

Further Analyses

1.0 Progress on Spatial Analysis

1.1 The coordinates for 200 of the 216 health districts have been obtained from www.latlong.net and a request has been sent to the geography and Geomatic Eng Departments at KNUST for the missing coordinates, most of which were in the eastern region.

A plot of the coordinates using GeoDa (version 1.8.16.4 open source) show that the coordinates lie within the boundary of Ghana as shown in figure1 .

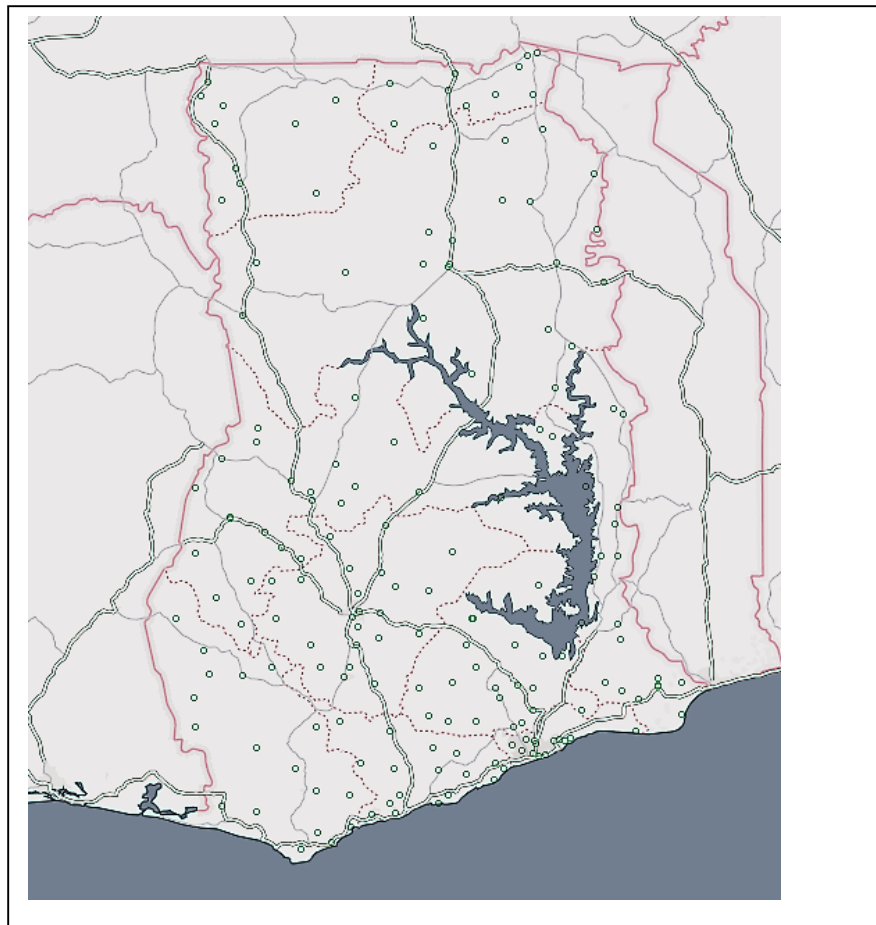


Fig 1 Health districts coordinates map

1.2 The shape files of the 110 geopolitical districts of Ghana (into which the 216 health districts are nested) have been acquired and the map is displayed as Figure 2 below. Regional shape files are yet to be acquired.

The next stage is to determine the intensity thresholds for Maternal Mortality Ratio and Neonatal Mortality Rates using WHO accepted rates and produce the respective intensity maps to identify hot spots.

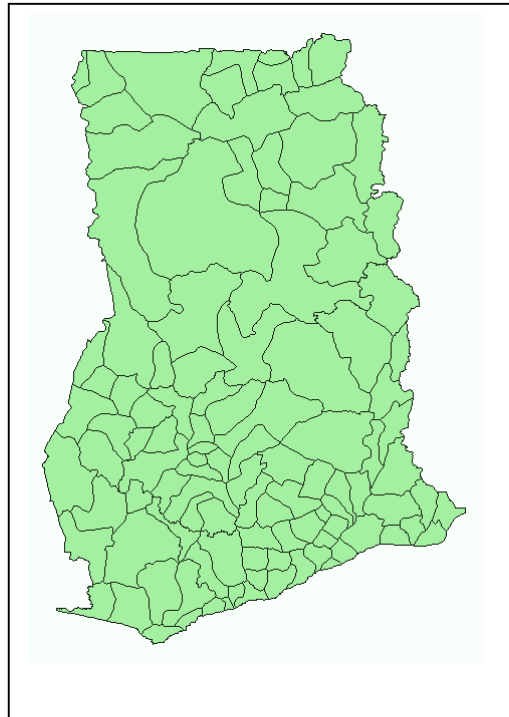


Fig 2 Geopolitical Districts of Ghana

1.3 The tests for global spatial autocorrelation was carried out using Moran's Indicator which is a test that the events are randomly occurring in a homogenous pattern across space against an alternative that the occurrence is not random. The result The Local Indicator Spatial Autocorrelation map was used to identify the location of the clusters and their significance. The KNN was used for the weights with $K=3$. Other weight matrices will be considered after the time series analysis is complete because this will provide specific information on the type of dependencies in the outcomes. The Moran's I value (Figure 3) show that the districts with high values of MMRatio are dispersed from districts with low values. The LISA maps show that 23 clusters exist and indicate their locations and significance.

