasons for the sharp contrasts in BECE performance between contiguous districts.

In the normal scheme of things, variability in academic performance should not necessarily be a cause for concern. However, in Ghana’s case, stakeholders should be concerned given the conspic-

uous decline of some districts on the BECE. Moreover, even more worrisome is the long-range forecast for Ghana's academic performance. Specifically, the multilevel growth curve modeling used in this study revealed higher-order polynomial trends (i.e., quadratic and cubic slopes) that suggest the low-performing districts, particularly the red-shaded districts, are unlikely to improve their performance at the BECE in the near future. In other words, without more effective targeted programs and interventions, the worse-performing school districts will continue to get worse, further widening the educational inequality gap, which has a huge impact on individual welfare. Government, policy makers, and stakeholders cannot afford to ignore this potential for further decline in performance at the BECE.

The potential for further decline can be reversed if serious localized measures are undertaken to improve performance standards in the low-performing districts. Evidence from a growing body of empirical studies and program reports from Ghana and other African countries suggest that decentralized measures that devolves power to schools and school districts fosters community and parental involve which are associated with improved academic outcomes (Dowd, 2001; Hyde, Kadzamira, Sichinga, Chibwana, & Ridker, 1997; Odonkor, 2000). Results from our study suggest that poor academic performance at the BECE is most likely a local issue because multiple trajectories exist within each region or even within the rural clusters shown in Fig. 6. The localized nature of the academic performance problem is precisely the reason why southwestern Ghana not only has the highest number of districts with positive trends (blue-shaded districts) but also has a disproportionately large share of poor-performing districts (red-shaded districts). There are promising districts within rural clusters, as shown in Fig. 6, because some rural districts have experienced improvements in BECE pass rates from time-to-time. It will be important for future studies to examine and glean lessons from the unique characteristics and success stories of districts such as Kintampo South and Kassena Nankana West that are deprived areas that have managed to experience a steady upward trajectory in the proportion of candidates passing the BECE.

Another finding of this study is that the noticeable spatio-temporal patterns in academic performance at the BECE generally follow the lines of rural/urban divide, which is in line with findings from a similar study in Kenya (Kimosop et al., 2015) and Uganda (Kasirye, 2009). Results of our multilevel growth curve modeling revealed that rural districts experienced disproportionate BECE performance declines whereas urban districts largely experienced increased fortunes. As shown in Fig. 2, whereas the rural–urban gap narrowed marginally after 2009, a substantial gap still remains partly due to the well documented rural–urban gap in socioeconomic development and educational resources (e.g., textbooks, trained teachers, physical infrastructure, and school supervision) that is in favor of urban areas (see Otiso & Owusu, 2008; Poku-Boansi & Amoako, 2014). Worryingly, forecasts from our higher-order polynomial trends suggest that if nothing is done, the rural–urban BECE achievement gap will continue to widen in the future. Therefore, the critical question is whether stakeholders can intervene in ways that will enable rural areas to narrow the gap with urban districts. Although daunting, such improvement in rural academic performance is possible given the right intervention.

The practical way forward should perhaps begin with the admission that a blanket global view of academic standards in Ghana masks the needs of certain areas that require additional localized interventions beyond the general efforts of government. This observation has important implications for the approaches that policy makers could use to address local challenges in BECE performance. Spatially targeted approaches to addressing the education challenges in Ghana are needed. Evidence suggests that interventions that target specific marginalized communities produce bet-

ter outcomes. One such intervention is the Education for Empowerment program, which is a partnership between IBIS, a Danish Non-governmental organization, and the Ghana Education Services (GES). The program, which seeks to bridge the educational inequality gap between rural and urban Ghana has yielded positive educational outcomes (Darvas & Balwanz, 2014). Other spatially-oriented interventions that have the potential to improve educational outcomes in deprived communities include the GES's supplemental funding to basics schools in deprived districts; the government's cash transfer program to support poor households' health and educational expenditure; and incentives such as salary increments for teachers in deprived districts (Darvas & Balwanz, 2014; Ministry of Education, 2012).

### 6.1. Limitations and strengths

Two data-related limitations of this study are worth mentioning. First, data on newly created districts were not available, and therefore, the present study could not examine the academic performance of these districts. Moreover, this study modeled only six waves of BECE academic performance data, starting from 2009. Expanding the data to include BECE pass rates prior to 2009 might offer further insights into the long-term trends in academic performance. However, earlier waves of data were not available at the time the present study was conducted. Despite these limitations, this study has the potential to advance the existing body of work on academic performance in Ghana in two important ways. First, the ability to model six waves of BECE data is an important improvement over the prior use of cross-sectional data to inform discussions about academic performance trends. Second, the analytical approach of combining growth curve modeling with spatial statistics is a superior approach that offers rich insights into the spatial and temporal dimension of academic performance.

## 7. Conclusion

Ghana has outpaced most developing countries in education investments and expenditure, and has made huge gains in access to education, but quality concerns remain. While the results of the present study validate the concerns of some stakeholders that academic standards are generally low, the trajectory of academic performance shown herein is more nuanced, with some districts declining, improving, or remaining stable. An important lesson from this study is that there are diverse geographical trajectories, and therefore, a localized approach to addressing the academic performance challenges at the junior high school level in Ghana is the prudent approach. As discussed earlier, the patterns of change in the percentage of candidates passing the BECE from 2009 to 2014 differs not only between the rural and urban districts but also within rural districts. This study cautions that barring any targeted intervention, rural–urban gap in performance at the BECE could widen. Government, researchers, education stakeholder and the media should also discuss the problem from a spatial perspective because some districts need additional attention and support to reverse their downward trend at the BECE. If social inequality in Ghana is to be addressed, then spatial disparities in the quality of education must be addressed in order to offer all young citizens better and equitable educational opportunities. Such a situation would ultimately go a long way in enhancing the well-being and quality of life of the citizenry as well as ensuring sustainable livelihoods.

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