# AN ANALYSIS OF MEASURES OF
# SPATIAL AUTOCORRELATION

By

GARY DAN HATFIELD

Bachelor of Science in Mathematics
Oklahoma State University
Stillwater, Oklahoma
1976

Master of Science in Statistics
Oklahoma State University
Stillwater, Oklahoma
1978

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SPATIAL AUTOCORRELATION

Dissertation Approved:

Dr. Carla L. Goad

Dissertation Adviser

Dr. Jonathan C. Comer

Dr. Mark E. Payton

Dr. Joshua D. Habiger

Dr. Sheryl A. Tucker

Dean of the Graduate College

TABLE OF CONTENTS

Chapter Page

Chapter Page

Chapter Page

Chapter Page

Chapter Page

Chapter Page

LIST OF TABLES

Table Page

Table Page

LIST OF FIGURES

Figure Page

Figure Page

# CHAPTER 1

## INTRODUCTION

Many disciplines are interested in relationships among geographically referenced data dispersed in a two-dimensional plane or three-dimensional space. These include geography, economics, biology, ecology, sociology, and epidemiology. It is well accepted in these disciplines that there are both macro and micro relationships involving spatial relationships. For example, geographers have long recognized the influence neighboring communities have on each other and often reference Tobler's First Law of Geography (1970) that "everything is related to everything else, but near things are more related than distant things."

Consider the following questions posed by researchers in various disciplines:

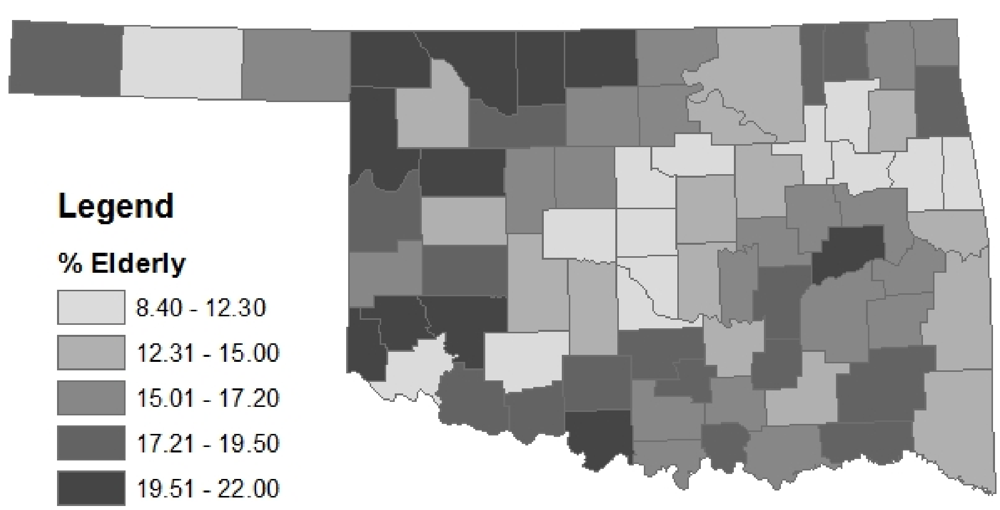
- Geography: A geographer is studying the percent of elderly residents in each county of Oklahoma. Do counties associated with metropolitan areas have a lower percentage of elderly residents than rural counties?
- Economics: An economist is interested in quantifying the pattern of the distribution of land prices in a city for residential, commercial and industrial use. Does one type exhibit more spatial autocorrelation than the other types?
- Biology: A biologist is interested in studying the spatial density of seals on pack ice in the Antarctic. Is there competition for resources that causes some seals

to drive others away.

- Ecology: An ecologist is analyzing bird count data for neighboring observation areas. Does a species tend to favor certain areas over others?
- Sociology: A sociologist is interested in examining electoral support for Democrats in a particular state. Do counties that support Democrats tend to be close to one another?
- Epidemiology: An epidemiologist is interested in studying the incidence of a disease in regions of a country. Do some regions have a higher incidence? If a region has a higher incidence, does this affect neighboring regions?

Measures of spatial autocorrelation can be used to answer all of these research questions. For example, the geographer studying the percent of elderly residents, which is defined as those 65 years old or older, in Oklahoma counties might use the following map with the data categorized using the Jenks method (http://help.arcgis.com) and displayed spatially:

Figure 1.1 Map of Percent Elderly for Oklahoma Counties



Observe that counties with the largest cities in Oklahoma are in the category with the smallest percent of elderly residents. There also appear to be clusters of counties with similar values. Measures of spatial autocorrelation can be used to determine if the observed pattern is different from a pattern that could be the result of random chance. The percent elderly by county data for Oklahoma is given in Appendix A.1 and is from Census 2000 using American FactFinder (www.factfinder.census.gov).

The objective of this research is to propose local measures of spatial autocorrelation to test the null hypothesis that there is no spatial autocorrelation. An investigation is also conducted of their empirical Type I error rates and power for various geographically weighted spatial connectivity matrices and patterned spatial autocorrelation matrices. The performance of the proposed measures is compared to the performance of current measures.

# CHAPTER 2

## MEASURES OF SPATIAL AUTOCORRELATION

Terminology and notation applicable to measures of spatial autocorrelation are provided in this chapter and forms the basis for this research.  A review of the literature is also included.

The phrase spatial autocorrelation is defined by Griffith (1984) on page 10 as "…the spatial term of this phrase refers to a geographical dependence structure for observations.  The term correlation refers to a relationship between entities, and the prefix auto- refers to the fact that a single variable is being related to itself."

Measures of spatial autocorrelation were first proposed by Moran (1950) followed by Geary (1954).  These are commonly designated as Moran's $I$ and Geary's $c$, respectively.  It is interesting to note that the terminology in Moran's article includes "spatially correlated" and Geary uses "contiguity ratio."  It was not until 1968 that the term "spatial autocorrelation" was first used in a paper presentation by Cliff and Ord (Getis 2008).

Moran's $I$ and Geary's $c$ statistics are global measures and provide an "average" measure of spatial autocorrelation over the entire collection of geographic regions.  Their main use is to test the statistical hypotheses:

$H_0$: There is spatial independence

$H_1$: There is spatial autocorrelation

The conduct of this test provides direction for further statistical analyses. If there is no spatial autocorrelation, then methods that require independence of observations are used. However, if there is spatial autocorrelation, then methods that incorporate spatial autocorrelation are used. Lee (2001) points out that when spatial dependence is present, the information from observations is less than would have been obtained from independent observations since a certain amount of the information carried by each observation is duplicated by other observations in surrounding regions.

Recall the map in Figure 1 of percent elderly for each Oklahoma county. It is easy to visualize areas where one county is different from surrounding counties, such as in the northwest part of the state, or clusters of similar counties such as in the central part of the state. The need to detect such patterns led to the creation of local measures of spatial autocorrelation. Sokal, Oden and Thomson (1998) explain that these were developed to detect geographical regions that exhibit spatial heterogeneity and show significant local departures from randomness. Boots (2002) points out that since local measures generate a result for each region, they yield a mappable data set that provides additional information about the original pattern of data values.

## 2.1 SPATIAL DATA

Spatial data contain location information as well as attribute information (Fotheringham and Rogerson 2009). The location information is used to determine neighbors and the attribute information is used to increase knowledge about a population of interest. The data to be analyzed are considered to be from a study area subdivided into $n$ regions, where each region is identified with location information, such as Cartesian coordinates or latitude and longitude, and a measurable attribute of interest to a researcher.

The attribute information must be numerical with at least an interval scale of measurement for the measures of spatial autocorrelation included in this study. To simplify the following discussion, let $y_i$ = observed attribute value for the $i^{th}$ data region, $i = 1, 2, \ldots, n$. Define Mean Centered Data as $z_i = y_i - \bar{y}$ where $\bar{y} = \frac{\sum_i y_i}{n}$, which enhances visual analysis by readily identifying regions above the mean with positive values and regions below the mean with negative values.

## 2.2 WHO'S MY NEIGHBOR? – GLOBALLY WEIGHTED SPATIAL CONNECTIVITY MATRICES

The influence of near and far neighbors is dependent on the definition of "neighbor." The common measures of autocorrelation appropriate for spatial data are examined by defining neighbor using three criteria: (1) the Rook Connectivity Case in which they share a common nonzero length boundary (Griffith 2003), (2) the Queen Connectivity Case in which they share a common boundary or only a vertex (Cliff and Ord 1973), and (3) all regions are potential neighbors with influence determined by a weighting function. The Rook Connectivity Case and Queen Connectivity Case are named after the types of moves that are allowed in the game of chess by these pieces.

The various measures of spatial autocorrelation incorporate a weight specifying the influence of neighbors, which are usually represented as matrices. Denote the Globally Weighted Spatial Connectivity Matrices as $\boldsymbol{GWSCM} = w_{ij}$, where $w_{ij}$ is the element in the $i^{th}$ row and $j^{th}$ column, with $i = 1, 2, \ldots, n$, and $j = 1, 2, \ldots, n$. When influence is simply an indication that a region is a neighbor, $w_{ij} = 1$, or not a neighbor, $w_{ij} = 0$, then these are referred to as connectivity or contiguity matrices. For such matrices, it is common to set $w_{ii} = 0$ since a region cannot be neighbors with itself.

Geographic regions may be regular polygons or irregular polygons. Regular polygons include triangles, squares, and hexagons. Figure 2.2.1 is an example of square geographic regions. In his early work, Griffith (1987) referred to this as a 4-by-4 regular lattice configuration of areal units, but in his later work, Griffith (2003) describes this as a regular square tessellation.

Figure 2.2.1 Example of 4x4 Regular Square Tessellation with Region Labels

| | | | |
|---|---|---|---|
| **1** | **2** | **3** | **4** |
| **5** | **6** | **7** | **8** |
| **9** | **10** | **11** | **12** |
| **13** | **14** | **15** | **16** |

These regions may be labeled as Region 1, Region 2, …, Region 16 as shown in Figure 2.2.1. Labeling the regions allows the attribute data to be readily identifiable to its geographic location and also for vectorization of attribute data to facilitate computations. Software used for computations and simulations, R and MATLAB, are both designed for efficiency by using vectors and matrices. The labels as shown are used to concatenate each successive row of four data regions into one row vector of 16 data regions. This is referred to as row vectorization, which converts a matrix into a row vector. It can easily be shown that measures of spatial autocorrelation are invariant to the labeling of regions. They are also invariant to the use of row or column vectorization.

Labeling the geographic regions also facilitates the creation of globally weighted spatial connectivity matrices. The Rook Connectivity Case identifies neighbors as those regions sharing a boundary of nonzero length. Region 1 neighbors Region 2 and Region 5. Since it is a corner region it has two neighbors. Region 2 neighbors Region 1, Region 3, and Region 6. As it is an edge region, it has three neighbors. Interior regions, such as Region 6, have four neighbors. For Region 6, these are Region 2, Region 5, Region 7 and Region 10. The Queen Connectivity Case identifies neighbors as those regions sharing a boundary of nonzero length as well as a corner, which is only a single point. Region 1 neighbors Region 2, Region 5, and Region 6. Since it is a corner region it has three neighbors. Region 2 neighbors Region 1, Region 3, Region 5, Region 6, and Region 7. As it is an edge region, it has five neighbors. Interior regions, such as Region 6, have eight neighbors. For Region 6, these are Region 1, Region2, Region 3, Region 5, Region 7, Region 9, Region 10, and Region 11.

It is seen that the Queen Connectivity Case for a regular square tessellation adds a significant number of neighbors for each region. Specifically, it adds one neighbor for each of the corners, two neighbors for each of the edge regions not at a corner, and four neighbors for each of the interior regions.

The Rook Connectivity Case and Queen Connectivity Case are equivalent to the weighting function:

$$w_{ij} = \begin{cases} 1, & d_{ij} \le d \\ 0, & otherwise \end{cases}, \text{ for appropriate choice of d.} \tag{2.2.1}$$

That is, matrix elements $w_{ij}$, can be determined using this binary function. For regular square tessellations comprised of unit squares and using area centroids, the Rook Connectivity Case has $d = 1$ and the Queen Connectivity Case has $d = \sqrt{2}$.

An alternative method of defining weights is to use distances between region centroids in a manner that gives relatively large weights to close neighbors and smaller weights to neighbors farther away. Rogerson (2006) gives various examples which include, $w_{ij} = d_{ij}^{-\beta}$, $w_{ij} = e^{-\beta d_{ij}}$, and $w_{ij} = e^{-\beta d_{ij}^2}$, where $d_{ij}$ is the Euclidean distance measured along the line connecting the centroids of the two regions $i$ and $j$, and $\beta$ is a scaling factor that must be estimated. Fotheringham, Brunsdon, and Charlton (2002) also give various choices of spatial weighting functions which include $w_{ij} = e^{-\frac{1}{2}\left(d_{ij}/b\right)^2}$, where $b$ is referred to as the bandwidth, and $w_{ij} = \begin{cases} \left[1 - \left(d_{ij}/b\right)^2\right]^2, & d_{ij} < b \\ 0, & otherwise \end{cases}$.

For the purposes of this study, the distance weighting function,

$$w_{ij} = e^{-\frac{1}{2}\left(d_{ij}/b\right)^2}, \qquad (2.2.2)$$

which incorporates all regions as neighbors in a 4x4 study area, has been selected. Equation (2.2.2) will be referred to as the Continuous Weighting Function (CWF) since it assigns weights to all regions based on a continuous function.

The CWF is conceptually appealing since the bandwidth, $b$, sets the scale of analysis for spatial relationships. For study regions comprised of unit squares, an appropriate bandwidth can be selected to match the definition of local consistent with the objective of the underlying study. For regular square tessellations comprised of unit squares and using area centroids, the distance between regions in the same row or the same column is a multiple of 1.0. The distance between regions in a diagonal direction is a multiple of $\sqrt{2}$. Guidance on the selection of *b* is provided by Rogerson (2006). Figure 2.2.2 shows weights for various bandwidths.

Figure 2.2.2 Weights for Various Bandwidths Using CWF

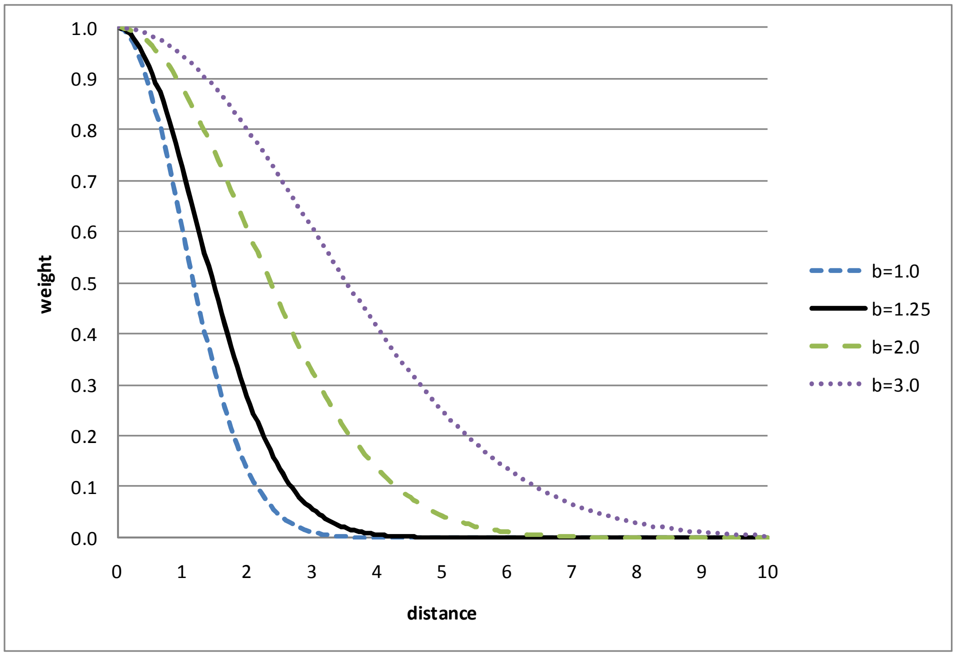


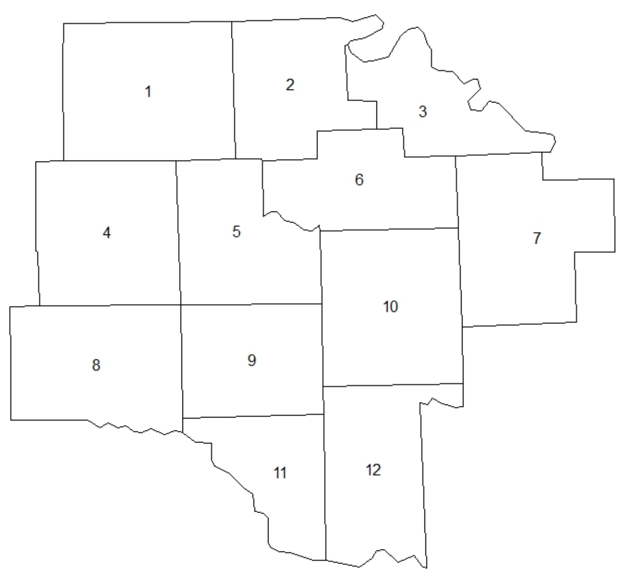

Figure 2.2.3 presents weights on Region 1, using the CWF with a bandwidth of *b*=1.25, for Region 2 through Region 16 along with their corresponding spatial location. For adjacent neighbors, such as Region 1 and Region 2, $w_{ij}$=0.726. The influence of Region 3 on Region 1 has $w_{ij}$=0.278. The influence of Region 6 on Region 1 has $w_{ij}$=0.527. Region 6 has a larger weight than Region 3 since it is geographically closer to Region 1. Region 16 has $w_{ij}$=0.004, which indicates it has negligible influence on Region 1 for this choice of *b*.

Figure 2.2.3 Geographic Distribution of Weights on Region 1 for Regions 2-16

| | | | |
|---|---|---|---|
| 0.000 | 0.726 | 0.278 | 0.056 |
| 0.726 | 0.527 | 0.202 | 0.041 |
| 0.278 | 0.202 | 0.077 | 0.016 |
| 0.056 | 0.041 | 0.016 | 0.003 |

Irregular polygons include a variety of shapes. Examples include regions in a country, counties in a state, states in a country, wards in a precinct, and census blocks in a city. Figure 2.2.4 is an example comprised of twelve central Oklahoma counties.

Figure 2.2.4 Example of Irregular Polygons with Labels




These twelve geographic regions may be labeled as shown in Figure 2.2.4. Vectorization of the data is accomplished by listing the attribute value for Region 1 as the first element in the vector, the attribute value for Region 2 as the second element in the vector, and repeating this process until all the data values are in one row vector.

In order to examine the effect of globally weighted spatial connectivity matrices on the various measures of spatial autocorrelation, only the Rook Connectivity Case, which considers the minimum number of neighbors, the Queen Connectivity Case, which increases the number of neighbors, and the Continuous Weighting Function (CWF) Connectivity Case, which considers even more neighbors, are considered.

## 2.3 GLOBAL MEASURES

Three well-known measures of global spatial autocorrelation (Fotheringham and Rogerson 2009) include Moran's *I*, Geary's *c*, and Getis and Ord's *G*. The latter is specifically designed to detect a specific pattern of spatial autocorrelation, referred to as spatial clustering.

For the following discussion, let $S_0 = \sum_i \sum_j w_{ij}$, which is the sum of all values in the globally weighted spatial connectivity matrix ***GWSCM***. Let $m_2 = \frac{\sum_i z_i^2}{n}$ denote the second sample moment about the mean, where $z_i$ is the Mean Centered Data value for region *i* and *n* is the number of regions in the study area. Note that $m_2$ is the maximum likelihood estimator and has not been adjusted to be an unbiased estimator of the variance.

Moran (1950) was the first to measure spatial autocorrelation for at least interval level data with his *I* statistic. It is defined as:

$$I = \frac{\sum_i \sum_j w_{ij} z_i z_j}{S_0 m_2} \qquad (2.3.1)$$

Geary (1954) defined his statistic as:

$$c = \frac{(n-1)\sum_i \sum_j w_{ij}(z_i - z_j)^2}{2nS_0 m_2} \qquad (2.3.2)$$

Getis and Ord (1992) defined their statistic, which requires positive values with a natural origin, as:

$$G = \frac{\sum_i \sum_j w_{ij} y_i y_j}{\sum_i \sum_j y_i y_j} \qquad (2.3.3)$$

Their statistic is based on original data values and measures the overall concentration, or lack of concentration, of all pairs of ($y_i$, $y_j$). When $w_{ij}$ is an adjacency indicator, the numerator is the sum of the multiples of each $y_i$ with all $y_j$'s with nonzero $w_{ij}$ values as a proportion of the sum of all cross products $y_i y_j$.

## 2.4 LOCAL MEASURES

Local measures of spatial autocorrelation were developed in the 1970s to identify smaller regions within the study area that share similar characteristics. The most commonly used measures (Fotheringham and Rogerson 2009) are Moran's $I_i$, Geary's $c_i$, and Getis and Ord's $G_i$ and $G_i$*, where the subscript refers to the $i^{th}$ data region, $i = 1,\ldots,n$. When the spatial statistic is calculated for the $i^{th}$ data region, the $i^{th}$ data region becomes the pivot point. It is the focus of the current calculation and its value is either included in the calculations or excluded from the calculations.

Anselin (1995) developed a class of statistics that provided consistency between global and local measures of spatial autocorrelation. He defined a Local Indicator of Spatial Association (LISA) as those statistics meeting the following two requirements:

(1) The LISA for each observation gives an indication of the extent of significant spatial clustering of similar values around the observations;

(2) The sum of LISAs for all observations is proportional to a global indicator of spatial association.

Two local statistics are given that meet these criteria: Moran's $I_i$ and Geary's $c_i$. The subscript refers to the $i^{\text{th}}$ data region.

An interpretation for Local Moran's $I_i$ is provided by Sokal et al. (1998). The $I_i$ statistic measures joint covariation of neighboring localities. If the neighbors deviate strongly from the mean with the same sign as the pivot, then there is positive spatial autocorrelation. However, if the pivot locality deviates widely from the mean and with a sign opposite to those of its neighbors, there is negative spatial autocorrelation. This is seen by examining the formula for $I_i$:

$$I_i = \frac{z_i}{m_2} \sum_j w_{ij} z_j \tag{2.4.1}$$

If $z_i$ and all the $z_j$s are all either greater than the mean or less than the mean, then it is obvious they will have the same sign. However, if some of the $z_j$s are greater than the mean and some are less than the mean, then there is a dampening effect and the sign of $I_i$ is not obvious.

Sokal et al. (1998) describe Geary's $c_i$ as measuring squared differences between the values of neighboring points and the pivot. High values of $c_i$ indicate negative spatial autocorrelation. Positive spatial autocorrelation, indicated by small values of $c_i$, is the result of the data value at the pivot and its neighbors' values being close to the mean.

$$c_i = \frac{1}{m_2}\sum_j w_{ij}\left(z_i - z_j\right)^2 \qquad (2.4.2)$$

Since $z_i$ and $z_j$ are deviations from the mean, their difference is

$$z_i - z_j = (y_i - \bar{y}) - (y_j - \bar{y}) = y_i - y_j.$$

It can be seen from these computations that squared differences for mean-centered data are actually squared deviations of all applicable $y_j$'s from $y_i$, for the $i^{th}$ region. Thus, similar values for a pivot and its neighbors result in positive spatial autocorrelation since $c_i$ will be small. However, very dissimilar values result in very large squared deviations, which is an indication of negative spatial autocorrelation.

The Getis and Ord (1992) local statistics measure, for any given region, the sum of $y_j$'s defined as neighbors of $y_i$, as a proportion of the sum of all $y_j$'s when $w_{ij}$ is an adjacency indicator. Since these are proportions, their values will be in the interval (0,1), assuming that each region has at least one neighbor. Formulas for the two statistics are:

$$G_i = \frac{\sum_j w_{ij} y_j}{\sum_j y_j} \text{ for } j \neq i, \text{ (excludes pivot region)} \qquad (2.4.3)$$

$$G_i{*} = \frac{\sum_j w_{ij} y_j}{\sum_j y_j}, \text{ where } j \text{ may equal } i, \text{ (includes pivot region)} \qquad (2.4.4)$$

It is pointed out by Sokal et al. (1998) that these statistics describe the spatial clustering of large or small values around or at the pivotal locality and tend to agree more with $I_i$ than with $c_i$. Anselin (1995) points out these are not LISAs since their individual components are not proportional to global measures of spatial autocorrelation. Getis and Ord's statistics have values that are only positive and are best interpreted by standardizing.

## 2.5 PERMUTATION AND RANDOMIZATION TESTS

The most common method to determine statistical significance is based on permutation tests for small sample sizes, or randomization tests with either total or conditional randomization. Total randomization is the permutation of data over all regions. Conditional randomization occurs when an observation at one data region is fixed, and the remaining observations are permuted over the other data regions. As Morris (2007) points out, permutation tests generate the sampling distribution of a test statistic by calculating the value of the test statistic for all possible permutations of the data under the null hypothesis. For large samples, a random sample of permutations is examined in lieu of all possible permutations.

The structure of the spatial autocorrelation measure determines the type of randomization that is appropriate. For example, global measures consider the $n!$ arrangement of all possible permutations, but local measures usually fix a region and consider the $(n-1)!$ possible permutations of the remaining regions. If $n=16$ as in Figure 2.2.1, then 16!=20,922,789,890,000 and (16-1)!=15!=1,307,674,368,000. Thus, randomization tests are more appropriate than permutation tests for large study areas.

An alternative to parametric procedures when assumptions are not met, such as data is not from a normal distribution, permutation and randomizations tests provide a measure of statistical significance. As Morris (2007) explains in her dissertation, a *p*-value is obtained by dividing the number of values that are greater than or equal to the test statistic by the total number of permutations of the data under the null hypothesis.

Lee (2009) presents a generalized randomization approach for local measures of spatial autocorrelation in order to provide a reliable foundation for tests of significance. It is composed of two testing procedures, the extended Mantel test and the generalized vector randomization test. These two procedures are then assigned to the two different randomization assumptions. His generalized randomization approach is designed to yield a reliable set of equations for the expected value and variance by taking into account all possible permutation situations occurring at and around a region.

## 2.6 INCONSISTENCIES IN PUBLISHED FORMULAS

Early simulations led to the revelation that not all published formulas give the same result for the variance of the common measures of spatial autocorrelation. Published formulas for variances from various sources for common measures of global spatial autocorrelation are examined for consistencies. Only formulas applicable to the randomization assumption are given since this is the only method considered for statistical significance in this research.

Published formulas for the variance of Moran's global measure under the total randomization assumption include:

Sokal et al. (1998):

Var($I$) = $\{n[(n^2-3n+3)S_1(W)-nS_2(W)+3S_0^2(W)]-b_2[(n^2-n)S_1(W)-2nS_2(W)+6S_0^2(W)]\}\,/[(n-1)(n-2)(n-3)S_0^2(W)]-(n-1)^{-2}$

where $S_0(W)=\sum_i\sum_j w_{ij}$, $S_1(W)=(1/2)\sum_i\sum_j\left(w_{ij}+w_{ji}\right)^2$, $S_2(W)=\sum_i(w_{i\cdot}+w_{\cdot i})^2$, $w_{i\cdot}=\sum_j w_{ij}$, $w_{\cdot i}=\sum_j w_{ji}$, $m_k=\frac{\sum_i z_i^k}{n}$, and $b_2=\frac{m_4}{m_2^2}=\frac{n\sum_i z_i^4}{\left(\sum_i z_i^2\right)^2}$.

Cliff and Ord (1973):

$$\text{Var}(I) = \frac{n[(n^2-3n+3)S_1-nS_2+3W^2]-b_2[(n^2-n)S_1-2nS_2+6W^2]}{(n-1)^{(3)}W^2} - \left(-\frac{1}{n-1}\right)^2 \text{ where}$$

$S_1 = \left(\frac{1}{2}\right)\sum_{i=1}^{n}\sum_{j=1,j\neq i}^{n}\left(w_{ij}+w_{ji}\right)^2$, $S_2 = \sum_i (w_{i.}+w_{.i})^2$, $w_{i.} = \sum_j w_{ij}$, $w_{.i} = \sum_j w_{ji}$,

$m_k = \frac{\sum_i z_i^k}{n}$, $b_2 = \frac{m_4}{m_2^2}$, and $W = \sum_i \sum_j w_{ij}$.

and Griffith (1987):

Var($I$) =

$$\Big[2n\left[(n^2-3n\mp 3)\sum_{i=1}^{n}\sum_{j=1}^{n}c_{ij}\right]-4\left\{\sum_{i=1}^{n}\sum_{j=1}^{n}c_{ij}+\sum_{i=1}^{n}\left[\sum_{j=1}^{n}c_{ij}\left(\sum_{j=1}^{n}c_{ij}-1\right)\right]\right\}n^2+3n\left(\sum_{i=1}^{n}\sum_{j=1}^{n}c_{ij}\right)^2-\left(\frac{m_4}{s^4}\right)\Big[2(n^2-n)\sum_{i=1}^{n}\sum_{j=1}^{n}c_{ij}-8n\left\{\sum_{i=1}^{n}\sum_{j=1}^{n}c_{ij}+\sum_{i=1}^{n}\left[\sum_{j=1}^{n}c_{ij}\left(\sum_{j=1}^{n}c_{ij}-1\right)\right]\right\}+6\left(\sum_{i=1}^{n}\sum_{j=1}^{n}c_{ij}\right)^2\Big]\Big]$$

$/\left[(n-1)(n-2)(n-3)\left(\sum_{i=1}^{n}\sum_{j=1}^{n}c_{ij}\right)^2\right]$-$\left[\frac{-1}{n-1}\right]^2$ where $c_{ij} = w_{ij}$, $m_k = \frac{\sum_i z_i^k}{n}$, and

$s^4 = (\sum_i z_i^2/n)^2$.

For example, the formula for the variance of Moran's $I$ in Griffith (1987) did not match the variance of simulated results. Sokal et al. (1998) found that a slight modification is necessary to match the assumption of total randomization.

Published formulas for the variance of Geary's global measure include:

Sokal et al. (1998):

$$\text{Var}(c) = \{(n-1)S_1(W)[n^2-3n+3-(n-1)b_2]-4^{-1}(n-1)S_2(W)[n^2+3n-6-(n^2-n+2)b_2]+S_0^2(W)[n^2-3-(n-1)^2b_2]\}/n(n-2)(n-3)S_0^2(W)$$

where $S_0(W) = \sum_i \sum_j w_{ij}$, $S_1(W) = (1/2) \sum_i \sum_j \left(w_{ij} + w_{ji}\right)^2$, $S_2(W) = \sum_i (w_{i\cdot} + w_{\cdot i})^2$,

$w_{i\cdot} = \sum_j w_{ij}$, $w_{\cdot i} = \sum_j w_{ji}$, $m_k = \frac{\sum_i z_i^k}{n}$, and $b_2 = \frac{m_4}{m_2^2} = \frac{n \sum_i z_i^4}{\left(\sum_i z_i^2\right)^2}$.

and Griffith (1987):

$$\mathrm{Var}(c) = \left[\frac{\left(\sum_{i=1}^n \sum_{j=1}^n c_{ij}\right)^2 \left[-\frac{(n-1)^2 m_4}{s^4} + (n^2-3)\right]}{2} + \left(\sum_{i=1}^n \sum_{j=1}^n c_{ij}\right)(n-1)\left[-\frac{(n-1)m_4}{s^4} + n^2 - 3n + 3\right] + \left\{\sum_{i=1}^n \sum_{j=1}^n c_{ij} + \sum_{i=1}^n \left[\sum_{j=1}^n c_{ij}\left(\sum_{j=1}^n c_{ij} - 1\right)\right]\right\}(n-1)\left[\frac{(n^2-n+2)m_4}{s^4} - (n^2+3n-6)\right]/2\right] / \left[n(n-2)(n-3)\left(\sum_{i=1}^n \sum_{j=1}^n c_{ij}\right)^2/2\right]$$

where $c_{ij} = w_{ij}$, $m_k = \frac{\sum_i z_i^k}{n}$, and $s^4 = (\sum_i z_i^2/n)^2$.

Even though there are similarities in the formulas and definitions of supporting quantities, it is obvious that a standard notation has not been adopted. The practitioner needs to be aware that these formulas do not give the same results as there are subtle differences between them. The formulas in Sokal et al. (1998) proved to be the most reliable for this research. Published formulas must be used with caution and their accuracy verified by theoretical calculations or simulation results.

# CHAPTER 3

## PROPOSED LOCAL MEASURES OF SPATIAL AUTOCORRELATION

The current measures of spatial autocorrelation result in values that are not easy to interpret. This is more evident for local measures than for global measures. Moran's global measure has values that are usually in the interval [-1, 1], with the sign of the measure indicating positive spatial autocorrelation for positive values and negative spatial autocorrelation for negative values. Geary's global measure has values that are usually in the interval [0, 2] with values less than one indicating positive spatial autocorrelation and values greater than one indicating negative spatial autocorrelation. Values near one indicate no spatial autocorrelation. Getis and Ord's global measure has values that are only positive and are best interpreted when transformed to standard normal scores. A value less than zero indicates values below the average are clustered and a value greater than zero indicates values above the average are clustered.

The interpretation of local measures of spatial autocorrelation is even more difficult because they do not have the same constraints as global measures. The current local measures of spatial autocorrelation can result in extreme values. The interpretation of a value large in magnitude is that the associated region has a large influence on the global measure of spatial autocorrelation, thus suggesting this region is exhibiting local spatial autocorrelation that warrants attention by the analyst.

## 3.1 SPATIAL AUTOCORRELATION MODEL

The model used for this investigation is

$$\boldsymbol{Y} = \boldsymbol{X}\beta + \boldsymbol{\eta} \tag{3.1.1}$$

where $\boldsymbol{Y}$ is a nx1 vector of observed values for the n regions in the study area,

$\boldsymbol{X}$ is a nx1 vector of ones,

$\beta$ is a scalar used to shift the mean of $\boldsymbol{Y}$, and

$\boldsymbol{\eta}$ is a nx1 vector distributed as Multivariate Normal with mean vector $\mathbf{0}$ and positive definite variance-covariance matrix $\boldsymbol{V}$.

## 3.2 PROPOSED LOCAL MEASURES

The proposed local measures of spatial autocorrelation are constrained to the interval [-1,+1], and the interpretation is similar to other common measures of correlation. Let $z_i = y_i - \bar{y}$ as before, $\bar{z}_{(i)} = \frac{\sum_j w_{ij}(y_j - \bar{y})}{\sum_j w_{ij}}$ $j \neq i$, and $\bar{z}_i = \frac{\sum_j w_{ij}(y_j - \bar{y})}{\sum_j w_{ij}}$ where *j* may equal $i$, and $w_{ij}$ is a weight specifying the influence of neighbors as defined in Section 2.2. Three equivalent expressions are given for each statistic. The first is a conceptual definition, the second is a computational definition, and the third is a matrix derivation.

The conceptual definitions are:

$$H_i = \begin{cases} \dfrac{\bar{z}_{(i)}}{z_i} & if\ absolute\ value\ is\ less\ than\ one \\ \dfrac{z_i}{\bar{z}_{(i)}} & otherwise \end{cases} \tag{3.2.1}$$

$$H_i^* = \begin{cases} \frac{\bar{z}_i}{z_i} \; if\ absolute\ value\ is\ less\ than\ one \\ \frac{z_i}{\bar{z}_i} \; otherwise \end{cases} \tag{3.2.2}$$

It is seen that the new statistics are ratios of random variables.

The computational definitions are:

$H_i = \frac{\min(|z_i|,|\bar{z}_{(i)}|)}{\max(|z_i|,|\bar{z}_{(i)}|)}\left(sign\left(\frac{z_i}{\bar{z}_{(i)}}\right)\right)$, which excludes the pivot point, and

$H_i{*} = \frac{\min(|z_i|,|\bar{z}_i|)}{\max(|z_i|,|\bar{z}_i|)}\left(sign\left(\frac{z_i}{\bar{z}_i}\right)\right)$, which includes the pivot point as defined in Section 2.4.

The sign (·) function returns -1 if the value of the argument is negative, 0 if the value of the argument is zero, and +1 if the value of the argument is positive. Its purpose is to maintain the direction of spatial autocorrelation.

Matrix derivations for $H_i$ are:

Given model (3.1.1), note that

$$\boldsymbol{Y} = \begin{pmatrix} Y_1 \\ \vdots \\ Y_n \end{pmatrix} \sim Multivariate\ Normal\ \left[\begin{pmatrix} \beta \\ \vdots \\ \beta \end{pmatrix}, \begin{pmatrix} \sigma_{11} & \cdots & \sigma_{1n} \\ \vdots & \ddots & \vdots \\ \sigma_{n1} & \cdots & \sigma_{nn} \end{pmatrix}\right]$$

Define other matrices as

$$\boldsymbol{j} = \begin{pmatrix} 1 \\ \vdots \\ 1 \end{pmatrix}, a\ nx1\ vector\ of\ ones,$$

$$\boldsymbol{J} = \begin{pmatrix} 1 & \cdots & 1 \\ \vdots & \ddots & \vdots \\ 1 & \cdots & 1 \end{pmatrix}, a\ nxn\ matrix\ of\ ones,$$

$$\boldsymbol{e}_i = \begin{pmatrix} 0 \\ \vdots \\ 0 \\ 1 \\ 0 \\ \vdots \\ 0 \end{pmatrix}, a\ nx1\ vector, the\ i^{th}\ element\ is\ 1\ and\ the\ remaining\ elements\ are\ 0,$$

$$\boldsymbol{I} = \begin{pmatrix} 1\ 0\ 0 \cdots\ 0 \\ 0\ 1\ 0 \cdots\ 0 \\ \ddots \\ 0\ 0 \cdots 0\ \ 1 \end{pmatrix}, a\ nxn\ identity\ matrix,$$

***GWSCM***, the *n*x*n* Globally Weighted Spatial Connectivity Matrix that excludes the pivot point,

$$\boldsymbol{GWSCM}_{(i)} = e_i' \boldsymbol{GWSCM}, the\ i^{th}\ column\ of\ \boldsymbol{GWSCM},$$

$$n_{(i)} = \boldsymbol{j}' \boldsymbol{GWSCM}_{(i)}, sum\ of\ the\ i^{th}\ column\ of\ \boldsymbol{GWSCM},$$

$$\bar{Y} = \left(\frac{1}{n}\right) \boldsymbol{j}' \boldsymbol{Y}, the\ mean\ of\ the\ observed\ values,$$

$$\boldsymbol{z} = \left[\boldsymbol{I} - \frac{1}{n} \boldsymbol{J}\right] \boldsymbol{Y}, the\ nx1\ vector\ of\ deviations\ Y_i - \bar{Y}$$

$$z_i = \boldsymbol{e}_i' \boldsymbol{z}, the\ i^{th}\ element\ of\ \boldsymbol{z}, \text{ and}$$

$$\bar{z}_{(i)} = \left(\frac{1}{n_i}\right) \boldsymbol{GWSCM}_i' \boldsymbol{z}.$$

Now, $H_i$ for an individual region may be calculated using Equation 3.2.1. Similar matrix calculations are made for $H_i$* except ***GWSCM*** includes the pivot point, the subscript "(*i*)" is replaced by "*i*", and Equation 3.2.2 is applied.

## 3.3 RATIO OF TWO NORMAL RANDOM VARIABLES

Equations for $H_i$ (3.2.1) and $H_i^*$ (3.2.2) are ratios of two random variables. Initial values are computed with the mean deviation of neighbors in the numerator and the deviation of the current region in the denominator.

When sampling from a bivariate normal distribution with $\boldsymbol{\mu} = \mathbf{0}$ and $\boldsymbol{\Sigma} = \boldsymbol{I}$, this ratio is distributed as a Cauchy random variable as proven in Theorem 3.3.1.

**Theorem 3.3.1.** If $(X_n, Y_n) \xrightarrow{d} N(\mathbf{0}, \mathbf{I})$, then $X_n/Y_n \xrightarrow{d} Cauchy$.

**Proof.** Since $(X_n, Y_n) \xrightarrow{d} N(\mathbf{0}, \boldsymbol{I})$, we have $X_n \xrightarrow{d} X, where\ X \sim N(0,1)$ and $Y_n \xrightarrow{d} Y, where\ Y \sim N(0,1)$. Let $g = X/Y$. Observe that $g$ is continuous a.e. Using Theorem 1.7 (iii) (Serfling 1980, page 24), $\frac{X_n}{Y_n} \xrightarrow{d} \frac{X}{Y}$. Now, let $U = X/Y$ and $V = Y$. So $X = UY$ and $Y$=$V$ with Jacobian = $v$. Since $f_{X,Y}(x,y)$ is bivariate normal with probability density function $\frac{1}{2\pi} e^{-\frac{x^2}{2}} e^{-\frac{y^2}{2}}$, we have $f_{U,V}(u,v) = f_{X,Y}(u,v)|J| = \frac{1}{2\pi} e^{-\frac{(uv)^2}{2}} e^{-\frac{v^2}{2}} |v| = \frac{|v|}{2\pi} e^{-\frac{1}{2}(u^2+1)v^2}$. Now, integrate out $v$ to find the marginal of $U$:

$$f_U(u) = \int_{-\infty}^{\infty} \frac{|v|}{2\pi} e^{-\frac{1}{2}(u^2+1)v^2} dv = \int_{-\infty}^{0} \frac{-v}{2\pi} e^{-\frac{1}{2}(u^2+1)v^2} dv + \int_{0}^{\infty} \frac{v}{2\pi} e^{-\frac{1}{2}(u^2+1)v^2} dv$$

$$= \int_0^\infty \frac{v}{\pi} e^{-\frac{1}{2}(u^2+1)v^2} dv = \frac{1}{\pi} \int_0^\infty v e^{-\frac{1}{2}(u^2+1)v^2} dv = \frac{1}{\pi(u^2+1)} \text{ for } -\infty < u < \infty.$$

However, this is the probability density function for a Cauchy (0,1). So $U$~Cauchy (0,1). This proof used the relation $\int_0^\infty x e^{-ax^2} dx = \frac{1}{2a}$ (personal conversation with Jordan Crabbe on September 30, 2010) and is based on Example (ii) given without details by Serfling (1980) on page 25.

The next condition to address is when $X$ and $Y$ are not independent. Their ratio is distributed as a Cauchy random variable as proven in Theorem 3.3.2.

**Theorem 3.3.2.** If $\binom{X}{Y} \sim Bivariate\ Normal\left[\binom{0}{0}, \begin{pmatrix} \sigma_1^2 & \sigma_1\sigma_2\rho \\ \sigma_1\sigma_2\rho & \sigma_2^2 \end{pmatrix}\right]$, then

$$\frac{X}{Y} \sim Cauchy\left(\frac{\rho\sigma_1}{\sigma_2}, \frac{\sigma_1\sqrt{1-\rho^2}}{\sigma_2}\right).$$

**Proof.** Let $U = \frac{X}{Y}\ and\ V = Y$. So $X = UY$ and $Y$=$V$ with Jacobian = $v$. Since $f_{X,Y}(x,y)$ is bivariate normal with probability density function

$$f_{X,Y}(x,y) = \frac{1}{2\pi\sigma_1\sigma_2\sqrt{1-\rho^2}} exp\left\{-\frac{1}{2(1-\rho^2)}\left[\frac{x^2}{\sigma_1^2} - 2\rho\frac{xy}{\sigma_1\sigma_2} + \frac{y^2}{\sigma_2^2}\right]\right\}$$

we have,

$$f_{U,V}(u,v) = \frac{|v|}{2\pi\sigma_1\sigma_2\sqrt{1-\rho^2}} exp\left\{-\frac{1}{2(1-\rho^2)}\left[\frac{(uv)^2}{\sigma_1^2} - 2\rho\frac{uv^2}{\sigma_1\sigma_2} + \frac{v^2}{\sigma_2^2}\right]\right\}$$

Now, integrate out $v$ to find the marginal of $U$:

$$f_U(u) = \int_{-\infty}^{\infty} \frac{|v|}{2\pi\sigma_1\sigma_2\sqrt{1-\rho^2}} exp\left\{-\frac{1}{2(1-\rho^2)}\left[\frac{(uv)^2}{\sigma_1^2} - 2\rho\frac{uv^2}{\sigma_1\sigma_2} + \frac{v^2}{\sigma_2^2}\right]\right\} dv$$

$$= \int_0^{\infty} \frac{v}{\pi\sigma_1\sigma_2\sqrt{1-\rho^2}} exp\left\{-\frac{1}{2(1-\rho^2)}\left[\frac{(uv)^2}{\sigma_1^2} - 2\rho\frac{uv^2}{\sigma_1\sigma_2} + \frac{v^2}{\sigma_2^2}\right]\right\} dv$$

$$= \int_0^{\infty} \frac{v}{\pi\sigma_1\sigma_2\sqrt{1-\rho^2}} exp\left\{-\frac{v^2}{2(1-\rho^2)}\left[\frac{u^2}{\sigma_1^2} - 2\rho\frac{u}{\sigma_1\sigma_2} + \frac{1}{\sigma_2^2}\right]\right\} dv$$

$$= \frac{1}{\pi\sigma_1\sigma_2\sqrt{1-\rho^2}} \int_0^{\infty} v \cdot exp\left\{-\frac{1}{2(1-\rho^2)}\left[\frac{u^2}{\sigma_1^2} - 2\rho\frac{u}{\sigma_1\sigma_2} + \frac{1}{\sigma_2^2}\right] v^2\right\} dv$$

$$= \left(\pi\sigma_1\sigma_2\sqrt{1-\rho^2}\right)^{-1} \left(\frac{1}{(1-\rho^2)}\left(\frac{u^2}{\sigma_1^2} - 2\rho\frac{u}{\sigma_1\sigma_2} + \frac{1}{\sigma_2^2}\right)\right)^{-1}$$

$$= \frac{\sqrt{1-\rho^2}}{\pi\sigma_1\sigma_2}\left(\frac{u^2}{\sigma_1^2} - 2\rho\frac{u}{\sigma_1\sigma_2} + \frac{1}{\sigma_2^2}\right)^{-1}$$

$$= \frac{1}{\pi\frac{\sigma_1\sqrt{1-\rho^2}}{\sigma_2}}\left[1 + \left(\frac{u - \frac{\rho\sigma_1}{\sigma_2}}{\frac{\sigma_1\sqrt{1-\rho^2}}{\sigma_2}}\right)^2\right]^{-1}$$

However, this is the probability density function for a Cauchy ($\frac{\rho\sigma_1}{\sigma_2}, \frac{\sigma_1\sqrt{1-\rho^2}}{\sigma_2}$). So

$U$~Cauchy ($\frac{\rho\sigma_1}{\sigma_2}, \frac{\sigma_1\sqrt{1-\rho^2}}{\sigma_2}$).

The following corollary is useful when positive definite correlation matrices are used as variance-covariance matrices.

**Corollary 3.3.3.** If $\binom{X}{Y} \sim Bivariate\ Normal\left[\binom{0}{0}, \begin{pmatrix} 1 & \rho \\ \rho & 1 \end{pmatrix}\right]$, then $\frac{X}{Y} \sim Cauchy\left(\rho, \sqrt{1-\rho^2}\right)$.

**Proof.** Substitute $\sigma_1 = 1\ and\ \sigma_2 = 1$ into the proof of Theorem 3.3.2.

The following corollary is useful when *X* and *Y* are independent but have different variances.

**Corollary 3.3.4.** If $\binom{X}{Y} \sim Bivariate\ Normal\left[\binom{0}{0}, \begin{pmatrix} \sigma_1^2 & 0 \\ 0 & \sigma_2^2 \end{pmatrix}\right]$, then $\frac{X}{Y} \sim Cauchy\left(0, \frac{\sigma_1}{\sigma_2}\right)$.

**Proof.** Substitute $\rho = 0$ into the proof of Theorem 3.3.2.

The following corollary is useful when *X* and *Y* are independent standard normal random variables.

**Corollary 3.3.5.** If $(X, Y)$ ~ *Bivariate Normal* (**0**, **I**), then $X/Y \sim Cauchy(0,1)$.

**Proof.** Substitute $\rho = 0, \sigma_1 = 1, and\ \sigma_2 = 1$ into the proof of Theorem 3.3.2.

## 3.4 TRUNCATED AND FOLDED DISTRIBUTIONS

A truncated distribution occurs when values below a certain point and/or above a certain point have been eliminated, or it is only possible to observe data in a specified range. Distributions are truncated, either intentionally or unintentionally, for various reasons. One reason for truncating is to restrict the support of a distribution with no moments, such as the Cauchy, to achieve a distribution with finite moments. The truncated Cauchy distribution is discussed by Johnson and Kotz (1970) and Nadarajah and Kotz (2006).

A simple folded distribution occurs when values below a certain point are "folded" by a mathematical operation. An example is when the algebraic sign of differences is unknown, lost, disregarded, or otherwise missing (Leone, Nelson et al. 1961) and only positive values are available for analysis. Nelson (1980) gives credit to R. B. Nottingham for the first use of the term "folding" in 1960 to describe what happens when the absolute values of data are analyzed instead of the original signed data. The most common example is the folded standard normal distribution, sometimes referred to as a half-normal distribution, which is the result of taking the absolute value of $Z$, where $Z \sim N(0,1)$ (Johnson and Kotz 1970). Johnson and Kotz (1970) also discuss the folded Cauchy distribution which is obtained by folding the distribution at 0.

This research is based on a twice-folded Cauchy distribution, where values below negative one are folded into the interval (-1, 0), and values above positive one are folded into the interval (0, 1). Folding is accomplished by taking the reciprocal of any values outside [-1, +1] and retaining the sign of the original value. The resulting folded distribution has support [-1, +1]. The rationale for the selection of -1 and +1 as points for folding the distribution is based on the concept of a correlation coefficient having values in the interval [-1, +1]. Values that are close to these fold points indicate numerators and denominators in the ratios that are more similar than ratios that are far from the fold points. For example, if the ratio of the mean of the neighbors' values to the current region's value is 1.1, then folding results in a value of 1/1.1 = 0.91. If the ratio is 10.0, then folding results in a value of 1/10.0 = 0.10. Folding is desirable for a measure of spatial autocorrelation since we are attempting to determine the degree of similarity, or dissimilarity, between a region and its neighbors.

The closer the ratio is to +1.0, the more similar the current region is to the mean of its neighbors. The closer the ratio is to -1.0, the more similar the current region is to the mean of its neighbors except for a difference in sign. The closer the ratio is to 0.0, the more dissimilar the current region is to the mean of its neighbors.

## 3.5 DENSITY FUNCTION AND MOMENTS OF THE TWICE-FOLDED CAUCHY DISTRIBUTION

The Cauchy distribution function has the following probability density function

$$f(y;\theta,\gamma) = \left(\pi\gamma\left[1+\left(\frac{y-\theta}{\gamma}\right)^2\right]\right)^{-1} \quad (3.3.1)$$

and cumulative distribution function

$$F(y;\theta,\gamma) = \frac{1}{\pi}arctan\left(\frac{y-\theta}{\gamma}\right)+\frac{1}{2} \quad (3.3.2)$$

where $\theta$ is a location parameter and $\gamma$ is a scale parameter. It is well known that the mean and variance of the Cauchy distribution do not exist (Bain and Engelhardt 1992).

The density function of the twice-folded Cauchy distribution was derived using the Method of Distribution Functions (Wackerly, Mendenhall et al. 2002). Let $Y$~Cauchy($\theta$, $\gamma$). The twice-folded Cauchy is folded at -1 and +1. Folding is accomplished by

$$X = \begin{cases} \frac{1}{y} & y < -1,\ y > 1 \\ y & -1 \le y \le +1 \end{cases}.$$

For the distribution function approach,

$$F_X(x) = P(X \le x)$$

$$= \left[P(Y \le x) - P\left(Y \le \frac{1}{x}\right)\right][I(x<0)] + \left[P(Y \le x) + \left(1 - P\left(Y \le \frac{1}{x}\right)\right)\right][I(x>0)]$$

where the indicator function $I(x<0) = \begin{cases} 1 & -1 \le x < 0 \\ 0 & otherwise \end{cases}$, and the indicator function $I(x > 0) = \begin{cases} 1 & 0 < x \le 1 \\ 0 & otherwise \end{cases}$. So

$$F_X(x) = \begin{cases} 0 & x < -1 \\ F_Y(x) - F_Y\left(\frac{1}{x}\right) & -1 \le x < 0 \\ F_Y(0) & x = 0 \\ F_Y(x) + \left[1 - F_Y\left(\frac{1}{x}\right)\right] & 0 < x \le 1 \\ 1 & x > 1 \end{cases}$$

The probability density function (pdf) of the twice-folded Cauchy distribution is

$$f_X(x) = \frac{dF_X(x)}{dx} = \frac{d}{dx}\left[F_Y(x) - F_Y\left(\frac{1}{x}\right)\right]$$

$$= \frac{d}{dx}\left[\left(\frac{1}{\pi}tan^{-1}\left(\frac{x-\theta}{\gamma}\right) + \frac{1}{2}\right) - \left(\frac{1}{\pi}tan^{-1}\left(\frac{\frac{1}{x}-\theta}{\gamma}\right) + \frac{1}{2}\right)\right]$$

$$= \begin{cases} \left(\pi\gamma\left[1 + \left(\frac{x-\theta}{\gamma}\right)^2\right]\right)^{-1} + \left(\pi\gamma x^2\left[1 + \left(\frac{\frac{1}{x}-\theta}{\gamma}\right)^2\right]\right)^{-1} & -1 \le x < 0 < x \le 1 \\ \frac{\gamma^3 + \gamma + \gamma\theta^2}{\pi\gamma^2 + \pi\theta^2} = \lim_{x \to 0} f_X(x) & x = 0 \\ 0 & otherwise \end{cases}$$

as computed by Maple 13 (Maple 2009).

It is proven in the following theorem that the Twice-Folded Cauchy distribution has finite moments.

**Theorem 3.5.1.** $E[|X^r|] < \infty$.

Proof. Recall that $X$ is bounded in the interval [-1, +1]. So

$$E[|X^r|] = \int |x^r| f(x)dx \le \int 1 \cdot f(x)dx = 1$$

since $|X^r| \leq 1$ and by the comparison test for improper integrals. See Theorem 15 on page 214 in Buck (1978).

Maple 13 was also used to compute the first two moments of $X$ ~ Twice-Folded Cauchy($\theta$, $\gamma$):

$$E[X] = \int_{-1}^{1} x\left(\left(\pi\gamma\left[1+\left(\frac{x-\theta}{\gamma}\right)^2\right]\right)^{-1} + \left(\pi\gamma x^2\left[1+\left(\frac{\frac{1}{x}-\theta}{\gamma}\right)^2\right]\right)^{-1}\right)dx$$

$$= -\frac{1}{2}\frac{1}{\pi(\gamma^2+\theta^2)}\Bigg[\gamma^3 ln(\gamma^2+2\theta+\theta^2+1) + \gamma\theta^2 ln(\gamma^2+2\theta+\theta^2+1)$$

$$- 2\gamma^2\theta arctan\left(\frac{1+\theta}{\gamma}\right) - 2\theta^3 arctan\left(\frac{1+\theta}{\gamma}\right) + \gamma ln(\gamma^2+2\theta+\theta^2+1)$$

$$- 2\theta arctan\left(\frac{\theta+\gamma^2+\theta^2}{\gamma}\right) - \gamma^3 ln(\gamma^2-2\theta+\theta^2+1)$$

$$- \gamma\theta^2 ln(\gamma^2-2\theta+\theta^2+1) + 2\gamma^2\theta \arctan\left(\frac{\theta-1}{\gamma}\right)$$

$$+ 2\theta^3 arctan\left(\frac{\theta-1}{\gamma}\right) - \gamma \ln(\gamma^2-2\theta+\theta^2+1)$$

$$- 2\theta arctan\left(\frac{\gamma^2+\theta^2-\theta}{\gamma}\right)\Bigg]$$

and

$$E[X^2] = \int_{-1}^{1} x^2\left(\left(\pi\gamma\left[1+\left(\frac{x-\theta}{\gamma}\right)^2\right]\right)^{-1} + \left(\pi\gamma x^2\left[1+\left(\frac{\frac{1}{x}-\theta}{\gamma}\right)^2\right]\right)^{-1}\right)dx$$

$$= -\frac{1}{2}\frac{1}{\pi(\gamma^4 + 2\gamma^2\theta^2 + \theta^4)}\Bigg[\gamma\theta^5 ln(\gamma^2 + 2\theta + \theta^2 + 1) + \gamma^5\theta ln(\gamma^2 + 2\theta + \theta^2 + 1)$$

$$+ \gamma^2\theta^4 arctan\left(\frac{\theta - 1}{\gamma}\right) - 2\gamma^3 + \gamma\theta ln(\gamma^2 + 2\theta + \theta^2 + 1)$$

$$- \gamma^5\theta ln(\gamma^2 - 2\theta + \theta^2 + 1) - 2\gamma^3\theta^3 ln(\gamma^2 - 2\theta + \theta^2 + 1) - 2\gamma\theta^2$$

$$- 4\gamma^3\theta^2 - 2\gamma\theta^4 + 2\gamma^3\theta^3 ln(\gamma^2 + 2\theta + \theta^2 + 1) - 2\gamma^5$$

$$+ \gamma^6\theta arctan\left(\frac{1 + \theta}{\gamma}\right) + \gamma^2 arctan\left(\frac{\theta + \gamma^2 + \theta^2}{\gamma}\right) - \theta^6 arctan\left(\frac{1 + \theta}{\gamma}\right)$$

$$- \theta^2 arctan\left(\frac{\theta + \gamma^2 + \theta^2}{\gamma}\right) + \gamma^4\theta^2 arctan\left(\frac{1 + \theta}{\gamma}\right)$$

$$- \gamma^2\theta^4 arctan\left(\frac{1 + \theta}{\gamma}\right) - \gamma\theta ln(\gamma^2 - 2\theta + \theta^2 + 1)$$

$$- \gamma\theta^5 ln(\gamma^2 - 2\theta + \theta^2 + 1) - \gamma^4\theta^2 \arctan\left(\frac{\theta - 1}{\gamma}\right)$$

$$- \gamma^6 arctan\left(\frac{\theta - 1}{\gamma}\right) + \theta^6 arctan\left(\frac{\theta - 1}{\gamma}\right) - \theta^2 arctan\left(\frac{\gamma^2 + \theta^2 - \theta}{\gamma}\right)$$

$$+ \gamma^2 arctan\left(\frac{\gamma^2 + \theta^2 - \theta}{\gamma}\right)\Bigg]$$

Now, var[$X$]=E[$X^2$]-(E[$X$])$^2$ and is finite by Theorem 3.5.1. Hence, the twice-folded Cauchy has finite mean and variance, which are functions of the parent Cauchy distribution parameters.

The relationship between the mean and variance of the twice-folded Cauchy and the parameters of its unfolded parent Cauchy distribution is examined in Table 3.5.1. The mean of the twice-folded Cauchy is closer in absolute value to zero than the mean of the parent Cauchy distribution and decreases as the variance $\gamma$ increases. Values chosen for illustration of the relationship between the parameters of the parent Cauchy distribution and the twice-folded Cauchy distribution have $\theta$ vary from -1.0 to +1.0 by 0.5 and $\gamma \in \{0.1, 0.5, 1.0, 5.0, 10.0\}$. These values are used for both Table 3.5.1 and Table 3.5.2. The values of $\theta$ were selected to cover a narrow interval around zero since data are mean centered before calculating measures of spatial autocorrelation. A broader range for $\gamma$ was selected since the deviations are not standardized.

Table 3.5.1 Mean of Twice-folded Cauchy Distribution Based on Selected Cauchy ($\theta$, $\gamma$) Distributions

| | $\theta$ | | | | |
|---|---|---|---|---|---|
| $\gamma$ | **-1.0** | **-0.5** | **0.0** | **0.5** | **1.0** |
| **0.1** | -0.81 | -0.45 | 0.0 | 0.45 | 0.81 |
| **0.5** | -0.48 | -0.29 | 0.0 | 0.29 | 0.48 |
| **1.0** | -0.29 | -0.17 | 0.0 | 0.17 | 0.29 |
| **5.0** | -0.03 | -0.02 | 0.0 | 0.02 | 0.03 |
| **10.0** | -0.01 | 0.0 | 0.0 | 0.0 | 0.01 |

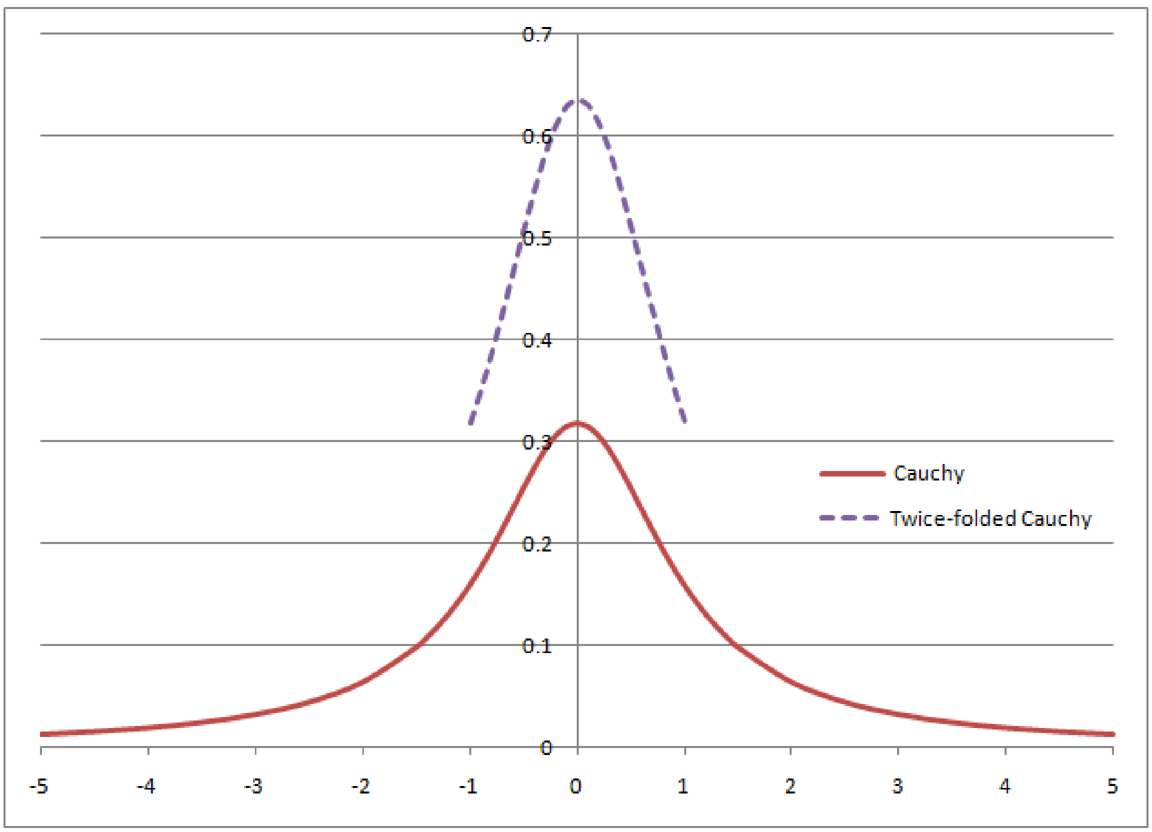
It is evident in Table 3.5.2 that the variance of the twice-folded Cauchy distribution increases as the variance of the parent Cauchy distribution increases up to $\gamma$ = 1.0, and then decreases as $\gamma$ increases. This is a result of the relationship of the twice-folded Cauchy to both the mean and variance of the parent Cauchy distribution.

A visual comparison of a standard Cauchy distribution and its twice-folded counterpart with folds at -1 and +1 is shown in Figure 3.5.1. Folding the tail areas of the parent Cauchy distribution has raised the central part of the distribution proportional to the area that is folded.

Table 3.5.2 Variance of Twice-folded Cauchy Distribution Based on Selected Cauchy ($\theta$, $\gamma$) Distributions

| | $\theta$ | | | | |
|---|---|---|---|---|---|
| $\gamma$ | **-1.0** | **-0.5** | **0.0** | **0.5** | **1.0** |
| **0.1** | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 |
| **0.5** | 0.20 | 0.23 | 0.23 | 0.23 | 0.20 |
| **1.0** | 0.23 | 0.26 | 0.27 | 0.26 | 0.23 |
| **5.0** | 0.13 | 0.13 | 0.13 | 0.13 | 0.13 |
| **10.0** | 0.07 | 0.08 | 0.08 | 0.08 | 0.07 |

Figure 3.5.1 Standard Cauchy and Twice-folded Cauchy Density Curves



The decision to fold instead of truncating the distribution was investigated by calculating the proportion of times the empirical sampling distribution of $H_i$ was folded for each region in a 4x4 study area using a Rook pattern variance-covariance matrix (see Appendix E.1) and each of the GWSCM's (see Appendices D.1, D.2, and D.3). These proportions are given in Table 3.5.3. Regions are identified by their row and column location. For example, Region 1 is in the first row and first column.

Some trends evident in Table 3.5.3 are that the largest proportions of folding are for corner regions, the smallest are for interior regions, and the proportion decreases as the number of neighbors increases with respect to GWSCM.

Table 3.5.3 Proportion of Empirical $H_i$ Distribution Folded for a 4x4 Study Area

| | | **Column** | | | |
|---|---|---|---|---|---|
| **Row** | **GWSCM** | **1** | **2** | **3** | **4** |
| **1** | **Rook** | 0.3787 | 0.3067 | 0.3127 | 0.3697 |
| | **Queen** | 0.3106 | 0.2263 | 0.2286 | 0.3070 |
| | **CWF** | 0.1784 | 0.1378 | 0.1445 | 0.1795 |
| **2** | **Rook** | 0.3264 | 0.2749 | 0.2633 | 0.3201 |
| | **Queen** | 0.2376 | 0.1591 | 0.1551 | 0.2329 |
| | **CWF** | 0.1462 | 0.0951 | 0.0900 | 0.1438 |
| **3** | **Rook** | 0.3102 | 0.2641 | 0.2631 | 0.3127 |
| | **Queen** | 0.2310 | 0.1501 | 0.1525 | 0.2276 |
| | **CWF** | 0.1367 | 0.0879 | 0.0877 | 0.1396 |
| **4** | **Rook** | 0.3860 | 0.3105 | 0.3169 | 0.3761 |
| | **Queen** | 0.3215 | 0.2363 | 0.2316 | 0.3072 |
| | **CWF** | 0.1866 | 0.1433 | 0.1410 | 0.1818 |

## 3.6 EXPERIMENTAL DESIGN FOR SIMULATIONS

The properties of local measures of spatial autocorrelation are investigated using the following conditions:

- Regular Square Tessellations with sizes of 4x4, 9x9 and 14x14. A 4x4 is the smallest practical size to study with randomization tests as exact results can be obtained for 2x2 and 3x3 regular square tessellation. A 14x14 is the maximum size for which the closest positive definite matrix can be found with current computing power. A 9x9 is between the smallest and largest study area sizes.
- Globally Weighted Spatial Connectivity Matrices for Rook Connectivity Case, Queen Connectivity Case and the Continuous Weighting Function (CWF) Connectivity Case with $b = 1.25$. A value of $b = 1.25$ is a reasonable extension to the Queen Connectivity Case as more neighbors are included in calculations.
- Spatial Correlation Pattern Matrices, to be used as variance-covariance matrices, based on Rook Connectivity Case, Queen Connectivity Case, Hot-Spot Case, and CWF Connectivity Case for highly correlated Regions, and an Identity matrix for size of test. Only positive spatial correlation is investigated since it is more common (Fotheringham 2009; Gumprecht, Muller et al. 2009).
- Six local measures: $I_i$, $c_i$, $G_i$, $G_i$*, $H_i$, and $H_i$*.

There were 45 scenarios that were run for each of the six local measures. This factorial arrangement of treatment conditions resulted in a total of 270 simulations. Personal desktop and laptop computers were used and run times varied from around an hour to a little over a week.

## 3.7 POSITIVE DEFINITE CORRELATION MATRICES

Valid correlation matrices must be positive semidefinite. Correlation matrices used as variance-covariance matrices in simulations must be positive definite. However, the correlation matrices resulting from connectivity matrices are not always positive definite. For example, the correlation matrix for the Rook Connectivity Case has the pattern shown in Table 3.7.1, where the correlation between neighboring regions has a high value of 0.9. Let $GWSCM_{Rook}$ = Rook Connectivity Case Geographically Weighted Spatial Connectivity Matrix and $\rho$ = correlation between two neighbors. Then the desired variance-covariance matrix for simulation studies is $R_{Rook}=\boldsymbol{I} + \rho \cdot GWSCM_{Rook}$, where $\boldsymbol{I}$ is an identity matrix.

Table 3.7.1 Example Spatial Autocorrelation Matrix for a 4x4 Study Area Based on Rook Connectivity Case with High Correlation

| Region | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 0.9 | 0 | 0 | 0.9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 0.9 | 1 | 0.9 | 0 | 0 | 0.9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 0 | 0.9 | 1 | 0.9 | 0 | 0 | 0.9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | 0 | 0 | 0.9 | 1 | 0 | 0 | 0 | 0.9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 0.9 | 0 | 0 | 0 | 1 | 0.9 | 0 | 0 | 0.9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | 0 | 0.9 | 0 | 0 | 0.9 | 1 | 0.9 | 0 | 0 | 0.9 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | 0 | 0 | 0.9 | 0 | 0 | 0.9 | 1 | 0.9 | 0 | 0 | 0.9 | 0 | 0 | 0 | 0 | 0 |
| 8 | 0 | 0 | 0 | 0.9 | 0 | 0 | 0.9 | 1 | 0 | 0 | 0 | 0.9 | 0 | 0 | 0 | 0 |
| 9 | 0 | 0 | 0 | 0 | 0.9 | 0 | 0 | 0 | 1 | 0.9 | 0 | 0 | 0.9 | 0 | 0 | 0 |
| 10 | 0 | 0 | 0 | 0 | 0 | 0.9 | 0 | 0 | 0.9 | 1 | 0.9 | 0 | 0 | 0.9 | 0 | 0 |
| 11 | 0 | 0 | 0 | 0 | 0 | 0 | 0.9 | 0 | 0 | 0.9 | 1 | 0.9 | 0 | 0 | 0.9 | 0 |
| 12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.9 | 0 | 0 | 0.9 | 1 | 0 | 0 | 0 | 0.9 |
| 13 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.9 | 0 | 0 | 0 | 1 | 0.9 | 0 | 0 |
| 14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.9 | 0 | 0 | 0.9 | 1 | 0.9 | 0 |
| 15 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.9 | 0 | 0 | 0.9 | 1 | 0.9 |
| 16 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.9 | 0 | 0 | 0.9 | 1 |

It is obvious that the Rook Connectivity Case excludes some correlations among regions. For example, since Region 2 is correlated with Regions 1, 3, and 6, and Region 1 is correlated with Regions 2 and 5, then Region 3 should be correlated with Region 5 and Region 1 should be correlated with Region 6. This is due to the transitive property of binary correlation as proved by Langford, et al. (2001). Whenever region *u* is related to region *v*, and region *v* is related to region *w*, then region *u* is also related to region *w*.

This matrix is not positive definite since it has eigenvalues that are not all greater than zero; they range from $\lambda_{max}$ = 4.20 to $\lambda_{min}$ = -2.20. Therefore, this matrix cannot be used as a variance-covariance matrix to simulate data in geographic regions. This led to the need to find the closest positive definite correlation matrix to a correlation matrix.

## 3.8 CLOSEST POSITIVE DEFINITE CORRELATION MATRIX

A MATLAB add-in software package for semidefinite-quadratic-linear programming, SDPT3, versions 3.0 and 4.0, developed by Toh, Tutuncu, and Todd (2006), was used to find the closest positive definite matrix to the desired correlation matrix. Closest is based on the Euclidean distance metric.

The closest positive definite matrix to $R_{Rook}$ with $\rho$ = 0.9 is given in Table 3.8.1. An examination of the binary correlations among all pairs of regions reveals that the largest correlation coefficient is 0.66 for each corner with its closest neighbors. It is also interesting to note that small correlation coefficients, say with absolute value less than 0.10, are at least a knight’s move from a given region.

Table 3.8.1 Closest Positive Definite Matrix to Spatial Autocorrelation Matrix for Rook Pattern with $\rho$=0.9

| Region | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 0.66 | 0.13 | -0.01 | 0.66 | 0.29 | -0.05 | -0.03 | 0.13 | -0.05 | -0.05 | 0.03 | -0.01 | -0.03 | 0.03 | 0.02 |
| 2 | 0.66 | 1 | 0.63 | 0.13 | 0.29 | 0.56 | 0.27 | -0.05 | -0.05 | 0.08 | -0.02 | -0.05 | -0.03 | 0.02 | -0.02 | 0.03 |
| 3 | 0.13 | 0.63 | 1 | 0.66 | -0.05 | 0.27 | 0.56 | 0.29 | -0.05 | -0.02 | 0.08 | -0.05 | 0.03 | -0.02 | 0.02 | -0.03 |
| 4 | -0.01 | 0.13 | 0.66 | 1 | -0.03 | -0.05 | 0.29 | 0.66 | 0.03 | -0.05 | -0.05 | 0.13 | 0.02 | 0.03 | -0.03 | -0.01 |
| 5 | 0.66 | 0.29 | -0.05 | -0.03 | 1 | 0.56 | 0.08 | 0.02 | 0.63 | 0.27 | -0.02 | -0.02 | 0.13 | -0.05 | -0.05 | 0.03 |
| 6 | 0.29 | 0.56 | 0.27 | -0.05 | 0.56 | 1 | 0.57 | 0.08 | 0.27 | 0.57 | 0.25 | -0.02 | -0.05 | 0.08 | -0.02 | -0.05 |
| 7 | -0.05 | 0.27 | 0.56 | 0.29 | 0.08 | 0.57 | 1 | 0.56 | -0.02 | 0.25 | 0.57 | 0.27 | -0.05 | -0.02 | 0.08 | -0.05 |
| 8 | -0.03 | -0.05 | 0.29 | 0.66 | 0.02 | 0.08 | 0.56 | 1 | -0.02 | -0.02 | 0.27 | 0.63 | 0.03 | -0.05 | -0.05 | 0.13 |
| 9 | 0.13 | -0.05 | -0.05 | 0.03 | 0.63 | 0.27 | -0.02 | -0.02 | 1 | 0.56 | 0.08 | 0.02 | 0.66 | 0.29 | -0.05 | -0.03 |
| 10 | -0.05 | 0.08 | -0.02 | -0.05 | 0.27 | 0.57 | 0.25 | -0.02 | 0.56 | 1 | 0.57 | 0.08 | 0.29 | 0.56 | 0.27 | -0.05 |
| 11 | -0.05 | -0.02 | 0.08 | -0.05 | -0.02 | 0.25 | 0.57 | 0.27 | 0.08 | 0.57 | 1 | 0.56 | -0.05 | 0.27 | 0.56 | 0.29 |
| 12 | 0.03 | -0.05 | -0.05 | 0.13 | -0.02 | -0.02 | 0.27 | 0.63 | 0.02 | 0.08 | 0.56 | 1 | -0.03 | -0.05 | 0.29 | 0.66 |
| 13 | -0.01 | -0.03 | 0.03 | 0.02 | 0.13 | -0.05 | -0.05 | 0.03 | 0.66 | 0.29 | -0.05 | -0.03 | 1 | 0.66 | 0.13 | -0.01 |
| 14 | -0.03 | 0.02 | -0.02 | 0.03 | -0.05 | 0.08 | -0.02 | -0.05 | 0.29 | 0.56 | 0.27 | -0.05 | 0.66 | 1 | 0.63 | 0.13 |
| 15 | 0.03 | -0.02 | 0.02 | -0.03 | -0.05 | -0.02 | 0.08 | -0.05 | -0.05 | 0.27 | 0.56 | 0.29 | 0.13 | 0.63 | 1 | 0.66 |
| 16 | 0.02 | 0.03 | -0.03 | -0.01 | 0.03 | -0.05 | -0.05 | 0.13 | -0.03 | -0.05 | 0.29 | 0.66 | -0.01 | 0.13 | 0.66 | 1 |

This software was also used to find the closest positive definite matrices to Rook Pattern variance-covariance matrices for 9x9 and 14x14 study areas, as well as those for Queen Pattern variance-covariance matrices for the three sizes of study areas. All variance-covariance matrices used in the simulation study are given in Appendix E.

## 3.9 MEASURES OF CORRELATION STRENGTH

To effectively compare correlation matrices, a meaningful measure of correlation strength for correlation matrices was selected. The statistic $CS = \frac{\lambda_{max}}{\sum_i \lambda_i}$ was chosen as the best overall measure of correlation strength, where $\lambda_i$ is an eigenvalue of the correlation matrix, $\lambda_{\max}$ is the largest eigenvalue, and *CS* denotes Correlation Strength. This method provides sufficient resolution to differentiate subtle differences in patterned correlation matrices. For an $n$x$n$ study area, possible values are $(1/n^2) \leq CS \leq 1.0$. The lower bound is obtained when there is no spatial autocorrelation and the upper bound is obtained when there is complete spatial autocorrelation among all regions. The concept underlying this statistic is based on the use of a similar ratio by Johnson and Graybill (1972). Other measures considered were $\lambda_{\max}$, $\lambda_{\min}$, $\frac{\lambda_{min}}{\lambda_{max}}$, Frobenius Norm, and a Modified Frobenius Norm.

The *CS* measure is illustrated in the following three scenarios which are based on a Rook pattern correlation matrix for a 4x4 regular square tessellation of geographic regions.

The example given in Table 3.7.1, when regions have a bivariate correlation of 0.9 among Rook Connectivity Case neighbors, is a correlation matrix with high positive spatial autocorrelation. It has $CS = 0.24$, which is very close to $CS_{RookMax} = 0.265$, the maximum value possible for a Rook pattern correlation matrix.

The closest positive definite correlation matrix to the example given in Table 3.7.1, which is given in Table 3.8.1, has $CS = 0.22$.

When regions have a very small bivariate correlation, say 0.03, among Rook Connectivity Case neighbors, then there is very little spatial autocorrelation among neighbors. This correlation matrix has $CS = 0.07$, which is very close to $CS$=0.0625 for an Identity matrix.

Table 3.9.1 gives the correlation strength and proportion of nonzero elements for each of the variance-covariance matrices used in the simulation study. The major trend

Table 3.9.1 Correlation Strength of Simulation Study Variance-Covariance Matrices

| Variance-Covariance Matrix Description | Correlation Strength | Proportion of Nonzero Elements |
|---|---|---|
| Identity Matrix for a 4x4 study area | 0.0625 | 0.0625 |
| Identity Matrix for a 9x9 study area | 0.0123 | 0.0123 |
| Identity Matrix for a 14x14 study area | 0.0051 | 0.0051 |
| Rook Pattern for 4x4 study area | 0.217 | 1.000 |
| Rook Pattern for 9x9 study area | 0.048 | 1.000 |
| Rook Pattern for 14x14 study area | 0.020 | 1.000 |
| Queen Pattern for 4x4 study area | 0.347 | 1.000 |
| Queen Pattern for 9x9 study area | 0.083 | 1.000 |
| Queen Pattern for 14x14 study area | 0.036 | 1.000 |
| Hot-Spot Pattern for 4x4 study area | 0.231 | 0.109 |
| Hot-Spot Pattern for 9x9 study area | 0.279 | 0.104 |
| Hot-Spot Pattern for 14x14 study area | 0.294 | 0.110 |
| Continuous-Weighting Pattern for 4x4 study area | 0.377 | 0.984 |
| Continuous-Weighting Pattern for 9x9 study area | 0.106 | 0.647 |
| Continuous-Weighting Pattern for 14x14 study area | 0.047 | 0.342 |

observed is that for a given pattern of variance-covariance matrix, *CS* decreases as the size of study area increases. The only exception is for the Hot-Spot Pattern, which was intentionally constructed to have similar *CS* values.

## 3.10 GENERATING MULTIVARIATE NORMAL RANDOM VECTORS

The R function dmnorn() was used to generate multivariate random variables with a mean of 10 and variance-covariance matrices described in Section 3.8. A mean of 10 was used to insure all values are positive, which is a requirement for the local measures $G_i$ and $G_i$* based on the original paper by Getis and Ord (1992).

## 3.11 SIZE AND POWER

Empirical estimates of size and power for the various local measures, under the appropriate randomization assumption, were estimated with simulation studies. Each simulation consisted of generating a random vector, considered the observed data for the geographic distribution of regions for the study area, and computing empirical p-values based on 1,000 randomizations. The *p*-value is found by computing the proportion of test statistic values that are more extreme or equal to the one obtained from the observed data. A total of 1,000 geographic distributions were simulated to estimate size and power. Since positive spatial autocorrelation is more common, as cited in Section 3.6, the alternative hypothesis is one-sided with respect to positive spatial autocorrelation.

An Identity matrix is used as the variance-covariance matrix when estimating the size of the test. The size of a test is the probability that a local measure will find a statistically significant result when the null hypothesis is true. This is referred to as the Type I error rate by Morris (2007). Only Type I error rates with $\alpha$=0.05 were investigated.

Power studies are based on the various patterned spatial correlation matrices used as variance-covariance matrices described in Section 3.8 and GWSCM matrices described in Section 2.2. Power is the probability of detecting a difference when the null hypothesis is false.

Three of the local measures, $G_i$, $G_i$*, and $H_i$* do not perform well in the simulations with respect to power. Recall that the model used for this research, given in Section 3.1, has constant mean. Getis and Ord (1992) state “A special feature of this statistic ($G_i$) is that the pattern of data points is neutralized when the expectation is that all $x$ values are the same.” This special feature is also applicable to $G_i$* and explains the low power for these two measures. The proposed measure, $H_i$*, did not perform well in the power study. Recall that this measure includes the current region’s value when calculating the mean of its neighbors, which necessitates the use of total randomization. As shown in Table 3.9.1, the proportion of nonzero entries in a variance-covariance matrix used to generate spatial autocorrelation is very small. Thus, the use of total randomization neutralizes the pattern of data points that is simulated to have spatial autocorrelation. Due to the neutralizing effect induced by the model on $G_i$ and $G_i$*, and the neutralizing effect induced by total randomization on $H_i$*, all three measures will be largely ignored in the power discussions to follow. For completeness, all three measures were included in the simulations.

# CHAPTER 4

# RESULTS AND FINDINGS

In order to evaluate the performance of the proposed measures, simulation studies as described in Section 3.6 were conducted. Results for the following scenarios are examined in detail for power:

- Rook Connectivity Case and Rook pattern variance-covariance matrix,
- Queen Connectivity Case and Queen pattern variance-covariance matrix,
- CWF Connectivity Case and CWF pattern variance-covariance matrix, and
- CWF Connectivity Case and Hot-Spot pattern variance-covariance matrix.

The first three scenarios were chosen based on a GWSCM and its association with the same pattern variance-covariance matrices. The last scenario was chosen since a hot spot is a cluster of regions and the CWF Connectivity Case provides the best definition of neighbors under these conditions. Other scenarios within the same class of variance-covariance matrix have GWSCM matrices that either over-specify or under-specify the true spatial autocorrelation among regions. Results for size of test are examined in detail for the Rook Connectivity Case only. Comparisons between $I_i$ and $H_i$ are highlighted to better understand the differences between these two local measures.

## 4.1 EMPIRICAL SIZE OF TEST

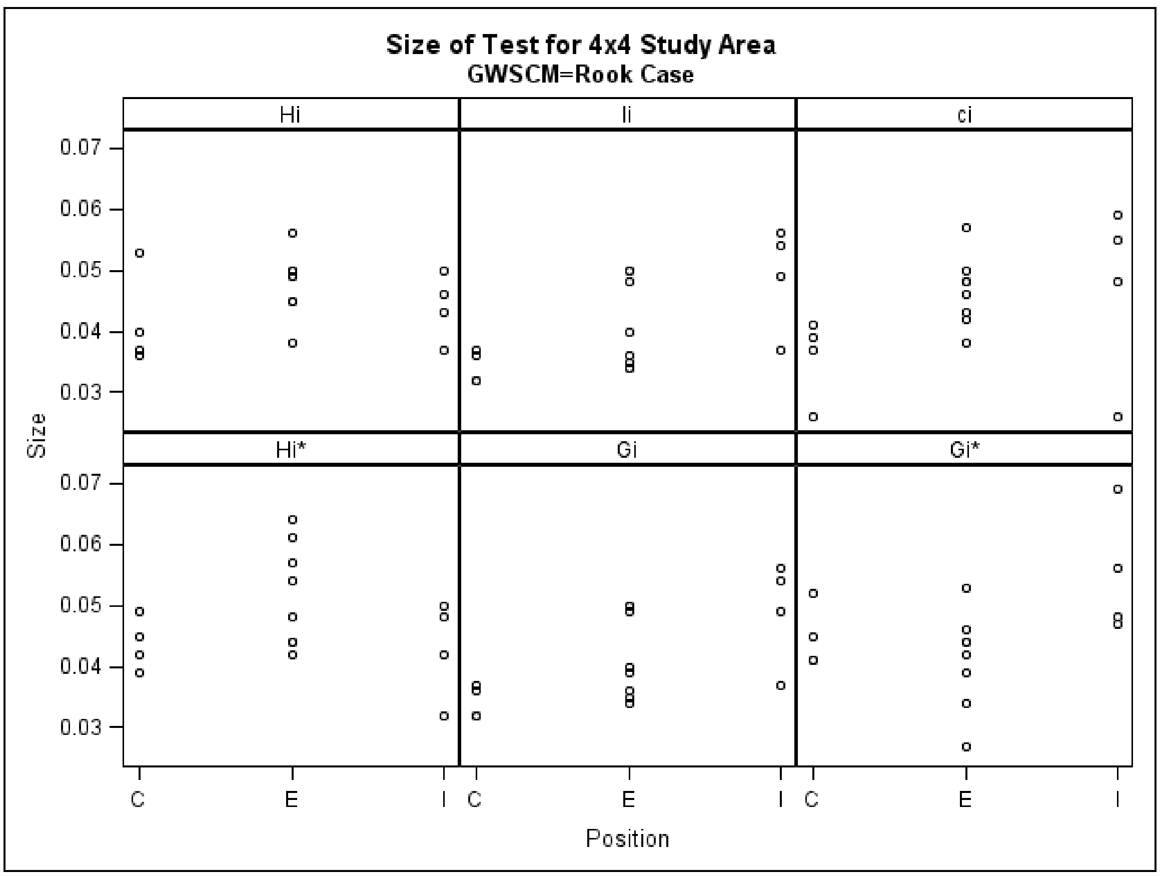
Results for size of test with $\alpha$=0.05 are summarized in Table 4.1.1. Table entries are obtained by averaging the sizes from all regions. It is seen that average size for a 4x4 study area is consistently less than 0.05 for all local measures and Geographically Weighted Spatially Connectivity Matrices. The average size is very close to 0.05 for 9x9 and 14x14 study areas for all local measures.

Table 4.1.1 Size of Test with $\alpha$=0.05 Averaged Over All Regions for Local Measures of Spatial Autocorrelation

| Local Measure | Size of Study Area | Rook Connectivity Case | Queen Connectivity Case | CWF Connectivity Case |
|---|---|---|---|---|
| $I_i$ | 4x4 | 0.0413 | 0.0461 | 0.0468 |
| | 9x9 | 0.0502 | 0.0507 | 0.0504 |
| | 14x14 | 0.0503 | 0.0499 | 0.0506 |
| $c_i$ | 4x4 | 0.0439 | 0.0485 | 0.0468 |
| | 9x9 | 0.0503 | 0.0509 | 0.0504 |
| | 14x14 | 0.0509 | 0.0506 | 0.0511 |
| Gi | 4x4 | 0.0416 | 0.0464 | 0.0468 |
| | 9x9 | 0.0502 | 0.0507 | 0.0504 |
| | 14x14 | 0.0503 | 0.0499 | 0.0506 |
| $G_i$* | 4x4 | 0.0455 | 0.0464 | 0.0465 |
| | 9x9 | 0.0505 | 0.0515 | 0.0510 |
| | 14x14 | 0.0508 | 0.0506 | 0.0506 |
| $H_i$ | 4x4 | 0.0453 | 0.0481 | 0.0476 |
| | 9x9 | 0.0498 | 0.0511 | 0.0503 |
| | 14x14 | 0.0509 | 0.0500 | 0.0501 |
| $H_i$* | 4x4 | 0.0476 | 0.0498 | 0.0488 |
| | 9x9 | 0.0495 | 0.0502 | 0.0501 |
| | 14x14 | 0.0507 | 0.0499 | 0.0509 |

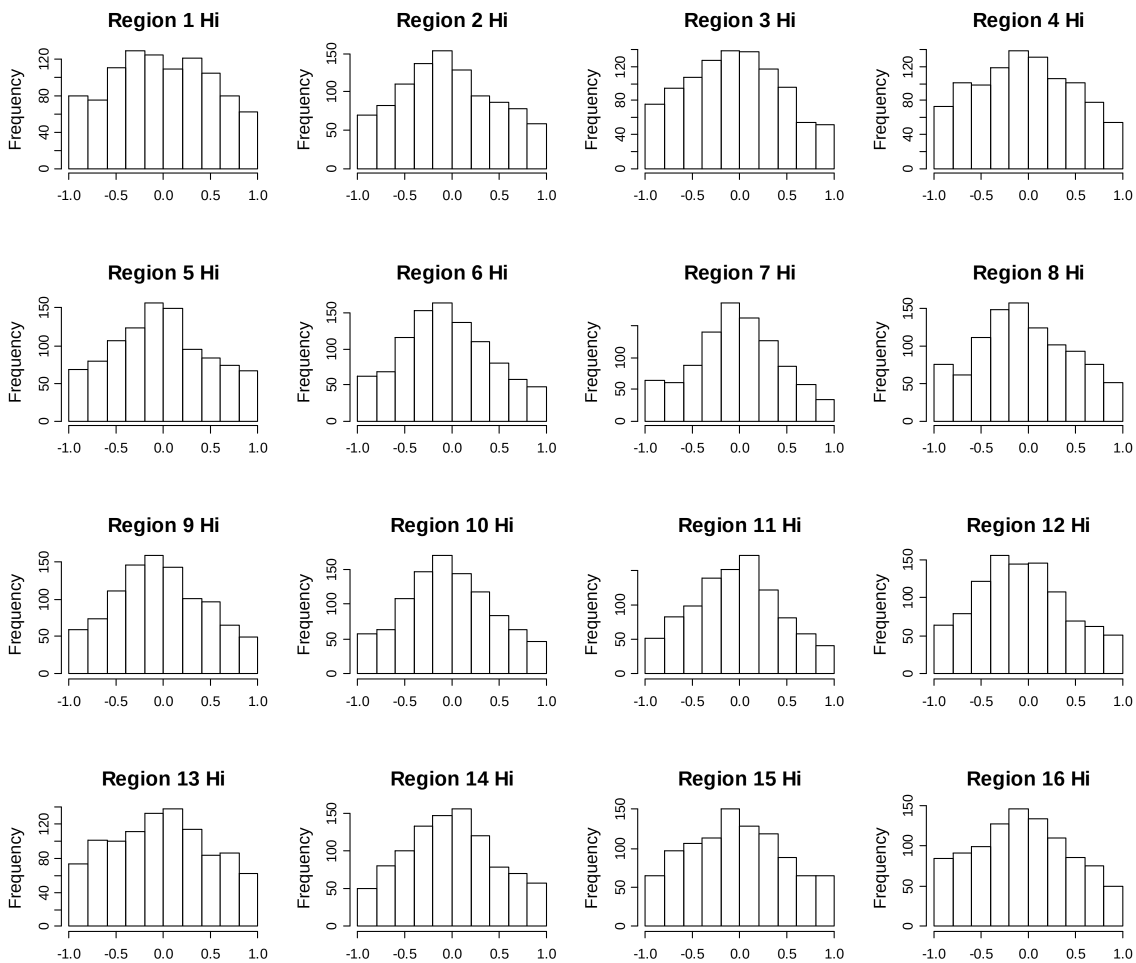
The number of neighbors associated with each region has some effect on the size and power of tests. Size results for each local measure of spatial autocorrelation based on the Rook Connectivity Case with $\alpha$=0.05 are presented for each region in Figure 4.1.1 for a 4x4 study area. The vertical axis is size of test and the horizontal axis is the location of a region within a study area which determines the number of neighbors, such as corner (C, 2 neighbors), edge (E, 3 neighbors), and interior (I, 4 neighbors). It is of interest to note that $H_i$ exhibits the smallest magnitude of changes as the number of neighbors is increased. Two-sigma tolerance limits based on 1,000 simulations are 0.05 ± 0.014. The only local measure with all values contained within these limits is $H_i$.