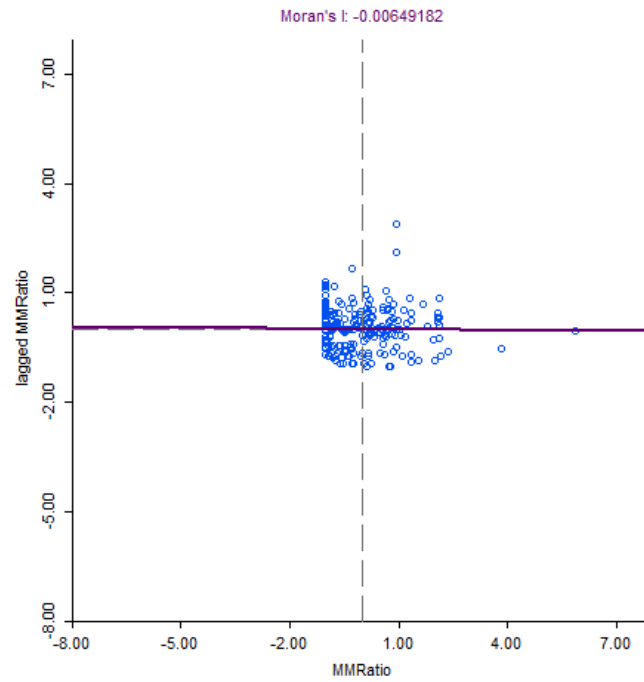


Fig 3 Moran's I for MMRatio

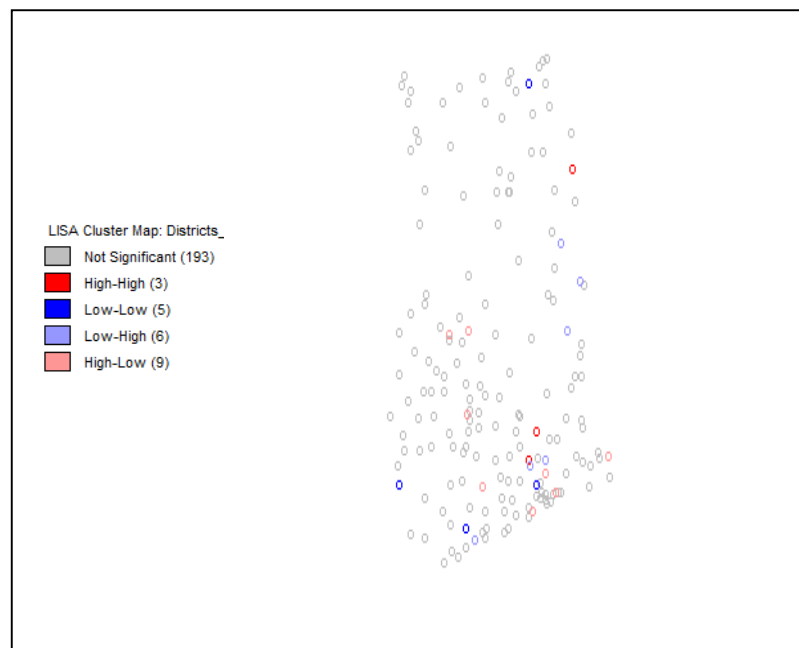


Fig 4 LISA Cluster Map for MMRatio

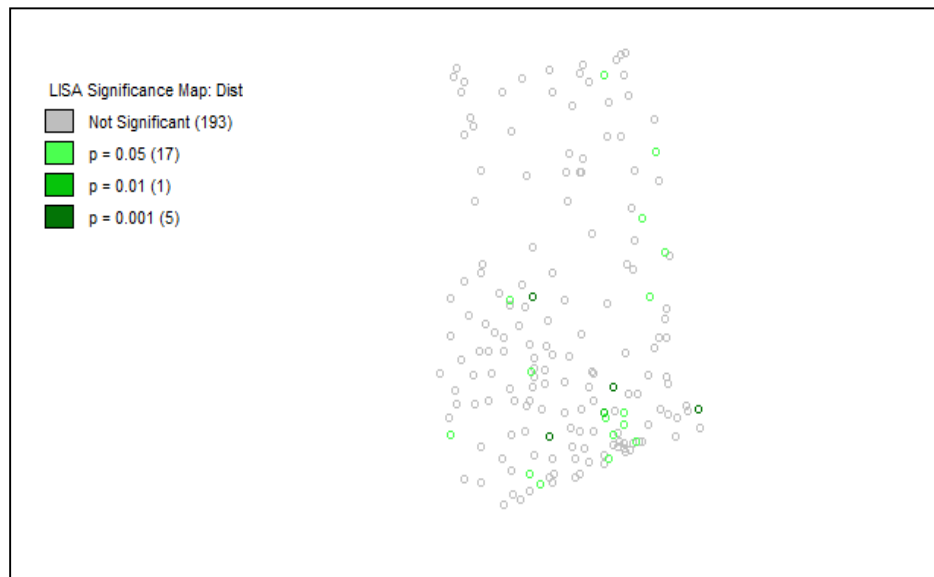


Fig 5 LISA Significance Map for MMRatio

The preliminary GetisOrd Maps for the identification of hotspots of high MMRatio is presented as Figures 6. These plots presented are all preliminary because the thresholds were determined using the quartiles in the data and not the WHO accepted threshold but they serve to indicate districts that are above the median threshold for national MMRatio.

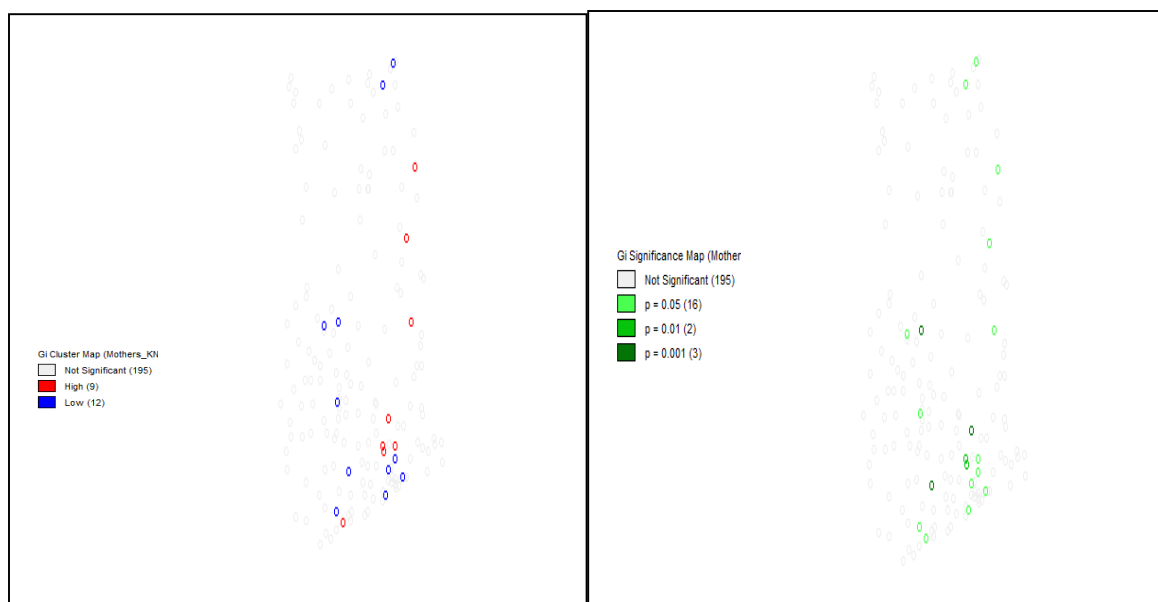


Fig 6 Gi Maps for High MMRatio

The Gi maps indicate 9 hotspots and 12 cold areas. These will be further investigated for possible resource challenges and best practices respectively. Also, these locations will be compared to those obtained from the NMRate for possible co-incidence. The Moran's I plot and LISA maps for NMRate are presented in the next set of figures 7 to 9.

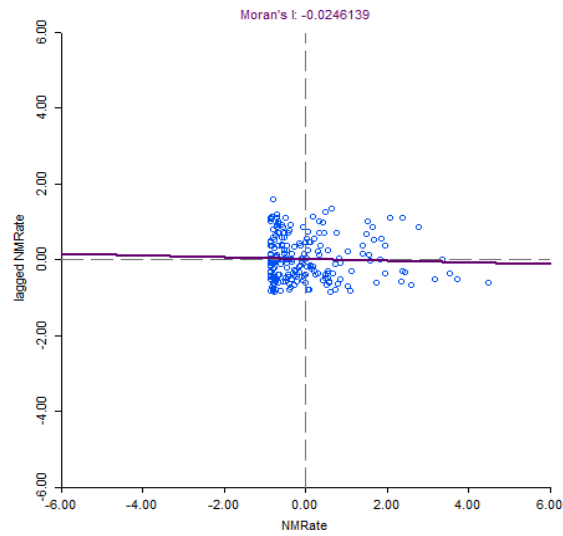


Fig 7 Moran's I for NMRate

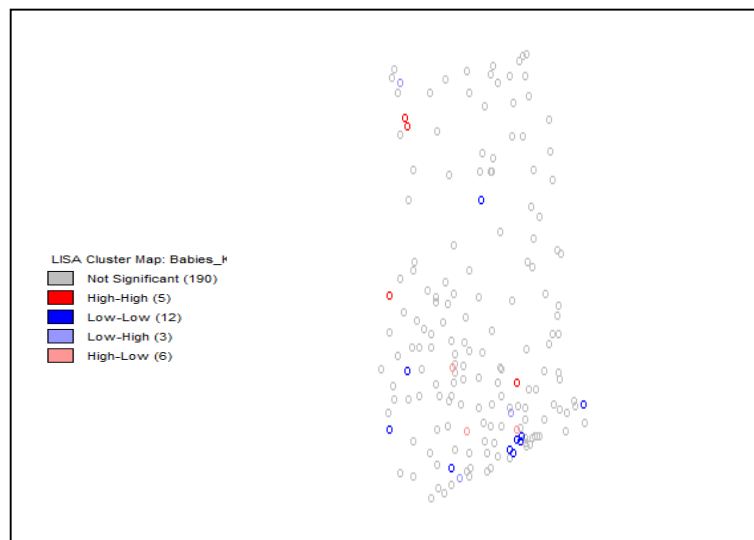


Fig 8 LISA Cluster Map for NMRate

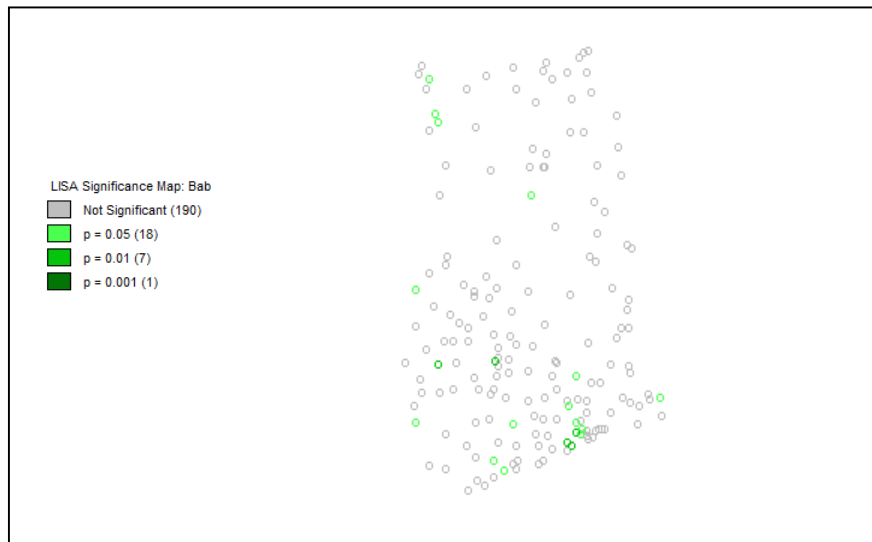


Fig9 LISA Significance Map

The Moran's I is also negative and significant and the LISA maps show 26 significant clusters. The Gi Maps identify 7 hot spots and 14 cold regions for NMRate.