Figure 4.1.1 Size of Test with α=0.05 for Local Measures of Spatial Autocorrelation using Rook Connectivity Case for a 4x4 Study Area



Histograms for two local measures, $H_i$ and $I_i$, are examined for each region in a 4x4 study area. Histograms for $H_i$ are given in Figure 4.1.2. All histograms have exhibited the same general shape.

Figure 4.1.2 Sampling Distribution of $H_i$ under Null Hypothesis using Rook Connectivity Case for a 4x4 Study Area




Summary statistics are provided for each region to help interpret any differences in the sampling distributions of the test statistic among regions. These include the mean, standard deviation, skewness and kurtosis. Skewness measures the extent to which a distribution has long tails on one side or the other. Negative values indicate skew to the left, positive values indicate skew to the right, and a zero value indicates that values are relatively symmetrical. Kurtosis measures whether a distribution is peaked or flat when compared to a normal distribution. Values less than three indicate flat, or platykurtic, distributions, and values greater than three indicate peaked, or leptokurtic, distributions. A normal distribution has kurtosis=3.0.

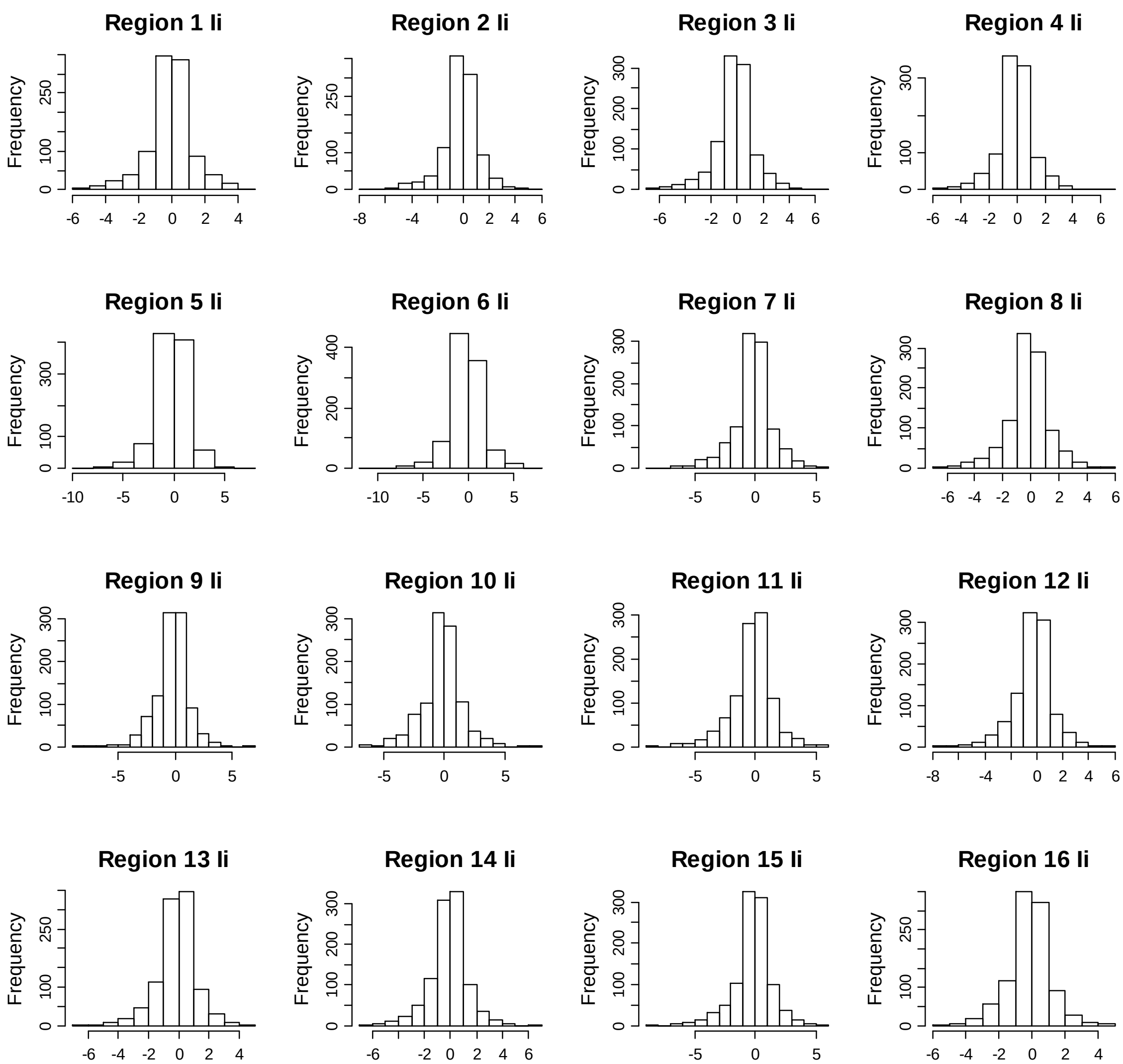
Statistics summarizing the distribution of $H_i$ values for each region for size of test are given in Table 4.1.2. The distributions for each region have exhibited little skewness and a slightly platykurtic shape. There is an inverse relationship between standard deviation and number of neighbors in that variation decreases as the number of neighbors increases.

Table 4.1.2 Summary Statistics of $H_i$ under Null Hypothesis using Rook Connectivity Case for a 4x4 Study Area

| **Region (Neighbors)** | **Mean** | **Std Dev** | **Skewness** | **Kurtosis** |
|---|---|---|---|---|
| 1 (2) | -0.0251 | 0.5195 | 0.0135 | 2.0476 |
| 2 (3) | -0.0380 | 0.5025 | 0.1226 | 2.1659 |
| 3 (3) | -0.0587 | 0.4990 | 0.0922 | 2.1631 |
| 4 (2) | -0.0368 | 0.5102 | 0.0687 | 2.0878 |
| 5 (3) | -0.0269 | 0.5013 | 0.1037 | 2.1951 |
| 6 (4) | -0.0536 | 0.4705 | 0.1415 | 2.3567 |
| 7 (4) | -0.0379 | 0.4521 | -0.0060 | 2.4682 |
| 8 (3) | -0.0382 | 0.5009 | 0.0870 | 2.2155 |
| 9 (3) | -0.0420 | 0.4826 | 0.1281 | 2.2520 |
| 10 (4) | -0.0336 | 0.4688 | 0.1161 | 2.3912 |
| 11 (4) | -0.0410 | 0.4637 | 0.0707 | 2.3747 |
| 12 (3) | -0.0647 | 0.4828 | 0.2043 | 2.3019 |
| 13 (2) | -0.0266 | 0.5194 | 0.0489 | 2.0450 |
| 14 (3) | -0.0130 | 0.4846 | 0.0900 | 2.2813 |
| 15 (3) | -0.0317 | 0.5051 | 0.0796 | 2.1514 |
| 16 (2) | -0.0544 | 0.5080 | 0.0866 | 2.1010 |

Histograms for $I_i$ are given in Figure 4.1.3. The sampling distributions have all exhibited a similar shape, which appears to be more peaked than a normal distribution.

Figure 4.1.3 Sampling Distribution of $I_i$ under Null Hypothesis using Rook Connectivity Case for a 4x4 Study Area



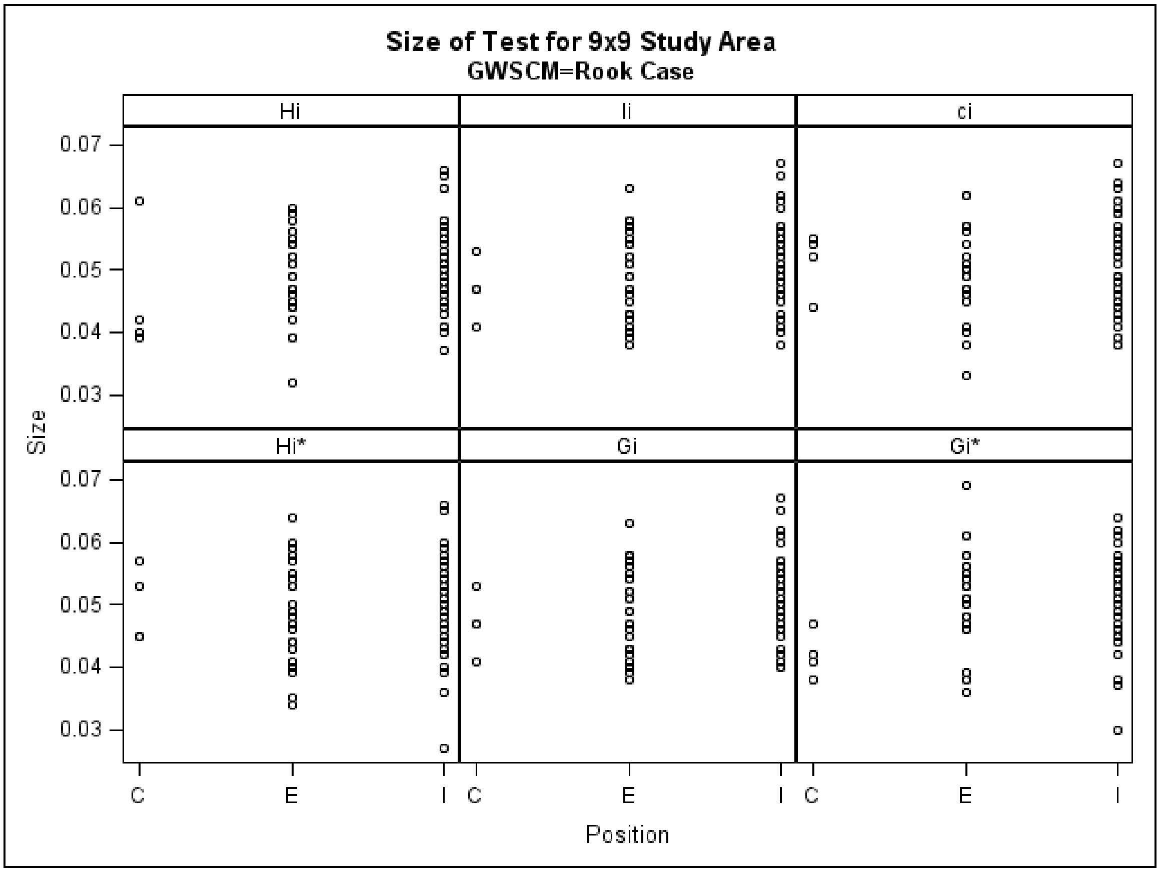

Summary statistics of the distribution of $I_i$ for each region are given in Table 4.1.3. Values of $I_i$ are seen to range from a minimum of -10.720 for Region 6 to a maximum of 7.726 for Region 10, with the distribution of each region skewed to the left and having a leptokurtic shape. There is a relationship between standard deviation and number of neighbors in that variation increases as the number of neighbors increases. This is opposite of the trend for $H_i$.

Table 4.1.3 Summary Statistics of $I_i$ under Null Hypothesis using Rook Connectivity Case for a 4x4 Study Area

| Region (Neighbors) | Min | Median | Mean | Max | Std Dev | Skewness | Kurtosis |
|---|---|---|---|---|---|---|---|
| 1 (2) | -5.5910 | -0.0205 | -0.1034 | 4.4110 | 1.3307 | -0.4633 | 5.0699 |
| 2 (3) | -7.6470 | -0.0645 | -0.2021 | 5.2530 | 1.3800 | -0.6339 | 6.2721 |
| 3 (3) | -6.4080 | -0.0579 | -0.1880 | 6.8770 | 1.5270 | -0.4707 | 5.9014 |
| 4 (2) | -5.6460 | -0.0271 | -0.1115 | 6.1620 | 1.3054 | -0.3696 | 5.8017 |
| 5 (3) | -8.2590 | -0.0425 | -0.1795 | 7.6320 | 1.5618 | -0.6565 | 6.4327 |
| 6 (4) | -10.720 | -0.0824 | -0.2162 | 7.0130 | 1.7458 | -0.3590 | 6.2300 |
| 7 (4) | -8.8530 | -0.0373 | -0.2027 | 5.5110 | 1.6613 | -0.7001 | 5.7841 |
| 8 (3) | -6.3170 | -0.0706 | -0.2182 | 5.5410 | 1.4836 | -0.4308 | 4.9434 |
| 9 (3) | -8.1380 | -0.0612 | -0.2488 | 6.3360 | 1.4748 | -0.4955 | 6.2369 |
| 10 (4) | -6.9170 | -0.0705 | -0.1951 | 7.7260 | 1.6546 | -0.1027 | 5.3108 |
| 11 (4) | -8.9960 | -0.0228 | -0.2606 | 5.2650 | 1.7266 | -0.6356 | 5.7487 |
| 12 (3) | -7.4250 | -0.1191 | -0.3111 | 5.2440 | 1.4862 | -0.6486 | 5.9496 |
| 13 (2) | -6.0480 | -0.0154 | -0.1502 | 4.7990 | 1.3129 | -0.5353 | 5.4333 |
| 14 (3) | -6.2030 | -0.0157 | -0.1524 | 6.9730 | 1.4404 | -0.3864 | 5.4569 |
| 15 (3) | -8.6560 | -0.0420 | -0.2184 | 5.4740 | 1.5413 | -0.8162 | 5.9025 |
| 16 (2) | -5.7280 | -0.0522 | -0.1830 | 4.7540 | 1.2552 | -0.3127 | 5.1040 |

The effect of increasing the number of regions on size of test using the Rook Connectivity Case is examined for 9x9 and 14x14 study areas. These results are plotted in Figure 4.1.4 and Figure 4.1.5. It is seen that size results are more consistently clustered around 0.05 for all locations within a study area for all local measures of spatial autocorrelation.

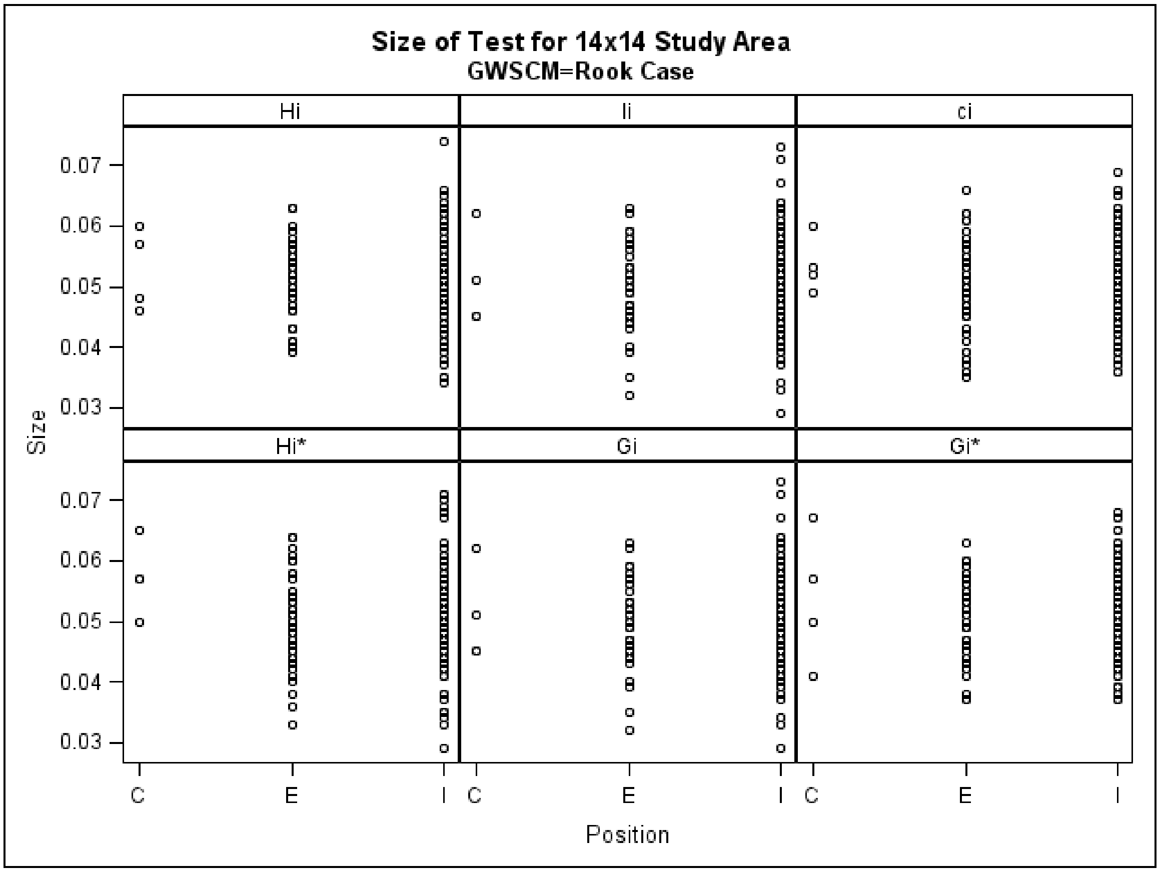
Figure 4.1.4 Size of Test with $\alpha$=0.05 for Local Measures of Spatial Autocorrelation using Rook Connectivity Case for a 9x9 Study Area




Size results for all other scenarios are presented in Appendix B. It is observed that size results for larger study areas and other Connectivity Cases are more consistent than the results for the 4x4 study area.

Based on these results for size of test, it is concluded that all local measures of spatial autocorrelation have empirical size of 0.05 when the study area is larger than 9x9. For a 4x4 study area, the test is slightly conservative.

Figure 4.1.5 Size of Test with $\alpha$=0.05 for Local Measures of Spatial Autocorrelation using Rook Connectivity Case for a 14x14 Study Area



## 4.2 EMPIRICAL POWER OF TEST

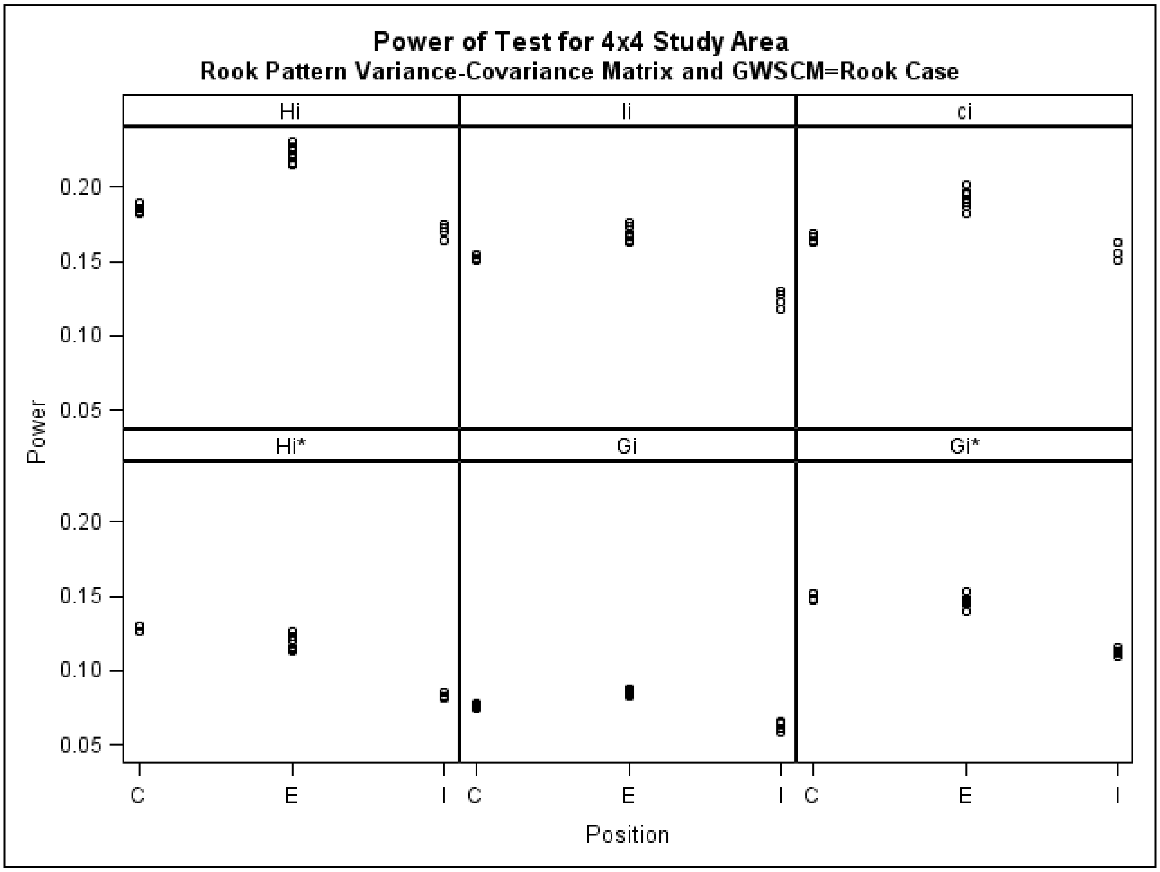
Power results averaged over all regions for a 4x4 study area for the three connectivity matrices for the Rook Pattern variance-covariance matrix are given in Table 4.2.1. It is observed that $H_i$ obtains the highest average power for each location for the Rook Connectivity Case, whereas $I_i$ obtains the highest power for each location for the Queen and CWF Connectivity Cases. There is also an effect with connectivity matrices. The four current measures obtain highest power for the CWF Connectivity Case, next highest power for the Queen Connectivity Case, and lowest power for the Rook Connectivity Case. The two proposed measures are almost invariant to Rook and Queen Connectivity matrices, but $H_i$ obtains slightly higher power for the CWF Connectivity matrix.

The location of each region within the study area has some effect on power. Results for power with $\alpha$=0.05 for a Rook Pattern variance-covariance matrix using Rook Connectivity Case for a 4x4 study area are plotted in Figure 4.2.1. Maximum power is obtained at edge regions, which have three neighbors, for $H_i$, $I_i$, and $c_i$. It is interesting to note that the range of points is fairly consistent with the number of neighbors for all local measures. It is evident that $H_i$ obtains the highest power for all locations for this scenario, with power that ranges from 0.21-0.23 for edge regions.

Table 4.2.1 Power of Test with $\alpha$=0.05 for Local Measures of Spatial Autocorrelation Averaged Over All Regions for a 4x4 Study Area Based on Rook Pattern Variance-Covariance Matrix

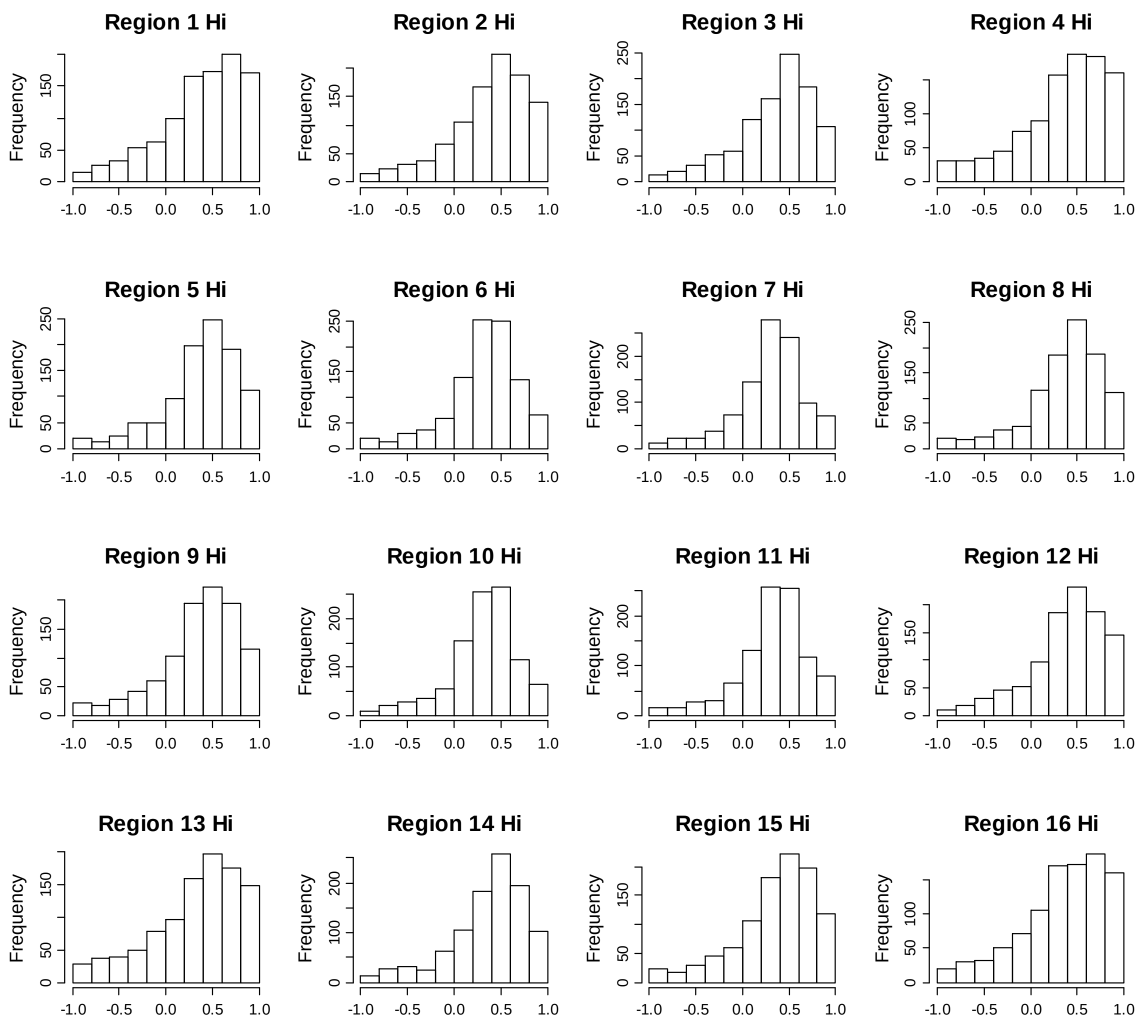
| **Local Measure** | **Region Location** | **Rook Connectivity Case** | **Queen Connectivity Case** | **CWF Connectivity Case** |
|---|---|---|---|---|
| $I_i$ | C | 0.1528 | 0.2358 | 0.2743 |
| | E | 0.1691 | 0.2510 | 0.2839 |
| | I | 0.1248 | 0.2313 | 0.2560 |
| $c_i$ | C | 0.1657 | 0.2143 | 0.2488 |
| | E | 0.1923 | 0.2361 | 0.2599 |
| | I | 0.1582 | 0.2115 | 0.2420 |
| $G_i$ | C | 0.0761 | 0.1328 | 0.1590 |
| | E | 0.0854 | 0.1359 | 0.1523 |
| | I | 0.0623 | 0.1223 | 0.1318 |
| $G_i$* | C | 0.1497 | 0.1708 | 0.1808 |
| | E | 0.1460 | 0.1679 | 0.1818 |
| | I | 0.1125 | 0.1400 | 0.1658 |
| $H_i$ | C | 0.1855 | 0.1815 | 0.2355 |
| | E | 0.2219 | 0.2204 | 0.2613 |
| | I | 0.1705 | 0.2168 | 0.2485 |
| $H_i$* | C | 0.1282 | 0.1123 | 0.0963 |
| | E | 0.1194 | 0.1140 | 0.1016 |
| | I | 0.0829 | 0.0930 | 0.0773 |

Figure 4.2.1 Power of Test with $\alpha$=0.05 for Local Measures of Spatial Autocorrelation for a 4x4 Study Area Based on Rook Pattern Variance-Covariance Matrix using Rook Connectivity Case




Histograms for two local measures, $H_i$ and $I_i$, are examined for each region in a 4x4 study area. Histograms for the sampling distribution of $H_i$ are given in Figure 4.2.2. It is seen that all sampling distributions are skewed to the left with slight differences between corner, edge, and interior regions.

Figure 4.2.2 Sampling Distribution of $H_i$ for a 4x4 Study Area Based on Rook Pattern Variance-Covariance Matrix using Rook Connectivity Case



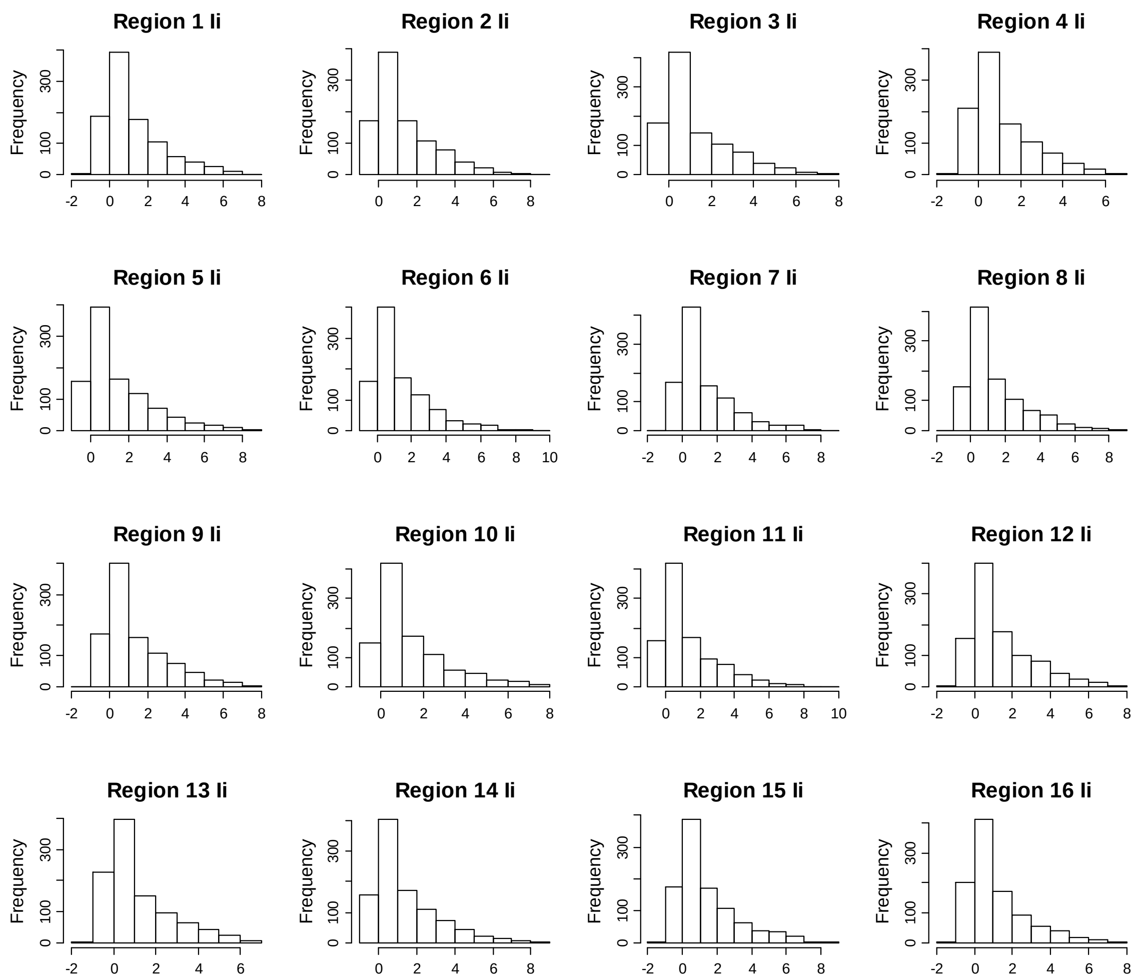

Summary statistics for the sampling distribution of $H_i$ are provided in Table 4.2.2 for each region to help interpret any trends with number of neighbors and examine differences in the distributions of the test statistic among regions. The sampling distribution for each region is skewed to the left, as shown by values of skewness around -1, is symmetrical for corner regions, slightly leptokurtic for edge regions, and more leptokurtic for interior regions. There is an inverse relationship between standard deviation and number of neighbors in that variation decreases as the number of neighbors increases.

Table 4.2.2 Summary Statistics of $H_i$ for a 4x4 Study Area Based on Rook Pattern Variance-Covariance Matrix using Rook Connectivity Case

| Region (Neighbors) | Mean | Std Dev | Skewness | Kurtosis |
|---|---|---|---|---|
| 1 (2) | 0.3706 | 0.4457 | -0.8450 | 3.1266 |
| 2 (3) | 0.3726 | 0.4211 | -0.9403 | 3.4925 |
| 3 (3) | 0.3460 | 0.4132 | -0.8847 | 3.4476 |
| 4 (2) | 0.3369 | 0.4757 | -0.8880 | 3.1152 |
| 5 (3) | 0.3707 | 0.4077 | -1.0542 | 3.9916 |
| 6 (4) | 0.3081 | 0.3751 | -1.0172 | 4.3419 |
| 7 (4) | 0.2985 | 0.3673 | -0.8434 | 4.0907 |
| 8 (3) | 0.3694 | 0.4057 | -1.1382 | 4.3482 |
| 9 (3) | 0.3574 | 0.4113 | -0.9902 | 3.7585 |
| 10 (4) | 0.3093 | 0.3559 | -0.9304 | 4.2179 |
| 11 (4) | 0.3176 | 0.3790 | -0.9579 | 4.2835 |
| 12 (3) | 0.3860 | 0.4081 | -0.9590 | 3.6175 |
| 13 (2) | 0.3218 | 0.4682 | -0.8151 | 3.0064 |
| 14 (3) | 0.3624 | 0.4074 | -1.0593 | 3.9405 |
| 15 (3) | 0.3553 | 0.4241 | -1.0314 | 3.8443 |
| 16 (2) | 0.3475 | 0.4524 | -0.8387 | 3.1293 |

Histograms for the sampling distribution of $I_i$ are given in Figure 4.2.3. It is seen that all distributions are skewed to the right and are similar for corner, edge, and interior regions.

Figure 4.2.3 Sampling Distribution of $I_i$ for a 4x4 Study Area Based on Rook Pattern Variance-Covariance Matrix using Rook Connectivity Case




Summary statistics of the sampling distribution of $I_i$ for each region are given in Table 4.2.3. The distribution of each region is skewed to the right and has a leptokurtic shape. There is a relationship between standard deviation and number of neighbors in that variation increases as the number of neighbors increases. This is opposite of the trend for $H_i$.

Table 4.2.3 Summary Statistics of $I_i$ for a 4x4 Study Area Based on Rook Pattern Variance-Covariance Matrix using Rook Connectivity Case

| Region (Neighbors) | Min | Median | Mean | Max | Std Dev | Skewness | Kurtosis |
|---|---|---|---|---|---|---|---|
| 1 (2) | -1.0800 | 0.6536 | 1.2000 | 7.3890 | 1.5503 | 1.3419 | 4.3860 |
| 2 (3) | -0.7485 | 0.7572 | 1.3220 | 8.9960 | 1.5979 | 1.3729 | 4.6392 |
| 3 (3) | -0.9260 | 0.5997 | 1.2570 | 7.9720 | 1.6168 | 1.4204 | 4.5748 |
| 4 (2) | -1.3860 | 0.5812 | 1.1190 | 6.8320 | 1.4730 | 1.2603 | 4.0758 |
| 5 (3) | -0.7972 | 0.8431 | 1.4420 | 8.2090 | 1.7531 | 1.4118 | 4.6249 |
| 6 (4) | -0.9946 | 0.7300 | 1.3680 | 9.0780 | 1.7074 | 1.5614 | 5.4209 |
| 7 (4) | -1.3020 | 0.6385 | 1.2540 | 8.4960 | 1.6148 | 1.5800 | 5.2948 |
| 8 (3) | -1.1560 | 0.7385 | 1.3670 | 8.5970 | 1.6574 | 1.3808 | 4.5240 |
| 9 (3) | -1.1660 | 0.7427 | 1.3320 | 7.8650 | 1.6285 | 1.3214 | 4.2915 |
| 10 (4) | -0.8394 | 0.7146 | 1.3430 | 7.7030 | 1.6447 | 1.4624 | 4.7545 |
| 11 (4) | -0.9014 | 0.7332 | 1.3240 | 9.5060 | 1.6582 | 1.5045 | 5.1406 |
| 12 (3) | -1.0570 | 0.8162 | 1.3500 | 7.9810 | 1.6112 | 1.3200 | 4.3531 |
| 13 (2) | -1.4210 | 0.5642 | 1.1020 | 9.8160 | 1.4927 | 1.3052 | 4.1228 |
| 14 (3) | -0.9904 | 0.7098 | 1.3050 | 8.1010 | 1.6074 | 1.4146 | 4.7378 |
| 15 (3) | -1.1490 | 0.6787 | 1.3410 | 8.0180 | 1.6657 | 1.3671 | 4.2490 |
| 16 (2) | -1.2940 | 0.5887 | 1.1190 | 7.4650 | 1.4930 | 1.5086 | 5.1104 |

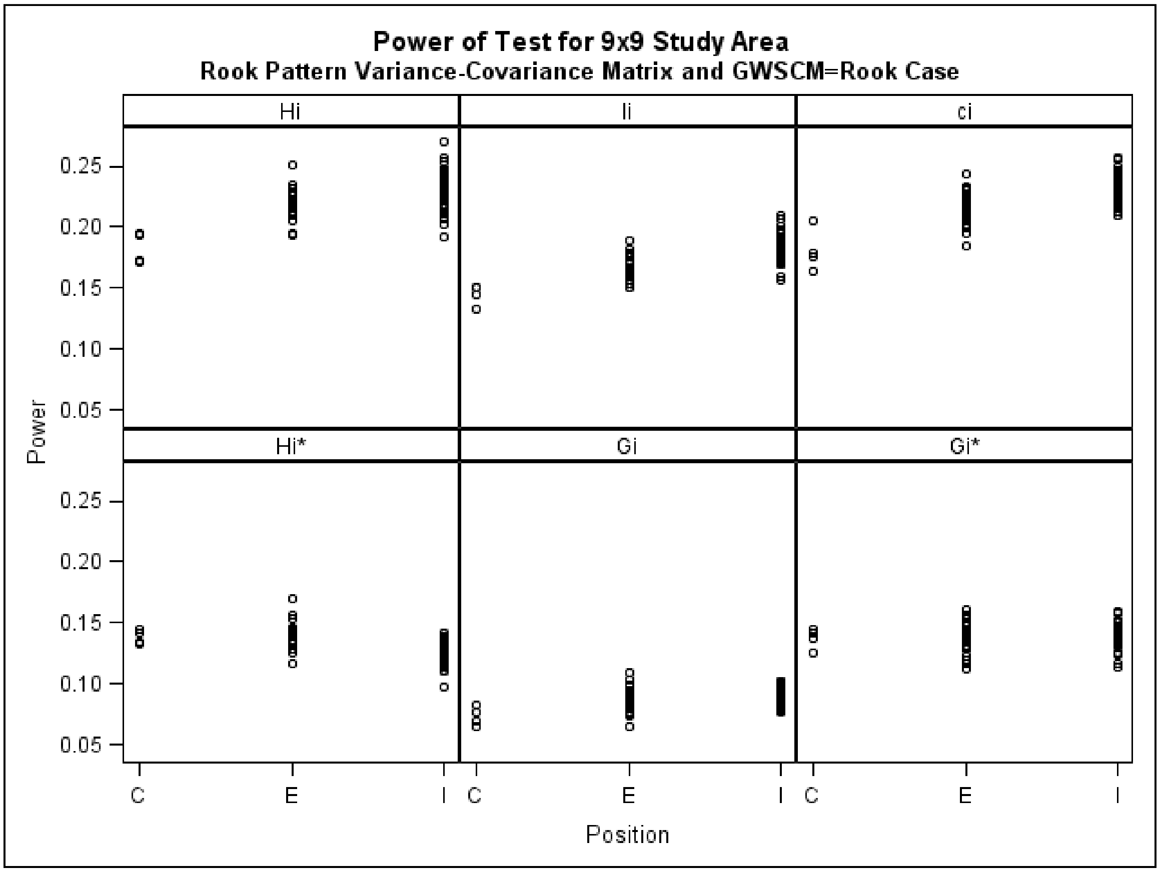
Power results averaged over all regions for a 9x9 study area for the Rook Pattern variance-covariance matrix are given in Table 4.2.4. It is observed that $H_i$ obtains the highest average power for each location for the Rook Connectivity Case, whereas $c_i$ obtains the highest average power for all locations for the Queen and CWF Connectivity Cases. There is also an effect with connectivity matrices. The four current measures obtain highest power for the CWF Connectivity Case, next highest power for the Queen Connectivity Case, and lowest power for the Rook Connectivity Case. The two proposed measures are invariant to connectivity matrix for this study area.

Table 4.2.4 Power of Test with $\alpha$=0.05 for Local Measures of Spatial Autocorrelation for a 9x9 Study Area Averaged Over Locations Based on Rook Pattern Variance-Covariance Matrix

| Local Measure | Region Location | Rook Connectivity Case | Queen Connectivity Case | CWF Connectivity Case |
|---|---|---|---|---|
| $I_i$ | C | 0.1445 | 0.2253 | 0.2645 |
| | E | 0.1672 | 0.2451 | 0.2792 |
| | I | 0.1838 | 0.2690 | 0.3006 |
| $c_i$ | C | 0.1805 | 0.2410 | 0.2768 |
| | E | 0.2163 | 0.2684 | 0.2974 |
| | I | 0.2292 | 0.2848 | 0.3057 |
| $G_i$ | C | 0.0733 | 0.1285 | 0.1623 |
| | E | 0.0857 | 0.1341 | 0.1629 |
| | I | 0.0904 | 0.1435 | 0.1705 |
| $G_i$* | C | 0.1373 | 0.1623 | 0.1803 |
| | E | 0.1389 | 0.1635 | 0.1806 |
| | I | 0.1390 | 0.1673 | 0.1878 |
| $H_i$ | C | 0.1828 | 0.1780 | 0.1980 |
| | E | 0.2203 | 0.2138 | 0.2406 |
| | I | 0.2307 | 0.2418 | 0.2701 |
| $H_i$* | C | 0.1380 | 0.1205 | 0.1028 |
| | E | 0.1391 | 0.1226 | 0.1128 |
| | I | 0.1247 | 0.1179 | 0.1130 |

The effect of location on power is examined for a 9x9 study area using the Rook Connectivity Case. These results are plotted in Figure 4.2.4. Maximum power is obtained at interior regions, which have four neighbors, for $H_i$, $I_i$, and $c_i$. It is also seen that the range of points varies with the number of neighbors for all local measures of spatial autocorrelation. It is evident that $H_i$ obtains the highest power for all locations for this scenario.

Figure 4.2.4 Power of Test with $\alpha$=0.05 for Local Measures of Spatial Autocorrelation for a 9x9 Study Area Based on Rook Pattern Variance-Covariance Matrix using Rook Connectivity Case




Power results averaged over all regions for a 14x14 study area for the Rook Pattern variance-covariance matrix are given in Table 4.2.5. It is observed that $c_i$ obtains the highest average power for all locations for the Rook, Queen, and CWF Connectivity Cases. There is also an effect with connectivity matrices. The four current measures obtain highest power for the CWF Connectivity Case, next highest power for the Queen Connectivity Case, and lowest power for the Rook Connectivity Case. The two proposed measures are almost invariant to Rook and Queen Connectivity matrices, but $H_i$ obtains slightly higher power for the CWF Connectivity matrix.

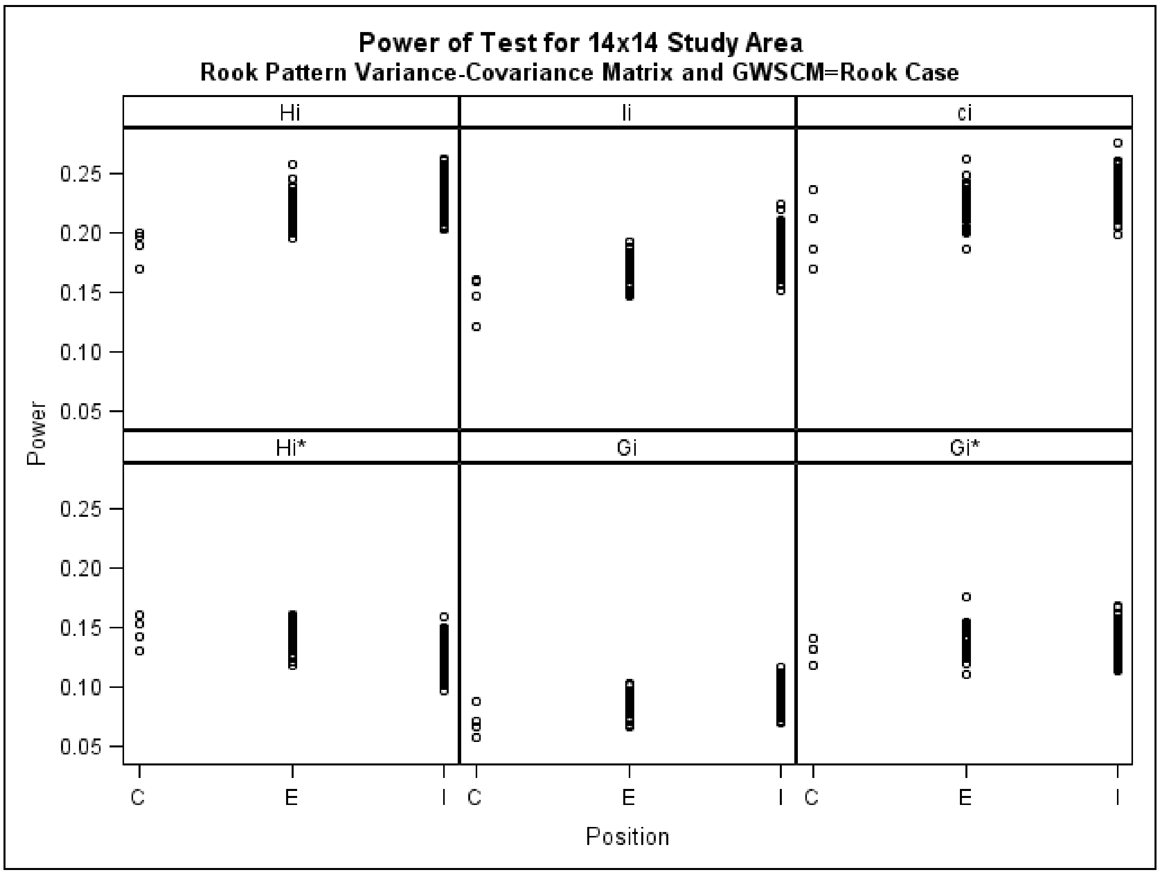
Table 4.2.5 Power of Test with $\alpha$=0.05 for Local Measures of Spatial Autocorrelation for a 14x14 Study Area Averaged Over Locations Based on Rook Pattern Variance-Covariance Matrix

| Local Measure | Region Location | Rook Connectivity Case | Queen Connectivity Case | CWF Connectivity Case |
|---|---|---|---|---|
| $I_i$ | C | 0.1470 | 0.2240 | 0.2678 |
| | E | 0.1696 | 0.2461 | 0.2826 |
| | I | 0.1835 | 0.2663 | 0.3001 |
| $c_i$ | C | 0.2010 | 0.2650 | 0.3025 |
| | E | 0.2240 | 0.2779 | 0.3067 |
| | I | 0.2337 | 0.2878 | 0.3105 |
| $G_i$ | C | 0.0713 | 0.1208 | 0.1585 |
| | E | 0.0852 | 0.1335 | 0.1654 |
| | I | 0.0917 | 0.1433 | 0.1737 |
| $G_i$* | C | 0.1308 | 0.1513 | 0.1700 |
| | E | 0.1389 | 0.1623 | 0.1814 |
| | I | 0.1406 | 0.1676 | 0.1904 |
| $H_i$ | C | 0.1890 | 0.1755 | 0.2075 |
| | E | 0.2215 | 0.2127 | 0.2413 |
| | I | 0.2315 | 0.2393 | 0.2644 |
| $H_i$* | C | 0.1470 | 0.1220 | 0.1163 |
| | E | 0.1414 | 0.1223 | 0.1116 |
| | I | 0.1291 | 0.1185 | 0.1104 |

The effect of location on power of the test is examined for a 14x14 study area using the Rook Connectivity Case. These results are plotted in Figure 4.2.5. Maximum power is obtained at interior regions, which have four neighbors, for $H_i$, $I_i$, and $c_i$, with a trend that increases as the number of neighbors associated with each location increases. The performance of $H_i$ and $c_i$ are very similar, and both have higher power than $I_i$.

Additional results are given in Appendix B for the Rook Pattern variance-covariance matrix using Queen and CWF Connectivity Cases. Both of these connectivity matrices over specify the relationship among neighbors for Rook Pattern spatial autocorrelation.

Figure 4.2.5 Power of Test with $\alpha$=0.05 for Local Measures of Spatial Autocorrelation for a 14x14 Study Area Based on Rook Pattern Variance-Covariance Matrix using Rook Connectivity Case




Power results averaged over all regions for a 4x4 study area for the Queen Pattern variance-covariance matrix are given in Table 4.2.6. For the Rook Connectivity Case, it is observed that $I_i$ obtains the highest average power for corner regions, $c_i$ obtains the highest average power for interior regions, and $H_i$ obtains the highest average power for edge regions. The highest average power for the Queen and CWF Connectivity Cases is obtained by $c_i$ for all locations. There is also an effect with connectivity matrices. The four current measures and the proposed measure, $H_i$, obtain highest power for the CWF Connectivity Case, next highest power for the Queen Connectivity Case, and lowest power for the Rook Connectivity Case.

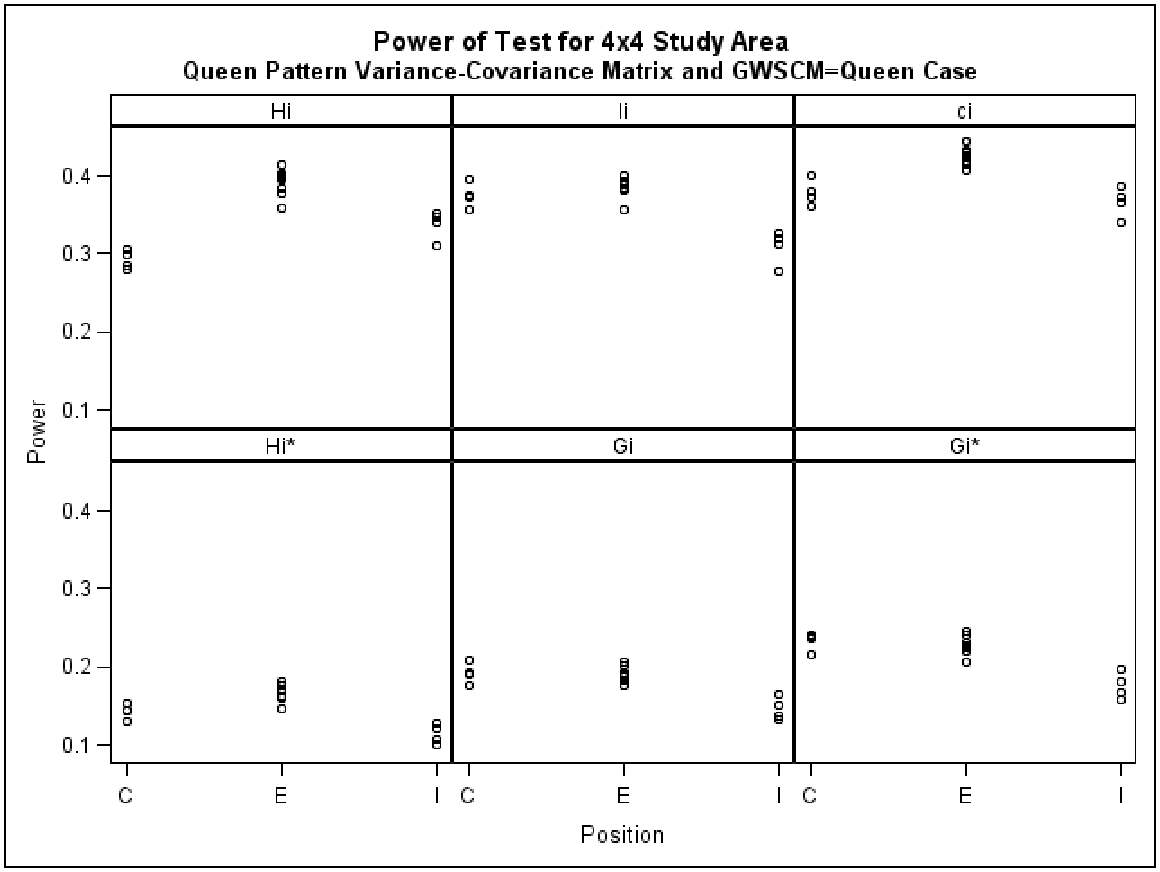
Table 4.2.6 Power of Test with $\alpha$=0.05 for Local Measures of Spatial Autocorrelation Averaged Over Locations for a 4x4 Study Area Based on Queen Pattern Variance-Covariance Matrix

| Local Measure | Region Location | Rook Connectivity Case | Queen Connectivity Case | CWF Connectivity Case |
|---|---|---|---|---|
| $I_i$ | C | 0.2855 | 0.3748 | 0.4175 |
| | E | 0.2634 | 0.3851 | 0.4266 |
| | I | 0.1675 | 0.3090 | 0.3313 |
| $c_i$ | C | 0.2603 | 0.3780 | 0.4183 |
| | E | 0.3031 | 0.4270 | 0.4588 |
| | I | 0.2585 | 0.3665 | 0.4163 |
| $G_i$ | C | 0.1440 | 0.1918 | 0.2295 |
| | E | 0.1318 | 0.1909 | 0.2166 |
| | I | 0.0765 | 0.1465 | 0.1585 |
| $G_i$* | C | 0.2128 | 0.2330 | 0.2555 |
| | E | 0.1924 | 0.2271 | 0.2434 |
| | I | 0.1270 | 0.1755 | 0.1900 |
| $H_i$ | C | 0.2638 | 0.2925 | 0.3610 |
| | E | 0.3410 | 0.3910 | 0.4139 |
| | I | 0.2315 | 0.3375 | 0.3453 |
| $H_i$* | C | 0.1520 | 0.1428 | 0.1310 |
| | E | 0.1670 | 0.1668 | 0.1243 |
| | I | 0.0883 | 0.1138 | 0.0898 |

Results for power with $\alpha$=0.05 using Queen Connectivity Case for a 4x4 study area are plotted in Figure 4.2.6. Maximum power is obtained at edge regions, which have five neighbors, and lower power is observed at corner and interior regions. The highest observed power, which ranges from 0.41 to 0.44, is achieved by $c_i$ for edge regions. $H_i$

obtains higher power than $I_i$ for edge and interior regions, but lower power for corner regions.

Figure 4.2.6 Power of Test with $\alpha$=0.05 for Local Measures of Spatial Autocorrelation for a 4x4 Study Area Based on Queen Pattern Variance-Covariance Matrix using Queen Connectivity Case



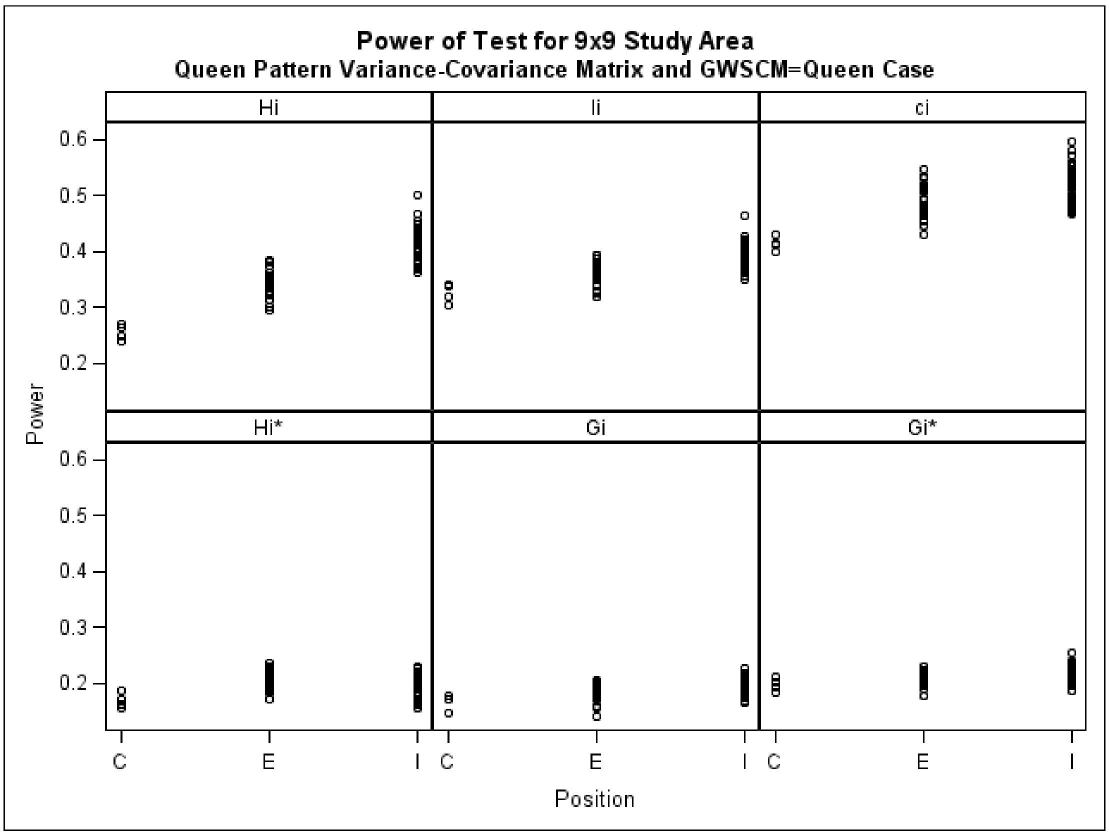

Power results averaged over all regions for a 9x9 study area for the Queen Pattern variance-covariance matrix are given in Table 4.2.7. It is observed that $c_i$ has the highest average power for all locations for the Rook, Queen, and CWF Connectivity Cases. There is also an effect with connectivity matrices. The four current measures and the proposed measure, $H_i$, obtain highest power for the CWF Connectivity Case, next highest power for the Queen Connectivity Case, and lowest power for the Rook Connectivity Case.

Table 4.2.7 Power of Test with $\alpha$=0.05 for Local Measures of Spatial Autocorrelation for a 9x9 Study Area Averaged Over Locations Based on Queen Pattern Variance-Covariance Matrix

| Local Measure | Region Location | Rook Connectivity Case | Queen Connectivity Case | CWF Connectivity Case |
|---|---|---|---|---|
| $I_i$ | C | 0.2328 | 0.3260 | 0.3783 |
| | E | 0.2495 | 0.3605 | 0.4118 |
| | I | 0.2774 | 0.3911 | 0.4424 |
| $c_i$ | C | 0.2968 | 0.4140 | 0.4640 |
| | E | 0.3653 | 0.4881 | 0.4991 |
| | I | 0.4231 | 0.5199 | 0.5244 |
| $G_i$ | C | 0.1198 | 0.1675 | 0.2140 |
| | E | 0.1269 | 0.1818 | 0.2200 |
| | I | 0.1377 | 0.1950 | 0.2302 |
| $G_i$* | C | 0.1688 | 0.1980 | 0.2210 |
| | E | 0.1745 | 0.2103 | 0.2342 |
| | I | 0.1788 | 0.2191 | 0.2472 |
| $H_i$ | C | 0.2410 | 0.2560 | 0.2805 |
| | E | 0.3246 | 0.3441 | 0.3529 |
| | I | 0.3708 | 0.4137 | 0.4137 |
| $H_i$* | C | 0.1805 | 0.1698 | 0.1463 |
| | E | 0.2250 | 0.2064 | 0.1654 |
| | I | 0.2151 | 0.1936 | 0.1671 |

The location of each region has some effect on power. Results for power with $\alpha$=0.05 using the Queen Connectivity Case for a 9x9 study area are plotted in Figure 4.2.7. Maximum power is obtained for interior regions, which have eight neighbors, for $H_i$, $I_i$, and $c_i$, with lower power obtained by edge regions and lowest power for corner regions. The highest overall power, which ranges from 0.47 to 0.60, is achieved by $c_i$ for interior regions. $H_i$ obtains higher power then $I_i$ for interior regions, no difference for edge regions, and lower power for corner regions.

Figure 4.2.7 Power of Test with $\alpha$=0.05 for Local Measures of Spatial Autocorrelation for a 9x9 Study Area Based on Queen Pattern Variance-Covariance Matrix using Queen Connectivity Case



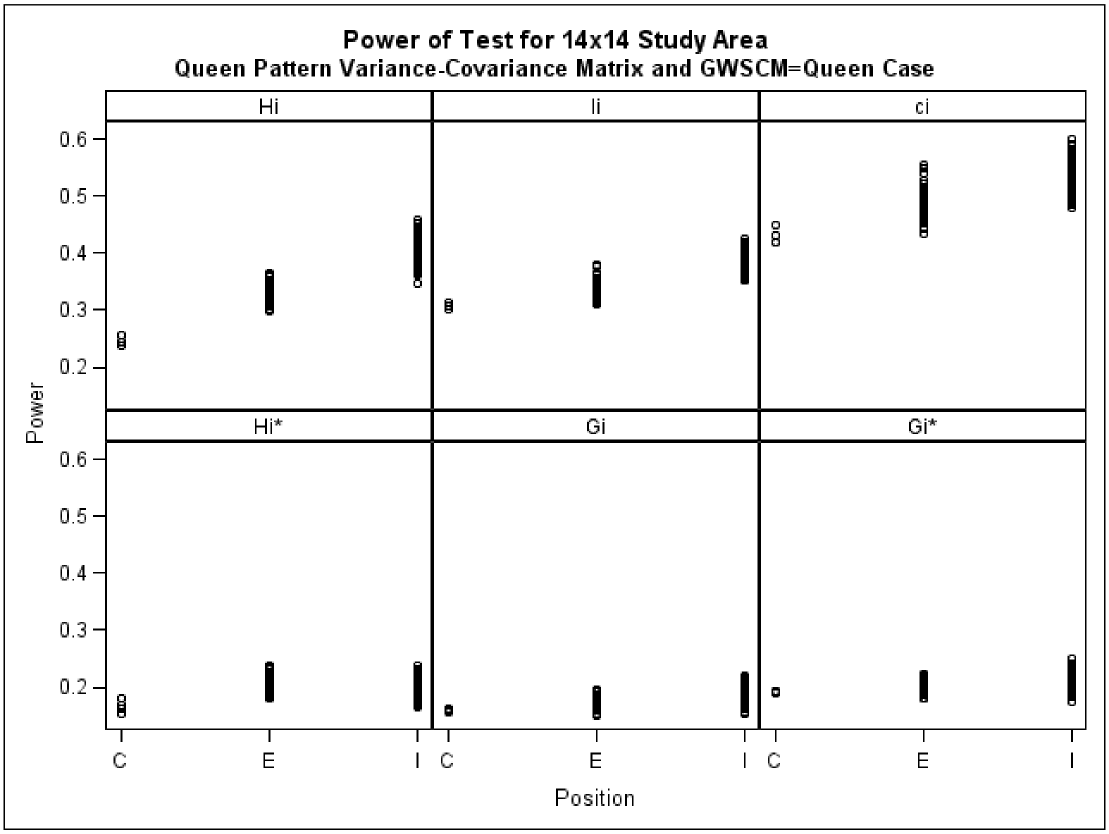

Power results averaged over all regions for a 14x14 study area for the Queen Pattern variance-covariance matrix are given in Table 4.2.8. It is observed that $c_i$ has the highest average power for all locations for the Rook, Queen, and CWF Connectivity Cases. There is also an effect with connectivity matrices. The four current measures and the proposed measure, $H_i$, obtain highest power for the CWF Connectivity Case and lowest power for the Rook Connectivity Case.

Table 4.2.8 Power of Test with $\alpha$=0.05 for Local Measures of Spatial Autocorrelation for a 14x14 Study Area Averaged Over Locations Based on Queen Pattern Variance-Covariance Matrix

| Local Measure | Region Location | Rook Connectivity Case | Queen Connectivity Case | CWF Connectivity Case |
|---|---|---|---|---|
| $I_i$ | C | 0.2203 | 0.3075 | 0.3573 |
| | E | 0.2378 | 0.3418 | 0.3909 |
| | I | 0.2728 | 0.3836 | 0.4396 |
| $c_i$ | C | 0.2970 | 0.4298 | 0.4650 |
| | E | 0.3656 | 0.4868 | 0.4979 |
| | I | 0.4330 | 0.5325 | 0.5318 |
| $G_i$ | C | 0.1108 | 0.1583 | 0.2035 |
| | E | 0.1204 | 0.1746 | 0.2156 |
| | I | 0.1354 | 0.1902 | 0.2290 |
| $G_i$* | C | 0.1575 | 0.1915 | 0.2120 |
| | E | 0.1683 | 0.2029 | 0.2306 |
| | I | 0.1769 | 0.2143 | 0.2427 |
| $H_i$ | C | 0.2373 | 0.2453 | 0.2635 |
| | E | 0.3136 | 0.3301 | 0.3365 |
| | I | 0.3670 | 0.4020 | 0.4019 |
| $H_i$* | C | 0.1853 | 0.1660 | 0.1380 |
| | E | 0.2244 | 0.2069 | 0.1624 |
| | I | 0.2260 | 0.2006 | 0.1682 |

The location of each region has some effect on power. Results for power of test with $\alpha$=0.05 using Queen Connectivity Case for a 14x14 study area are plotted in Figure 4.2.8. Maximum power is obtained for interior regions, which have eight neighbors, for $H_i$, $I_i$, and $c_i$, with lower power obtained by edge regions and lowest power for corner regions. The highest overall power, which ranges from 0.48 to 0.60, is achieved by $c_i$ for interior regions. $H_i$ obtains higher power then $I_i$ for interior regions and lower power for corner and edge regions. There are minimal differences between the 9x9 and 14x14 study areas with respect to power for this scenario. The largest increase in power was observed when the study area was increased from 4x4 to 9x9. Results for power of test with $\alpha$=0.05 for the 9x9 study area for this scenario are plotted in Figure B.23.

Figure 4.2.8 Power of Test with $\alpha$=0.05 for Local Measures of Spatial Autocorrelation for a 14x14 Study Area Based on Queen Pattern Variance-Covariance Matrix using Queen Connectivity Case




Additional results are given in Appendix B for the Queen Pattern variance-covariance matrix using Rook and CWF Connectivity Cases. The Rook Connectivity Case under-specifies the relationship among neighbors and the CWF Connectivity Case over-specifies the relationship among neighbors for Queen Pattern spatial autocorrelation.

Power results averaged over all regions for a 4x4 study area for the CWF Pattern variance-covariance matrix are given in Table 4.2.9. It is observed that for the Rook

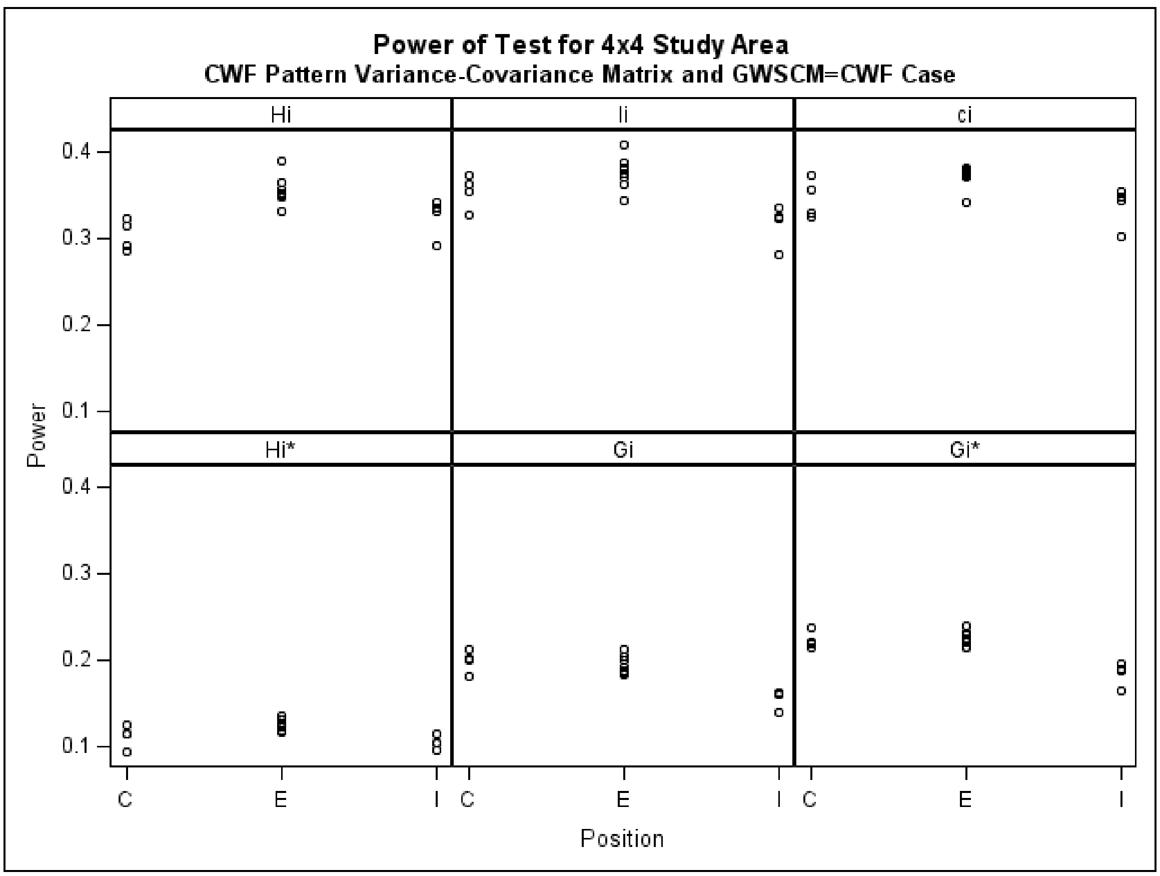
Connectivity Case, $H_i$ has the highest average power for the corner and edge regions and $c_i$ has the highest power for interior regions. For the Queen and CWF Connectivity Cases, $I_i$ has the highest average power for the corner and edge regions and $c_i$ has the highest power for interior regions. There is also an effect with connectivity matrices. The four current measures and the proposed measure, $H_i$, obtain highest power for the CWF Connectivity Case, next highest power for the Queen Connectivity Case, and lowest power for the Rook Connectivity Case.

Table 4.2.9 Power of Test with $\alpha$=0.05 for Local Measures of Spatial Autocorrelation Averaged Over Locations for a 4x4 Study Area Based on CWF Pattern Variance-Covariance Matrix

| Local Measure | Region Location | Rook Connectivity Case | Queen Connectivity Case | CWF Connectivity Case |
|---|---|---|---|---|
| $I_i$ | C | 0.2048 | 0.2890 | 0.3533 |
| | E | 0.2269 | 0.3323 | 0.3759 |
| | I | 0.1495 | 0.2960 | 0.3155 |
| $c_i$ | C | 0.2010 | 0.2818 | 0.3455 |
| | E | 0.2470 | 0.3269 | 0.3709 |
| | I | 0.2170 | .03100 | 0.3365 |
| $G_i$ | C | 0.1030 | 0.1528 | 0.1980 |
| | E | 0.1136 | 0.1698 | 0.1955 |
| | I | 0.0730 | 0.1485 | 0.1548 |
| $G_i$* | C | 0.1780 | 0.1933 | 0.2228 |
| | E | 0.1726 | 0.2013 | 0.2250 |
| | I | 0.1205 | 0.1735 | 0.1838 |
| $H_i$ | C | 0.2243 | 0.2340 | 0.3033 |
| | E | 0.2741 | 0.3111 | 0.3548 |
| | I | 0.2095 | 0.3003 | 0.3245 |
| $H_i$* | C | 0.1513 | 0.1323 | 0.1118 |
| | E | 0.1520 | 0.1451 | 0.1244 |
| | I | 0.1135 | 0.1330 | 0.1043 |

The location of region within a study area has some effect on power. Results for power with $\alpha$=0.05 using CWF Connectivity Case for a 4x4 study area are plotted in Figure 4.2.9. Maximum power is obtained at edge regions for $H_i$, $I_i$, and $c_i$, with lower power obtained by corner and interior regions. The highest overall power, which ranges from 0.34 to 0.41, is achieved by $I_i$ for edge regions.

Figure 4.2.9 Power of Test with $\alpha$=0.05 for Local Measures of Spatial Autocorrelation for a 4x4 Study Area Based on CWF Pattern Variance-Covariance Matrix using CWF Connectivity Case



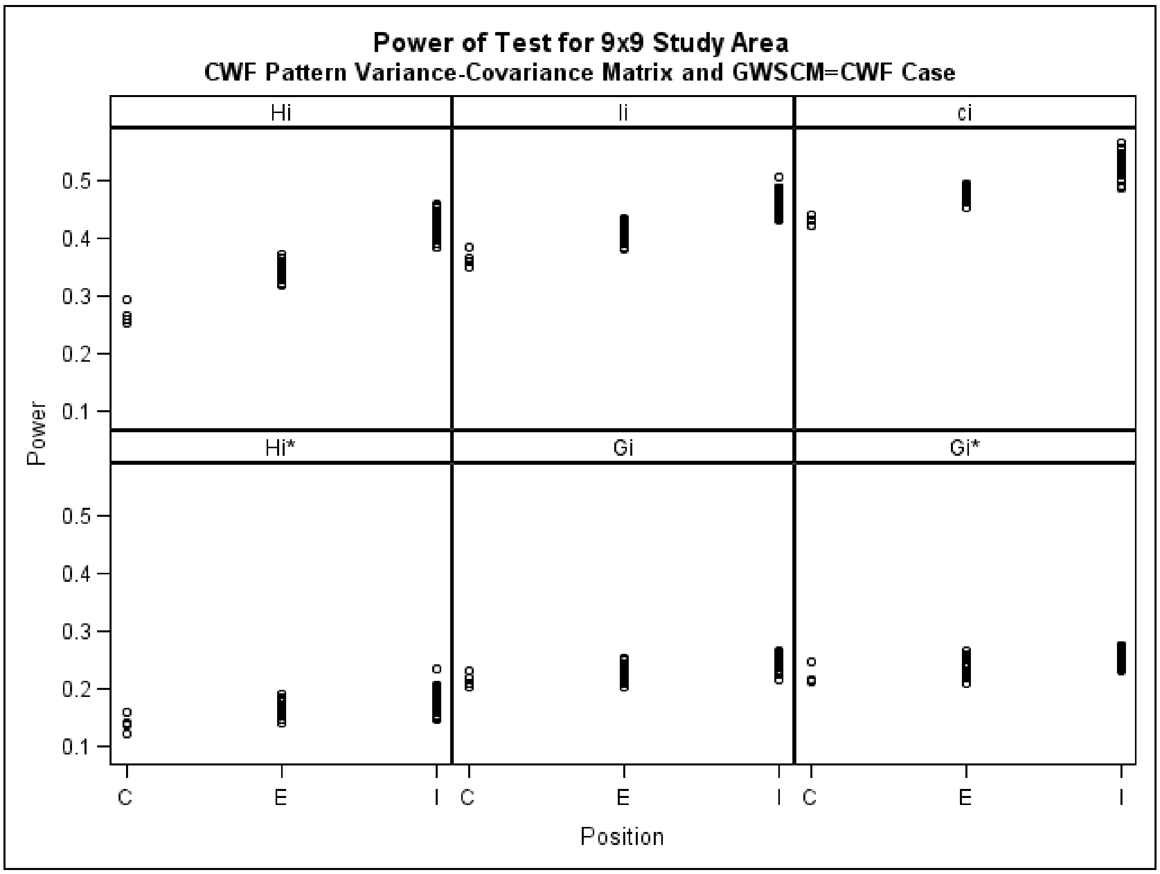

Power results averaged over all regions for a 9x9 study area for the CWF Pattern variance-covariance matrix are given in Table 4.2.10. It is observed that $c_i$ obtains the highest average power for all locations for the Rook, Queen, and CWF Connectivity Cases. There is also an effect with connectivity matrices. The four current measures and the proposed measure, $H_i$, obtain highest power for the CWF Connectivity Case, next highest power for the Queen Connectivity Case, and lowest power for the Rook Connectivity Case.

Table 4.2.10 Power of Test with $\alpha$=0.05 for Local Measures of Spatial Autocorrelation for a 9x9 Study Area Averaged Over Locations Based on CWF Pattern Variance-Covariance Matrix

| Local Measure | Region Location | Rook Connectivity Case | Queen Connectivity Case | CWF Connectivity Case |
|---|---|---|---|---|
| $I_i$ | C | 0.2113 | 0.2933 | 0.3655 |
| | E | 0.2458 | 0.3457 | 0.4122 |
| | I | 0.2818 | 0.4002 | 0.4639 |
| $c_i$ | C | 0.2425 | 0.3265 | 0.4303 |
| | E | 0.3250 | 0.4239 | 0.4771 |
| | I | 0.3935 | 0.4996 | 0.5286 |
| $G_i$ | C | 0.1088 | 0.1595 | 0.2160 |
| | E | 0.1224 | 0.1780 | 0.2276 |
| | I | 0.1407 | 0.2014 | 0.2445 |
| $G_i$* | C | 0.1610 | 0.1875 | 0.2238 |
| | E | 0.1706 | 0.2060 | 0.2391 |
| | I | 0.1826 | 0.2234 | 0.2565 |
| $H_i$ | C | 0.2205 | 0.2283 | 0.2683 |
| | E | 0.2944 | 0.3084 | 0.3474 |
| | I | 0.3499 | 0.3904 | 0.4230 |
| $H_i$* | C | 0.1578 | 0.1435 | 0.1398 |
| | E | 0.2006 | 0.1838 | 0.1696 |
| | I | 0.2204 | 0.2026 | 0.1828 |

The location of region within a study area has some effect on power. Results for power with $\alpha$=0.05 using CWF Connectivity Case for a 9x9 study area are plotted in Figure 4.2.10. Maximum power is obtained at interior regions for $H_i$, $I_i$, and $c_i$ with lower power obtained by corner and edge regions. The highest overall power, which ranges from 0.49 to 0.57, is achieved by $c_i$ for interior regions.

Figure 4.2.10 Power of Test with $\alpha$=0.05 for Local Measures of Spatial Autocorrelation for a 9x9 Study Area Based on CWF Pattern Variance-Covariance Matrix using CWF Connectivity Case




Power results averaged over all regions for a 14x14 study area for the CWF Pattern variance-covariance matrix are given in Table 4.2.11. It is observed that $c_i$ obtains the highest average power for the Rook, Queen, and CWF Connectivity Cases for all locations. There is also an effect with connectivity matrices. The four current measures and the proposed measure, $H_i$, obtain highest power for the CWF Connectivity

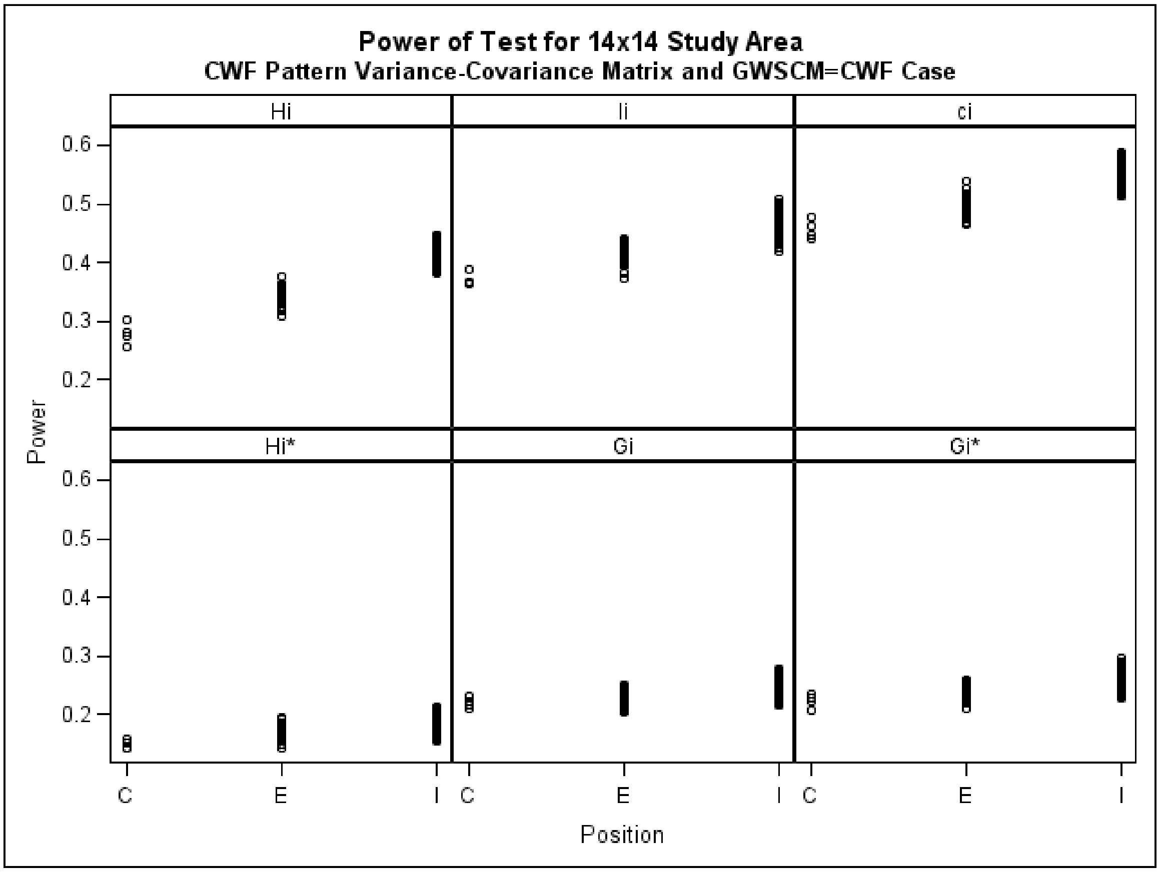
Case, next highest power for the Queen Connectivity Case, and lowest power for the Rook Connectivity Case.

Table 4.2.11 Power of Test with $\alpha$=0.05 for Local Measures of Spatial Autocorrelation for a 14x14 Study Area Averaged Over Locations Based on CWF Pattern Variance-Covariance Matrix

| Local Measure | Region Location | Rook Connectivity Case | Queen Connectivity Case | CWF Connectivity Case |
|---|---|---|---|---|
| $I_i$ | C | 0.2063 | 0.2893 | 0.3713 |
| | E | 0.2403 | 0.3419 | 0.4141 |
| | I | 0.2826 | 0.4020 | 0.4683 |
| $c_i$ | C | 0.2475 | 0.3573 | 0.4555 |
| | E | 0.3391 | 0.4397 | 0.4943 |
| | I | 0.4193 | 0.5251 | 0.5531 |
| $G_i$ | C | 0.1075 | 0.1530 | 0.2210 |
| | E | 0.1209 | 0.1765 | 0.2295 |
| | I | 0.1405 | 0.2017 | 0.2467 |
| $G_i$* | C | 0.1575 | 0.1938 | 0.2238 |
| | E | 0.1685 | 0.2049 | 0.2405 |
| | I | 0.1816 | 0.2242 | 0.2582 |
| $H_i$ | C | 0.2145 | 0.2230 | 0.2798 |
| | E | 0.2905 | 0.3034 | 0.3438 |
| | I | 0.3531 | 0.3907 | 0.4196 |
| $H_i$* | C | 0.1608 | 0.1490 | 0.1495 |
| | E | 0.2070 | 0.1851 | 0.1698 |
| | I | 0.2304 | 0.2097 | 0.1880 |

The location of a region has some effect on power. Results for power of test with $\alpha$=0.05 using CWF Connectivity Case for a 14x14 study area are plotted in Figure 4.2.11. Maximum power is obtained for interior regions for $H_i$, $I_i$, and $c_i$ with lower power obtained by edge regions, and lowest power for corner regions. The highest overall power, which ranges from 0.49 to 0.57, is achieved by $c_i$ for interior regions.

Figure 4.2.11 Power of Test with $\alpha$=0.05 for Local Measures of Spatial Autocorrelation for a 14x14 Study Area Based on CWF Pattern Variance-Covariance Matrix using CWF Connectivity Case




Additional results are given in Appendix B for the CWF Pattern variance-covariance matrix using Rook and Queen Connectivity Cases. Both of these cases under specify the relationship among neighbors for CWF Pattern spatial autocorrelation.

Power results averaged over all regions for a 4x4 study area for the Hot-Spot Pattern variance-covariance matrix are given in Table 4.2.12. The hot spot is comprised of all interior regions for this size of study area. It is observed that $c_i$ obtains the highest average power for interior regions for the Rook and Queen Connectivity Cases. For the

CWF Connectivity Case, $I_i$ and $H_i$ obtain the highest average power. There is also an effect with connectivity matrices for interior regions. The four current measures and the proposed measure, $H_i$, obtain highest power for the CWF Connectivity Case, next highest power for the Queen Connectivity Case, and lowest power for the Rook Connectivity Case.

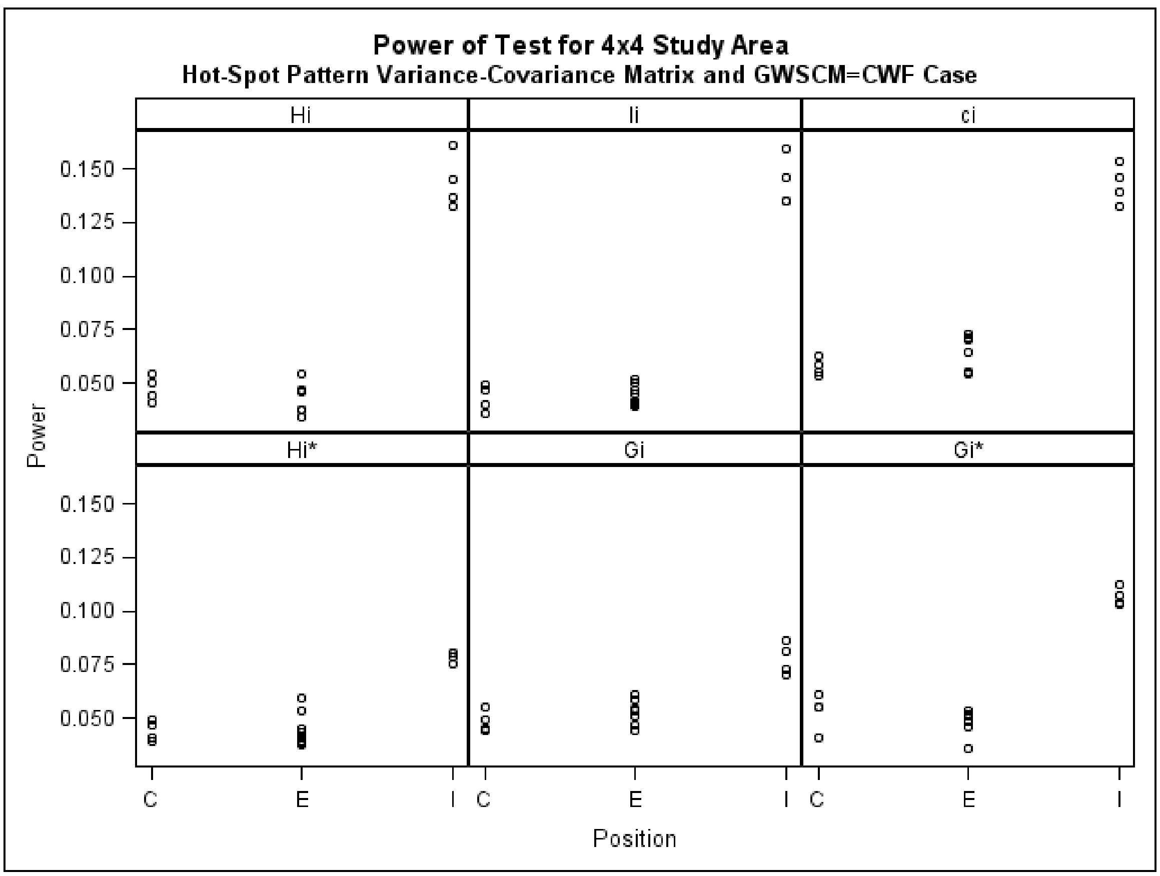
Table 4.2.12 Power of Test with $\alpha$=0.05 for Local Measures of Spatial Autocorrelation Averaged Over Locations for a 4x4 Study Area Based on Hot-Spot Pattern Variance-Covariance Matrix

| Local Measure | Region Location | Rook Connectivity Case | Queen Connectivity Case | CWF Connectivity Case |
|---|---|---|---|---|
| $I_i$ | C | 0.0605 | 0.0298 | 0.0430 |
| | E | 0.0246 | 0.0324 | 0.0445 |
| | I | 0.1040 | 0.1340 | 0.1438 |
| $c_i$ | C | 0.0538 | 0.0325 | 0.0573 |
| | E | 0.0276 | 0.0420 | 0.0644 |
| | I | 0.1363 | 0.1428 | 0.1425 |
| $G_i$ | C | 0.0593 | 0.0325 | 0.0483 |
| | E | 0.0284 | 0.0379 | 0.0528 |
| | I | 0.0583 | 0.0748 | 0.0775 |
| $G_i$* | C | 0.0700 | 0.0348 | 0.0530 |
| | E | 0.0323 | 0.0369 | 0.0483 |
| | I | 0.0863 | 0.0923 | 0.1065 |
| $H_i$ | C | 0.0523 | 0.0393 | 0.0473 |
| | E | 0.0403 | 0.0384 | 0.0424 |
| | I | 0.1048 | 0.1225 | 0.1438 |
| $H_i$* | C | 0.0543 | 0.0400 | 0.0440 |
| | E | 0.0390 | 0.0434 | 0.0444 |
| | I | 0.0908 | 0.0855 | 0.0785 |

The location of region within a study area has some effect on power. Results for power with $\alpha$=0.05 using CWF Connectivity Case for a 4x4 study area are plotted in Figure 4.2.12. As expected, maximum power is obtained for interior regions for all local measures. The highest overall power, which ranges from 0.13 to 0.16, is achieved by $H_i$. For this scenario, $c_i$ is a slightly liberal test for the corner and edge regions as the size of test ranges from 0.053 to 0.073.