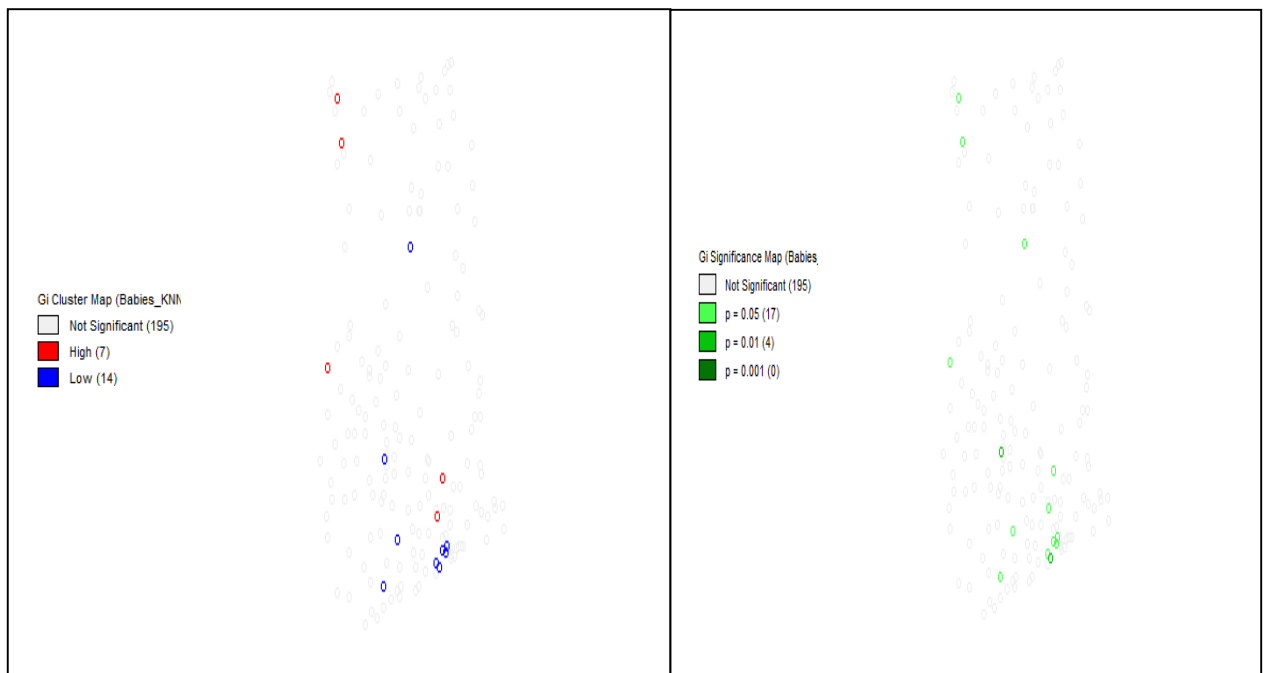


Fig 10 Gi Maps for High MMRatio

1.4 The cartograms of MMRatio is presented in the following figure with the sizes of the bubbles determined by the total number of cases. The same is done for NMRate with the bubble size determined by the total number of livebirths. The bubbles in the cartogram retain their relative positions in the original spatial map but with some degree of clustering.

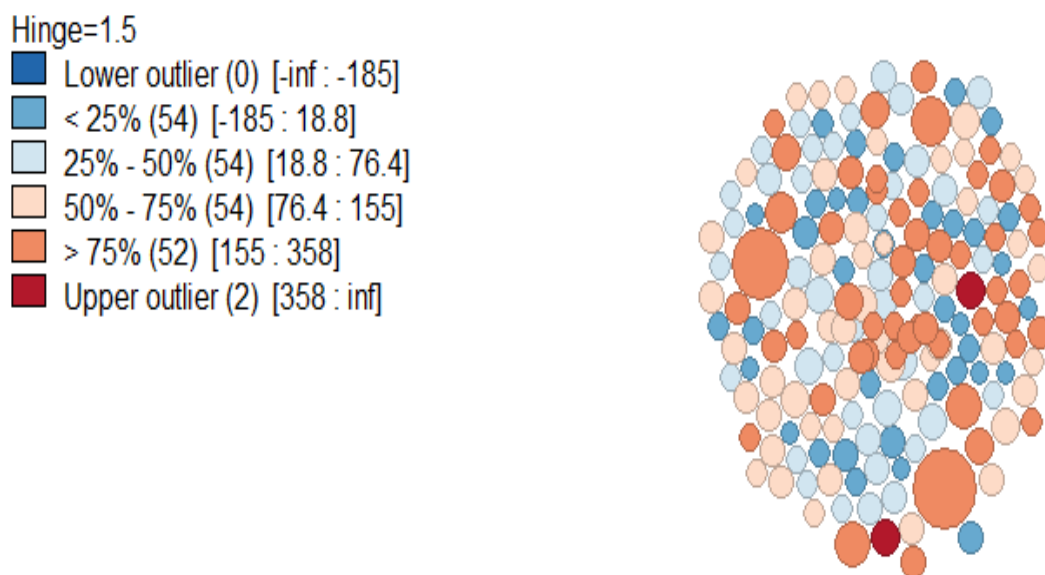


Fig11 Cartogram of MMRatio

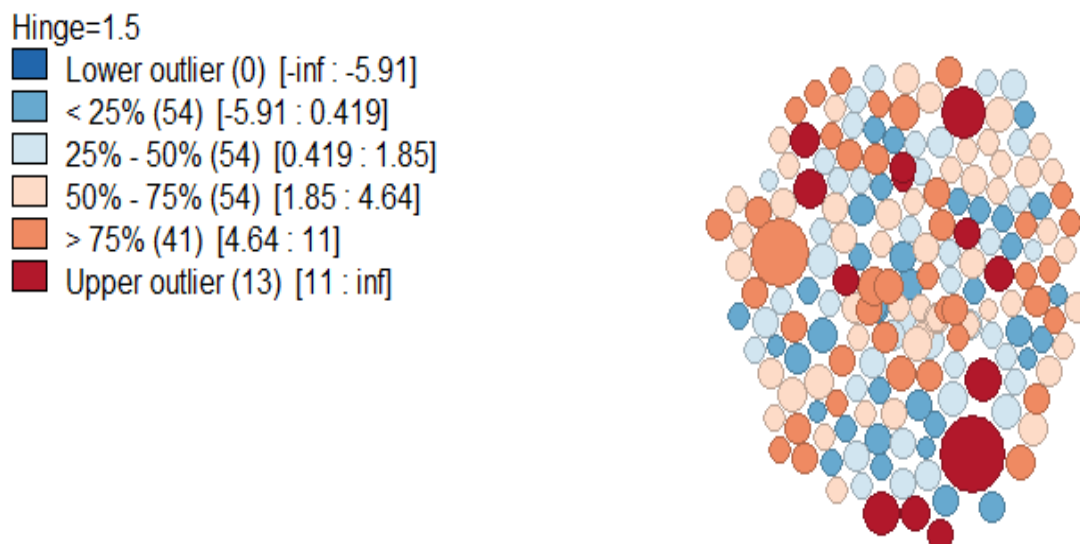


Fig12 Cartogram of NMRate

2 Coincident/Stress plots.

The conditional plot for all delivery cases (mothersall) versus the number shows the change in number of maternal deaths relative to the total number of deliveries. The top right is the worst scenario with very high intensity of maternal mortalities. A similar plot was obtained for neonatal deaths as a function of all livebirths.

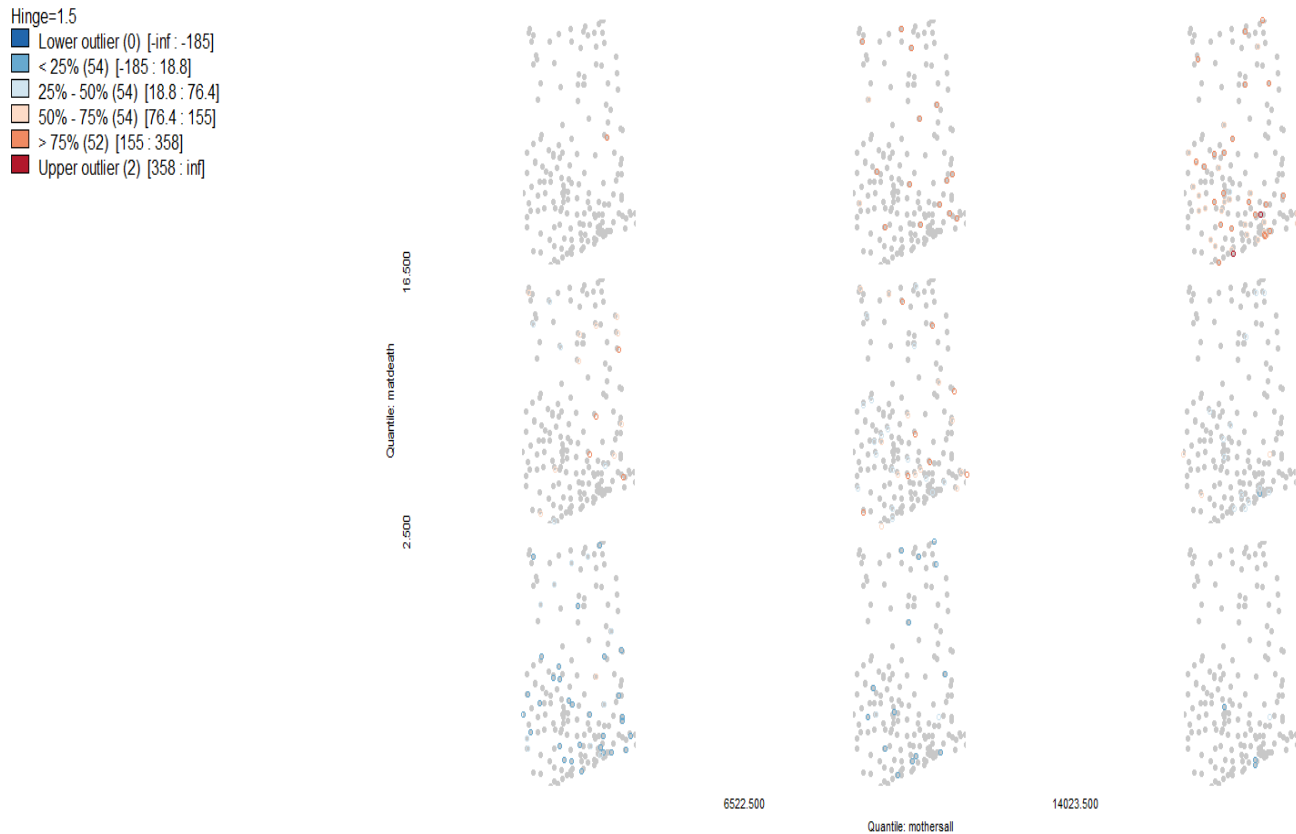


Fig 13 Conditional plot of Mothersall and maternal death

The conditional plot show a rapid increase in maternal mortality figures when there is an upsurge in the number of deliveries as can be observed from the middle and top row. There are only a few districts (bottom right) that do not become stressed when there is an upsurge in cases.

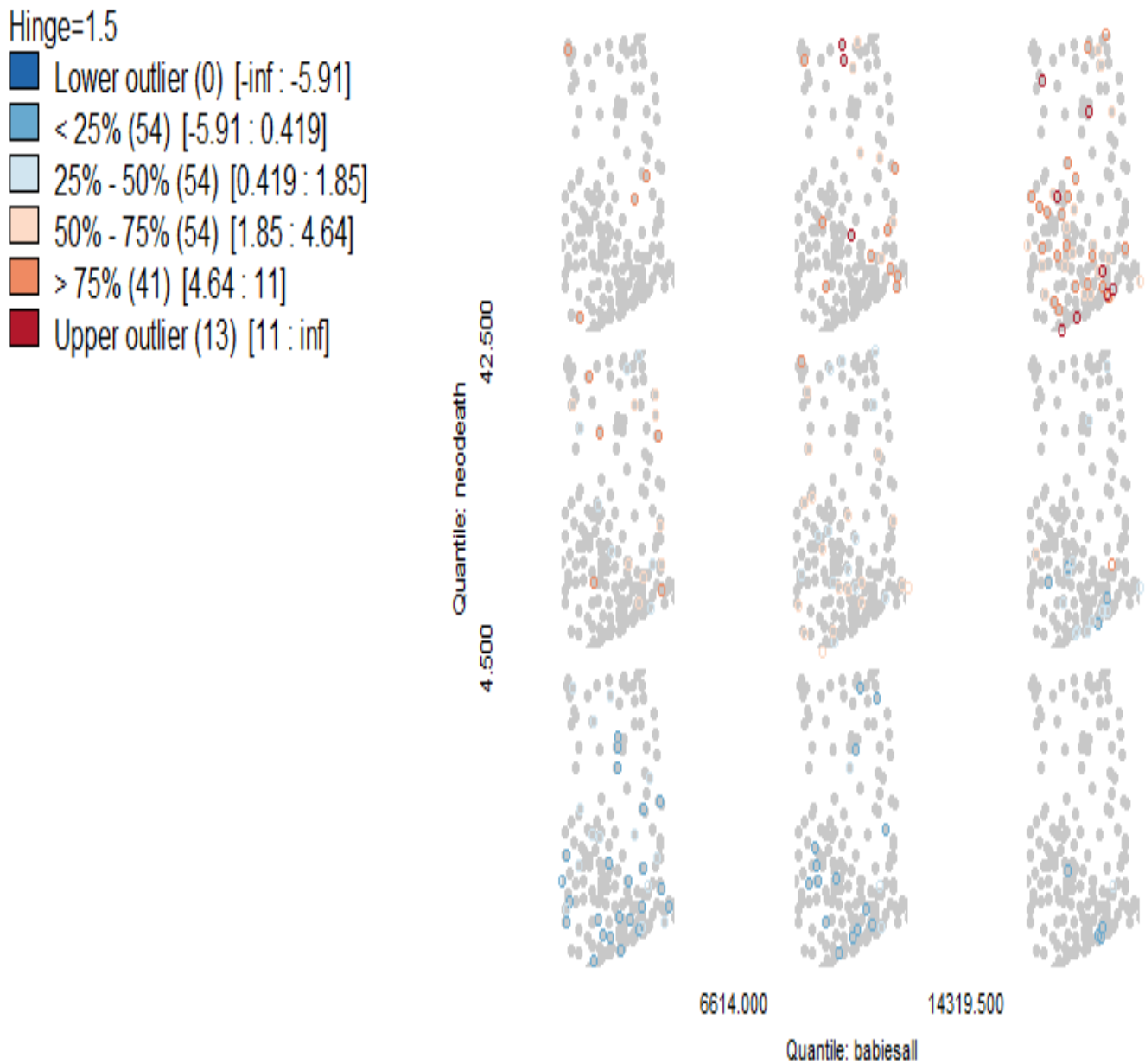


Fig14 Conditional plot of babiesall and neonatal death

The conditional plot for neonatal mortality show more districts becoming stressed with an increase in number of deliveries. The spatial distribution of districts experiencing high NMRates with increase in number of deliveries (top row of figure 14) is more extensive than was observed in the conditional plots for maternal mortalities.

The scatter plots of mothersall and matdeath showed a strong clustering. Maternal death was modelled using mothersall as a predictor for an OLS model, this gave a high R^2 value of 0.89 with the slope having a p-value $< .0001$. The Lowess was also fitted to the data and gave the same coefficients as the OLS although the plot appeared more flexible. The plot and coefficients are displayed in figure 14 below. The plot and coefficients for neonatal death being explained by all livebirths is presented in figure 15.