For this scenario, there is a tendency for the test to be conservative for corner and edge regions for other connectivity matrices as shown in Figure B.10 for the Rook Connectivity Case and Figure B.11 for the Queen Connectivity Case.

Figure 4.2.12 Power of Test with $\alpha$=0.05 for Local Measures of Spatial Autocorrelation for a 4x4 Study Area Based on Hot-Spot Pattern Variance-Covariance Matrix using CWF Connectivity Case



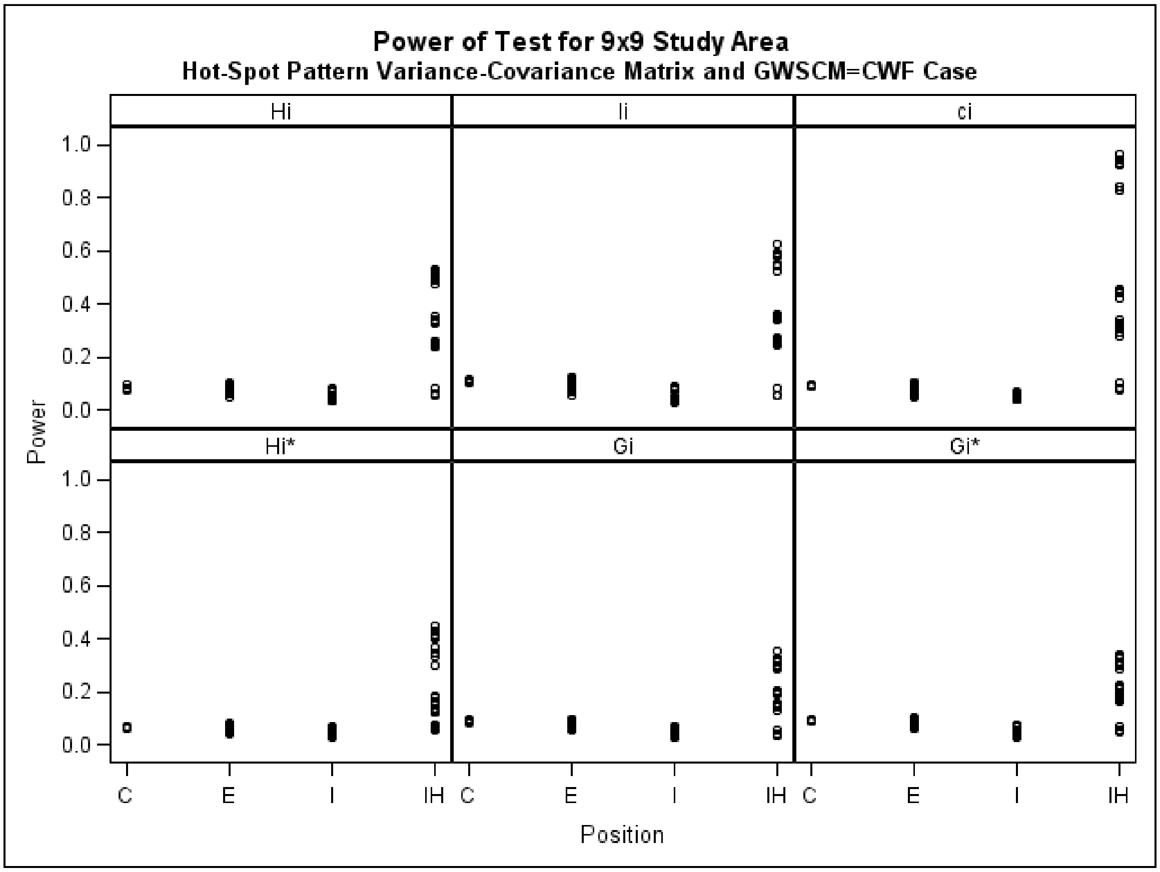
Power results averaged over all regions for a 9x9 study area for the Hot-Spot Pattern variance-covariance matrix are given in Table 4.2.13. The hot spot is comprised of the inner-most 25 interior regions for this study area which are designated as IH for "Interior Hot-Spot." It is observed that $c_i$ obtains the highest average power for the Rook, Queen, and CWF Connectivity Cases for interior hot-spot regions. There is also an effect with connectivity matrices for interior hot-spot regions. The four current measures and the proposed measure, $H_i$, obtain highest power for the CWF Connectivity Case, next highest power for the Queen Connectivity Case, and lowest power for the Rook Connectivity Case.

The location of regions within a study area has an effect on power. Results for power with $\alpha$=0.05 using CWF Connectivity Case for a 9x9 study area are plotted in Figure 4.2.13. As expected, maximum power is obtained for interior hot-spot regions for all local measures. The highest overall power, which ranges from 0.93 to 0.97, is achieved by $c_i$, for the inner-most interior hot-spot regions. The patterned grouping of points for these regions is examined for a 14x14 study area in Figure 4.2.15. Corner, edge, and other interior regions should have estimated size of test since there is no spatial autocorrelation for these locations.

Table 4.2.13 Power of Test with $\alpha$=0.05 for Local Measures of Spatial Autocorrelation for a 9x9 Study Area Averaged Over Locations Based on Hot-Spot Pattern Variance-Covariance Matrix

| Local Measure | Region Location | Rook Connectivity Case | Queen Connectivity Case | CWF Connectivity Case |
|---|---|---|---|---|
| $I_i$ | C | 0.0788 | 0.0870 | 0.1065 |
| | E | 0.0856 | 0.1035 | 0.0894 |
| | I | 0.0533 | 0.0437 | 0.0475 |
| | IH | 0.1764 | 0.2571 | 0.3531 |
| $c_i$ | C | 0.0678 | 0.0775 | 0.0900 |
| | E | 0.0763 | 0.0919 | 0.0735 |
| | I | 0.0431 | 0.0402 | 0.0515 |
| | IH | 0.3039 | 0.4239 | 0.5064 |
| $G_i$ | C | 0.0690 | 0.0733 | 0.0858 |
| | E | 0.0738 | 0.0847 | 0.0741 |
| | I | 0.0484 | 0.0402 | 0.0462 |
| | IH | 0.0998 | 0.1442 | 0.1971 |
| $G_i$* | C | 0.0740 | 0.0813 | 0.0910 |
| | E | 0.0783 | 0.0906 | 0.0803 |
| | I | 0.0533 | 0.0422 | 0.0463 |
| | IH | 0.1297 | 0.1637 | 0.2132 |
| $H_i$ | C | 0.0570 | 0.0618 | 0.0833 |
| | E | 0.0670 | 0.0796 | 0.0791 |
| | I | 0.0508 | 0.0458 | 0.0486 |
| | IH | 0.1679 | 0.2237 | 0.3266 |
| $H_i$* | C | 0.0523 | 0.0533 | 0.0653 |
| | E | 0.0550 | 0.0605 | 0.0609 |
| | I | 0.0446 | 0.0439 | 0.0466 |
| | IH | 0.1651 | 0.1906 | 0.2170 |

Figure 4.2.13 Power of Test with $\alpha$=0.05 for Local Measures of Spatial Autocorrelation for a 9x9 Study Area Based on Hot-Spot Pattern Variance-Covariance Matrix using CWF Connectivity Case




Power results averaged over all regions for a 14x14 study area for the Hot-Spot Pattern variance-covariance matrix are given in Table 4.2.14. The hot spot is comprised of the inner-most 64 interior regions for this study area which are designated as IH for "Interior Hot-spot." It is observed that $c_i$ has the highest average power for the Rook, Queen, and CWF Connectivity Cases for interior hot-spot regions. There is also an effect with connectivity matrices for interior hot-spot regions. The four current measures and the proposed measure, $H_i$, obtain highest power for the CWF Connectivity Case, next highest power for the Queen Connectivity Case, and lowest power for the Rook Connectivity Case.

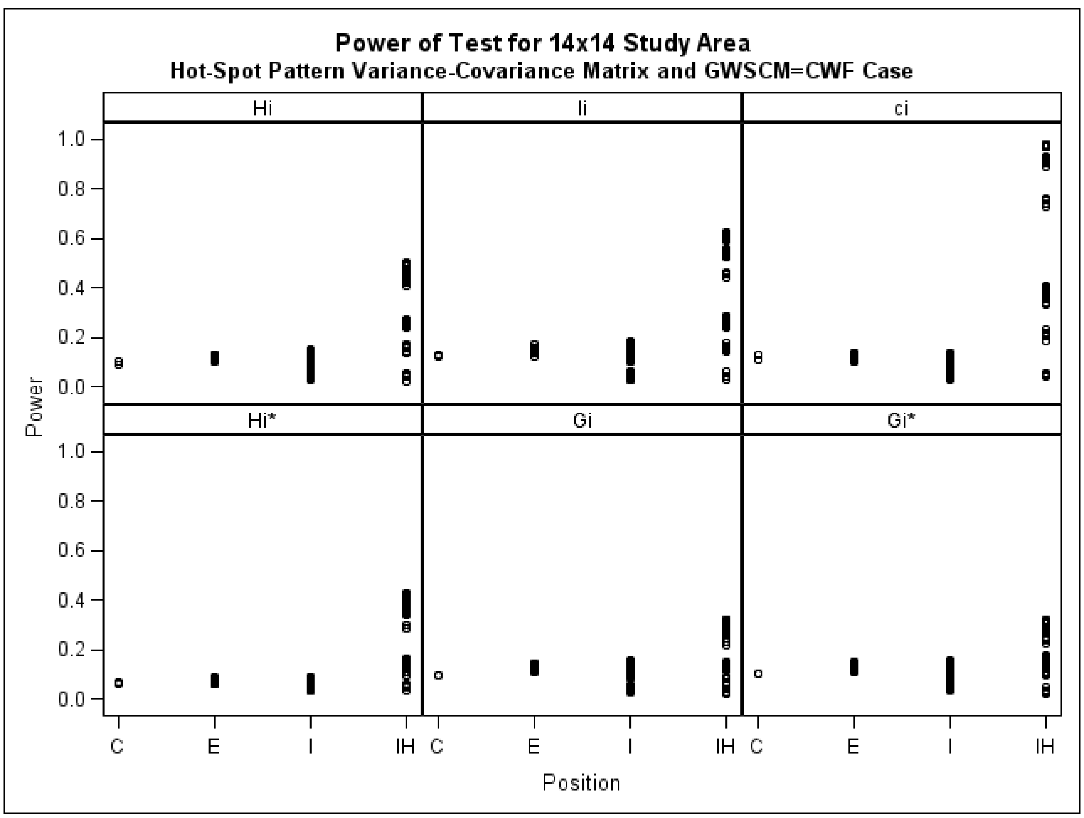
Table 4.2.14 Power of Test with $\alpha$=0.05 for Local Measures of Spatial Autocorrelation for a 14x14 Study Area Averaged Over Locations Based on Hot-Spot Pattern Variance-Covariance Matrix

| Local Measure | Region Location | Rook Connectivity Case | Queen Connectivity Case | CWF Connectivity Case |
|---|---|---|---|---|
| $I_i$ | C | 0.0805 | 0.0910 | 0.1250 |
| | E | 0.0913 | 0.1095 | 0.1509 |
| | I | 0.0791 | 0.0973 | 0.1043 |
| | IH | 0.1706 | 0.2821 | 0.4047 |
| $c_i$ | C | 0.0770 | 0.0830 | 0.1200 |
| | E | 0.0789 | 0.0967 | 0.1221 |
| | I | 0.0684 | 0.0813 | 0.0860 |
| | IH | 0.3435 | 0.5410 | 0.6423 |
| $G_i$ | C | 0.0625 | 0.0700 | 0.0955 |
| | E | 0.0811 | 0.0949 | 0.1269 |
| | I | 0.0718 | 0.0849 | 0.0904 |
| | IH | 0.0855 | 0.1433 | 0.2076 |
| $G_i$* | C | 0.0805 | 0.0805 | 0.1025 |
| | E | 0.0877 | 0.1017 | 0.1284 |
| | I | 0.0784 | 0.0899 | 0.0962 |
| | IH | 0.1139 | 0.1598 | 0.2185 |
| $H_i$ | C | 0.0680 | 0.0705 | 0.0960 |
| | E | 0.0701 | 0.0839 | 0.1187 |
| | I | 0.0661 | 0.0790 | 0.0890 |
| | IH | 0.1653 | 0.2311 | 0.3490 |
| $H_i$* | C | 0.0660 | 0.0560 | 0.0655 |
| | E | 0.0564 | 0.0612 | 0.0723 |
| | I | 0.0538 | 0.0562 | 0.0622 |
| | IH | 0.1728 | 0.20110 | 0.2661 |

The location of regions within a study area has an effect on power. Results for power with $\alpha$=0.05 using CWF Connectivity Case for a 14x14 study area are plotted in

Figure 4.2.14. As expected, maximum power is obtained for interior hot-spot regions for all local measures. The highest overall power for interior hot-spot regions, which ranges from 0.97 to 0.98, is achieved by $c_i$ for the inner-most regions of the hot spot. The patterned grouping of points for regions in the hot-spot is even more pronounced for this size of study area. Corner, edge, and other interior regions should have estimated size of test since there is no spatial autocorrelation for these locations.

Figure 4.2.14 Power of Test with $\alpha$=0.05 for Local Measures of Spatial Autocorrelation for a 14x14 Study Area Based on Hot-Spot Pattern Variance-Covariance Matrix using CWF Connectivity Case




The grouping of points for interior hot-spot regions is examined in detail for $c_i$ for a 14x14 study area in Figure 4.2.15. The hot-spot is comprised of the innermost 64 regions and is represented by regions with a gray background. The highest power is obtained for the 16 innermost regions and ranges from 0.97 to 0.98. The next highest power is for the 16 edge regions that border these 16 innermost regions with values of 0.89 to 0.93. The four corner regions that border the 16 innermost regions have power that ranges from 0.73 to 0.76. The 16 edge regions for the hot-spot have power that ranges from 0.18 to 0.40. The lowest power for the hot spot is observed for its four corners with power that ranges from 0.04 to 0.06. Thus, the power to detect local spatial autocorrelation is affected by the location of a region within the hot spot. This explains the five groups of points for $c_i$ for interior hot spot regions in Figure 4.2.13 and Figure 4.2.14. This same phenomenon explains the similar groupings observed for $H_i$ and $I_i$.

It is also observed for this scenario that there are extraneous location factors that influence power for regions not associated with the hot spot. The edge and corner regions of the study area have power that ranges from 0.10 to 0.14 when there is actually no local spatial autocorrelation. The interior regions immediately adjacent to the edge and corner regions have power that ranges from 0.08 to 0.14. The interior regions with the lowest power are those immediately adjacent to the hot spot with values that range from 0.03 to 0.10. These higher-than-expected power results could be due to the use of the CWF Connectivity Case which always includes a few regions in the hot spot as neighbors for all regions.

Additional results are given in Appendix B for the Hot-Spot Pattern variance-covariance matrix using Rook and Queen Connectivity Cases. Both of these cases under-specify the relationship among neighbors in the hot-spot for Hot-Spot Pattern spatial autocorrelation. Highest power is obtained by $c_i$ for these scenarios with the relationship that power for the Rook Connectivity Case is less than power for the Queen Connectivity case is less than power for the CWF Connectivity Case.

Figure 4.2.15 Power of Test with $\alpha$=0.05 for Local Measure of Spatial Autocorrelation $c_i$ for a 14x14 Study Area Based on Hot-Spot Pattern Variance-Covariance Matrix using CWF Connectivity Case

| **Row/ Column** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | .13 | .13 | .12 | .12 | .11 | .12 | .12 | .12 | .12 | .12 | .11 | .14 | .12 | .11 |
| **2** | .13 | .13 | .12 | .12 | .10 | .09 | .09 | .09 | .09 | .09 | .09 | .11 | .13 | .13 |
| **3** | .13 | .13 | .10 | .04 | .05 | .04 | .05 | .06 | .05 | .04 | .04 | .08 | .12 | .12 |
| **4** | .13 | .10 | .04 | .06 | .21 | .33 | .38 | .40 | .35 | .22 | .05 | .04 | .11 | .12 |
| **5** | .14 | .11 | .04 | .23 | .74 | .91 | .93 | .92 | .91 | .73 | .21 | .03 | .09 | .12 |
| **6** | .13 | .10 | .07 | .34 | .91 | .97 | .97 | .98 | .98 | .89 | .36 | .04 | .08 | .10 |
| **7** | .13 | .09 | .06 | .39 | .91 | .98 | .98 | .98 | .98 | .92 | .39 | .06 | .08 | .13 |
| **8** | .11 | .08 | .05 | .39 | .92 | .98 | .97 | .98 | .97 | .92 | .39 | .06 | .11 | .12 |
| **9** | .10 | .09 | .04 | .36 | .90 | .98 | .98 | .98 | .97 | .91 | .37 | .07 | .11 | .13 |
| **10** | .12 | .09 | .04 | .22 | .76 | .91 | .93 | .92 | .91 | .76 | .21 | .05 | .11 | .13 |
| **11** | .13 | .11 | .04 | .04 | .18 | .38 | .40 | .41 | .36 | .21 | .05 | .04 | .10 | .12 |
| **12** | .13 | .14 | .09 | .04 | .04 | .05 | .05 | .05 | .04 | .03 | .04 | .09 | .12. | 13 |
| **13** | .12 | .13 | .13 | .10 | .11 | .09 | .09 | .09 | .09 | .09 | .11 | .14 | .13 | .12 |
| **14** | .11 | .11 | .13 | .12 | .12 | .12 | .12 | .12 | .12 | .11 | .12 | .12 | .13 | .12 |

## 4.3 COMPARISON OF THEORETICAL AND EMPIRICAL RESULTS

Theoretical and empirical results for $H_i$ can be evaluated for goodness of fit by comparing the theoretical density curve for a twice-folded Cauchy distribution to an empirical sampling distribution of $H_i$. Recall from Section 3.2 that

$$\boldsymbol{Y} = \begin{pmatrix} Y_1 \\ \vdots \\ Y_n \end{pmatrix} \sim Multivariate\ Normal\ \left[\begin{pmatrix} \beta \\ \vdots \\ \beta \end{pmatrix}, \begin{pmatrix} \sigma_{11} & \cdots & \sigma_{1n} \\ \vdots & \ddots & \vdots \\ \sigma_{n1} & \cdots & \sigma_{nn} \end{pmatrix}\right]$$

and $\boldsymbol{z} = \left(\boldsymbol{I} - \frac{1}{n}\boldsymbol{J}\right)\boldsymbol{Y}.$ Then

$$\boldsymbol{z} = \begin{pmatrix} z_1 \\ \vdots \\ z_n \end{pmatrix} \sim Multivariate\ Normal\ \left[\begin{pmatrix} 0 \\ \vdots \\ 0 \end{pmatrix}, Var(\boldsymbol{z})\right] \text{ where}$$

$$Var(\boldsymbol{z}) = \left(\boldsymbol{I} - \frac{1}{n}\boldsymbol{J}\right)\boldsymbol{Var}(\boldsymbol{Y})\left(\boldsymbol{I} - \frac{1}{n}\boldsymbol{J}\right).$$

By the use of Theorem 3.3.2 in Section 3.3, it is known that if

$\begin{pmatrix} \bar{z}_{(i)} \\ z_i \end{pmatrix} \sim Bivariate\ Normal \left[\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma_1^2 & \sigma_1\sigma_2\rho \\ \sigma_1\sigma_2\rho & \sigma_2^2 \end{pmatrix}\right]$, then

$H_i \sim Twice - Folded\ Cauchy\left(\theta = \frac{\rho\sigma_1}{\sigma_2}, \gamma = \frac{\sigma_1\sqrt{1-\rho^2}}{\sigma_2}\right).$

Let $\boldsymbol{w}_i$ be the 2x$n$ matrix used to calculate $\bar{z}_{(i)}$ and extract $z_i$ from **z**. Then $\boldsymbol{w}_i = \begin{pmatrix} \frac{1}{n}\boldsymbol{GWSCM}_i \\ \boldsymbol{e}_i' \end{pmatrix}$, where $n$ represents the number of neighbors for the $i^{\text{th}}$ region, and $\begin{pmatrix} \bar{z}_{(i)} \\ z \end{pmatrix} = \boldsymbol{w}_i\boldsymbol{z}$, with $Var(\boldsymbol{w}_i\boldsymbol{z}) = \boldsymbol{w}_i Var(\boldsymbol{z})\boldsymbol{w}_i'$. Now, since $\bar{z}_{(i)}$ and $z_i$ are linear combinations of $\boldsymbol{z}$, then $\begin{pmatrix} \bar{z}_{(i)} \\ z \end{pmatrix} \sim Bivariate\ Normal\left[\begin{pmatrix} 0 \\ 0 \end{pmatrix}, Var(\boldsymbol{w}_i\boldsymbol{z})\right]$.

As an example, consider Region 1 from Geographical Distribution 1 for the simulation study based on the Rook Pattern variance-covariance matrix using Rook

Connectivity Case for a 4x4 study area. Observed and mean-centered data for this Geographical Distribution are given in Figure 4.3.1.

Figure 4.3.1 Simulated and Mean-Centered Data for Geographical Distribution 1

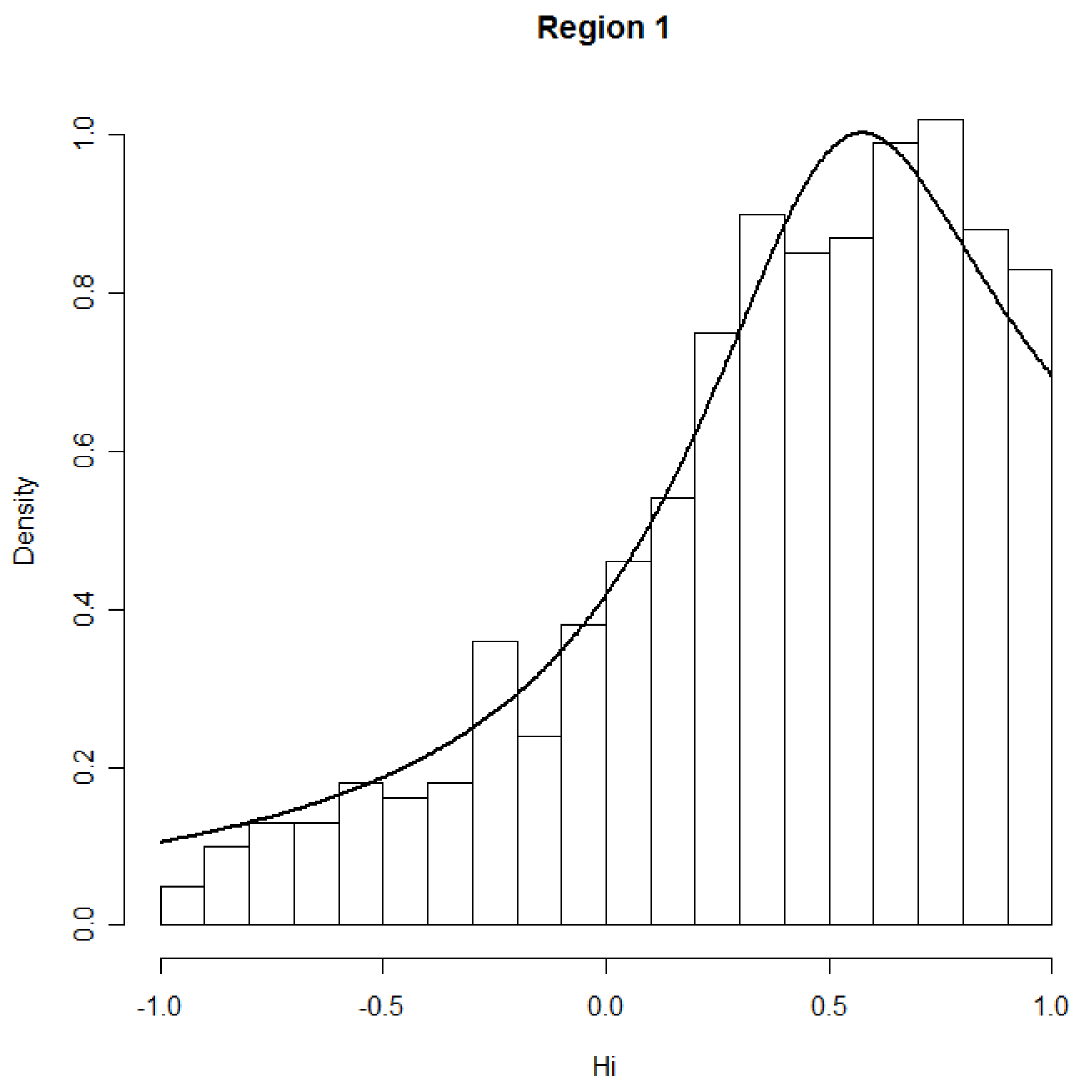
| $y_i$ | | | | | $z_i$ | | | |
|---|---|---|---|---|---|---|---|---|
| **8.17** | **9.01** | **9.25** | **9.10** | | **-1.37** | **-0.53** | **-0.29** | **-0.44** |
| **8.67** | **10.02** | **9.87** | **9.17** | | **-0.87** | **0.48** | **0.33** | **-0.37** |
| **10.08** | **11.23** | **10.26** | **9.16** | | **0.54** | **1.69** | **0.72** | **-0.38** |
| **10.20** | **10.48** | **9.30** | **8.67** | | **0.66** | **0.94** | **-0.24** | **-0.87** |

Now for Region 1 we have $\boldsymbol{w}_1 = \begin{pmatrix} 0\ \frac{1}{2}\ 0\ 0\ \frac{1}{2}\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0 \\ 1\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0 \end{pmatrix}$ and $\begin{pmatrix} \bar{z}_{(1)} \\ z_1 \end{pmatrix} =$ $\begin{pmatrix} -0.70 \\ -1.37 \end{pmatrix}$, with $Var(\boldsymbol{w}_1\boldsymbol{z}) = \begin{pmatrix} 0.42 & 0.48 \\ 0.48 & 0.88 \end{pmatrix}$. So

$$H_1 \sim Twice - Folded\ Cauchy(0.54, 0.42)$$

Figure 4.3.2 is a histogram of the sampling distribution for the 1000 simulated values for $H_1$ from this scenario along with its theoretical density curve. A goodness of fit test resulted in the conclusion that there is not a discrepancy between the hypothetical and observed distributions ($\chi^2_{(19)}$=18.276, $\alpha$ = 0.01, p-value = 0.5041).

Figure 4.3.2 Theoretical Density Curve and Histogram of $H_i$ for Region 1 from Geographical Distribution 1 for a Rook Pattern Variance-Covariance Matrix Using Rook Connectivity Case for a 4x4 Study Area



## 4.4 COMPARISON OF $H_i$ AND $I_i$

An investigation is undertaken in this section to verify the claim that the proposed measure $H_i$ provides information that is not provided by the most common measure $I_i$. The purpose of this comparison is to determine what $H_i$ tells us that $I_i$ does not.

Data for this comparison is from Geographical Distribution 15 from the simulation study for the Rook Pattern variance-covariance matrix using Rook Connectivity Case for a 4x4 study area.  It is given in Figure 4.4.1.

Figure 4.4.1     Simulated Data for Geographical Distribution 15

| | | | |
|---|---|---|---|
| **8.53** | **9.51** | **10.25** | **9.89** |
| **9.62** | **10.71** | **10.93** | **10.08** |
| **9.28** | **9.45** | **9.57** | **9.59** |
| **8.99** | **8.88** | **9.47** | **10.08** |

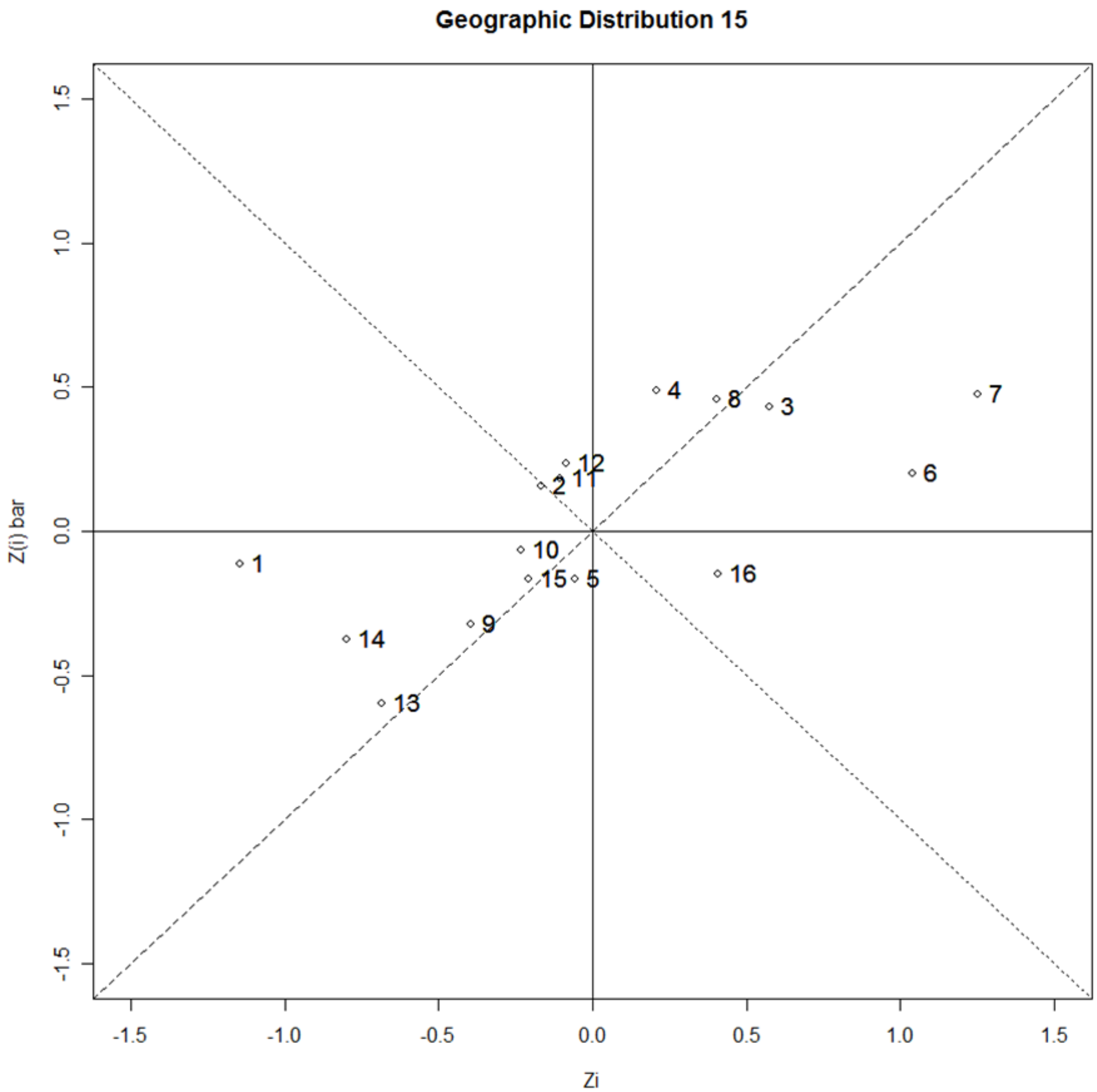
Mean-centered data, $z_i$, and the mean deviation of each Region's neighbors, $\bar{z}_{(i)}$, are given in Figure 4.4.2.  These are the denominator and the numerator, respectively, in the initial calculation for $H_i$.

Figure 4.4.2 Mean-centered Data and Mean Deviation of Each Region's Neighbors for Geographical Distribution 15

| $z_i$ | | | | | $\bar{z}_{(i)}$ | | | |
|---|---|---|---|---|---|---|---|---|
| **-1.15** | **-0.17** | **0.57** | **0.21** | | **-0.11** | **0.16** | **0.43** | **0.49** |
| **-0.06** | **1.01** | **1.25** | **0.40** | | **-0.17** | **0.20** | **0.48** | **0.46** |
| **-0.40** | **-0.23** | **-0.11** | **-0.09** | | **-0.32** | **-0.07** | **0.18** | **0.23** |
| **-0.68** | **-0.80** | **-0.21** | **0.41** | | **-0.60** | **-0.37** | **-0.17** | **-0.15** |

A scatterplot of each Region's deviations and mean deviation of its neighbors is shown in Figure 4.4.3. Each point is labeled with its Region number as defined in Figure 2.2.1. The dashed line with positive slope represents a +1 measure of local spatial autocorrelation. Values of $z_i$ and $\bar{z}_{(i)}$ that are identical will fall along this line. It is seen that Regions 8, 9, 13, and 15 are very close to this line and have values of $H_i$ that are at least 0.80 in Figure 4.4.4. The dashed line with negative slope represents a -1 measure of local spatial autocorrelation. Values of $z_i$ and $\bar{z}_{(i)}$ that are identical except for their sign will fall along this line. Region 2 is closest to this line and has a $H_i$ value of -0.92 as shown in Figure 4.4.4. It is concluded that this type of scatterplot is useful for interpreting values of $H_i$.

Figure 4.4.3 Scatterplot of Each Region's Deviation versus Mean Deviation of Its Neighbors for Geographical Distribution 15



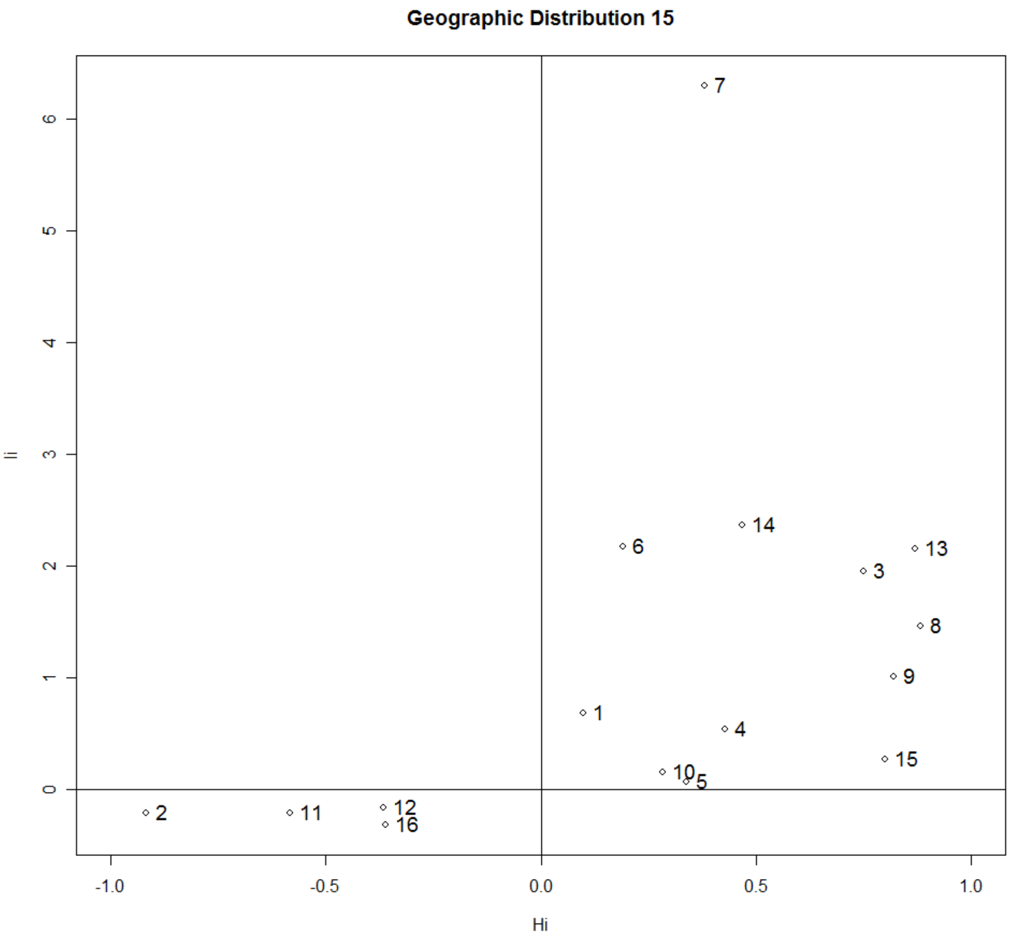
Values for the proposed measure, $H_i$, and the most common measure $I_i$, are given in Figure 4.4.4. Comparison of these two measures is facilitated by using this side-by-side view. For example, it is seen that $H_1$ = 0.10 and $I_1$ = 0.68. The value of $H_i$ with the largest magnitude is $H_2$ = -0.92 and the corresponding $I_i$ value is $I_2$ = -0.21.

Figure 4.4.4 Values of $H_i$ and $I_i$ for Geographical Distribution 15

| $H_i$ | | | | | $I_i$ | | | |
|---|---|---|---|---|---|---|---|---|
| **0.10** | **-0.92** | **0.75** | **0.73** | | **0.68** | **-0.21** | **1.95** | **0.54** |
| **0.34** | **0.19** | **0.38** | **0.88** | | **0.08** | **2.18** | **6.30** | **1.46** |
| **0.82** | **0.28** | **-0.58** | **-0.37** | | **1.01** | **0.16** | **-0.20** | **-0.16** |
| **0.87** | **0.47** | **0.80** | **-0.36** | | **2.16** | **2.37** | **0.27** | **-0.31** |

A scatterplot of each Region's $I_i$ and $H_i$ values is shown in Figure 4.4.5. Each point is labeled with its Region number as defined in Figure 2.2.1. It is observed that $I_7$ = 6.30 is the largest value for local Moran's $I_i$. The corresponding value for the proposed measure is $H_7$ = 0.38. Based on a conditional randomization test for a two-sided alternative hypothesis, both of these values are statistically significant at the 0.05 level. While no other values of $I_i$ are statistically significant at the 0.05 level, there are two other Regions with $H_i$ values that are statistically significant at the 0.05 level. These are $H_2$ = -0.92 and $H_8$ = 0.88. The corresponding values for the local Moran's measure are $I_2$ = -0.21 and $I_8$ = 1.46.

Figure 4.4.5 Scatterplot of Each Region's $I_i$ and $H_i$ values for Geographical Distribution 15




It is seen that Region 2 has a large negative value, $H_2$ = -0.92, since the mean deviation of its neighbors is 0.16 and the deviation for Region 2 is -0.17, as shown in Figure 4.4.2. The reason Region 8 has a large positive value, $H_8$ = 0.88, is that the mean deviation of its neighbors is 0.46, as compared to the deviation for Region 8, which is 0.40. It is interesting to note that these are the largest values in magnitude for $H_i$ and the two points closest to the dashed lines in Figure 4.4.3.

The proposed measure, $H_i$, is a direct comparison of a region's deviation with the mean deviation of its neighbors. When $|H_i| \cong 1$, it is detecting regions that have deviations very similar to the mean deviation of its neighbors. Not all such regions have values of $I_i$ that are large in magnitude. To determine when a region will have a large $I_i$ value, three cases will be examined. Case 1: A region may have a large deviation as compared to the second sample moment, which is then adjusted based on the sum of its neighbors' deviations. This is illustrated by $I_{14}$ = 2.37. Region 14 has the largest negative deviation from the mean with $z_{14}$ = -0.80, which is over two times the second sample moment ($m_2$ = 0.38), and the sum of its neighbors' deviations almost triples this. For $H_i$ to have a large value under these conditions, a region with a large deviation must have neighbors whose mean deviation is similar in magnitude. Case 2: A region may have a small deviation but the sum of its neighbors' deviations must be large when compared to the second sample moment. This is illustrated by $I_8$ = 1.46. Region 8 has deviation $z_8$ = 0.40 that is almost identical to the second sample moment, but the sum of its neighbors' deviations is 3.6 times greater than the second sample moment. For $H_i$ to have a large value under these conditions, a region with a small deviation must have neighbors whose mean deviation is similar in magnitude. Case 3: Both a region and the sum of its neighbors' deviations may be large as compared to the second sample moment. This will result in the largest $I_i$ values. This is illustrated by $I_7$ = 6.25. Region 7 has the largest deviation from the mean with $z_7$ = 1.25, which is over three times the second sample moment, and the sum of its neighbors' deviations almost doubles this. For $H_i$ to have a large value under these conditions, a region with a large deviation must have neighbors whose mean deviation is similar in magnitude. Since these three cases are not identical, the information provided by $H_i$ does not have a one-to-one correspondence to the information provided by $I_i$.

# CHAPTER 5

## APPLIED EXAMPLE

An applied example is presented to compare and contrast the well-known measures with the proposed local measures local spatial autocorrelation.  The percent elderly in Oklahoma counties is examined for the Rook Connectivity Matrix.  The data for this example come from an underlying distribution that is unknown.

Local measures using the Rook Connectivity Case for percent elderly in Oklahoma counties, computed from the data in Table A.1, are given in Table 5.1.  As an illustration of the difficulty of interpreting local measures of spatial autocorrelation, the maxima and minima for each statistic are given.  It is seen that values of $I_i$ vary from -6.474 to 11.476, values of $c_i$ vary from 0.081 to 35.878, values of $G_i$ vary from 0.008 to 0.108, values of $G_i$* vary from 0.023 to 0.119, values of $H_i$ vary from -0.989 to 0.947, and values from $H_i$* vary from -0.970 to 0.965.  The minimum value of 0.081 for $c_i$ and maxima of 0.947 and 0.965 for $H_i$, and $H_i$*, respectively, occur for Ottawa County which indicates positive spatial autocorrelation.  The maximum value of 11.476 for $I_i$ occurs for Cleveland County which indicates positive spatial autocorrelation.  The maxima of 0.108 and 0.119 for $G_i$ and $G_i$*, respectively, occur for Pontotoc County and their minima of 0.008 and 0.023, respectively, occur for Cimarron County.  Values for $G_i$ and $G_i$* are not standardized so their interpretation is difficult.  The maximum value of 35.878 for $c_i$

Table 5.1 Local Measures of Spatial Autocorrelation using Rook Connectivity Case for Percent Elderly in Oklahoma Counties

| | | Local Measure of Spatial Autocorrelation | | | | | |
|---|---|---|---|---|---|---|---|
| **County** | **Region** | $I_i$ | $c_i$ | $G_i$ | $G_i$* | $H_i$ | $H_i$* |
| ADAIR | 1 | 1.836 | 3.092 | 0.035 | 0.045 | 0.411 | 0.558 |
| ALFALFA | 2 | 5.437 | 2.056 | 0.063 | 0.079 | 0.724 | 0.779 |
| ATOKA | 3 | -0.634 | 3.295 | 0.084 | 0.095 | -0.827 | -0.566 |
| BEAVER | 4 | 0.540 | 8.938 | 0.044 | 0.058 | 0.469 | 0.541 |
| BECKHAM | 5 | -0.731 | 9.316 | 0.093 | 0.104 | -0.164 | -0.197 |
| BLAINE | 6 | -0.148 | 8.836 | 0.077 | 0.090 | -0.367 | -0.171 |
| BRYAN | 7 | -0.174 | 2.014 | 0.055 | 0.067 | -0.684 | -0.970 |
| CADDO | 8 | 0.978 | 10.260 | 0.084 | 0.095 | 0.763 | 0.786 |
| CANADIAN | 9 | 9.187 | 13.199 | 0.066 | 0.074 | 0.386 | 0.474 |
| CARTER | 10 | 0.057 | 4.336 | 0.104 | 0.116 | 0.020 | 0.023 |
| CHEROKEE | 11 | 4.652 | 5.237 | 0.069 | 0.078 | 0.520 | 0.589 |
| CHOCTAW | 12 | -0.183 | 2.201 | 0.052 | 0.065 | -0.231 | 0.015 |
| CIMARRON | 13 | -1.447 | 6.714 | 0.008 | 0.023 | -0.459 | -0.590 |
| CLEVELAND | 14 | 11.746 | 5.497 | 0.039 | 0.046 | 0.540 | 0.632 |
| COAL | 15 | 0.205 | 2.417 | 0.067 | 0.080 | 0.114 | 0.262 |
| COMANCHE | 16 | -4.775 | 35.878 | 0.085 | 0.093 | -0.221 | -0.046 |
| COTTON | 17 | 0.677 | 6.853 | 0.056 | 0.070 | 0.525 | 0.620 |
| CRAIG | 18 | -0.043 | 2.768 | 0.064 | 0.077 | -0.638 | -0.878 |
| CREEK | 19 | 3.922 | 2.640 | 0.068 | 0.078 | 0.689 | 0.733 |
| CUSTER | 20 | -2.138 | 11.283 | 0.087 | 0.097 | -0.734 | -0.487 |
| DELAWARE | 21 | -1.143 | 6.595 | 0.059 | 0.073 | -0.989 | -0.676 |
| DEWEY | 22 | 4.341 | 11.990 | 0.087 | 0.102 | 0.299 | 0.399 |
| ELLIS | 23 | 7.305 | 9.403 | 0.077 | 0.093 | 0.421 | 0.517 |
| GARFIELD | 24 | 0.033 | 7.114 | 0.086 | 0.098 | 0.030 | 0.035 |
| GARVIN | 25 | -0.490 | 6.716 | 0.077 | 0.090 | -0.228 | -0.052 |
| GRADY | 26 | 3.577 | 7.659 | 0.068 | 0.078 | 0.767 | 0.800 |
| GRANT | 27 | 2.860 | 4.712 | 0.044 | 0.061 | 0.338 | 0.504 |
| GREER | 28 | 1.871 | 8.273 | 0.057 | 0.072 | 0.301 | 0.441 |
| HARMON | 29 | -0.228 | 10.852 | 0.039 | 0.056 | -0.031 | 0.226 |
| HARPER | 30 | 5.007 | 7.861 | 0.060 | 0.077 | 0.399 | 0.519 |
| HASKELL | 31 | 0.218 | 4.875 | 0.081 | 0.093 | 0.248 | 0.356 |
| HUGHES | 32 | 2.274 | 3.315 | 0.087 | 0.100 | 0.571 | 0.632 |
| JACKSON | 33 | -6.474 | 26.045 | 0.066 | 0.075 | -0.968 | -0.626 |
| JEFFERSON | 34 | 1.839 | 3.794 | 0.057 | 0.072 | 0.282 | 0.425 |
| JOHNSTON | 35 | -0.286 | 3.192 | 0.097 | 0.108 | -0.725 | -0.925 |
| KAY | 36 | 0.181 | 3.598 | 0.041 | 0.054 | 0.584 | 0.688 |
| KINGFISHER | 37 | 0.308 | 5.969 | 0.061 | 0.073 | 0.482 | 0.528 |
| KIOWA | 38 | -0.623 | 22.488 | 0.091 | 0.106 | -0.050 | 0.082 |

| | | Local Measure of Spatial Autocorrelation | | | | | |
|---|---|---|---|---|---|---|---|
| **County** | **Region** | $I_i$ | $c_i$ | $G_i$ | $G_i^*$ | $H_i$ | $H_i^*$ |
| LATIMER | 39 | 0.035 | 1.174 | 0.055 | 0.067 | 0.221 | 0.261 |
| LE FLORE | 40 | 0.142 | 3.542 | 0.065 | 0.076 | 0.064 | 0.220 |
| LINCOLN | 41 | 3.437 | 2.097 | 0.064 | 0.075 | 0.704 | 0.735 |
| LOGAN | 42 | 4.264 | 3.476 | 0.069 | 0.078 | 0.558 | 0.621 |
| LOVE | 43 | 0.178 | 2.487 | 0.046 | 0.058 | 0.094 | 0.121 |
| MCCLAIN | 44 | 4.366 | 5.825 | 0.056 | 0.065 | 0.586 | 0.655 |
| MCCURTAIN | 45 | -0.303 | 2.863 | 0.041 | 0.052 | -0.277 | 0.043 |
| MCINTOSH | 46 | 2.139 | 16.259 | 0.083 | 0.099 | 0.110 | 0.237 |
| MAJOR | 47 | 3.926 | 6.201 | 0.102 | 0.117 | 0.498 | 0.561 |
| MARSHALL | 48 | -0.281 | 5.401 | 0.052 | 0.067 | -0.059 | 0.153 |
| MAYES | 49 | 1.268 | 4.939 | 0.055 | 0.067 | 0.420 | 0.465 |
| MURRAY | 50 | 0.113 | 2.709 | 0.053 | 0.067 | 0.046 | 0.237 |
| MUSKOGEE | 51 | 0.373 | 8.186 | 0.074 | 0.086 | 0.664 | 0.697 |
| NOBLE | 52 | 0.848 | 3.446 | 0.069 | 0.081 | 0.387 | 0.424 |
| NOWATA | 53 | -0.329 | 3.564 | 0.037 | 0.051 | -0.640 | -0.230 |
| OKFUSKEE | 54 | 0.032 | 5.842 | 0.093 | 0.105 | 0.414 | 0.488 |
| OKLAHOMA | 55 | 7.829 | 2.587 | 0.048 | 0.057 | 0.858 | 0.879 |
| OKMULGEE | 56 | 0.617 | 8.236 | 0.073 | 0.084 | 0.682 | 0.715 |
| OSAGE | 57 | 0.868 | 4.404 | 0.063 | 0.073 | 0.223 | 0.353 |
| OTTAWA | 58 | 0.160 | 0.081 | 0.028 | 0.041 | 0.947 | 0.965 |
| PAWNEE | 59 | 1.774 | 3.049 | 0.052 | 0.064 | 0.360 | 0.403 |
| PAYNE | 60 | 5.297 | 4.873 | 0.057 | 0.065 | 0.418 | 0.515 |
| PITTSBURG | 61 | 1.411 | 3.113 | 0.103 | 0.115 | 0.615 | 0.646 |
| PONTOTOC | 62 | -0.286 | 5.283 | 0.108 | 0.119 | -0.409 | -0.252 |
| POTTAWATOMIE | 63 | 3.534 | 4.859 | 0.078 | 0.088 | 0.878 | 0.892 |
| PUSHMATAHA | 64 | -0.568 | 5.526 | 0.077 | 0.091 | -0.182 | -0.013 |
| ROGER MILLS | 65 | 2.182 | 4.892 | 0.060 | 0.074 | 0.763 | 0.810 |
| ROGERS | 66 | 3.347 | 11.102 | 0.072 | 0.081 | 0.270 | 0.374 |
| SEMINOLE | 67 | -0.009 | 1.434 | 0.053 | 0.065 | -0.045 | 0.164 |
| SEQUOYAH | 68 | 2.220 | 2.048 | 0.058 | 0.068 | 0.772 | 0.810 |
| STEPHENS | 69 | -0.254 | 10.895 | 0.078 | 0.092 | -0.069 | 0.084 |
| TEXAS | 70 | -1.963 | 10.985 | 0.029 | 0.037 | -0.311 | 0.126 |
| TILLMAN | 71 | -1.282 | 14.106 | 0.049 | 0.064 | -0.302 | -0.041 |
| TULSA | 72 | 6.572 | 5.841 | 0.078 | 0.087 | 0.571 | 0.624 |
| WAGONER | 73 | 8.410 | 7.528 | 0.066 | 0.074 | 0.444 | 0.524 |
| WASHINGTON | 74 | -1.811 | 9.571 | 0.044 | 0.058 | -0.713 | -0.922 |
| WASHITA | 75 | 0.153 | 5.172 | 0.053 | 0.068 | 0.050 | 0.240 |
| WOODS | 76 | 4.450 | 3.447 | 0.063 | 0.078 | 0.753 | 0.802 |
| WOODWARD | 77 | -4.050 | 21.204 | 0.086 | 0.096 | -0.363 | -0.470 |
| **Minimum** | | -6.474 | 0.081 | 0.008 | 0.023 | -0.989 | -0.970 |
| **Maximum** | | 11.746 | 35.878 | 0.108 | 0.119 | 0.947 | 0.965 |

occurs for Comanche County and indicates negative spatial autocorrelation. The minima of -0.989 and -0.970 for $H_i$ and $H_i$*, respectively, occur for Delaware County and Bryan County which indicates negative spatial autocorrelation. The minimum value of -6.474 for $I_i$ occurs for Jackson County which indicates negative spatial autocorrelation.

A scatterplot matrix of local measures of spatial autocorrelation for percent elderly using Rook Connectivity Case is given in Figure 5.1. As expected, there is a very strong association between $G_i$ and $G_i$*, as well as between $H_i$ and $H_i$*. There are weaker associations between $I_i$ and $H_i$, $I_i$ and $H_i$*, $c_i$ and $G_i$, $c_i$ and $H_i$, and $c_i$ and $H_i$*. However, there are not any very strong linear associations among $I_i$, $c_i$, $G_i$, and $H_i$.

The association between each pair of measures is further investigated using a correlation matrix based on Spearman correlation coefficients. These results are given in Table 5.2. It is seen there is significant association between $I_i$ and $H_i$ with $r_s = 0.81$ ($p<0.0001$) and between $I_i$ and $H_i$* with $r_s = 0.80$ ($p<0.0001$). Thus, there are positive monotonic associations among these measures. The only other significant association is between $c_i$ and $G_i$ with $r_s = 0.30$ ($p=0.0078$).

Figure 5.1 Scatterplot Matrix of Local Measures of Spatial Autocorrelation using Rook Connectivity Case for Percent Elderly in Oklahoma Counties

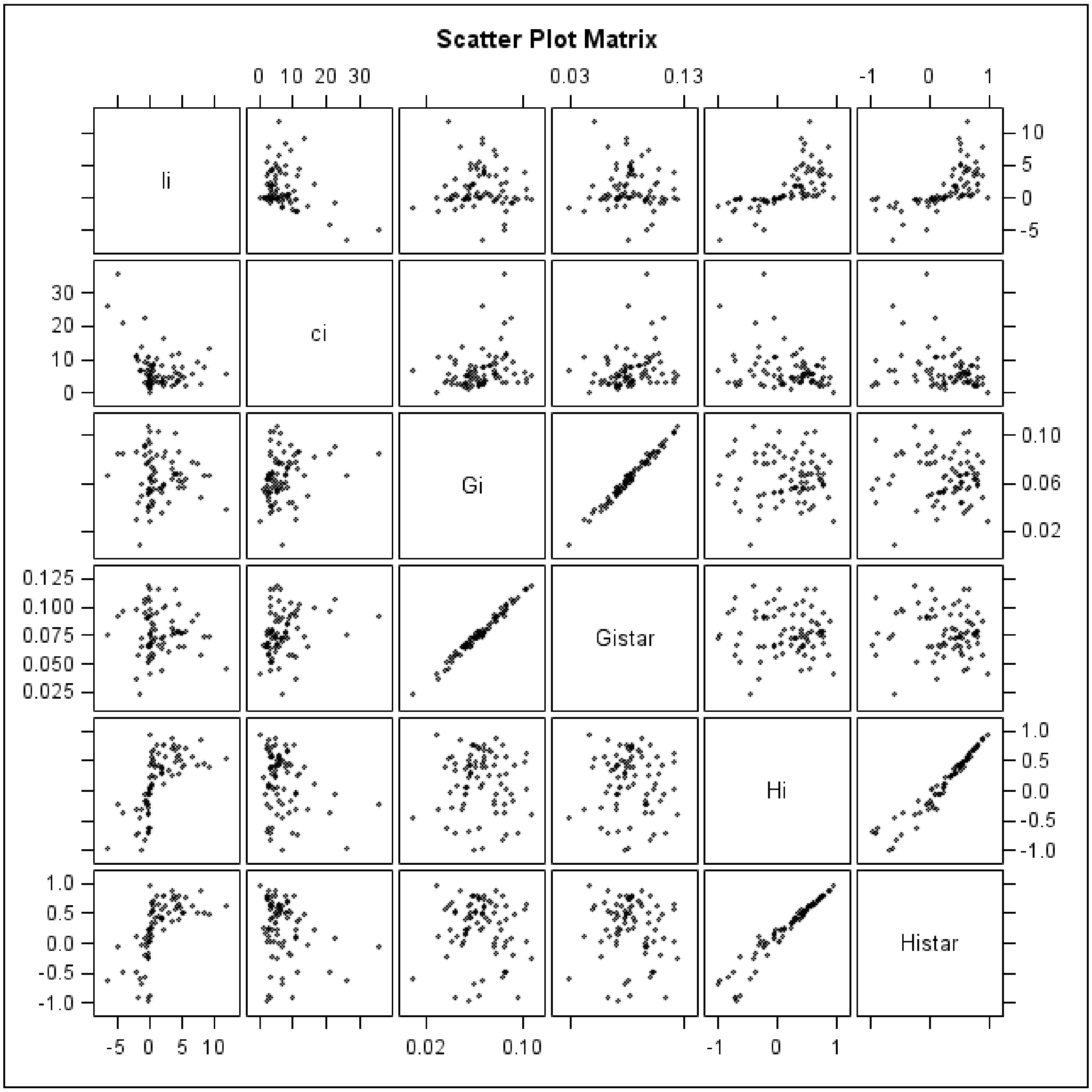
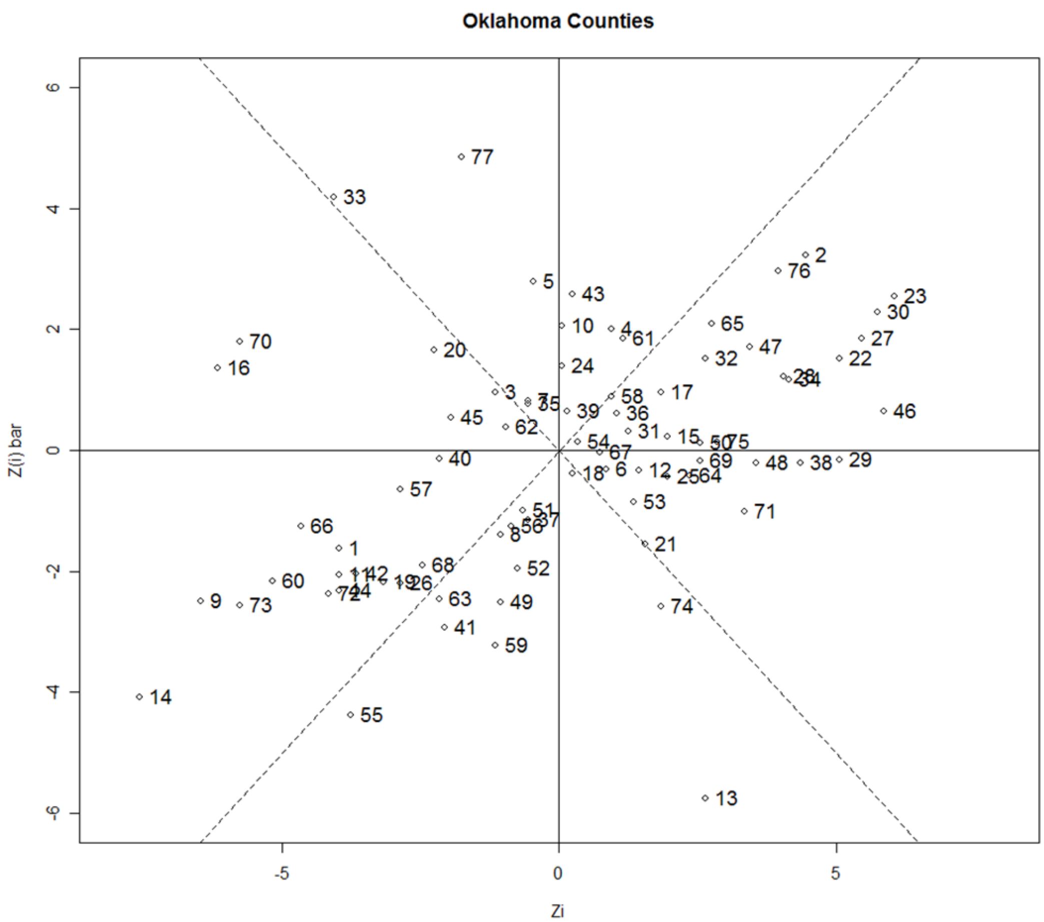


Table 5.2 Spearman Correlation Coefficients for Local Measures of Spatial Autocorrelation using Rook Connectivity Case for Percent Elderly in Oklahoma Counties

| Spearman Correlation Coefficients, N = 77<br>Prob > \|r\| under H0: Rho=0 | | | | | | |
|---|---|---|---|---|---|---|
| | **Ii** | **ci** | **Gi** | **Gistar** | **Hi** | **Histar** |
| **Ii**<br>Ii | 1.00000 | -0.19157<br>0.0951 | -0.00660<br>0.9546 | -0.01885<br>0.8707 | 0.80680<br><.0001 | 0.80054<br><.0001 |
| **ci**<br>ci | -0.19157<br>0.0951 | 1.00000 | 0.30096<br>0.0078 | 0.28504<br>0.0120 | -0.22706<br>0.0470 | -0.21870<br>0.0560 |
| **Gi**<br>Gi | -0.00660<br>0.9546 | 0.30096<br>0.0078 | 1.00000 | 0.98714<br><.0001 | -0.01938<br>0.8672 | -0.07816<br>0.4993 |
| **Gistar**<br>Gi* | -0.01885<br>0.8707 | 0.28504<br>0.0120 | 0.98714<br><.0001 | 1.00000 | -0.02948<br>0.7991 | -0.08475<br>0.4637 |
| **Hi**<br>Hi | 0.80680<br><.0001 | -0.22706<br>0.0470 | -0.01938<br>0.8672 | -0.02948<br>0.7991 | 1.00000 | 0.98814<br><.0001 |
| **Histar**<br>Hi* | 0.80054<br><.0001 | -0.21870<br>0.0560 | -0.07816<br>0.4993 | -0.08475<br>0.4637 | 0.98814<br><.0001 | 1.00000 |

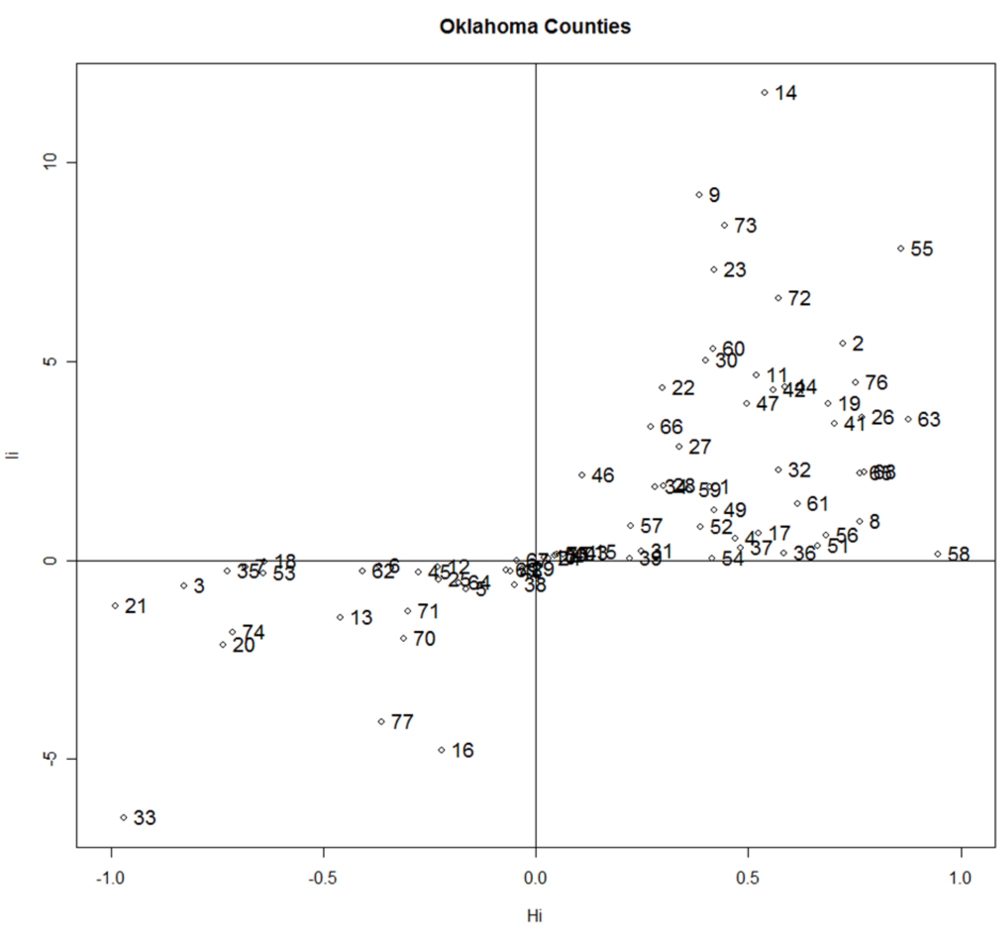
A scatterplot of each county's deviation and mean deviation of its neighboring counties is shown in Figure 5.2. Each point is labeled with its Region number as defined in Table 5.1. The dashed line with positive slope represents a +1 measure of local spatial autocorrelation. Values of $z_i$ and $\bar{z}_{(i)}$ that are identical will fall along this line. It is seen that Oklahoma County (Region 55), Ottawa County (Region 58), and Pottawatomie County (Region 63) are very close to this line and have values of $H_i$ that are at least 0.80 in Table 5.1. The dashed line with negative slope represents a -1 measure of local spatial autocorrelation. Values of $z_i$ and $\bar{z}_{(i)}$ that are identical except for their sign will fall along this line. It is seen that Delaware County (Region 21), Jackson County (Region 33), and Atoka County (Region 3) are very close to this line and have values of $H_i$ that are less than -0.80 in Table 5.1. The purpose of this scatterplot is to assist in the interpretation of the proposed measure, $H_i$.

Figure 5.2 Scatterplot of Each County's Deviation versus Mean Deviation of Neighboring Counties using Rook Connectivity Matrix




A scatterplot of each county's $I_i$ and $H_i$ values is shown in Figure 5.3. Each point is labeled with its Region number as defined in Table 5.1. A comparison of $I_i$ and $H_i$ reveals two counties that have extreme $H_i$ values for which values of $I_i$ are close to zero. Ottawa County, Region 58, is particularly interesting with respect to the proposed measure as $H_{58}$ = 0.947 is very close to positive one indicating very strong spatial autocorrelation, yet $I_{58}$ = 0.160, which is very close to zero indicating no spatial autocorrelation. Delaware County, Region 21, has $H_{21}$ = -0.989 which indicates very strong negative spatial autocorrelation and $I_{21}$ = -1.143 which indicates very weak negative spatial autocorrelation. Thus, the proposed measure, $H_i$, has identified two regions with very strong spatial autocorrelation that the most common measure, $I_i$, has overlooked. This is accomplished by making a direct comparison of a region's

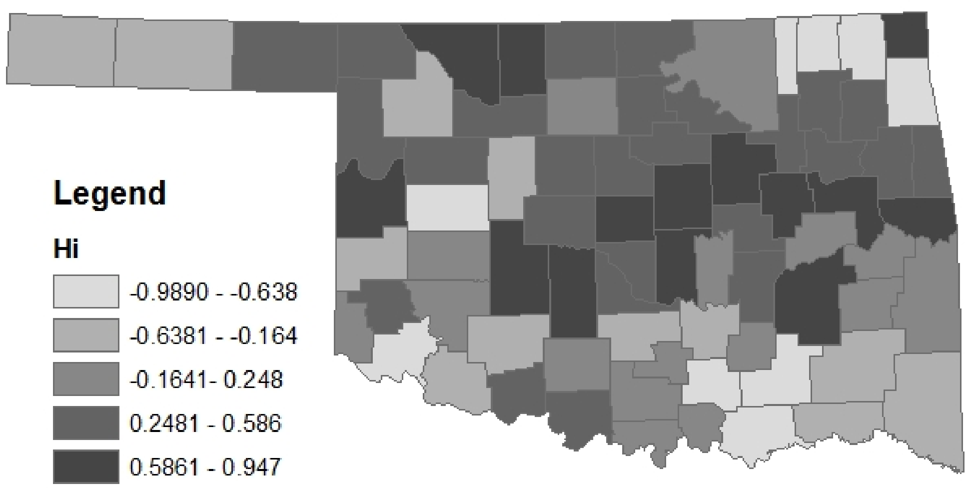
Figure 5.3 Scatterplot of Each County's $I_i$ and $H_i$ Values Using Rook Connectivity Matrix



deviation to the mean deviations of its neighbors instead of weighting a current region's deviation by the second sample moment and the sum of its neighbors deviations.

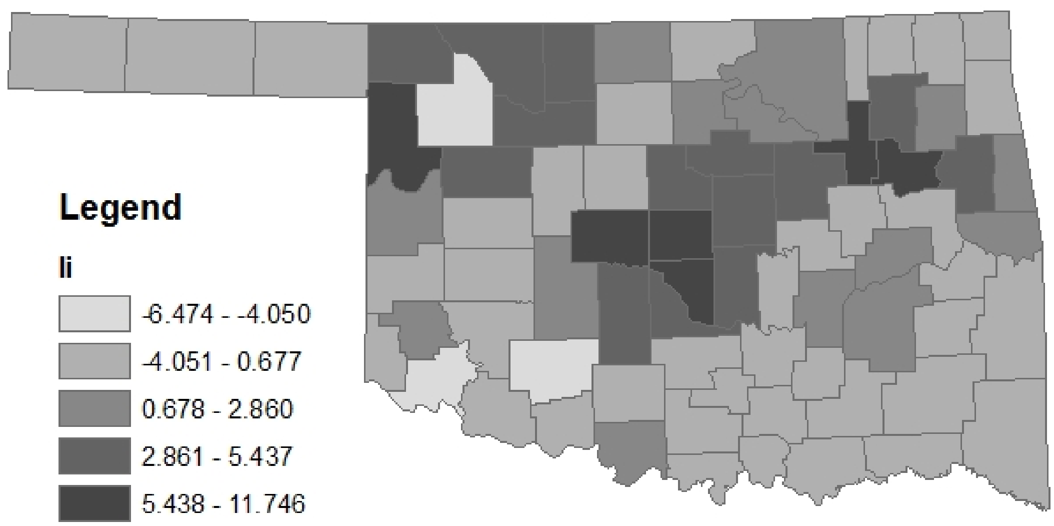
A map of county $H_i$ values with the data categorized using the Jenks method and displayed spatially is given in Figure 5.4. Most of the counties with the highest level of positive local spatial autocorrelation are located along or near Interstate 40 in the eastern part of the state and Interstate 44 in the central part of the state. There are clusters of counties with high negative spatial autocorrelation in the northeast and south central parts of the state, with isolated counties in the southwest and west-central parts of the state.

Figure 5.4 Map of $H_i$ Values for Oklahoma Counties




A map of county $I_i$ values with the data categorized using the Jenks method and displayed spatially is given in Figure 5.5. Counties with the highest level of positive spatial autocorrelation are part of the Oklahoma City Metropolitan Area (Oklahoma, Canadian, and Cleveland), part of the Tulsa Metropolitan Area (Tulsa, Wagoner), or Ellis County in the northwest part of the state and which has the highest percent of residents 65 and over.  The county with the highest magnitude of negative spatial autocorrelation is Woodward County in the northwest part of the state.

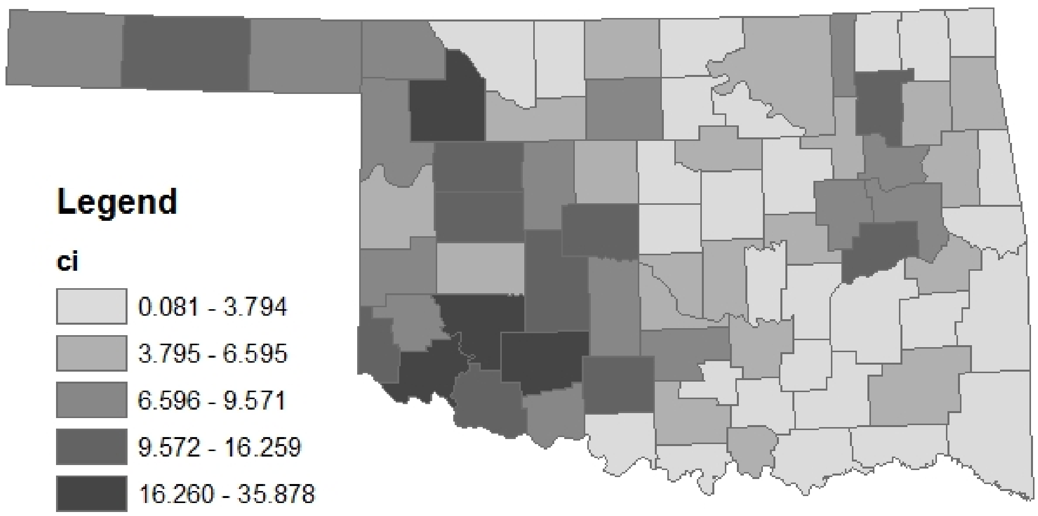
Figure 5.5    Map of $I_i$ Values for Oklahoma Counties




A map of county $c_i$ values with the data categorized using the Jenks method and displayed spatially is given in Figure 5.6.  Three counties (Jackson, Kiowa, and Comanche) with the highest level of negative spatial autocorrelation are clustered in the southwestern part of the state and one county (Woodward) is in the northwestern part of the state.  It is not possible to relate positive spatial autocorrelation values to specific counties because the category for the smallest $c_i$ values ranges from 0.081, which indicates very strong positive spatial autocorrelation, to 3.794, which indicates weak negative spatial autocorrelation.  Perhaps a different categorization method, or forcing a category break at a value between 0 and 1, would provide a more meaningful separation between positive and negative spatial autocorrelation for this measure.

It is interesting to note that there is some overlap in the categorization of counties for these three measures of local spatial autocorrelation; however, there is not a one-to-one correspondence among them. Each measure contributes to the interpretation of spatial autocorrelation in its own unique manner.

Figure 5.6 Map of $c_i$ Values for Oklahoma Counties



# CHAPTER 6

## CONCLUSIONS AND FUTURE RESEARCH

When sampling from a multivariate normal distribution, $H_i$ is distributed as a twice-folded Cauchy distribution with finite moments. The folds are at -1 and +1, which constrains values to the interval [-1, +1]. Values of $H_i$ are interpreted similar to usual measures of correlation with +1 indicating positive local spatial autocorrelation and -1 indicating negative local spatial autocorrelation. The parameters of the twice-folded Cauchy distribution are shown to be functions of the parameters of the multivariate normal distribution.

The proposed measure, $H_i$, obtains highest power for Rook pattern spatial autocorrelation using the Rook Connectivity Case in 4x4 and 9x9 study areas. It is a valuable tool in the search for spatial autocorrelation as it identifies regions that the most common local measure, $I_i$, overlooks. A scatterplot of region deviations against the mean deviation of its neighbors is presented to assist in its interpretation. $H_i$ provides a useful supplement to the set of current measures of local spatial autocorrelation.

Based on the simulations in this study, Geary's $c_i$ should be used more extensively. This measure obtained the highest power for many of the scenarios investigated and was the only measure to obtain power close to one. Of the 24 scenarios used to examine power for 9x9 and 14x14 study areas, it obtained the highest power at all locations within a study area for 23 of the scenarios. For interior and interior hot-spot regions, $c_i$ obtained the highest power for 32 of the 36 scenarios investigated for power.

Moran's $I_i$ obtained highest power for all regions within a 4x4 study area for Rook pattern spatial autocorrelation using the Queen and CWF Connectivity Cases. It also obtained highest power at corner and edge regions for CWF pattern spatial autocorrelation using Queen Connectivity and CWF Connectivity Cases for a 4x4 study area.

Tests of significance for all six measures for the model used in this research are size alpha tests for 9x9 and 14x14 study areas and are slightly conservative for a 4x4 study area.

There are opportunities to expand current research in many meaningful directions. One direction is to investigate size and power for different models; in particular, those that do not have a stationary mean. This will provide meaningful results for all measures and not exclude any due to neutralizing effects induced by a stationary mean. Another direction is to investigate various methods of folding the distribution, such as symmetrical, or perhaps even asymmetrical about zero, based on predefined fold points. This could be done in conjunction with developing a procedure to find fold points that maximize power. An issue that appears repeatedly in the literature, and should be addressed, is the multiplicity problem. The number of simultaneous hypothesis tests conducted for this research ranged from 16 for a 4x4 study area to 196 for a 14x14 study area. An intriguing direction is to investigate linear combinations of the four local measures which exclude the pivot point, $c_i$, $I_i$, $G_i$, and $H_i$, to determine if there is a synergistic effect that leads to larger power. Finally, it may be possible to obtain higher power for $H_i$ using the twice-folded Cauchy distribution.

# BIBLIOGRAPHY

Anselin, L. (1995). "Local indicators of spatial association - LISA." Geographical Analysis **27**(2): 93-115.

Bain, L. J. and M. Engelhardt (1992). Introduction to Probability and Mathematical Statistics. Pacific Grove, CA, Duxbury.

Boots, B. (2002). "Local measures of spatial association." Ecoscience **9**(2): 168-176.

Buck, R. C. (1978). Advanced Calculus. Longrove, Illinois, Waveland Press, Inc.

Cliff, A. D. and J. K. Ord (1973). Spatial Autocorrelation. London, Pion Limited.

Fotheringham, A. S. (2009). ""The Problem of Spatial Autocorrelation" and Local Spatial Statistics." Geographical Analysis **41**(4): 398-403.

Fotheringham, A. S., C. Brunsdon, et al. (2002). Geographically Weighted Regression: The Analysis of Spatially Varying Relationships. West Sussex, England, John Wiley & Sons Ltd.

Fotheringham, A. S. and P. A. Rogerson, Eds. (2009). The SAGE Handbook of Spatial Analysis. London, SAGE Publications Ltd.

Geary, R. C. (1954). "The Contiguity Ratio and Statistical Mapping." The Incorporated Statistician **5**(3): 115-145.

Getis, A. (2008). "A history of the concept of spatial autocorrelation: A geographer's perspective." Geographical Analysis **40**(3): 297-309.

Getis, A. and J. K. Ord (1992). "The analysis of spatial association by use of distance statistics." Geographical Analysis **24**(3): 189-206.

Griffith, D. A. (1984). Theory of Spatial Statistics. Spatial Statistics and Models. G. L. Gaile and C. Willmott. Boston, D. Reidel Publishing Company.

Griffith, D. A. (1987). Spatial Autocorrelation: A Primer. Washington, D.C., Association of American Geographers.

Griffith, D. A. (2003). Spatial Autocorrelation and Spatial Filtering. Berlin, Springer-Verlag.

Gumprecht, D., W. G. Muller, et al. (2009). "Designs for Detecting Spatial Dependence." Geographical Analysis **41**(2): 127-143.

Johnson, D. E. and F. A. Graybill (1972). "An analysis of a two-way model with interaction and no replication." Journal of the American Statistical Association **67**: 862-868.

Johnson, N. L. and S. Kotz (1970). Continuous Univariate Distributions - 1. Boston, Houghton Mifflin Company.

Langford, E., N. Schwertman, et al. (2001). "Is the Property of Being Positively Correlated Transitive?" The American Statistician **55**(4): 322-325.

Lee, S. I. (2001). "Developing a Bivariate Spatial Association Measure: An Integration of Pearson's r and Moran's I." Journal of Geographical Systems **3**(4): 369-385.

Lee, S. I. (2009). "A Generalized Randomization Approach to Local Measures of Spatial Association (vol 41, pg 221, 2009)." Geographical Analysis **41**(3): 1-2.

Leone, F. C., L. S. Nelson, et al. (1961). "The folded normal distribution." Technometrics **4**(2): 543-550.

Maple (2009). Maple 13. Waterloo, Ontario, Maplesoft, a division of Waterloo Maple Inc.

MATLAB (2008). MATLAB. Natick, MA, The MathWorks Inc.

Moran, P. A. P. (1950). "Notes on Continuous Stochastic Phenomena." Biometrika **37**(1/2): 17-23.

Morris, T. L. (2007). A Permutation Test for the Structure of a Covariance Matrix. Statistics Department. Stillwater, Oklahoma State University. **Doctor of Philosophy**.

Nadarajah, S. and S. Kotz (2006). "A truncated Cauchy distribution." International Journal of Mathematical Education in Science and Technology **37**(5): 605-608.

Nelson, L. S. (1980). "The folded normal distribution." Journal of Quality Technology **12**(4): 236-238.

Rogerson, P. A. (2006). Statistical Methods for Geography. London, SAGE Publications Ltd.

SAS (2002-2008). Version 9.2 of the SAS System for Windows. Cary, NC, USA, SAS Institute Inc.

Serfling, R. J. (1980). Approximation Theorems of Mathematical Statistics. New York, John Wiley & Sons, Inc.

Sokal, R. R., N. L. Oden, et al. (1998). "Local spatial autocorrelation in a biological model." Geographical Analysis **30**(4): 331-354.

Team, R. D. C. (2007). R: A Language and Environment for Statistical Computing. Vienna, Austria, R Foundation for Statistical Computing.

Tobler, W. R. (1970). "A Computer Movie Simulating Urban Growth in the Detroit Region." Economic Geography **46**: 234-240.

Toh, K. C., R. H. Tutuncu, et al. (2006) "On the implementation and usage of SDPT3 - a MATLAB software package for semidefinite-quadratic-linear programming, version 4.0."

Wackerly, D. D., W. Mendenhall, et al. (2002). Mathematical Statistics with Applications. Pacific Grove, CA, Duxbury.

APPENDICES

## A. DATA TABLES AND MAPS FOR PERCENT ELDERLY IN OKLAHOMA COUNTIES

Table A.1 Data for Percent Elderly in Oklahoma Counties

| COUNTY | TOTAL | NUMBER 65 YEARS AND OVER | PERCENT 65 YEARS AND OVER |
|---|---|---|---|
| ADAIR | 21,038 | 2,535 | 12.0 |
| ALFALFA | 6,105 | 1,243 | 20.4 |
| ATOKA | 13,879 | 2,050 | 14.8 |
| BEAVER | 5,857 | 992 | 16.9 |
| BECKHAM | 19,799 | 3,059 | 15.5 |
| BLAINE | 11,976 | 2,015 | 16.8 |
| BRYAN | 36,534 | 5,638 | 15.4 |
| CADDO | 30,150 | 4,499 | 14.9 |
| CANADIAN | 87,697 | 8,364 | 9.5 |
| CARTER | 45,621 | 7,293 | 16.0 |
| CHEROKEE | 42,521 | 5,097 | 12.0 |
| CHOCTAW | 15,342 | 2,664 | 17.4 |
| CIMARRON | 3,148 | 585 | 18.6 |
| CLEVELAND | 208,016 | 17,537 | 8.4 |
| COAL | 6,031 | 1,078 | 17.9 |
| COMANCHE | 114,996 | 11,220 | 9.8 |
| COTTON | 6,614 | 1,174 | 17.8 |
| CRAIG | 14,950 | 2,418 | 16.2 |
| CREEK | 67,367 | 8,650 | 12.8 |
| CUSTER | 26,142 | 3,593 | 13.7 |
| DELAWARE | 37,077 | 6,501 | 17.5 |
| DEWEY | 4,743 | 995 | 21.0 |
| ELLIS | 4,075 | 895 | 22.0 |
| GARFIELD | 57,813 | 9,262 | 16.0 |
| GARVIN | 27,210 | 4,883 | 17.9 |
| GRADY | 45,516 | 5,958 | 13.1 |

| COUNTY | TOTAL | NUMBER 65 YEARS AND OVER | PERCENT 65 YEARS AND OVER |
|---|---|---|---|
| GRANT | 5,144 | 1,103 | 21.4 |
| GREER | 6,061 | 1,215 | 20.0 |
| HARMON | 3,283 | 691 | 21.0 |
| HARPER | 3,562 | 773 | 21.7 |
| HASKELL | 11,792 | 2,024 | 17.2 |
| HUGHES | 14,154 | 2,626 | 18.6 |
| JACKSON | 28,439 | 3,388 | 11.9 |
| JEFFERSON | 6,818 | 1,372 | 20.1 |
| JOHNSTON | 10,513 | 1,621 | 15.4 |
| KAY | 48,080 | 8,154 | 17.0 |
| KINGFISHER | 13,926 | 2,139 | 15.4 |
| KIOWA | 10,227 | 2,079 | 20.3 |
| LATIMER | 10,692 | 1,718 | 16.1 |
| LE FLORE | 48,109 | 6,615 | 13.8 |
| LINCOLN | 32,080 | 4,463 | 13.9 |
| LOGAN | 33,924 | 4,188 | 12.3 |
| LOVE | 8,831 | 1,428 | 16.2 |
| MCCLAIN | 27,740 | 3,321 | 12.0 |
| MCCURTAIN | 34,402 | 4,811 | 14.0 |
| MCINTOSH | 19,456 | 4,238 | 21.8 |
| MAJOR | 7,545 | 1,465 | 19.4 |
| MARSHALL | 13,184 | 2,576 | 19.5 |
| MAYES | 38,369 | 5,703 | 14.9 |
| MURRAY | 12,623 | 2,331 | 18.5 |
| MUSKOGEE | 69,451 | 10,624 | 15.3 |
| NOBLE | 11,411 | 1,737 | 15.2 |
| NOWATA | 10,569 | 1,829 | 17.3 |
| OKFUSKEE | 11,814 | 1,925 | 16.3 |
| OKLAHOMA | 660,448 | 80,716 | 12.2 |
| OKMULGEE | 39,685 | 6,003 | 15.1 |
| OSAGE | 44,437 | 5,807 | 13.1 |
| OTTAWA | 33,194 | 5,601 | 16.9 |
| PAWNEE | 16,612 | 2,453 | 14.8 |
| PAYNE | 68,190 | 7,349 | 10.8 |
| PITTSBURG | 43,953 | 7,536 | 17.1 |
| PONTOTOC | 35,143 | 5,260 | 15.0 |
| POTTAWATOMIE | 65,521 | 9,014 | 13.8 |
| PUSHMATAHA | 11,667 | 2,131 | 18.3 |
| ROGER MILLS | 3,436 | 644 | 18.7 |
| ROGERS | 70,641 | 7,961 | 11.3 |
| SEMINOLE | 24,894 | 4,169 | 16.7 |
| SEQUOYAH | 38,972 | 5,256 | 13.5 |

| COUNTY | TOTAL | NUMBER 65 YEARS AND OVER | PERCENT 65 YEARS AND OVER |
|---|---|---|---|
| STEPHENS | 43,182 | 7,982 | 18.5 |
| TEXAS | 20,107 | 2,056 | 10.2 |
| TILLMAN | 9,287 | 1,795 | 19.3 |
| TULSA | 563,299 | 66,735 | 11.8 |
| WAGONER | 57,491 | 5,838 | 10.2 |
| WASHINGTON | 48,996 | 8,700 | 17.8 |
| WASHITA | 11,508 | 2,160 | 18.8 |
| WOODS | 9,089 | 1,808 | 19.9 |
| WOODWARD | 18,486 | 2,621 | 14.2 |

Figure A.1  Map of Percent Elderly by Oklahoma County

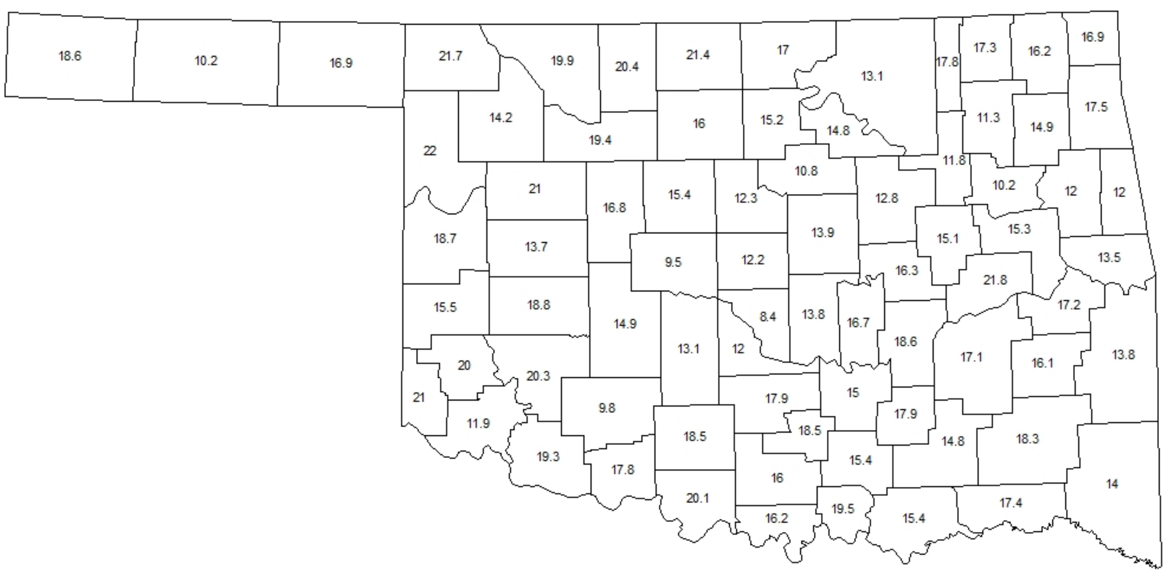
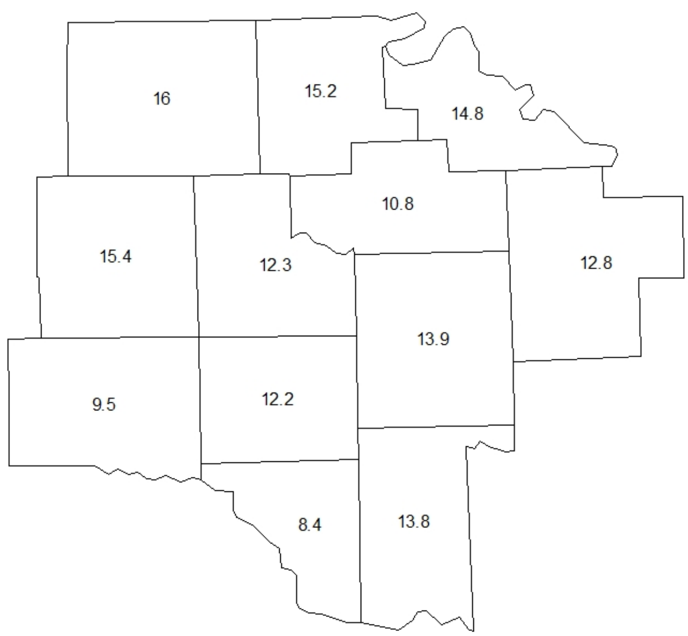


Figure A.2  Oklahoma Map with County Names


Figure A.3    Twelve Central Oklahoma Counties with Percent Elderly Values



## B. EMPIRICAL POWER AND SIZE TABLES AND GRAPHS

Table B.1 Empirical Size Using Rook Connectivity Case for a 4x4 Study Area

| | | **Column** | | | |
|---|---|---|---|---|---|
| **Row** | **Statistic** | **1** | **2** | **3** | **4** |
| **1** | $c_i$ | 0.041 | 0.038 | 0.042 | 0.026 |
| | $G_i$ | 0.032 | 0.040 | 0.035 | 0.037 |
| | $G_i$* | 0.052 | 0.044 | 0.042 | 0.041 |
| | $H_i$ | 0.053 | 0.045 | 0.049 | 0.040 |
| | $H_i$* | 0.045 | 0.042 | 0.044 | 0.049 |
| | $I_i$ | 0.032 | 0.040 | 0.034 | 0.037 |
| **2** | $c_i$ | 0.048 | 0.055 | 0.026 | 0.050 |
| | $G_i$ | 0.050 | 0.054 | 0.037 | 0.034 |
| | $G_i$* | 0.053 | 0.069 | 0.047 | 0.044 |
| | $H_i$ | 0.049 | 0.050 | 0.037 | 0.050 |
| | $H_i$* | 0.061 | 0.050 | 0.032 | 0.044 |
| | $I_i$ | 0.050 | 0.054 | 0.037 | 0.034 |
| **3** | $c_i$ | 0.048 | 0.048 | 0.059 | 0.043 |
| | $G_i$ | 0.050 | 0.049 | 0.056 | 0.036 |
| | $G_i$* | 0.039 | 0.056 | 0.048 | 0.027 |
| | $H_i$ | 0.038 | 0.043 | 0.046 | 0.045 |
| | $H_i$* | 0.054 | 0.048 | 0.042 | 0.048 |
| | $I_i$ | 0.048 | 0.049 | 0.056 | 0.035 |
| **4** | $c_i$ | 0.037 | 0.046 | 0.057 | 0.039 |
| | $G_i$ | 0.032 | 0.039 | 0.049 | 0.036 |
| | $G_i$* | 0.045 | 0.046 | 0.034 | 0.041 |
| | $H_i$ | 0.037 | 0.050 | 0.056 | 0.036 |
| | $H_i$* | 0.042 | 0.057 | 0.064 | 0.039 |
| | $I_i$ | 0.032 | 0.036 | 0.050 | 0.036 |

Figure B.1 Empirical Size Using Rook Connectivity Case for a 4x4 Study Area

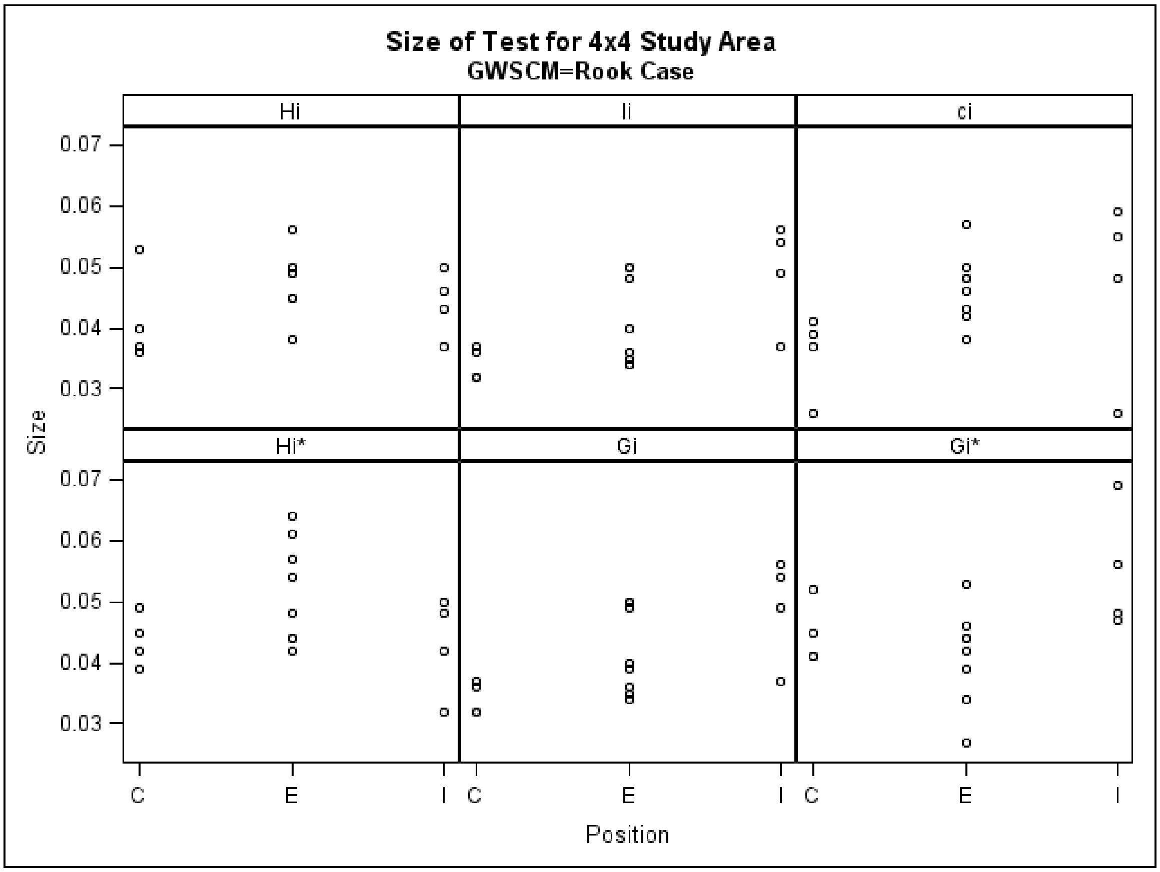


Table B.2 Empirical Size Using Queen Connectivity Case for a 4x4 Study Area

| | | Column | | | |
|---|---|---|---|---|---|
| **Row** | **Statistic** | **1** | **2** | **3** | **4** |
| **1** | $c_i$ | 0.055 | 0.049 | 0.051 | 0.039 |
| | $G_i$ | 0.050 | 0.047 | 0.041 | 0.056 |
| | $G_i$* | 0.057 | 0.047 | 0.047 | 0.056 |
| | $H_i$ | 0.053 | 0.052 | 0.054 | 0.043 |
| | $H_i$* | 0.057 | 0.068 | 0.043 | 0.048 |
| | $I_i$ | 0.050 | 0.047 | 0.041 | 0.055 |
| **2** | $c_i$ | 0.056 | 0.046 | 0.044 | 0.053 |
| | $G_i$ | 0.049 | 0.059 | 0.049 | 0.050 |
| | $G_i$* | 0.052 | 0.055 | 0.052 | 0.045 |
| | $H_i$ | 0.057 | 0.056 | 0.037 | 0.051 |
| | $H_i$* | 0.047 | 0.049 | 0.044 | 0.053 |
| | $I_i$ | 0.049 | 0.059 | 0.049 | 0.049 |
| **3** | $c_i$ | 0.054 | 0.045 | 0.050 | 0.042 |
| | $G_i$ | 0.053 | 0.048 | 0.038 | 0.039 |
| | $G_i$* | 0.047 | 0.050 | 0.032 | 0.039 |
| | $H_i$ | 0.040 | 0.053 | 0.038 | 0.042 |
| | $H_i$* | 0.042 | 0.057 | 0.050 | 0.049 |
| | $I_i$ | 0.053 | 0.048 | 0.038 | 0.038 |
| **4** | $c_i$ | 0.044 | 0.053 | 0.048 | 0.047 |
| | $G_i$ | 0.041 | 0.043 | 0.043 | 0.036 |
| | $G_i$* | 0.042 | 0.044 | 0.042 | 0.035 |
| | $H_i$ | 0.043 | 0.048 | 0.048 | 0.054 |
| | $H_i$* | 0.047 | 0.053 | 0.054 | 0.036 |
| | $I_i$ | 0.041 | 0.042 | 0.043 | 0.036 |

Figure B.2 Empirical Size Using Queen Connectivity Case for a 4x4 Study Area

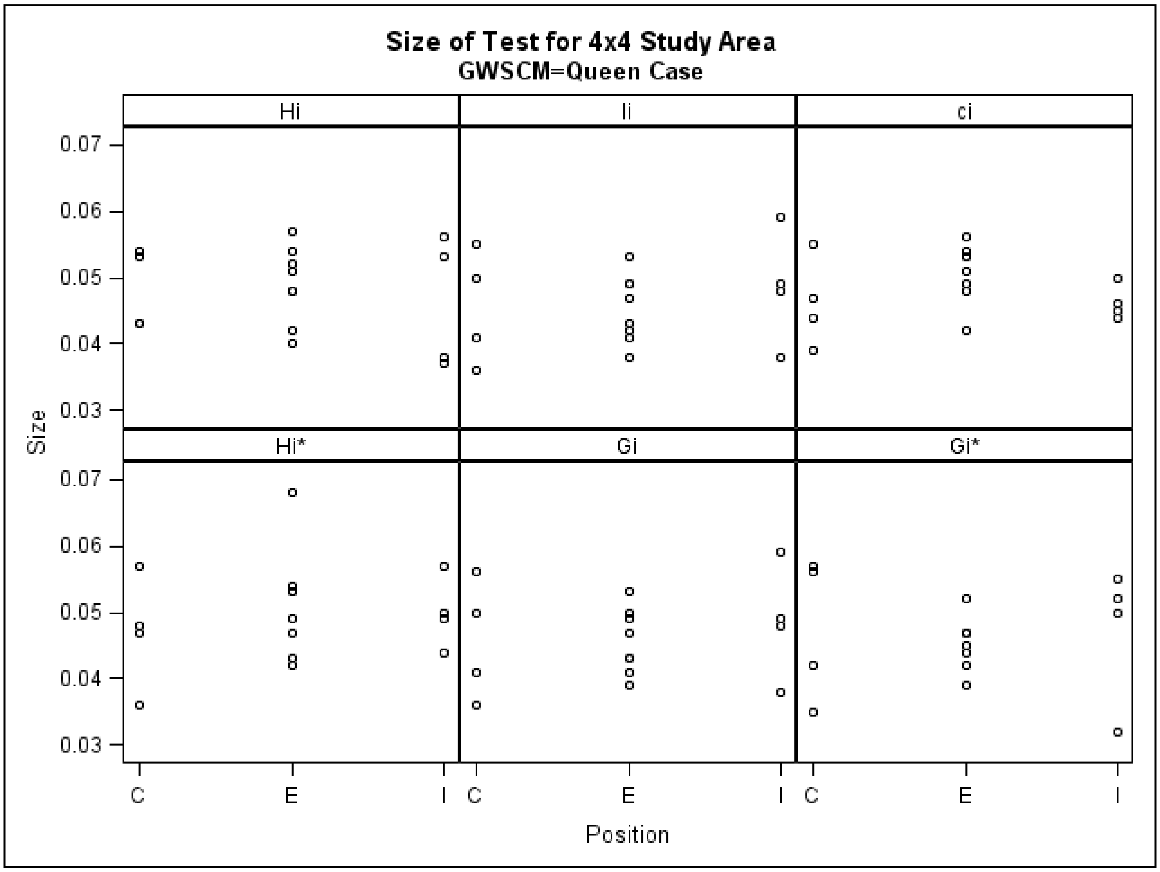


Table B.3 Empirical Size Using CWF Connectivity Case for a 4x4 Study Area

| | | Column | | | |
|---|---|---|---|---|---|
| **Row** | **Statistic** | **1** | **2** | **3** | **4** |
| **1** | $c_i$ | 0.052 | 0.040 | 0.040 | 0.037 |
| | $G_i$ | 0.043 | 0.047 | 0.051 | 0.046 |
| | $G_i$* | 0.052 | 0.041 | 0.042 | 0.050 |
| | $H_i$ | 0.045 | 0.046 | 0.057 | 0.047 |
| | $H_i$* | 0.042 | 0.051 | 0.055 | 0.049 |
| | $I_i$ | 0.043 | 0.047 | 0.051 | 0.046 |
| **2** | $c_i$ | 0.057 | 0.052 | 0.038 | 0.047 |
| | $G_i$ | 0.044 | 0.058 | 0.053 | 0.048 |
| | $G_i$* | 0.056 | 0.059 | 0.041 | 0.052 |
| | $H_i$ | 0.049 | 0.051 | 0.056 | 0.052 |
| | $H_i$* | 0.053 | 0.044 | 0.066 | 0.058 |
| | $I_i$ | 0.044 | 0.058 | 0.053 | 0.048 |
| **3** | $c_i$ | 0.042 | 0.050 | 0.054 | 0.036 |
| | $G_i$ | 0.054 | 0.044 | 0.036 | 0.043 |
| | $G_i$* | 0.043 | 0.049 | 0.043 | 0.037 |
| | $H_i$ | 0.046 | 0.049 | 0.044 | 0.038 |
| | $H_i$* | 0.049 | 0.045 | 0.038 | 0.049 |
| | $I_i$ | 0.054 | 0.044 | 0.036 | 0.043 |
| **4** | $c_i$ | 0.045 | 0.060 | 0.053 | 0.046 |
| | $G_i$ | 0.044 | 0.044 | 0.048 | 0.046 |
| | $G_i$* | 0.045 | 0.044 | 0.045 | 0.045 |
| | $H_i$ | 0.047 | 0.042 | 0.050 | 0.042 |
| | $H_i$* | 0.051 | 0.046 | 0.039 | 0.046 |
| | $I_i$ | 0.044 | 0.044 | 0.048 | 0.046 |

Figure B.3 Empirical Size Using CWF Connectivity Case for a 4x4 Study Area

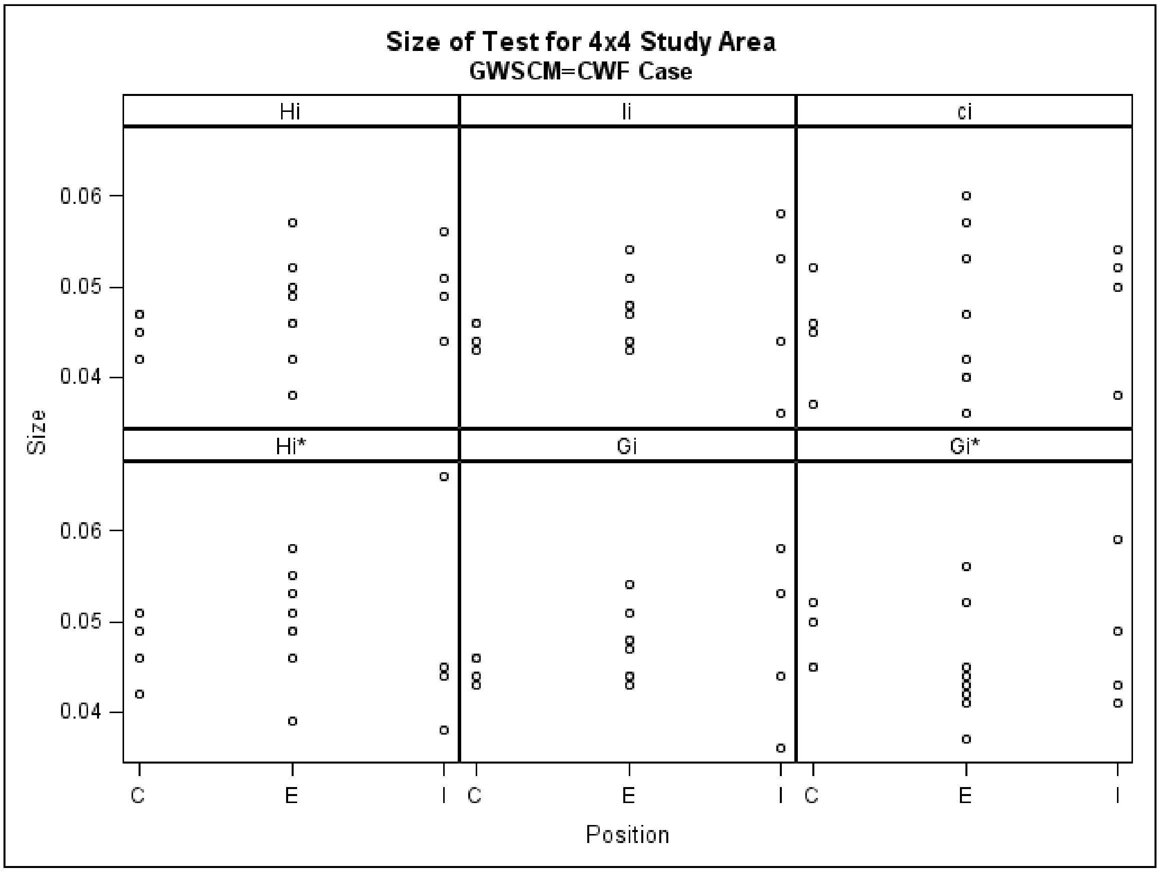


Table B.4 Empirical Power Based on Rook Pattern Variance-Covariance Matrix Using Rook Connectivity Case for a 4x4 Study Area

| | | Column | | | |
|---|---|---|---|---|---|
| **Row** | **Statistic** | **1** | **2** | **3** | **4** |
| **1** | $c_i$ | 0.169 | 0.196 | 0.191 | 0.163 |
| | $G_i$ | 0.076 | 0.088 | 0.087 | 0.078 |
| | $G_i$* | 0.152 | 0.149 | 0.153 | 0.152 |
| | $H_i$ | 0.186 | 0.222 | 0.219 | 0.189 |
| | $H_i$* | 0.126 | 0.116 | 0.127 | 0.127 |
| | $I_i$ | 0.155 | 0.173 | 0.164 | 0.154 |
| **2** | $c_i$ | 0.189 | 0.151 | 0.163 | 0.187 |
| | $G_i$ | 0.085 | 0.058 | 0.065 | 0.084 |
| | $G_i$* | 0.146 | 0.110 | 0.113 | 0.146 |
| | $H_i$ | 0.215 | 0.165 | 0.173 | 0.225 |
| | $H_i$* | 0.113 | 0.082 | 0.082 | 0.121 |
| | $I_i$ | 0.167 | 0.119 | 0.128 | 0.168 |
| **3** | $c_i$ | 0.183 | 0.156 | 0.163 | 0.202 |
| | $G_i$ | 0.083 | 0.060 | 0.066 | 0.087 |
| | $G_i$* | 0.144 | 0.112 | 0.115 | 0.147 |
| | $H_i$ | 0.216 | 0.170 | 0.175 | 0.231 |
| | $H_i$* | 0.122 | 0.083 | 0.085 | 0.115 |
| | $I_i$ | 0.163 | 0.123 | 0.130 | 0.176 |
| **4** | $c_i$ | 0.167 | 0.195 | 0.195 | 0.165 |
| | $G_i$ | 0.076 | 0.087 | 0.083 | 0.074 |
| | $G_i$* | 0.147 | 0.145 | 0.139 | 0.149 |
| | $H_i$ | 0.184 | 0.227 | 0.221 | 0.182 |
| | $H_i$* | 0.130 | 0.120 | 0.123 | 0.130 |
| | $I_i$ | 0.152 | 0.174 | 0.168 | 0.151 |

Figure B.4 Empirical Power Based on Rook Pattern Variance-Covariance Matrix Using Rook Connectivity Case for a 4x4 Study Area

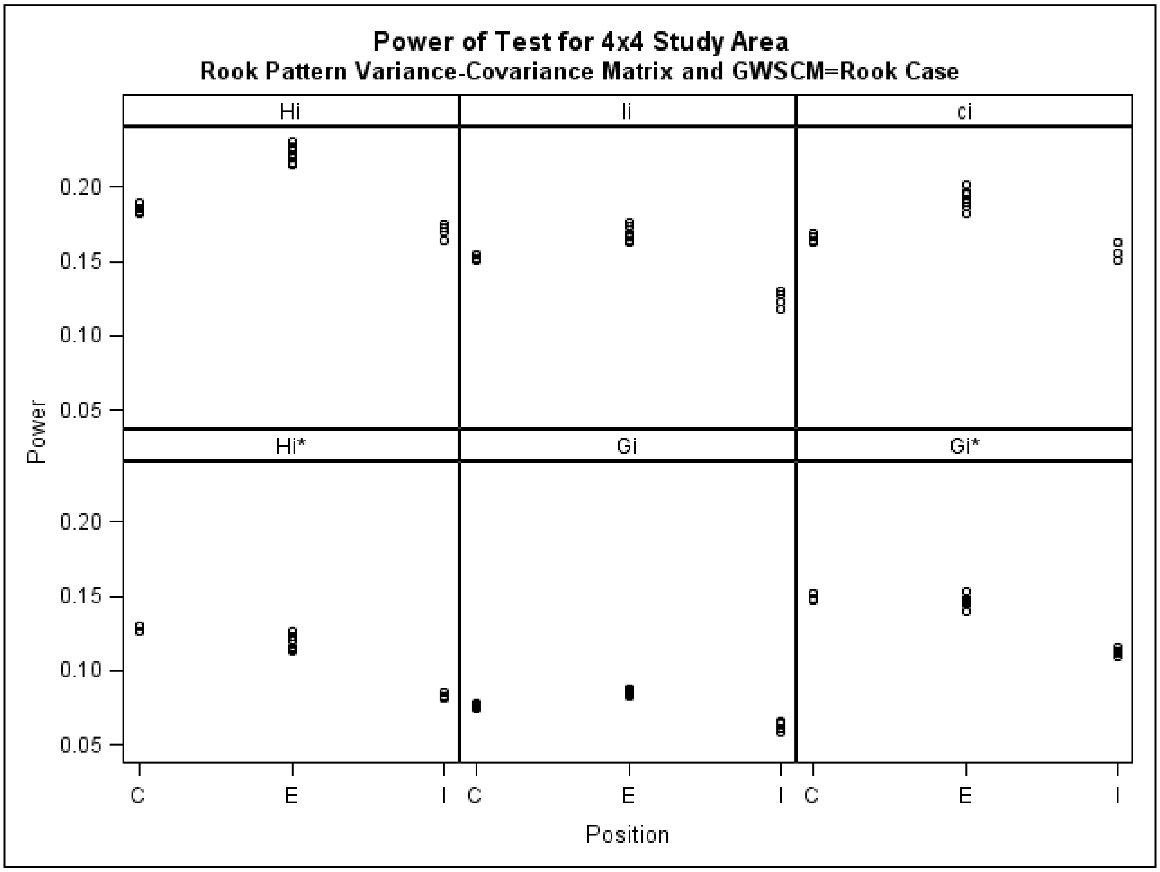


Table B.5 Empirical Power Based on Rook Pattern Variance-Covariance Matrix Using Queen Connectivity Case for a 4x4 Study Area

| | | Column | | | |
|---|---|---|---|---|---|
| **Row** | **Statistic** | **1** | **2** | **3** | **4** |
| **1** | $c_i$ | 0.225 | 0.241 | 0.220 | 0.217 |
| | $G_i$ | 0.145 | 0.139 | 0.129 | 0.120 |
| | $G_i$* | 0.178 | 0.169 | 0.165 | 0.156 |
| | $H_i$ | 0.198 | 0.233 | 0.206 | 0.169 |
| | $H_i$* | 0.126 | 0.135 | 0.101 | 0.107 |
| | $I_i$ | 0.260 | 0.256 | 0.240 | 0.218 |
| **2** | $c_i$ | 0.262 | 0.249 | 0.190 | 0.239 |
| | $G_i$ | 0.158 | 0.140 | 0.115 | 0.119 |
| | $G_i$* | 0.186 | 0.156 | 0.128 | 0.153 |
| | $H_i$ | 0.239 | 0.240 | 0.190 | 0.220 |
| | $H_i$* | 0.108 | 0.094 | 0.090 | 0.123 |
| | $I_i$ | 0.281 | 0.254 | 0.211 | 0.246 |
| **3** | $c_i$ | 0.227 | 0.196 | 0.211 | 0.242 |
| | $G_i$ | 0.130 | 0.115 | 0.119 | 0.125 |
| | $G_i$* | 0.162 | 0.136 | 0.140 | 0.158 |
| | $H_i$ | 0.211 | 0.202 | 0.235 | 0.208 |
| | $H_i$* | 0.112 | 0.081 | 0.107 | 0.112 |
| | $I_i$ | 0.238 | 0.221 | 0.239 | 0.239 |
| **4** | $c_i$ | 0.201 | 0.218 | 0.240 | 0.214 |
| | $G_i$ | 0.134 | 0.137 | 0.150 | 0.132 |
| | $G_i$* | 0.175 | 0.171 | 0.179 | 0.174 |
| | $H_i$ | 0.172 | 0.202 | 0.244 | 0.187 |
| | $H_i$* | 0.105 | 0.102 | 0.119 | 0.111 |
| | $I_i$ | 0.229 | 0.246 | 0.262 | 0.236 |

Figure B.5 Empirical Power Based on Rook Pattern Variance-Covariance Matrix Using Queen Connectivity Case for a 4x4 Study Area

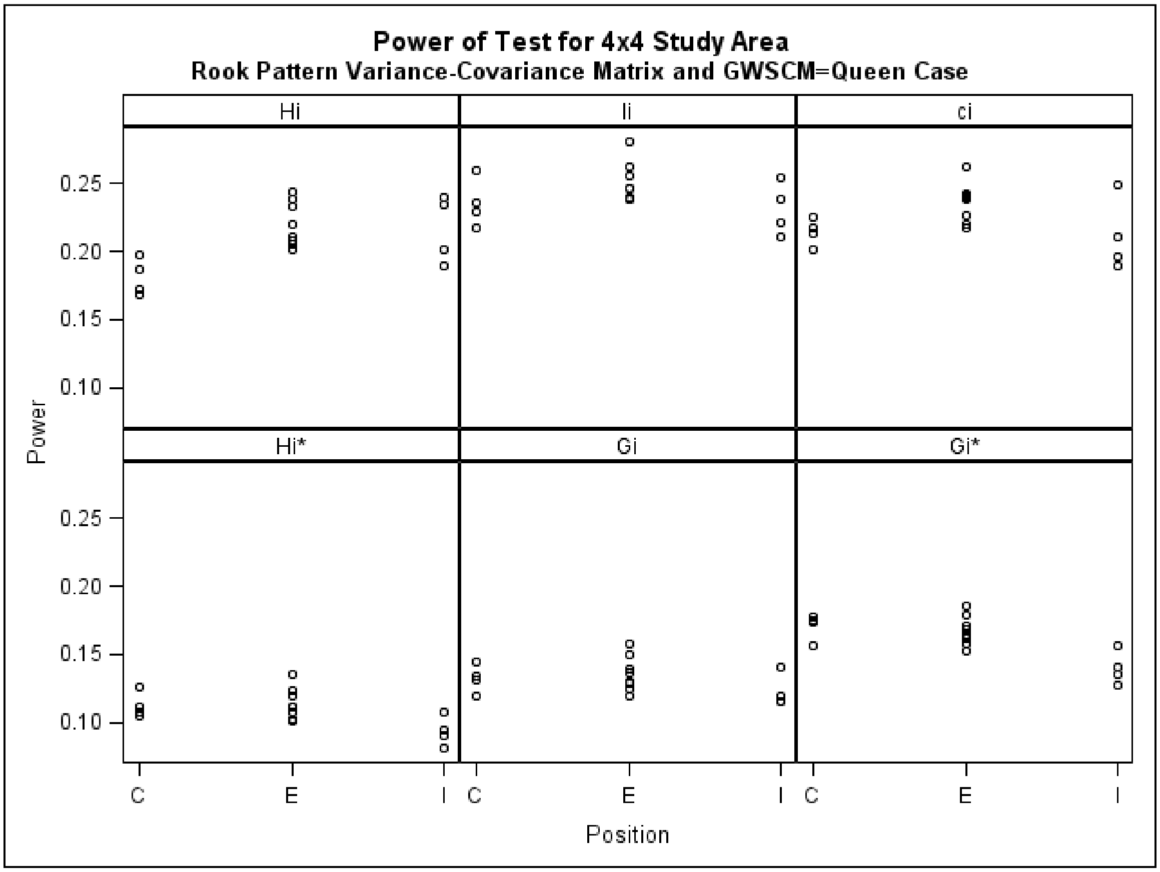


Table B.6 Empirical Power Based on Rook Pattern Variance-Covariance Matrix Using CWF Connectivity Case for a 4x4 Study Area

| | | **Column** | | | |
|---|---|---|---|---|---|
| **Row** | **Statistic** | **1** | **2** | **3** | **4** |
| **1** | $c_i$ | 0.272 | 0.264 | 0.228 | 0.252 |
| | $G_i$ | 0.170 | 0.159 | 0.154 | 0.150 |
| | $G_i$* | 0.193 | 0.188 | 0.178 | 0.179 |
| | $H_i$ | 0.257 | 0.283 | 0.262 | 0.228 |
| | $H_i$* | 0.096 | 0.107 | 0.105 | 0.094 |
| | $I_i$ | 0.297 | 0.296 | 0.277 | 0.261 |
| **2** | $c_i$ | 0.269 | 0.257 | 0.228 | 0.268 |
| | $G_i$ | 0.166 | 0.138 | 0.119 | 0.136 |
| | $G_i$* | 0.196 | 0.169 | 0.153 | 0.172 |
| | $H_i$ | 0.274 | 0.262 | 0.221 | 0.252 |
| | $H_i$* | 0.097 | 0.090 | 0.066 | 0.101 |
| | $I_i$ | 0.301 | 0.267 | 0.233 | 0.277 |
| **3** | $c_i$ | 0.245 | 0.242 | 0.241 | 0.270 |
| | $G_i$ | 0.145 | 0.143 | 0.127 | 0.151 |
| | $G_i$* | 0.186 | 0.176 | 0.165 | 0.173 |
| | $H_i$ | 0.243 | 0.264 | 0.247 | 0.258 |
| | $H_i$* | 0.090 | 0.071 | 0.082 | 0.101 |
| | $I_i$ | 0.272 | 0.266 | 0.258 | 0.279 |
| **4** | $c_i$ | 0.216 | 0.253 | 0.282 | 0.255 |
| | $G_i$ | 0.152 | 0.147 | 0.160 | 0.164 |
| | $G_i$* | 0.171 | 0.183 | 0.178 | 0.180 |
| | $H_i$ | 0.228 | 0.247 | 0.271 | 0.229 |
| | $H_i$* | 0.105 | 0.109 | 0.103 | 0.090 |
| | $I_i$ | 0.255 | 0.277 | 0.292 | 0.284 |

Figure B.6 Empirical Power Based on Rook Pattern Variance-Covariance Matrix Using CWF Connectivity Case for a 4x4 Study Area

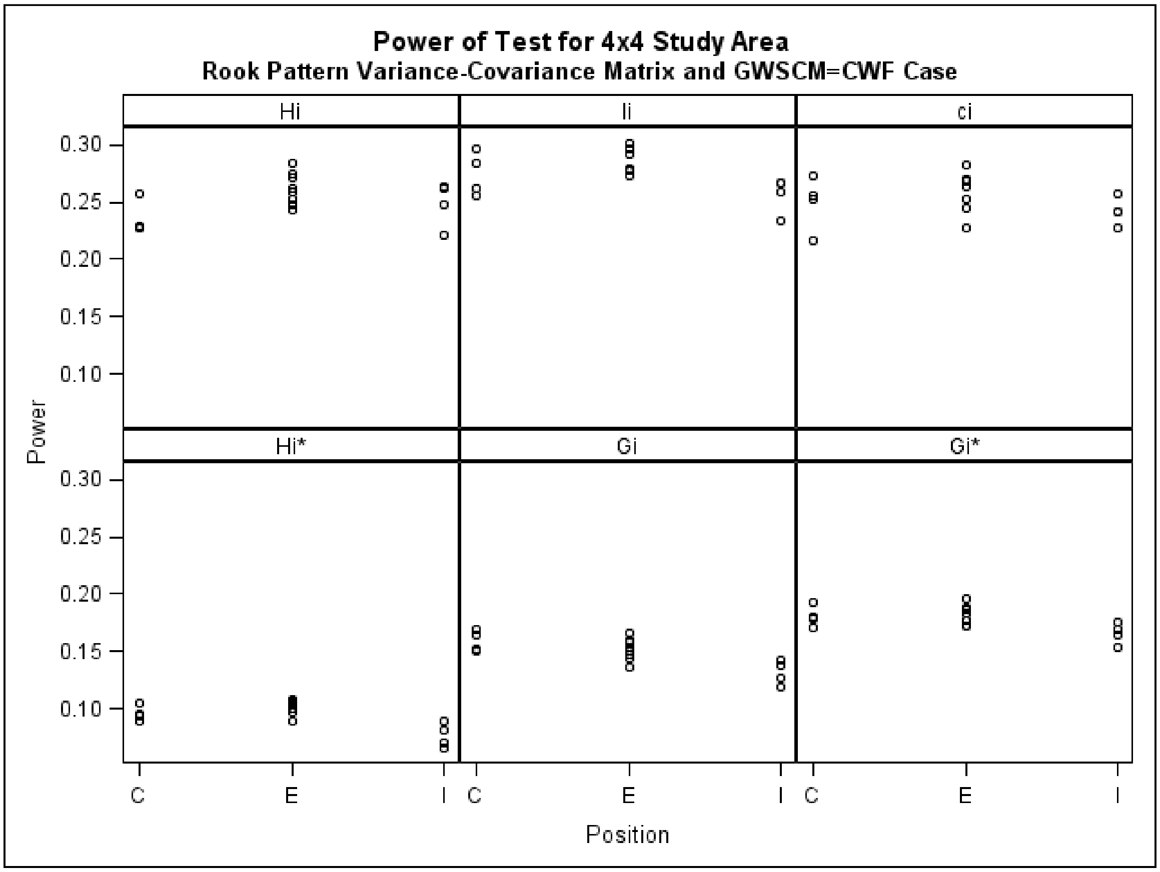


Table B.7 Empirical Power Based on Queen Pattern Variance-Covariance Matrix Using Rook Connectivity Case for a 4x4 Study Area

| | | **Column** | | | |
|---|---|---|---|---|---|
| **Row** | **Statistic** | **1** | **2** | **3** | **4** |
| **1** | $c_i$ | 0.282 | 0.299 | 0.294 | 0.275 |
| | $G_i$ | 0.153 | 0.140 | 0.121 | 0.148 |
| | $G_i$* | 0.217 | 0.203 | 0.177 | 0.221 |
| | $H_i$ | 0.269 | 0.353 | 0.331 | 0.270 |
| | $H_i$* | 0.157 | 0.168 | 0.179 | 0.152 |
| | $I_i$ | 0.298 | 0.271 | 0.238 | 0.278 |
| **2** | $c_i$ | 0.319 | 0.250 | 0.241 | 0.311 |
| | $G_i$ | 0.141 | 0.076 | 0.071 | 0.140 |
| | $G_i$* | 0.198 | 0.134 | 0.111 | 0.202 |
| | $H_i$ | 0.353 | 0.227 | 0.208 | 0.358 |
| | $H_i$* | 0.181 | 0.085 | 0.106 | 0.187 |
| | $I_i$ | 0.276 | 0.168 | 0.135 | 0.275 |
| **3** | $c_i$ | 0.303 | 0.274 | 0.269 | 0.296 |
| | $G_i$ | 0.136 | 0.085 | 0.074 | 0.120 |
| | $G_i$* | 0.195 | 0.138 | 0.125 | 0.184 |
| | $H_i$ | 0.329 | 0.244 | 0.247 | 0.337 |
| | $H_i$* | 0.162 | 0.075 | 0.087 | 0.150 |
| | $I_i$ | 0.262 | 0.189 | 0.178 | 0.262 |
| **4** | $c_i$ | 0.239 | 0.288 | 0.315 | 0.245 |
| | $G_i$ | 0.136 | 0.126 | 0.130 | 0.139 |
| | $G_i$* | 0.207 | 0.196 | 0.184 | 0.206 |
| | $H_i$ | 0.250 | 0.322 | 0.345 | 0.266 |
| | $H_i$* | 0.140 | 0.144 | 0.165 | 0.159 |
| | $I_i$ | 0.282 | 0.260 | 0.263 | 0.284 |

Figure B.7 Empirical Power Based on Queen Pattern Variance-Covariance Matrix Using Rook Connectivity Case for a 4x4 Study Area

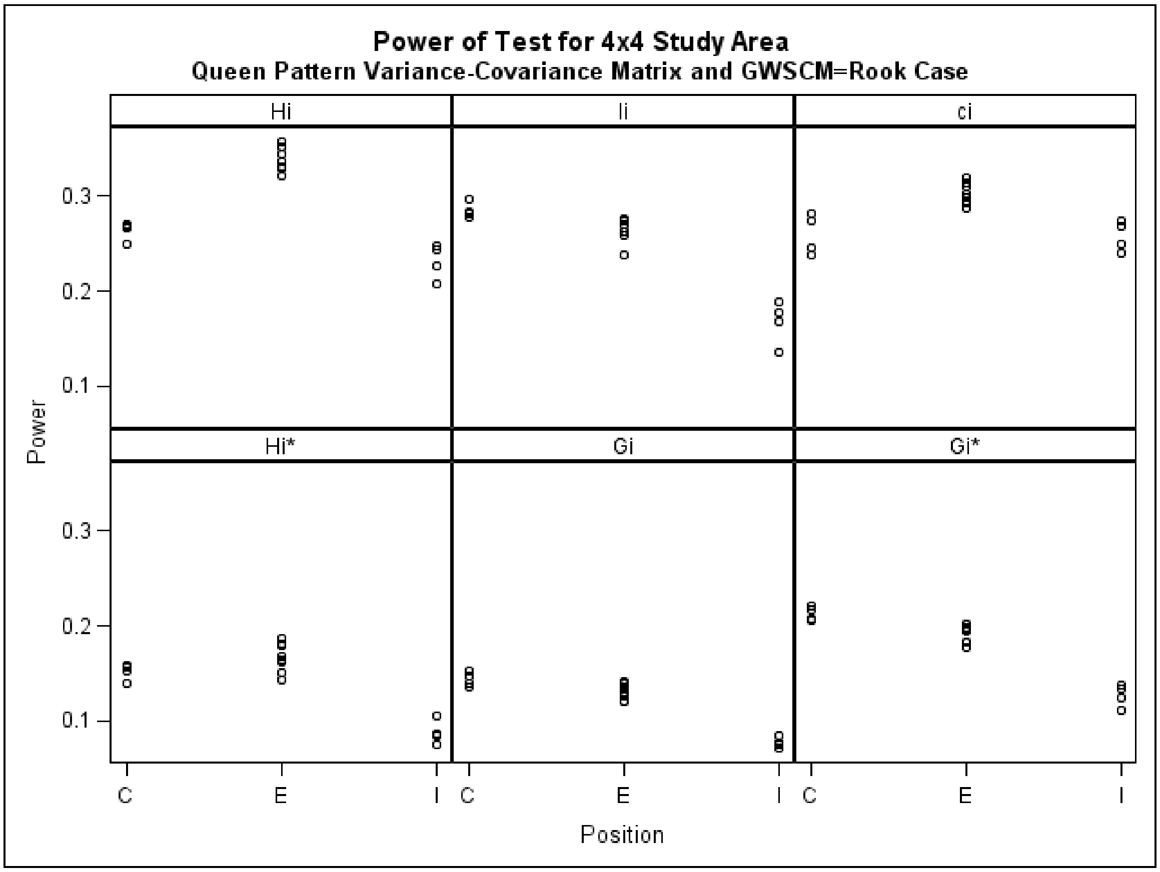


Table B.8 Empirical Power Based on Queen Pattern Variance-Covariance Matrix Using Queen Connectivity Case for a 4x4 Study Area

| | | **Column** | | | |
|---|---|---|---|---|---|
| **Row** | **Statistic** | **1** | **2** | **3** | **4** |
| **1** | $c_i$ | 0.399 | 0.432 | 0.408 | 0.379 |
| | $G_i$ | 0.208 | 0.206 | 0.191 | 0.190 |
| | $G_i$* | 0.242 | 0.245 | 0.224 | 0.239 |
| | $H_i$ | 0.306 | 0.398 | 0.358 | 0.284 |
| | $H_i$* | 0.154 | 0.162 | 0.176 | 0.144 |
| | $I_i$ | 0.395 | 0.394 | 0.357 | 0.357 |
| **2** | $c_i$ | 0.430 | 0.366 | 0.341 | 0.444 |
| | $G_i$ | 0.201 | 0.164 | 0.132 | 0.192 |
| | $G_i$* | 0.242 | 0.196 | 0.166 | 0.219 |
| | $H_i$ | 0.415 | 0.341 | 0.311 | 0.403 |
| | $H_i$* | 0.159 | 0.100 | 0.128 | 0.171 |
| | $I_i$ | 0.400 | 0.319 | 0.278 | 0.393 |
| **3** | $c_i$ | 0.419 | 0.387 | 0.372 | 0.444 |
| | $G_i$ | 0.190 | 0.152 | 0.138 | 0.183 |
| | $G_i$* | 0.228 | 0.182 | 0.158 | 0.221 |
| | $H_i$ | 0.383 | 0.351 | 0.347 | 0.396 |
| | $H_i$* | 0.181 | 0.106 | 0.121 | 0.169 |
| | $I_i$ | 0.384 | 0.327 | 0.312 | 0.384 |
| **4** | $c_i$ | 0.361 | 0.414 | 0.425 | 0.373 |
| | $G_i$ | 0.192 | 0.187 | 0.177 | 0.177 |
| | $G_i$* | 0.236 | 0.231 | 0.207 | 0.215 |
| | $H_i$ | 0.281 | 0.376 | 0.399 | 0.299 |
| | $H_i$* | 0.130 | 0.146 | 0.170 | 0.143 |
| | $I_i$ | 0.375 | 0.381 | 0.388 | 0.372 |

Figure B.8 Empirical Power Based on Queen Pattern Variance-Covariance Matrix Using Queen Connectivity Case for a 4x4 Study Area

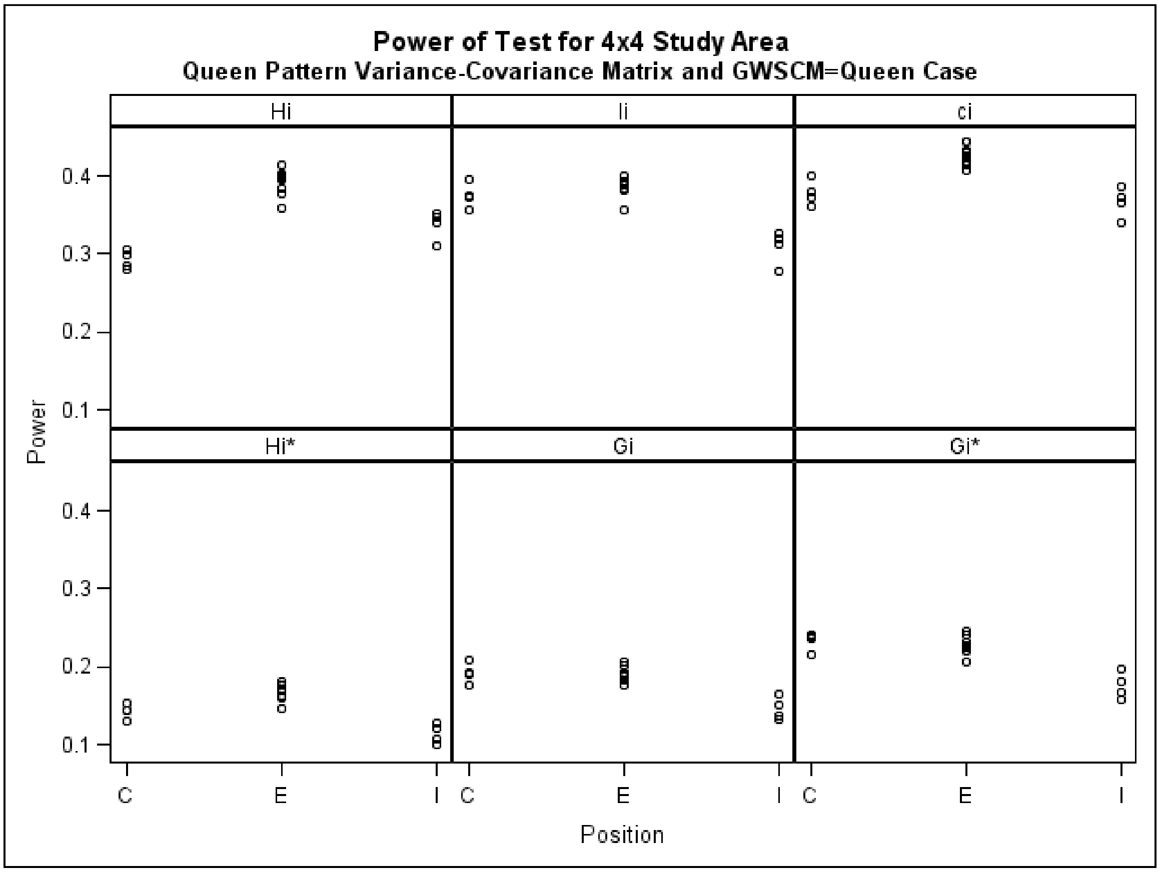


Table B.9 Empirical Power Based on Queen Pattern Variance-Covariance Matrix Using CWF Connectivity Case for a 4x4 Study Area

| | | **Column** | | | |
|---|---|---|---|---|---|
| **Row** | **Statistic** | **1** | **2** | **3** | **4** |
| **1** | $c_i$ | 0.438 | 0.464 | 0.438 | 0.424 |
| | $G_i$ | 0.246 | 0.231 | 0.215 | 0.229 |
| | $G_i$* | 0.269 | 0.264 | 0.248 | 0.262 |
| | $H_i$ | 0.390 | 0.419 | 0.395 | 0.358 |
| | $H_i$* | 0.158 | 0.112 | 0.146 | 0.120 |
| | $I_i$ | 0.440 | 0.436 | 0.405 | 0.403 |
| **2** | $c_i$ | 0.454 | 0.418 | 0.393 | 0.471 |
| | $G_i$ | 0.233 | 0.178 | 0.143 | 0.208 |
| | $G_i$* | 0.246 | 0.209 | 0.180 | 0.235 |
| | $H_i$ | 0.429 | 0.356 | 0.314 | 0.415 |
| | $H_i$* | 0.123 | 0.077 | 0.105 | 0.120 |
| | $I_i$ | 0.444 | 0.340 | 0.299 | 0.415 |
| **3** | $c_i$ | 0.462 | 0.428 | 0.426 | 0.466 |
| | $G_i$ | 0.223 | 0.167 | 0.146 | 0.219 |
| | $G_i$* | 0.244 | 0.195 | 0.176 | 0.232 |
| | $H_i$ | 0.410 | 0.360 | 0.351 | 0.412 |
| | $H_i$* | 0.120 | 0.078 | 0.099 | 0.128 |
| | $I_i$ | 0.426 | 0.354 | 0.332 | 0.440 |
| **4** | $c_i$ | 0.395 | 0.458 | 0.457 | 0.416 |
| | $G_i$ | 0.235 | 0.210 | 0.194 | 0.208 |
| | $G_i$* | 0.254 | 0.254 | 0.224 | 0.237 |
| | $H_i$ | 0.350 | 0.415 | 0.416 | 0.346 |
| | $H_i$* | 0.127 | 0.129 | 0.116 | 0.119 |
| | $I_i$ | 0.418 | 0.428 | 0.419 | 0.409 |

Figure B.9 Empirical Power Based on Queen Pattern Variance-Covariance Matrix Using CWF Connectivity Case for a 4x4 Study Area

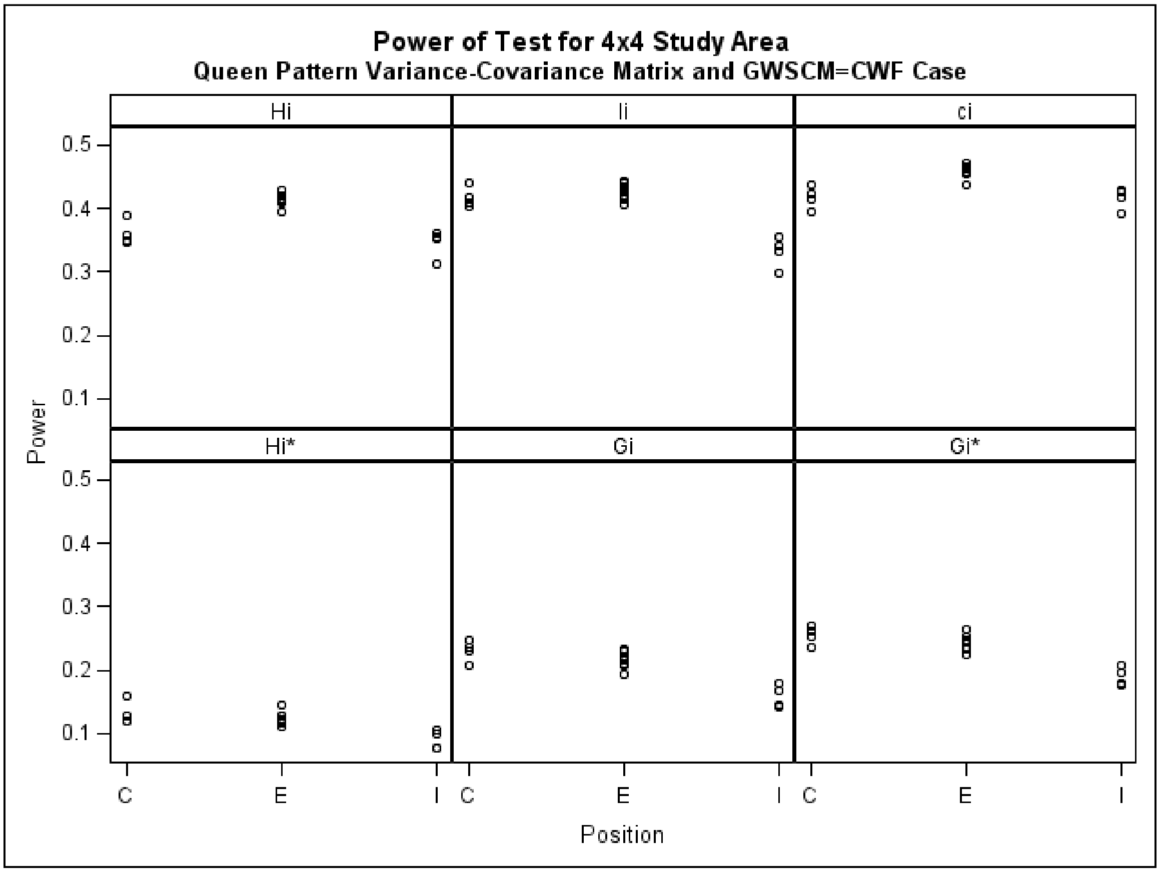


Table B.10 Empirical Power Based on Hot-Spot Pattern Variance-Covariance Matrix Using Rook Connectivity Case for a 4x4 Study Area

| | | **Column** | | | |
|---|---|---|---|---|---|
| **Row** | **Statistic** | **1** | **2** | **3** | **4** |
| **1** | $c_i$ | 0.072 | 0.020 | 0.037 | 0.041 |
| | $G_i$ | 0.051 | 0.033 | 0.028 | 0.065 |
| | $G_i$* | 0.068 | 0.042 | 0.027 | 0.074 |
| | $H_i$ | 0.059 | 0.043 | 0.048 | 0.054 |
| | $H_i$* | 0.059 | 0.044 | 0.043 | 0.056 |
| | $I_i$ | 0.059 | 0.029 | 0.020 | 0.060 |
| **2** | $c_i$ | 0.025 | 0.153 | 0.126 | 0.038 |
| | $G_i$ | 0.030 | 0.060 | 0.044 | 0.027 |
| | $G_i$* | 0.038 | 0.086 | 0.070 | 0.029 |
| | $H_i$ | 0.047 | 0.117 | 0.089 | 0.039 |
| | $H_i$* | 0.049 | 0.107 | 0.087 | 0.037 |
| | $I_i$ | 0.022 | 0.119 | 0.083 | 0.026 |
| **3** | $c_i$ | 0.020 | 0.138 | 0.128 | 0.026 |
| | $G_i$ | 0.026 | 0.066 | 0.063 | 0.029 |
| | $G_i$* | 0.031 | 0.098 | 0.091 | 0.028 |
| | $H_i$ | 0.029 | 0.110 | 0.103 | 0.038 |
| | $H_i$* | 0.025 | 0.087 | 0.082 | 0.036 |
| | $I_i$ | 0.024 | 0.102 | 0.112 | 0.022 |
| **4** | $c_i$ | 0.053 | 0.026 | 0.029 | 0.049 |
| | $G_i$ | 0.063 | 0.026 | 0.028 | 0.058 |
| | $G_i$* | 0.081 | 0.034 | 0.029 | 0.057 |
| | $H_i$ | 0.052 | 0.040 | 0.038 | 0.044 |
| | $H_i$* | 0.059 | 0.042 | 0.036 | 0.043 |
| | $I_i$ | 0.063 | 0.029 | 0.025 | 0.060 |

Figure B.10 Empirical Power Based on Hot-Spot Pattern Variance-Covariance Matrix Using Rook Connectivity Case for a 4x4 Study Area

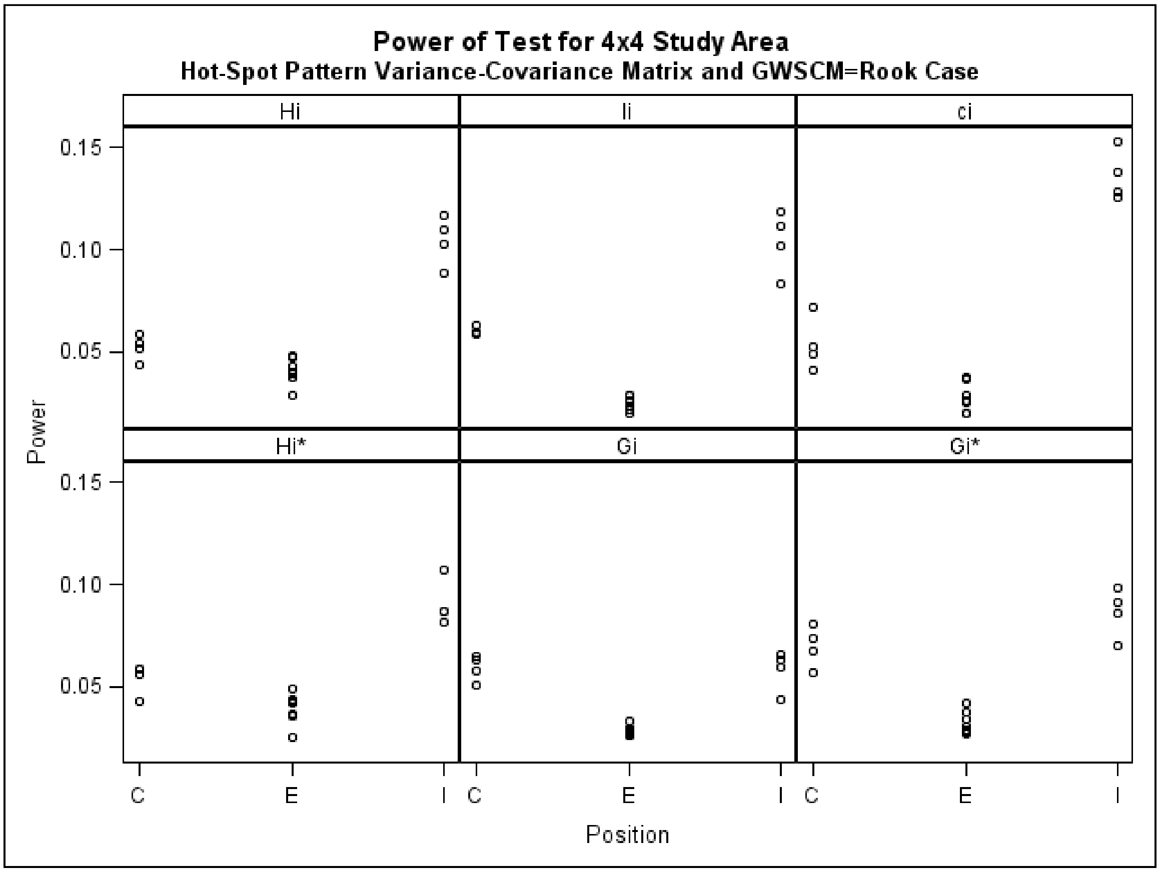


Table B.11 Empirical Power Based on Hot-Spot Pattern Variance-Covariance Matrix Using Queen Connectivity Case for a 4x4 Study Area

| | | **Column** | | | |
|---|---|---|---|---|---|
| **Row** | **Statistic** | **1** | **2** | **3** | **4** |
| **1** | $c_i$ | 0.040 | 0.033 | 0.045 | 0.033 |
| | $G_i$ | 0.033 | 0.037 | 0.042 | 0.035 |
| | $G_i$* | 0.040 | 0.038 | 0.041 | 0.035 |
| | $H_i$ | 0.043 | 0.047 | 0.039 | 0.043 |
| | $H_i$* | 0.042 | 0.051 | 0.046 | 0.043 |
| | $I_i$ | 0.035 | 0.039 | 0.032 | 0.030 |
| **2** | $c_i$ | 0.049 | 0.138 | 0.137 | 0.051 |
| | $G_i$ | 0.044 | 0.079 | 0.075 | 0.030 |
| | $G_i$* | 0.043 | 0.093 | 0.093 | 0.034 |
| | $H_i$ | 0.044 | 0.124 | 0.114 | 0.043 |
| | $H_i$* | 0.046 | 0.084 | 0.076 | 0.048 |
| | $I_i$ | 0.040 | 0.141 | 0.130 | 0.032 |
| **3** | $c_i$ | 0.032 | 0.140 | 0.156 | 0.042 |
| | $G_i$ | 0.037 | 0.073 | 0.072 | 0.033 |
| | $G_i$* | 0.037 | 0.088 | 0.095 | 0.034 |
| | $H_i$ | 0.029 | 0.126 | 0.126 | 0.027 |
| | $H_i$* | 0.029 | 0.100 | 0.082 | 0.039 |
| | $I_i$ | 0.031 | 0.131 | 0.134 | 0.024 |
| **4** | $c_i$ | 0.024 | 0.043 | 0.041 | 0.033 |
| | $G_i$ | 0.031 | 0.040 | 0.040 | 0.031 |
| | $G_i$* | 0.039 | 0.036 | 0.032 | 0.025 |
| | $H_i$ | 0.031 | 0.041 | 0.037 | 0.040 |
| | $H_i$* | 0.034 | 0.043 | 0.045 | 0.041 |
| | $I_i$ | 0.022 | 0.028 | 0.033 | 0.032 |

Figure B.11 Empirical Power Based on Hot-Spot Pattern Variance-Covariance Matrix Using Queen Connectivity Case for a 4x4 Study Area

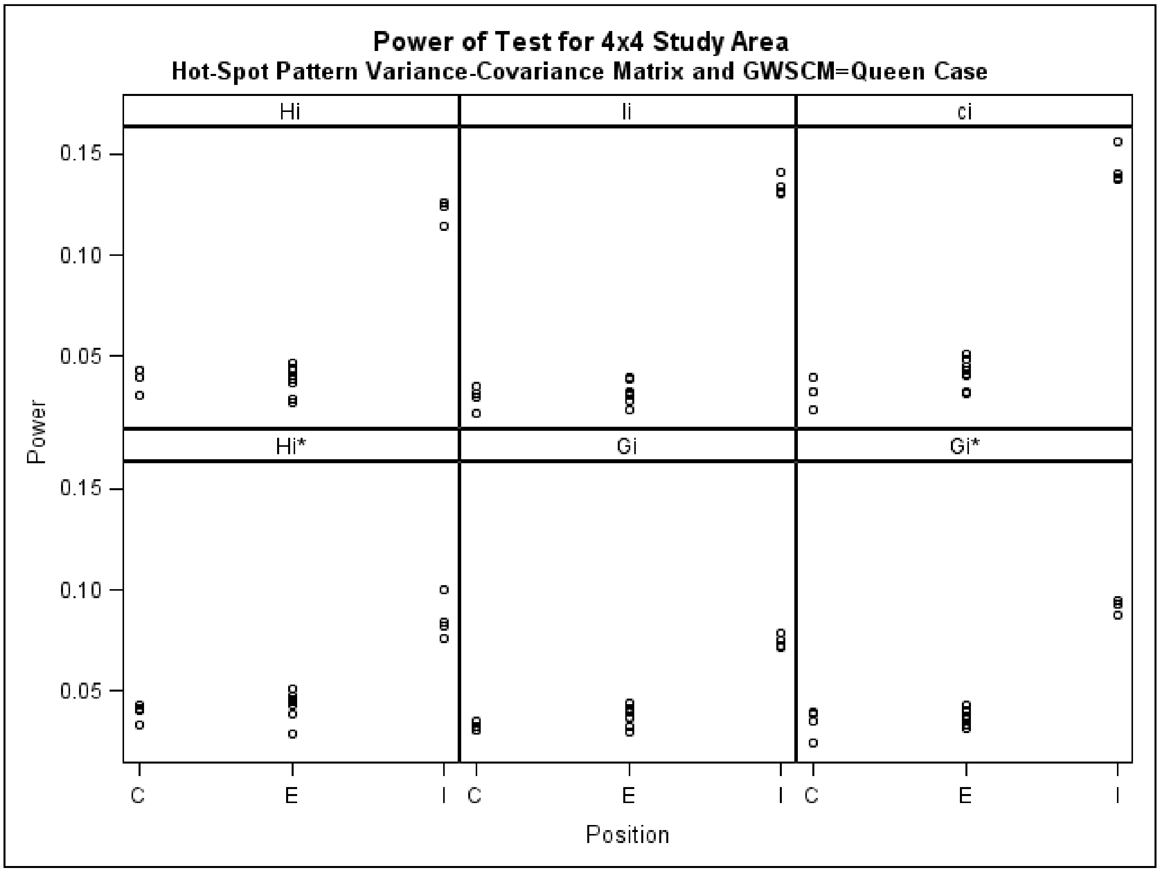


Table B.12 Empirical Power Based on Hot-Spot Pattern Variance-Covariance Matrix Using CWF Connectivity Case for a 4x4 Study Area

| | | **Column** | | | |
|---|---|---|---|---|---|
| **Row** | **Statistic** | **1** | **2** | **3** | **4** |
| **1** | $c_i$ | 0.058 | 0.055 | 0.064 | 0.063 |
| | $G_i$ | 0.044 | 0.044 | 0.047 | 0.055 |
| | $G_i$* | 0.061 | 0.051 | 0.052 | 0.055 |
| | $H_i$ | 0.050 | 0.037 | 0.037 | 0.054 |
| | $H_i$* | 0.041 | 0.053 | 0.038 | 0.049 |
| | $I_i$ | 0.047 | 0.042 | 0.040 | 0.049 |
| **2** | $c_i$ | 0.071 | 0.139 | 0.132 | 0.073 |
| | $G_i$ | 0.058 | 0.070 | 0.081 | 0.053 |
| | $G_i$* | 0.053 | 0.103 | 0.107 | 0.048 |
| | $H_i$ | 0.054 | 0.145 | 0.132 | 0.047 |
| | $H_i$* | 0.059 | 0.080 | 0.075 | 0.037 |
| | $I_i$ | 0.050 | 0.146 | 0.135 | 0.047 |
| **3** | $c_i$ | 0.054 | 0.146 | 0.153 | 0.055 |
| | $G_i$ | 0.051 | 0.073 | 0.086 | 0.054 |
| | $G_i$* | 0.048 | 0.104 | 0.112 | 0.036 |
| | $H_i$ | 0.034 | 0.137 | 0.161 | 0.037 |
| | $H_i$* | 0.043 | 0.080 | 0.079 | 0.039 |
| | $I_i$ | 0.041 | 0.135 | 0.159 | 0.039 |
| **4** | $c_i$ | 0.055 | 0.073 | 0.070 | 0.053 |
| | $G_i$ | 0.049 | 0.054 | 0.061 | 0.045 |
| | $G_i$* | 0.055 | 0.046 | 0.052 | 0.041 |
| | $H_i$ | 0.041 | 0.046 | 0.047 | 0.044 |
| | $H_i$* | 0.039 | 0.041 | 0.045 | 0.047 |
| | $I_i$ | 0.036 | 0.045 | 0.052 | 0.040 |

Figure B.12 Empirical Power Based on Hot-Spot Pattern Variance-Covariance Matrix Using CWF Connectivity Case for a 4x4 Study Area

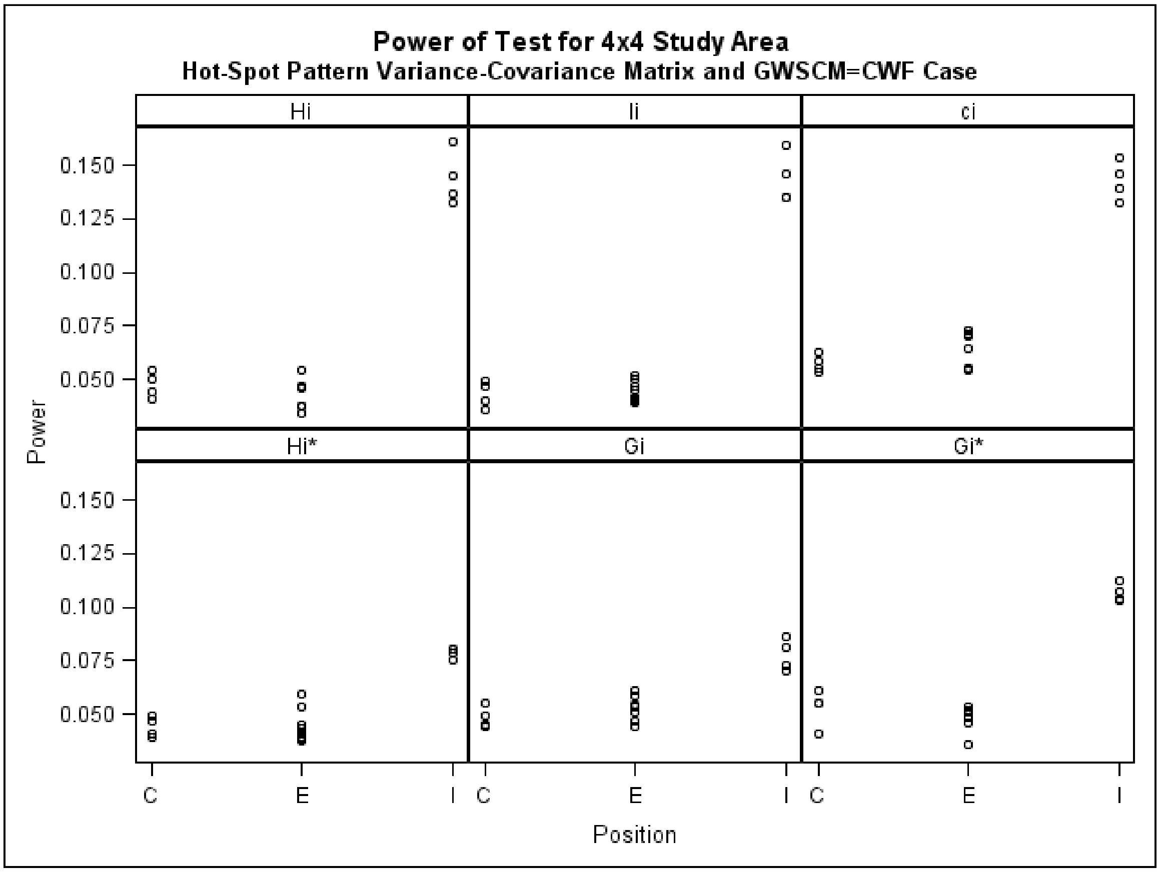


Table B.13 Empirical Power Based on CWF Pattern Variance-Covariance Matrix Using Rook Connectivity Case for a 4x4 Study Area

| | | Column | | | |
|---|---|---|---|---|---|
| **Row** | **Statistic** | **1** | **2** | **3** | **4** |
| **1** | $c_i$ | 0.214 | 0.246 | 0.230 | 0.205 |
| | $G_i$ | 0.112 | 0.109 | 0.108 | 0.108 |
| | $G_i$* | 0.196 | 0.178 | 0.163 | 0.179 |
| | $H_i$ | 0.242 | 0.268 | 0.271 | 0.226 |
| | $H_i$* | 0.170 | 0.164 | 0.155 | 0.142 |
| | $I_i$ | 0.214 | 0.221 | 0.204 | 0.205 |
| **2** | $c_i$ | 0.263 | 0.221 | 0.197 | 0.260 |
| | $G_i$ | 0.124 | 0.075 | 0.068 | 0.114 |
| | $G_i$* | 0.179 | 0.128 | 0.103 | 0.176 |
| | $H_i$ | 0.274 | 0.218 | 0.194 | 0.289 |
| | $H_i$* | 0.155 | 0.129 | 0.115 | 0.164 |
| | $I_i$ | 0.242 | 0.155 | 0.130 | 0.236 |
| **3** | $c_i$ | 0.236 | 0.232 | 0.218 | 0.257 |
| | $G_i$ | 0.107 | 0.081 | 0.068 | 0.111 |
| | $G_i$* | 0.162 | 0.130 | 0.121 | 0.184 |
| | $H_i$ | 0.270 | 0.216 | 0.210 | 0.280 |
| | $H_i$* | 0.150 | 0.093 | 0.117 | 0.146 |
| | $I_i$ | 0.226 | 0.168 | 0.145 | 0.229 |
| **4** | $c_i$ | 0.185 | 0.230 | 0.254 | 0.200 |
| | $G_i$ | 0.094 | 0.119 | 0.117 | 0.098 |
| | $G_i$* | 0.157 | 0.167 | 0.172 | 0.180 |
| | $H_i$ | 0.216 | 0.263 | 0.278 | 0.213 |
| | $H_i$* | 0.143 | 0.142 | 0.140 | 0.150 |
| | $I_i$ | 0.200 | 0.229 | 0.228 | 0.200 |

Figure B.13 Empirical Power Based on CWF Pattern Variance-Covariance Matrix Using Rook Connectivity Case for a 4x4 Study Area

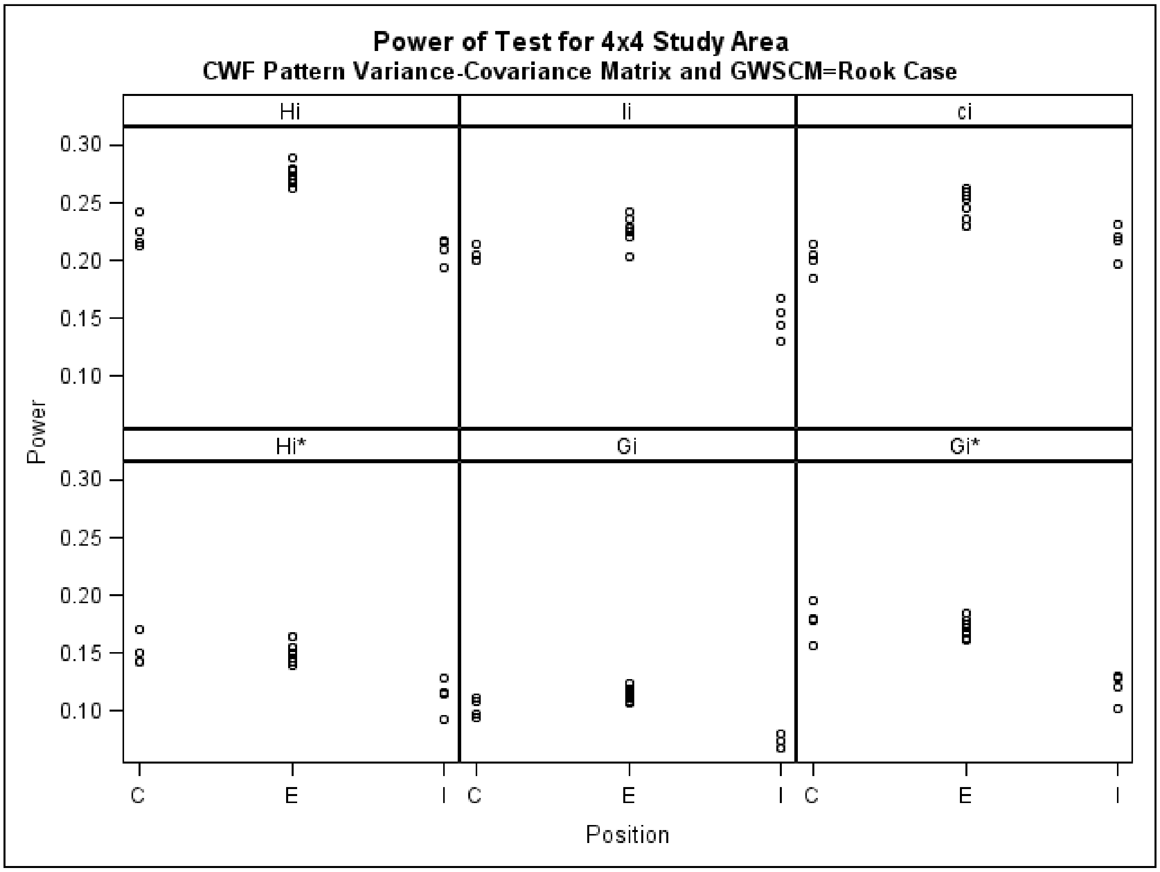


Table B.14 Empirical Power Based on CWF Pattern Variance-Covariance Matrix Using Queen Connectivity Case for a 4x4 Study Area

| | | Column | | | |
|---|---|---|---|---|---|
| **Row** | **Statistic** | **1** | **2** | **3** | **4** |
| **1** | $c_i$ | 0.296 | 0.319 | 0.287 | 0.285 |
| | $G_i$ | 0.157 | 0.178 | 0.164 | 0.143 |
| | $G_i$* | 0.201 | 0.209 | 0.191 | 0.186 |
| | $H_i$ | 0.244 | 0.331 | 0.292 | 0.230 |
| | $H_i$* | 0.140 | 0.159 | 0.152 | 0.123 |
| | $I_i$ | 0.306 | 0.342 | 0.307 | 0.270 |
| **2** | $c_i$ | 0.341 | 0.323 | 0.290 | 0.343 |
| | $G_i$ | 0.193 | 0.156 | 0.133 | 0.158 |
| | $G_i$* | 0.217 | 0.182 | 0.155 | 0.195 |
| | $H_i$ | 0.322 | 0.305 | 0.274 | 0.303 |
| | $H_i$* | 0.149 | 0.142 | 0.129 | 0.157 |
| | $I_i$ | 0.363 | 0.300 | 0.258 | 0.320 |
| **3** | $c_i$ | 0.319 | 0.313 | 0.314 | 0.362 |
| | $G_i$ | 0.162 | 0.152 | 0.153 | 0.173 |
| | $G_i$* | 0.188 | 0.178 | 0.179 | 0.210 |
| | $H_i$ | 0.297 | 0.305 | 0.317 | 0.321 |
| | $H_i$* | 0.146 | 0.118 | 0.143 | 0.139 |
| | $I_i$ | 0.317 | 0.305 | 0.321 | 0.343 |
| **4** | $c_i$ | 0.261 | 0.327 | 0.317 | 0.285 |
| | $G_i$ | 0.157 | 0.166 | 0.164 | 0.154 |
| | $G_i$* | 0.189 | 0.196 | 0.204 | 0.197 |
| | $H_i$ | 0.224 | 0.308 | 0.315 | 0.238 |
| | $H_i$* | 0.126 | 0.127 | 0.132 | 0.140 |
| | $I_i$ | 0.284 | 0.337 | 0.329 | 0.296 |

Figure B.14 Empirical Power Based on CWF Pattern Variance-Covariance Matrix Using Queen Connectivity Case for a 4x4 Study Area

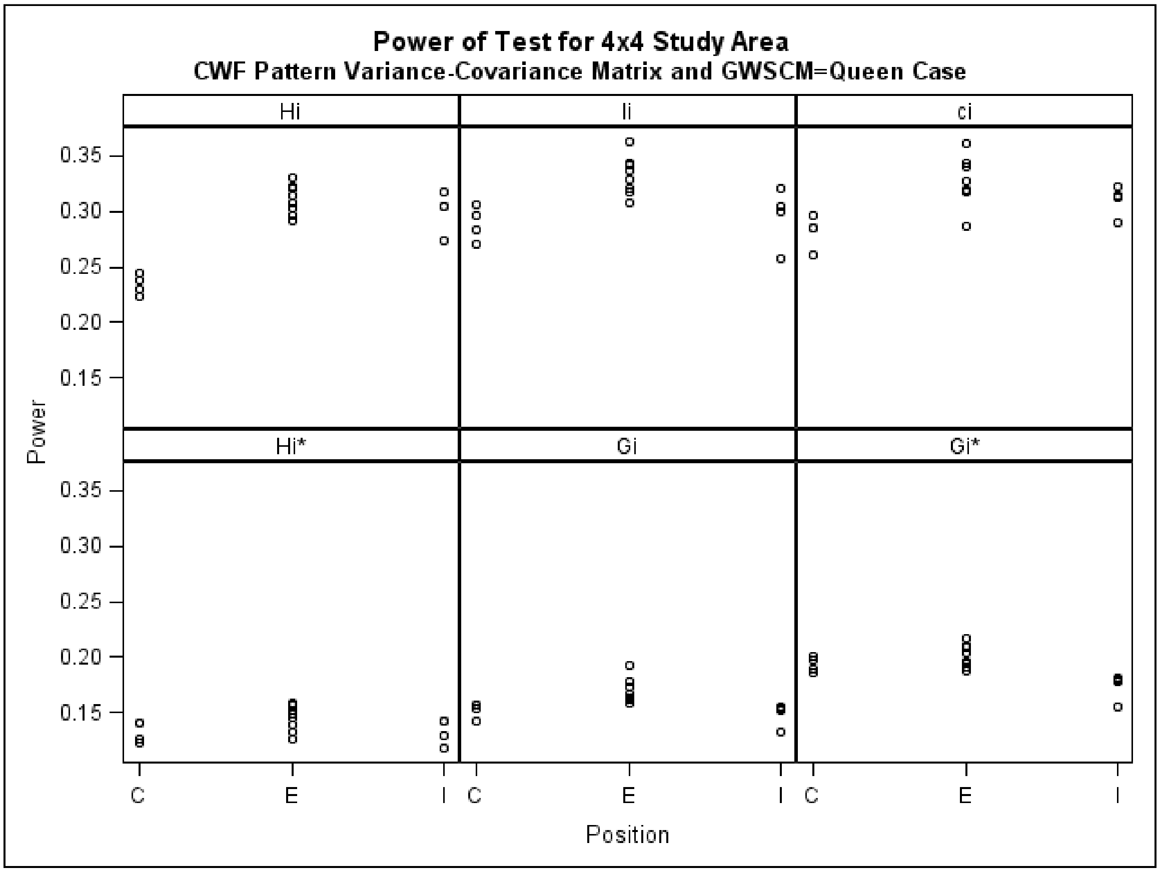


Table B.15 Empirical Power Based on CWF Pattern Variance-Covariance Matrix Using CWF Connectivity Case for a 4x4 Study Area

| | | **Column** | | | |
|---|---|---|---|---|---|
| **Row** | **Statistic** | **1** | **2** | **3** | **4** |
| **1** | $c_i$ | 0.373 | 0.374 | 0.342 | 0.328 |
| | $G_i$ | 0.211 | 0.204 | 0.183 | 0.181 |
| | $G_i$* | 0.237 | 0.231 | 0.213 | 0.219 |
| | $H_i$ | 0.323 | 0.356 | 0.331 | 0.291 |
| | $H_i$* | 0.125 | 0.116 | 0.135 | 0.115 |
| | $I_i$ | 0.372 | 0.381 | 0.343 | 0.326 |
| **2** | $c_i$ | 0.376 | 0.347 | 0.301 | 0.373 |
| | $G_i$ | 0.211 | 0.159 | 0.139 | 0.185 |
| | $G_i$* | 0.230 | 0.189 | 0.163 | 0.221 |
| | $H_i$ | 0.390 | 0.334 | 0.291 | 0.350 |
| | $H_i$* | 0.130 | 0.104 | 0.103 | 0.124 |
| | $I_i$ | 0.408 | 0.322 | 0.280 | 0.362 |
| **3** | $c_i$ | 0.373 | 0.354 | 0.344 | 0.379 |
| | $G_i$ | 0.186 | 0.160 | 0.161 | 0.203 |
| | $G_i$* | 0.213 | 0.196 | 0.187 | 0.239 |
| | $H_i$ | 0.351 | 0.331 | 0.342 | 0.365 |
| | $H_i$* | 0.123 | 0.095 | 0.115 | 0.123 |
| | $I_i$ | 0.375 | 0.325 | 0.335 | 0.381 |
| **4** | $c_i$ | 0.325 | 0.380 | 0.370 | 0.356 |
| | $G_i$ | 0.201 | 0.200 | 0.192 | 0.199 |
| | $G_i$* | 0.214 | 0.225 | 0.228 | 0.221 |
| | $H_i$ | 0.284 | 0.348 | 0.347 | 0.315 |
| | $H_i$* | 0.093 | 0.118 | 0.126 | 0.114 |
| | $I_i$ | 0.353 | 0.387 | 0.370 | 0.362 |

Figure B.15 Empirical Power Based on CWF Pattern Variance-Covariance Matrix Using CWF Connectivity Case for a 4x4 Study Area

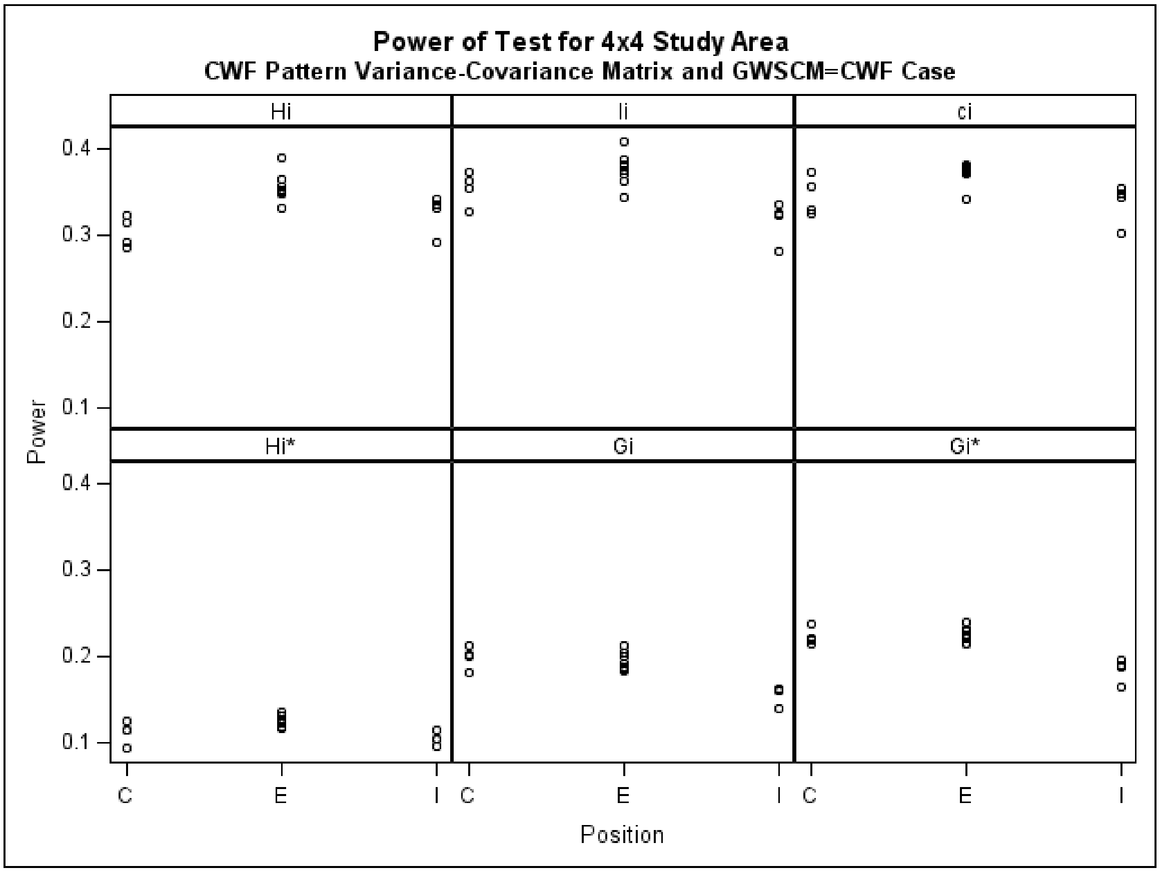


Table B.16 Empirical Size Using Rook Connectivity Case for a 9x9 Study Area

| | | Column | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 1 | $c_i$ | 0.055 | 0.056 | 0.049 | 0.051 | 0.046 | 0.040 | 0.057 | 0.050 | 0.052 |
| | $G_i$ | 0.041 | 0.055 | 0.043 | 0.058 | 0.038 | 0.056 | 0.057 | 0.049 | 0.047 |
| | $G_i$* | 0.041 | 0.047 | 0.050 | 0.046 | 0.038 | 0.056 | 0.061 | 0.055 | 0.038 |
| | $H_i$ | 0.042 | 0.060 | 0.059 | 0.051 | 0.032 | 0.047 | 0.056 | 0.044 | 0.061 |
| | $H_i$* | 0.057 | 0.064 | 0.060 | 0.058 | 0.041 | 0.050 | 0.044 | 0.040 | 0.053 |
| | $I_i$ | 0.041 | 0.055 | 0.043 | 0.058 | 0.038 | 0.056 | 0.057 | 0.049 | 0.047 |
| 2 | $c_i$ | 0.051 | 0.047 | 0.049 | 0.045 | 0.061 | 0.060 | 0.042 | 0.053 | 0.038 |
| | $G_i$ | 0.049 | 0.051 | 0.060 | 0.055 | 0.056 | 0.061 | 0.050 | 0.049 | 0.039 |
| | $G_i$* | 0.051 | 0.054 | 0.054 | 0.064 | 0.051 | 0.056 | 0.052 | 0.053 | 0.039 |
| | $H_i$ | 0.047 | 0.053 | 0.063 | 0.051 | 0.045 | 0.046 | 0.051 | 0.055 | 0.049 |
| | $H_i$* | 0.040 | 0.049 | 0.049 | 0.027 | 0.059 | 0.044 | 0.049 | 0.044 | 0.059 |
| | $I_i$ | 0.049 | 0.051 | 0.060 | 0.055 | 0.056 | 0.061 | 0.050 | 0.049 | 0.039 |
| 3 | $c_i$ | 0.054 | 0.044 | 0.049 | 0.055 | 0.054 | 0.045 | 0.064 | 0.052 | 0.045 |
| | $G_i$ | 0.058 | 0.050 | 0.046 | 0.053 | 0.049 | 0.057 | 0.055 | 0.050 | 0.043 |
| | $G_i$* | 0.058 | 0.051 | 0.047 | 0.054 | 0.054 | 0.056 | 0.044 | 0.044 | 0.038 |
| | $H_i$ | 0.055 | 0.050 | 0.052 | 0.055 | 0.051 | 0.044 | 0.066 | 0.047 | 0.055 |
| | $H_i$* | 0.053 | 0.051 | 0.055 | 0.056 | 0.050 | 0.045 | 0.060 | 0.052 | 0.047 |
| | $I_i$ | 0.058 | 0.050 | 0.046 | 0.053 | 0.049 | 0.057 | 0.055 | 0.050 | 0.043 |
| 4 | $c_i$ | 0.046 | 0.048 | 0.038 | 0.044 | 0.054 | 0.051 | 0.044 | 0.048 | 0.052 |
| | $G_i$ | 0.043 | 0.052 | 0.051 | 0.046 | 0.045 | 0.046 | 0.040 | 0.054 | 0.047 |
| | $G_i$* | 0.056 | 0.051 | 0.054 | 0.050 | 0.052 | 0.057 | 0.030 | 0.046 | 0.048 |
| | $H_i$ | 0.039 | 0.055 | 0.050 | 0.055 | 0.045 | 0.055 | 0.050 | 0.058 | 0.054 |
| | $H_i$* | 0.044 | 0.039 | 0.042 | 0.059 | 0.048 | 0.057 | 0.055 | 0.051 | 0.039 |
| | $I_i$ | 0.043 | 0.052 | 0.051 | 0.046 | 0.045 | 0.046 | 0.040 | 0.054 | 0.047 |
| 5 | $c_i$ | 0.062 | 0.039 | 0.063 | 0.067 | 0.039 | 0.038 | 0.056 | 0.049 | 0.047 |
| | $G_i$ | 0.051 | 0.048 | 0.047 | 0.053 | 0.055 | 0.048 | 0.042 | 0.046 | 0.041 |
| | $G_i$* | 0.050 | 0.061 | 0.054 | 0.060 | 0.042 | 0.045 | 0.037 | 0.038 | 0.046 |
| | $H_i$ | 0.044 | 0.065 | 0.054 | 0.048 | 0.057 | 0.037 | 0.049 | 0.049 | 0.052 |
| | $H_i$* | 0.043 | 0.052 | 0.058 | 0.054 | 0.053 | 0.051 | 0.050 | 0.049 | 0.054 |
| | $I_i$ | 0.051 | 0.048 | 0.047 | 0.053 | 0.055 | 0.038 | 0.042 | 0.046 | 0.041 |
| 6 | $c_i$ | 0.062 | 0.043 | 0.052 | 0.056 | 0.055 | 0.044 | 0.048 | 0.041 | 0.050 |
| | $G_i$ | 0.051 | 0.040 | 0.043 | 0.048 | 0.055 | 0.050 | 0.050 | 0.042 | 0.054 |
| | $G_i$* | 0.053 | 0.053 | 0.045 | 0.056 | 0.054 | 0.048 | 0.051 | 0.058 | 0.053 |
| | $H_i$ | 0.045 | 0.056 | 0.044 | 0.041 | 0.047 | 0.063 | 0.051 | 0.048 | 0.046 |
| | $H_i$* | 0.057 | 0.056 | 0.042 | 0.054 | 0.036 | 0.054 | 0.040 | 0.065 | 0.053 |
| | $I_i$ | 0.051 | 0.050 | 0.043 | 0.048 | 0.055 | 0.050 | 0.050 | 0.042 | 0.054 |
| 7 | $c_i$ | 0.046 | 0.045 | 0.059 | 0.046 | 0.053 | 0.059 | 0.059 | 0.061 | 0.050 |
| | $G_i$ | 0.054 | 0.048 | 0.055 | 0.046 | 0.056 | 0.067 | 0.055 | 0.062 | 0.052 |
| | $G_i$* | 0.069 | 0.045 | 0.049 | 0.046 | 0.046 | 0.062 | 0.046 | 0.055 | 0.058 |
| | $H_i$ | 0.054 | 0.047 | 0.048 | 0.048 | 0.041 | 0.058 | 0.040 | 0.051 | 0.047 |
| | $H_i$* | 0.049 | 0.049 | 0.046 | 0.048 | 0.066 | 0.047 | 0.049 | 0.047 | 0.049 |

| | | Column | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| | $I_i$ | 0.054 | 0.048 | 0.055 | 0.046 | 0.056 | 0.067 | 0.055 | 0.062 | 0.052 |
| 8 | $c_i$ | 0.049 | 0.055 | 0.045 | 0.055 | 0.053 | 0.055 | 0.057 | 0.048 | 0.047 |
| | $G_i$ | 0.042 | 0.065 | 0.041 | 0.057 | 0.046 | 0.054 | 0.054 | 0.054 | 0.047 |
| | $G_i$* | 0.053 | 0.055 | 0.045 | 0.056 | 0.049 | 0.056 | 0.055 | 0.050 | 0.048 |
| | $H_i$ | 0.054 | 0.045 | 0.051 | 0.043 | 0.044 | 0.049 | 0.055 | 0.057 | 0.045 |
| | $H_i$* | 0.055 | 0.054 | 0.043 | 0.045 | 0.052 | 0.050 | 0.053 | 0.043 | 0.049 |
| | $I_i$ | 0.042 | 0.065 | 0.041 | 0.057 | 0.046 | 0.054 | 0.054 | 0.054 | 0.047 |
| 9 | $c_i$ | 0.054 | 0.050 | 0.041 | 0.033 | 0.057 | 0.047 | 0.057 | 0.050 | 0.044 |
| | $G_i$ | 0.053 | 0.040 | 0.063 | 0.046 | 0.043 | 0.052 | 0.058 | 0.045 | 0.047 |
| | $G_i$* | 0.047 | 0.036 | 0.051 | 0.055 | 0.048 | 0.054 | 0.061 | 0.051 | 0.042 |
| | $H_i$ | 0.039 | 0.049 | 0.044 | 0.042 | 0.052 | 0.039 | 0.058 | 0.051 | 0.040 |
| | $H_i$* | 0.045 | 0.035 | 0.044 | 0.048 | 0.047 | 0.034 | 0.046 | 0.059 | 0.045 |
| | $I_i$ | 0.053 | 0.040 | 0.063 | 0.046 | 0.043 | 0.052 | 0.058 | 0.045 | 0.047 |