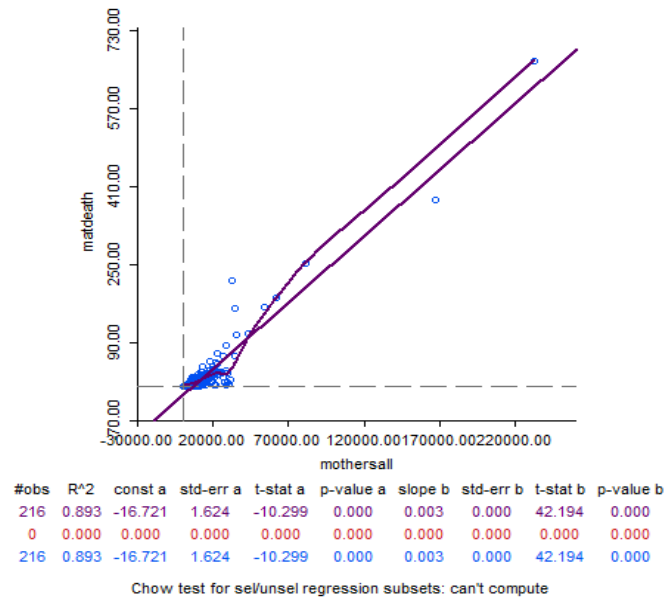


Fig 14 OLS and LOWESS for maternal death

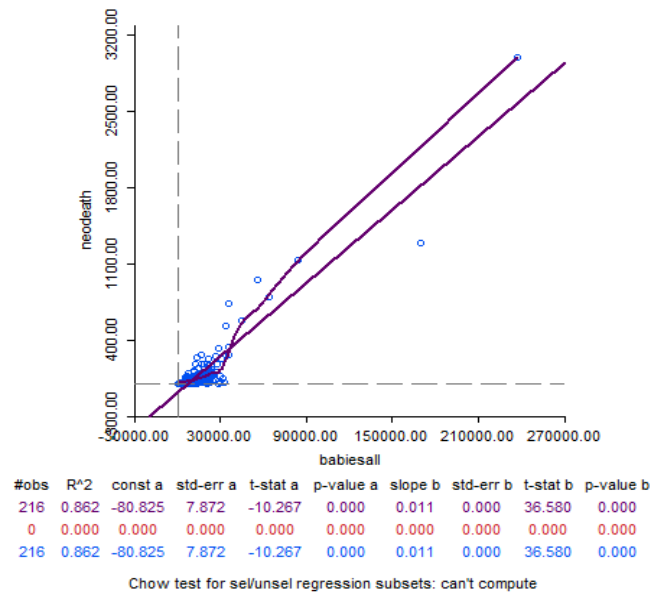


Fig 15 OLS and LOWESS for neonatal death

The change in mortality rates will be further explored with regions to identify regional differences in the patterns.

3.0 Time series analysis

3.1 Given below are the time plots for maternal and neonatal probabilities of survival over the study period by regions. While some appear to be stationary, others appear quite noisy.