Figure B.16 Empirical Size Using Rook Connectivity Case for a 9x9 Study Area

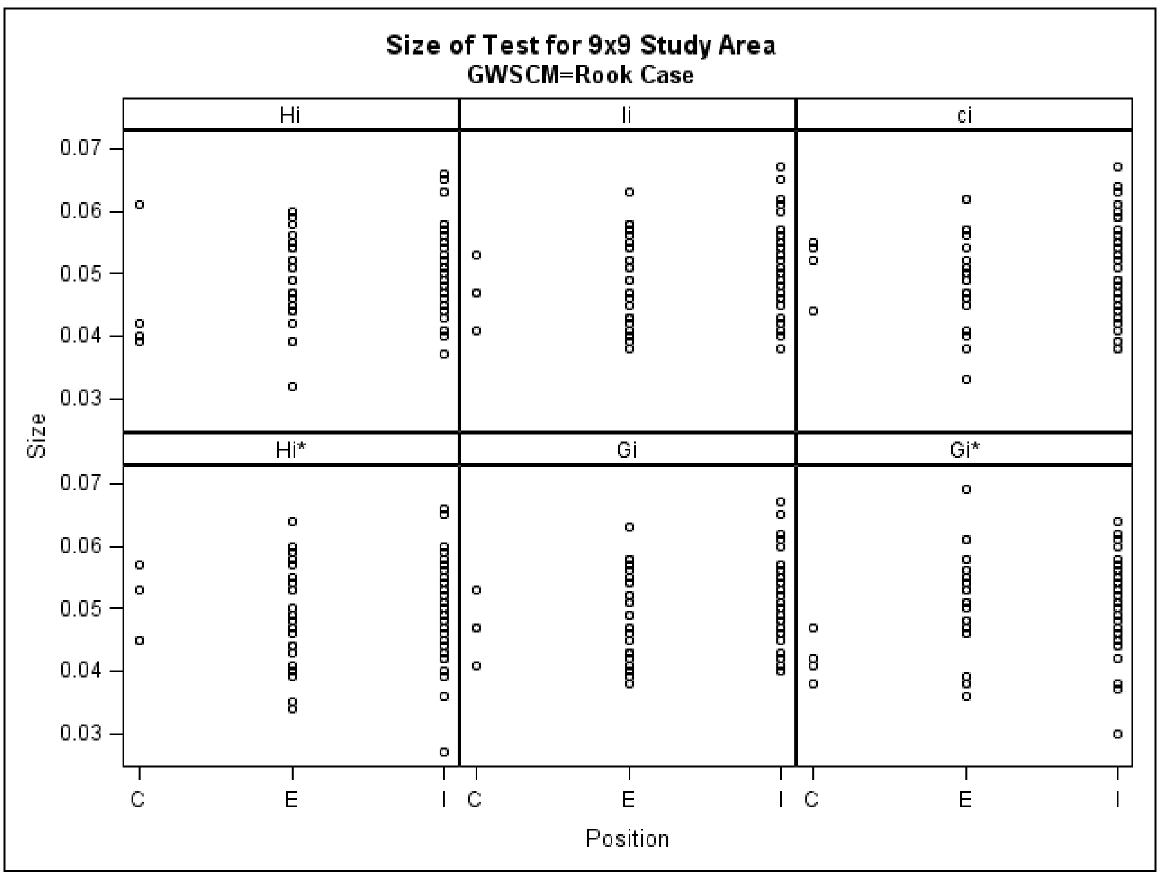


Table B.17 Empirical Size Using Queen Connectivity Case for a 9x9 Study Area

| | | Column | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 1 | $c_i$ | 0.046 | 0.059 | 0.043 | 0.059 | 0.045 | 0.039 | 0.062 | 0.057 | 0.050 |
| | $G_i$ | 0.040 | 0.057 | 0.051 | 0.046 | 0.048 | 0.037 | 0.058 | 0.055 | 0.045 |
| | $G_i$* | 0.053 | 0.060 | 0.052 | 0.047 | 0.041 | 0.052 | 0.055 | 0.046 | 0.040 |
| | $H_i$ | 0.041 | 0.058 | 0.050 | 0.065 | 0.054 | 0.049 | 0.045 | 0.055 | 0.044 |
| | $H_i$* | 0.048 | 0.063 | 0.037 | 0.049 | 0.062 | 0.050 | 0.050 | 0.049 | 0.045 |
| | $I_i$ | 0.040 | 0.057 | 0.051 | 0.046 | 0.048 | 0.037 | 0.058 | 0.055 | 0.045 |
| 2 | $c_i$ | 0.049 | 0.053 | 0.060 | 0.053 | 0.046 | 0.060 | 0.054 | 0.055 | 0.040 |
| | $G_i$ | 0.050 | 0.040 | 0.062 | 0.057 | 0.056 | 0.055 | 0.051 | 0.051 | 0.034 |
| | $G_i$* | 0.044 | 0.044 | 0.056 | 0.058 | 0.053 | 0.050 | 0.042 | 0.048 | 0.038 |
| | $H_i$ | 0.055 | 0.045 | 0.053 | 0.061 | 0.067 | 0.051 | 0.056 | 0.056 | 0.040 |
| | $H_i$* | 0.048 | 0.041 | 0.048 | 0.057 | 0.056 | 0.054 | 0.050 | 0.044 | 0.064 |
| | $I_i$ | 0.050 | 0.040 | 0.062 | 0.057 | 0.056 | 0.055 | 0.051 | 0.051 | 0.034 |
| 3 | $c_i$ | 0.057 | 0.041 | 0.056 | 0.059 | 0.068 | 0.043 | 0.055 | 0.041 | 0.049 |
| | $G_i$ | 0.047 | 0.048 | 0.047 | 0.060 | 0.058 | 0.045 | 0.062 | 0.050 | 0.043 |
| | $G_i$* | 0.051 | 0.045 | 0.050 | 0.061 | 0.059 | 0.043 | 0.051 | 0.044 | 0.044 |
| | $H_i$ | 0.049 | 0.056 | 0.057 | 0.050 | 0.054 | 0.042 | 0.060 | 0.050 | 0.047 |
| | $H_i$* | 0.053 | 0.045 | 0.056 | 0.040 | 0.055 | 0.037 | 0.058 | 0.047 | 0.041 |
| | $I_i$ | 0.047 | 0.048 | 0.047 | 0.060 | 0.058 | 0.045 | 0.062 | 0.050 | 0.043 |
| 4 | $c_i$ | 0.053 | 0.039 | 0.047 | 0.053 | 0.066 | 0.051 | 0.047 | 0.043 | 0.049 |
| | $G_i$ | 0.053 | 0.046 | 0.062 | 0.058 | 0.053 | 0.041 | 0.051 | 0.045 | 0.048 |
| | $G_i$* | 0.057 | 0.049 | 0.068 | 0.058 | 0.051 | 0.045 | 0.051 | 0.042 | 0.045 |
| | $H_i$ | 0.043 | 0.053 | 0.053 | 0.060 | 0.046 | 0.044 | 0.044 | 0.053 | 0.055 |
| | $H_i$* | 0.050 | 0.050 | 0.048 | 0.056 | 0.050 | 0.056 | 0.058 | 0.056 | 0.068 |
| | $I_i$ | 0.053 | 0.046 | 0.062 | 0.058 | 0.053 | 0.041 | 0.051 | 0.045 | 0.048 |
| 5 | $c_i$ | 0.045 | 0.035 | 0.056 | 0.064 | 0.038 | 0.051 | 0.063 | 0.039 | 0.059 |
| | $G_i$ | 0.041 | 0.036 | 0.053 | 0.054 | 0.040 | 0.032 | 0.054 | 0.037 | 0.047 |
| | $G_i$* | 0.045 | 0.044 | 0.057 | 0.056 | 0.040 | 0.036 | 0.053 | 0.043 | 0.042 |
| | $H_i$ | 0.052 | 0.047 | 0.060 | 0.057 | 0.036 | 0.050 | 0.058 | 0.033 | 0.051 |
| | $H_i$* | 0.042 | 0.031 | 0.046 | 0.062 | 0.056 | 0.056 | 0.054 | 0.039 | 0.063 |
| | $I_i$ | 0.041 | 0.036 | 0.053 | 0.054 | 0.040 | 0.032 | 0.054 | 0.037 | 0.047 |
| 6 | $c_i$ | 0.059 | 0.046 | 0.045 | 0.047 | 0.051 | 0.036 | 0.056 | 0.049 | 0.058 |
| | $G_i$ | 0.056 | 0.048 | 0.056 | 0.056 | 0.052 | 0.049 | 0.056 | 0.050 | 0.059 |
| | $G_i$* | 0.059 | 0.041 | 0.051 | 0.057 | 0.051 | 0.056 | 0.055 | 0.053 | 0.057 |
| | $H_i$ | 0.052 | 0.059 | 0.049 | 0.055 | 0.059 | 0.050 | 0.048 | 0.042 | 0.052 |
| | $H_i$* | 0.048 | 0.046 | 0.053 | 0.052 | 0.049 | 0.056 | 0.047 | 0.045 | 0.055 |
| | $I_i$ | 0.056 | 0.048 | 0.056 | 0.056 | 0.052 | 0.049 | 0.056 | 0.050 | 0.059 |
| 7 | $c_i$ | 0.049 | 0.057 | 0.052 | 0.050 | 0.051 | 0.056 | 0.062 | 0.045 | 0.062 |
| | $G_i$ | 0.046 | 0.053 | 0.052 | 0.055 | 0.047 | 0.063 | 0.063 | 0.056 | 0.063 |
| | $G_i$* | 0.049 | 0.051 | 0.058 | 0.057 | 0.055 | 0.057 | 0.059 | 0.069 | 0.071 |
| | $H_i$ | 0.041 | 0.056 | 0.048 | 0.051 | 0.054 | 0.062 | 0.060 | 0.044 | 0.050 |
| | $H_i$* | 0.050 | 0.050 | 0.051 | 0.045 | 0.048 | 0.047 | 0.070 | 0.043 | 0.050 |

| | | Column | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| | $I_i$ | 0.046 | 0.053 | 0.052 | 0.055 | 0.047 | 0.063 | 0.063 | 0.056 | 0.063 |
| 8 | $c_i$ | 0.052 | 0.052 | 0.056 | 0.051 | 0.050 | 0.052 | 0.061 | 0.053 | 0.053 |
| | $G_i$ | 0.043 | 0.045 | 0.051 | 0.048 | 0.056 | 0.056 | 0.058 | 0.057 | 0.068 |
| | $G_i$* | 0.053 | 0.049 | 0.049 | 0.052 | 0.055 | 0.064 | 0.060 | 0.066 | 0.058 |
| | $H_i$ | 0.053 | 0.046 | 0.048 | 0.050 | 0.044 | 0.053 | 0.058 | 0.059 | 0.060 |
| | $H_i$* | 0.044 | 0.054 | 0.045 | 0.051 | 0.049 | 0.048 | 0.040 | 0.058 | 0.049 |
| | $I_i$ | 0.043 | 0.045 | 0.051 | 0.048 | 0.054 | 0.056 | 0.058 | 0.057 | 0.068 |
| 9 | $c_i$ | 0.046 | 0.057 | 0.042 | 0.041 | 0.042 | 0.046 | 0.059 | 0.044 | 0.039 |
| | $G_i$ | 0.045 | 0.051 | 0.058 | 0.056 | 0.042 | 0.056 | 0.052 | 0.042 | 0.039 |
| | $G_i$* | 0.048 | 0.039 | 0.056 | 0.054 | 0.042 | 0.060 | 0.057 | 0.050 | 0.047 |
| | $H_i$ | 0.059 | 0.049 | 0.053 | 0.050 | 0.052 | 0.046 | 0.049 | 0.037 | 0.036 |
| | $H_i$* | 0.051 | 0.045 | 0.057 | 0.044 | 0.047 | 0.053 | 0.055 | 0.036 | 0.051 |
| | $I_i$ | 0.045 | 0.051 | 0.058 | 0.056 | 0.042 | 0.056 | 0.052 | 0.042 | 0.039 |

Figure B.17 Empirical Size Using Queen Connectivity Case for a 9x9 Study Area

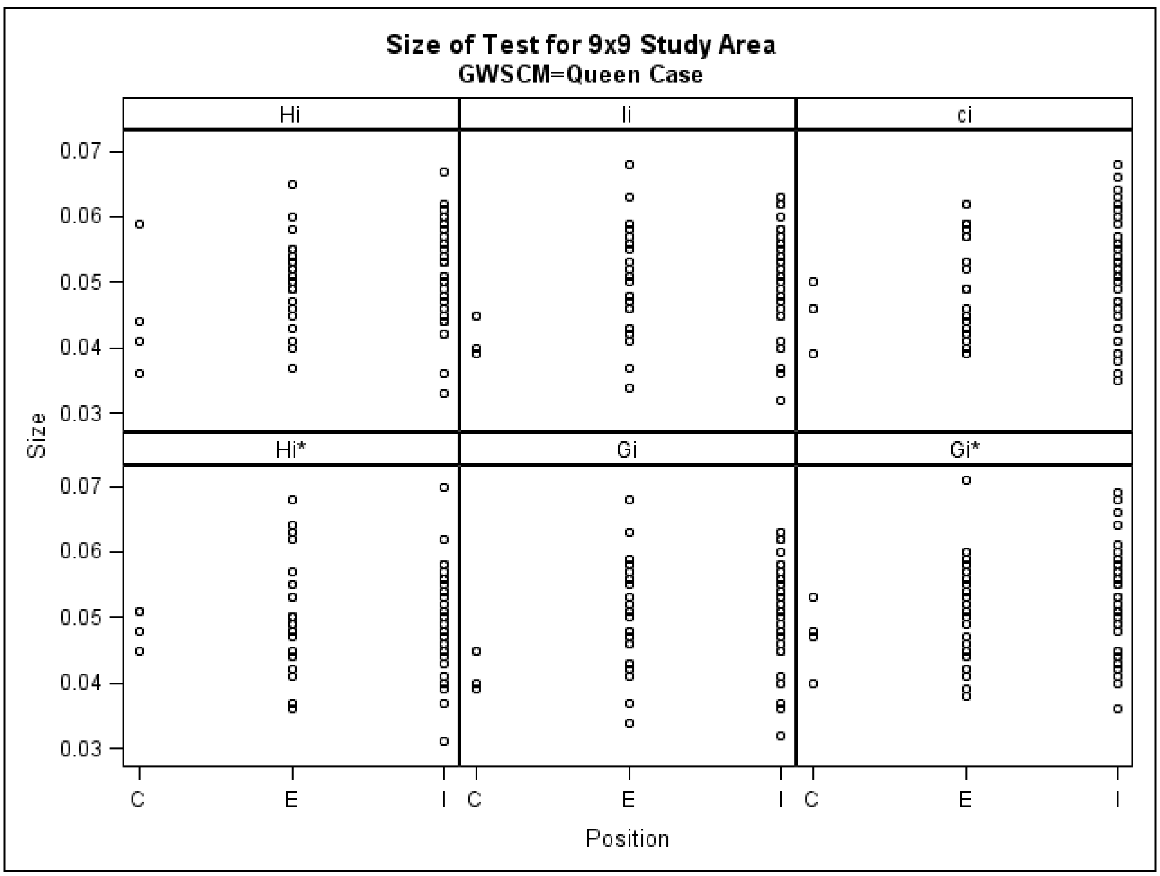


Table B.18 Empirical Size Using CWF Connectivity Case for a 9x9 Study Area

| | | Column | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 1 | $c_i$ | 0.045 | 0.068 | 0.052 | 0.056 | 0.056 | 0.043 | 0.050 | 0.061 | 0.056 |
| | $G_i$ | 0.043 | 0.053 | 0.054 | 0.048 | 0.046 | 0.043 | 0.046 | 0.049 | 0.048 |
| | $G_i$* | 0.047 | 0.055 | 0.052 | 0.047 | 0.038 | 0.053 | 0.055 | 0.042 | 0.035 |
| | $H_i$ | 0.052 | 0.055 | 0.049 | 0.054 | 0.052 | 0.046 | 0.053 | 0.057 | 0.053 |
| | $H_i$* | 0.047 | 0.059 | 0.037 | 0.064 | 0.062 | 0.035 | 0.045 | 0.052 | 0.047 |
| | $I_i$ | 0.043 | 0.053 | 0.054 | 0.048 | 0.046 | 0.043 | 0.046 | 0.049 | 0.048 |
| 2 | $c_i$ | 0.050 | 0.049 | 0.062 | 0.056 | 0.045 | 0.064 | 0.049 | 0.043 | 0.041 |
| | $G_i$ | 0.049 | 0.048 | 0.056 | 0.053 | 0.056 | 0.057 | 0.046 | 0.044 | 0.033 |
| | $G_i$* | 0.046 | 0.051 | 0.054 | 0.056 | 0.051 | 0.053 | 0.050 | 0.050 | 0.040 |
| | $H_i$ | 0.046 | 0.041 | 0.063 | 0.052 | 0.048 | 0.052 | 0.046 | 0.052 | 0.045 |
| | $H_i$* | 0.052 | 0.049 | 0.050 | 0.052 | 0.052 | 0.039 | 0.046 | 0.050 | 0.041 |
| | $I_i$ | 0.049 | 0.048 | 0.056 | 0.053 | 0.056 | 0.057 | 0.046 | 0.044 | 0.033 |
| 3 | $c_i$ | 0.052 | 0.046 | 0.056 | 0.053 | 0.061 | 0.046 | 0.051 | 0.040 | 0.049 |
| | $G_i$ | 0.055 | 0.044 | 0.058 | 0.069 | 0.052 | 0.052 | 0.059 | 0.047 | 0.032 |
| | $G_i$* | 0.043 | 0.053 | 0.057 | 0.071 | 0.049 | 0.049 | 0.049 | 0.047 | 0.039 |
| | $H_i$ | 0.062 | 0.049 | 0.056 | 0.059 | 0.054 | 0.056 | 0.048 | 0.041 | 0.033 |
| | $H_i$* | 0.058 | 0.044 | 0.051 | 0.042 | 0.053 | 0.045 | 0.046 | 0.046 | 0.050 |
| | $I_i$ | 0.055 | 0.044 | 0.058 | 0.069 | 0.052 | 0.052 | 0.059 | 0.047 | 0.032 |
| 4 | $c_i$ | 0.051 | 0.046 | 0.046 | 0.044 | 0.053 | 0.053 | 0.037 | 0.044 | 0.050 |
| | $G_i$ | 0.049 | 0.048 | 0.057 | 0.051 | 0.044 | 0.042 | 0.053 | 0.049 | 0.048 |
| | $G_i$* | 0.052 | 0.054 | 0.048 | 0.051 | 0.042 | 0.044 | 0.045 | 0.047 | 0.036 |
| | $H_i$ | 0.054 | 0.042 | 0.057 | 0.058 | 0.047 | 0.051 | 0.055 | 0.044 | 0.039 |
| | $H_i$* | 0.043 | 0.042 | 0.060 | 0.055 | 0.051 | 0.065 | 0.068 | 0.051 | 0.045 |
| | $I_i$ | 0.049 | 0.048 | 0.057 | 0.051 | 0.044 | 0.042 | 0.053 | 0.049 | 0.048 |
| 5 | $c_i$ | 0.044 | 0.047 | 0.056 | 0.066 | 0.047 | 0.045 | 0.054 | 0.051 | 0.048 |
| | $G_i$ | 0.044 | 0.043 | 0.054 | 0.047 | 0.043 | 0.037 | 0.049 | 0.043 | 0.047 |
| | $G_i$* | 0.046 | 0.059 | 0.064 | 0.057 | 0.051 | 0.046 | 0.044 | 0.048 | 0.048 |
| | $H_i$ | 0.042 | 0.039 | 0.057 | 0.053 | 0.044 | 0.043 | 0.043 | 0.053 | 0.051 |
| | $H_i$* | 0.050 | 0.042 | 0.054 | 0.047 | 0.051 | 0.050 | 0.042 | 0.054 | 0.052 |
| | $I_i$ | 0.044 | 0.043 | 0.054 | 0.047 | 0.043 | 0.037 | 0.049 | 0.043 | 0.047 |
| 6 | $c_i$ | 0.054 | 0.046 | 0.049 | 0.045 | 0.054 | 0.045 | 0.058 | 0.047 | 0.053 |
| | $G_i$ | 0.047 | 0.054 | 0.048 | 0.057 | 0.060 | 0.047 | 0.065 | 0.060 | 0.063 |
| | $G_i$* | 0.053 | 0.046 | 0.057 | 0.060 | 0.057 | 0.057 | 0.052 | 0.064 | 0.054 |
| | $H_i$ | 0.049 | 0.051 | 0.050 | 0.053 | 0.056 | 0.049 | 0.049 | 0.054 | 0.052 |
| | $H_i$* | 0.042 | 0.045 | 0.054 | 0.050 | 0.050 | 0.064 | 0.053 | 0.065 | 0.050 |
| | $I_i$ | 0.047 | 0.054 | 0.048 | 0.057 | 0.060 | 0.047 | 0.065 | 0.060 | 0.063 |
| 7 | $c_i$ | 0.046 | 0.054 | 0.049 | 0.044 | 0.055 | 0.042 | 0.055 | 0.057 | 0.051 |
| | $G_i$ | 0.044 | 0.040 | 0.048 | 0.051 | 0.051 | 0.063 | 0.061 | 0.057 | 0.060 |
| | $G_i$* | 0.057 | 0.041 | 0.044 | 0.046 | 0.053 | 0.059 | 0.061 | 0.060 | 0.067 |
| | $H_i$ | 0.043 | 0.041 | 0.048 | 0.051 | 0.055 | 0.064 | 0.051 | 0.050 | 0.046 |
| | $H_i$* | 0.055 | 0.046 | 0.048 | 0.056 | 0.053 | 0.049 | 0.055 | 0.044 | 0.051 |

| | | Column | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| | $I_i$ | 0.044 | 0.040 | 0.048 | 0.051 | 0.051 | 0.063 | 0.061 | 0.057 | 0.060 |
| 8 | $c_i$ | 0.051 | 0.041 | 0.048 | 0.048 | 0.054 | 0.058 | 0.056 | 0.055 | 0.047 |
| | $G_i$ | 0.041 | 0.045 | 0.040 | 0.052 | 0.054 | 0.059 | 0.060 | 0.053 | 0.069 |
| | $G_i$* | 0.051 | 0.043 | 0.047 | 0.050 | 0.048 | 0.059 | 0.062 | 0.059 | 0.052 |
| | $H_i$ | 0.044 | 0.054 | 0.054 | 0.047 | 0.050 | 0.054 | 0.059 | 0.055 | 0.063 |
| | $H_i$* | 0.041 | 0.054 | 0.054 | 0.037 | 0.052 | 0.053 | 0.042 | 0.041 | 0.060 |
| | $I_i$ | 0.041 | 0.045 | 0.040 | 0.052 | 0.054 | 0.059 | 0.060 | 0.053 | 0.069 |
| 9 | $c_i$ | 0.057 | 0.057 | 0.044 | 0.045 | 0.045 | 0.047 | 0.057 | 0.043 | 0.041 |
| | $G_i$ | 0.055 | 0.042 | 0.050 | 0.044 | 0.050 | 0.052 | 0.058 | 0.042 | 0.050 |
| | $G_i$* | 0.049 | 0.046 | 0.053 | 0.055 | 0.048 | 0.055 | 0.059 | 0.057 | 0.040 |
| | $H_i$ | 0.052 | 0.044 | 0.053 | 0.042 | 0.049 | 0.046 | 0.062 | 0.041 | 0.047 |
| | $H_i$* | 0.054 | 0.042 | 0.050 | 0.053 | 0.046 | 0.056 | 0.064 | 0.045 | 0.048 |
| | $I_i$ | 0.055 | 0.042 | 0.050 | 0.044 | 0.050 | 0.052 | 0.058 | 0.042 | 0.050 |

Figure B.18 Empirical Size Using CWF Connectivity Case for a 9x9 Study Area

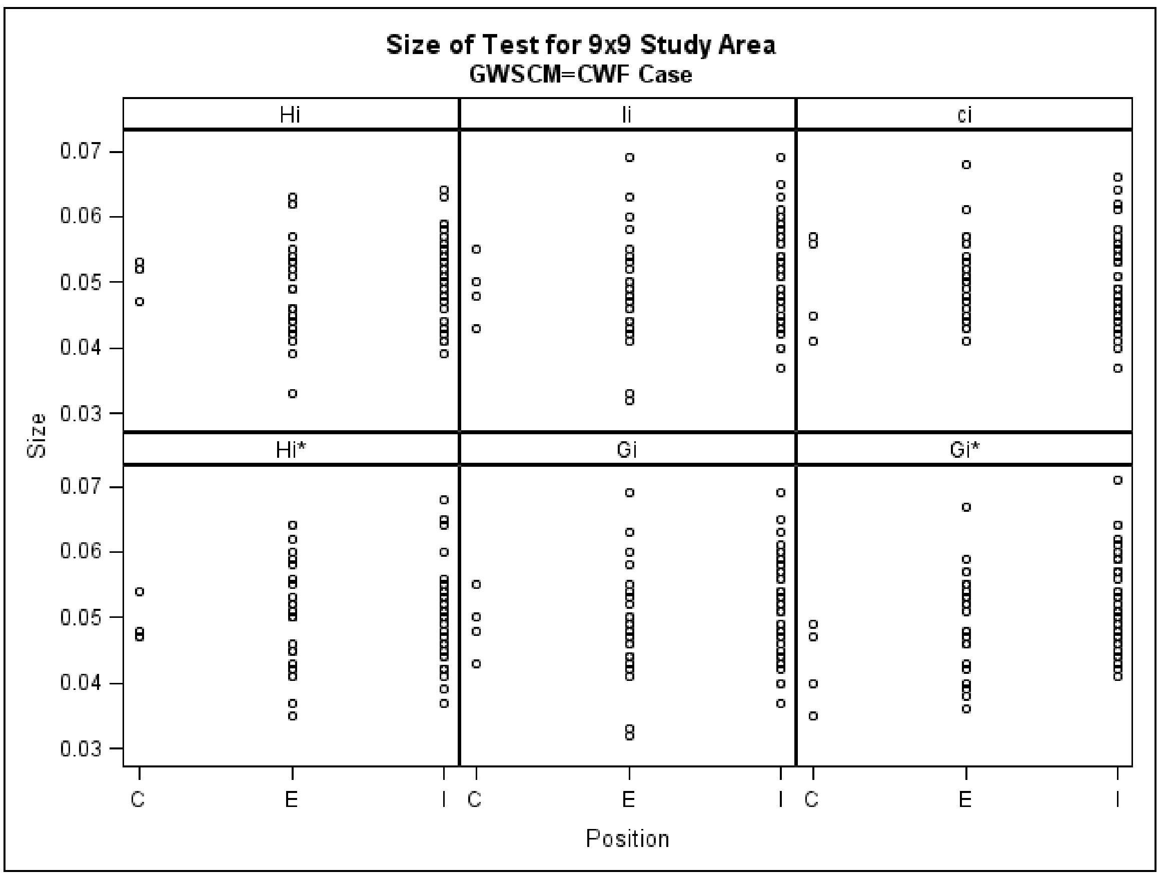


Table B.19 Empirical Power Based on Rook Pattern Variance-Covariance Matrix Using Rook Connectivity Case for a 9x9 Study Area

| | | Column | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 1 | $c_i$ | 0.205 | 0.233 | 0.226 | 0.218 | 0.185 | 0.202 | 0.217 | 0.244 | 0.164 |
| | $G_i$ | 0.083 | 0.084 | 0.076 | 0.080 | 0.076 | 0.065 | 0.074 | 0.086 | 0.069 |
| | $G_i$* | 0.142 | 0.140 | 0.130 | 0.129 | 0.112 | 0.116 | 0.130 | 0.138 | 0.137 |
| | $H_i$ | 0.193 | 0.227 | 0.205 | 0.222 | 0.213 | 0.218 | 0.216 | 0.220 | 0.172 |
| | $H_i$* | 0.144 | 0.153 | 0.134 | 0.142 | 0.135 | 0.134 | 0.143 | 0.144 | 0.134 |
| | $I_i$ | 0.151 | 0.156 | 0.151 | 0.163 | 0.154 | 0.151 | 0.163 | 0.164 | 0.132 |
| 2 | $c_i$ | 0.224 | 0.249 | 0.224 | 0.239 | 0.230 | 0.217 | 0.236 | 0.215 | 0.210 |
| | $G_i$ | 0.088 | 0.097 | 0.082 | 0.102 | 0.091 | 0.078 | 0.093 | 0.090 | 0.083 |
| | $G_i$* | 0.157 | 0.151 | 0.125 | 0.131 | 0.131 | 0.133 | 0.143 | 0.143 | 0.134 |
| | $H_i$ | 0.220 | 0.222 | 0.211 | 0.232 | 0.233 | 0.226 | 0.238 | 0.224 | 0.216 |
| | $H_i$* | 0.144 | 0.111 | 0.131 | 0.117 | 0.130 | 0.128 | 0.136 | 0.125 | 0.129 |
| | $I_i$ | 0.164 | 0.190 | 0.169 | 0.197 | 0.192 | 0.175 | 0.195 | 0.184 | 0.164 |
| 3 | $c_i$ | 0.199 | 0.213 | 0.217 | 0.245 | 0.257 | 0.227 | 0.220 | 0.219 | 0.209 |
| | $G_i$ | 0.095 | 0.099 | 0.088 | 0.087 | 0.101 | 0.096 | 0.100 | 0.101 | 0.086 |
| | $G_i$* | 0.155 | 0.134 | 0.133 | 0.134 | 0.150 | 0.150 | 0.152 | 0.158 | 0.137 |
| | $H_i$ | 0.194 | 0.228 | 0.248 | 0.223 | 0.253 | 0.248 | 0.216 | 0.245 | 0.227 |
| | $H_i$* | 0.126 | 0.139 | 0.134 | 0.118 | 0.113 | 0.130 | 0.127 | 0.142 | 0.141 |
| | $I_i$ | 0.163 | 0.175 | 0.171 | 0.180 | 0.210 | 0.189 | 0.184 | 0.201 | 0.170 |
| 4 | $c_i$ | 0.211 | 0.230 | 0.221 | 0.221 | 0.234 | 0.237 | 0.235 | 0.209 | 0.222 |
| | $G_i$ | 0.087 | 0.099 | 0.082 | 0.077 | 0.087 | 0.090 | 0.081 | 0.089 | 0.090 |
| | $G_i$* | 0.157 | 0.146 | 0.140 | 0.136 | 0.134 | 0.139 | 0.139 | 0.143 | 0.143 |
| | $H_i$ | 0.215 | 0.235 | 0.206 | 0.208 | 0.223 | 0.235 | 0.237 | 0.239 | 0.232 |
| | $H_i$* | 0.134 | 0.139 | 0.116 | 0.115 | 0.111 | 0.124 | 0.133 | 0.118 | 0.146 |
| | $I_i$ | 0.162 | 0.189 | 0.169 | 0.169 | 0.185 | 0.189 | 0.182 | 0.188 | 0.176 |
| 5 | $c_i$ | 0.230 | 0.247 | 0.242 | 0.255 | 0.234 | 0.230 | 0.230 | 0.242 | 0.214 |
| | $G_i$ | 0.094 | 0.093 | 0.086 | 0.092 | 0.095 | 0.090 | 0.084 | 0.095 | 0.088 |
| | $G_i$* | 0.150 | 0.141 | 0.136 | 0.135 | 0.140 | 0.139 | 0.135 | 0.143 | 0.131 |
| | $H_i$ | 0.227 | 0.270 | 0.227 | 0.219 | 0.231 | 0.256 | 0.239 | 0.244 | 0.218 |
| | $H_i$* | 0.133 | 0.138 | 0.116 | 0.113 | 0.129 | 0.136 | 0.134 | 0.120 | 0.145 |
| | $I_i$ | 0.179 | 0.206 | 0.184 | 0.190 | 0.185 | 0.194 | 0.182 | 0.188 | 0.178 |
| 6 | $c_i$ | 0.207 | 0.229 | 0.257 | 0.217 | 0.225 | 0.236 | 0.240 | 0.220 | 0.225 |
| | $G_i$ | 0.079 | 0.083 | 0.098 | 0.095 | 0.095 | 0.091 | 0.085 | 0.091 | 0.084 |
| | $G_i$* | 0.128 | 0.126 | 0.144 | 0.135 | 0.139 | 0.148 | 0.143 | 0.138 | 0.145 |
| | $H_i$ | 0.229 | 0.245 | 0.234 | 0.246 | 0.240 | 0.233 | 0.219 | 0.229 | 0.219 |
| | $H_i$* | 0.134 | 0.137 | 0.114 | 0.131 | 0.129 | 0.128 | 0.111 | 0.128 | 0.157 |
| | $I_i$ | 0.181 | 0.185 | 0.192 | 0.184 | 0.191 | 0.187 | 0.182 | 0.185 | 0.161 |
| 7 | $c_i$ | 0.222 | 0.223 | 0.217 | 0.221 | 0.234 | 0.228 | 0.235 | 0.237 | 0.217 |
| | $G_i$ | 0.075 | 0.076 | 0.085 | 0.079 | 0.081 | 0.091 | 0.090 | 0.102 | 0.089 |
| | $G_i$* | 0.122 | 0.114 | 0.140 | 0.117 | 0.124 | 0.141 | 0.135 | 0.151 | 0.150 |

| | | Column | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| | $H_i$ | 0.209 | 0.211 | 0.230 | 0.218 | 0.240 | 0.231 | 0.235 | 0.234 | 0.212 |
| | $H_i$* | 0.144 | 0.126 | 0.138 | 0.118 | 0.142 | 0.120 | 0.129 | 0.121 | 0.134 |
| | $I_i$ | 0.164 | 0.157 | 0.172 | 0.177 | 0.182 | 0.176 | 0.170 | 0.196 | 0.175 |
| 8 | $c_i$ | 0.221 | 0.216 | 0.227 | 0.215 | 0.226 | 0.210 | 0.215 | 0.227 | 0.231 |
| | $G_i$ | 0.083 | 0.097 | 0.091 | 0.087 | 0.096 | 0.087 | 0.085 | 0.101 | 0.109 |
| | $G_i$* | 0.137 | 0.135 | 0.147 | 0.142 | 0.159 | 0.138 | 0.131 | 0.148 | 0.161 |
| | $H_i$ | 0.228 | 0.236 | 0.219 | 0.227 | 0.235 | 0.191 | 0.202 | 0.231 | 0.234 |
| | $H_i$* | 0.141 | 0.114 | 0.119 | 0.127 | 0.118 | 0.097 | 0.119 | 0.120 | 0.143 |
| | $I_i$ | 0.177 | 0.206 | 0.176 | 0.174 | 0.188 | 0.169 | 0.159 | 0.187 | 0.189 |
| 9 | $c_i$ | 0.178 | 0.230 | 0.222 | 0.206 | 0.215 | 0.194 | 0.206 | 0.217 | 0.175 |
| | $G_i$ | 0.065 | 0.084 | 0.099 | 0.092 | 0.103 | 0.085 | 0.079 | 0.086 | 0.076 |
| | $G_i$* | 0.126 | 0.139 | 0.149 | 0.153 | 0.148 | 0.136 | 0.120 | 0.142 | 0.144 |
| | $H_i$ | 0.171 | 0.228 | 0.232 | 0.223 | 0.229 | 0.211 | 0.193 | 0.251 | 0.195 |
| | $H_i$* | 0.133 | 0.129 | 0.139 | 0.128 | 0.145 | 0.132 | 0.117 | 0.170 | 0.141 |
| | $I_i$ | 0.150 | 0.175 | 0.175 | 0.173 | 0.175 | 0.160 | 0.153 | 0.165 | 0.145 |

Figure B.19 Empirical Power Based on Rook Pattern Variance-Covariance Matrix

Using Rook Connectivity Case for a 9x9 Study Area

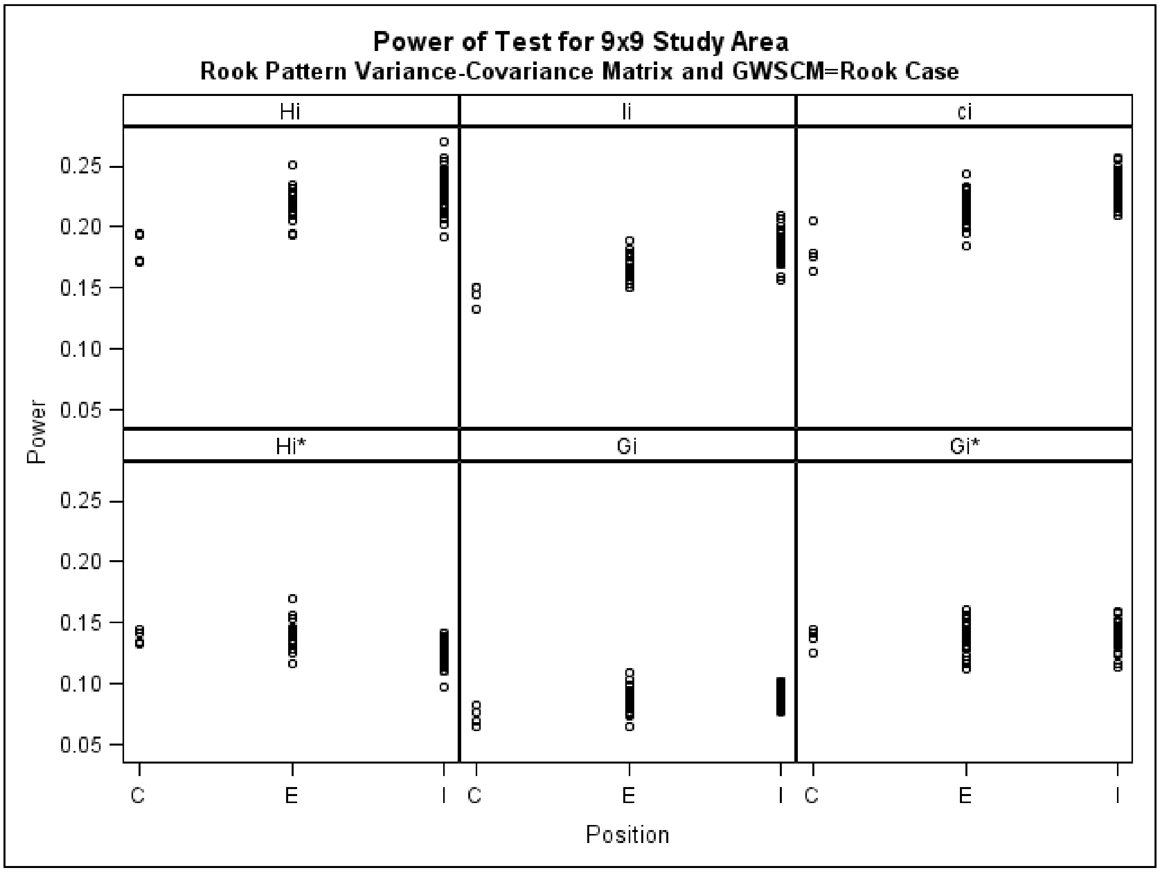


Table B.20 Empirical Power Based on Rook Pattern Variance-Covariance Matrix Using Queen Connectivity Case for a 9x9 Study Area

| | | Column | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 1 | $c_i$ | 0.247 | 0.277 | 0.265 | 0.275 | 0.253 | 0.243 | 0.258 | 0.267 | 0.245 |
| | $G_i$ | 0.133 | 0.145 | 0.117 | 0.122 | 0.113 | 0.118 | 0.123 | 0.140 | 0.125 |
| | $G_i$* | 0.166 | 0.177 | 0.154 | 0.155 | 0.133 | 0.136 | 0.156 | 0.163 | 0.166 |
| | $H_i$ | 0.178 | 0.226 | 0.202 | 0.206 | 0.208 | 0.209 | 0.216 | 0.215 | 0.173 |
| | $H_i$* | 0.132 | 0.142 | 0.113 | 0.115 | 0.131 | 0.117 | 0.130 | 0.123 | 0.119 |
| | $I_i$ | 0.220 | 0.259 | 0.226 | 0.242 | 0.230 | 0.238 | 0.238 | 0.249 | 0.215 |
| 2 | $c_i$ | 0.294 | 0.294 | 0.287 | 0.303 | 0.287 | 0.273 | 0.311 | 0.281 | 0.264 |
| | $G_i$ | 0.149 | 0.153 | 0.130 | 0.149 | 0.140 | 0.141 | 0.145 | 0.154 | 0.136 |
| | $G_i$* | 0.180 | 0.190 | 0.154 | 0.164 | 0.160 | 0.162 | 0.174 | 0.182 | 0.167 |
| | $H_i$ | 0.229 | 0.233 | 0.226 | 0.248 | 0.241 | 0.232 | 0.248 | 0.237 | 0.200 |
| | $H_i$* | 0.129 | 0.104 | 0.116 | 0.109 | 0.115 | 0.112 | 0.124 | 0.117 | 0.107 |
| | $I_i$ | 0.264 | 0.260 | 0.239 | 0.273 | 0.285 | 0.281 | 0.287 | 0.281 | 0.251 |
| 3 | $c_i$ | 0.257 | 0.285 | 0.273 | 0.297 | 0.296 | 0.285 | 0.281 | 0.275 | 0.260 |
| | $G_i$ | 0.143 | 0.151 | 0.133 | 0.135 | 0.149 | 0.149 | 0.151 | 0.186 | 0.148 |
| | $G_i$* | 0.171 | 0.170 | 0.155 | 0.161 | 0.168 | 0.174 | 0.183 | 0.184 | 0.171 |
| | $H_i$ | 0.202 | 0.246 | 0.234 | 0.244 | 0.268 | 0.257 | 0.231 | 0.262 | 0.227 |
| | $H_i$* | 0.125 | 0.141 | 0.114 | 0.107 | 0.122 | 0.120 | 0.102 | 0.130 | 0.117 |
| | $I_i$ | 0.242 | 0.261 | 0.247 | 0.273 | 0.289 | 0.284 | 0.267 | 0.288 | 0.275 |
| 4 | $c_i$ | 0.281 | 0.287 | 0.267 | 0.262 | 0.299 | 0.288 | 0.272 | 0.268 | 0.272 |
| | $G_i$ | 0.139 | 0.150 | 0.136 | 0.136 | 0.152 | 0.138 | 0.141 | 0.140 | 0.133 |
| | $G_i$* | 0.177 | 0.171 | 0.170 | 0.163 | 0.166 | 0.168 | 0.172 | 0.170 | 0.161 |
| | $H_i$ | 0.219 | 0.243 | 0.233 | 0.231 | 0.247 | 0.250 | 0.244 | 0.242 | 0.218 |
| | $H_i$* | 0.117 | 0.116 | 0.116 | 0.114 | 0.113 | 0.121 | 0.118 | 0.115 | 0.125 |
| | $I_i$ | 0.247 | 0.258 | 0.240 | 0.259 | 0.278 | 0.269 | 0.270 | 0.266 | 0.235 |
| 5 | $c_i$ | 0.282 | 0.294 | 0.275 | 0.315 | 0.293 | 0.293 | 0.282 | 0.287 | 0.283 |
| | $G_i$ | 0.141 | 0.155 | 0.128 | 0.132 | 0.129 | 0.137 | 0.127 | 0.140 | 0.122 |
| | $G_i$* | 0.179 | 0.183 | 0.153 | 0.161 | 0.152 | 0.160 | 0.151 | 0.160 | 0.151 |
| | $H_i$ | 0.234 | 0.272 | 0.226 | 0.237 | 0.238 | 0.241 | 0.238 | 0.249 | 0.219 |
| | $H_i$* | 0.119 | 0.133 | 0.102 | 0.109 | 0.109 | 0.126 | 0.116 | 0.116 | 0.128 |
| | $I_i$ | 0.252 | 0.297 | 0.258 | 0.270 | 0.266 | 0.275 | 0.253 | 0.266 | 0.250 |
| 6 | $c_i$ | 0.261 | 0.284 | 0.291 | 0.305 | 0.290 | 0.285 | 0.293 | 0.281 | 0.259 |
| | $G_i$ | 0.128 | 0.144 | 0.134 | 0.148 | 0.142 | 0.151 | 0.141 | 0.149 | 0.143 |
| | $G_i$* | 0.150 | 0.160 | 0.169 | 0.173 | 0.161 | 0.177 | 0.167 | 0.172 | 0.168 |
| | $H_i$ | 0.224 | 0.246 | 0.262 | 0.240 | 0.253 | 0.267 | 0.238 | 0.228 | 0.220 |
| | $H_i$* | 0.124 | 0.128 | 0.124 | 0.110 | 0.122 | 0.129 | 0.114 | 0.118 | 0.133 |
| | $I_i$ | 0.259 | 0.280 | 0.273 | 0.284 | 0.275 | 0.292 | 0.265 | 0.267 | 0.260 |
| 7 | $c_i$ | 0.264 | 0.276 | 0.272 | 0.243 | 0.267 | 0.272 | 0.269 | 0.292 | 0.281 |
| | $G_i$ | 0.117 | 0.130 | 0.137 | 0.124 | 0.125 | 0.132 | 0.148 | 0.162 | 0.150 |
| | $G_i$* | 0.147 | 0.145 | 0.156 | 0.143 | 0.159 | 0.156 | 0.174 | 0.179 | 0.176 |

| | | Column | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| | $H_i$ | 0.209 | 0.222 | 0.230 | 0.209 | 0.235 | 0.242 | 0.240 | 0.266 | 0.208 |
| | $H_i$* | 0.137 | 0.122 | 0.123 | 0.119 | 0.125 | 0.122 | 0.128 | 0.124 | 0.109 |
| | $I_i$ | 0.229 | 0.244 | 0.264 | 0.245 | 0.257 | 0.261 | 0.260 | 0.282 | 0.261 |
| 8 | $c_i$ | 0.275 | 0.313 | 0.299 | 0.291 | 0.278 | 0.253 | 0.264 | 0.329 | 0.298 |
| | $G_i$ | 0.120 | 0.158 | 0.153 | 0.141 | 0.149 | 0.138 | 0.141 | 0.178 | 0.150 |
| | $G_i$* | 0.154 | 0.169 | 0.179 | 0.173 | 0.175 | 0.170 | 0.157 | 0.202 | 0.188 |
| | $H_i$ | 0.209 | 0.249 | 0.232 | 0.234 | 0.252 | 0.204 | 0.228 | 0.275 | 0.217 |
| | $H_i$* | 0.112 | 0.118 | 0.112 | 0.116 | 0.119 | 0.101 | 0.121 | 0.125 | 0.123 |
| | $I_i$ | 0.240 | 0.294 | 0.279 | 0.258 | 0.281 | 0.242 | 0.244 | 0.293 | 0.256 |
| 9 | $c_i$ | 0.239 | 0.288 | 0.272 | 0.254 | 0.269 | 0.224 | 0.243 | 0.295 | 0.233 |
| | $G_i$ | 0.121 | 0.143 | 0.147 | 0.142 | 0.144 | 0.118 | 0.124 | 0.139 | 0.135 |
| | $G_i$* | 0.154 | 0.173 | 0.176 | 0.178 | 0.168 | 0.157 | 0.140 | 0.172 | 0.163 |
| | $H_i$ | 0.178 | 0.211 | 0.215 | 0.212 | 0.225 | 0.200 | 0.182 | 0.223 | 0.183 |
| | $H_i$* | 0.117 | 0.125 | 0.110 | 0.109 | 0.124 | 0.123 | 0.108 | 0.158 | 0.114 |
| | $I_i$ | 0.236 | 0.250 | 0.252 | 0.237 | 0.247 | 0.212 | 0.219 | 0.242 | 0.230 |

Figure B.20 Empirical Power Based on Rook Pattern Variance-Covariance Matrix Using Queen Connectivity Case for a 9x9 Study Area

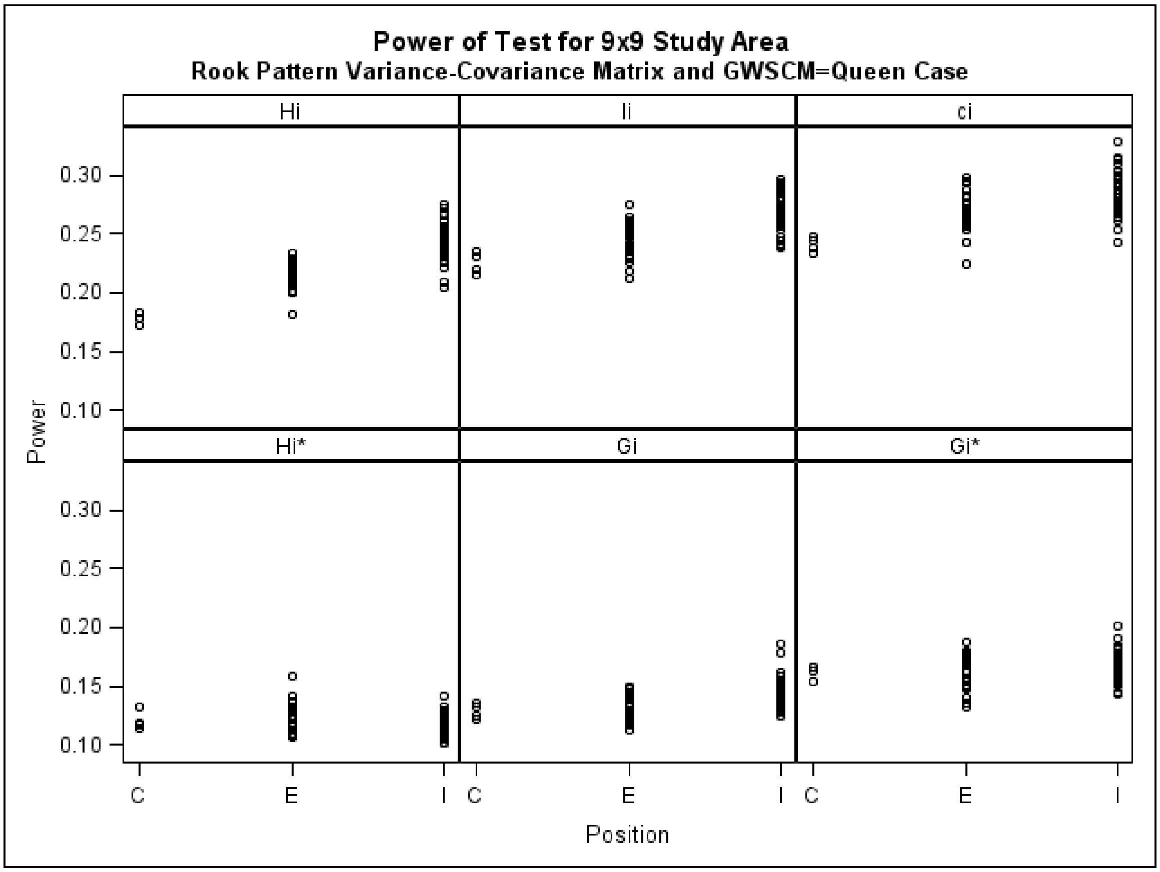


Table B.21 Empirical Power Based on Rook Pattern Variance-Covariance Matrix Using CWF Connectivity Case for a 9x9 Study Area

| | | Column | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 1 | $c_i$ | 0.281 | 0.299 | 0.298 | 0.315 | 0.293 | 0.283 | 0.304 | 0.297 | 0.266 |
| | $G_i$ | 0.164 | 0.165 | 0.158 | 0.154 | 0.166 | 0.158 | 0.158 | 0.163 | 0.158 |
| | $G_i$* | 0.192 | 0.189 | 0.169 | 0.175 | 0.165 | 0.160 | 0.176 | 0.175 | 0.173 |
| | $H_i$ | 0.192 | 0.237 | 0.212 | 0.245 | 0.242 | 0.244 | 0.242 | 0.231 | 0.193 |
| | $H_i$* | 0.109 | 0.126 | 0.100 | 0.115 | 0.105 | 0.103 | 0.118 | 0.101 | 0.098 |
| | $I_i$ | 0.256 | 0.277 | 0.257 | 0.275 | 0.287 | 0.286 | 0.287 | 0.285 | 0.264 |
| 2 | $c_i$ | 0.310 | 0.301 | 0.306 | 0.324 | 0.311 | 0.308 | 0.327 | 0.300 | 0.286 |
| | $G_i$ | 0.166 | 0.170 | 0.160 | 0.164 | 0.173 | 0.177 | 0.179 | 0.166 | 0.155 |
| | $G_i$* | 0.188 | 0.191 | 0.175 | 0.183 | 0.191 | 0.187 | 0.196 | 0.190 | 0.176 |
| | $H_i$ | 0.233 | 0.245 | 0.243 | 0.273 | 0.281 | 0.281 | 0.280 | 0.266 | 0.236 |
| | $H_i$* | 0.098 | 0.100 | 0.106 | 0.116 | 0.112 | 0.121 | 0.120 | 0.118 | 0.098 |
| | $I_i$ | 0.283 | 0.272 | 0.272 | 0.292 | 0.335 | 0.316 | 0.323 | 0.305 | 0.280 |
| 3 | $c_i$ | 0.294 | 0.295 | 0.289 | 0.323 | 0.315 | 0.317 | 0.317 | 0.332 | 0.299 |
| | $G_i$ | 0.171 | 0.168 | 0.167 | 0.173 | 0.165 | 0.175 | 0.183 | 0.177 | 0.174 |
| | $G_i$* | 0.190 | 0.190 | 0.186 | 0.194 | 0.191 | 0.195 | 0.209 | 0.205 | 0.193 |
| | $H_i$ | 0.230 | 0.249 | 0.258 | 0.279 | 0.289 | 0.284 | 0.276 | 0.287 | 0.258 |
| | $H_i$* | 0.117 | 0.124 | 0.113 | 0.103 | 0.111 | 0.111 | 0.113 | 0.121 | 0.113 |
| | $I_i$ | 0.265 | 0.284 | 0.287 | 0.305 | 0.324 | 0.319 | 0.315 | 0.306 | 0.284 |
| 4 | $c_i$ | 0.295 | 0.301 | 0.281 | 0.285 | 0.315 | 0.313 | 0.290 | 0.287 | 0.293 |
| | $G_i$ | 0.168 | 0.175 | 0.167 | 0.164 | 0.170 | 0.167 | 0.176 | 0.169 | 0.162 |
| | $G_i$* | 0.199 | 0.195 | 0.178 | 0.184 | 0.190 | 0.182 | 0.203 | 0.188 | 0.175 |
| | $H_i$ | 0.247 | 0.266 | 0.254 | 0.257 | 0.286 | 0.273 | 0.276 | 0.271 | 0.237 |
| | $H_i$* | 0.113 | 0.108 | 0.113 | 0.130 | 0.123 | 0.114 | 0.119 | 0.107 | 0.100 |
| | $I_i$ | 0.283 | 0.281 | 0.274 | 0.290 | 0.315 | 0.312 | 0.297 | 0.304 | 0.263 |
| 5 | $c_i$ | 0.317 | 0.312 | 0.306 | 0.320 | 0.317 | 0.290 | 0.319 | 0.292 | 0.306 |
| | $G_i$ | 0.163 | 0.177 | 0.172 | 0.165 | 0.162 | 0.180 | 0.172 | 0.160 | 0.148 |
| | $G_i$* | 0.183 | 0.188 | 0.192 | 0.182 | 0.184 | 0.185 | 0.180 | 0.178 | 0.163 |
| | $H_i$ | 0.257 | 0.288 | 0.271 | 0.269 | 0.275 | 0.283 | 0.277 | 0.261 | 0.238 |
| | $H_i$* | 0.120 | 0.118 | 0.103 | 0.113 | 0.100 | 0.119 | 0.119 | 0.116 | 0.111 |
| | $I_i$ | 0.282 | 0.320 | 0.301 | 0.304 | 0.304 | 0.315 | 0.297 | 0.277 | 0.271 |
| 6 | $c_i$ | 0.288 | 0.309 | 0.310 | 0.313 | 0.308 | 0.301 | 0.310 | 0.309 | 0.310 |
| | $G_i$ | 0.160 | 0.173 | 0.168 | 0.163 | 0.158 | 0.174 | 0.178 | 0.165 | 0.168 |
| | $G_i$* | 0.164 | 0.179 | 0.184 | 0.190 | 0.174 | 0.193 | 0.195 | 0.189 | 0.181 |
| | $H_i$ | 0.251 | 0.274 | 0.279 | 0.268 | 0.286 | 0.293 | 0.277 | 0.266 | 0.254 |
| | $H_i$* | 0.117 | 0.114 | 0.113 | 0.106 | 0.094 | 0.093 | 0.113 | 0.121 | 0.137 |
| | $I_i$ | 0.293 | 0.315 | 0.302 | 0.304 | 0.302 | 0.327 | 0.309 | 0.288 | 0.296 |
| 7 | $c_i$ | 0.293 | 0.294 | 0.280 | 0.271 | 0.296 | 0.314 | 0.295 | 0.315 | 0.307 |
| | $G_i$ | 0.151 | 0.164 | 0.168 | 0.158 | 0.160 | 0.159 | 0.187 | 0.186 | 0.173 |
| | $G_i$* | 0.161 | 0.169 | 0.179 | 0.175 | 0.170 | 0.180 | 0.209 | 0.202 | 0.198 |

| | | Column | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| | $H_i$ | 0.239 | 0.255 | 0.270 | 0.247 | 0.258 | 0.268 | 0.263 | 0.274 | 0.258 |
| | $H_i$* | 0.133 | 0.101 | 0.123 | 0.115 | 0.116 | 0.097 | 0.120 | 0.114 | 0.119 |
| | $I_i$ | 0.273 | 0.294 | 0.306 | 0.278 | 0.280 | 0.293 | 0.309 | 0.311 | 0.294 |
| 8 | $c_i$ | 0.288 | 0.314 | 0.319 | 0.294 | 0.314 | 0.294 | 0.302 | 0.326 | 0.320 |
| | $G_i$ | 0.150 | 0.176 | 0.169 | 0.176 | 0.177 | 0.165 | 0.173 | 0.186 | 0.189 |
| | $G_i$* | 0.170 | 0.176 | 0.196 | 0.192 | 0.192 | 0.183 | 0.181 | 0.204 | 0.205 |
| | $H_i$ | 0.241 | 0.270 | 0.273 | 0.269 | 0.283 | 0.239 | 0.258 | 0.268 | 0.247 |
| | $H_i$* | 0.125 | 0.102 | 0.126 | 0.110 | 0.123 | 0.103 | 0.137 | 0.106 | 0.121 |
| | $I_i$ | 0.279 | 0.313 | 0.304 | 0.292 | 0.302 | 0.278 | 0.284 | 0.294 | 0.292 |
| 9 | $c_i$ | 0.279 | 0.297 | 0.307 | 0.277 | 0.293 | 0.261 | 0.273 | 0.325 | 0.281 |
| | $G_i$ | 0.157 | 0.154 | 0.173 | 0.172 | 0.160 | 0.153 | 0.162 | 0.167 | 0.170 |
| | $G_i$* | 0.174 | 0.193 | 0.203 | 0.194 | 0.182 | 0.167 | 0.174 | 0.190 | 0.182 |
| | $H_i$ | 0.202 | 0.226 | 0.250 | 0.261 | 0.238 | 0.222 | 0.209 | 0.251 | 0.205 |
| | $H_i$* | 0.101 | 0.099 | 0.117 | 0.105 | 0.112 | 0.101 | 0.101 | 0.133 | 0.103 |
| | $I_i$ | 0.275 | 0.284 | 0.300 | 0.282 | 0.273 | 0.251 | 0.258 | 0.277 | 0.263 |

Figure B.21 Empirical Power Based on Rook Pattern Variance-Covariance Matrix Using CWF Connectivity Case for a 9x9 Study Area

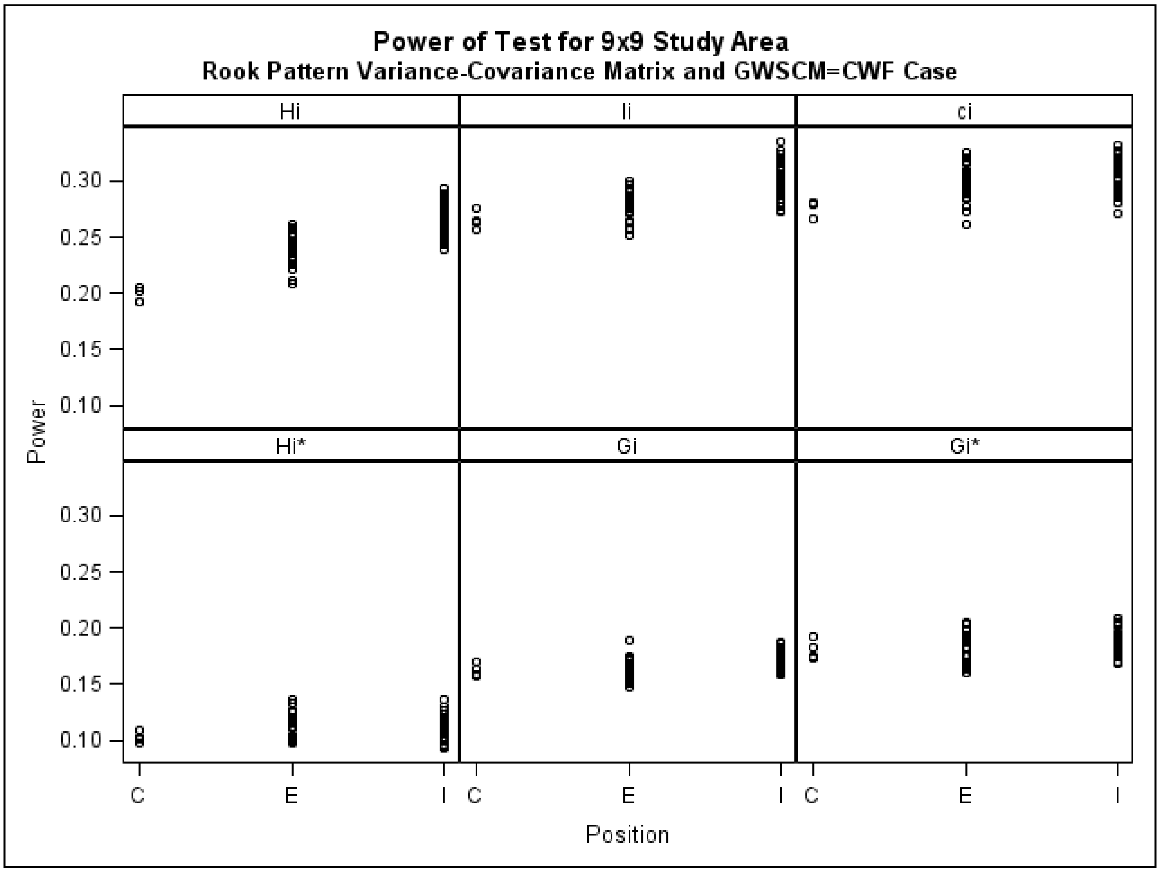


Table B.22 Empirical Power Based on Queen Pattern Variance-Covariance Matrix

Using Rook Connectivity Case for a 9x9 Study Area

| | | Column | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 1 | $c_i$ | 0.303 | 0.400 | 0.324 | 0.375 | 0.324 | 0.336 | 0.334 | 0.379 | 0.297 |
| | $G_i$ | 0.126 | 0.133 | 0.107 | 0.111 | 0.113 | 0.096 | 0.100 | 0.125 | 0.124 |
| | $G_i$* | 0.176 | 0.173 | 0.154 | 0.162 | 0.153 | 0.149 | 0.143 | 0.175 | 0.179 |
| | $H_i$ | 0.253 | 0.343 | 0.290 | 0.304 | 0.301 | 0.295 | 0.296 | 0.347 | 0.225 |
| | $H_i$* | 0.186 | 0.236 | 0.210 | 0.203 | 0.201 | 0.202 | 0.205 | 0.256 | 0.154 |
| | $I_i$ | 0.233 | 0.242 | 0.211 | 0.232 | 0.225 | 0.218 | 0.225 | 0.251 | 0.241 |
| 2 | $c_i$ | 0.400 | 0.482 | 0.414 | 0.481 | 0.427 | 0.406 | 0.394 | 0.483 | 0.403 |
| | $G_i$ | 0.136 | 0.156 | 0.127 | 0.136 | 0.125 | 0.113 | 0.119 | 0.145 | 0.134 |
| | $G_i$* | 0.190 | 0.196 | 0.173 | 0.173 | 0.154 | 0.141 | 0.167 | 0.192 | 0.186 |
| | $H_i$ | 0.342 | 0.418 | 0.356 | 0.363 | 0.368 | 0.366 | 0.340 | 0.404 | 0.352 |
| | $H_i$* | 0.239 | 0.250 | 0.232 | 0.210 | 0.242 | 0.220 | 0.204 | 0.248 | 0.255 |
| | $I_i$ | 0.259 | 0.291 | 0.254 | 0.271 | 0.258 | 0.256 | 0.261 | 0.298 | 0.266 |
| 3 | $c_i$ | 0.357 | 0.456 | 0.395 | 0.422 | 0.422 | 0.378 | 0.349 | 0.427 | 0.345 |
| | $G_i$ | 0.134 | 0.147 | 0.131 | 0.139 | 0.148 | 0.125 | 0.137 | 0.154 | 0.128 |
| | $G_i$* | 0.186 | 0.195 | 0.162 | 0.164 | 0.186 | 0.172 | 0.170 | 0.196 | 0.172 |
| | $H_i$ | 0.315 | 0.373 | 0.341 | 0.372 | 0.380 | 0.352 | 0.350 | 0.378 | 0.314 |
| | $H_i$* | 0.222 | 0.219 | 0.181 | 0.204 | 0.223 | 0.200 | 0.206 | 0.217 | 0.225 |
| | $I_i$ | 0.252 | 0.284 | 0.265 | 0.286 | 0.285 | 0.258 | 0.261 | 0.296 | 0.260 |
| 4 | $c_i$ | 0.346 | 0.457 | 0.397 | 0.383 | 0.390 | 0.450 | 0.395 | 0.408 | 0.370 |
| | $G_i$ | 0.136 | 0.145 | 0.133 | 0.138 | 0.153 | 0.161 | 0.137 | 0.144 | 0.139 |
| | $G_i$* | 0.178 | 0.174 | 0.170 | 0.182 | 0.187 | 0.204 | 0.194 | 0.179 | 0.196 |
| | $H_i$ | 0.295 | 0.373 | 0.357 | 0.358 | 0.351 | 0.381 | 0.343 | 0.368 | 0.316 |
| | $H_i$* | 0.206 | 0.220 | 0.194 | 0.197 | 0.184 | 0.181 | 0.204 | 0.220 | 0.213 |
| | $I_i$ | 0.239 | 0.276 | 0.263 | 0.272 | 0.287 | 0.305 | 0.255 | 0.265 | 0.256 |
| 5 | $c_i$ | 0.344 | 0.426 | 0.388 | 0.404 | 0.382 | 0.435 | 0.389 | 0.436 | 0.354 |
| | $G_i$ | 0.129 | 0.141 | 0.140 | 0.134 | 0.139 | 0.140 | 0.139 | 0.138 | 0.134 |
| | $G_i$* | 0.172 | 0.183 | 0.181 | 0.174 | 0.185 | 0.189 | 0.190 | 0.191 | 0.183 |
| | $H_i$ | 0.319 | 0.394 | 0.349 | 0.358 | 0.347 | 0.383 | 0.354 | 0.373 | 0.324 |
| | $H_i$* | 0.228 | 0.233 | 0.185 | 0.211 | 0.220 | 0.198 | 0.221 | 0.232 | 0.220 |
| | $I_i$ | 0.251 | 0.286 | 0.266 | 0.270 | 0.267 | 0.303 | 0.276 | 0.271 | 0.251 |
| 6 | $c_i$ | 0.373 | 0.453 | 0.397 | 0.390 | 0.397 | 0.401 | 0.405 | 0.480 | 0.363 |
| | $G_i$ | 0.128 | 0.142 | 0.132 | 0.122 | 0.128 | 0.125 | 0.130 | 0.153 | 0.133 |
| | $G_i$* | 0.184 | 0.179 | 0.172 | 0.162 | 0.165 | 0.178 | 0.171 | 0.186 | 0.172 |
| | $H_i$ | 0.348 | 0.396 | 0.350 | 0.366 | 0.321 | 0.372 | 0.369 | 0.397 | 0.328 |
| | $H_i$* | 0.228 | 0.218 | 0.211 | 0.210 | 0.178 | 0.210 | 0.223 | 0.218 | 0.223 |
| | $I_i$ | 0.264 | 0.298 | 0.256 | 0.261 | 0.245 | 0.272 | 0.274 | 0.308 | 0.261 |
| 7 | $c_i$ | 0.350 | 0.436 | 0.394 | 0.401 | 0.382 | 0.419 | 0.390 | 0.447 | 0.349 |
| | $G_i$ | 0.134 | 0.148 | 0.132 | 0.140 | 0.128 | 0.121 | 0.120 | 0.133 | 0.120 |
| | $G_i$* | 0.183 | 0.194 | 0.179 | 0.173 | 0.172 | 0.160 | 0.150 | 0.176 | 0.165 |

| | | Column | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| | $H_i$ | 0.314 | 0.397 | 0.349 | 0.374 | 0.347 | 0.364 | 0.328 | 0.380 | 0.304 |
| | $H_i$* | 0.212 | 0.248 | 0.200 | 0.229 | 0.186 | 0.213 | 0.193 | 0.221 | 0.201 |
| | $I_i$ | 0.256 | 0.287 | 0.277 | 0.276 | 0.266 | 0.264 | 0.258 | 0.287 | 0.243 |
| 8 | $c_i$ | 0.407 | 0.502 | 0.457 | 0.448 | 0.443 | 0.452 | 0.453 | 0.511 | 0.391 |
| | $G_i$ | 0.149 | 0.157 | 0.146 | 0.143 | 0.149 | 0.135 | 0.136 | 0.145 | 0.115 |
| | $G_i$* | 0.194 | 0.203 | 0.192 | 0.187 | 0.183 | 0.181 | 0.185 | 0.189 | 0.177 |
| | $H_i$ | 0.376 | 0.435 | 0.396 | 0.399 | 0.387 | 0.389 | 0.380 | 0.424 | 0.336 |
| | $H_i$* | 0.239 | 0.251 | 0.213 | 0.233 | 0.226 | 0.216 | 0.232 | 0.255 | 0.243 |
| | $I_i$ | 0.284 | 0.320 | 0.297 | 0.291 | 0.296 | 0.287 | 0.286 | 0.300 | 0.240 |
| 9 | $c_i$ | 0.296 | 0.408 | 0.345 | 0.373 | 0.367 | 0.338 | 0.358 | 0.416 | 0.291 |
| | $G_i$ | 0.129 | 0.136 | 0.135 | 0.139 | 0.128 | 0.126 | 0.135 | 0.121 | 0.100 |
| | $G_i$* | 0.169 | 0.184 | 0.175 | 0.179 | 0.177 | 0.172 | 0.179 | 0.173 | 0.151 |
| | $H_i$ | 0.256 | 0.364 | 0.324 | 0.316 | 0.326 | 0.324 | 0.315 | 0.360 | 0.230 |
| | $H_i$* | 0.198 | 0.252 | 0.231 | 0.214 | 0.229 | 0.247 | 0.223 | 0.236 | 0.184 |
| | $I_i$ | 0.250 | 0.255 | 0.262 | 0.259 | 0.254 | 0.250 | 0.266 | 0.254 | 0.207 |

Figure B.22 Empirical Power Based on Queen Pattern Variance-Covariance Matrix Using Rook Connectivity Case for a 9x9 Study Area

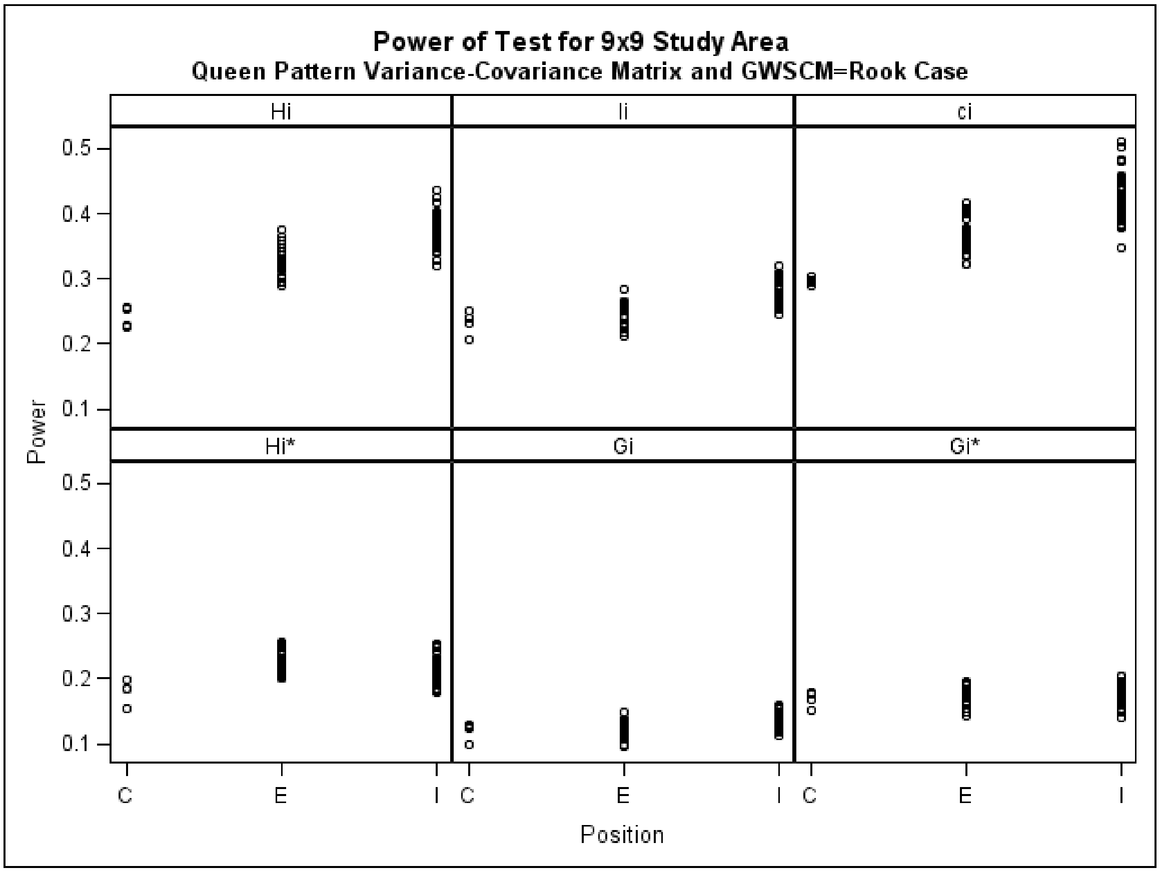


Table B.23 Empirical Power Based on Queen Pattern Variance-Covariance Matrix

Using Queen Connectivity Case for a 9x9 Study Area

| | | Column | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 1 | $c_i$ | 0.430 | 0.520 | 0.446 | 0.507 | 0.456 | 0.446 | 0.430 | 0.512 | 0.415 |
| | $G_i$ | 0.179 | 0.182 | 0.172 | 0.158 | 0.159 | 0.141 | 0.161 | 0.174 | 0.172 |
| | $G_i$* | 0.195 | 0.216 | 0.200 | 0.198 | 0.179 | 0.179 | 0.189 | 0.203 | 0.211 |
| | $H_i$ | 0.264 | 0.358 | 0.294 | 0.324 | 0.315 | 0.302 | 0.315 | 0.363 | 0.249 |
| | $H_i$* | 0.172 | 0.222 | 0.187 | 0.191 | 0.184 | 0.185 | 0.193 | 0.237 | 0.158 |
| | $I_i$ | 0.320 | 0.352 | 0.328 | 0.326 | 0.320 | 0.320 | 0.337 | 0.356 | 0.339 |
| 2 | $c_i$ | 0.534 | 0.560 | 0.524 | 0.571 | 0.538 | 0.520 | 0.479 | 0.560 | 0.532 |
| | $G_i$ | 0.197 | 0.207 | 0.194 | 0.194 | 0.181 | 0.169 | 0.180 | 0.205 | 0.204 |
| | $G_i$* | 0.225 | 0.235 | 0.221 | 0.220 | 0.202 | 0.186 | 0.202 | 0.236 | 0.229 |
| | $H_i$ | 0.381 | 0.456 | 0.405 | 0.421 | 0.419 | 0.399 | 0.383 | 0.444 | 0.383 |
| | $H_i$* | 0.219 | 0.216 | 0.222 | 0.193 | 0.211 | 0.204 | 0.194 | 0.203 | 0.229 |
| | $I_i$ | 0.388 | 0.404 | 0.382 | 0.386 | 0.371 | 0.380 | 0.371 | 0.413 | 0.393 |
| 3 | $c_i$ | 0.474 | 0.546 | 0.500 | 0.524 | 0.517 | 0.500 | 0.467 | 0.531 | 0.478 |
| | $G_i$ | 0.188 | 0.197 | 0.178 | 0.186 | 0.196 | 0.189 | 0.191 | 0.218 | 0.183 |
| | $G_i$* | 0.216 | 0.221 | 0.203 | 0.206 | 0.218 | 0.214 | 0.210 | 0.240 | 0.207 |
| | $H_i$ | 0.330 | 0.404 | 0.372 | 0.405 | 0.426 | 0.394 | 0.382 | 0.428 | 0.326 |
| | $H_i$* | 0.185 | 0.196 | 0.167 | 0.171 | 0.204 | 0.199 | 0.191 | 0.199 | 0.203 |
| | $I_i$ | 0.353 | 0.372 | 0.363 | 0.395 | 0.396 | 0.381 | 0.366 | 0.413 | 0.360 |
| 4 | $c_i$ | 0.465 | 0.540 | 0.478 | 0.496 | 0.514 | 0.553 | 0.472 | 0.523 | 0.481 |
| | $G_i$ | 0.178 | 0.196 | 0.192 | 0.194 | 0.189 | 0.216 | 0.196 | 0.200 | 0.188 |
| | $G_i$* | 0.207 | 0.223 | 0.213 | 0.214 | 0.218 | 0.236 | 0.228 | 0.226 | 0.231 |
| | $H_i$ | 0.323 | 0.413 | 0.378 | 0.405 | 0.399 | 0.435 | 0.394 | 0.417 | 0.356 |
| | $H_i$* | 0.173 | 0.207 | 0.179 | 0.182 | 0.167 | 0.158 | 0.189 | 0.207 | 0.214 |
| | $I_i$ | 0.340 | 0.370 | 0.367 | 0.375 | 0.389 | 0.419 | 0.386 | 0.386 | 0.351 |
| 5 | $c_i$ | 0.481 | 0.529 | 0.495 | 0.502 | 0.494 | 0.528 | 0.491 | 0.526 | 0.481 |
| | $G_i$ | 0.178 | 0.207 | 0.187 | 0.187 | 0.205 | 0.206 | 0.199 | 0.209 | 0.190 |
| | $G_i$* | 0.210 | 0.231 | 0.210 | 0.207 | 0.228 | 0.228 | 0.230 | 0.240 | 0.223 |
| | $H_i$ | 0.348 | 0.454 | 0.371 | 0.395 | 0.417 | 0.422 | 0.407 | 0.419 | 0.335 |
| | $H_i$* | 0.212 | 0.216 | 0.163 | 0.183 | 0.199 | 0.164 | 0.196 | 0.211 | 0.202 |
| | $I_i$ | 0.357 | 0.417 | 0.349 | 0.369 | 0.401 | 0.417 | 0.390 | 0.392 | 0.364 |
| 6 | $c_i$ | 0.495 | 0.545 | 0.494 | 0.502 | 0.477 | 0.495 | 0.490 | 0.557 | 0.494 |
| | $G_i$ | 0.184 | 0.204 | 0.185 | 0.176 | 0.183 | 0.186 | 0.188 | 0.197 | 0.181 |
| | $G_i$* | 0.217 | 0.220 | 0.210 | 0.196 | 0.204 | 0.209 | 0.220 | 0.225 | 0.211 |
| | $H_i$ | 0.356 | 0.444 | 0.381 | 0.391 | 0.370 | 0.423 | 0.416 | 0.432 | 0.347 |
| | $H_i$* | 0.207 | 0.185 | 0.182 | 0.189 | 0.156 | 0.179 | 0.193 | 0.184 | 0.214 |
| | $I_i$ | 0.360 | 0.405 | 0.363 | 0.362 | 0.367 | 0.382 | 0.393 | 0.411 | 0.368 |
| 7 | $c_i$ | 0.463 | 0.517 | 0.476 | 0.501 | 0.485 | 0.498 | 0.473 | 0.534 | 0.473 |
| | $G_i$ | 0.205 | 0.218 | 0.195 | 0.188 | 0.188 | 0.183 | 0.165 | 0.195 | 0.175 |
| | $G_i$* | 0.220 | 0.240 | 0.217 | 0.210 | 0.211 | 0.207 | 0.188 | 0.215 | 0.201 |

| | | Column | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| | $H_i$ | 0.343 | 0.448 | 0.385 | 0.395 | 0.394 | 0.401 | 0.362 | 0.421 | 0.353 |
| | $H_i$* | 0.199 | 0.227 | 0.192 | 0.202 | 0.189 | 0.184 | 0.173 | 0.204 | 0.210 |
| | $I_i$ | 0.378 | 0.420 | 0.374 | 0.377 | 0.393 | 0.397 | 0.357 | 0.407 | 0.372 |
| 8 | $c_i$ | 0.547 | 0.582 | 0.553 | 0.553 | 0.560 | 0.554 | 0.553 | 0.596 | 0.513 |
| | $G_i$ | 0.202 | 0.226 | 0.208 | 0.202 | 0.212 | 0.195 | 0.196 | 0.199 | 0.180 |
| | $G_i$* | 0.224 | 0.254 | 0.234 | 0.234 | 0.237 | 0.225 | 0.213 | 0.221 | 0.209 |
| | $H_i$ | 0.380 | 0.500 | 0.429 | 0.441 | 0.438 | 0.432 | 0.435 | 0.468 | 0.354 |
| | $H_i$* | 0.224 | 0.219 | 0.191 | 0.204 | 0.199 | 0.203 | 0.210 | 0.229 | 0.222 |
| | $I_i$ | 0.395 | 0.463 | 0.414 | 0.410 | 0.419 | 0.401 | 0.400 | 0.427 | 0.370 |
| 9 | $c_i$ | 0.411 | 0.517 | 0.473 | 0.492 | 0.469 | 0.471 | 0.483 | 0.533 | 0.400 |
| | $G_i$ | 0.171 | 0.199 | 0.189 | 0.175 | 0.191 | 0.185 | 0.189 | 0.181 | 0.148 |
| | $G_i$* | 0.202 | 0.220 | 0.221 | 0.213 | 0.220 | 0.210 | 0.211 | 0.200 | 0.184 |
| | $H_i$ | 0.271 | 0.376 | 0.334 | 0.346 | 0.340 | 0.341 | 0.349 | 0.363 | 0.240 |
| | $H_i$* | 0.187 | 0.226 | 0.198 | 0.190 | 0.205 | 0.221 | 0.211 | 0.217 | 0.162 |
| | $I_i$ | 0.341 | 0.393 | 0.377 | 0.357 | 0.361 | 0.370 | 0.375 | 0.372 | 0.304 |

Figure B.23 Empirical Power Based on Queen Pattern Variance-Covariance Matrix Using Queen Connectivity Case for a 9x9 Study Area

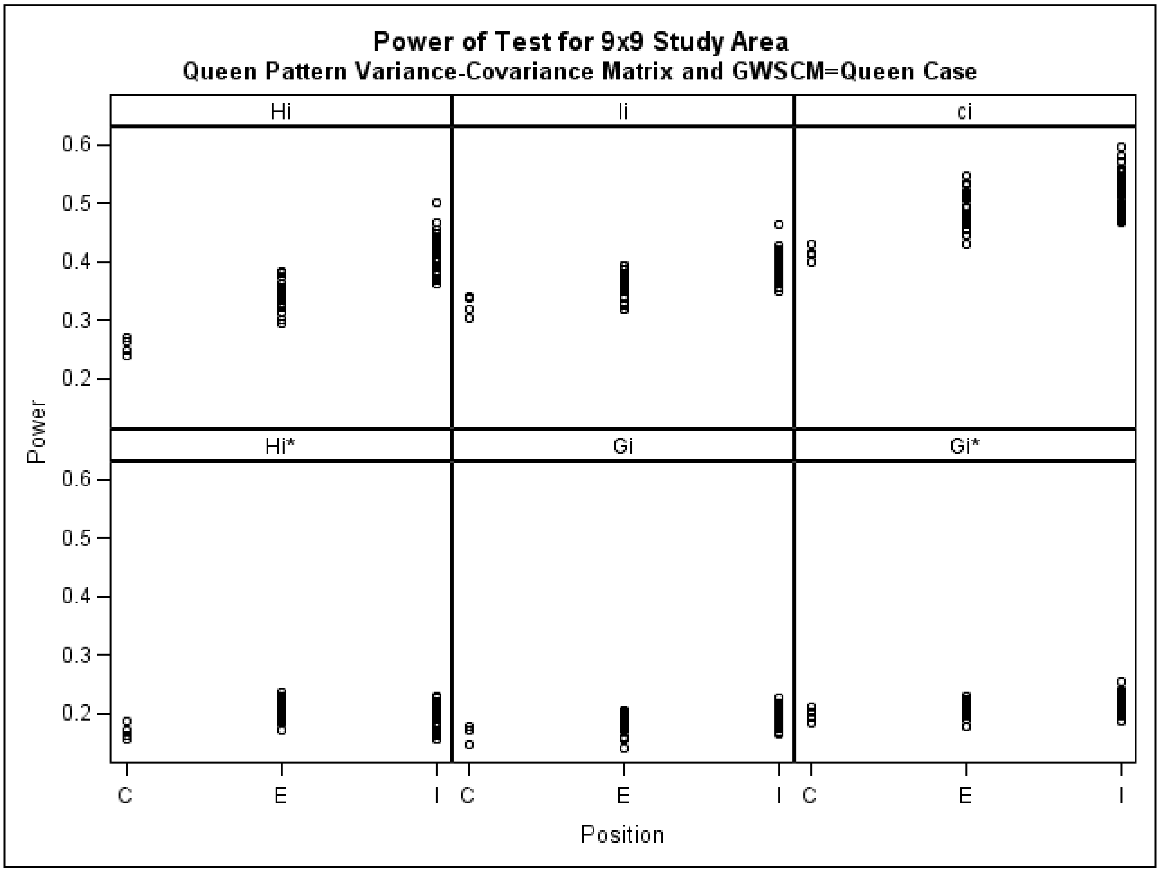


Table B.24 Empirical Power Based on Queen Pattern Variance-Covariance Matrix

Using CWF Connectivity Case for a 9x9 Study Area

| | | Column | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 1 | $c_i$ | 0.476 | 0.511 | 0.475 | 0.498 | 0.479 | 0.474 | 0.467 | 0.522 | 0.467 |
| | $G_i$ | 0.218 | 0.221 | 0.225 | 0.213 | 0.198 | 0.178 | 0.205 | 0.212 | 0.209 |
| | $G_i$* | 0.229 | 0.239 | 0.225 | 0.221 | 0.210 | 0.201 | 0.221 | 0.228 | 0.225 |
| | $H_i$ | 0.279 | 0.344 | 0.320 | 0.331 | 0.338 | 0.308 | 0.329 | 0.366 | 0.287 |
| | $H_i$* | 0.141 | 0.162 | 0.168 | 0.158 | 0.147 | 0.144 | 0.156 | 0.168 | 0.159 |
| | $I_i$ | 0.367 | 0.388 | 0.386 | 0.383 | 0.385 | 0.367 | 0.380 | 0.419 | 0.386 |
| 2 | $c_i$ | 0.526 | 0.568 | 0.527 | 0.573 | 0.545 | 0.536 | 0.508 | 0.561 | 0.529 |
| | $G_i$ | 0.226 | 0.233 | 0.225 | 0.232 | 0.221 | 0.208 | 0.231 | 0.226 | 0.215 |
| | $G_i$* | 0.246 | 0.253 | 0.246 | 0.250 | 0.234 | 0.214 | 0.232 | 0.245 | 0.238 |
| | $H_i$ | 0.344 | 0.420 | 0.404 | 0.417 | 0.416 | 0.404 | 0.396 | 0.442 | 0.367 |
| | $H_i$* | 0.154 | 0.184 | 0.197 | 0.176 | 0.167 | 0.165 | 0.177 | 0.173 | 0.186 |
| | $I_i$ | 0.411 | 0.439 | 0.430 | 0.448 | 0.441 | 0.422 | 0.440 | 0.446 | 0.416 |
| 3 | $c_i$ | 0.470 | 0.527 | 0.513 | 0.533 | 0.536 | 0.521 | 0.479 | 0.513 | 0.500 |
| | $G_i$ | 0.224 | 0.230 | 0.221 | 0.228 | 0.247 | 0.237 | 0.235 | 0.249 | 0.238 |
| | $G_i$* | 0.242 | 0.242 | 0.242 | 0.246 | 0.251 | 0.251 | 0.243 | 0.263 | 0.250 |
| | $H_i$ | 0.336 | 0.392 | 0.381 | 0.420 | 0.430 | 0.417 | 0.395 | 0.419 | 0.360 |
| | $H_i$* | 0.156 | 0.173 | 0.152 | 0.153 | 0.158 | 0.178 | 0.187 | 0.166 | 0.166 |
| | $I_i$ | 0.391 | 0.423 | 0.423 | 0.453 | 0.461 | 0.461 | 0.434 | 0.455 | 0.427 |
| 4 | $c_i$ | 0.489 | 0.537 | 0.490 | 0.519 | 0.528 | 0.554 | 0.512 | 0.514 | 0.491 |
| | $G_i$ | 0.231 | 0.225 | 0.231 | 0.240 | 0.225 | 0.238 | 0.242 | 0.234 | 0.225 |
| | $G_i$* | 0.231 | 0.244 | 0.248 | 0.253 | 0.243 | 0.261 | 0.266 | 0.252 | 0.243 |
| | $H_i$ | 0.338 | 0.406 | 0.400 | 0.419 | 0.422 | 0.436 | 0.411 | 0.406 | 0.351 |
| | $H_i$* | 0.148 | 0.174 | 0.160 | 0.166 | 0.146 | 0.128 | 0.176 | 0.171 | 0.158 |
| | $I_i$ | 0.409 | 0.427 | 0.422 | 0.452 | 0.444 | 0.456 | 0.454 | 0.441 | 0.413 |
| 5 | $c_i$ | 0.492 | 0.528 | 0.508 | 0.485 | 0.513 | 0.533 | 0.514 | 0.516 | 0.505 |
| | $G_i$ | 0.226 | 0.233 | 0.232 | 0.224 | 0.221 | 0.244 | 0.239 | 0.241 | 0.235 |
| | $G_i$* | 0.232 | 0.257 | 0.241 | 0.248 | 0.242 | 0.267 | 0.265 | 0.263 | 0.251 |
| | $H_i$ | 0.372 | 0.437 | 0.380 | 0.404 | 0.407 | 0.436 | 0.407 | 0.416 | 0.356 |
| | $H_i$* | 0.140 | 0.185 | 0.148 | 0.154 | 0.156 | 0.138 | 0.167 | 0.185 | 0.157 |
| | $I_i$ | 0.414 | 0.455 | 0.412 | 0.427 | 0.429 | 0.473 | 0.444 | 0.440 | 0.421 |
| 6 | $c_i$ | 0.490 | 0.540 | 0.512 | 0.488 | 0.477 | 0.509 | 0.503 | 0.551 | 0.495 |
| | $G_i$ | 0.226 | 0.230 | 0.232 | 0.215 | 0.232 | 0.226 | 0.231 | 0.219 | 0.211 |
| | $G_i$* | 0.250 | 0.246 | 0.246 | 0.227 | 0.241 | 0.245 | 0.247 | 0.247 | 0.234 |
| | $H_i$ | 0.374 | 0.422 | 0.388 | 0.384 | 0.389 | 0.404 | 0.427 | 0.422 | 0.359 |
| | $H_i$* | 0.154 | 0.156 | 0.144 | 0.144 | 0.150 | 0.153 | 0.178 | 0.167 | 0.174 |
| | $I_i$ | 0.403 | 0.447 | 0.423 | 0.408 | 0.423 | 0.439 | 0.449 | 0.450 | 0.424 |
| 7 | $c_i$ | 0.470 | 0.523 | 0.494 | 0.496 | 0.504 | 0.506 | 0.482 | 0.539 | 0.492 |
| | $G_i$ | 0.232 | 0.260 | 0.239 | 0.215 | 0.220 | 0.224 | 0.216 | 0.215 | 0.208 |
| | $G_i$* | 0.246 | 0.267 | 0.251 | 0.234 | 0.247 | 0.237 | 0.228 | 0.236 | 0.230 |

| | | Column | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| | $H_i$ | 0.361 | 0.456 | 0.397 | 0.387 | 0.404 | 0.426 | 0.379 | 0.417 | 0.360 |
| | $H_i$* | 0.173 | 0.211 | 0.163 | 0.172 | 0.169 | 0.181 | 0.149 | 0.170 | 0.181 |
| | $I_i$ | 0.424 | 0.482 | 0.445 | 0.416 | 0.435 | 0.446 | 0.422 | 0.441 | 0.420 |
| 8 | $c_i$ | 0.532 | 0.567 | 0.538 | 0.550 | 0.549 | 0.549 | 0.540 | 0.587 | 0.515 |
| | $G_i$ | 0.235 | 0.252 | 0.236 | 0.224 | 0.235 | 0.228 | 0.225 | 0.214 | 0.209 |
| | $G_i$* | 0.243 | 0.274 | 0.257 | 0.251 | 0.249 | 0.245 | 0.239 | 0.235 | 0.222 |
| | $H_i$ | 0.369 | 0.468 | 0.410 | 0.434 | 0.420 | 0.439 | 0.424 | 0.433 | 0.343 |
| | $H_i$* | 0.163 | 0.190 | 0.162 | 0.171 | 0.152 | 0.173 | 0.181 | 0.193 | 0.185 |
| | $I_i$ | 0.444 | 0.497 | 0.440 | 0.451 | 0.452 | 0.453 | 0.454 | 0.454 | 0.414 |
| 9 | $c_i$ | 0.455 | 0.515 | 0.484 | 0.490 | 0.500 | 0.503 | 0.518 | 0.544 | 0.458 |
| | $G_i$ | 0.234 | 0.229 | 0.232 | 0.216 | 0.227 | 0.227 | 0.218 | 0.218 | 0.195 |
| | $G_i$* | 0.226 | 0.248 | 0.242 | 0.233 | 0.239 | 0.235 | 0.231 | 0.227 | 0.204 |
| | $H_i$ | 0.287 | 0.367 | 0.356 | 0.371 | 0.357 | 0.367 | 0.366 | 0.370 | 0.269 |
| | $H_i$* | 0.145 | 0.159 | 0.176 | 0.177 | 0.177 | 0.182 | 0.176 | 0.186 | 0.140 |
| | $I_i$ | 0.406 | 0.449 | 0.430 | 0.409 | 0.414 | 0.437 | 0.423 | 0.430 | 0.354 |

Figure B.24 Empirical Power Based on Queen Pattern Variance-Covariance Matrix Using CWF Connectivity Case for a 9x9 Study Area

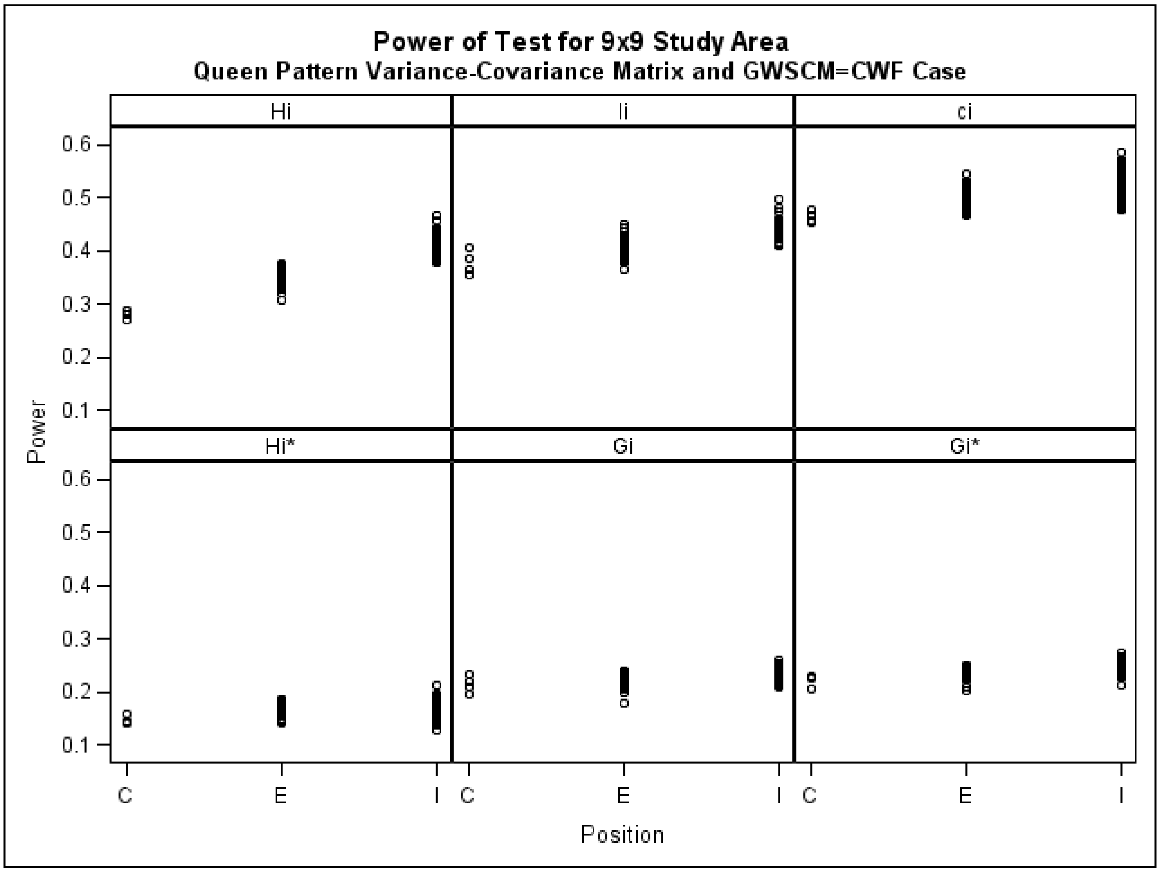


Table B.25 Empirical Power Based on Hot-Spot Pattern Variance-Covariance Matrix

Using Rook Connectivity Case for a 9x9 Study Area

| | | Column | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 1 | $c_i$ | 0.069 | 0.085 | 0.077 | 0.062 | 0.050 | 0.089 | 0.085 | 0.078 | 0.072 |
| | $G_i$ | 0.066 | 0.073 | 0.075 | 0.064 | 0.058 | 0.076 | 0.082 | 0.071 | 0.068 |
| | $G_i$* | 0.078 | 0.087 | 0.078 | 0.064 | 0.067 | 0.079 | 0.077 | 0.083 | 0.068 |
| | $H_i$ | 0.062 | 0.071 | 0.070 | 0.069 | 0.048 | 0.078 | 0.082 | 0.057 | 0.051 |
| | $H_i$* | 0.053 | 0.062 | 0.063 | 0.055 | 0.043 | 0.065 | 0.053 | 0.042 | 0.048 |
| | $I_i$ | 0.081 | 0.086 | 0.087 | 0.076 | 0.057 | 0.098 | 0.089 | 0.078 | 0.070 |
| 2 | $c_i$ | 0.070 | 0.085 | 0.040 | 0.041 | 0.029 | 0.027 | 0.041 | 0.102 | 0.078 |
| | $G_i$ | 0.077 | 0.085 | 0.040 | 0.038 | 0.038 | 0.046 | 0.037 | 0.086 | 0.065 |
| | $G_i$* | 0.084 | 0.085 | 0.035 | 0.047 | 0.035 | 0.038 | 0.053 | 0.091 | 0.070 |
| | $H_i$ | 0.064 | 0.072 | 0.051 | 0.049 | 0.035 | 0.037 | 0.057 | 0.077 | 0.072 |
| | $H_i$* | 0.056 | 0.061 | 0.040 | 0.039 | 0.039 | 0.042 | 0.043 | 0.058 | 0.054 |
| | $I_i$ | 0.074 | 0.088 | 0.051 | 0.043 | 0.039 | 0.039 | 0.045 | 0.109 | 0.083 |
| 3 | $c_i$ | 0.073 | 0.035 | 0.070 | 0.203 | 0.200 | 0.194 | 0.065 | 0.032 | 0.083 |
| | $G_i$ | 0.078 | 0.052 | 0.027 | 0.074 | 0.089 | 0.076 | 0.032 | 0.031 | 0.065 |
| | $G_i$* | 0.081 | 0.045 | 0.038 | 0.106 | 0.126 | 0.114 | 0.049 | 0.039 | 0.067 |
| | $H_i$ | 0.062 | 0.050 | 0.059 | 0.148 | 0.142 | 0.119 | 0.051 | 0.046 | 0.075 |
| | $H_i$* | 0.049 | 0.043 | 0.087 | 0.154 | 0.142 | 0.126 | 0.067 | 0.046 | 0.061 |
| | $I_i$ | 0.086 | 0.042 | 0.048 | 0.123 | 0.140 | 0.121 | 0.046 | 0.034 | 0.080 |
| 4 | $c_i$ | 0.066 | 0.027 | 0.181 | 0.560 | 0.538 | 0.556 | 0.187 | 0.041 | 0.075 |
| | $G_i$ | 0.077 | 0.042 | 0.076 | 0.173 | 0.156 | 0.163 | 0.060 | 0.031 | 0.076 |
| | $G_i$* | 0.079 | 0.038 | 0.114 | 0.201 | 0.187 | 0.191 | 0.098 | 0.042 | 0.076 |
| | $H_i$ | 0.063 | 0.049 | 0.133 | 0.270 | 0.267 | 0.251 | 0.117 | 0.045 | 0.066 |
| | $H_i$* | 0.054 | 0.052 | 0.125 | 0.251 | 0.250 | 0.241 | 0.131 | 0.047 | 0.056 |
| | $I_i$ | 0.083 | 0.045 | 0.132 | 0.301 | 0.293 | 0.290 | 0.105 | 0.045 | 0.088 |
| 5 | $c_i$ | 0.078 | 0.031 | 0.181 | 0.549 | 0.548 | 0.541 | 0.209 | 0.034 | 0.076 |
| | $G_i$ | 0.072 | 0.042 | 0.068 | 0.162 | 0.173 | 0.169 | 0.069 | 0.038 | 0.076 |
| | $G_i$* | 0.085 | 0.052 | 0.096 | 0.191 | 0.197 | 0.191 | 0.105 | 0.040 | 0.083 |
| | $H_i$ | 0.069 | 0.049 | 0.124 | 0.250 | 0.246 | 0.268 | 0.137 | 0.047 | 0.074 |
| | $H_i$* | 0.062 | 0.036 | 0.128 | 0.236 | 0.237 | 0.246 | 0.130 | 0.047 | 0.060 |
| | $I_i$ | 0.082 | 0.051 | 0.124 | 0.307 | 0.287 | 0.310 | 0.124 | 0.031 | 0.096 |
| 6 | $c_i$ | 0.085 | 0.021 | 0.210 | 0.552 | 0.565 | 0.547 | 0.204 | 0.048 | 0.075 |
| | $G_i$ | 0.084 | 0.054 | 0.061 | 0.174 | 0.168 | 0.158 | 0.072 | 0.039 | 0.079 |
| | $G_i$* | 0.080 | 0.053 | 0.104 | 0.203 | 0.207 | 0.198 | 0.105 | 0.052 | 0.083 |
| | $H_i$ | 0.073 | 0.039 | 0.126 | 0.263 | 0.261 | 0.260 | 0.142 | 0.054 | 0.064 |
| | $H_i$* | 0.052 | 0.036 | 0.134 | 0.256 | 0.241 | 0.239 | 0.141 | 0.047 | 0.052 |
| | $I_i$ | 0.095 | 0.041 | 0.124 | 0.303 | 0.311 | 0.293 | 0.125 | 0.049 | 0.089 |
| 7 | $c_i$ | 0.081 | 0.034 | 0.072 | 0.182 | 0.200 | 0.217 | 0.066 | 0.037 | 0.092 |
| | $G_i$ | 0.075 | 0.043 | 0.040 | 0.063 | 0.074 | 0.084 | 0.033 | 0.045 | 0.068 |
| | $G_i$* | 0.093 | 0.038 | 0.043 | 0.100 | 0.111 | 0.120 | 0.047 | 0.059 | 0.077 |

| | | Column | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| | $H_i$ | 0.069 | 0.046 | 0.057 | 0.139 | 0.153 | 0.157 | 0.058 | 0.046 | 0.053 |
| | $H_i$* | 0.061 | 0.041 | 0.058 | 0.132 | 0.160 | 0.150 | 0.065 | 0.038 | 0.047 |
| | $I_i$ | 0.090 | 0.040 | 0.056 | 0.117 | 0.125 | 0.149 | 0.056 | 0.056 | 0.088 |
| 8 | $c_i$ | 0.081 | 0.071 | 0.039 | 0.039 | 0.037 | 0.032 | 0.038 | 0.074 | 0.068 |
| | $G_i$ | 0.074 | 0.072 | 0.037 | 0.049 | 0.049 | 0.044 | 0.035 | 0.088 | 0.070 |
| | $G_i$* | 0.078 | 0.085 | 0.043 | 0.052 | 0.052 | 0.057 | 0.052 | 0.095 | 0.082 |
| | $H_i$ | 0.077 | 0.070 | 0.051 | 0.038 | 0.053 | 0.047 | 0.047 | 0.064 | 0.058 |
| | $H_i$* | 0.058 | 0.055 | 0.040 | 0.034 | 0.050 | 0.034 | 0.042 | 0.060 | 0.053 |
| | $I_i$ | 0.092 | 0.097 | 0.038 | 0.057 | 0.046 | 0.049 | 0.044 | 0.099 | 0.084 |
| 9 | $c_i$ | 0.070 | 0.069 | 0.073 | 0.065 | 0.076 | 0.079 | 0.087 | 0.081 | 0.060 |
| | $G_i$ | 0.073 | 0.074 | 0.072 | 0.058 | 0.083 | 0.082 | 0.078 | 0.085 | 0.069 |
| | $G_i$* | 0.082 | 0.065 | 0.075 | 0.064 | 0.072 | 0.097 | 0.087 | 0.079 | 0.068 |
| | $H_i$ | 0.060 | 0.062 | 0.058 | 0.060 | 0.071 | 0.061 | 0.081 | 0.069 | 0.055 |
| | $H_i$* | 0.056 | 0.053 | 0.046 | 0.052 | 0.064 | 0.048 | 0.070 | 0.050 | 0.052 |
| | $I_i$ | 0.076 | 0.075 | 0.090 | 0.086 | 0.079 | 0.090 | 0.110 | 0.086 | 0.088 |

Figure B.25 Empirical Power Based on Hot-Spot Pattern Variance-Covariance Matrix Using Rook Connectivity Case for a 9x9 Study Area

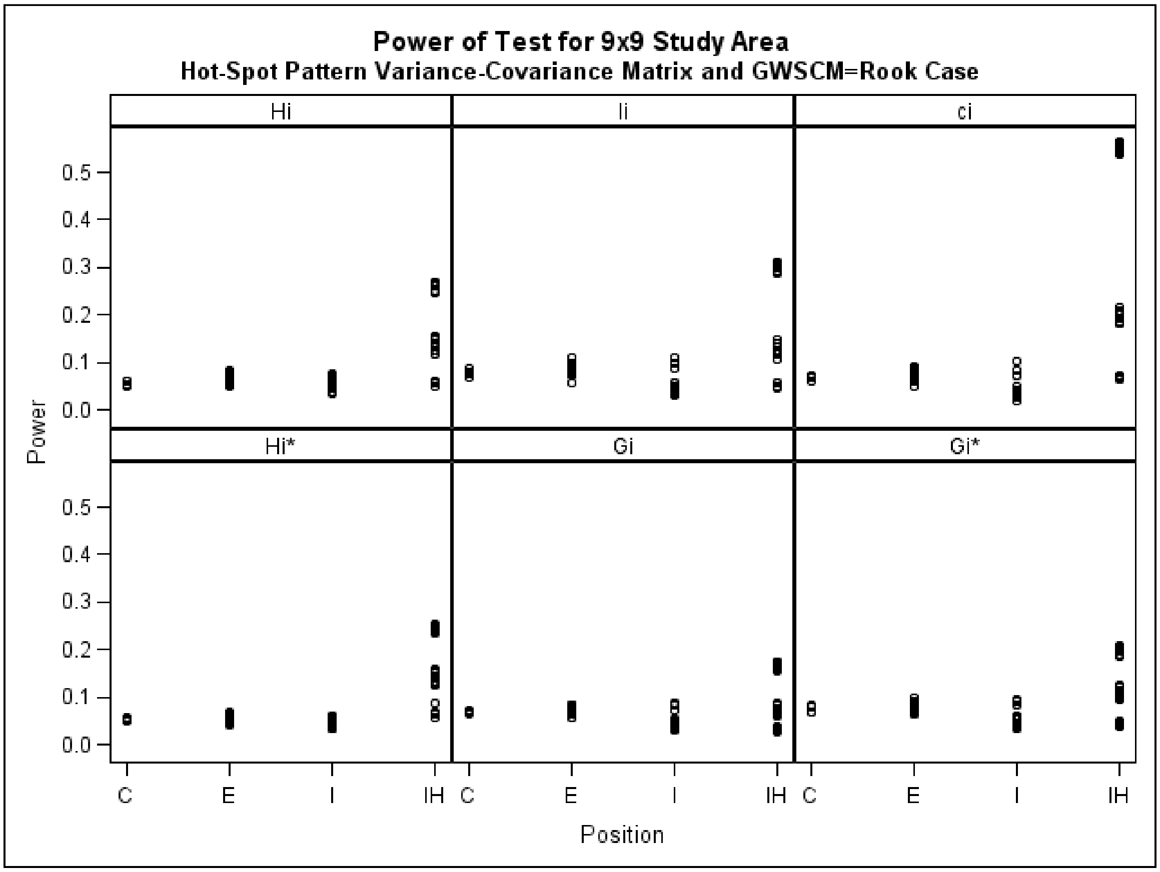


Table B.26 Empirical Power Based on Hot-Spot Pattern Variance-Covariance Matrix Using Queen Connectivity Case for a 9x9 Study Area

| | | Column | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 1 | $c_i$ | 0.086 | 0.089 | 0.097 | 0.079 | 0.074 | 0.097 | 0.101 | 0.098 | 0.077 |
| | $G_i$ | 0.072 | 0.083 | 0.074 | 0.069 | 0.085 | 0.085 | 0.089 | 0.076 | 0.074 |
| | $G_i$* | 0.083 | 0.097 | 0.079 | 0.082 | 0.087 | 0.087 | 0.098 | 0.088 | 0.083 |
| | $H_i$ | 0.064 | 0.078 | 0.084 | 0.068 | 0.074 | 0.084 | 0.084 | 0.074 | 0.054 |
| | $H_i$* | 0.055 | 0.069 | 0.066 | 0.055 | 0.059 | 0.069 | 0.064 | 0.050 | 0.043 |
| | $I_i$ | 0.088 | 0.099 | 0.101 | 0.086 | 0.089 | 0.098 | 0.107 | 0.092 | 0.082 |
| 2 | $c_i$ | 0.086 | 0.058 | 0.044 | 0.035 | 0.028 | 0.036 | 0.041 | 0.075 | 0.104 |
| | $G_i$ | 0.087 | 0.063 | 0.041 | 0.033 | 0.039 | 0.039 | 0.046 | 0.058 | 0.079 |
| | $G_i$* | 0.086 | 0.066 | 0.050 | 0.037 | 0.033 | 0.040 | 0.051 | 0.068 | 0.084 |
| | $H_i$ | 0.086 | 0.062 | 0.044 | 0.037 | 0.037 | 0.036 | 0.046 | 0.073 | 0.077 |
| | $H_i$* | 0.066 | 0.052 | 0.029 | 0.039 | 0.042 | 0.039 | 0.044 | 0.059 | 0.061 |
| | $I_i$ | 0.108 | 0.081 | 0.053 | 0.029 | 0.032 | 0.035 | 0.043 | 0.075 | 0.107 |
| 3 | $c_i$ | 0.085 | 0.033 | 0.052 | 0.234 | 0.224 | 0.233 | 0.047 | 0.038 | 0.099 |
| | $G_i$ | 0.076 | 0.034 | 0.038 | 0.088 | 0.103 | 0.097 | 0.030 | 0.038 | 0.088 |
| | $G_i$* | 0.088 | 0.039 | 0.040 | 0.127 | 0.133 | 0.125 | 0.032 | 0.031 | 0.084 |
| | $H_i$ | 0.082 | 0.043 | 0.063 | 0.163 | 0.162 | 0.164 | 0.045 | 0.053 | 0.072 |
| | $H_i$* | 0.057 | 0.042 | 0.066 | 0.137 | 0.123 | 0.135 | 0.062 | 0.042 | 0.061 |
| | $I_i$ | 0.087 | 0.039 | 0.046 | 0.157 | 0.173 | 0.159 | 0.040 | 0.039 | 0.095 |
| 4 | $c_i$ | 0.081 | 0.030 | 0.195 | 0.854 | 0.865 | 0.867 | 0.195 | 0.046 | 0.089 |
| | $G_i$ | 0.083 | 0.039 | 0.085 | 0.262 | 0.256 | 0.266 | 0.087 | 0.030 | 0.083 |
| | $G_i$* | 0.088 | 0.031 | 0.122 | 0.274 | 0.267 | 0.266 | 0.117 | 0.027 | 0.089 |
| | $H_i$ | 0.068 | 0.039 | 0.149 | 0.398 | 0.370 | 0.359 | 0.151 | 0.034 | 0.099 |
| | $H_i$* | 0.062 | 0.042 | 0.122 | 0.354 | 0.338 | 0.307 | 0.117 | 0.038 | 0.072 |
| | $I_i$ | 0.098 | 0.032 | 0.146 | 0.482 | 0.475 | 0.484 | 0.146 | 0.032 | 0.107 |
| 5 | $c_i$ | 0.088 | 0.025 | 0.196 | 0.859 | 0.854 | 0.866 | 0.204 | 0.029 | 0.089 |
| | $G_i$ | 0.081 | 0.033 | 0.088 | 0.255 | 0.257 | 0.265 | 0.094 | 0.025 | 0.080 |
| | $G_i$* | 0.098 | 0.039 | 0.122 | 0.271 | 0.277 | 0.280 | 0.119 | 0.036 | 0.090 |
| | $H_i$ | 0.081 | 0.034 | 0.153 | 0.402 | 0.374 | 0.378 | 0.153 | 0.027 | 0.070 |
| | $H_i$* | 0.057 | 0.030 | 0.124 | 0.342 | 0.301 | 0.334 | 0.124 | 0.026 | 0.063 |
| | $I_i$ | 0.103 | 0.028 | 0.162 | 0.471 | 0.472 | 0.482 | 0.156 | 0.026 | 0.095 |
| 6 | $c_i$ | 0.114 | 0.033 | 0.212 | 0.888 | 0.878 | 0.881 | 0.215 | 0.037 | 0.086 |
| | $G_i$ | 0.091 | 0.033 | 0.079 | 0.265 | 0.256 | 0.265 | 0.095 | 0.032 | 0.095 |
| | $G_i$* | 0.106 | 0.026 | 0.109 | 0.273 | 0.277 | 0.274 | 0.120 | 0.037 | 0.096 |
| | $H_i$ | 0.094 | 0.038 | 0.138 | 0.408 | 0.391 | 0.401 | 0.150 | 0.050 | 0.081 |
| | $H_i$* | 0.071 | 0.039 | 0.124 | 0.362 | 0.334 | 0.322 | 0.120 | 0.059 | 0.051 |
| | $I_i$ | 0.117 | 0.029 | 0.143 | 0.486 | 0.483 | 0.488 | 0.162 | 0.032 | 0.109 |
| 7 | $c_i$ | 0.103 | 0.049 | 0.053 | 0.225 | 0.233 | 0.211 | 0.057 | 0.035 | 0.099 |
| | $G_i$ | 0.075 | 0.040 | 0.032 | 0.085 | 0.108 | 0.100 | 0.049 | 0.036 | 0.083 |
| | $G_i$* | 0.086 | 0.038 | 0.031 | 0.122 | 0.133 | 0.128 | 0.054 | 0.042 | 0.095 |

| | | Column | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| | $H_i$ | 0.081 | 0.047 | 0.049 | 0.158 | 0.189 | 0.162 | 0.062 | 0.046 | 0.081 |
| | $H_i$* | 0.065 | 0.052 | 0.067 | 0.124 | 0.135 | 0.120 | 0.072 | 0.042 | 0.066 |
| | $I_i$ | 0.109 | 0.033 | 0.041 | 0.158 | 0.180 | 0.172 | 0.064 | 0.051 | 0.108 |
| 8 | $c_i$ | 0.091 | 0.056 | 0.051 | 0.032 | 0.029 | 0.042 | 0.030 | 0.053 | 0.087 |
| | $G_i$ | 0.098 | 0.059 | 0.044 | 0.037 | 0.037 | 0.031 | 0.031 | 0.066 | 0.099 |
| | $G_i$* | 0.095 | 0.064 | 0.045 | 0.036 | 0.028 | 0.036 | 0.045 | 0.068 | 0.097 |
| | $H_i$ | 0.095 | 0.058 | 0.044 | 0.035 | 0.039 | 0.045 | 0.053 | 0.080 | 0.082 |
| | $H_i$* | 0.063 | 0.056 | 0.040 | 0.040 | 0.037 | 0.045 | 0.047 | 0.073 | 0.056 |
| | $I_i$ | 0.123 | 0.075 | 0.051 | 0.030 | 0.035 | 0.037 | 0.048 | 0.083 | 0.120 |
| 9 | $c_i$ | 0.077 | 0.097 | 0.092 | 0.098 | 0.079 | 0.092 | 0.095 | 0.085 | 0.070 |
| | $G_i$ | 0.068 | 0.092 | 0.085 | 0.082 | 0.092 | 0.095 | 0.082 | 0.085 | 0.079 |
| | $G_i$* | 0.080 | 0.085 | 0.081 | 0.094 | 0.095 | 0.106 | 0.089 | 0.088 | 0.079 |
| | $H_i$ | 0.067 | 0.061 | 0.091 | 0.074 | 0.075 | 0.082 | 0.084 | 0.066 | 0.062 |
| | $H_i$* | 0.067 | 0.038 | 0.069 | 0.052 | 0.050 | 0.067 | 0.071 | 0.044 | 0.048 |
| | $I_i$ | 0.084 | 0.085 | 0.113 | 0.113 | 0.107 | 0.111 | 0.111 | 0.101 | 0.094 |

Figure B.26 Empirical Power Based on Hot-Spot Pattern Variance-Covariance Matrix Using Queen Connectivity Case for a 9x9 Study Area

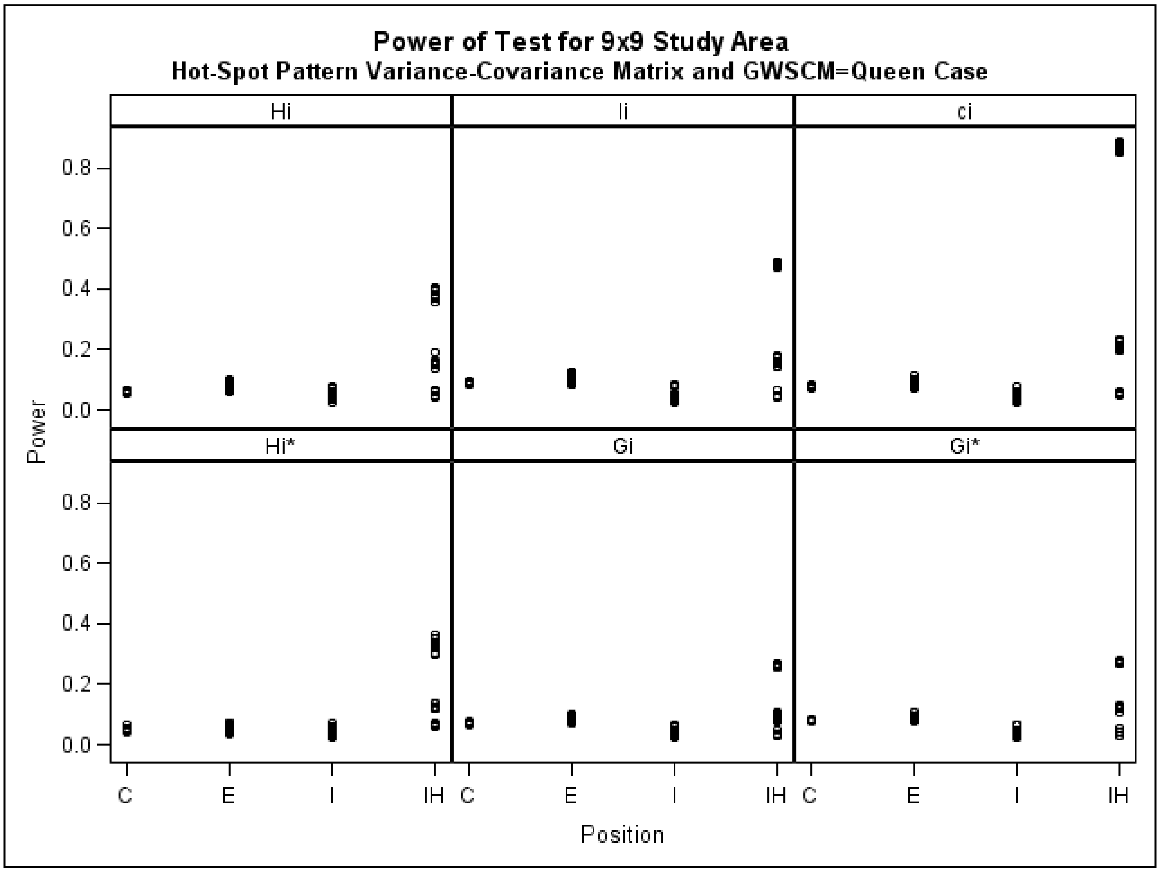


Table B.27 Empirical Power Based on Hot-Spot Pattern Variance-Covariance Matrix Using CWF Connectivity Case for a 9x9 Study Area

| | | Column | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 1 | $c_i$ | 0.090 | 0.095 | 0.074 | 0.066 | 0.055 | 0.057 | 0.084 | 0.099 | 0.094 |
| | $G_i$ | 0.081 | 0.084 | 0.074 | 0.060 | 0.057 | 0.066 | 0.083 | 0.086 | 0.086 |
| | $G_i$* | 0.092 | 0.082 | 0.081 | 0.072 | 0.059 | 0.078 | 0.087 | 0.089 | 0.090 |
| | $H_i$ | 0.078 | 0.089 | 0.079 | 0.063 | 0.060 | 0.075 | 0.080 | 0.091 | 0.074 |
| | $H_i$* | 0.067 | 0.065 | 0.058 | 0.056 | 0.059 | 0.054 | 0.061 | 0.067 | 0.064 |
| | $I_i$ | 0.108 | 0.106 | 0.094 | 0.072 | 0.053 | 0.072 | 0.089 | 0.099 | 0.105 |
| 2 | $c_i$ | 0.085 | 0.062 | 0.051 | 0.054 | 0.051 | 0.054 | 0.049 | 0.064 | 0.105 |
| | $G_i$ | 0.081 | 0.060 | 0.039 | 0.046 | 0.054 | 0.047 | 0.039 | 0.059 | 0.079 |
| | $G_i$* | 0.092 | 0.073 | 0.043 | 0.040 | 0.041 | 0.045 | 0.038 | 0.071 | 0.092 |
| | $H_i$ | 0.090 | 0.067 | 0.049 | 0.040 | 0.042 | 0.046 | 0.043 | 0.075 | 0.090 |
| | $H_i$* | 0.054 | 0.055 | 0.049 | 0.035 | 0.043 | 0.037 | 0.038 | 0.060 | 0.070 |
| | $I_i$ | 0.106 | 0.077 | 0.048 | 0.037 | 0.042 | 0.041 | 0.041 | 0.083 | 0.108 |
| 3 | $c_i$ | 0.064 | 0.040 | 0.104 | 0.343 | 0.457 | 0.327 | 0.077 | 0.039 | 0.073 |
| | $G_i$ | 0.079 | 0.040 | 0.039 | 0.143 | 0.195 | 0.150 | 0.034 | 0.034 | 0.083 |
| | $G_i$* | 0.072 | 0.038 | 0.054 | 0.172 | 0.209 | 0.182 | 0.056 | 0.031 | 0.079 |
| | $H_i$ | 0.082 | 0.047 | 0.055 | 0.260 | 0.339 | 0.252 | 0.061 | 0.037 | 0.088 |
| | $H_i$* | 0.051 | 0.050 | 0.061 | 0.150 | 0.177 | 0.124 | 0.058 | 0.029 | 0.065 |
| | $I_i$ | 0.094 | 0.036 | 0.056 | 0.258 | 0.352 | 0.258 | 0.054 | 0.040 | 0.098 |
| 4 | $c_i$ | 0.050 | 0.048 | 0.279 | 0.831 | 0.925 | 0.840 | 0.290 | 0.050 | 0.059 |
| | $G_i$ | 0.064 | 0.052 | 0.160 | 0.298 | 0.322 | 0.285 | 0.149 | 0.032 | 0.060 |
| | $G_i$* | 0.072 | 0.041 | 0.188 | 0.303 | 0.314 | 0.287 | 0.175 | 0.032 | 0.067 |
| | $H_i$ | 0.051 | 0.044 | 0.261 | 0.488 | 0.511 | 0.477 | 0.240 | 0.044 | 0.069 |
| | $H_i$* | 0.042 | 0.037 | 0.129 | 0.349 | 0.428 | 0.365 | 0.127 | 0.049 | 0.066 |
| | $I_i$ | 0.071 | 0.042 | 0.270 | 0.542 | 0.584 | 0.524 | 0.249 | 0.033 | 0.070 |
| 5 | $c_i$ | 0.062 | 0.059 | 0.419 | 0.933 | 0.967 | 0.930 | 0.452 | 0.061 | 0.057 |
| | $G_i$ | 0.064 | 0.049 | 0.201 | 0.326 | 0.351 | 0.313 | 0.194 | 0.045 | 0.061 |
| | $G_i$* | 0.076 | 0.054 | 0.220 | 0.334 | 0.343 | 0.315 | 0.208 | 0.042 | 0.067 |
| | $H_i$ | 0.069 | 0.042 | 0.324 | 0.525 | 0.524 | 0.514 | 0.332 | 0.039 | 0.065 |
| | $H_i$* | 0.053 | 0.043 | 0.161 | 0.408 | 0.449 | 0.412 | 0.155 | 0.037 | 0.059 |
| | $I_i$ | 0.072 | 0.035 | 0.343 | 0.586 | 0.624 | 0.577 | 0.349 | 0.044 | 0.069 |
| 6 | $c_i$ | 0.072 | 0.043 | 0.315 | 0.843 | 0.943 | 0.830 | 0.317 | 0.050 | 0.063 |
| | $G_i$ | 0.078 | 0.049 | 0.127 | 0.298 | 0.322 | 0.294 | 0.141 | 0.045 | 0.064 |
| | $G_i$* | 0.086 | 0.040 | 0.165 | 0.299 | 0.327 | 0.299 | 0.180 | 0.046 | 0.069 |
| | $H_i$ | 0.075 | 0.034 | 0.241 | 0.499 | 0.531 | 0.492 | 0.242 | 0.051 | 0.066 |
| | $H_i$* | 0.048 | 0.042 | 0.122 | 0.334 | 0.400 | 0.302 | 0.135 | 0.060 | 0.057 |
| | $I_i$ | 0.090 | 0.033 | 0.244 | 0.545 | 0.594 | 0.549 | 0.255 | 0.043 | 0.078 |
| 7 | $c_i$ | 0.087 | 0.046 | 0.083 | 0.325 | 0.442 | 0.305 | 0.082 | 0.040 | 0.068 |
| | $G_i$ | 0.071 | 0.031 | 0.033 | 0.145 | 0.198 | 0.151 | 0.058 | 0.042 | 0.069 |
| | $G_i$* | 0.089 | 0.041 | 0.046 | 0.172 | 0.228 | 0.185 | 0.068 | 0.046 | 0.089 |

| | | Column | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| | $H_i$ | 0.083 | 0.035 | 0.058 | 0.253 | 0.355 | 0.248 | 0.082 | 0.055 | 0.074 |
| | $H_i$* | 0.068 | 0.041 | 0.066 | 0.127 | 0.184 | 0.126 | 0.075 | 0.056 | 0.058 |
| | $I_i$ | 0.093 | 0.031 | 0.054 | 0.258 | 0.358 | 0.264 | 0.081 | 0.050 | 0.094 |
| 8 | $c_i$ | 0.094 | 0.068 | 0.043 | 0.056 | 0.060 | 0.058 | 0.038 | 0.051 | 0.074 |
| | $G_i$ | 0.090 | 0.066 | 0.026 | 0.046 | 0.055 | 0.045 | 0.036 | 0.071 | 0.096 |
| | $G_i$* | 0.099 | 0.068 | 0.041 | 0.040 | 0.045 | 0.045 | 0.040 | 0.069 | 0.091 |
| | $H_i$ | 0.097 | 0.069 | 0.036 | 0.042 | 0.050 | 0.046 | 0.050 | 0.083 | 0.094 |
| | $H_i$* | 0.072 | 0.060 | 0.042 | 0.048 | 0.045 | 0.051 | 0.043 | 0.069 | 0.072 |
| | $I_i$ | 0.121 | 0.084 | 0.037 | 0.036 | 0.049 | 0.044 | 0.049 | 0.086 | 0.113 |
| 9 | $c_i$ | 0.090 | 0.102 | 0.077 | 0.064 | 0.056 | 0.052 | 0.068 | 0.097 | 0.086 |
| | $G_i$ | 0.082 | 0.085 | 0.069 | 0.059 | 0.076 | 0.070 | 0.069 | 0.098 | 0.094 |
| | $G_i$* | 0.094 | 0.088 | 0.075 | 0.064 | 0.072 | 0.080 | 0.086 | 0.094 | 0.088 |
| | $H_i$ | 0.084 | 0.068 | 0.089 | 0.075 | 0.083 | 0.076 | 0.100 | 0.094 | 0.097 |
| | $H_i$* | 0.060 | 0.048 | 0.081 | 0.053 | 0.059 | 0.066 | 0.077 | 0.067 | 0.070 |
| | $I_i$ | 0.100 | 0.080 | 0.088 | 0.080 | 0.084 | 0.087 | 0.102 | 0.121 | 0.113 |

Figure B.27 Empirical Power Based on Hot-Spot Pattern Variance-Covariance Matrix Using CWF Connectivity Case for a 9x9 Study Area

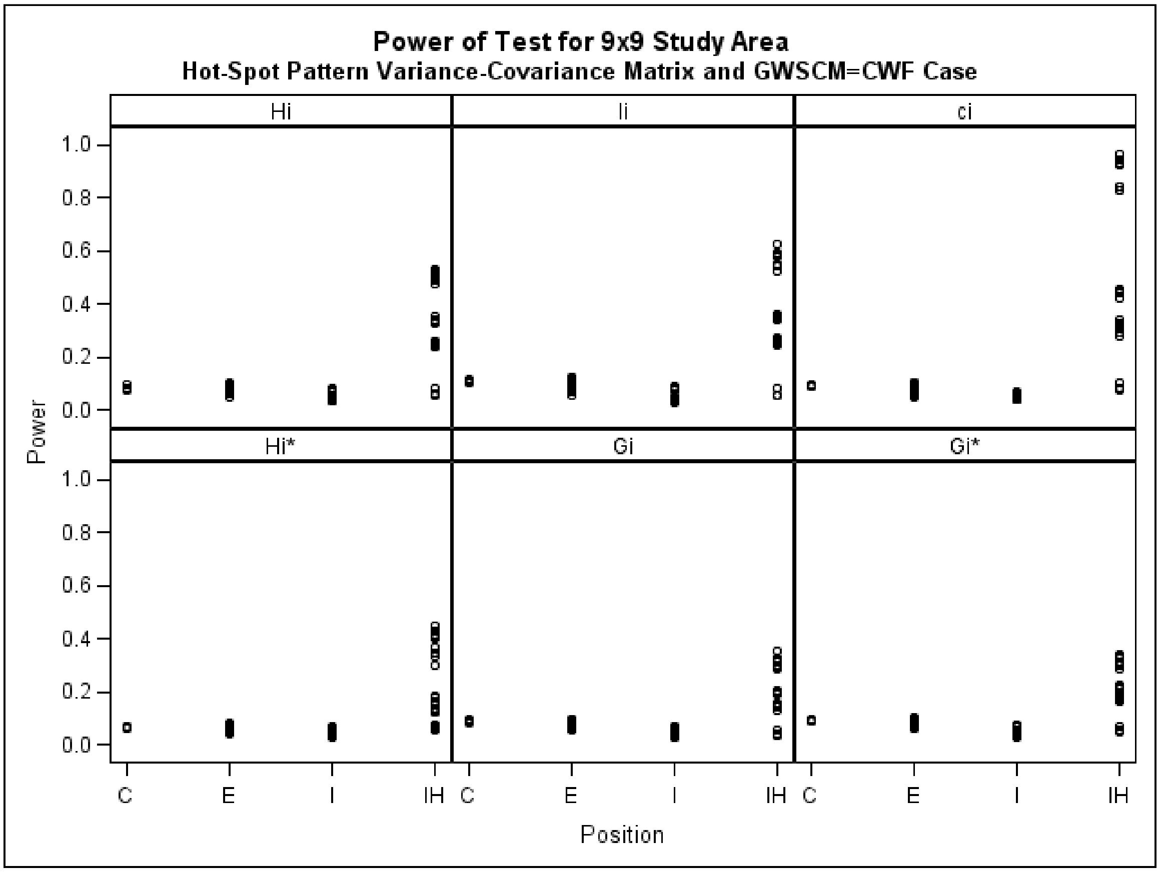


Table B.28 Empirical Power Based on CWF Pattern Variance-Covariance Matrix Using Rook Connectivity Case for a 9x9 Study Area

| | | Column | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 1 | $c_i$ | 0.260 | 0.335 | 0.309 | 0.319 | 0.296 | 0.317 | 0.328 | 0.343 | 0.236 |
| | $G_i$ | 0.118 | 0.133 | 0.126 | 0.114 | 0.106 | 0.099 | 0.114 | 0.127 | 0.103 |
| | $G_i$* | 0.163 | 0.185 | 0.168 | 0.157 | 0.144 | 0.137 | 0.169 | 0.174 | 0.156 |
| | $H_i$ | 0.231 | 0.288 | 0.280 | 0.309 | 0.268 | 0.273 | 0.281 | 0.285 | 0.210 |
| | $H_i$* | 0.175 | 0.210 | 0.208 | 0.205 | 0.176 | 0.177 | 0.194 | 0.184 | 0.139 |
| | $I_i$ | 0.204 | 0.242 | 0.229 | 0.225 | 0.228 | 0.218 | 0.239 | 0.248 | 0.201 |
| 2 | $c_i$ | 0.348 | 0.410 | 0.380 | 0.409 | 0.400 | 0.358 | 0.400 | 0.396 | 0.323 |
| | $G_i$ | 0.135 | 0.158 | 0.142 | 0.148 | 0.136 | 0.133 | 0.139 | 0.149 | 0.118 |
| | $G_i$* | 0.202 | 0.207 | 0.183 | 0.189 | 0.169 | 0.172 | 0.182 | 0.189 | 0.167 |
| | $H_i$ | 0.301 | 0.354 | 0.332 | 0.344 | 0.361 | 0.325 | 0.338 | 0.354 | 0.289 |
| | $H_i$* | 0.206 | 0.237 | 0.203 | 0.207 | 0.232 | 0.228 | 0.208 | 0.239 | 0.212 |
| | $I_i$ | 0.255 | 0.293 | 0.259 | 0.288 | 0.285 | 0.286 | 0.280 | 0.279 | 0.238 |
| 3 | $c_i$ | 0.318 | 0.385 | 0.384 | 0.401 | 0.410 | 0.391 | 0.393 | 0.384 | 0.324 |
| | $G_i$ | 0.139 | 0.149 | 0.141 | 0.141 | 0.144 | 0.138 | 0.148 | 0.140 | 0.107 |
| | $G_i$* | 0.192 | 0.184 | 0.190 | 0.188 | 0.193 | 0.193 | 0.191 | 0.191 | 0.156 |
| | $H_i$ | 0.295 | 0.348 | 0.335 | 0.339 | 0.363 | 0.340 | 0.360 | 0.362 | 0.299 |
| | $H_i$* | 0.211 | 0.226 | 0.211 | 0.231 | 0.216 | 0.219 | 0.234 | 0.238 | 0.212 |
| | $I_i$ | 0.248 | 0.270 | 0.257 | 0.279 | 0.289 | 0.273 | 0.281 | 0.282 | 0.224 |
| 4 | $c_i$ | 0.336 | 0.384 | 0.373 | 0.378 | 0.397 | 0.410 | 0.433 | 0.404 | 0.315 |
| | $G_i$ | 0.133 | 0.150 | 0.131 | 0.139 | 0.153 | 0.145 | 0.155 | 0.150 | 0.101 |
| | $G_i$* | 0.192 | 0.192 | 0.171 | 0.177 | 0.194 | 0.189 | 0.201 | 0.186 | 0.156 |
| | $H_i$ | 0.280 | 0.334 | 0.322 | 0.323 | 0.368 | 0.343 | 0.391 | 0.362 | 0.284 |
| | $H_i$* | 0.182 | 0.214 | 0.215 | 0.170 | 0.216 | 0.202 | 0.236 | 0.236 | 0.212 |
| | $I_i$ | 0.245 | 0.276 | 0.248 | 0.275 | 0.288 | 0.281 | 0.300 | 0.299 | 0.216 |
| 5 | $c_i$ | 0.325 | 0.368 | 0.357 | 0.382 | 0.384 | 0.365 | 0.399 | 0.379 | 0.317 |
| | $G_i$ | 0.130 | 0.139 | 0.127 | 0.140 | 0.130 | 0.130 | 0.154 | 0.144 | 0.116 |
| | $G_i$* | 0.178 | 0.179 | 0.163 | 0.177 | 0.176 | 0.185 | 0.185 | 0.180 | 0.150 |
| | $H_i$ | 0.297 | 0.337 | 0.309 | 0.336 | 0.332 | 0.354 | 0.340 | 0.356 | 0.282 |
| | $H_i$* | 0.184 | 0.218 | 0.206 | 0.215 | 0.211 | 0.219 | 0.217 | 0.237 | 0.208 |
| | $I_i$ | 0.252 | 0.261 | 0.242 | 0.264 | 0.267 | 0.262 | 0.274 | 0.300 | 0.231 |
| 6 | $c_i$ | 0.331 | 0.393 | 0.395 | 0.416 | 0.394 | 0.353 | 0.399 | 0.399 | 0.316 |
| | $G_i$ | 0.132 | 0.159 | 0.127 | 0.134 | 0.134 | 0.123 | 0.144 | 0.143 | 0.129 |
| | $G_i$* | 0.181 | 0.196 | 0.172 | 0.177 | 0.178 | 0.172 | 0.172 | 0.180 | 0.171 |
| | $H_i$ | 0.309 | 0.375 | 0.344 | 0.352 | 0.360 | 0.325 | 0.334 | 0.365 | 0.298 |
| | $H_i$* | 0.200 | 0.212 | 0.214 | 0.195 | 0.223 | 0.217 | 0.201 | 0.229 | 0.198 |
| | $I_i$ | 0.267 | 0.301 | 0.273 | 0.285 | 0.278 | 0.256 | 0.275 | 0.292 | 0.257 |
| 7 | $c_i$ | 0.342 | 0.411 | 0.386 | 0.383 | 0.428 | 0.413 | 0.392 | 0.403 | 0.346 |
| | $G_i$ | 0.130 | 0.145 | 0.131 | 0.117 | 0.152 | 0.141 | 0.130 | 0.139 | 0.124 |
| | $G_i$* | 0.174 | 0.177 | 0.177 | 0.153 | 0.196 | 0.185 | 0.177 | 0.183 | 0.162 |

| | | Column | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| | $H_i$ | 0.286 | 0.360 | 0.347 | 0.345 | 0.364 | 0.366 | 0.376 | 0.381 | 0.312 |
| | $H_i$* | 0.200 | 0.234 | 0.225 | 0.210 | 0.236 | 0.221 | 0.239 | 0.253 | 0.211 |
| | $I_i$ | 0.254 | 0.303 | 0.284 | 0.282 | 0.301 | 0.288 | 0.283 | 0.300 | 0.263 |
| 8 | $c_i$ | 0.325 | 0.405 | 0.389 | 0.408 | 0.400 | 0.423 | 0.409 | 0.367 | 0.352 |
| | $G_i$ | 0.125 | 0.143 | 0.133 | 0.121 | 0.138 | 0.151 | 0.147 | 0.150 | 0.134 |
| | $G_i$* | 0.174 | 0.186 | 0.171 | 0.166 | 0.179 | 0.192 | 0.192 | 0.190 | 0.180 |
| | $H_i$ | 0.302 | 0.354 | 0.359 | 0.346 | 0.351 | 0.378 | 0.346 | 0.357 | 0.310 |
| | $H_i$* | 0.200 | 0.224 | 0.218 | 0.205 | 0.220 | 0.242 | 0.218 | 0.223 | 0.192 |
| | $I_i$ | 0.261 | 0.293 | 0.281 | 0.282 | 0.298 | 0.311 | 0.294 | 0.308 | 0.274 |
| 9 | $c_i$ | 0.256 | 0.329 | 0.317 | 0.322 | 0.321 | 0.322 | 0.323 | 0.302 | 0.218 |
| | $G_i$ | 0.106 | 0.117 | 0.119 | 0.112 | 0.115 | 0.129 | 0.135 | 0.127 | 0.108 |
| | $G_i$* | 0.161 | 0.181 | 0.164 | 0.161 | 0.166 | 0.170 | 0.184 | 0.182 | 0.164 |
| | $H_i$ | 0.223 | 0.314 | 0.302 | 0.302 | 0.293 | 0.301 | 0.318 | 0.286 | 0.218 |
| | $H_i$* | 0.157 | 0.216 | 0.224 | 0.202 | 0.203 | 0.201 | 0.200 | 0.189 | 0.160 |
| | $I_i$ | 0.221 | 0.250 | 0.244 | 0.243 | 0.241 | 0.265 | 0.267 | 0.258 | 0.219 |

Figure B.28 Empirical Power Based on CWF Pattern Variance-Covariance Matrix Using Rook Connectivity Case for a 9x9 Study Area

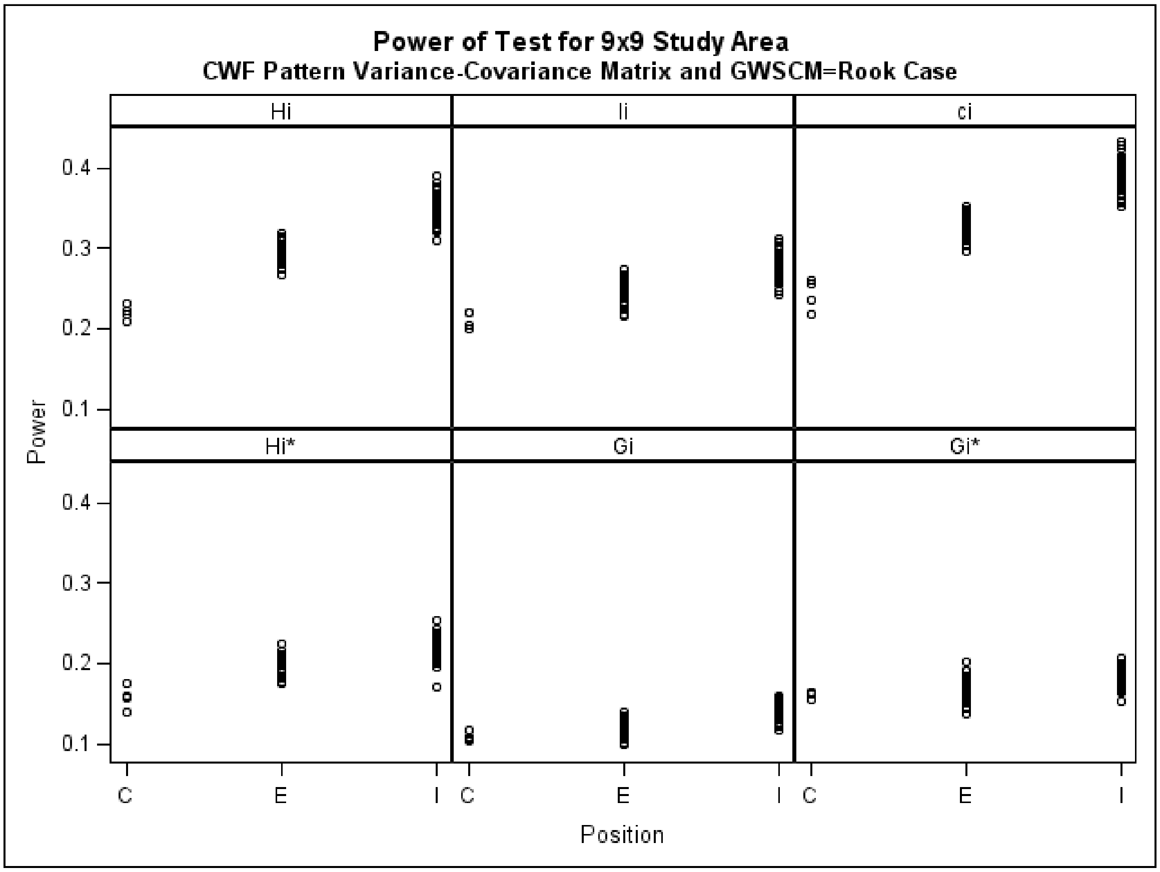


Table B.29 Empirical Power Based on CWF Pattern Variance-Covariance Matrix Using Queen Connectivity Case for a 9x9 Study Area

| | | Column | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 1 | $c_i$ | 0.346 | 0.412 | 0.411 | 0.433 | 0.402 | 0.407 | 0.436 | 0.445 | 0.321 |
| | $G_i$ | 0.174 | 0.198 | 0.190 | 0.174 | 0.157 | 0.151 | 0.169 | 0.183 | 0.157 |
| | $G_i$* | 0.195 | 0.212 | 0.208 | 0.202 | 0.180 | 0.175 | 0.200 | 0.212 | 0.186 |
| | $H_i$ | 0.231 | 0.296 | 0.296 | 0.311 | 0.279 | 0.283 | 0.312 | 0.289 | 0.212 |
| | $H_i$* | 0.153 | 0.186 | 0.175 | 0.196 | 0.167 | 0.161 | 0.179 | 0.151 | 0.129 |
| | $I_i$ | 0.296 | 0.341 | 0.342 | 0.332 | 0.324 | 0.317 | 0.335 | 0.337 | 0.282 |
| 2 | $c_i$ | 0.450 | 0.506 | 0.492 | 0.522 | 0.507 | 0.479 | 0.517 | 0.500 | 0.417 |
| | $G_i$ | 0.205 | 0.243 | 0.216 | 0.205 | 0.193 | 0.194 | 0.214 | 0.216 | 0.172 |
| | $G_i$* | 0.236 | 0.259 | 0.236 | 0.232 | 0.212 | 0.216 | 0.234 | 0.235 | 0.199 |
| | $H_i$ | 0.317 | 0.377 | 0.365 | 0.383 | 0.385 | 0.364 | 0.384 | 0.394 | 0.305 |
| | $H_i$* | 0.189 | 0.206 | 0.198 | 0.196 | 0.214 | 0.215 | 0.178 | 0.211 | 0.172 |
| | $I_i$ | 0.363 | 0.414 | 0.386 | 0.392 | 0.393 | 0.393 | 0.413 | 0.419 | 0.340 |
| 3 | $c_i$ | 0.420 | 0.493 | 0.475 | 0.512 | 0.508 | 0.504 | 0.506 | 0.503 | 0.435 |
| | $G_i$ | 0.201 | 0.222 | 0.203 | 0.202 | 0.210 | 0.209 | 0.205 | 0.206 | 0.164 |
| | $G_i$* | 0.227 | 0.243 | 0.225 | 0.224 | 0.227 | 0.237 | 0.235 | 0.230 | 0.190 |
| | $H_i$ | 0.323 | 0.396 | 0.381 | 0.399 | 0.403 | 0.389 | 0.385 | 0.416 | 0.298 |
| | $H_i$* | 0.200 | 0.218 | 0.205 | 0.205 | 0.204 | 0.198 | 0.205 | 0.229 | 0.189 |
| | $I_i$ | 0.355 | 0.406 | 0.379 | 0.401 | 0.409 | 0.408 | 0.393 | 0.403 | 0.330 |
| 4 | $c_i$ | 0.427 | 0.478 | 0.463 | 0.494 | 0.515 | 0.510 | 0.536 | 0.510 | 0.426 |
| | $G_i$ | 0.194 | 0.215 | 0.185 | 0.193 | 0.190 | 0.207 | 0.221 | 0.206 | 0.176 |
| | $G_i$* | 0.221 | 0.243 | 0.212 | 0.216 | 0.213 | 0.234 | 0.246 | 0.235 | 0.205 |
| | $H_i$ | 0.304 | 0.380 | 0.354 | 0.380 | 0.381 | 0.403 | 0.430 | 0.404 | 0.300 |
| | $H_i$* | 0.162 | 0.187 | 0.184 | 0.162 | 0.188 | 0.187 | 0.203 | 0.213 | 0.182 |
| | $I_i$ | 0.332 | 0.384 | 0.354 | 0.387 | 0.382 | 0.403 | 0.430 | 0.407 | 0.332 |
| 5 | $c_i$ | 0.417 | 0.483 | 0.474 | 0.494 | 0.477 | 0.470 | 0.519 | 0.508 | 0.399 |
| | $G_i$ | 0.173 | 0.201 | 0.181 | 0.191 | 0.188 | 0.200 | 0.207 | 0.199 | 0.175 |
| | $G_i$* | 0.210 | 0.223 | 0.206 | 0.210 | 0.213 | 0.220 | 0.226 | 0.216 | 0.194 |
| | $H_i$ | 0.316 | 0.369 | 0.348 | 0.382 | 0.381 | 0.397 | 0.398 | 0.402 | 0.300 |
| | $H_i$* | 0.190 | 0.204 | 0.181 | 0.194 | 0.203 | 0.210 | 0.208 | 0.221 | 0.194 |
| | $I_i$ | 0.347 | 0.378 | 0.349 | 0.379 | 0.387 | 0.394 | 0.407 | 0.405 | 0.332 |
| 6 | $c_i$ | 0.450 | 0.499 | 0.488 | 0.493 | 0.498 | 0.470 | 0.489 | 0.508 | 0.417 |
| | $G_i$ | 0.177 | 0.211 | 0.181 | 0.188 | 0.189 | 0.184 | 0.187 | 0.206 | 0.186 |
| | $G_i$* | 0.221 | 0.228 | 0.202 | 0.207 | 0.208 | 0.206 | 0.209 | 0.229 | 0.205 |
| | $H_i$ | 0.309 | 0.401 | 0.374 | 0.392 | 0.394 | 0.366 | 0.376 | 0.394 | 0.320 |
| | $H_i$* | 0.182 | 0.203 | 0.197 | 0.179 | 0.207 | 0.192 | 0.201 | 0.212 | 0.195 |
| | $I_i$ | 0.350 | 0.414 | 0.374 | 0.391 | 0.395 | 0.377 | 0.374 | 0.406 | 0.360 |
| 7 | $c_i$ | 0.441 | 0.497 | 0.496 | 0.502 | 0.541 | 0.522 | 0.496 | 0.497 | 0.439 |
| | $G_i$ | 0.183 | 0.194 | 0.186 | 0.173 | 0.203 | 0.191 | 0.207 | 0.203 | 0.172 |
| | $G_i$* | 0.218 | 0.204 | 0.211 | 0.200 | 0.226 | 0.220 | 0.232 | 0.229 | 0.204 |

| | | Column | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| | $H_i$ | 0.316 | 0.405 | 0.378 | 0.382 | 0.413 | 0.395 | 0.397 | 0.425 | 0.332 |
| | $H_i$* | 0.198 | 0.218 | 0.200 | 0.204 | 0.203 | 0.209 | 0.224 | 0.241 | 0.210 |
| | $I_i$ | 0.351 | 0.419 | 0.397 | 0.398 | 0.417 | 0.398 | 0.410 | 0.424 | 0.356 |
| 8 | $c_i$ | 0.435 | 0.513 | 0.495 | 0.488 | 0.523 | 0.519 | 0.502 | 0.490 | 0.440 |
| | $G_i$ | 0.182 | 0.214 | 0.198 | 0.189 | 0.206 | 0.214 | 0.214 | 0.209 | 0.189 |
| | $G_i$* | 0.205 | 0.233 | 0.225 | 0.205 | 0.217 | 0.230 | 0.237 | 0.233 | 0.216 |
| | $H_i$ | 0.303 | 0.399 | 0.391 | 0.384 | 0.416 | 0.409 | 0.399 | 0.411 | 0.327 |
| | $H_i$* | 0.181 | 0.208 | 0.188 | 0.176 | 0.208 | 0.223 | 0.195 | 0.210 | 0.174 |
| | $I_i$ | 0.354 | 0.424 | 0.415 | 0.411 | 0.422 | 0.442 | 0.418 | 0.429 | 0.378 |
| 9 | $c_i$ | 0.340 | 0.422 | 0.415 | 0.428 | 0.411 | 0.414 | 0.413 | 0.408 | 0.299 |
| | $G_i$ | 0.148 | 0.176 | 0.170 | 0.162 | 0.159 | 0.179 | 0.181 | 0.185 | 0.159 |
| | $G_i$* | 0.183 | 0.205 | 0.194 | 0.198 | 0.198 | 0.207 | 0.213 | 0.213 | 0.186 |
| | $H_i$ | 0.231 | 0.321 | 0.302 | 0.331 | 0.307 | 0.310 | 0.313 | 0.316 | 0.239 |
| | $H_i$* | 0.147 | 0.199 | 0.191 | 0.194 | 0.184 | 0.180 | 0.179 | 0.186 | 0.145 |
| | $I_i$ | 0.284 | 0.349 | 0.351 | 0.348 | 0.341 | 0.361 | 0.354 | 0.367 | 0.311 |

Figure B.29 Empirical Power Based on CWF Pattern Variance-Covariance Matrix Using Queen Connectivity Case for a 9x9 Study Area

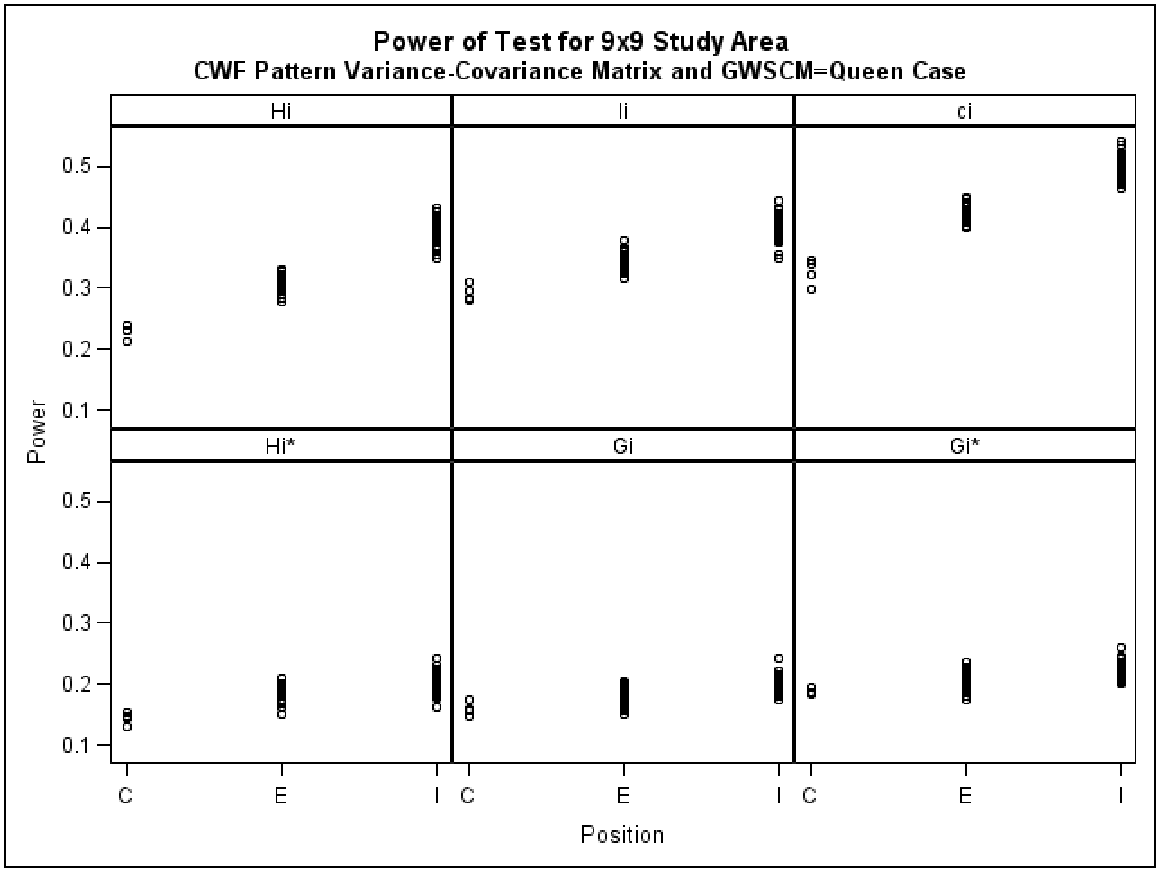


Table B.30 Empirical Power Based on CWF Pattern Variance-Covariance Matrix Using CWF Connectivity Case for a 9x9 Study Area

| | | Column | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 1 | $c_i$ | 0.442 | 0.473 | 0.475 | 0.491 | 0.467 | 0.454 | 0.485 | 0.465 | 0.423 |
| | $G_i$ | 0.232 | 0.245 | 0.244 | 0.223 | 0.205 | 0.215 | 0.229 | 0.219 | 0.211 |
| | $G_i$* | 0.247 | 0.254 | 0.252 | 0.239 | 0.211 | 0.221 | 0.238 | 0.233 | 0.214 |
| | $H_i$ | 0.267 | 0.322 | 0.328 | 0.341 | 0.336 | 0.318 | 0.347 | 0.328 | 0.259 |
| | $H_i$* | 0.138 | 0.165 | 0.168 | 0.170 | 0.161 | 0.171 | 0.178 | 0.157 | 0.121 |
| | $I_i$ | 0.366 | 0.397 | 0.406 | 0.404 | 0.393 | 0.383 | 0.417 | 0.405 | 0.361 |
| 2 | $c_i$ | 0.494 | 0.523 | 0.513 | 0.534 | 0.536 | 0.502 | 0.521 | 0.518 | 0.477 |
| | $G_i$ | 0.251 | 0.254 | 0.262 | 0.247 | 0.233 | 0.242 | 0.261 | 0.239 | 0.215 |
| | $G_i$* | 0.266 | 0.275 | 0.273 | 0.262 | 0.245 | 0.256 | 0.264 | 0.252 | 0.224 |
| | $H_i$ | 0.353 | 0.399 | 0.398 | 0.413 | 0.421 | 0.402 | 0.411 | 0.402 | 0.337 |
| | $H_i$* | 0.166 | 0.181 | 0.180 | 0.183 | 0.193 | 0.183 | 0.165 | 0.203 | 0.182 |
| | $I_i$ | 0.426 | 0.443 | 0.458 | 0.444 | 0.459 | 0.456 | 0.464 | 0.453 | 0.385 |
| 3 | $c_i$ | 0.495 | 0.520 | 0.514 | 0.547 | 0.556 | 0.543 | 0.543 | 0.535 | 0.482 |
| | $G_i$ | 0.254 | 0.258 | 0.254 | 0.244 | 0.241 | 0.253 | 0.252 | 0.262 | 0.235 |
| | $G_i$* | 0.259 | 0.268 | 0.261 | 0.250 | 0.257 | 0.274 | 0.267 | 0.274 | 0.237 |
| | $H_i$ | 0.358 | 0.417 | 0.407 | 0.430 | 0.438 | 0.440 | 0.422 | 0.439 | 0.356 |
| | $H_i$* | 0.168 | 0.193 | 0.205 | 0.179 | 0.186 | 0.183 | 0.184 | 0.206 | 0.180 |
| | $I_i$ | 0.424 | 0.457 | 0.449 | 0.464 | 0.461 | 0.468 | 0.470 | 0.469 | 0.408 |
| 4 | $c_i$ | 0.467 | 0.490 | 0.492 | 0.533 | 0.542 | 0.538 | 0.567 | 0.557 | 0.488 |
| | $G_i$ | 0.249 | 0.258 | 0.249 | 0.233 | 0.231 | 0.249 | 0.263 | 0.257 | 0.227 |
| | $G_i$* | 0.261 | 0.268 | 0.258 | 0.243 | 0.247 | 0.267 | 0.277 | 0.273 | 0.244 |
| | $H_i$ | 0.351 | 0.398 | 0.393 | 0.419 | 0.423 | 0.455 | 0.456 | 0.437 | 0.343 |
| | $H_i$* | 0.147 | 0.176 | 0.172 | 0.146 | 0.150 | 0.169 | 0.182 | 0.200 | 0.165 |
| | $I_i$ | 0.399 | 0.438 | 0.438 | 0.452 | 0.442 | 0.478 | 0.489 | 0.489 | 0.407 |
| 5 | $c_i$ | 0.488 | 0.519 | 0.488 | 0.525 | 0.530 | 0.525 | 0.549 | 0.543 | 0.462 |
| | $G_i$ | 0.235 | 0.238 | 0.242 | 0.244 | 0.230 | 0.251 | 0.251 | 0.243 | 0.221 |
| | $G_i$* | 0.249 | 0.259 | 0.252 | 0.241 | 0.246 | 0.266 | 0.258 | 0.255 | 0.229 |
| | $H_i$ | 0.356 | 0.384 | 0.386 | 0.421 | 0.420 | 0.433 | 0.435 | 0.429 | 0.346 |
| | $H_i$* | 0.169 | 0.173 | 0.182 | 0.163 | 0.182 | 0.185 | 0.170 | 0.185 | 0.161 |
| | $I_i$ | 0.411 | 0.434 | 0.432 | 0.453 | 0.460 | 0.475 | 0.473 | 0.472 | 0.404 |
| 6 | $c_i$ | 0.496 | 0.514 | 0.532 | 0.522 | 0.529 | 0.511 | 0.514 | 0.519 | 0.480 |
| | $G_i$ | 0.239 | 0.237 | 0.239 | 0.226 | 0.241 | 0.224 | 0.237 | 0.241 | 0.224 |
| | $G_i$* | 0.250 | 0.249 | 0.258 | 0.239 | 0.247 | 0.235 | 0.249 | 0.254 | 0.239 |
| | $H_i$ | 0.367 | 0.412 | 0.408 | 0.416 | 0.441 | 0.410 | 0.408 | 0.428 | 0.359 |
| | $H_i$* | 0.185 | 0.191 | 0.151 | 0.153 | 0.165 | 0.162 | 0.167 | 0.184 | 0.177 |
| | $I_i$ | 0.428 | 0.444 | 0.444 | 0.442 | 0.473 | 0.442 | 0.461 | 0.480 | 0.422 |
| 7 | $c_i$ | 0.476 | 0.528 | 0.530 | 0.548 | 0.559 | 0.538 | 0.525 | 0.529 | 0.493 |
| | $G_i$ | 0.225 | 0.241 | 0.239 | 0.230 | 0.248 | 0.243 | 0.267 | 0.250 | 0.230 |
| | $G_i$* | 0.237 | 0.248 | 0.249 | 0.247 | 0.259 | 0.253 | 0.275 | 0.260 | 0.241 |

| | | Column | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| | $H_i$ | 0.351 | 0.433 | 0.416 | 0.434 | 0.449 | 0.436 | 0.459 | 0.448 | 0.366 |
| | $H_i$* | 0.169 | 0.204 | 0.192 | 0.178 | 0.168 | 0.186 | 0.208 | 0.235 | 0.182 |
| | $I_i$ | 0.417 | 0.483 | 0.466 | 0.472 | 0.484 | 0.481 | 0.507 | 0.487 | 0.435 |
| 8 | $c_i$ | 0.480 | 0.526 | 0.515 | 0.520 | 0.537 | 0.546 | 0.532 | 0.525 | 0.483 |
| | $G_i$ | 0.220 | 0.238 | 0.230 | 0.217 | 0.249 | 0.242 | 0.258 | 0.242 | 0.226 |
| | $G_i$* | 0.231 | 0.249 | 0.246 | 0.232 | 0.253 | 0.263 | 0.260 | 0.254 | 0.238 |
| | $H_i$ | 0.341 | 0.417 | 0.418 | 0.421 | 0.448 | 0.437 | 0.418 | 0.443 | 0.372 |
| | $H_i$* | 0.167 | 0.201 | 0.197 | 0.185 | 0.196 | 0.199 | 0.174 | 0.204 | 0.164 |
| | $I_i$ | 0.413 | 0.466 | 0.471 | 0.452 | 0.483 | 0.488 | 0.478 | 0.487 | 0.430 |
| 9 | $c_i$ | 0.433 | 0.470 | 0.465 | 0.481 | 0.464 | 0.463 | 0.468 | 0.476 | 0.423 |
| | $G_i$ | 0.202 | 0.218 | 0.214 | 0.209 | 0.215 | 0.226 | 0.240 | 0.219 | 0.219 |
| | $G_i$* | 0.217 | 0.242 | 0.218 | 0.231 | 0.227 | 0.230 | 0.257 | 0.238 | 0.217 |
| | $H_i$ | 0.254 | 0.347 | 0.349 | 0.348 | 0.360 | 0.356 | 0.346 | 0.344 | 0.293 |
| | $H_i$* | 0.140 | 0.191 | 0.177 | 0.142 | 0.178 | 0.163 | 0.172 | 0.173 | 0.160 |
| | $I_i$ | 0.350 | 0.408 | 0.417 | 0.400 | 0.413 | 0.433 | 0.427 | 0.429 | 0.385 |

Figure B.30 Empirical Power Based on CWF Pattern Variance-Covariance Matrix Using CWF Connectivity Case for a 9x9 Study Area