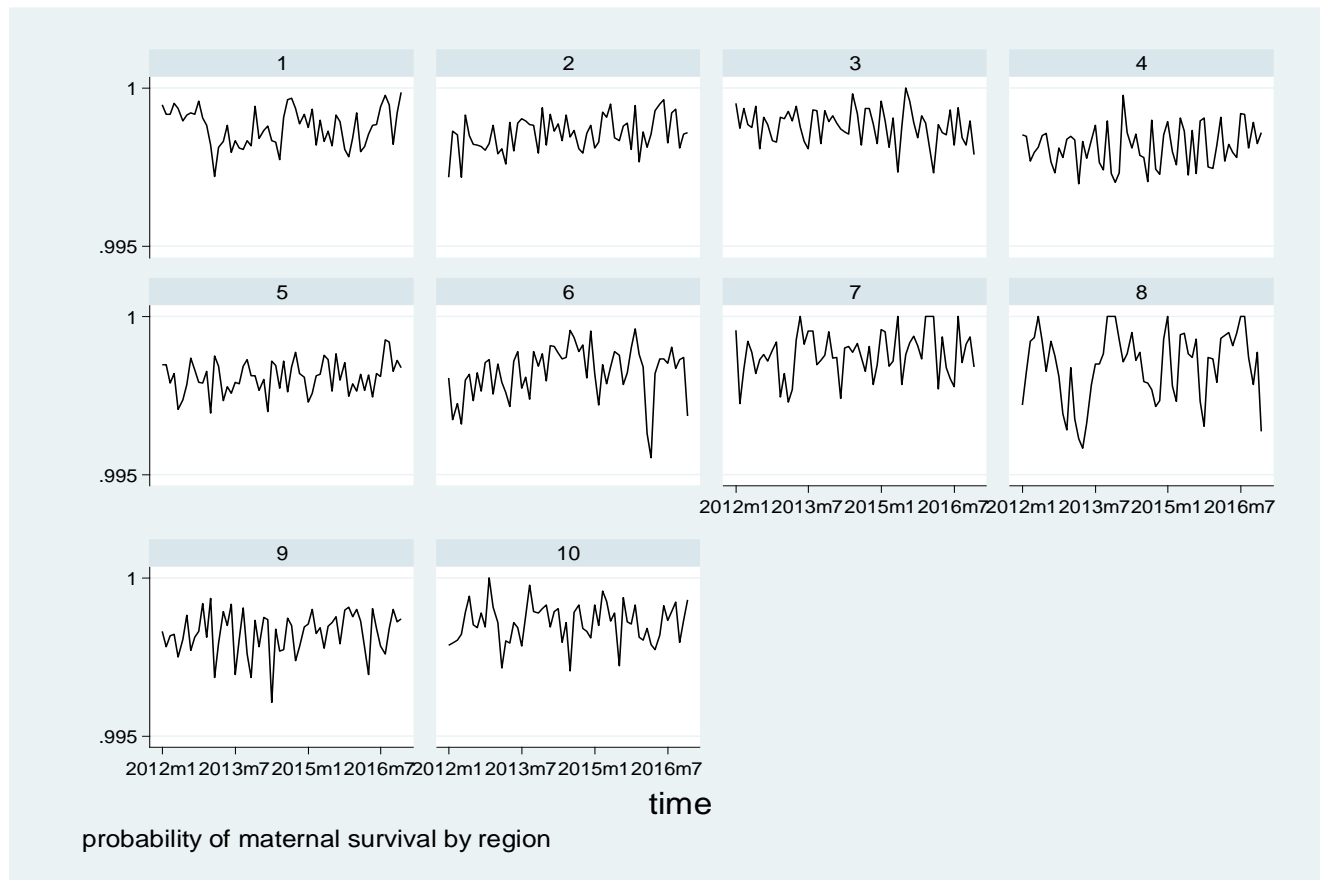


Fig 16 Time plots for maternal survival probabilities

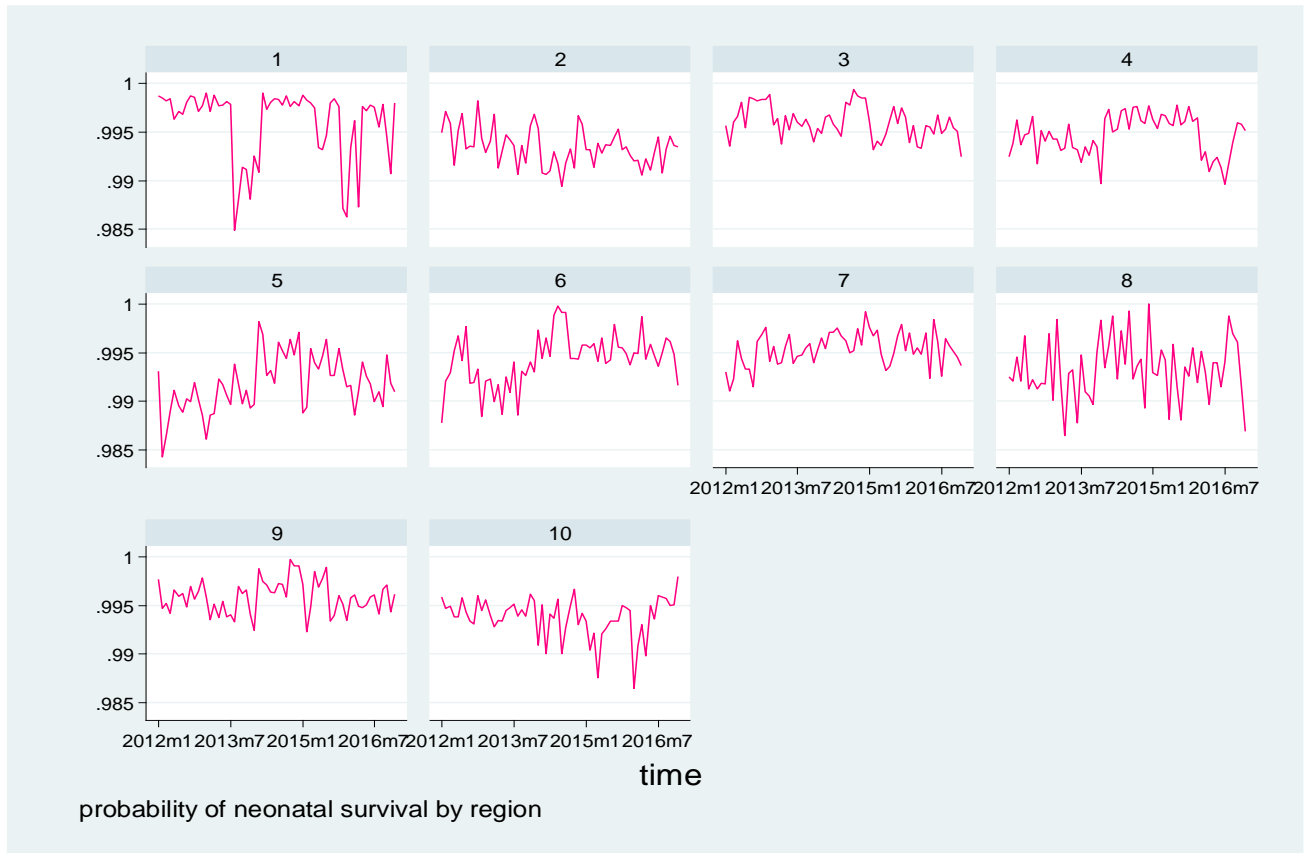
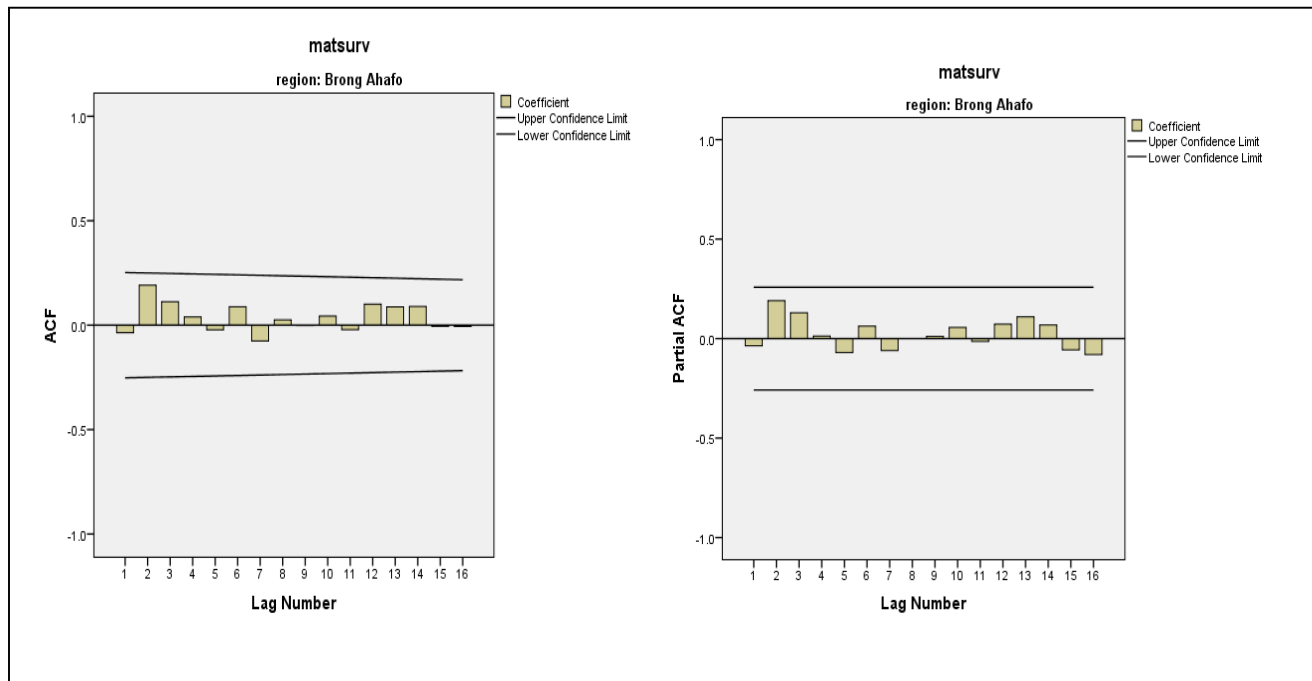
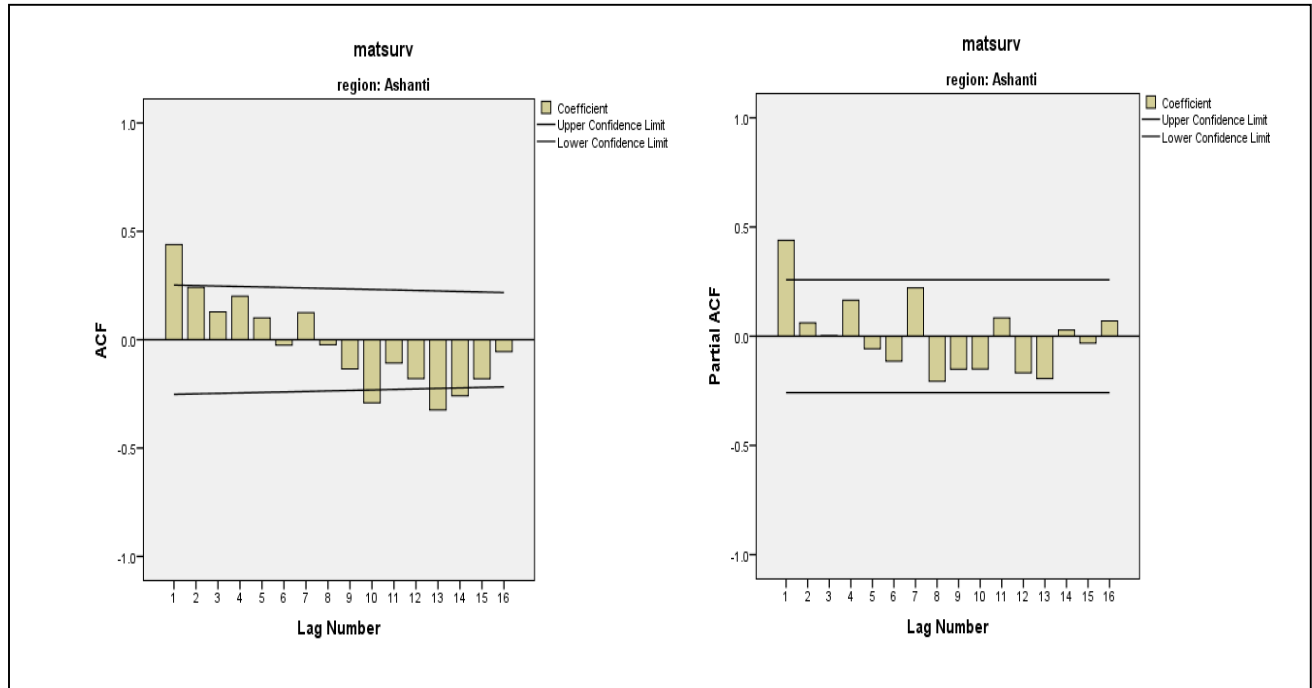
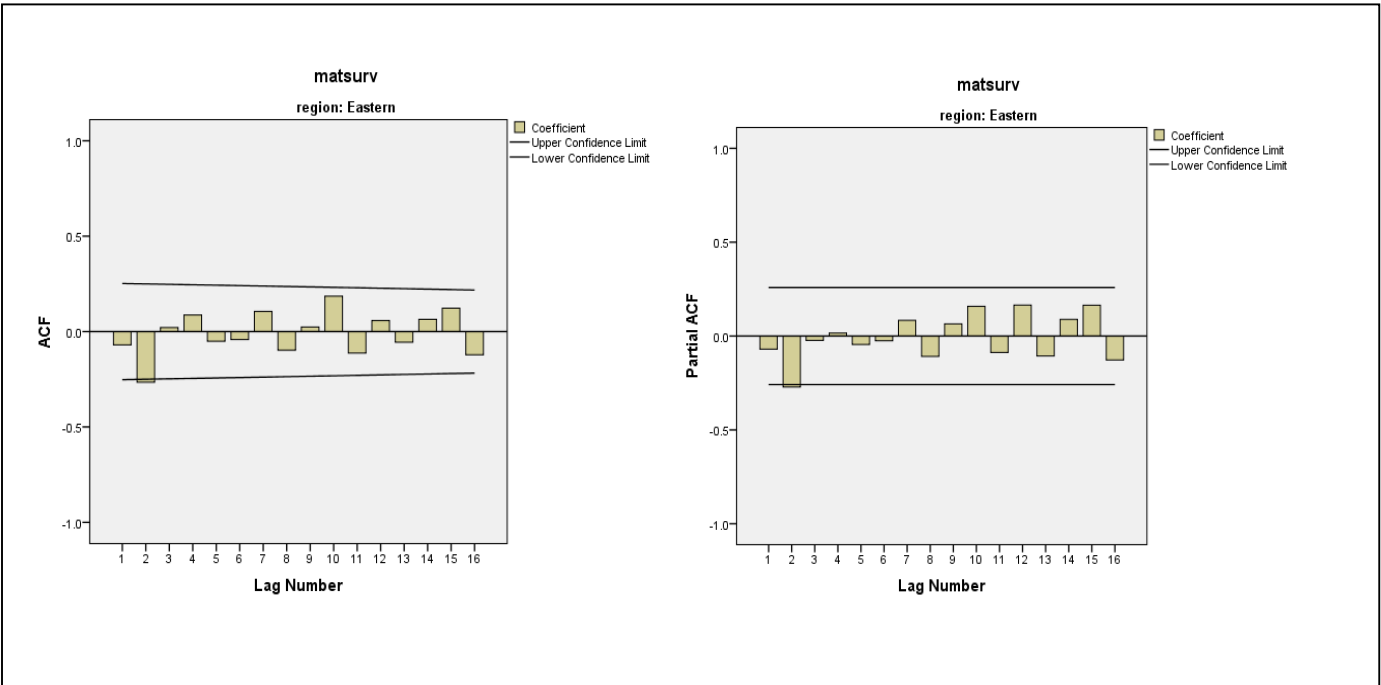
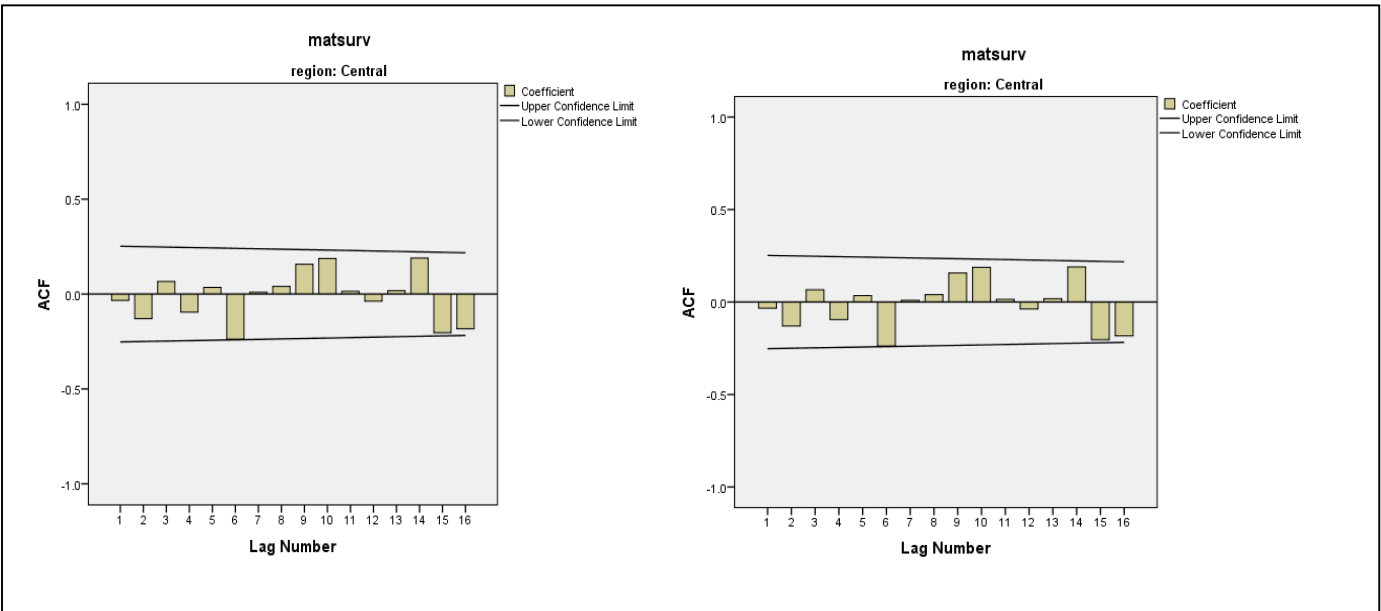
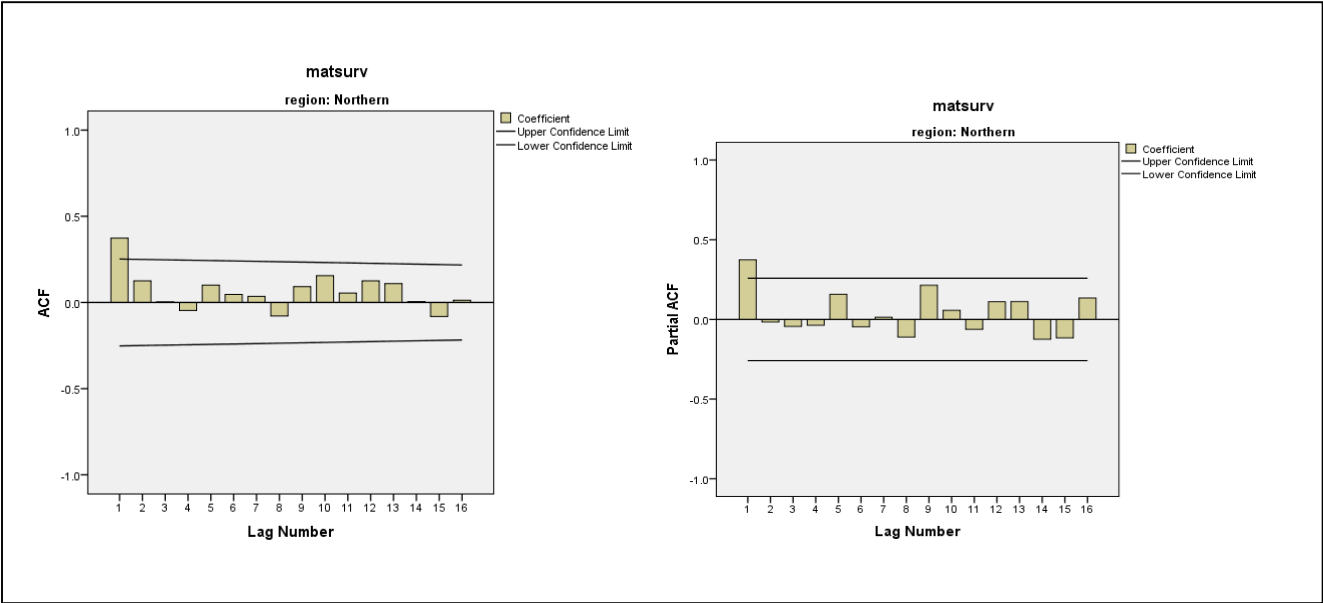
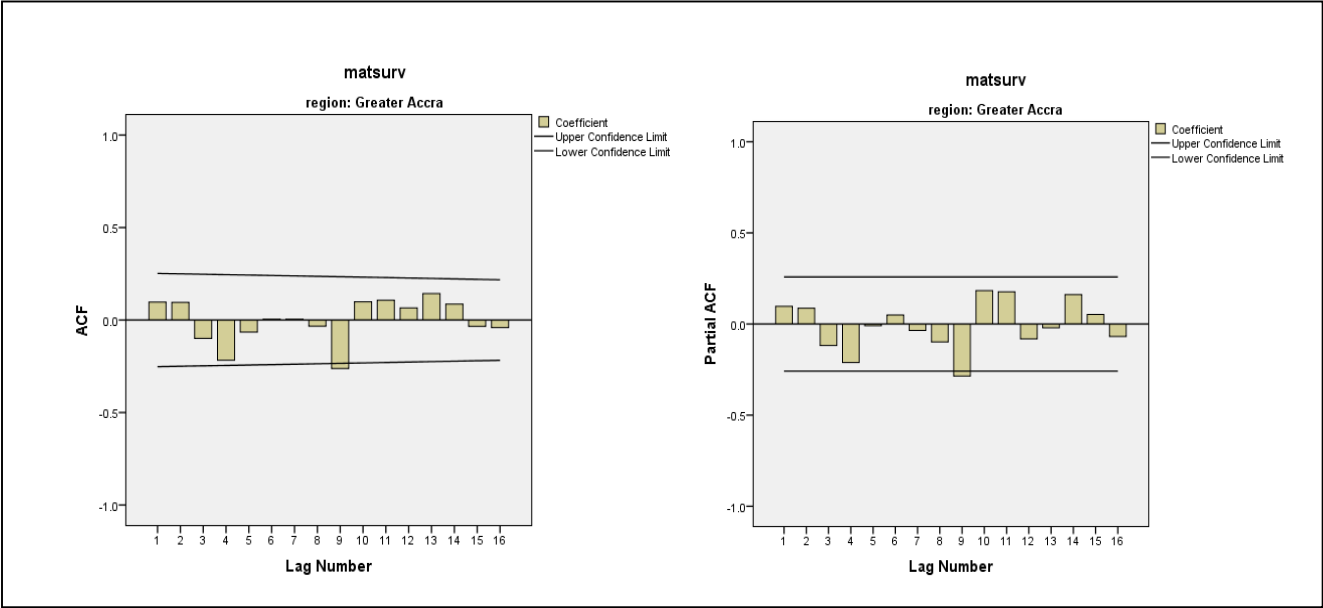


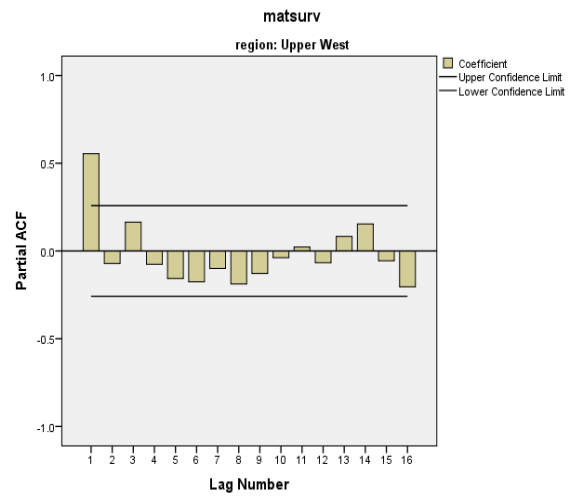
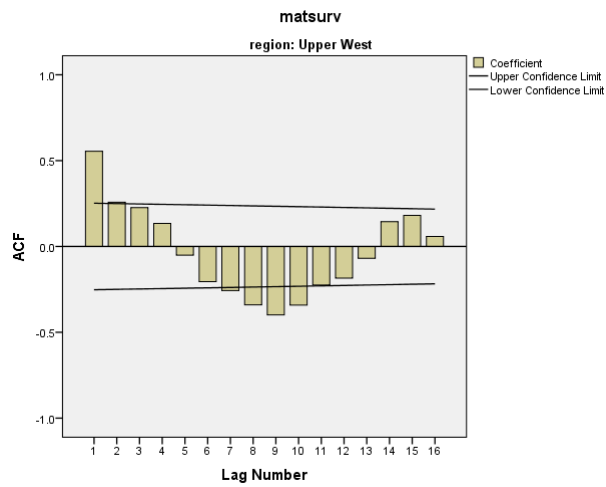
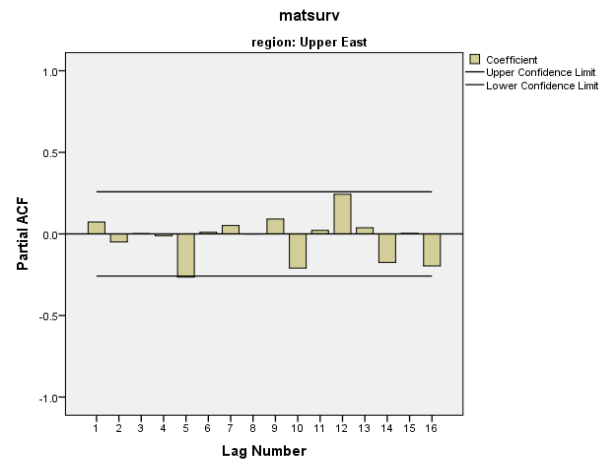
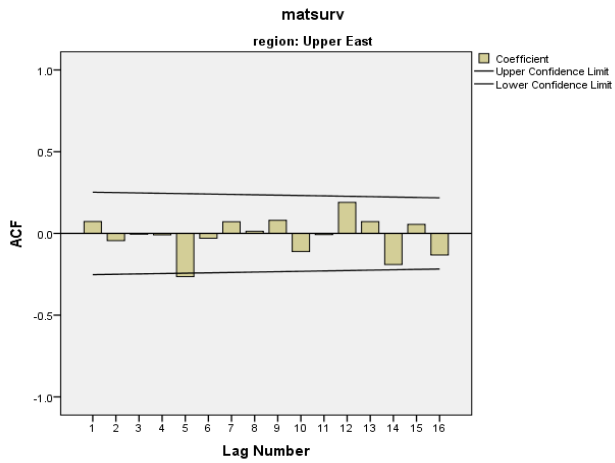
Fig 17 Time plots for neonatal survival probabilities