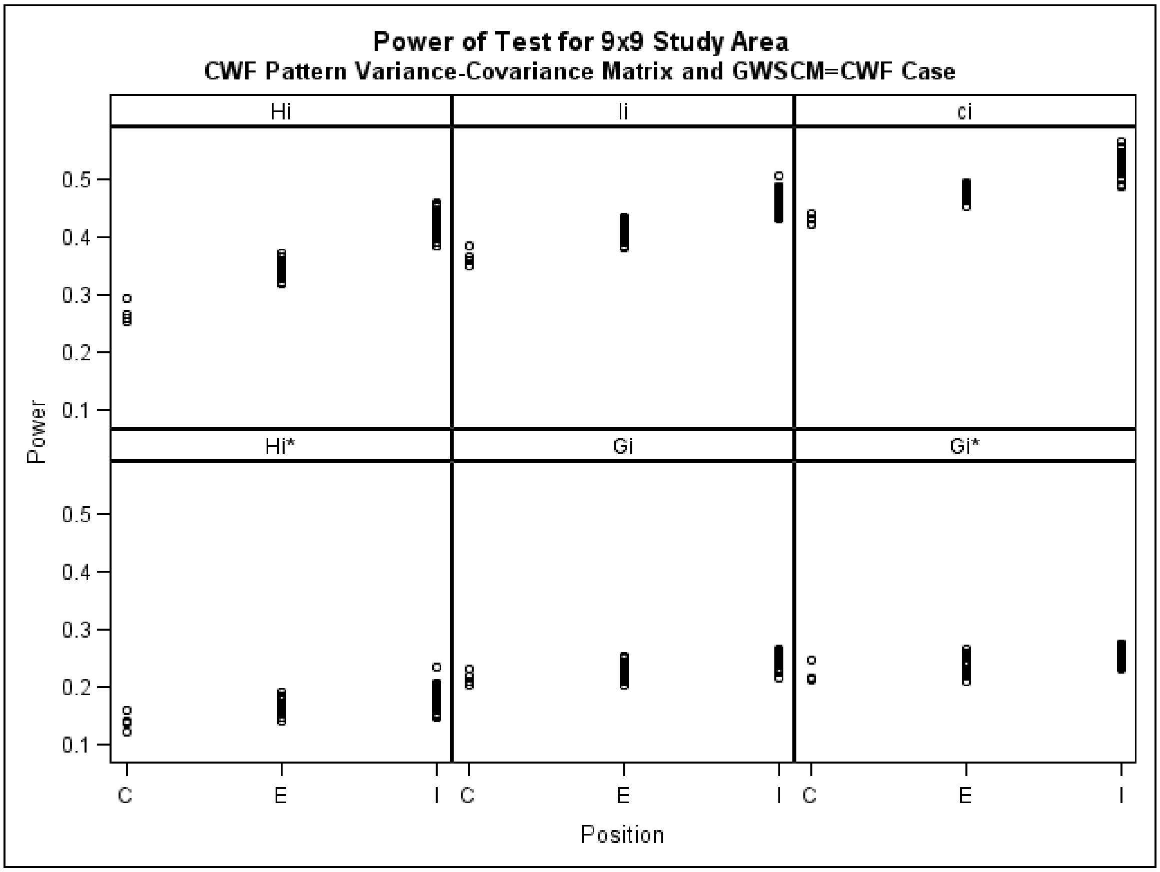


Table B.31 Empirical Size Using Rook Connectivity Case for a 14x14 Study Area

| | | Column | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1 | $c_i$ | 0.049 | 0.041 | 0.047 | 0.045 | 0.056 | 0.059 | 0.050 |
| | $G_i$ | 0.045 | 0.059 | 0.044 | 0.049 | 0.053 | 0.050 | 0.043 |
| | $G_i$* | 0.041 | 0.056 | 0.046 | 0.046 | 0.047 | 0.058 | 0.054 |
| | $H_i$ | 0.046 | 0.039 | 0.052 | 0.043 | 0.054 | 0.055 | 0.060 |
| | $H_i$* | 0.050 | 0.044 | 0.064 | 0.060 | 0.057 | 0.055 | 0.044 |
| | $I_i$ | 0.045 | 0.059 | 0.044 | 0.049 | 0.053 | 0.050 | 0.043 |
| 2 | $c_i$ | 0.050 | 0.040 | 0.046 | 0.051 | 0.060 | 0.040 | 0.057 |
| | $G_i$ | 0.053 | 0.045 | 0.053 | 0.050 | 0.049 | 0.053 | 0.043 |
| | $G_i$* | 0.053 | 0.037 | 0.053 | 0.053 | 0.057 | 0.052 | 0.043 |
| | $H_i$ | 0.053 | 0.040 | 0.050 | 0.061 | 0.055 | 0.047 | 0.051 |
| | $H_i$* | 0.060 | 0.050 | 0.069 | 0.055 | 0.055 | 0.051 | 0.049 |
| | $I_i$ | 0.053 | 0.045 | 0.053 | 0.050 | 0.049 | 0.053 | 0.043 |
| 3 | $c_i$ | 0.035 | 0.039 | 0.039 | 0.052 | 0.054 | 0.046 | 0.044 |
| | $G_i$ | 0.044 | 0.045 | 0.029 | 0.043 | 0.045 | 0.041 | 0.049 |
| | $G_i$* | 0.051 | 0.039 | 0.042 | 0.039 | 0.048 | 0.046 | 0.043 |
| | $H_i$ | 0.050 | 0.046 | 0.042 | 0.052 | 0.050 | 0.064 | 0.050 |
| | $H_i$* | 0.044 | 0.045 | 0.048 | 0.057 | 0.048 | 0.071 | 0.052 |
| | $I_i$ | 0.044 | 0.045 | 0.029 | 0.043 | 0.045 | 0.041 | 0.049 |
| 4 | $c_i$ | 0.045 | 0.051 | 0.046 | 0.053 | 0.043 | 0.054 | 0.042 |
| | $G_i$ | 0.047 | 0.052 | 0.038 | 0.060 | 0.040 | 0.053 | 0.047 |
| | $G_i$* | 0.054 | 0.049 | 0.042 | 0.061 | 0.041 | 0.046 | 0.044 |
| | $H_i$ | 0.056 | 0.053 | 0.047 | 0.052 | 0.050 | 0.057 | 0.053 |
| | $H_i$* | 0.064 | 0.046 | 0.035 | 0.041 | 0.049 | 0.048 | 0.063 |
| | $I_i$ | 0.047 | 0.052 | 0.038 | 0.060 | 0.040 | 0.053 | 0.047 |
| 5 | $c_i$ | 0.048 | 0.043 | 0.042 | 0.048 | 0.052 | 0.053 | 0.054 |
| | $G_i$ | 0.059 | 0.049 | 0.053 | 0.045 | 0.055 | 0.045 | 0.042 |
| | $G_i$* | 0.053 | 0.044 | 0.055 | 0.045 | 0.055 | 0.047 | 0.045 |
| | $H_i$ | 0.059 | 0.044 | 0.061 | 0.037 | 0.051 | 0.042 | 0.035 |
| | $H_i$* | 0.061 | 0.043 | 0.044 | 0.038 | 0.052 | 0.052 | 0.029 |
| | $I_i$ | 0.059 | 0.049 | 0.053 | 0.045 | 0.055 | 0.045 | 0.042 |
| 6 | $c_i$ | 0.046 | 0.056 | 0.053 | 0.062 | 0.045 | 0.044 | 0.049 |
| | $G_i$ | 0.044 | 0.061 | 0.059 | 0.060 | 0.055 | 0.052 | 0.042 |
| | $G_i$* | 0.044 | 0.065 | 0.054 | 0.048 | 0.053 | 0.054 | 0.049 |
| | $H_i$ | 0.055 | 0.052 | 0.050 | 0.052 | 0.053 | 0.046 | 0.038 |
| | $H_i$* | 0.060 | 0.059 | 0.057 | 0.050 | 0.052 | 0.061 | 0.046 |
| | $I_i$ | 0.044 | 0.061 | 0.059 | 0.060 | 0.055 | 0.052 | 0.042 |
| 7 | $c_i$ | 0.066 | 0.054 | 0.052 | 0.050 | 0.057 | 0.048 | 0.066 |
| | $G_i$ | 0.058 | 0.051 | 0.053 | 0.052 | 0.057 | 0.049 | 0.060 |
| | $G_i$* | 0.060 | 0.063 | 0.051 | 0.055 | 0.059 | 0.059 | 0.053 |
| | $H_i$ | 0.054 | 0.055 | 0.060 | 0.047 | 0.047 | 0.049 | 0.051 |
| | $H_i$* | 0.058 | 0.048 | 0.057 | 0.055 | 0.055 | 0.043 | 0.052 |
| | $I_i$ | 0.058 | 0.051 | 0.053 | 0.052 | 0.057 | 0.049 | 0.060 |
| 8 | $c_i$ | 0.045 | 0.053 | 0.048 | 0.065 | 0.051 | 0.053 | 0.046 |
| | $G_i$ | 0.045 | 0.050 | 0.042 | 0.056 | 0.059 | 0.073 | 0.053 |
| | $G_i$* | 0.049 | 0.046 | 0.038 | 0.060 | 0.062 | 0.055 | 0.053 |

| | | Column | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | $H_i$ | 0.047 | 0.052 | 0.052 | 0.060 | 0.065 | 0.060 | 0.052 |
| | $H_i$* | 0.046 | 0.051 | 0.046 | 0.050 | 0.051 | 0.054 | 0.047 |
| | $I_i$ | 0.045 | 0.050 | 0.042 | 0.056 | 0.059 | 0.073 | 0.053 |
| 9 | $c_i$ | 0.054 | 0.042 | 0.049 | 0.036 | 0.059 | 0.051 | 0.052 |
| | $G_i$ | 0.046 | 0.044 | 0.063 | 0.050 | 0.071 | 0.044 | 0.051 |
| | $G_i$* | 0.041 | 0.053 | 0.043 | 0.042 | 0.067 | 0.046 | 0.058 |
| | $H_i$ | 0.052 | 0.039 | 0.054 | 0.046 | 0.066 | 0.044 | 0.057 |
| | $H_i$* | 0.053 | 0.054 | 0.062 | 0.042 | 0.071 | 0.060 | 0.052 |
| | $I_i$ | 0.046 | 0.044 | 0.063 | 0.050 | 0.071 | 0.044 | 0.051 |
| 10 | $c_i$ | 0.051 | 0.046 | 0.046 | 0.048 | 0.036 | 0.054 | 0.039 |
| | $G_i$ | 0.047 | 0.058 | 0.048 | 0.057 | 0.045 | 0.059 | 0.052 |
| | $G_i$* | 0.045 | 0.057 | 0.050 | 0.055 | 0.045 | 0.057 | 0.052 |
| | $H_i$ | 0.040 | 0.051 | 0.050 | 0.048 | 0.046 | 0.055 | 0.041 |
| | $H_i$* | 0.051 | 0.070 | 0.053 | 0.048 | 0.035 | 0.067 | 0.033 |
| | $I_i$ | 0.047 | 0.058 | 0.048 | 0.057 | 0.045 | 0.059 | 0.052 |
| 11 | $c_i$ | 0.051 | 0.051 | 0.048 | 0.053 | 0.059 | 0.044 | 0.044 |
| | $G_i$ | 0.051 | 0.041 | 0.058 | 0.048 | 0.067 | 0.043 | 0.047 |
| | $G_i$* | 0.058 | 0.039 | 0.045 | 0.057 | 0.055 | 0.038 | 0.042 |
| | $H_i$ | 0.046 | 0.051 | 0.053 | 0.058 | 0.058 | 0.055 | 0.048 |
| | $H_i$* | 0.052 | 0.057 | 0.038 | 0.046 | 0.050 | 0.051 | 0.050 |
| | $I_i$ | 0.051 | 0.041 | 0.058 | 0.048 | 0.067 | 0.043 | 0.047 |
| 12 | $c_i$ | 0.049 | 0.061 | 0.063 | 0.046 | 0.054 | 0.050 | 0.046 |
| | $G_i$ | 0.045 | 0.042 | 0.062 | 0.055 | 0.045 | 0.053 | 0.042 |
| | $G_i$* | 0.055 | 0.045 | 0.053 | 0.061 | 0.054 | 0.044 | 0.046 |
| | $H_i$ | 0.056 | 0.044 | 0.062 | 0.054 | 0.049 | 0.044 | 0.048 |
| | $H_i$* | 0.058 | 0.051 | 0.053 | 0.043 | 0.034 | 0.048 | 0.050 |
| | $I_i$ | 0.045 | 0.042 | 0.062 | 0.055 | 0.045 | 0.053 | 0.042 |
| 13 | $c_i$ | 0.050 | 0.048 | 0.053 | 0.051 | 0.057 | 0.049 | 0.045 |
| | $G_i$ | 0.057 | 0.057 | 0.050 | 0.053 | 0.048 | 0.053 | 0.039 |
| | $G_i$* | 0.059 | 0.055 | 0.050 | 0.052 | 0.049 | 0.048 | 0.037 |
| | $H_i$ | 0.056 | 0.050 | 0.053 | 0.047 | 0.051 | 0.050 | 0.049 |
| | $H_i$* | 0.064 | 0.060 | 0.047 | 0.044 | 0.042 | 0.053 | 0.055 |
| | $I_i$ | 0.057 | 0.057 | 0.050 | 0.053 | 0.048 | 0.053 | 0.039 |
| 14 | $c_i$ | 0.052 | 0.061 | 0.061 | 0.062 | 0.053 | 0.039 | 0.055 |
| | $G_i$ | 0.051 | 0.058 | 0.063 | 0.053 | 0.047 | 0.032 | 0.050 |
| | $G_i$* | 0.057 | 0.054 | 0.060 | 0.056 | 0.054 | 0.037 | 0.047 |
| | $H_i$ | 0.048 | 0.063 | 0.053 | 0.051 | 0.052 | 0.043 | 0.050 |
| | $H_i$* | 0.065 | 0.049 | 0.053 | 0.045 | 0.048 | 0.047 | 0.048 |
| | $I_i$ | 0.051 | 0.058 | 0.063 | 0.053 | 0.047 | 0.032 | 0.050 |

| | | Column | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 1 | $c_i$ | 0.055 | 0.047 | 0.039 | 0.048 | 0.057 | 0.056 | 0.053 |
| | $G_i$ | 0.052 | 0.056 | 0.045 | 0.050 | 0.056 | 0.052 | 0.045 |
| | $G_i$* | 0.057 | 0.053 | 0.057 | 0.053 | 0.046 | 0.063 | 0.050 |
| | $H_i$ | 0.053 | 0.043 | 0.057 | 0.050 | 0.041 | 0.058 | 0.057 |
| | $H_i$* | 0.045 | 0.048 | 0.054 | 0.050 | 0.038 | 0.044 | 0.057 |
| | $I_i$ | 0.052 | 0.056 | 0.045 | 0.050 | 0.056 | 0.052 | 0.045 |
| 2 | $c_i$ | 0.058 | 0.061 | 0.063 | 0.045 | 0.037 | 0.044 | 0.036 |
| | $G_i$ | 0.049 | 0.050 | 0.045 | 0.061 | 0.048 | 0.057 | 0.044 |
| | $G_i$* | 0.056 | 0.042 | 0.068 | 0.057 | 0.045 | 0.049 | 0.037 |
| | $H_i$ | 0.042 | 0.054 | 0.051 | 0.047 | 0.057 | 0.062 | 0.057 |
| | $H_i$* | 0.047 | 0.057 | 0.068 | 0.046 | 0.049 | 0.070 | 0.049 |
| | $I_i$ | 0.049 | 0.050 | 0.045 | 0.061 | 0.048 | 0.057 | 0.044 |
| 3 | $c_i$ | 0.057 | 0.051 | 0.060 | 0.049 | 0.046 | 0.052 | 0.058 |
| | $G_i$ | 0.044 | 0.041 | 0.049 | 0.057 | 0.049 | 0.049 | 0.059 |
| | $G_i$* | 0.044 | 0.049 | 0.058 | 0.061 | 0.052 | 0.049 | 0.053 |
| | $H_i$ | 0.046 | 0.054 | 0.061 | 0.046 | 0.043 | 0.034 | 0.056 |
| | $H_i$* | 0.053 | 0.045 | 0.049 | 0.043 | 0.049 | 0.050 | 0.054 |
| | $I_i$ | 0.044 | 0.041 | 0.049 | 0.057 | 0.049 | 0.049 | 0.059 |
| 4 | $c_i$ | 0.058 | 0.061 | 0.053 | 0.054 | 0.047 | 0.069 | 0.062 |
| | $G_i$ | 0.044 | 0.043 | 0.045 | 0.058 | 0.056 | 0.043 | 0.053 |
| | $G_i$* | 0.045 | 0.045 | 0.056 | 0.058 | 0.058 | 0.049 | 0.056 |
| | $H_i$ | 0.063 | 0.047 | 0.047 | 0.056 | 0.045 | 0.048 | 0.041 |
| | $H_i$* | 0.055 | 0.042 | 0.058 | 0.056 | 0.059 | 0.048 | 0.048 |
| | $I_i$ | 0.044 | 0.043 | 0.045 | 0.058 | 0.056 | 0.043 | 0.053 |
| 5 | $c_i$ | 0.042 | 0.045 | 0.062 | 0.055 | 0.038 | 0.049 | 0.047 |
| | $G_i$ | 0.046 | 0.050 | 0.052 | 0.056 | 0.048 | 0.058 | 0.045 |
| | $G_i$* | 0.046 | 0.045 | 0.051 | 0.054 | 0.043 | 0.056 | 0.051 |
| | $H_i$ | 0.048 | 0.046 | 0.041 | 0.054 | 0.052 | 0.043 | 0.048 |
| | $H_i$* | 0.053 | 0.045 | 0.041 | 0.047 | 0.054 | 0.055 | 0.051 |
| | $I_i$ | 0.046 | 0.050 | 0.052 | 0.056 | 0.048 | 0.058 | 0.045 |
| 6 | $c_i$ | 0.054 | 0.060 | 0.045 | 0.049 | 0.059 | 0.065 | 0.051 |
| | $G_i$ | 0.052 | 0.048 | 0.034 | 0.053 | 0.058 | 0.064 | 0.049 |
| | $G_i$* | 0.067 | 0.052 | 0.043 | 0.062 | 0.057 | 0.057 | 0.038 |
| | $H_i$ | 0.052 | 0.047 | 0.046 | 0.052 | 0.060 | 0.057 | 0.063 |
| | $H_i$* | 0.054 | 0.046 | 0.042 | 0.056 | 0.046 | 0.050 | 0.051 |
| | $I_i$ | 0.052 | 0.048 | 0.034 | 0.053 | 0.058 | 0.064 | 0.049 |
| 7 | $c_i$ | 0.047 | 0.054 | 0.062 | 0.052 | 0.047 | 0.055 | 0.037 |
| | $G_i$ | 0.041 | 0.056 | 0.051 | 0.047 | 0.064 | 0.053 | 0.051 |
| | $G_i$* | 0.053 | 0.050 | 0.053 | 0.049 | 0.065 | 0.051 | 0.049 |
| | $H_i$ | 0.035 | 0.064 | 0.047 | 0.046 | 0.044 | 0.041 | 0.048 |
| | $H_i$* | 0.045 | 0.049 | 0.054 | 0.035 | 0.049 | 0.048 | 0.053 |
| | $I_i$ | 0.041 | 0.056 | 0.051 | 0.047 | 0.064 | 0.053 | 0.051 |
| 8 | $c_i$ | 0.050 | 0.057 | 0.052 | 0.050 | 0.050 | 0.053 | 0.054 |
| | $G_i$ | 0.053 | 0.043 | 0.049 | 0.048 | 0.063 | 0.037 | 0.049 |
| | $G_i$* | 0.058 | 0.048 | 0.041 | 0.047 | 0.056 | 0.045 | 0.044 |
| | $H_i$ | 0.050 | 0.048 | 0.049 | 0.052 | 0.051 | 0.043 | 0.051 |

| | | Column | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| | $H_i$* | 0.053 | 0.043 | 0.044 | 0.052 | 0.060 | 0.043 | 0.036 |
| | $I_i$ | 0.053 | 0.043 | 0.049 | 0.048 | 0.063 | 0.037 | 0.049 |
| 9 | $c_i$ | 0.051 | 0.045 | 0.049 | 0.056 | 0.054 | 0.061 | 0.053 |
| | $G_i$ | 0.042 | 0.054 | 0.048 | 0.056 | 0.049 | 0.048 | 0.045 |
| | $G_i$* | 0.044 | 0.054 | 0.043 | 0.057 | 0.042 | 0.047 | 0.042 |
| | $H_i$ | 0.053 | 0.054 | 0.047 | 0.049 | 0.060 | 0.048 | 0.041 |
| | $H_i$* | 0.044 | 0.048 | 0.059 | 0.051 | 0.057 | 0.037 | 0.042 |
| | $I_i$ | 0.042 | 0.054 | 0.048 | 0.056 | 0.049 | 0.048 | 0.045 |
| 10 | $c_i$ | 0.048 | 0.048 | 0.049 | 0.041 | 0.055 | 0.057 | 0.053 |
| | $G_i$ | 0.059 | 0.046 | 0.063 | 0.053 | 0.052 | 0.051 | 0.055 |
| | $G_i$* | 0.053 | 0.051 | 0.054 | 0.050 | 0.054 | 0.046 | 0.060 |
| | $H_i$ | 0.056 | 0.049 | 0.059 | 0.053 | 0.059 | 0.048 | 0.052 |
| | $H_i$* | 0.048 | 0.056 | 0.053 | 0.055 | 0.052 | 0.050 | 0.043 |
| | $I_i$ | 0.059 | 0.046 | 0.063 | 0.053 | 0.052 | 0.051 | 0.055 |
| 11 | $c_i$ | 0.062 | 0.056 | 0.059 | 0.061 | 0.054 | 0.056 | 0.057 |
| | $G_i$ | 0.051 | 0.054 | 0.057 | 0.062 | 0.057 | 0.057 | 0.051 |
| | $G_i$* | 0.051 | 0.039 | 0.048 | 0.063 | 0.052 | 0.061 | 0.054 |
| | $H_i$ | 0.054 | 0.053 | 0.062 | 0.074 | 0.038 | 0.050 | 0.051 |
| | $H_i$* | 0.050 | 0.057 | 0.058 | 0.060 | 0.049 | 0.049 | 0.051 |
| | $I_i$ | 0.051 | 0.054 | 0.057 | 0.062 | 0.057 | 0.057 | 0.051 |
| 12 | $c_i$ | 0.050 | 0.045 | 0.054 | 0.052 | 0.047 | 0.058 | 0.052 |
| | $G_i$ | 0.039 | 0.043 | 0.050 | 0.040 | 0.048 | 0.056 | 0.062 |
| | $G_i$* | 0.043 | 0.047 | 0.046 | 0.062 | 0.057 | 0.059 | 0.055 |
| | $H_i$ | 0.052 | 0.050 | 0.060 | 0.046 | 0.052 | 0.047 | 0.055 |
| | $H_i$* | 0.047 | 0.054 | 0.053 | 0.053 | 0.049 | 0.052 | 0.048 |
| | $I_i$ | 0.039 | 0.043 | 0.050 | 0.040 | 0.048 | 0.056 | 0.062 |
| 13 | $c_i$ | 0.051 | 0.045 | 0.051 | 0.045 | 0.051 | 0.066 | 0.042 |
| | $G_i$ | 0.033 | 0.042 | 0.052 | 0.046 | 0.050 | 0.058 | 0.052 |
| | $G_i$* | 0.045 | 0.042 | 0.055 | 0.050 | 0.060 | 0.045 | 0.047 |
| | $H_i$ | 0.052 | 0.049 | 0.053 | 0.055 | 0.054 | 0.057 | 0.043 |
| | $H_i$* | 0.057 | 0.047 | 0.061 | 0.059 | 0.044 | 0.042 | 0.052 |
| | $I_i$ | 0.033 | 0.042 | 0.052 | 0.046 | 0.050 | 0.058 | 0.052 |
| 14 | $c_i$ | 0.036 | 0.038 | 0.047 | 0.050 | 0.043 | 0.046 | 0.060 |
| | $G_i$ | 0.045 | 0.039 | 0.047 | 0.044 | 0.035 | 0.040 | 0.062 |
| | $G_i$* | 0.052 | 0.049 | 0.043 | 0.050 | 0.042 | 0.049 | 0.067 |
| | $H_i$ | 0.048 | 0.046 | 0.049 | 0.063 | 0.054 | 0.046 | 0.060 |
| | $H_i$* | 0.040 | 0.051 | 0.043 | 0.062 | 0.041 | 0.033 | 0.057 |
| | $I_i$ | 0.045 | 0.039 | 0.047 | 0.044 | 0.035 | 0.040 | 0.062 |

Figure B.31 Empirical Size Using Rook Connectivity Case for a 14x14 Study Area

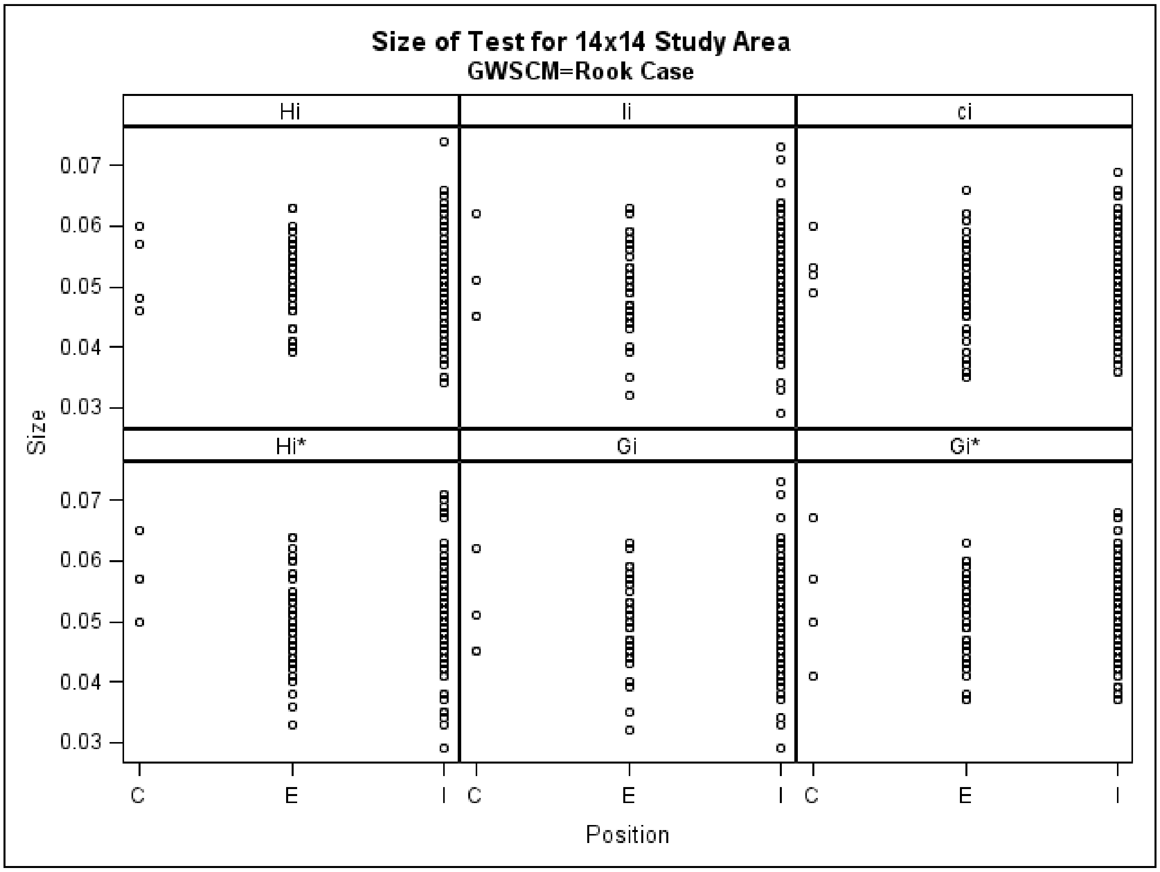


Table B.32 Empirical Size Using Queen Connectivity Case for a 14x14 Study Area

| | | Column | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1 | $c_i$ | 0.051 | 0.049 | 0.050 | 0.049 | 0.065 | 0.052 | 0.062 |
| | $G_i$ | 0.030 | 0.053 | 0.046 | 0.056 | 0.054 | 0.050 | 0.053 |
| | $G_i$* | 0.047 | 0.047 | 0.044 | 0.045 | 0.054 | 0.046 | 0.052 |
| | $H_i$ | 0.055 | 0.054 | 0.034 | 0.055 | 0.050 | 0.053 | 0.048 |
| | $H_i$* | 0.047 | 0.050 | 0.035 | 0.060 | 0.054 | 0.053 | 0.037 |
| | $I_i$ | 0.030 | 0.053 | 0.046 | 0.056 | 0.054 | 0.050 | 0.053 |
| 2 | $c_i$ | 0.048 | 0.048 | 0.054 | 0.050 | 0.046 | 0.040 | 0.043 |
| | $G_i$ | 0.047 | 0.049 | 0.045 | 0.047 | 0.042 | 0.033 | 0.042 |
| | $G_i$* | 0.046 | 0.040 | 0.043 | 0.041 | 0.051 | 0.039 | 0.041 |
| | $H_i$ | 0.046 | 0.047 | 0.049 | 0.058 | 0.061 | 0.039 | 0.047 |
| | $H_i$* | 0.057 | 0.053 | 0.044 | 0.056 | 0.076 | 0.054 | 0.050 |
| | $I_i$ | 0.047 | 0.049 | 0.045 | 0.047 | 0.042 | 0.033 | 0.042 |
| 3 | $c_i$ | 0.032 | 0.028 | 0.039 | 0.043 | 0.053 | 0.049 | 0.052 |
| | $G_i$ | 0.037 | 0.040 | 0.035 | 0.039 | 0.048 | 0.041 | 0.048 |
| | $G_i$* | 0.041 | 0.033 | 0.036 | 0.046 | 0.046 | 0.037 | 0.047 |
| | $H_i$ | 0.046 | 0.043 | 0.048 | 0.049 | 0.038 | 0.049 | 0.049 |
| | $H_i$* | 0.044 | 0.055 | 0.049 | 0.048 | 0.039 | 0.052 | 0.050 |
| | $I_i$ | 0.037 | 0.040 | 0.035 | 0.039 | 0.048 | 0.041 | 0.048 |
| 4 | $c_i$ | 0.040 | 0.041 | 0.044 | 0.052 | 0.057 | 0.052 | 0.047 |
| | $G_i$ | 0.039 | 0.043 | 0.039 | 0.056 | 0.048 | 0.051 | 0.045 |
| | $G_i$* | 0.040 | 0.047 | 0.038 | 0.047 | 0.055 | 0.052 | 0.042 |
| | $H_i$ | 0.045 | 0.046 | 0.043 | 0.053 | 0.052 | 0.062 | 0.046 |
| | $H_i$* | 0.044 | 0.041 | 0.042 | 0.048 | 0.059 | 0.056 | 0.060 |
| | $I_i$ | 0.039 | 0.043 | 0.039 | 0.056 | 0.048 | 0.051 | 0.045 |
| 5 | $c_i$ | 0.057 | 0.049 | 0.058 | 0.041 | 0.055 | 0.048 | 0.062 |
| | $G_i$ | 0.048 | 0.051 | 0.057 | 0.047 | 0.054 | 0.045 | 0.047 |
| | $G_i$* | 0.046 | 0.059 | 0.051 | 0.047 | 0.050 | 0.045 | 0.050 |
| | $H_i$ | 0.044 | 0.043 | 0.060 | 0.044 | 0.054 | 0.041 | 0.050 |
| | $H_i$* | 0.043 | 0.054 | 0.052 | 0.041 | 0.044 | 0.034 | 0.036 |
| | $I_i$ | 0.048 | 0.051 | 0.057 | 0.047 | 0.054 | 0.045 | 0.047 |
| 6 | $c_i$ | 0.055 | 0.049 | 0.049 | 0.052 | 0.048 | 0.052 | 0.065 |
| | $G_i$ | 0.054 | 0.049 | 0.063 | 0.059 | 0.054 | 0.058 | 0.059 |
| | $G_i$* | 0.051 | 0.056 | 0.061 | 0.063 | 0.050 | 0.056 | 0.054 |
| | $H_i$ | 0.056 | 0.061 | 0.065 | 0.047 | 0.052 | 0.058 | 0.062 |
| | $H_i$* | 0.046 | 0.056 | 0.064 | 0.040 | 0.053 | 0.054 | 0.050 |
| | $I_i$ | 0.054 | 0.049 | 0.063 | 0.059 | 0.054 | 0.058 | 0.059 |
| 7 | $c_i$ | 0.053 | 0.046 | 0.061 | 0.057 | 0.057 | 0.061 | 0.046 |
| | $G_i$ | 0.058 | 0.055 | 0.061 | 0.047 | 0.060 | 0.047 | 0.057 |
| | $G_i$* | 0.068 | 0.052 | 0.054 | 0.059 | 0.069 | 0.053 | 0.059 |
| | $H_i$ | 0.047 | 0.049 | 0.053 | 0.060 | 0.050 | 0.045 | 0.055 |
| | $H_i$* | 0.052 | 0.057 | 0.048 | 0.057 | 0.047 | 0.045 | 0.050 |
| | $I_i$ | 0.058 | 0.055 | 0.061 | 0.047 | 0.060 | 0.047 | 0.057 |
| 8 | $c_i$ | 0.050 | 0.060 | 0.048 | 0.045 | 0.039 | 0.050 | 0.043 |
| | $G_i$ | 0.046 | 0.049 | 0.052 | 0.067 | 0.063 | 0.063 | 0.049 |
| | $G_i$* | 0.053 | 0.054 | 0.047 | 0.070 | 0.071 | 0.053 | 0.052 |

| | | Column | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | $H_i$ | 0.042 | 0.048 | 0.049 | 0.051 | 0.052 | 0.052 | 0.043 |
| | $H_i$* | 0.048 | 0.054 | 0.051 | 0.053 | 0.048 | 0.053 | 0.058 |
| | $I_i$ | 0.046 | 0.049 | 0.052 | 0.067 | 0.063 | 0.063 | 0.049 |
| 9 | $c_i$ | 0.057 | 0.043 | 0.044 | 0.048 | 0.050 | 0.047 | 0.055 |
| | $G_i$ | 0.058 | 0.050 | 0.048 | 0.055 | 0.048 | 0.044 | 0.051 |
| | $G_i$* | 0.058 | 0.051 | 0.050 | 0.045 | 0.049 | 0.046 | 0.054 |
| | $H_i$ | 0.058 | 0.039 | 0.052 | 0.055 | 0.055 | 0.053 | 0.041 |
| | $H_i$* | 0.069 | 0.045 | 0.049 | 0.051 | 0.044 | 0.050 | 0.055 |
| | $I_i$ | 0.058 | 0.050 | 0.048 | 0.055 | 0.048 | 0.044 | 0.051 |
| 10 | $c_i$ | 0.055 | 0.052 | 0.043 | 0.043 | 0.031 | 0.044 | 0.038 |
| | $G_i$ | 0.050 | 0.054 | 0.052 | 0.047 | 0.037 | 0.036 | 0.043 |
| | $G_i$* | 0.038 | 0.048 | 0.045 | 0.055 | 0.060 | 0.052 | 0.063 |
| | $H_i$ | 0.050 | 0.057 | 0.053 | 0.050 | 0.047 | 0.040 | 0.051 |
| | $H_i$* | 0.038 | 0.058 | 0.041 | 0.041 | 0.057 | 0.040 | 0.052 |
| | $I_i$ | 0.050 | 0.054 | 0.052 | 0.047 | 0.037 | 0.036 | 0.043 |
| 11 | $c_i$ | 0.061 | 0.056 | 0.054 | 0.053 | 0.053 | 0.033 | 0.050 |
| | $G_i$ | 0.050 | 0.051 | 0.045 | 0.052 | 0.055 | 0.056 | 0.052 |
| | $G_i$* | 0.059 | 0.046 | 0.051 | 0.044 | 0.054 | 0.056 | 0.058 |
| | $H_i$ | 0.044 | 0.062 | 0.046 | 0.050 | 0.051 | 0.059 | 0.064 |
| | $H_i$* | 0.050 | 0.062 | 0.053 | 0.045 | 0.055 | 0.057 | 0.065 |
| | $I_i$ | 0.050 | 0.051 | 0.045 | 0.052 | 0.055 | 0.056 | 0.052 |
| 12 | $c_i$ | 0.047 | 0.045 | 0.061 | 0.053 | 0.052 | 0.049 | 0.053 |
| | $G_i$ | 0.047 | 0.042 | 0.053 | 0.051 | 0.056 | 0.044 | 0.042 |
| | $G_i$* | 0.038 | 0.047 | 0.054 | 0.057 | 0.063 | 0.042 | 0.051 |
| | $H_i$ | 0.059 | 0.057 | 0.052 | 0.044 | 0.048 | 0.057 | 0.039 |
| | $H_i$* | 0.054 | 0.049 | 0.038 | 0.049 | 0.039 | 0.039 | 0.055 |
| | $I_i$ | 0.047 | 0.042 | 0.053 | 0.051 | 0.056 | 0.044 | 0.042 |
| 13 | $c_i$ | 0.057 | 0.047 | 0.051 | 0.045 | 0.052 | 0.059 | 0.043 |
| | $G_i$ | 0.060 | 0.053 | 0.053 | 0.044 | 0.053 | 0.052 | 0.050 |
| | $G_i$* | 0.057 | 0.060 | 0.056 | 0.047 | 0.055 | 0.048 | 0.045 |
| | $H_i$ | 0.046 | 0.056 | 0.061 | 0.044 | 0.051 | 0.055 | 0.054 |
| | $H_i$* | 0.047 | 0.054 | 0.052 | 0.046 | 0.049 | 0.050 | 0.054 |
| | $I_i$ | 0.060 | 0.053 | 0.053 | 0.044 | 0.053 | 0.052 | 0.050 |
| 14 | $c_i$ | 0.051 | 0.060 | 0.042 | 0.052 | 0.049 | 0.051 | 0.056 |
| | $G_i$ | 0.045 | 0.062 | 0.050 | 0.048 | 0.054 | 0.033 | 0.050 |
| | $G_i$* | 0.060 | 0.060 | 0.050 | 0.061 | 0.056 | 0.035 | 0.046 |
| | $H_i$ | 0.046 | 0.047 | 0.049 | 0.052 | 0.046 | 0.045 | 0.045 |
| | $H_i$* | 0.051 | 0.048 | 0.056 | 0.042 | 0.044 | 0.046 | 0.051 |
| | $I_i$ | 0.045 | 0.062 | 0.050 | 0.048 | 0.054 | 0.033 | 0.050 |

| | | Column | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 1 | $c_i$ | 0.056 | 0.057 | 0.045 | 0.057 | 0.057 | 0.049 | 0.057 |
| | $G_i$ | 0.055 | 0.067 | 0.047 | 0.072 | 0.057 | 0.055 | 0.053 |
| | $G_i$* | 0.059 | 0.058 | 0.054 | 0.060 | 0.042 | 0.056 | 0.045 |
| | $H_i$ | 0.058 | 0.050 | 0.042 | 0.045 | 0.065 | 0.055 | 0.049 |
| | $H_i$* | 0.038 | 0.041 | 0.041 | 0.053 | 0.060 | 0.048 | 0.048 |
| | $I_i$ | 0.055 | 0.067 | 0.047 | 0.072 | 0.057 | 0.055 | 0.053 |
| 2 | $c_i$ | 0.048 | 0.055 | 0.062 | 0.046 | 0.057 | 0.040 | 0.041 |
| | $G_i$ | 0.040 | 0.054 | 0.046 | 0.066 | 0.050 | 0.058 | 0.045 |
| | $G_i$* | 0.046 | 0.048 | 0.045 | 0.058 | 0.055 | 0.061 | 0.056 |
| | $H_i$ | 0.048 | 0.052 | 0.049 | 0.055 | 0.053 | 0.050 | 0.040 |
| | $H_i$* | 0.051 | 0.041 | 0.051 | 0.050 | 0.067 | 0.048 | 0.046 |
| | $I_i$ | 0.040 | 0.054 | 0.046 | 0.066 | 0.050 | 0.058 | 0.045 |
| 3 | $c_i$ | 0.068 | 0.049 | 0.058 | 0.051 | 0.052 | 0.054 | 0.050 |
| | $G_i$ | 0.042 | 0.048 | 0.061 | 0.055 | 0.045 | 0.068 | 0.060 |
| | $G_i$* | 0.047 | 0.049 | 0.062 | 0.051 | 0.045 | 0.068 | 0.056 |
| | $H_i$ | 0.050 | 0.044 | 0.058 | 0.050 | 0.046 | 0.062 | 0.058 |
| | $H_i$* | 0.054 | 0.039 | 0.051 | 0.059 | 0.060 | 0.059 | 0.052 |
| | $I_i$ | 0.042 | 0.048 | 0.061 | 0.055 | 0.045 | 0.068 | 0.060 |
| 4 | $c_i$ | 0.036 | 0.058 | 0.048 | 0.048 | 0.054 | 0.057 | 0.058 |
| | $G_i$ | 0.033 | 0.045 | 0.050 | 0.074 | 0.056 | 0.045 | 0.053 |
| | $G_i$* | 0.037 | 0.042 | 0.047 | 0.071 | 0.062 | 0.052 | 0.051 |
| | $H_i$ | 0.037 | 0.043 | 0.062 | 0.054 | 0.046 | 0.048 | 0.056 |
| | $H_i$* | 0.048 | 0.042 | 0.044 | 0.051 | 0.056 | 0.052 | 0.044 |
| | $I_i$ | 0.033 | 0.045 | 0.050 | 0.074 | 0.056 | 0.045 | 0.053 |
| 5 | $c_i$ | 0.052 | 0.058 | 0.063 | 0.046 | 0.039 | 0.045 | 0.043 |
| | $G_i$ | 0.042 | 0.051 | 0.053 | 0.046 | 0.052 | 0.043 | 0.048 |
| | $G_i$* | 0.044 | 0.052 | 0.048 | 0.053 | 0.055 | 0.043 | 0.049 |
| | $H_i$ | 0.043 | 0.046 | 0.058 | 0.043 | 0.044 | 0.043 | 0.041 |
| | $H_i$* | 0.047 | 0.046 | 0.063 | 0.045 | 0.053 | 0.038 | 0.039 |
| | $I_i$ | 0.042 | 0.051 | 0.053 | 0.046 | 0.052 | 0.043 | 0.048 |
| 6 | $c_i$ | 0.051 | 0.058 | 0.056 | 0.044 | 0.046 | 0.051 | 0.051 |
| | $G_i$ | 0.048 | 0.050 | 0.046 | 0.049 | 0.050 | 0.052 | 0.055 |
| | $G_i$* | 0.053 | 0.054 | 0.055 | 0.049 | 0.051 | 0.050 | 0.048 |
| | $H_i$ | 0.055 | 0.048 | 0.046 | 0.054 | 0.047 | 0.052 | 0.055 |
| | $H_i$* | 0.051 | 0.058 | 0.053 | 0.066 | 0.051 | 0.056 | 0.052 |
| | $I_i$ | 0.048 | 0.050 | 0.046 | 0.049 | 0.050 | 0.052 | 0.055 |
| 7 | $c_i$ | 0.042 | 0.054 | 0.048 | 0.047 | 0.054 | 0.054 | 0.044 |
| | $G_i$ | 0.040 | 0.059 | 0.040 | 0.044 | 0.043 | 0.048 | 0.047 |
| | $G_i$* | 0.043 | 0.056 | 0.049 | 0.050 | 0.049 | 0.044 | 0.044 |
| | $H_i$ | 0.045 | 0.049 | 0.044 | 0.041 | 0.050 | 0.047 | 0.038 |
| | $H_i$* | 0.055 | 0.049 | 0.038 | 0.049 | 0.048 | 0.046 | 0.053 |
| | $I_i$ | 0.040 | 0.059 | 0.040 | 0.044 | 0.043 | 0.048 | 0.047 |
| 8 | $c_i$ | 0.048 | 0.046 | 0.046 | 0.057 | 0.039 | 0.049 | 0.055 |
| | $G_i$ | 0.047 | 0.050 | 0.044 | 0.052 | 0.051 | 0.043 | 0.042 |
| | $G_i$* | 0.049 | 0.047 | 0.045 | 0.050 | 0.056 | 0.047 | 0.034 |
| | $H_i$ | 0.053 | 0.049 | 0.048 | 0.044 | 0.047 | 0.061 | 0.036 |
| | $H_i$* | 0.059 | 0.052 | 0.045 | 0.049 | 0.053 | 0.054 | 0.045 |

| | | Column | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| | $I_i$ | 0.047 | 0.050 | 0.044 | 0.052 | 0.051 | 0.043 | 0.042 |
| 9 | $c_i$ | 0.052 | 0.055 | 0.063 | 0.056 | 0.051 | 0.058 | 0.045 |
| | $G_i$ | 0.051 | 0.043 | 0.053 | 0.053 | 0.040 | 0.039 | 0.038 |
| | $G_i$* | 0.050 | 0.044 | 0.054 | 0.051 | 0.051 | 0.040 | 0.046 |
| | $H_i$ | 0.045 | 0.043 | 0.053 | 0.048 | 0.048 | 0.046 | 0.041 |
| | $H_i$* | 0.055 | 0.043 | 0.049 | 0.046 | 0.057 | 0.050 | 0.052 |
| | $I_i$ | 0.051 | 0.043 | 0.053 | 0.053 | 0.040 | 0.039 | 0.038 |
| 10 | $c_i$ | 0.045 | 0.057 | 0.053 | 0.046 | 0.049 | 0.051 | 0.060 |
| | $G_i$ | 0.052 | 0.048 | 0.061 | 0.053 | 0.050 | 0.048 | 0.044 |
| | $G_i$* | 0.056 | 0.057 | 0.059 | 0.051 | 0.046 | 0.042 | 0.038 |
| | $H_i$ | 0.060 | 0.051 | 0.050 | 0.056 | 0.049 | 0.045 | 0.050 |
| | $H_i$* | 0.052 | 0.052 | 0.040 | 0.056 | 0.049 | 0.049 | 0.052 |
| | $I_i$ | 0.052 | 0.048 | 0.061 | 0.053 | 0.050 | 0.048 | 0.044 |
| 11 | $c_i$ | 0.056 | 0.058 | 0.057 | 0.050 | 0.040 | 0.057 | 0.063 |
| | $G_i$ | 0.047 | 0.053 | 0.054 | 0.051 | 0.053 | 0.059 | 0.050 |
| | $G_i$* | 0.053 | 0.054 | 0.048 | 0.049 | 0.044 | 0.033 | 0.054 |
| | $H_i$ | 0.053 | 0.055 | 0.051 | 0.044 | 0.052 | 0.050 | 0.065 |
| | $H_i$* | 0.047 | 0.056 | 0.042 | 0.053 | 0.059 | 0.050 | 0.050 |
| | $I_i$ | 0.047 | 0.053 | 0.054 | 0.051 | 0.053 | 0.059 | 0.050 |
| 12 | $c_i$ | 0.059 | 0.060 | 0.060 | 0.046 | 0.050 | 0.059 | 0.050 |
| | $G_i$ | 0.059 | 0.073 | 0.047 | 0.059 | 0.049 | 0.058 | 0.054 |
| | $G_i$* | 0.052 | 0.058 | 0.052 | 0.054 | 0.059 | 0.047 | 0.048 |
| | $H_i$ | 0.050 | 0.060 | 0.042 | 0.044 | 0.057 | 0.055 | 0.056 |
| | $H_i$* | 0.038 | 0.048 | 0.043 | 0.035 | 0.048 | 0.051 | 0.066 |
| | $I_i$ | 0.059 | 0.073 | 0.047 | 0.059 | 0.049 | 0.058 | 0.054 |
| 13 | $c_i$ | 0.044 | 0.048 | 0.050 | 0.044 | 0.045 | 0.040 | 0.051 |
| | $G_i$ | 0.042 | 0.042 | 0.051 | 0.042 | 0.046 | 0.055 | 0.052 |
| | $G_i$* | 0.051 | 0.040 | 0.041 | 0.052 | 0.056 | 0.059 | 0.065 |
| | $H_i$ | 0.043 | 0.040 | 0.065 | 0.046 | 0.043 | 0.050 | 0.049 |
| | $H_i$* | 0.049 | 0.041 | 0.050 | 0.059 | 0.038 | 0.054 | 0.046 |
| | $I_i$ | 0.042 | 0.042 | 0.051 | 0.042 | 0.046 | 0.055 | 0.052 |
| 14 | $c_i$ | 0.038 | 0.048 | 0.052 | 0.049 | 0.048 | 0.059 | 0.064 |
| | $G_i$ | 0.038 | 0.045 | 0.050 | 0.057 | 0.039 | 0.045 | 0.061 |
| | $G_i$* | 0.038 | 0.046 | 0.050 | 0.050 | 0.061 | 0.053 | 0.058 |
| | $H_i$ | 0.041 | 0.042 | 0.053 | 0.067 | 0.047 | 0.049 | 0.060 |
| | $H_i$* | 0.042 | 0.052 | 0.048 | 0.063 | 0.054 | 0.045 | 0.047 |
| | $I_i$ | 0.038 | 0.045 | 0.050 | 0.057 | 0.039 | 0.045 | 0.061 |

Figure B.32 Empirical Size Using Queen Connectivity Case for a 14x14 Study Area

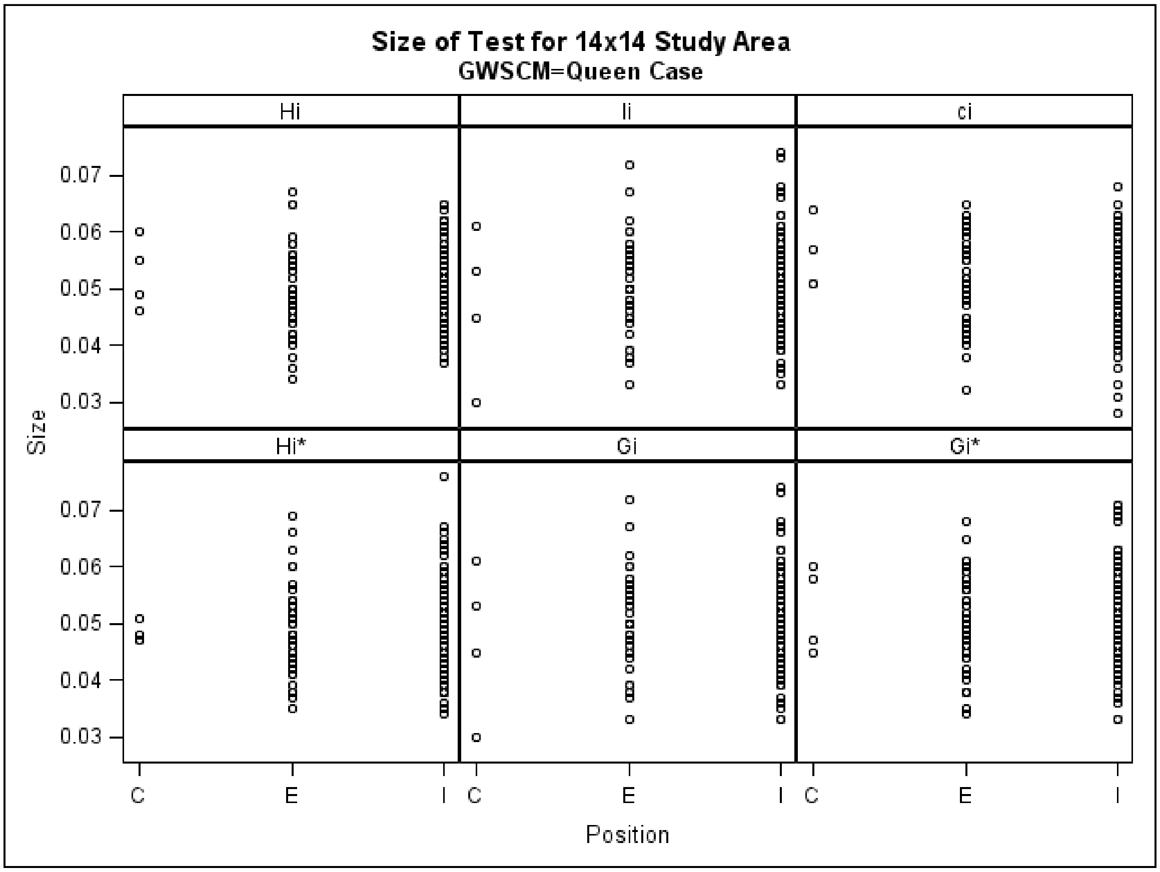


Table B.33 Empirical Size Using CWF Connectivity Case for a 14x14 Study Area

| | | Column | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1 | $c_i$ | 0.047 | 0.053 | 0.051 | 0.042 | 0.063 | 0.042 | 0.051 |
| | $G_i$ | 0.042 | 0.051 | 0.043 | 0.048 | 0.065 | 0.048 | 0.049 |
| | $G_i$* | 0.053 | 0.043 | 0.054 | 0.043 | 0.041 | 0.049 | 0.049 |
| | $H_i$ | 0.049 | 0.062 | 0.045 | 0.050 | 0.053 | 0.046 | 0.046 |
| | $H_i$* | 0.058 | 0.060 | 0.045 | 0.063 | 0.057 | 0.047 | 0.035 |
| | $I_i$ | 0.042 | 0.051 | 0.043 | 0.048 | 0.065 | 0.048 | 0.049 |
| 2 | $c_i$ | 0.041 | 0.043 | 0.047 | 0.052 | 0.048 | 0.040 | 0.044 |
| | $G_i$ | 0.046 | 0.050 | 0.051 | 0.049 | 0.042 | 0.045 | 0.036 |
| | $G_i$* | 0.054 | 0.043 | 0.037 | 0.047 | 0.051 | 0.043 | 0.047 |
| | $H_i$ | 0.046 | 0.054 | 0.055 | 0.051 | 0.057 | 0.035 | 0.032 |
| | $H_i$* | 0.046 | 0.039 | 0.050 | 0.054 | 0.054 | 0.046 | 0.050 |
| | $I_i$ | 0.046 | 0.050 | 0.051 | 0.049 | 0.042 | 0.045 | 0.036 |
| 3 | $c_i$ | 0.032 | 0.032 | 0.035 | 0.036 | 0.060 | 0.038 | 0.052 |
| | $G_i$ | 0.043 | 0.038 | 0.037 | 0.036 | 0.054 | 0.037 | 0.051 |
| | $G_i$* | 0.042 | 0.038 | 0.032 | 0.038 | 0.044 | 0.043 | 0.038 |
| | $H_i$ | 0.044 | 0.047 | 0.046 | 0.050 | 0.049 | 0.034 | 0.054 |
| | $H_i$* | 0.039 | 0.056 | 0.053 | 0.056 | 0.050 | 0.053 | 0.054 |
| | $I_i$ | 0.043 | 0.038 | 0.037 | 0.036 | 0.054 | 0.037 | 0.051 |
| 4 | $c_i$ | 0.037 | 0.038 | 0.039 | 0.048 | 0.053 | 0.051 | 0.047 |
| | $G_i$ | 0.035 | 0.047 | 0.044 | 0.045 | 0.047 | 0.046 | 0.036 |
| | $G_i$* | 0.037 | 0.040 | 0.040 | 0.051 | 0.046 | 0.045 | 0.038 |
| | $H_i$ | 0.050 | 0.048 | 0.045 | 0.041 | 0.056 | 0.044 | 0.045 |
| | $H_i$* | 0.046 | 0.054 | 0.042 | 0.048 | 0.056 | 0.050 | 0.064 |
| | $I_i$ | 0.035 | 0.047 | 0.044 | 0.045 | 0.047 | 0.046 | 0.036 |
| 5 | $c_i$ | 0.051 | 0.046 | 0.048 | 0.045 | 0.056 | 0.047 | 0.060 |
| | $G_i$ | 0.057 | 0.058 | 0.050 | 0.046 | 0.057 | 0.046 | 0.049 |
| | $G_i$* | 0.039 | 0.052 | 0.048 | 0.047 | 0.052 | 0.051 | 0.049 |
| | $H_i$ | 0.052 | 0.050 | 0.050 | 0.051 | 0.059 | 0.045 | 0.052 |
| | $H_i$* | 0.054 | 0.055 | 0.044 | 0.055 | 0.062 | 0.035 | 0.046 |
| | $I_i$ | 0.057 | 0.058 | 0.050 | 0.046 | 0.057 | 0.046 | 0.049 |
| 6 | $c_i$ | 0.058 | 0.048 | 0.043 | 0.057 | 0.056 | 0.069 | 0.060 |
| | $G_i$ | 0.057 | 0.045 | 0.065 | 0.058 | 0.060 | 0.049 | 0.053 |
| | $G_i$* | 0.049 | 0.057 | 0.063 | 0.046 | 0.047 | 0.049 | 0.049 |
| | $H_i$ | 0.041 | 0.050 | 0.061 | 0.052 | 0.052 | 0.047 | 0.057 |
| | $H_i$* | 0.050 | 0.042 | 0.057 | 0.058 | 0.047 | 0.052 | 0.062 |
| | $I_i$ | 0.057 | 0.045 | 0.065 | 0.058 | 0.060 | 0.049 | 0.053 |
| 7 | $c_i$ | 0.053 | 0.050 | 0.053 | 0.057 | 0.070 | 0.054 | 0.053 |
| | $G_i$ | 0.052 | 0.055 | 0.052 | 0.055 | 0.063 | 0.052 | 0.053 |
| | $G_i$* | 0.052 | 0.054 | 0.046 | 0.064 | 0.064 | 0.055 | 0.053 |
| | $H_i$ | 0.047 | 0.050 | 0.062 | 0.048 | 0.067 | 0.047 | 0.054 |
| | $H_i$* | 0.054 | 0.045 | 0.048 | 0.048 | 0.051 | 0.047 | 0.062 |
| | $I_i$ | 0.052 | 0.055 | 0.052 | 0.055 | 0.063 | 0.052 | 0.053 |
| 8 | $c_i$ | 0.045 | 0.058 | 0.046 | 0.046 | 0.046 | 0.061 | 0.043 |
| | $G_i$ | 0.059 | 0.050 | 0.055 | 0.057 | 0.059 | 0.071 | 0.054 |
| | $G_i$* | 0.051 | 0.060 | 0.052 | 0.062 | 0.077 | 0.063 | 0.060 |

| | | Column | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | $H_i$ | 0.057 | 0.054 | 0.061 | 0.053 | 0.056 | 0.052 | 0.054 |
| | $H_i$* | 0.051 | 0.056 | 0.046 | 0.057 | 0.057 | 0.046 | 0.052 |
| | $I_i$ | 0.059 | 0.050 | 0.055 | 0.057 | 0.059 | 0.071 | 0.054 |
| 9 | $c_i$ | 0.057 | 0.049 | 0.041 | 0.044 | 0.063 | 0.047 | 0.051 |
| | $G_i$ | 0.050 | 0.047 | 0.046 | 0.050 | 0.054 | 0.051 | 0.053 |
| | $G_i$* | 0.051 | 0.058 | 0.053 | 0.044 | 0.056 | 0.055 | 0.057 |
| | $H_i$ | 0.055 | 0.048 | 0.061 | 0.048 | 0.061 | 0.047 | 0.052 |
| | $H_i$* | 0.051 | 0.045 | 0.061 | 0.056 | 0.050 | 0.043 | 0.049 |
| | $I_i$ | 0.050 | 0.047 | 0.046 | 0.050 | 0.054 | 0.051 | 0.053 |
| 10 | $c_i$ | 0.039 | 0.048 | 0.043 | 0.048 | 0.039 | 0.048 | 0.042 |
| | $G_i$ | 0.050 | 0.059 | 0.043 | 0.051 | 0.045 | 0.054 | 0.048 |
| | $G_i$* | 0.044 | 0.053 | 0.043 | 0.046 | 0.056 | 0.063 | 0.069 |
| | $H_i$ | 0.046 | 0.055 | 0.044 | 0.046 | 0.042 | 0.055 | 0.054 |
| | $H_i$* | 0.046 | 0.058 | 0.040 | 0.045 | 0.037 | 0.062 | 0.051 |
| | $I_i$ | 0.050 | 0.059 | 0.043 | 0.051 | 0.045 | 0.054 | 0.048 |
| 11 | $c_i$ | 0.051 | 0.047 | 0.056 | 0.058 | 0.046 | 0.044 | 0.054 |
| | $G_i$ | 0.049 | 0.054 | 0.048 | 0.052 | 0.059 | 0.050 | 0.056 |
| | $G_i$* | 0.043 | 0.043 | 0.039 | 0.049 | 0.052 | 0.059 | 0.069 |
| | $H_i$ | 0.057 | 0.046 | 0.053 | 0.059 | 0.052 | 0.049 | 0.060 |
| | $H_i$* | 0.059 | 0.050 | 0.054 | 0.062 | 0.061 | 0.044 | 0.056 |
| | $I_i$ | 0.049 | 0.054 | 0.048 | 0.052 | 0.059 | 0.050 | 0.056 |
| 12 | $c_i$ | 0.057 | 0.054 | 0.050 | 0.052 | 0.057 | 0.051 | 0.053 |
| | $G_i$ | 0.050 | 0.046 | 0.055 | 0.051 | 0.051 | 0.055 | 0.048 |
| | $G_i$* | 0.036 | 0.048 | 0.058 | 0.054 | 0.062 | 0.049 | 0.047 |
| | $H_i$ | 0.058 | 0.049 | 0.050 | 0.062 | 0.048 | 0.054 | 0.050 |
| | $H_i$* | 0.051 | 0.053 | 0.047 | 0.055 | 0.053 | 0.055 | 0.053 |
| | $I_i$ | 0.050 | 0.046 | 0.055 | 0.051 | 0.051 | 0.055 | 0.048 |
| 13 | $c_i$ | 0.056 | 0.058 | 0.056 | 0.050 | 0.065 | 0.053 | 0.040 |
| | $G_i$ | 0.062 | 0.058 | 0.055 | 0.050 | 0.060 | 0.052 | 0.051 |
| | $G_i$* | 0.057 | 0.057 | 0.053 | 0.059 | 0.056 | 0.052 | 0.046 |
| | $H_i$ | 0.058 | 0.055 | 0.059 | 0.049 | 0.056 | 0.044 | 0.041 |
| | $H_i$* | 0.062 | 0.040 | 0.059 | 0.040 | 0.044 | 0.055 | 0.045 |
| | $I_i$ | 0.062 | 0.058 | 0.055 | 0.050 | 0.060 | 0.052 | 0.051 |
| 14 | $c_i$ | 0.068 | 0.060 | 0.061 | 0.053 | 0.051 | 0.048 | 0.057 |
| | $G_i$ | 0.058 | 0.058 | 0.059 | 0.064 | 0.052 | 0.035 | 0.055 |
| | $G_i$* | 0.063 | 0.061 | 0.065 | 0.059 | 0.045 | 0.050 | 0.042 |
| | $H_i$ | 0.057 | 0.049 | 0.068 | 0.053 | 0.054 | 0.042 | 0.051 |
| | $H_i$* | 0.053 | 0.049 | 0.050 | 0.045 | 0.070 | 0.055 | 0.063 |
| | $I_i$ | 0.058 | 0.058 | 0.059 | 0.064 | 0.052 | 0.035 | 0.055 |

| | | Column | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 1 | $c_i$ | 0.049 | 0.059 | 0.035 | 0.064 | 0.050 | 0.043 | 0.059 |
| | $G_i$ | 0.049 | 0.061 | 0.035 | 0.065 | 0.046 | 0.048 | 0.062 |
| | $G_i$* | 0.058 | 0.053 | 0.058 | 0.057 | 0.048 | 0.051 | 0.044 |
| | $H_i$ | 0.045 | 0.051 | 0.034 | 0.057 | 0.052 | 0.045 | 0.063 |
| | $H_i$* | 0.053 | 0.041 | 0.038 | 0.039 | 0.041 | 0.050 | 0.046 |
| | $I_i$ | 0.049 | 0.061 | 0.035 | 0.065 | 0.046 | 0.048 | 0.062 |
| 2 | $c_i$ | 0.047 | 0.050 | 0.051 | 0.041 | 0.054 | 0.038 | 0.044 |
| | $G_i$ | 0.038 | 0.050 | 0.050 | 0.048 | 0.052 | 0.059 | 0.048 |
| | $G_i$* | 0.048 | 0.054 | 0.054 | 0.051 | 0.048 | 0.057 | 0.050 |
| | $H_i$ | 0.038 | 0.052 | 0.050 | 0.046 | 0.052 | 0.039 | 0.041 |
| | $H_i$* | 0.051 | 0.053 | 0.057 | 0.043 | 0.052 | 0.055 | 0.046 |
| | $I_i$ | 0.038 | 0.050 | 0.050 | 0.048 | 0.052 | 0.059 | 0.048 |
| 3 | $c_i$ | 0.050 | 0.051 | 0.061 | 0.045 | 0.052 | 0.055 | 0.045 |
| | $G_i$ | 0.038 | 0.045 | 0.057 | 0.048 | 0.051 | 0.057 | 0.060 |
| | $G_i$* | 0.042 | 0.047 | 0.058 | 0.055 | 0.059 | 0.054 | 0.059 |
| | $H_i$ | 0.047 | 0.039 | 0.052 | 0.040 | 0.045 | 0.053 | 0.060 |
| | $H_i$* | 0.047 | 0.049 | 0.043 | 0.043 | 0.059 | 0.051 | 0.058 |
| | $I_i$ | 0.038 | 0.045 | 0.057 | 0.048 | 0.051 | 0.057 | 0.060 |
| 4 | $c_i$ | 0.055 | 0.044 | 0.055 | 0.055 | 0.052 | 0.058 | 0.055 |
| | $G_i$ | 0.039 | 0.053 | 0.054 | 0.064 | 0.057 | 0.053 | 0.055 |
| | $G_i$* | 0.038 | 0.049 | 0.061 | 0.066 | 0.059 | 0.053 | 0.052 |
| | $H_i$ | 0.033 | 0.048 | 0.047 | 0.064 | 0.042 | 0.054 | 0.064 |
| | $H_i$* | 0.041 | 0.042 | 0.051 | 0.062 | 0.036 | 0.054 | 0.049 |
| | $I_i$ | 0.039 | 0.053 | 0.054 | 0.064 | 0.057 | 0.053 | 0.055 |
| 5 | $c_i$ | 0.054 | 0.052 | 0.054 | 0.055 | 0.049 | 0.049 | 0.042 |
| | $G_i$ | 0.042 | 0.052 | 0.055 | 0.054 | 0.048 | 0.048 | 0.041 |
| | $G_i$* | 0.041 | 0.047 | 0.051 | 0.051 | 0.056 | 0.048 | 0.051 |
| | $H_i$ | 0.054 | 0.045 | 0.047 | 0.057 | 0.042 | 0.039 | 0.055 |
| | $H_i$* | 0.065 | 0.053 | 0.047 | 0.052 | 0.052 | 0.041 | 0.046 |
| | $I_i$ | 0.042 | 0.052 | 0.055 | 0.054 | 0.048 | 0.048 | 0.041 |
| 6 | $c_i$ | 0.060 | 0.062 | 0.053 | 0.045 | 0.052 | 0.054 | 0.051 |
| | $G_i$ | 0.051 | 0.049 | 0.052 | 0.043 | 0.043 | 0.048 | 0.042 |
| | $G_i$* | 0.050 | 0.045 | 0.049 | 0.044 | 0.048 | 0.033 | 0.045 |
| | $H_i$ | 0.051 | 0.049 | 0.050 | 0.056 | 0.044 | 0.042 | 0.053 |
| | $H_i$* | 0.057 | 0.065 | 0.049 | 0.055 | 0.051 | 0.053 | 0.053 |
| | $I_i$ | 0.051 | 0.049 | 0.052 | 0.043 | 0.043 | 0.048 | 0.042 |
| 7 | $c_i$ | 0.055 | 0.039 | 0.053 | 0.052 | 0.056 | 0.052 | 0.042 |
| | $G_i$ | 0.039 | 0.045 | 0.044 | 0.040 | 0.049 | 0.042 | 0.036 |
| | $G_i$* | 0.059 | 0.052 | 0.049 | 0.048 | 0.046 | 0.039 | 0.043 |
| | $H_i$ | 0.036 | 0.040 | 0.045 | 0.044 | 0.047 | 0.041 | 0.031 |
| | $H_i$* | 0.043 | 0.051 | 0.043 | 0.041 | 0.035 | 0.066 | 0.040 |
| | $I_i$ | 0.039 | 0.045 | 0.044 | 0.040 | 0.049 | 0.042 | 0.036 |
| 8 | $c_i$ | 0.047 | 0.041 | 0.045 | 0.055 | 0.053 | 0.055 | 0.064 |
| | $G_i$ | 0.052 | 0.054 | 0.042 | 0.054 | 0.065 | 0.039 | 0.052 |
| | $G_i$* | 0.055 | 0.045 | 0.047 | 0.051 | 0.049 | 0.048 | 0.042 |
| | $H_i$ | 0.053 | 0.052 | 0.045 | 0.049 | 0.054 | 0.053 | 0.051 |
| | $H_i$* | 0.045 | 0.051 | 0.050 | 0.049 | 0.050 | 0.044 | 0.059 |

| | | Column | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| | $I_i$ | 0.052 | 0.054 | 0.042 | 0.054 | 0.065 | 0.039 | 0.052 |
| 9 | $c_i$ | 0.048 | 0.069 | 0.055 | 0.049 | 0.047 | 0.062 | 0.057 |
| | $G_i$ | 0.053 | 0.057 | 0.053 | 0.062 | 0.050 | 0.047 | 0.045 |
| | $G_i$* | 0.057 | 0.054 | 0.059 | 0.056 | 0.049 | 0.042 | 0.045 |
| | $H_i$ | 0.045 | 0.054 | 0.052 | 0.050 | 0.044 | 0.051 | 0.049 |
| | $H_i$* | 0.055 | 0.062 | 0.063 | 0.050 | 0.045 | 0.053 | 0.051 |
| | $I_i$ | 0.053 | 0.057 | 0.053 | 0.062 | 0.050 | 0.047 | 0.045 |
| 10 | $c_i$ | 0.044 | 0.051 | 0.049 | 0.061 | 0.062 | 0.062 | 0.055 |
| | $G_i$ | 0.067 | 0.050 | 0.068 | 0.052 | 0.054 | 0.045 | 0.049 |
| | $G_i$* | 0.058 | 0.055 | 0.057 | 0.049 | 0.040 | 0.035 | 0.036 |
| | $H_i$ | 0.061 | 0.045 | 0.064 | 0.046 | 0.051 | 0.045 | 0.045 |
| | $H_i$* | 0.052 | 0.048 | 0.046 | 0.042 | 0.053 | 0.059 | 0.049 |
| | $I_i$ | 0.067 | 0.050 | 0.068 | 0.052 | 0.054 | 0.045 | 0.049 |
| 11 | $c_i$ | 0.059 | 0.055 | 0.061 | 0.054 | 0.051 | 0.054 | 0.058 |
| | $G_i$ | 0.050 | 0.058 | 0.052 | 0.056 | 0.057 | 0.056 | 0.057 |
| | $G_i$* | 0.064 | 0.065 | 0.064 | 0.055 | 0.047 | 0.031 | 0.043 |
| | $H_i$ | 0.057 | 0.061 | 0.052 | 0.059 | 0.054 | 0.054 | 0.060 |
| | $H_i$* | 0.060 | 0.066 | 0.050 | 0.057 | 0.050 | 0.047 | 0.045 |
| | $I_i$ | 0.050 | 0.058 | 0.052 | 0.056 | 0.057 | 0.056 | 0.057 |
| 12 | $c_i$ | 0.047 | 0.051 | 0.056 | 0.049 | 0.048 | 0.066 | 0.057 |
| | $G_i$ | 0.046 | 0.055 | 0.054 | 0.050 | 0.052 | 0.053 | 0.060 |
| | $G_i$* | 0.052 | 0.046 | 0.051 | 0.063 | 0.058 | 0.050 | 0.063 |
| | $H_i$ | 0.047 | 0.048 | 0.055 | 0.058 | 0.054 | 0.054 | 0.061 |
| | $H_i$* | 0.055 | 0.051 | 0.054 | 0.047 | 0.047 | 0.056 | 0.057 |
| | $I_i$ | 0.046 | 0.055 | 0.054 | 0.050 | 0.052 | 0.053 | 0.060 |
| 13 | $c_i$ | 0.045 | 0.051 | 0.052 | 0.050 | 0.052 | 0.048 | 0.059 |
| | $G_i$ | 0.040 | 0.040 | 0.045 | 0.052 | 0.054 | 0.054 | 0.050 |
| | $G_i$* | 0.048 | 0.040 | 0.050 | 0.045 | 0.058 | 0.054 | 0.057 |
| | $H_i$ | 0.033 | 0.045 | 0.046 | 0.052 | 0.049 | 0.052 | 0.045 |
| | $H_i$* | 0.049 | 0.046 | 0.047 | 0.053 | 0.052 | 0.050 | 0.055 |
| | $I_i$ | 0.040 | 0.040 | 0.045 | 0.052 | 0.054 | 0.054 | 0.050 |
| 14 | $c_i$ | 0.048 | 0.043 | 0.060 | 0.042 | 0.049 | 0.055 | 0.060 |
| | $G_i$ | 0.043 | 0.039 | 0.047 | 0.047 | 0.045 | 0.047 | 0.055 |
| | $G_i$* | 0.046 | 0.047 | 0.044 | 0.042 | 0.054 | 0.057 | 0.061 |
| | $H_i$ | 0.044 | 0.039 | 0.041 | 0.052 | 0.050 | 0.042 | 0.059 |
| | $H_i$* | 0.051 | 0.048 | 0.036 | 0.043 | 0.059 | 0.046 | 0.073 |
| | $I_i$ | 0.043 | 0.039 | 0.047 | 0.047 | 0.045 | 0.047 | 0.055 |

Figure B.33 Empirical Size Using CWF Connectivity Case for a 14x14 Study Area

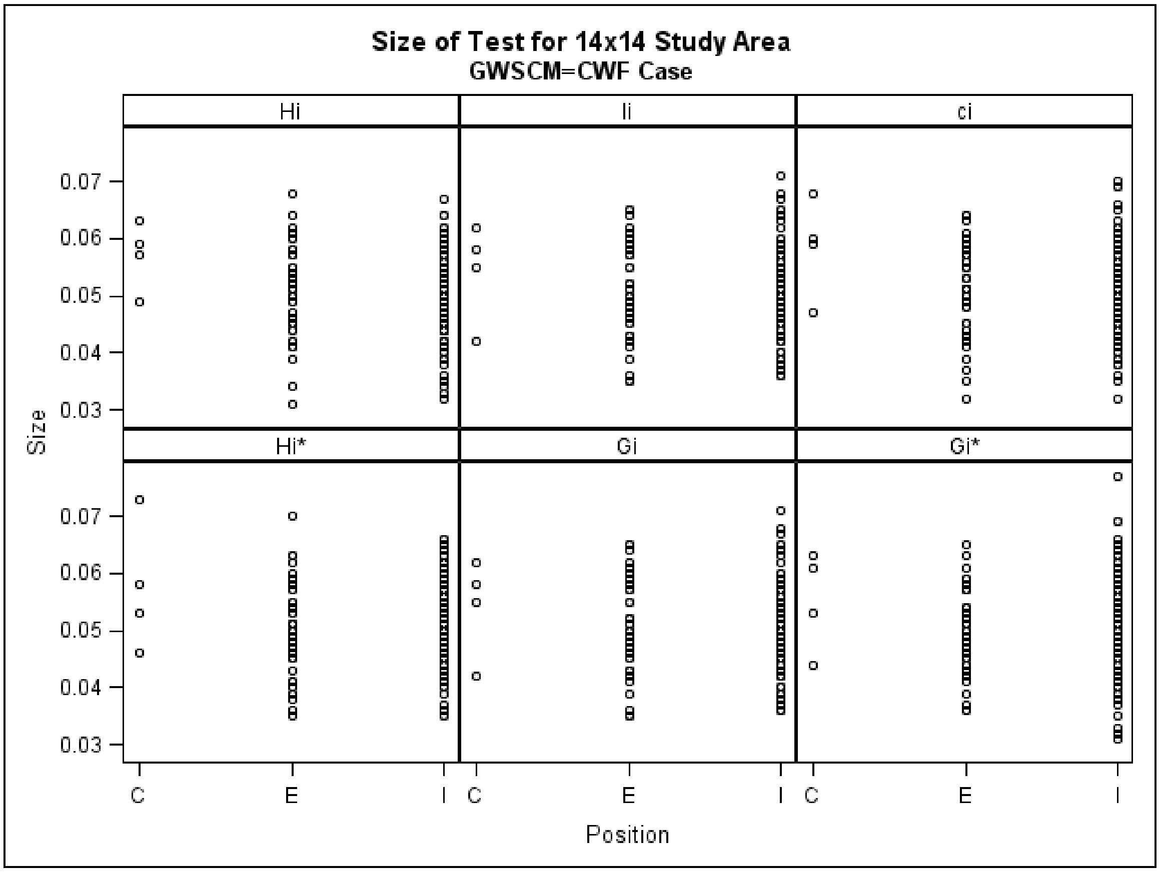


Table B.34 Empirical Power Based on Rook Pattern Variance-Covariance Matrix Using Rook Connectivity Case for a 14x14 Study Area

| | | Column | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1 | $c_i$ | 0.212 | 0.243 | 0.203 | 0.219 | 0.186 | 0.203 | 0.224 |
| | $G_i$ | 0.088 | 0.091 | 0.068 | 0.078 | 0.079 | 0.073 | 0.068 |
| | $G_i$* | 0.141 | 0.142 | 0.125 | 0.129 | 0.125 | 0.126 | 0.128 |
| | $H_i$ | 0.189 | 0.203 | 0.200 | 0.223 | 0.208 | 0.204 | 0.217 |
| | $H_i$* | 0.131 | 0.145 | 0.136 | 0.149 | 0.147 | 0.124 | 0.141 |
| | $I_i$ | 0.161 | 0.162 | 0.147 | 0.157 | 0.152 | 0.166 | 0.150 |
| 2 | $c_i$ | 0.241 | 0.250 | 0.249 | 0.238 | 0.251 | 0.259 | 0.234 |
| | $G_i$ | 0.093 | 0.100 | 0.087 | 0.084 | 0.096 | 0.089 | 0.089 |
| | $G_i$* | 0.153 | 0.154 | 0.138 | 0.138 | 0.146 | 0.136 | 0.137 |
| | $H_i$ | 0.228 | 0.232 | 0.226 | 0.239 | 0.231 | 0.242 | 0.224 |
| | $H_i$* | 0.138 | 0.132 | 0.135 | 0.135 | 0.135 | 0.127 | 0.117 |
| | $I_i$ | 0.178 | 0.187 | 0.177 | 0.176 | 0.178 | 0.189 | 0.186 |
| 3 | $c_i$ | 0.232 | 0.242 | 0.224 | 0.217 | 0.241 | 0.247 | 0.225 |
| | $G_i$ | 0.089 | 0.097 | 0.092 | 0.071 | 0.091 | 0.086 | 0.081 |
| | $G_i$* | 0.150 | 0.145 | 0.135 | 0.113 | 0.152 | 0.141 | 0.122 |
| | $H_i$ | 0.211 | 0.234 | 0.221 | 0.206 | 0.218 | 0.261 | 0.245 |
| | $H_i$* | 0.130 | 0.133 | 0.106 | 0.118 | 0.126 | 0.131 | 0.134 |
| | $I_i$ | 0.166 | 0.185 | 0.182 | 0.151 | 0.185 | 0.190 | 0.186 |
| 4 | $c_i$ | 0.230 | 0.220 | 0.235 | 0.237 | 0.230 | 0.212 | 0.223 |
| | $G_i$ | 0.101 | 0.091 | 0.080 | 0.082 | 0.074 | 0.077 | 0.074 |
| | $G_i$* | 0.147 | 0.140 | 0.126 | 0.126 | 0.136 | 0.119 | 0.118 |
| | $H_i$ | 0.209 | 0.225 | 0.230 | 0.210 | 0.224 | 0.215 | 0.215 |
| | $H_i$* | 0.126 | 0.134 | 0.147 | 0.120 | 0.122 | 0.116 | 0.121 |
| | $I_i$ | 0.166 | 0.168 | 0.161 | 0.158 | 0.167 | 0.169 | 0.182 |
| 5 | $c_i$ | 0.217 | 0.225 | 0.234 | 0.220 | 0.235 | 0.216 | 0.231 |
| | $G_i$ | 0.086 | 0.090 | 0.089 | 0.089 | 0.091 | 0.076 | 0.070 |
| | $G_i$* | 0.136 | 0.134 | 0.144 | 0.133 | 0.141 | 0.119 | 0.115 |
| | $H_i$ | 0.213 | 0.211 | 0.228 | 0.229 | 0.231 | 0.222 | 0.243 |
| | $H_i$* | 0.130 | 0.123 | 0.120 | 0.123 | 0.112 | 0.121 | 0.132 |
| | $I_i$ | 0.164 | 0.172 | 0.196 | 0.178 | 0.180 | 0.178 | 0.179 |
| 6 | $c_i$ | 0.234 | 0.233 | 0.248 | 0.248 | 0.246 | 0.257 | 0.230 |
| | $G_i$ | 0.073 | 0.097 | 0.095 | 0.100 | 0.098 | 0.090 | 0.088 |
| | $G_i$* | 0.120 | 0.134 | 0.136 | 0.137 | 0.151 | 0.133 | 0.137 |
| | $H_i$ | 0.211 | 0.241 | 0.240 | 0.246 | 0.258 | 0.244 | 0.233 |
| | $H_i$* | 0.135 | 0.128 | 0.121 | 0.145 | 0.134 | 0.139 | 0.159 |
| | $I_i$ | 0.156 | 0.189 | 0.195 | 0.203 | 0.203 | 0.194 | 0.180 |
| 7 | $c_i$ | 0.214 | 0.249 | 0.217 | 0.251 | 0.246 | 0.253 | 0.240 |
| | $G_i$ | 0.083 | 0.088 | 0.097 | 0.087 | 0.097 | 0.096 | 0.094 |
| | $G_i$* | 0.134 | 0.129 | 0.140 | 0.129 | 0.145 | 0.143 | 0.144 |
| | $H_i$ | 0.222 | 0.228 | 0.233 | 0.243 | 0.250 | 0.243 | 0.234 |
| | $H_i$* | 0.160 | 0.126 | 0.119 | 0.135 | 0.140 | 0.135 | 0.127 |
| | $I_i$ | 0.151 | 0.179 | 0.205 | 0.196 | 0.202 | 0.191 | 0.184 |
| 8 | $c_i$ | 0.229 | 0.239 | 0.247 | 0.206 | 0.225 | 0.227 | 0.236 |

| | | Column | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | $G_i$ | 0.086 | 0.098 | 0.097 | 0.074 | 0.086 | 0.081 | 0.102 |
| | $G_i$* | 0.130 | 0.150 | 0.151 | 0.117 | 0.125 | 0.134 | 0.145 |
| | $H_i$ | 0.221 | 0.234 | 0.254 | 0.244 | 0.241 | 0.218 | 0.237 |
| | $H_i$* | 0.139 | 0.127 | 0.119 | 0.142 | 0.132 | 0.146 | 0.124 |
| | $I_i$ | 0.162 | 0.188 | 0.202 | 0.180 | 0.181 | 0.169 | 0.199 |
| 9 | $c_i$ | 0.220 | 0.230 | 0.229 | 0.216 | 0.217 | 0.211 | 0.230 |
| | $G_i$ | 0.067 | 0.085 | 0.085 | 0.080 | 0.092 | 0.079 | 0.084 |
| | $G_i$* | 0.132 | 0.137 | 0.137 | 0.137 | 0.130 | 0.127 | 0.132 |
| | $H_i$ | 0.196 | 0.233 | 0.235 | 0.239 | 0.232 | 0.227 | 0.222 |
| | $H_i$* | 0.128 | 0.127 | 0.140 | 0.140 | 0.126 | 0.128 | 0.118 |
| | $I_i$ | 0.149 | 0.179 | 0.186 | 0.188 | 0.181 | 0.165 | 0.176 |
| 10 | $c_i$ | 0.216 | 0.240 | 0.225 | 0.237 | 0.218 | 0.250 | 0.237 |
| | $G_i$ | 0.088 | 0.088 | 0.076 | 0.087 | 0.090 | 0.099 | 0.086 |
| | $G_i$* | 0.135 | 0.142 | 0.139 | 0.147 | 0.155 | 0.141 | 0.134 |
| | $H_i$ | 0.221 | 0.231 | 0.213 | 0.235 | 0.232 | 0.243 | 0.217 |
| | $H_i$* | 0.150 | 0.139 | 0.110 | 0.120 | 0.136 | 0.123 | 0.142 |
| | $I_i$ | 0.174 | 0.171 | 0.171 | 0.196 | 0.181 | 0.189 | 0.170 |
| 11 | $c_i$ | 0.225 | 0.226 | 0.219 | 0.237 | 0.214 | 0.248 | 0.247 |
| | $G_i$ | 0.087 | 0.089 | 0.092 | 0.105 | 0.097 | 0.082 | 0.095 |
| | $G_i$* | 0.143 | 0.144 | 0.145 | 0.149 | 0.132 | 0.138 | 0.144 |
| | $H_i$ | 0.235 | 0.228 | 0.224 | 0.242 | 0.239 | 0.223 | 0.224 |
| | $H_i$* | 0.143 | 0.115 | 0.122 | 0.120 | 0.140 | 0.133 | 0.141 |
| | $I_i$ | 0.176 | 0.186 | 0.183 | 0.189 | 0.182 | 0.169 | 0.179 |
| 12 | $c_i$ | 0.231 | 0.214 | 0.223 | 0.230 | 0.219 | 0.231 | 0.242 |
| | $G_i$ | 0.072 | 0.093 | 0.090 | 0.099 | 0.090 | 0.094 | 0.097 |
| | $G_i$* | 0.111 | 0.137 | 0.143 | 0.148 | 0.143 | 0.140 | 0.151 |
| | $H_i$ | 0.220 | 0.222 | 0.203 | 0.220 | 0.214 | 0.213 | 0.231 |
| | $H_i$* | 0.143 | 0.110 | 0.097 | 0.129 | 0.136 | 0.118 | 0.125 |
| | $I_i$ | 0.164 | 0.184 | 0.176 | 0.179 | 0.171 | 0.167 | 0.189 |
| 13 | $c_i$ | 0.225 | 0.221 | 0.243 | 0.242 | 0.246 | 0.218 | 0.231 |
| | $G_i$ | 0.071 | 0.091 | 0.105 | 0.107 | 0.096 | 0.099 | 0.094 |
| | $G_i$* | 0.124 | 0.140 | 0.153 | 0.144 | 0.147 | 0.143 | 0.142 |
| | $H_i$ | 0.210 | 0.223 | 0.242 | 0.262 | 0.222 | 0.217 | 0.222 |
| | $H_i$* | 0.142 | 0.138 | 0.130 | 0.135 | 0.121 | 0.138 | 0.128 |
| | $I_i$ | 0.154 | 0.175 | 0.196 | 0.208 | 0.195 | 0.170 | 0.176 |
| 14 | $c_i$ | 0.170 | 0.235 | 0.263 | 0.237 | 0.232 | 0.237 | 0.205 |
| | $G_i$ | 0.058 | 0.082 | 0.097 | 0.094 | 0.094 | 0.103 | 0.080 |
| | $G_i$* | 0.118 | 0.143 | 0.176 | 0.143 | 0.146 | 0.142 | 0.131 |
| | $H_i$ | 0.170 | 0.218 | 0.245 | 0.226 | 0.246 | 0.258 | 0.218 |
| | $H_i$* | 0.143 | 0.137 | 0.156 | 0.146 | 0.134 | 0.147 | 0.147 |
| | $I_i$ | 0.121 | 0.155 | 0.179 | 0.183 | 0.188 | 0.193 | 0.164 |

| | | Column | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 1 | $c_i$ | 0.232 | 0.222 | 0.230 | 0.227 | 0.218 | 0.249 | 0.236 |
| | $G_i$ | 0.082 | 0.101 | 0.085 | 0.095 | 0.083 | 0.078 | 0.072 |
| | $G_i$* | 0.141 | 0.146 | 0.147 | 0.154 | 0.145 | 0.139 | 0.132 |
| | $H_i$ | 0.214 | 0.222 | 0.217 | 0.217 | 0.223 | 0.224 | 0.197 |
| | $H_i$* | 0.137 | 0.150 | 0.148 | 0.155 | 0.154 | 0.153 | 0.161 |
| | $I_i$ | 0.166 | 0.183 | 0.167 | 0.170 | 0.172 | 0.166 | 0.159 |
| 2 | $c_i$ | 0.223 | 0.231 | 0.248 | 0.260 | 0.243 | 0.240 | 0.239 |
| | $G_i$ | 0.089 | 0.096 | 0.093 | 0.111 | 0.107 | 0.096 | 0.084 |
| | $G_i$* | 0.158 | 0.157 | 0.167 | 0.163 | 0.161 | 0.150 | 0.140 |
| | $H_i$ | 0.241 | 0.233 | 0.228 | 0.238 | 0.252 | 0.228 | 0.229 |
| | $H_i$* | 0.131 | 0.131 | 0.150 | 0.135 | 0.139 | 0.136 | 0.160 |
| | $I_i$ | 0.186 | 0.181 | 0.175 | 0.202 | 0.210 | 0.200 | 0.177 |
| 3 | $c_i$ | 0.229 | 0.219 | 0.217 | 0.214 | 0.251 | 0.259 | 0.210 |
| | $G_i$ | 0.078 | 0.082 | 0.098 | 0.102 | 0.095 | 0.102 | 0.084 |
| | $G_i$* | 0.133 | 0.133 | 0.142 | 0.145 | 0.150 | 0.142 | 0.134 |
| | $H_i$ | 0.223 | 0.212 | 0.215 | 0.219 | 0.244 | 0.262 | 0.210 |
| | $H_i$* | 0.128 | 0.120 | 0.139 | 0.122 | 0.135 | 0.137 | 0.131 |
| | $I_i$ | 0.163 | 0.156 | 0.168 | 0.178 | 0.189 | 0.206 | 0.164 |
| 4 | $c_i$ | 0.254 | 0.238 | 0.210 | 0.231 | 0.225 | 0.254 | 0.221 |
| | $G_i$ | 0.080 | 0.092 | 0.087 | 0.094 | 0.104 | 0.110 | 0.082 |
| | $G_i$* | 0.126 | 0.140 | 0.149 | 0.141 | 0.158 | 0.157 | 0.129 |
| | $H_i$ | 0.224 | 0.211 | 0.205 | 0.212 | 0.255 | 0.254 | 0.238 |
| | $H_i$* | 0.138 | 0.106 | 0.122 | 0.101 | 0.137 | 0.121 | 0.137 |
| | $I_i$ | 0.173 | 0.171 | 0.158 | 0.166 | 0.195 | 0.220 | 0.180 |
| 5 | $c_i$ | 0.237 | 0.223 | 0.210 | 0.204 | 0.226 | 0.240 | 0.205 |
| | $G_i$ | 0.077 | 0.077 | 0.082 | 0.093 | 0.102 | 0.092 | 0.084 |
| | $G_i$* | 0.118 | 0.128 | 0.133 | 0.131 | 0.150 | 0.149 | 0.133 |
| | $H_i$ | 0.229 | 0.226 | 0.205 | 0.218 | 0.236 | 0.251 | 0.227 |
| | $H_i$* | 0.128 | 0.117 | 0.118 | 0.125 | 0.121 | 0.139 | 0.137 |
| | $I_i$ | 0.187 | 0.178 | 0.163 | 0.168 | 0.190 | 0.197 | 0.182 |
| 6 | $c_i$ | 0.212 | 0.220 | 0.247 | 0.223 | 0.241 | 0.244 | 0.228 |
| | $G_i$ | 0.072 | 0.086 | 0.102 | 0.088 | 0.107 | 0.093 | 0.081 |
| | $G_i$* | 0.122 | 0.129 | 0.141 | 0.146 | 0.157 | 0.141 | 0.130 |
| | $H_i$ | 0.225 | 0.221 | 0.246 | 0.228 | 0.217 | 0.254 | 0.228 |
| | $H_i$* | 0.148 | 0.120 | 0.123 | 0.135 | 0.121 | 0.141 | 0.151 |
| | $I_i$ | 0.168 | 0.181 | 0.189 | 0.170 | 0.191 | 0.202 | 0.175 |
| 7 | $c_i$ | 0.261 | 0.242 | 0.257 | 0.247 | 0.236 | 0.246 | 0.233 |
| | $G_i$ | 0.100 | 0.087 | 0.094 | 0.099 | 0.094 | 0.093 | 0.089 |
| | $G_i$* | 0.151 | 0.137 | 0.145 | 0.143 | 0.142 | 0.149 | 0.143 |
| | $H_i$ | 0.230 | 0.229 | 0.233 | 0.230 | 0.219 | 0.228 | 0.231 |
| | $H_i$* | 0.121 | 0.133 | 0.111 | 0.132 | 0.131 | 0.133 | 0.157 |
| | $I_i$ | 0.197 | 0.182 | 0.191 | 0.188 | 0.171 | 0.183 | 0.183 |
| 8 | $c_i$ | 0.276 | 0.218 | 0.214 | 0.258 | 0.211 | 0.218 | 0.212 |
| | $G_i$ | 0.117 | 0.090 | 0.097 | 0.097 | 0.080 | 0.083 | 0.084 |
| | $G_i$* | 0.169 | 0.141 | 0.134 | 0.148 | 0.140 | 0.129 | 0.135 |
| | $H_i$ | 0.257 | 0.241 | 0.235 | 0.233 | 0.225 | 0.220 | 0.239 |
| | $H_i$* | 0.131 | 0.149 | 0.148 | 0.109 | 0.133 | 0.114 | 0.136 |

| | | Column | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| | $I_i$ | 0.225 | 0.182 | 0.194 | 0.193 | 0.174 | 0.173 | 0.174 |
| 9 | $c_i$ | 0.241 | 0.229 | 0.225 | 0.232 | 0.220 | 0.232 | 0.200 |
| | $G_i$ | 0.096 | 0.088 | 0.091 | 0.098 | 0.100 | 0.089 | 0.081 |
| | $G_i$* | 0.153 | 0.121 | 0.137 | 0.158 | 0.143 | 0.128 | 0.137 |
| | $H_i$ | 0.253 | 0.223 | 0.216 | 0.238 | 0.222 | 0.219 | 0.203 |
| | $H_i$* | 0.130 | 0.113 | 0.118 | 0.116 | 0.134 | 0.125 | 0.126 |
| | $I_i$ | 0.196 | 0.182 | 0.177 | 0.185 | 0.181 | 0.178 | 0.160 |
| 10 | $c_i$ | 0.234 | 0.237 | 0.206 | 0.227 | 0.235 | 0.233 | 0.201 |
| | $G_i$ | 0.077 | 0.082 | 0.092 | 0.098 | 0.101 | 0.110 | 0.094 |
| | $G_i$* | 0.139 | 0.130 | 0.131 | 0.151 | 0.155 | 0.151 | 0.147 |
| | $H_i$ | 0.232 | 0.236 | 0.230 | 0.233 | 0.245 | 0.229 | 0.210 |
| | $H_i$* | 0.136 | 0.136 | 0.144 | 0.148 | 0.136 | 0.117 | 0.140 |
| | $I_i$ | 0.177 | 0.173 | 0.189 | 0.179 | 0.178 | 0.180 | 0.165 |
| 11 | $c_i$ | 0.253 | 0.245 | 0.243 | 0.198 | 0.226 | 0.230 | 0.216 |
| | $G_i$ | 0.096 | 0.086 | 0.081 | 0.097 | 0.109 | 0.112 | 0.101 |
| | $G_i$* | 0.151 | 0.143 | 0.126 | 0.140 | 0.152 | 0.163 | 0.149 |
| | $H_i$ | 0.255 | 0.240 | 0.223 | 0.224 | 0.224 | 0.237 | 0.230 |
| | $H_i$* | 0.132 | 0.138 | 0.136 | 0.138 | 0.119 | 0.137 | 0.135 |
| | $I_i$ | 0.185 | 0.181 | 0.172 | 0.175 | 0.185 | 0.185 | 0.183 |
| 12 | $c_i$ | 0.252 | 0.246 | 0.223 | 0.241 | 0.242 | 0.245 | 0.230 |
| | $G_i$ | 0.098 | 0.085 | 0.079 | 0.088 | 0.107 | 0.100 | 0.094 |
| | $G_i$* | 0.143 | 0.131 | 0.127 | 0.147 | 0.151 | 0.150 | 0.141 |
| | $H_i$ | 0.244 | 0.237 | 0.203 | 0.229 | 0.253 | 0.242 | 0.234 |
| | $H_i$* | 0.137 | 0.143 | 0.104 | 0.132 | 0.147 | 0.143 | 0.128 |
| | $I_i$ | 0.199 | 0.186 | 0.172 | 0.177 | 0.197 | 0.192 | 0.193 |
| 13 | $c_i$ | 0.237 | 0.232 | 0.240 | 0.240 | 0.239 | 0.230 | 0.228 |
| | $G_i$ | 0.102 | 0.088 | 0.088 | 0.097 | 0.100 | 0.095 | 0.081 |
| | $G_i$* | 0.152 | 0.135 | 0.127 | 0.140 | 0.146 | 0.151 | 0.139 |
| | $H_i$ | 0.254 | 0.235 | 0.230 | 0.246 | 0.236 | 0.239 | 0.235 |
| | $H_i$* | 0.118 | 0.139 | 0.137 | 0.130 | 0.125 | 0.130 | 0.146 |
| | $I_i$ | 0.209 | 0.195 | 0.183 | 0.200 | 0.200 | 0.193 | 0.187 |
| 14 | $c_i$ | 0.228 | 0.227 | 0.223 | 0.217 | 0.214 | 0.243 | 0.186 |
| | $G_i$ | 0.088 | 0.088 | 0.086 | 0.084 | 0.086 | 0.092 | 0.067 |
| | $G_i$* | 0.141 | 0.143 | 0.139 | 0.141 | 0.151 | 0.150 | 0.132 |
| | $H_i$ | 0.213 | 0.240 | 0.218 | 0.228 | 0.218 | 0.223 | 0.200 |
| | $H_i$* | 0.119 | 0.159 | 0.142 | 0.149 | 0.142 | 0.122 | 0.153 |
| | $I_i$ | 0.182 | 0.177 | 0.164 | 0.171 | 0.167 | 0.177 | 0.147 |

Figure B.34 Empirical Power Based on Rook Pattern Variance-Covariance Matrix Using Rook Connectivity Case for a 14x14 Study Area