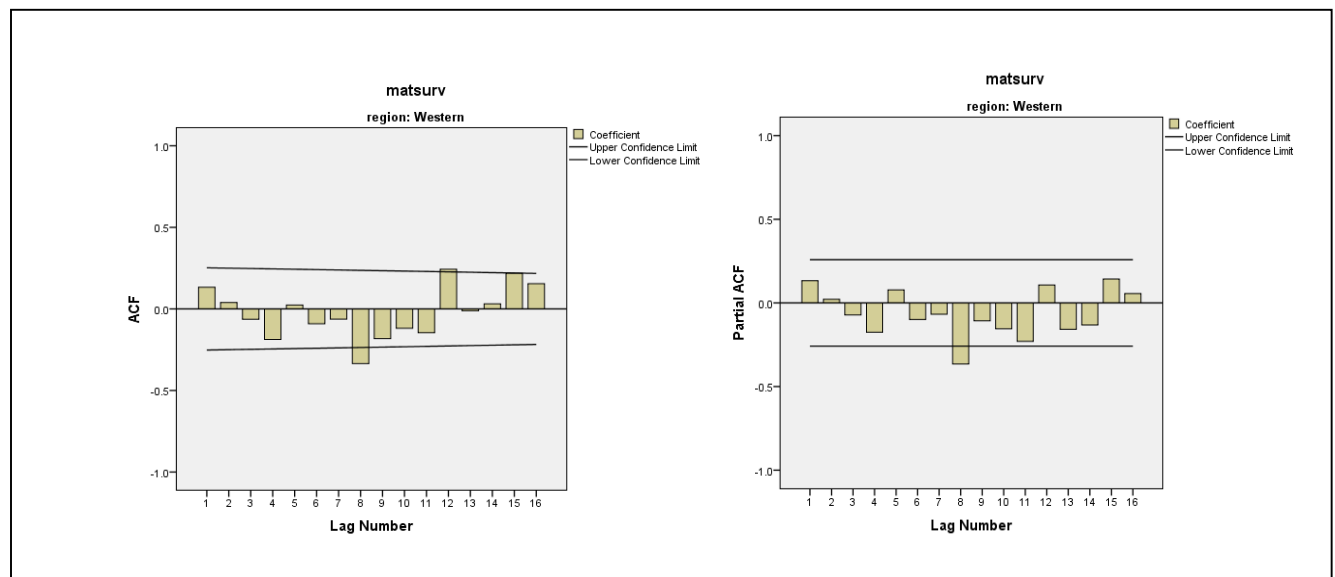
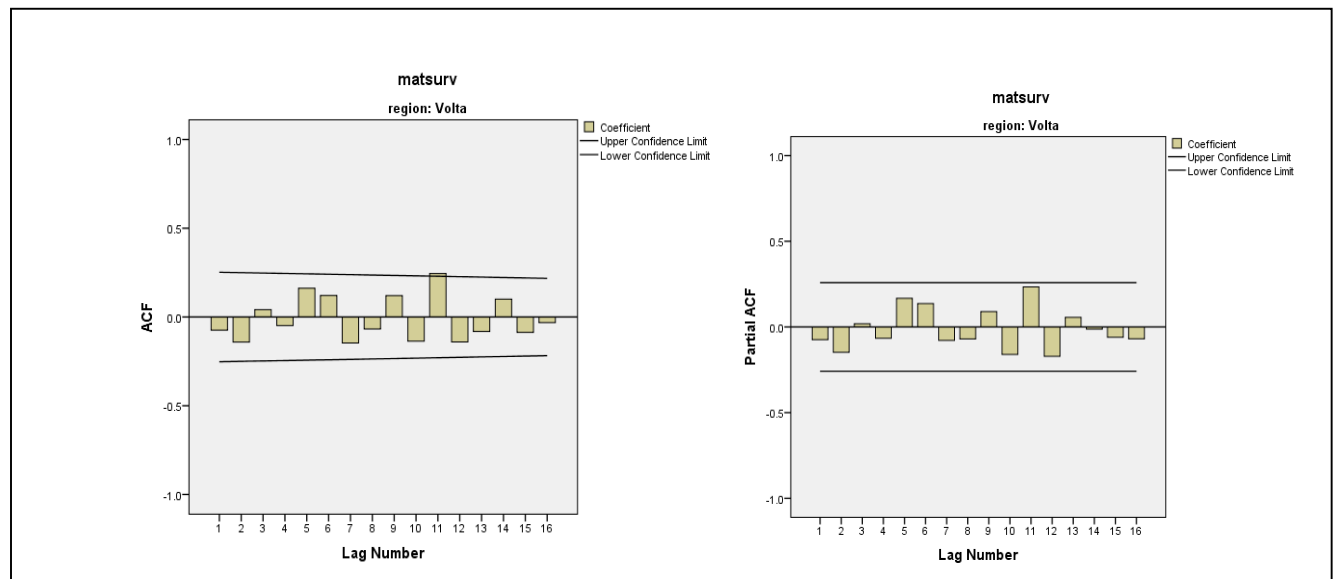
3.2 The Autocorrelation and Partial Autocorrelations analyses were done by region for both maternal and neonatal survival. These are presented in the following figures.











The ACFs and PACFs show differences in lags across regions. This is an indication that the temporal dynamics for maternal survival are heterogeneous across regions.