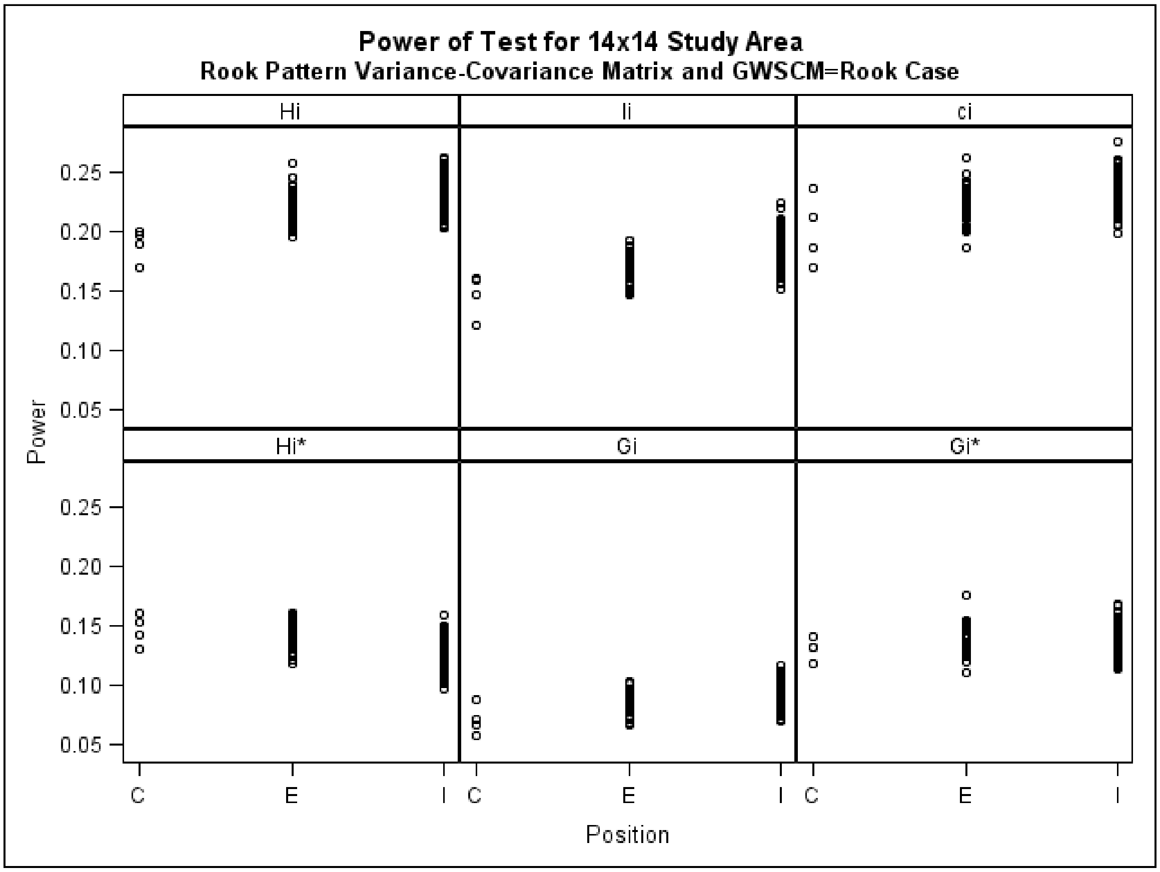


Table B.35 Empirical Power Based on Rook Pattern Variance-Covariance Matrix Using Queen Connectivity Case for a 14x14 Study Area

| | | Column | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1 | $c_i$ | 0.264 | 0.316 | 0.248 | 0.284 | 0.247 | 0.263 | 0.282 |
| | $G_i$ | 0.129 | 0.132 | 0.124 | 0.128 | 0.129 | 0.123 | 0.122 |
| | $G_i$* | 0.156 | 0.162 | 0.155 | 0.151 | 0.149 | 0.154 | 0.155 |
| | $H_i$ | 0.175 | 0.204 | 0.180 | 0.215 | 0.207 | 0.199 | 0.210 |
| | $H_i$* | 0.119 | 0.122 | 0.103 | 0.128 | 0.127 | 0.113 | 0.130 |
| | $I_i$ | 0.219 | 0.235 | 0.222 | 0.225 | 0.228 | 0.235 | 0.239 |
| 2 | $c_i$ | 0.319 | 0.322 | 0.321 | 0.306 | 0.304 | 0.295 | 0.295 |
| | $G_i$ | 0.146 | 0.160 | 0.151 | 0.144 | 0.133 | 0.130 | 0.124 |
| | $G_i$* | 0.177 | 0.179 | 0.168 | 0.165 | 0.169 | 0.169 | 0.159 |
| | $H_i$ | 0.215 | 0.255 | 0.236 | 0.251 | 0.231 | 0.238 | 0.221 |
| | $H_i$* | 0.124 | 0.121 | 0.117 | 0.119 | 0.118 | 0.121 | 0.116 |
| | $I_i$ | 0.265 | 0.286 | 0.262 | 0.270 | 0.260 | 0.260 | 0.261 |
| 3 | $c_i$ | 0.299 | 0.286 | 0.288 | 0.285 | 0.295 | 0.302 | 0.264 |
| | $G_i$ | 0.152 | 0.155 | 0.131 | 0.135 | 0.139 | 0.140 | 0.122 |
| | $G_i$* | 0.170 | 0.171 | 0.166 | 0.154 | 0.170 | 0.151 | 0.142 |
| | $H_i$ | 0.205 | 0.242 | 0.220 | 0.220 | 0.228 | 0.254 | 0.238 |
| | $H_i$* | 0.110 | 0.118 | 0.092 | 0.106 | 0.110 | 0.119 | 0.121 |
| | $I_i$ | 0.244 | 0.271 | 0.255 | 0.250 | 0.268 | 0.272 | 0.250 |
| 4 | $c_i$ | 0.281 | 0.284 | 0.300 | 0.279 | 0.277 | 0.268 | 0.272 |
| | $G_i$ | 0.138 | 0.142 | 0.128 | 0.128 | 0.118 | 0.126 | 0.127 |
| | $G_i$* | 0.165 | 0.164 | 0.152 | 0.151 | 0.149 | 0.147 | 0.147 |
| | $H_i$ | 0.207 | 0.231 | 0.236 | 0.218 | 0.210 | 0.208 | 0.240 |
| | $H_i$* | 0.111 | 0.127 | 0.124 | 0.109 | 0.101 | 0.111 | 0.106 |
| | $I_i$ | 0.235 | 0.254 | 0.241 | 0.240 | 0.243 | 0.253 | 0.268 |
| 5 | $c_i$ | 0.275 | 0.297 | 0.287 | 0.282 | 0.298 | 0.287 | 0.271 |
| | $G_i$ | 0.127 | 0.138 | 0.139 | 0.147 | 0.140 | 0.136 | 0.115 |
| | $G_i$* | 0.153 | 0.164 | 0.158 | 0.175 | 0.159 | 0.151 | 0.135 |
| | $H_i$ | 0.196 | 0.229 | 0.241 | 0.225 | 0.246 | 0.229 | 0.243 |
| | $H_i$* | 0.110 | 0.129 | 0.111 | 0.119 | 0.102 | 0.114 | 0.121 |
| | $I_i$ | 0.240 | 0.262 | 0.264 | 0.262 | 0.278 | 0.270 | 0.261 |
| 6 | $c_i$ | 0.274 | 0.321 | 0.314 | 0.293 | 0.300 | 0.302 | 0.294 |
| | $G_i$ | 0.124 | 0.140 | 0.147 | 0.148 | 0.142 | 0.138 | 0.137 |
| | $G_i$* | 0.144 | 0.170 | 0.177 | 0.172 | 0.172 | 0.156 | 0.161 |
| | $H_i$ | 0.200 | 0.253 | 0.256 | 0.259 | 0.247 | 0.250 | 0.259 |
| | $H_i$* | 0.122 | 0.117 | 0.125 | 0.141 | 0.124 | 0.136 | 0.136 |
| | $I_i$ | 0.231 | 0.271 | 0.290 | 0.284 | 0.278 | 0.278 | 0.270 |
| 7 | $c_i$ | 0.265 | 0.303 | 0.283 | 0.285 | 0.310 | 0.301 | 0.295 |
| | $G_i$ | 0.122 | 0.134 | 0.141 | 0.140 | 0.147 | 0.147 | 0.134 |
| | $G_i$* | 0.158 | 0.162 | 0.167 | 0.168 | 0.167 | 0.170 | 0.161 |
| | $H_i$ | 0.198 | 0.233 | 0.245 | 0.253 | 0.239 | 0.246 | 0.238 |
| | $H_i$* | 0.133 | 0.112 | 0.109 | 0.133 | 0.118 | 0.130 | 0.114 |
| | $I_i$ | 0.223 | 0.273 | 0.285 | 0.267 | 0.294 | 0.275 | 0.263 |
| 8 | $c_i$ | 0.282 | 0.294 | 0.281 | 0.281 | 0.283 | 0.301 | 0.288 |

| | | Column | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | $G_i$ | 0.130 | 0.143 | 0.146 | 0.134 | 0.124 | 0.144 | 0.158 |
| | $G_i$* | 0.157 | 0.166 | 0.165 | 0.155 | 0.149 | 0.169 | 0.172 |
| | $H_i$ | 0.214 | 0.217 | 0.262 | 0.251 | 0.218 | 0.238 | 0.244 |
| | $H_i$* | 0.136 | 0.114 | 0.105 | 0.126 | 0.115 | 0.127 | 0.102 |
| | $I_i$ | 0.230 | 0.266 | 0.284 | 0.277 | 0.247 | 0.257 | 0.275 |
| 9 | $c_i$ | 0.258 | 0.295 | 0.262 | 0.275 | 0.266 | 0.258 | 0.265 |
| | $G_i$ | 0.125 | 0.141 | 0.129 | 0.131 | 0.125 | 0.137 | 0.149 |
| | $G_i$* | 0.158 | 0.164 | 0.160 | 0.146 | 0.152 | 0.168 | 0.170 |
| | $H_i$ | 0.196 | 0.249 | 0.234 | 0.251 | 0.215 | 0.230 | 0.230 |
| | $H_i$* | 0.115 | 0.122 | 0.127 | 0.121 | 0.107 | 0.123 | 0.102 |
| | $I_i$ | 0.237 | 0.270 | 0.257 | 0.268 | 0.250 | 0.256 | 0.265 |
| 10 | $c_i$ | 0.279 | 0.296 | 0.281 | 0.287 | 0.293 | 0.296 | 0.291 |
| | $G_i$ | 0.134 | 0.151 | 0.137 | 0.146 | 0.133 | 0.151 | 0.155 |
| | $G_i$* | 0.161 | 0.170 | 0.164 | 0.169 | 0.174 | 0.176 | 0.176 |
| | $H_i$ | 0.219 | 0.241 | 0.243 | 0.239 | 0.249 | 0.242 | 0.240 |
| | $H_i$* | 0.135 | 0.129 | 0.117 | 0.108 | 0.129 | 0.114 | 0.138 |
| | $I_i$ | 0.253 | 0.270 | 0.265 | 0.274 | 0.268 | 0.283 | 0.278 |
| 11 | $c_i$ | 0.278 | 0.292 | 0.273 | 0.283 | 0.281 | 0.288 | 0.316 |
| | $G_i$ | 0.121 | 0.146 | 0.138 | 0.155 | 0.145 | 0.137 | 0.163 |
| | $G_i$* | 0.162 | 0.170 | 0.170 | 0.170 | 0.167 | 0.168 | 0.187 |
| | $H_i$ | 0.224 | 0.252 | 0.233 | 0.242 | 0.233 | 0.232 | 0.241 |
| | $H_i$* | 0.122 | 0.116 | 0.119 | 0.117 | 0.113 | 0.123 | 0.148 |
| | $I_i$ | 0.254 | 0.272 | 0.248 | 0.274 | 0.264 | 0.253 | 0.278 |
| 12 | $c_i$ | 0.267 | 0.282 | 0.276 | 0.287 | 0.265 | 0.272 | 0.281 |
| | $G_i$ | 0.108 | 0.148 | 0.145 | 0.154 | 0.139 | 0.142 | 0.150 |
| | $G_i$* | 0.138 | 0.176 | 0.175 | 0.181 | 0.163 | 0.170 | 0.177 |
| | $H_i$ | 0.196 | 0.229 | 0.217 | 0.230 | 0.230 | 0.221 | 0.236 |
| | $H_i$* | 0.120 | 0.113 | 0.092 | 0.119 | 0.113 | 0.107 | 0.114 |
| | $I_i$ | 0.221 | 0.266 | 0.249 | 0.265 | 0.246 | 0.243 | 0.265 |
| 13 | $c_i$ | 0.286 | 0.275 | 0.316 | 0.288 | 0.303 | 0.286 | 0.275 |
| | $G_i$ | 0.114 | 0.168 | 0.165 | 0.148 | 0.150 | 0.153 | 0.152 |
| | $G_i$* | 0.147 | 0.181 | 0.192 | 0.173 | 0.190 | 0.178 | 0.176 |
| | $H_i$ | 0.189 | 0.256 | 0.252 | 0.256 | 0.245 | 0.238 | 0.232 |
| | $H_i$* | 0.119 | 0.112 | 0.125 | 0.129 | 0.124 | 0.120 | 0.119 |
| | $I_i$ | 0.228 | 0.287 | 0.279 | 0.279 | 0.272 | 0.266 | 0.272 |
| 14 | $c_i$ | 0.235 | 0.273 | 0.311 | 0.278 | 0.294 | 0.298 | 0.248 |
| | $G_i$ | 0.108 | 0.146 | 0.141 | 0.140 | 0.144 | 0.139 | 0.131 |
| | $G_i$* | 0.145 | 0.173 | 0.177 | 0.168 | 0.177 | 0.168 | 0.163 |
| | $H_i$ | 0.160 | 0.209 | 0.234 | 0.215 | 0.211 | 0.237 | 0.203 |
| | $H_i$* | 0.125 | 0.129 | 0.147 | 0.123 | 0.116 | 0.131 | 0.120 |
| | $I_i$ | 0.198 | 0.251 | 0.249 | 0.253 | 0.265 | 0.255 | 0.245 |

| | | Column | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 1 | $c_i$ | 0.273 | 0.273 | 0.281 | 0.289 | 0.266 | 0.308 | 0.305 |
| | $G_i$ | 0.138 | 0.143 | 0.151 | 0.148 | 0.147 | 0.141 | 0.118 |
| | $G_i$* | 0.168 | 0.170 | 0.171 | 0.176 | 0.180 | 0.168 | 0.147 |
| | $H_i$ | 0.211 | 0.215 | 0.221 | 0.226 | 0.229 | 0.239 | 0.202 |
| | $H_i$* | 0.118 | 0.131 | 0.123 | 0.127 | 0.135 | 0.140 | 0.138 |
| | $I_i$ | 0.237 | 0.244 | 0.255 | 0.261 | 0.267 | 0.269 | 0.235 |
| 2 | $c_i$ | 0.295 | 0.291 | 0.300 | 0.299 | 0.312 | 0.316 | 0.305 |
| | $G_i$ | 0.144 | 0.138 | 0.161 | 0.169 | 0.161 | 0.155 | 0.144 |
| | $G_i$* | 0.163 | 0.172 | 0.190 | 0.190 | 0.195 | 0.180 | 0.159 |
| | $H_i$ | 0.240 | 0.231 | 0.254 | 0.244 | 0.259 | 0.254 | 0.235 |
| | $H_i$* | 0.122 | 0.112 | 0.135 | 0.114 | 0.116 | 0.127 | 0.147 |
| | $I_i$ | 0.265 | 0.254 | 0.275 | 0.281 | 0.295 | 0.296 | 0.279 |
| 3 | $c_i$ | 0.278 | 0.266 | 0.263 | 0.275 | 0.254 | 0.306 | 0.263 |
| | $G_i$ | 0.124 | 0.124 | 0.130 | 0.147 | 0.138 | 0.152 | 0.131 |
| | $G_i$* | 0.163 | 0.149 | 0.159 | 0.176 | 0.159 | 0.188 | 0.150 |
| | $H_i$ | 0.224 | 0.217 | 0.211 | 0.215 | 0.235 | 0.259 | 0.223 |
| | $H_i$* | 0.113 | 0.116 | 0.101 | 0.112 | 0.120 | 0.131 | 0.123 |
| | $I_i$ | 0.235 | 0.235 | 0.234 | 0.248 | 0.257 | 0.290 | 0.255 |
| 4 | $c_i$ | 0.288 | 0.267 | 0.259 | 0.273 | 0.269 | 0.303 | 0.278 |
| | $G_i$ | 0.119 | 0.130 | 0.138 | 0.143 | 0.149 | 0.151 | 0.138 |
| | $G_i$* | 0.143 | 0.154 | 0.162 | 0.166 | 0.177 | 0.183 | 0.167 |
| | $H_i$ | 0.220 | 0.220 | 0.214 | 0.203 | 0.248 | 0.257 | 0.235 |
| | $H_i$* | 0.118 | 0.099 | 0.114 | 0.100 | 0.108 | 0.117 | 0.147 |
| | $I_i$ | 0.259 | 0.244 | 0.238 | 0.239 | 0.276 | 0.290 | 0.265 |
| 5 | $c_i$ | 0.288 | 0.276 | 0.268 | 0.249 | 0.281 | 0.288 | 0.251 |
| | $G_i$ | 0.123 | 0.129 | 0.141 | 0.142 | 0.153 | 0.149 | 0.131 |
| | $G_i$* | 0.143 | 0.160 | 0.158 | 0.171 | 0.184 | 0.177 | 0.151 |
| | $H_i$ | 0.245 | 0.239 | 0.206 | 0.228 | 0.243 | 0.266 | 0.202 |
| | $H_i$* | 0.130 | 0.129 | 0.098 | 0.121 | 0.116 | 0.127 | 0.104 |
| | $I_i$ | 0.279 | 0.243 | 0.248 | 0.250 | 0.271 | 0.288 | 0.256 |
| 6 | $c_i$ | 0.284 | 0.261 | 0.283 | 0.281 | 0.287 | 0.307 | 0.277 |
| | $G_i$ | 0.124 | 0.138 | 0.148 | 0.134 | 0.153 | 0.147 | 0.124 |
| | $G_i$* | 0.144 | 0.158 | 0.168 | 0.161 | 0.176 | 0.172 | 0.157 |
| | $H_i$ | 0.237 | 0.222 | 0.250 | 0.236 | 0.243 | 0.271 | 0.228 |
| | $H_i$* | 0.127 | 0.111 | 0.122 | 0.122 | 0.118 | 0.126 | 0.131 |
| | $I_i$ | 0.261 | 0.257 | 0.264 | 0.247 | 0.265 | 0.291 | 0.257 |
| 7 | $c_i$ | 0.319 | 0.303 | 0.281 | 0.292 | 0.276 | 0.310 | 0.280 |
| | $G_i$ | 0.149 | 0.147 | 0.139 | 0.150 | 0.148 | 0.149 | 0.132 |
| | $G_i$* | 0.171 | 0.168 | 0.160 | 0.171 | 0.172 | 0.165 | 0.164 |
| | $H_i$ | 0.248 | 0.245 | 0.256 | 0.249 | 0.227 | 0.237 | 0.229 |
| | $H_i$* | 0.118 | 0.121 | 0.117 | 0.127 | 0.121 | 0.125 | 0.130 |
| | $I_i$ | 0.286 | 0.278 | 0.272 | 0.266 | 0.259 | 0.276 | 0.249 |
| 8 | $c_i$ | 0.309 | 0.288 | 0.265 | 0.319 | 0.254 | 0.284 | 0.263 |
| | $G_i$ | 0.154 | 0.152 | 0.145 | 0.152 | 0.142 | 0.146 | 0.130 |
| | $G_i$* | 0.186 | 0.170 | 0.170 | 0.167 | 0.162 | 0.164 | 0.153 |
| | $H_i$ | 0.258 | 0.255 | 0.238 | 0.257 | 0.222 | 0.227 | 0.196 |
| | $H_i$* | 0.110 | 0.137 | 0.124 | 0.111 | 0.129 | 0.108 | 0.107 |

| | | Column | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| | $I_i$ | 0.298 | 0.275 | 0.274 | 0.272 | 0.246 | 0.259 | 0.235 |
| 9 | $c_i$ | 0.292 | 0.284 | 0.285 | 0.311 | 0.284 | 0.280 | 0.270 |
| | $G_i$ | 0.144 | 0.136 | 0.140 | 0.151 | 0.156 | 0.148 | 0.131 |
| | $G_i$* | 0.168 | 0.155 | 0.157 | 0.183 | 0.179 | 0.166 | 0.156 |
| | $H_i$ | 0.258 | 0.242 | 0.240 | 0.255 | 0.237 | 0.243 | 0.201 |
| | $H_i$* | 0.128 | 0.113 | 0.114 | 0.112 | 0.115 | 0.134 | 0.109 |
| | $I_i$ | 0.269 | 0.258 | 0.262 | 0.261 | 0.265 | 0.266 | 0.244 |
| 10 | $c_i$ | 0.273 | 0.283 | 0.279 | 0.268 | 0.279 | 0.285 | 0.256 |
| | $G_i$ | 0.140 | 0.136 | 0.136 | 0.146 | 0.162 | 0.167 | 0.137 |
| | $G_i$* | 0.157 | 0.158 | 0.160 | 0.172 | 0.183 | 0.189 | 0.164 |
| | $H_i$ | 0.232 | 0.248 | 0.229 | 0.232 | 0.246 | 0.233 | 0.197 |
| | $H_i$* | 0.114 | 0.125 | 0.127 | 0.128 | 0.126 | 0.109 | 0.099 |
| | $I_i$ | 0.265 | 0.259 | 0.247 | 0.243 | 0.271 | 0.266 | 0.230 |
| 11 | $c_i$ | 0.301 | 0.303 | 0.299 | 0.264 | 0.285 | 0.299 | 0.264 |
| | $G_i$ | 0.153 | 0.142 | 0.133 | 0.151 | 0.147 | 0.161 | 0.149 |
| | $G_i$* | 0.175 | 0.165 | 0.159 | 0.163 | 0.180 | 0.190 | 0.180 |
| | $H_i$ | 0.251 | 0.254 | 0.219 | 0.240 | 0.235 | 0.260 | 0.202 |
| | $H_i$* | 0.122 | 0.121 | 0.109 | 0.113 | 0.116 | 0.122 | 0.114 |
| | $I_i$ | 0.277 | 0.281 | 0.249 | 0.258 | 0.246 | 0.287 | 0.255 |
| 12 | $c_i$ | 0.292 | 0.290 | 0.286 | 0.294 | 0.299 | 0.305 | 0.289 |
| | $G_i$ | 0.156 | 0.147 | 0.129 | 0.138 | 0.151 | 0.156 | 0.143 |
| | $G_i$* | 0.173 | 0.167 | 0.143 | 0.168 | 0.177 | 0.185 | 0.169 |
| | $H_i$ | 0.262 | 0.254 | 0.217 | 0.241 | 0.247 | 0.250 | 0.221 |
| | $H_i$* | 0.121 | 0.129 | 0.091 | 0.122 | 0.117 | 0.128 | 0.111 |
| | $I_i$ | 0.285 | 0.286 | 0.255 | 0.256 | 0.260 | 0.281 | 0.256 |
| 13 | $c_i$ | 0.310 | 0.285 | 0.296 | 0.284 | 0.281 | 0.305 | 0.287 |
| | $G_i$ | 0.144 | 0.147 | 0.129 | 0.165 | 0.159 | 0.157 | 0.138 |
| | $G_i$* | 0.177 | 0.164 | 0.159 | 0.184 | 0.187 | 0.183 | 0.169 |
| | $H_i$ | 0.267 | 0.229 | 0.248 | 0.254 | 0.243 | 0.254 | 0.210 |
| | $H_i$* | 0.117 | 0.130 | 0.132 | 0.122 | 0.118 | 0.118 | 0.101 |
| | $I_i$ | 0.294 | 0.286 | 0.261 | 0.281 | 0.278 | 0.281 | 0.258 |
| 14 | $c_i$ | 0.297 | 0.262 | 0.267 | 0.282 | 0.264 | 0.291 | 0.256 |
| | $G_i$ | 0.125 | 0.127 | 0.129 | 0.133 | 0.130 | 0.128 | 0.128 |
| | $G_i$* | 0.161 | 0.158 | 0.167 | 0.166 | 0.166 | 0.158 | 0.157 |
| | $H_i$ | 0.228 | 0.228 | 0.208 | 0.212 | 0.207 | 0.222 | 0.165 |
| | $H_i$* | 0.115 | 0.136 | 0.116 | 0.130 | 0.117 | 0.111 | 0.106 |
| | $I_i$ | 0.249 | 0.243 | 0.240 | 0.258 | 0.238 | 0.248 | 0.244 |

Figure B.35 Empirical Power Based on Rook Pattern Variance-Covariance Matrix Using Queen Connectivity Case for a 14x14 Study Area

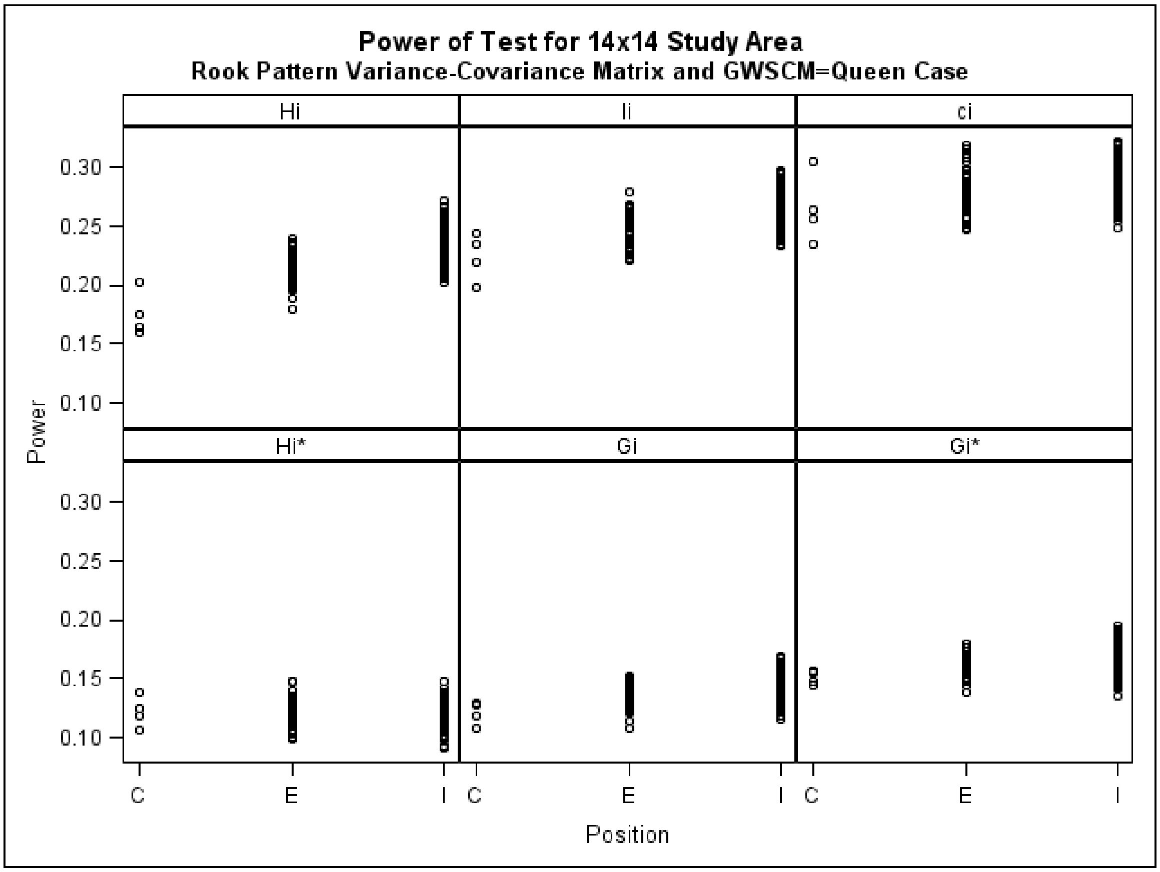


Table B.36 Empirical Power Based on Rook Pattern Variance-Covariance Matrix Using CWF Connectivity Case for a 14x14 Study Area

| | | Column | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1 | $c_i$ | 0.324 | 0.337 | 0.305 | 0.306 | 0.288 | 0.294 | 0.294 |
| | $G_i$ | 0.165 | 0.154 | 0.170 | 0.164 | 0.154 | 0.150 | 0.148 |
| | $G_i$* | 0.178 | 0.164 | 0.170 | 0.164 | 0.169 | 0.177 | 0.172 |
| | $H_i$ | 0.203 | 0.222 | 0.214 | 0.226 | 0.229 | 0.224 | 0.226 |
| | $H_i$* | 0.118 | 0.109 | 0.113 | 0.101 | 0.125 | 0.100 | 0.098 |
| | $I_i$ | 0.266 | 0.267 | 0.275 | 0.254 | 0.266 | 0.270 | 0.272 |
| 2 | $c_i$ | 0.325 | 0.336 | 0.339 | 0.326 | 0.325 | 0.325 | 0.313 |
| | $G_i$ | 0.159 | 0.168 | 0.170 | 0.173 | 0.157 | 0.162 | 0.151 |
| | $G_i$* | 0.191 | 0.189 | 0.194 | 0.185 | 0.181 | 0.184 | 0.180 |
| | $H_i$ | 0.243 | 0.263 | 0.271 | 0.262 | 0.254 | 0.261 | 0.257 |
| | $H_i$* | 0.108 | 0.116 | 0.126 | 0.105 | 0.111 | 0.125 | 0.107 |
| | $I_i$ | 0.281 | 0.298 | 0.302 | 0.300 | 0.290 | 0.294 | 0.286 |
| 3 | $c_i$ | 0.327 | 0.323 | 0.331 | 0.314 | 0.298 | 0.311 | 0.317 |
| | $G_i$ | 0.163 | 0.171 | 0.163 | 0.173 | 0.161 | 0.161 | 0.154 |
| | $G_i$* | 0.183 | 0.191 | 0.187 | 0.180 | 0.182 | 0.183 | 0.167 |
| | $H_i$ | 0.237 | 0.258 | 0.251 | 0.253 | 0.262 | 0.258 | 0.259 |
| | $H_i$* | 0.108 | 0.108 | 0.094 | 0.106 | 0.113 | 0.101 | 0.103 |
| | $I_i$ | 0.272 | 0.285 | 0.300 | 0.297 | 0.303 | 0.297 | 0.279 |
| 4 | $c_i$ | 0.316 | 0.314 | 0.305 | 0.309 | 0.306 | 0.298 | 0.314 |
| | $G_i$ | 0.169 | 0.164 | 0.170 | 0.165 | 0.162 | 0.165 | 0.159 |
| | $G_i$* | 0.180 | 0.183 | 0.176 | 0.175 | 0.182 | 0.168 | 0.175 |
| | $H_i$ | 0.243 | 0.250 | 0.268 | 0.249 | 0.254 | 0.259 | 0.261 |
| | $H_i$* | 0.117 | 0.130 | 0.108 | 0.112 | 0.102 | 0.124 | 0.122 |
| | $I_i$ | 0.290 | 0.286 | 0.291 | 0.279 | 0.285 | 0.297 | 0.300 |
| 5 | $c_i$ | 0.308 | 0.330 | 0.316 | 0.300 | 0.322 | 0.303 | 0.304 |
| | $G_i$ | 0.153 | 0.173 | 0.163 | 0.178 | 0.168 | 0.169 | 0.158 |
| | $G_i$* | 0.167 | 0.180 | 0.188 | 0.187 | 0.197 | 0.181 | 0.166 |
| | $H_i$ | 0.248 | 0.260 | 0.256 | 0.254 | 0.265 | 0.259 | 0.282 |
| | $H_i$* | 0.124 | 0.107 | 0.097 | 0.106 | 0.105 | 0.097 | 0.109 |
| | $I_i$ | 0.273 | 0.296 | 0.288 | 0.300 | 0.310 | 0.310 | 0.309 |
| 6 | $c_i$ | 0.318 | 0.328 | 0.324 | 0.331 | 0.325 | 0.325 | 0.331 |
| | $G_i$ | 0.154 | 0.172 | 0.168 | 0.170 | 0.179 | 0.169 | 0.162 |
| | $G_i$* | 0.177 | 0.187 | 0.199 | 0.188 | 0.194 | 0.183 | 0.191 |
| | $H_i$ | 0.224 | 0.278 | 0.280 | 0.282 | 0.291 | 0.277 | 0.288 |
| | $H_i$* | 0.108 | 0.115 | 0.114 | 0.111 | 0.115 | 0.106 | 0.129 |
| | $I_i$ | 0.272 | 0.304 | 0.321 | 0.313 | 0.319 | 0.325 | 0.308 |
| 7 | $c_i$ | 0.314 | 0.315 | 0.316 | 0.308 | 0.323 | 0.322 | 0.337 |
| | $G_i$ | 0.167 | 0.163 | 0.181 | 0.177 | 0.175 | 0.176 | 0.179 |
| | $G_i$* | 0.185 | 0.177 | 0.188 | 0.188 | 0.180 | 0.188 | 0.188 |
| | $H_i$ | 0.261 | 0.262 | 0.291 | 0.289 | 0.271 | 0.282 | 0.266 |
| | $H_i$* | 0.111 | 0.101 | 0.124 | 0.116 | 0.126 | 0.109 | 0.114 |
| | $I_i$ | 0.290 | 0.313 | 0.332 | 0.308 | 0.317 | 0.309 | 0.326 |
| 8 | $c_i$ | 0.301 | 0.307 | 0.317 | 0.300 | 0.295 | 0.307 | 0.322 |

| | | Column | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | $G_i$ | 0.163 | 0.167 | 0.175 | 0.159 | 0.160 | 0.178 | 0.178 |
| | $G_i$* | 0.176 | 0.183 | 0.197 | 0.179 | 0.176 | 0.190 | 0.196 |
| | $H_i$ | 0.241 | 0.267 | 0.283 | 0.269 | 0.258 | 0.284 | 0.273 |
| | $H_i$* | 0.116 | 0.123 | 0.097 | 0.116 | 0.115 | 0.126 | 0.099 |
| | $I_i$ | 0.275 | 0.313 | 0.324 | 0.301 | 0.300 | 0.312 | 0.308 |
| 9 | $c_i$ | 0.297 | 0.319 | 0.298 | 0.301 | 0.292 | 0.300 | 0.291 |
| | $G_i$ | 0.156 | 0.168 | 0.168 | 0.162 | 0.165 | 0.175 | 0.185 |
| | $G_i$* | 0.167 | 0.183 | 0.192 | 0.177 | 0.174 | 0.189 | 0.189 |
| | $H_i$ | 0.236 | 0.265 | 0.262 | 0.273 | 0.242 | 0.262 | 0.251 |
| | $H_i$* | 0.113 | 0.123 | 0.106 | 0.110 | 0.101 | 0.115 | 0.099 |
| | $I_i$ | 0.276 | 0.293 | 0.301 | 0.301 | 0.292 | 0.301 | 0.310 |
| 10 | $c_i$ | 0.303 | 0.307 | 0.311 | 0.305 | 0.314 | 0.322 | 0.314 |
| | $G_i$ | 0.168 | 0.169 | 0.171 | 0.178 | 0.174 | 0.182 | 0.188 |
| | $G_i$* | 0.172 | 0.192 | 0.188 | 0.188 | 0.189 | 0.198 | 0.211 |
| | $H_i$ | 0.242 | 0.252 | 0.271 | 0.265 | 0.273 | 0.250 | 0.275 |
| | $H_i$* | 0.121 | 0.115 | 0.111 | 0.100 | 0.111 | 0.096 | 0.128 |
| | $I_i$ | 0.282 | 0.294 | 0.299 | 0.297 | 0.311 | 0.309 | 0.315 |
| 11 | $c_i$ | 0.319 | 0.316 | 0.295 | 0.300 | 0.304 | 0.307 | 0.346 |
| | $G_i$ | 0.166 | 0.176 | 0.186 | 0.182 | 0.174 | 0.181 | 0.194 |
| | $G_i$* | 0.180 | 0.196 | 0.197 | 0.193 | 0.195 | 0.195 | 0.212 |
| | $H_i$ | 0.253 | 0.260 | 0.258 | 0.257 | 0.263 | 0.258 | 0.281 |
| | $H_i$* | 0.123 | 0.105 | 0.118 | 0.113 | 0.108 | 0.110 | 0.124 |
| | $I_i$ | 0.304 | 0.303 | 0.292 | 0.289 | 0.293 | 0.288 | 0.317 |
| 12 | $c_i$ | 0.306 | 0.302 | 0.304 | 0.291 | 0.302 | 0.290 | 0.325 |
| | $G_i$ | 0.155 | 0.173 | 0.180 | 0.182 | 0.174 | 0.175 | 0.179 |
| | $G_i$* | 0.168 | 0.193 | 0.200 | 0.192 | 0.191 | 0.192 | 0.201 |
| | $H_i$ | 0.232 | 0.262 | 0.244 | 0.259 | 0.256 | 0.240 | 0.270 |
| | $H_i$* | 0.108 | 0.115 | 0.104 | 0.111 | 0.121 | 0.102 | 0.118 |
| | $I_i$ | 0.262 | 0.285 | 0.284 | 0.303 | 0.286 | 0.274 | 0.307 |
| 13 | $c_i$ | 0.306 | 0.309 | 0.312 | 0.317 | 0.304 | 0.312 | 0.306 |
| | $G_i$ | 0.161 | 0.178 | 0.188 | 0.185 | 0.177 | 0.181 | 0.180 |
| | $G_i$* | 0.170 | 0.202 | 0.202 | 0.206 | 0.201 | 0.199 | 0.200 |
| | $H_i$ | 0.224 | 0.263 | 0.273 | 0.268 | 0.280 | 0.260 | 0.261 |
| | $H_i$* | 0.109 | 0.091 | 0.102 | 0.100 | 0.141 | 0.108 | 0.114 |
| | $I_i$ | 0.270 | 0.299 | 0.309 | 0.325 | 0.301 | 0.306 | 0.308 |
| 14 | $c_i$ | 0.278 | 0.306 | 0.327 | 0.311 | 0.324 | 0.312 | 0.302 |
| | $G_i$ | 0.146 | 0.167 | 0.170 | 0.181 | 0.171 | 0.173 | 0.170 |
| | $G_i$* | 0.160 | 0.190 | 0.194 | 0.193 | 0.192 | 0.189 | 0.186 |
| | $H_i$ | 0.174 | 0.229 | 0.272 | 0.248 | 0.246 | 0.257 | 0.236 |
| | $H_i$* | 0.108 | 0.117 | 0.116 | 0.108 | 0.116 | 0.099 | 0.106 |
| | $I_i$ | 0.240 | 0.284 | 0.296 | 0.290 | 0.294 | 0.294 | 0.284 |

| | | Column | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 1 | $c_i$ | 0.291 | 0.305 | 0.307 | 0.314 | 0.295 | 0.314 | 0.315 |
| | $G_i$ | 0.166 | 0.174 | 0.170 | 0.178 | 0.187 | 0.157 | 0.164 |
| | $G_i$* | 0.179 | 0.191 | 0.182 | 0.186 | 0.194 | 0.188 | 0.172 |
| | $H_i$ | 0.224 | 0.230 | 0.239 | 0.247 | 0.249 | 0.252 | 0.236 |
| | $H_i$* | 0.091 | 0.109 | 0.117 | 0.128 | 0.132 | 0.115 | 0.115 |
| | $I_i$ | 0.266 | 0.259 | 0.274 | 0.298 | 0.307 | 0.282 | 0.287 |
| 2 | $c_i$ | 0.291 | 0.316 | 0.309 | 0.316 | 0.320 | 0.331 | 0.320 |
| | $G_i$ | 0.168 | 0.175 | 0.169 | 0.186 | 0.184 | 0.174 | 0.164 |
| | $G_i$* | 0.173 | 0.198 | 0.199 | 0.197 | 0.211 | 0.194 | 0.185 |
| | $H_i$ | 0.251 | 0.253 | 0.262 | 0.261 | 0.276 | 0.279 | 0.245 |
| | $H_i$* | 0.109 | 0.112 | 0.116 | 0.101 | 0.107 | 0.121 | 0.121 |
| | $I_i$ | 0.293 | 0.285 | 0.284 | 0.294 | 0.319 | 0.324 | 0.299 |
| 3 | $c_i$ | 0.300 | 0.286 | 0.275 | 0.282 | 0.314 | 0.312 | 0.299 |
| | $G_i$ | 0.159 | 0.167 | 0.171 | 0.170 | 0.176 | 0.170 | 0.163 |
| | $G_i$* | 0.180 | 0.179 | 0.186 | 0.200 | 0.203 | 0.199 | 0.177 |
| | $H_i$ | 0.244 | 0.249 | 0.216 | 0.239 | 0.264 | 0.280 | 0.246 |
| | $H_i$* | 0.106 | 0.103 | 0.092 | 0.108 | 0.113 | 0.119 | 0.102 |
| | $I_i$ | 0.280 | 0.276 | 0.267 | 0.269 | 0.303 | 0.324 | 0.295 |
| 4 | $c_i$ | 0.303 | 0.293 | 0.286 | 0.291 | 0.312 | 0.303 | 0.297 |
| | $G_i$ | 0.149 | 0.167 | 0.171 | 0.168 | 0.176 | 0.178 | 0.172 |
| | $G_i$* | 0.169 | 0.189 | 0.177 | 0.177 | 0.196 | 0.205 | 0.189 |
| | $H_i$ | 0.260 | 0.255 | 0.239 | 0.242 | 0.270 | 0.289 | 0.264 |
| | $H_i$* | 0.103 | 0.103 | 0.118 | 0.094 | 0.094 | 0.112 | 0.114 |
| | $I_i$ | 0.295 | 0.274 | 0.266 | 0.275 | 0.297 | 0.321 | 0.309 |
| 5 | $c_i$ | 0.313 | 0.316 | 0.265 | 0.267 | 0.290 | 0.316 | 0.294 |
| | $G_i$ | 0.149 | 0.166 | 0.167 | 0.170 | 0.178 | 0.179 | 0.163 |
| | $G_i$* | 0.169 | 0.174 | 0.180 | 0.182 | 0.207 | 0.189 | 0.176 |
| | $H_i$ | 0.282 | 0.264 | 0.248 | 0.249 | 0.257 | 0.292 | 0.257 |
| | $H_i$* | 0.110 | 0.103 | 0.107 | 0.114 | 0.110 | 0.124 | 0.124 |
| | $I_i$ | 0.322 | 0.295 | 0.284 | 0.274 | 0.298 | 0.321 | 0.307 |
| 6 | $c_i$ | 0.314 | 0.315 | 0.315 | 0.320 | 0.300 | 0.305 | 0.293 |
| | $G_i$ | 0.160 | 0.172 | 0.175 | 0.175 | 0.182 | 0.173 | 0.160 |
| | $G_i$* | 0.179 | 0.185 | 0.201 | 0.192 | 0.208 | 0.185 | 0.181 |
| | $H_i$ | 0.266 | 0.269 | 0.267 | 0.250 | 0.258 | 0.285 | 0.248 |
| | $H_i$* | 0.105 | 0.122 | 0.105 | 0.109 | 0.123 | 0.116 | 0.118 |
| | $I_i$ | 0.311 | 0.307 | 0.296 | 0.289 | 0.285 | 0.312 | 0.293 |
| 7 | $c_i$ | 0.353 | 0.318 | 0.298 | 0.315 | 0.307 | 0.316 | 0.306 |
| | $G_i$ | 0.185 | 0.173 | 0.173 | 0.190 | 0.189 | 0.171 | 0.158 |
| | $G_i$* | 0.202 | 0.181 | 0.196 | 0.199 | 0.205 | 0.195 | 0.178 |
| | $H_i$ | 0.292 | 0.277 | 0.272 | 0.278 | 0.267 | 0.261 | 0.246 |
| | $H_i$* | 0.116 | 0.108 | 0.109 | 0.116 | 0.126 | 0.091 | 0.098 |
| | $I_i$ | 0.323 | 0.307 | 0.290 | 0.304 | 0.316 | 0.306 | 0.274 |
| 8 | $c_i$ | 0.322 | 0.321 | 0.312 | 0.345 | 0.292 | 0.294 | 0.295 |
| | $G_i$ | 0.187 | 0.180 | 0.176 | 0.185 | 0.179 | 0.165 | 0.162 |
| | $G_i$* | 0.200 | 0.198 | 0.201 | 0.196 | 0.188 | 0.185 | 0.183 |
| | $H_i$ | 0.275 | 0.270 | 0.274 | 0.278 | 0.245 | 0.250 | 0.245 |
| | $H_i$* | 0.106 | 0.120 | 0.119 | 0.103 | 0.107 | 0.104 | 0.125 |

| | | Column | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| | $I_i$ | 0.318 | 0.306 | 0.300 | 0.305 | 0.287 | 0.278 | 0.270 |
| 9 | $c_i$ | 0.328 | 0.300 | 0.303 | 0.331 | 0.301 | 0.289 | 0.290 |
| | $G_i$ | 0.188 | 0.180 | 0.180 | 0.177 | 0.199 | 0.185 | 0.165 |
| | $G_i$* | 0.198 | 0.185 | 0.194 | 0.202 | 0.210 | 0.191 | 0.173 |
| | $H_i$ | 0.278 | 0.261 | 0.261 | 0.269 | 0.254 | 0.265 | 0.226 |
| | $H_i$* | 0.106 | 0.110 | 0.111 | 0.108 | 0.106 | 0.108 | 0.109 |
| | $I_i$ | 0.315 | 0.282 | 0.296 | 0.287 | 0.299 | 0.296 | 0.275 |
| 10 | $c_i$ | 0.315 | 0.316 | 0.305 | 0.296 | 0.313 | 0.295 | 0.288 |
| | $G_i$ | 0.179 | 0.170 | 0.173 | 0.181 | 0.186 | 0.195 | 0.172 |
| | $G_i$* | 0.200 | 0.186 | 0.186 | 0.198 | 0.209 | 0.204 | 0.186 |
| | $H_i$ | 0.269 | 0.259 | 0.264 | 0.269 | 0.267 | 0.260 | 0.239 |
| | $H_i$* | 0.112 | 0.110 | 0.104 | 0.103 | 0.121 | 0.107 | 0.113 |
| | $I_i$ | 0.304 | 0.296 | 0.299 | 0.302 | 0.297 | 0.299 | 0.275 |
| 11 | $c_i$ | 0.321 | 0.329 | 0.324 | 0.301 | 0.293 | 0.304 | 0.299 |
| | $G_i$ | 0.187 | 0.180 | 0.177 | 0.172 | 0.181 | 0.176 | 0.188 |
| | $G_i$* | 0.203 | 0.191 | 0.182 | 0.180 | 0.199 | 0.204 | 0.199 |
| | $H_i$ | 0.274 | 0.283 | 0.270 | 0.228 | 0.249 | 0.258 | 0.257 |
| | $H_i$* | 0.125 | 0.113 | 0.113 | 0.107 | 0.091 | 0.108 | 0.115 |
| | $I_i$ | 0.323 | 0.315 | 0.307 | 0.266 | 0.282 | 0.303 | 0.299 |
| 12 | $c_i$ | 0.347 | 0.318 | 0.301 | 0.298 | 0.315 | 0.307 | 0.305 |
| | $G_i$ | 0.181 | 0.177 | 0.156 | 0.176 | 0.176 | 0.181 | 0.182 |
| | $G_i$* | 0.197 | 0.189 | 0.168 | 0.180 | 0.206 | 0.208 | 0.190 |
| | $H_i$ | 0.284 | 0.276 | 0.248 | 0.248 | 0.263 | 0.267 | 0.259 |
| | $H_i$* | 0.115 | 0.119 | 0.102 | 0.103 | 0.108 | 0.113 | 0.108 |
| | $I_i$ | 0.312 | 0.311 | 0.288 | 0.282 | 0.302 | 0.307 | 0.299 |
| 13 | $c_i$ | 0.328 | 0.301 | 0.323 | 0.297 | 0.304 | 0.316 | 0.319 |
| | $G_i$ | 0.177 | 0.169 | 0.161 | 0.182 | 0.183 | 0.178 | 0.169 |
| | $G_i$* | 0.200 | 0.186 | 0.172 | 0.192 | 0.206 | 0.196 | 0.187 |
| | $H_i$ | 0.290 | 0.255 | 0.268 | 0.272 | 0.272 | 0.267 | 0.248 |
| | $H_i$* | 0.112 | 0.111 | 0.105 | 0.107 | 0.114 | 0.112 | 0.103 |
| | $I_i$ | 0.319 | 0.300 | 0.294 | 0.311 | 0.310 | 0.305 | 0.292 |
| 14 | $c_i$ | 0.309 | 0.318 | 0.312 | 0.301 | 0.289 | 0.314 | 0.293 |
| | $G_i$ | 0.158 | 0.166 | 0.157 | 0.175 | 0.172 | 0.155 | 0.159 |
| | $G_i$* | 0.184 | 0.178 | 0.189 | 0.188 | 0.191 | 0.178 | 0.170 |
| | $H_i$ | 0.245 | 0.248 | 0.231 | 0.247 | 0.243 | 0.232 | 0.217 |
| | $H_i$* | 0.096 | 0.099 | 0.119 | 0.106 | 0.117 | 0.104 | 0.124 |
| | $I_i$ | 0.284 | 0.283 | 0.273 | 0.296 | 0.292 | 0.271 | 0.278 |

Figure B.36 Empirical Power Based on Rook Pattern Variance-Covariance Matrix Using CWF Connectivity Case for a 14x14 Study Area

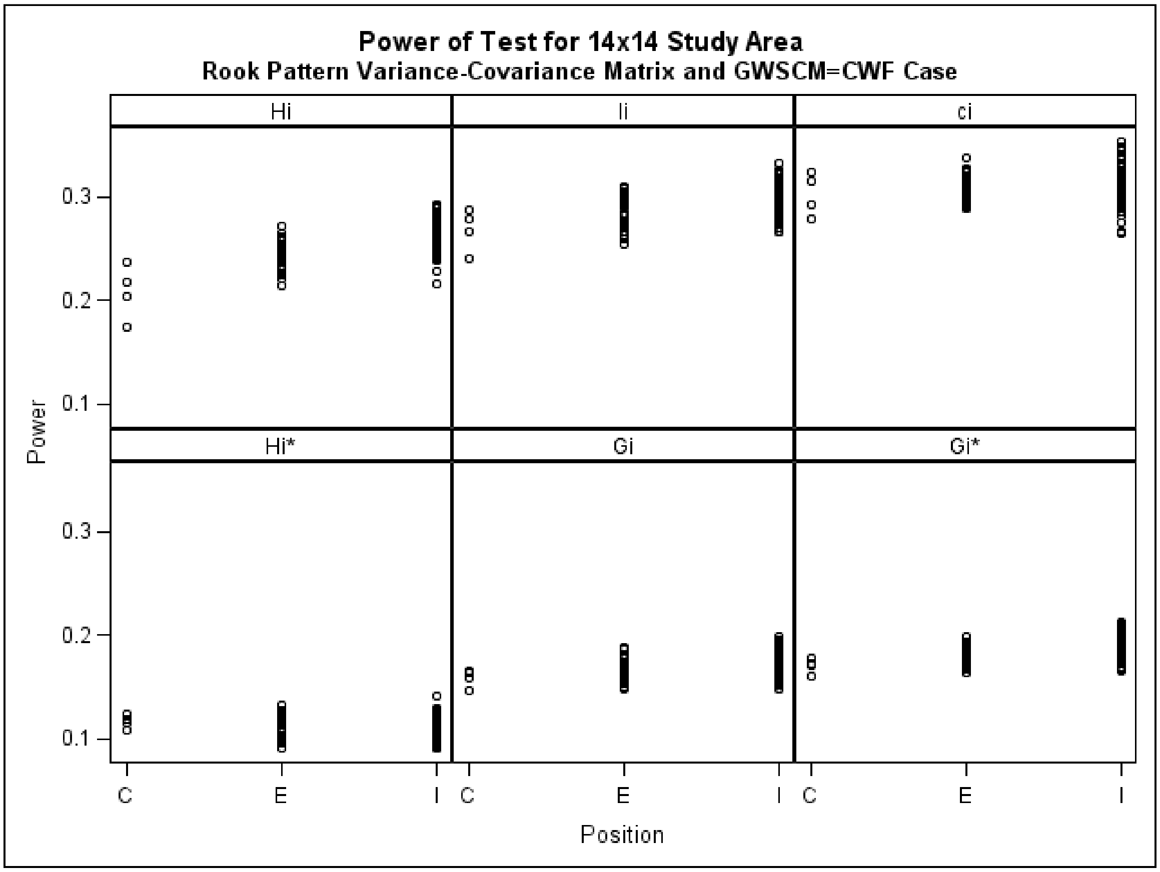


Table B.37 Empirical Power Based on Queen Pattern Variance-Covariance Matrix

Using Rook Connectivity Case for a 14x14 Study Area

| | | Column | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1 | $c_i$ | 0.299 | 0.410 | 0.326 | 0.362 | 0.340 | 0.339 | 0.338 |
| | $G_i$ | 0.116 | 0.128 | 0.100 | 0.110 | 0.113 | 0.111 | 0.109 |
| | $G_i$* | 0.159 | 0.170 | 0.145 | 0.155 | 0.154 | 0.158 | 0.149 |
| | $H_i$ | 0.240 | 0.346 | 0.289 | 0.288 | 0.284 | 0.306 | 0.307 |
| | $H_i$* | 0.190 | 0.264 | 0.238 | 0.193 | 0.203 | 0.208 | 0.211 |
| | $I_i$ | 0.217 | 0.235 | 0.210 | 0.219 | 0.221 | 0.215 | 0.239 |
| 2 | $c_i$ | 0.436 | 0.526 | 0.468 | 0.465 | 0.438 | 0.481 | 0.458 |
| | $G_i$ | 0.130 | 0.142 | 0.132 | 0.129 | 0.131 | 0.136 | 0.133 |
| | $G_i$* | 0.175 | 0.180 | 0.180 | 0.172 | 0.164 | 0.173 | 0.175 |
| | $H_i$ | 0.345 | 0.400 | 0.379 | 0.361 | 0.378 | 0.357 | 0.389 |
| | $H_i$* | 0.246 | 0.269 | 0.260 | 0.213 | 0.239 | 0.241 | 0.221 |
| | $I_i$ | 0.250 | 0.282 | 0.273 | 0.272 | 0.266 | 0.261 | 0.275 |
| 3 | $c_i$ | 0.363 | 0.462 | 0.429 | 0.425 | 0.435 | 0.443 | 0.418 |
| | $G_i$ | 0.128 | 0.141 | 0.133 | 0.132 | 0.143 | 0.134 | 0.128 |
| | $G_i$* | 0.170 | 0.178 | 0.177 | 0.172 | 0.178 | 0.193 | 0.181 |
| | $H_i$ | 0.309 | 0.382 | 0.357 | 0.356 | 0.363 | 0.356 | 0.346 |
| | $H_i$* | 0.211 | 0.238 | 0.222 | 0.218 | 0.218 | 0.229 | 0.207 |
| | $I_i$ | 0.270 | 0.289 | 0.281 | 0.268 | 0.277 | 0.260 | 0.261 |
| 4 | $c_i$ | 0.367 | 0.447 | 0.400 | 0.419 | 0.432 | 0.463 | 0.433 |
| | $G_i$ | 0.111 | 0.128 | 0.122 | 0.106 | 0.131 | 0.138 | 0.127 |
| | $G_i$* | 0.154 | 0.167 | 0.164 | 0.151 | 0.179 | 0.179 | 0.180 |
| | $H_i$ | 0.326 | 0.373 | 0.324 | 0.350 | 0.358 | 0.376 | 0.362 |
| | $H_i$* | 0.219 | 0.234 | 0.206 | 0.236 | 0.230 | 0.234 | 0.226 |
| | $I_i$ | 0.250 | 0.271 | 0.247 | 0.240 | 0.265 | 0.280 | 0.274 |
| 5 | $c_i$ | 0.344 | 0.418 | 0.401 | 0.416 | 0.394 | 0.411 | 0.404 |
| | $G_i$ | 0.102 | 0.125 | 0.130 | 0.119 | 0.121 | 0.117 | 0.115 |
| | $G_i$* | 0.150 | 0.161 | 0.168 | 0.165 | 0.159 | 0.162 | 0.166 |
| | $H_i$ | 0.298 | 0.355 | 0.346 | 0.349 | 0.340 | 0.337 | 0.341 |
| | $H_i$* | 0.226 | 0.218 | 0.209 | 0.222 | 0.197 | 0.207 | 0.212 |
| | $I_i$ | 0.213 | 0.265 | 0.264 | 0.246 | 0.261 | 0.249 | 0.259 |
| 6 | $c_i$ | 0.311 | 0.418 | 0.399 | 0.449 | 0.435 | 0.404 | 0.408 |
| | $G_i$ | 0.105 | 0.130 | 0.121 | 0.126 | 0.127 | 0.121 | 0.115 |
| | $G_i$* | 0.150 | 0.169 | 0.157 | 0.164 | 0.156 | 0.160 | 0.147 |
| | $H_i$ | 0.289 | 0.372 | 0.344 | 0.349 | 0.359 | 0.349 | 0.360 |
| | $H_i$* | 0.216 | 0.248 | 0.197 | 0.210 | 0.206 | 0.231 | 0.217 |
| | $I_i$ | 0.202 | 0.258 | 0.256 | 0.264 | 0.267 | 0.256 | 0.268 |
| 7 | $c_i$ | 0.365 | 0.462 | 0.415 | 0.424 | 0.428 | 0.461 | 0.429 |
| | $G_i$ | 0.120 | 0.146 | 0.149 | 0.133 | 0.120 | 0.125 | 0.113 |
| | $G_i$* | 0.165 | 0.189 | 0.193 | 0.169 | 0.161 | 0.159 | 0.155 |
| | $H_i$ | 0.332 | 0.375 | 0.378 | 0.374 | 0.366 | 0.364 | 0.345 |
| | $H_i$* | 0.228 | 0.212 | 0.222 | 0.246 | 0.257 | 0.221 | 0.223 |
| | $I_i$ | 0.233 | 0.292 | 0.300 | 0.276 | 0.264 | 0.267 | 0.255 |
| 8 | $c_i$ | 0.373 | 0.476 | 0.410 | 0.421 | 0.429 | 0.442 | 0.428 |

| | | Column | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | $G_i$ | 0.122 | 0.142 | 0.136 | 0.138 | 0.121 | 0.123 | 0.137 |
| | $G_i$* | 0.165 | 0.187 | 0.168 | 0.173 | 0.165 | 0.154 | 0.168 |
| | $H_i$ | 0.332 | 0.412 | 0.376 | 0.390 | 0.367 | 0.363 | 0.368 |
| | $H_i$* | 0.248 | 0.242 | 0.244 | 0.259 | 0.233 | 0.230 | 0.245 |
| | $I_i$ | 0.239 | 0.291 | 0.291 | 0.288 | 0.287 | 0.266 | 0.278 |
| 9 | $c_i$ | 0.346 | 0.445 | 0.420 | 0.448 | 0.434 | 0.419 | 0.447 |
| | $G_i$ | 0.116 | 0.130 | 0.132 | 0.144 | 0.140 | 0.136 | 0.144 |
| | $G_i$* | 0.160 | 0.179 | 0.167 | 0.172 | 0.184 | 0.176 | 0.188 |
| | $H_i$ | 0.307 | 0.406 | 0.378 | 0.390 | 0.371 | 0.356 | 0.387 |
| | $H_i$* | 0.215 | 0.238 | 0.224 | 0.229 | 0.240 | 0.233 | 0.215 |
| | $I_i$ | 0.240 | 0.287 | 0.298 | 0.304 | 0.279 | 0.255 | 0.290 |
| 10 | $c_i$ | 0.363 | 0.447 | 0.405 | 0.440 | 0.425 | 0.398 | 0.424 |
| | $G_i$ | 0.112 | 0.132 | 0.137 | 0.130 | 0.138 | 0.141 | 0.159 |
| | $G_i$* | 0.183 | 0.174 | 0.168 | 0.168 | 0.186 | 0.188 | 0.201 |
| | $H_i$ | 0.306 | 0.394 | 0.377 | 0.367 | 0.361 | 0.386 | 0.387 |
| | $H_i$* | 0.225 | 0.237 | 0.220 | 0.232 | 0.227 | 0.238 | 0.224 |
| | $I_i$ | 0.239 | 0.289 | 0.284 | 0.285 | 0.272 | 0.285 | 0.315 |
| 11 | $c_i$ | 0.374 | 0.472 | 0.413 | 0.433 | 0.421 | 0.460 | 0.429 |
| | $G_i$ | 0.129 | 0.149 | 0.127 | 0.118 | 0.143 | 0.150 | 0.151 |
| | $G_i$* | 0.172 | 0.203 | 0.159 | 0.163 | 0.179 | 0.189 | 0.191 |
| | $H_i$ | 0.324 | 0.410 | 0.360 | 0.364 | 0.373 | 0.382 | 0.384 |
| | $H_i$* | 0.237 | 0.235 | 0.224 | 0.233 | 0.242 | 0.226 | 0.249 |
| | $I_i$ | 0.251 | 0.303 | 0.277 | 0.257 | 0.269 | 0.291 | 0.292 |
| 12 | $c_i$ | 0.359 | 0.465 | 0.397 | 0.429 | 0.417 | 0.409 | 0.394 |
| | $G_i$ | 0.114 | 0.146 | 0.132 | 0.125 | 0.128 | 0.125 | 0.120 |
| | $G_i$* | 0.158 | 0.190 | 0.161 | 0.164 | 0.169 | 0.158 | 0.165 |
| | $H_i$ | 0.313 | 0.394 | 0.340 | 0.354 | 0.337 | 0.356 | 0.334 |
| | $H_i$* | 0.221 | 0.219 | 0.220 | 0.224 | 0.228 | 0.222 | 0.226 |
| | $I_i$ | 0.244 | 0.299 | 0.263 | 0.248 | 0.256 | 0.270 | 0.249 |
| 13 | $c_i$ | 0.394 | 0.483 | 0.456 | 0.485 | 0.454 | 0.436 | 0.444 |
| | $G_i$ | 0.110 | 0.137 | 0.146 | 0.146 | 0.140 | 0.132 | 0.124 |
| | $G_i$* | 0.167 | 0.178 | 0.189 | 0.184 | 0.182 | 0.164 | 0.170 |
| | $H_i$ | 0.348 | 0.414 | 0.384 | 0.385 | 0.379 | 0.360 | 0.340 |
| | $H_i$* | 0.248 | 0.252 | 0.219 | 0.216 | 0.241 | 0.218 | 0.210 |
| | $I_i$ | 0.247 | 0.290 | 0.282 | 0.281 | 0.261 | 0.254 | 0.247 |
| 14 | $c_i$ | 0.291 | 0.414 | 0.335 | 0.398 | 0.371 | 0.350 | 0.358 |
| | $G_i$ | 0.108 | 0.126 | 0.133 | 0.131 | 0.130 | 0.113 | 0.110 |
| | $G_i$* | 0.146 | 0.175 | 0.175 | 0.182 | 0.179 | 0.173 | 0.163 |
| | $H_i$ | 0.258 | 0.344 | 0.309 | 0.313 | 0.309 | 0.301 | 0.313 |
| | $H_i$* | 0.202 | 0.238 | 0.215 | 0.218 | 0.235 | 0.229 | 0.231 |
| | $I_i$ | 0.233 | 0.253 | 0.252 | 0.249 | 0.234 | 0.220 | 0.216 |

| | | Column | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 1 | $c_i$ | 0.374 | 0.363 | 0.361 | 0.353 | 0.348 | 0.423 | 0.280 |
| | $G_i$ | 0.107 | 0.121 | 0.117 | 0.123 | 0.130 | 0.130 | 0.112 |
| | $G_i$* | 0.161 | 0.162 | 0.176 | 0.179 | 0.181 | 0.183 | 0.155 |
| | $H_i$ | 0.308 | 0.300 | 0.308 | 0.303 | 0.299 | 0.350 | 0.227 |
| | $H_i$* | 0.194 | 0.207 | 0.225 | 0.219 | 0.214 | 0.251 | 0.173 |
| | $I_i$ | 0.238 | 0.237 | 0.228 | 0.232 | 0.247 | 0.258 | 0.218 |
| 2 | $c_i$ | 0.461 | 0.441 | 0.461 | 0.467 | 0.435 | 0.505 | 0.402 |
| | $G_i$ | 0.135 | 0.136 | 0.141 | 0.153 | 0.153 | 0.156 | 0.134 |
| | $G_i$* | 0.178 | 0.189 | 0.189 | 0.223 | 0.195 | 0.191 | 0.189 |
| | $H_i$ | 0.375 | 0.352 | 0.367 | 0.386 | 0.370 | 0.416 | 0.341 |
| | $H_i$* | 0.212 | 0.203 | 0.229 | 0.231 | 0.219 | 0.250 | 0.259 |
| | $I_i$ | 0.278 | 0.268 | 0.267 | 0.280 | 0.283 | 0.299 | 0.252 |
| 3 | $c_i$ | 0.401 | 0.387 | 0.400 | 0.449 | 0.405 | 0.446 | 0.341 |
| | $G_i$ | 0.130 | 0.125 | 0.137 | 0.160 | 0.149 | 0.157 | 0.125 |
| | $G_i$* | 0.162 | 0.178 | 0.182 | 0.197 | 0.185 | 0.197 | 0.171 |
| | $H_i$ | 0.329 | 0.302 | 0.360 | 0.379 | 0.343 | 0.390 | 0.282 |
| | $H_i$* | 0.207 | 0.188 | 0.220 | 0.235 | 0.217 | 0.226 | 0.196 |
| | $I_i$ | 0.277 | 0.246 | 0.261 | 0.283 | 0.269 | 0.284 | 0.226 |
| 4 | $c_i$ | 0.398 | 0.409 | 0.426 | 0.436 | 0.417 | 0.444 | 0.371 |
| | $G_i$ | 0.112 | 0.109 | 0.127 | 0.143 | 0.144 | 0.148 | 0.130 |
| | $G_i$* | 0.145 | 0.158 | 0.177 | 0.182 | 0.187 | 0.192 | 0.181 |
| | $H_i$ | 0.355 | 0.335 | 0.348 | 0.363 | 0.341 | 0.379 | 0.305 |
| | $H_i$* | 0.215 | 0.230 | 0.213 | 0.207 | 0.225 | 0.236 | 0.220 |
| | $I_i$ | 0.262 | 0.237 | 0.251 | 0.258 | 0.253 | 0.268 | 0.231 |
| 5 | $c_i$ | 0.432 | 0.428 | 0.423 | 0.401 | 0.403 | 0.497 | 0.373 |
| | $G_i$ | 0.112 | 0.116 | 0.141 | 0.130 | 0.136 | 0.163 | 0.139 |
| | $G_i$* | 0.149 | 0.158 | 0.180 | 0.184 | 0.171 | 0.212 | 0.192 |
| | $H_i$ | 0.359 | 0.365 | 0.366 | 0.346 | 0.326 | 0.392 | 0.336 |
| | $H_i$* | 0.220 | 0.217 | 0.224 | 0.206 | 0.202 | 0.203 | 0.237 |
| | $I_i$ | 0.268 | 0.254 | 0.264 | 0.242 | 0.252 | 0.304 | 0.270 |
| 6 | $c_i$ | 0.432 | 0.445 | 0.428 | 0.426 | 0.404 | 0.470 | 0.385 |
| | $G_i$ | 0.108 | 0.133 | 0.128 | 0.125 | 0.136 | 0.156 | 0.128 |
| | $G_i$* | 0.143 | 0.180 | 0.171 | 0.172 | 0.182 | 0.194 | 0.171 |
| | $H_i$ | 0.379 | 0.353 | 0.366 | 0.343 | 0.357 | 0.416 | 0.331 |
| | $H_i$* | 0.227 | 0.210 | 0.233 | 0.222 | 0.225 | 0.251 | 0.239 |
| | $I_i$ | 0.267 | 0.283 | 0.265 | 0.241 | 0.262 | 0.317 | 0.256 |
| 7 | $c_i$ | 0.424 | 0.411 | 0.412 | 0.415 | 0.426 | 0.462 | 0.347 |
| | $G_i$ | 0.111 | 0.117 | 0.130 | 0.138 | 0.136 | 0.142 | 0.128 |
| | $G_i$* | 0.139 | 0.171 | 0.175 | 0.177 | 0.174 | 0.176 | 0.163 |
| | $H_i$ | 0.355 | 0.348 | 0.331 | 0.352 | 0.349 | 0.411 | 0.316 |
| | $H_i$* | 0.229 | 0.192 | 0.204 | 0.230 | 0.228 | 0.246 | 0.227 |
| | $I_i$ | 0.252 | 0.258 | 0.255 | 0.267 | 0.269 | 0.310 | 0.263 |
| 8 | $c_i$ | 0.403 | 0.411 | 0.421 | 0.428 | 0.424 | 0.446 | 0.359 |
| | $G_i$ | 0.132 | 0.141 | 0.145 | 0.154 | 0.138 | 0.136 | 0.111 |
| | $G_i$* | 0.176 | 0.177 | 0.181 | 0.194 | 0.184 | 0.178 | 0.149 |
| | $H_i$ | 0.361 | 0.357 | 0.353 | 0.372 | 0.362 | 0.388 | 0.318 |
| | $H_i$* | 0.248 | 0.206 | 0.221 | 0.236 | 0.224 | 0.231 | 0.233 |

| | | Column | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| | $I_i$ | 0.255 | 0.275 | 0.276 | 0.285 | 0.274 | 0.290 | 0.235 |
| 9 | $c_i$ | 0.439 | 0.405 | 0.434 | 0.443 | 0.422 | 0.467 | 0.354 |
| | $G_i$ | 0.151 | 0.144 | 0.147 | 0.149 | 0.144 | 0.141 | 0.108 |
| | $G_i$* | 0.185 | 0.189 | 0.192 | 0.203 | 0.197 | 0.182 | 0.167 |
| | $H_i$ | 0.380 | 0.390 | 0.367 | 0.362 | 0.391 | 0.397 | 0.290 |
| | $H_i$* | 0.240 | 0.226 | 0.193 | 0.214 | 0.219 | 0.231 | 0.211 |
| | $I_i$ | 0.294 | 0.293 | 0.288 | 0.286 | 0.296 | 0.286 | 0.238 |
| 10 | $c_i$ | 0.422 | 0.412 | 0.396 | 0.417 | 0.407 | 0.471 | 0.346 |
| | $G_i$ | 0.151 | 0.151 | 0.139 | 0.138 | 0.133 | 0.127 | 0.117 |
| | $G_i$* | 0.203 | 0.190 | 0.181 | 0.186 | 0.180 | 0.183 | 0.181 |
| | $H_i$ | 0.382 | 0.374 | 0.362 | 0.386 | 0.349 | 0.362 | 0.304 |
| | $H_i$* | 0.220 | 0.216 | 0.211 | 0.241 | 0.219 | 0.227 | 0.202 |
| | $I_i$ | 0.296 | 0.295 | 0.276 | 0.276 | 0.269 | 0.259 | 0.228 |
| 11 | $c_i$ | 0.419 | 0.423 | 0.410 | 0.396 | 0.390 | 0.467 | 0.368 |
| | $G_i$ | 0.143 | 0.148 | 0.152 | 0.129 | 0.141 | 0.139 | 0.126 |
| | $G_i$* | 0.177 | 0.188 | 0.185 | 0.181 | 0.169 | 0.180 | 0.165 |
| | $H_i$ | 0.371 | 0.380 | 0.381 | 0.359 | 0.361 | 0.374 | 0.296 |
| | $H_i$* | 0.214 | 0.238 | 0.213 | 0.222 | 0.226 | 0.250 | 0.199 |
| | $I_i$ | 0.288 | 0.282 | 0.288 | 0.262 | 0.268 | 0.267 | 0.242 |
| 12 | $c_i$ | 0.409 | 0.409 | 0.423 | 0.419 | 0.415 | 0.453 | 0.334 |
| | $G_i$ | 0.137 | 0.149 | 0.143 | 0.134 | 0.139 | 0.128 | 0.121 |
| | $G_i$* | 0.178 | 0.197 | 0.190 | 0.171 | 0.183 | 0.167 | 0.158 |
| | $H_i$ | 0.342 | 0.359 | 0.352 | 0.343 | 0.340 | 0.381 | 0.284 |
| | $H_i$* | 0.225 | 0.244 | 0.210 | 0.217 | 0.196 | 0.251 | 0.204 |
| | $I_i$ | 0.257 | 0.275 | 0.267 | 0.257 | 0.277 | 0.272 | 0.230 |
| 13 | $c_i$ | 0.476 | 0.497 | 0.479 | 0.460 | 0.451 | 0.487 | 0.402 |
| | $G_i$ | 0.135 | 0.152 | 0.147 | 0.141 | 0.138 | 0.144 | 0.120 |
| | $G_i$* | 0.180 | 0.185 | 0.191 | 0.182 | 0.173 | 0.187 | 0.161 |
| | $H_i$ | 0.373 | 0.374 | 0.396 | 0.374 | 0.391 | 0.448 | 0.357 |
| | $H_i$* | 0.258 | 0.236 | 0.240 | 0.245 | 0.234 | 0.260 | 0.258 |
| | $I_i$ | 0.263 | 0.276 | 0.285 | 0.265 | 0.270 | 0.302 | 0.243 |
| 14 | $c_i$ | 0.348 | 0.366 | 0.378 | 0.356 | 0.333 | 0.427 | 0.318 |
| | $G_i$ | 0.114 | 0.133 | 0.136 | 0.123 | 0.117 | 0.126 | 0.107 |
| | $G_i$* | 0.163 | 0.185 | 0.182 | 0.171 | 0.173 | 0.169 | 0.170 |
| | $H_i$ | 0.295 | 0.313 | 0.321 | 0.307 | 0.309 | 0.342 | 0.224 |
| | $H_i$* | 0.210 | 0.225 | 0.219 | 0.236 | 0.212 | 0.250 | 0.176 |
| | $I_i$ | 0.210 | 0.237 | 0.242 | 0.239 | 0.246 | 0.245 | 0.213 |

Figure B.37 Empirical Power Based on Queen Pattern Variance-Covariance Matrix Using Rook Connectivity Case for a 14x14 Study Area

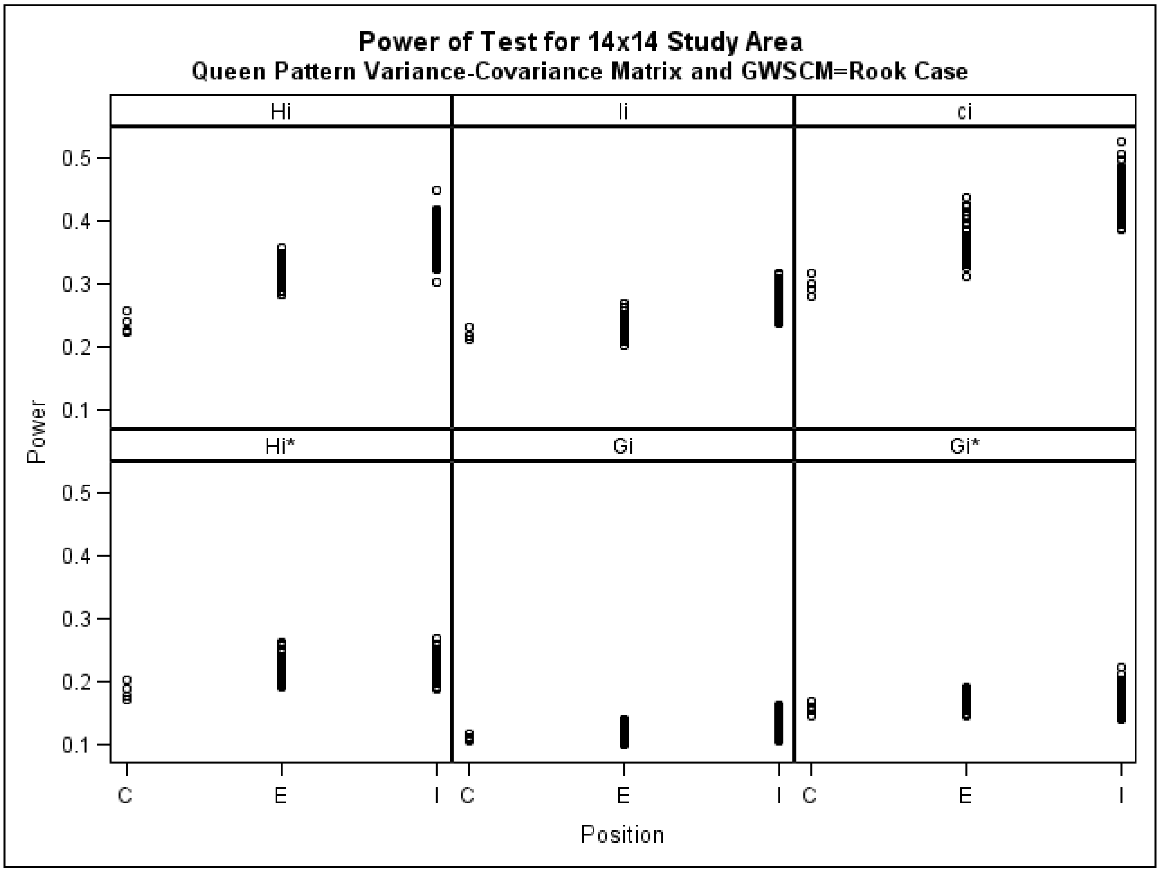


Table B.38 Empirical Power Based on Queen Pattern Variance-Covariance Matrix

Using Queen Connectivity Case for a 14x14 Study Area

| | | Column | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1 | $c_i$ | 0.450 | 0.529 | 0.443 | 0.493 | 0.469 | 0.464 | 0.474 |
| | $G_i$ | 0.156 | 0.170 | 0.171 | 0.161 | 0.150 | 0.163 | 0.168 |
| | $G_i$* | 0.193 | 0.201 | 0.199 | 0.190 | 0.186 | 0.187 | 0.196 |
| | $H_i$ | 0.245 | 0.349 | 0.302 | 0.311 | 0.301 | 0.315 | 0.322 |
| | $H_i$* | 0.168 | 0.237 | 0.206 | 0.188 | 0.181 | 0.194 | 0.184 |
| | $I_i$ | 0.301 | 0.338 | 0.333 | 0.326 | 0.309 | 0.326 | 0.349 |
| 2 | $c_i$ | 0.555 | 0.601 | 0.555 | 0.578 | 0.547 | 0.564 | 0.541 |
| | $G_i$ | 0.184 | 0.201 | 0.184 | 0.191 | 0.190 | 0.181 | 0.195 |
| | $G_i$* | 0.211 | 0.220 | 0.219 | 0.218 | 0.205 | 0.204 | 0.218 |
| | $H_i$ | 0.363 | 0.446 | 0.413 | 0.404 | 0.407 | 0.404 | 0.414 |
| | $H_i$* | 0.232 | 0.220 | 0.229 | 0.179 | 0.210 | 0.215 | 0.198 |
| | $I_i$ | 0.355 | 0.403 | 0.377 | 0.382 | 0.386 | 0.380 | 0.384 |
| 3 | $c_i$ | 0.493 | 0.559 | 0.521 | 0.542 | 0.538 | 0.534 | 0.521 |
| | $G_i$ | 0.172 | 0.195 | 0.192 | 0.197 | 0.191 | 0.203 | 0.177 |
| | $G_i$* | 0.200 | 0.220 | 0.218 | 0.217 | 0.209 | 0.228 | 0.202 |
| | $H_i$ | 0.327 | 0.427 | 0.399 | 0.403 | 0.382 | 0.376 | 0.391 |
| | $H_i$* | 0.194 | 0.207 | 0.199 | 0.191 | 0.186 | 0.198 | 0.194 |
| | $I_i$ | 0.344 | 0.402 | 0.396 | 0.395 | 0.370 | 0.381 | 0.376 |
| 4 | $c_i$ | 0.499 | 0.539 | 0.499 | 0.529 | 0.532 | 0.560 | 0.540 |
| | $G_i$ | 0.160 | 0.175 | 0.172 | 0.177 | 0.196 | 0.197 | 0.191 |
| | $G_i$* | 0.181 | 0.199 | 0.198 | 0.206 | 0.220 | 0.223 | 0.217 |
| | $H_i$ | 0.340 | 0.414 | 0.372 | 0.399 | 0.424 | 0.425 | 0.414 |
| | $H_i$* | 0.209 | 0.210 | 0.189 | 0.208 | 0.209 | 0.213 | 0.197 |
| | $I_i$ | 0.334 | 0.375 | 0.364 | 0.380 | 0.394 | 0.402 | 0.399 |
| 5 | $c_i$ | 0.471 | 0.541 | 0.489 | 0.505 | 0.507 | 0.498 | 0.518 |
| | $G_i$ | 0.152 | 0.171 | 0.179 | 0.181 | 0.165 | 0.169 | 0.183 |
| | $G_i$* | 0.181 | 0.195 | 0.197 | 0.199 | 0.200 | 0.191 | 0.201 |
| | $H_i$ | 0.314 | 0.404 | 0.377 | 0.389 | 0.364 | 0.376 | 0.390 |
| | $H_i$* | 0.205 | 0.192 | 0.186 | 0.196 | 0.168 | 0.185 | 0.188 |
| | $I_i$ | 0.321 | 0.377 | 0.368 | 0.362 | 0.356 | 0.355 | 0.383 |
| 6 | $c_i$ | 0.434 | 0.529 | 0.526 | 0.560 | 0.528 | 0.524 | 0.512 |
| | $G_i$ | 0.166 | 0.183 | 0.177 | 0.178 | 0.171 | 0.170 | 0.161 |
| | $G_i$* | 0.181 | 0.207 | 0.199 | 0.195 | 0.189 | 0.189 | 0.184 |
| | $H_i$ | 0.306 | 0.416 | 0.382 | 0.401 | 0.382 | 0.390 | 0.363 |
| | $H_i$* | 0.198 | 0.216 | 0.187 | 0.185 | 0.184 | 0.213 | 0.183 |
| | $I_i$ | 0.326 | 0.383 | 0.374 | 0.375 | 0.369 | 0.356 | 0.365 |
| 7 | $c_i$ | 0.494 | 0.584 | 0.524 | 0.535 | 0.556 | 0.560 | 0.532 |
| | $G_i$ | 0.175 | 0.202 | 0.194 | 0.188 | 0.182 | 0.165 | 0.167 |
| | $G_i$* | 0.195 | 0.225 | 0.214 | 0.208 | 0.207 | 0.189 | 0.189 |
| | $H_i$ | 0.341 | 0.424 | 0.417 | 0.407 | 0.409 | 0.386 | 0.375 |
| | $H_i$* | 0.211 | 0.178 | 0.204 | 0.220 | 0.227 | 0.199 | 0.210 |
| | $I_i$ | 0.349 | 0.416 | 0.399 | 0.388 | 0.397 | 0.360 | 0.369 |
| 8 | $c_i$ | 0.498 | 0.539 | 0.522 | 0.513 | 0.519 | 0.558 | 0.535 |

| | | Column | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | $G_i$ | 0.181 | 0.200 | 0.183 | 0.188 | 0.179 | 0.176 | 0.180 |
| | $G_i$* | 0.202 | 0.228 | 0.209 | 0.208 | 0.203 | 0.194 | 0.197 |
| | $H_i$ | 0.336 | 0.439 | 0.409 | 0.408 | 0.394 | 0.409 | 0.406 |
| | $H_i$* | 0.216 | 0.210 | 0.222 | 0.228 | 0.215 | 0.232 | 0.226 |
| | $I_i$ | 0.354 | 0.412 | 0.391 | 0.391 | 0.393 | 0.389 | 0.375 |
| 9 | $c_i$ | 0.467 | 0.555 | 0.536 | 0.549 | 0.541 | 0.524 | 0.529 |
| | $G_i$ | 0.174 | 0.202 | 0.188 | 0.196 | 0.189 | 0.189 | 0.194 |
| | $G_i$* | 0.204 | 0.220 | 0.211 | 0.213 | 0.219 | 0.214 | 0.219 |
| | $H_i$ | 0.329 | 0.432 | 0.411 | 0.411 | 0.406 | 0.386 | 0.411 |
| | $H_i$* | 0.219 | 0.224 | 0.207 | 0.197 | 0.222 | 0.210 | 0.193 |
| | $I_i$ | 0.352 | 0.418 | 0.410 | 0.406 | 0.399 | 0.391 | 0.398 |
| 10 | $c_i$ | 0.473 | 0.548 | 0.513 | 0.546 | 0.532 | 0.516 | 0.548 |
| | $G_i$ | 0.171 | 0.194 | 0.188 | 0.175 | 0.197 | 0.200 | 0.214 |
| | $G_i$* | 0.207 | 0.213 | 0.207 | 0.204 | 0.218 | 0.224 | 0.237 |
| | $H_i$ | 0.333 | 0.422 | 0.398 | 0.402 | 0.398 | 0.412 | 0.414 |
| | $H_i$* | 0.218 | 0.208 | 0.211 | 0.200 | 0.202 | 0.211 | 0.189 |
| | $I_i$ | 0.356 | 0.411 | 0.395 | 0.385 | 0.392 | 0.408 | 0.416 |
| 11 | $c_i$ | 0.507 | 0.579 | 0.519 | 0.523 | 0.524 | 0.552 | 0.529 |
| | $G_i$ | 0.191 | 0.212 | 0.191 | 0.180 | 0.190 | 0.202 | 0.198 |
| | $G_i$* | 0.224 | 0.241 | 0.210 | 0.203 | 0.215 | 0.231 | 0.226 |
| | $H_i$ | 0.354 | 0.453 | 0.400 | 0.401 | 0.396 | 0.418 | 0.408 |
| | $H_i$* | 0.200 | 0.204 | 0.197 | 0.204 | 0.200 | 0.209 | 0.237 |
| | $I_i$ | 0.377 | 0.424 | 0.392 | 0.371 | 0.384 | 0.403 | 0.391 |
| 12 | $c_i$ | 0.465 | 0.545 | 0.496 | 0.530 | 0.510 | 0.499 | 0.512 |
| | $G_i$ | 0.171 | 0.194 | 0.177 | 0.176 | 0.188 | 0.174 | 0.180 |
| | $G_i$* | 0.194 | 0.218 | 0.203 | 0.200 | 0.218 | 0.203 | 0.209 |
| | $H_i$ | 0.327 | 0.428 | 0.373 | 0.379 | 0.386 | 0.390 | 0.375 |
| | $H_i$* | 0.187 | 0.204 | 0.196 | 0.206 | 0.193 | 0.206 | 0.211 |
| | $I_i$ | 0.347 | 0.399 | 0.373 | 0.357 | 0.367 | 0.372 | 0.377 |
| 13 | $c_i$ | 0.508 | 0.567 | 0.539 | 0.560 | 0.553 | 0.508 | 0.529 |
| | $G_i$ | 0.171 | 0.188 | 0.193 | 0.189 | 0.195 | 0.182 | 0.185 |
| | $G_i$* | 0.205 | 0.221 | 0.218 | 0.215 | 0.219 | 0.203 | 0.204 |
| | $H_i$ | 0.349 | 0.444 | 0.416 | 0.408 | 0.401 | 0.395 | 0.393 |
| | $H_i$* | 0.233 | 0.207 | 0.198 | 0.184 | 0.200 | 0.193 | 0.182 |
| | $I_i$ | 0.350 | 0.386 | 0.384 | 0.375 | 0.370 | 0.364 | 0.366 |
| 14 | $c_i$ | 0.420 | 0.523 | 0.462 | 0.512 | 0.492 | 0.458 | 0.480 |
| | $G_i$ | 0.155 | 0.179 | 0.195 | 0.187 | 0.175 | 0.178 | 0.159 |
| | $G_i$* | 0.188 | 0.210 | 0.219 | 0.213 | 0.215 | 0.205 | 0.197 |
| | $H_i$ | 0.255 | 0.360 | 0.322 | 0.330 | 0.331 | 0.329 | 0.325 |
| | $H_i$* | 0.179 | 0.210 | 0.184 | 0.186 | 0.233 | 0.213 | 0.219 |
| | $I_i$ | 0.314 | 0.356 | 0.366 | 0.346 | 0.321 | 0.335 | 0.315 |

| | | Column | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 1 | $c_i$ | 0.486 | 0.478 | 0.478 | 0.468 | 0.454 | 0.539 | 0.418 |
| | $G_i$ | 0.181 | 0.174 | 0.175 | 0.193 | 0.185 | 0.175 | 0.162 |
| | $G_i$* | 0.210 | 0.202 | 0.206 | 0.219 | 0.218 | 0.205 | 0.192 |
| | $H_i$ | 0.340 | 0.331 | 0.323 | 0.318 | 0.342 | 0.361 | 0.237 |
| | $H_i$* | 0.200 | 0.200 | 0.199 | 0.201 | 0.198 | 0.236 | 0.163 |
| | $I_i$ | 0.353 | 0.341 | 0.327 | 0.345 | 0.351 | 0.346 | 0.308 |
| 2 | $c_i$ | 0.559 | 0.552 | 0.541 | 0.571 | 0.538 | 0.589 | 0.517 |
| | $G_i$ | 0.192 | 0.192 | 0.200 | 0.216 | 0.209 | 0.205 | 0.184 |
| | $G_i$* | 0.217 | 0.227 | 0.230 | 0.251 | 0.238 | 0.233 | 0.213 |
| | $H_i$ | 0.419 | 0.392 | 0.400 | 0.430 | 0.408 | 0.452 | 0.345 |
| | $H_i$* | 0.185 | 0.188 | 0.197 | 0.206 | 0.196 | 0.207 | 0.221 |
| | $I_i$ | 0.387 | 0.366 | 0.367 | 0.389 | 0.393 | 0.390 | 0.350 |
| 3 | $c_i$ | 0.501 | 0.486 | 0.496 | 0.542 | 0.498 | 0.538 | 0.479 |
| | $G_i$ | 0.179 | 0.183 | 0.194 | 0.215 | 0.207 | 0.208 | 0.178 |
| | $G_i$* | 0.210 | 0.207 | 0.218 | 0.239 | 0.228 | 0.236 | 0.212 |
| | $H_i$ | 0.367 | 0.348 | 0.391 | 0.426 | 0.379 | 0.409 | 0.316 |
| | $H_i$* | 0.170 | 0.175 | 0.201 | 0.204 | 0.197 | 0.200 | 0.195 |
| | $I_i$ | 0.372 | 0.352 | 0.371 | 0.395 | 0.379 | 0.384 | 0.333 |
| 4 | $c_i$ | 0.518 | 0.501 | 0.509 | 0.542 | 0.516 | 0.550 | 0.475 |
| | $G_i$ | 0.161 | 0.171 | 0.192 | 0.200 | 0.208 | 0.209 | 0.191 |
| | $G_i$* | 0.188 | 0.194 | 0.217 | 0.228 | 0.226 | 0.226 | 0.210 |
| | $H_i$ | 0.387 | 0.376 | 0.381 | 0.402 | 0.385 | 0.403 | 0.332 |
| | $H_i$* | 0.203 | 0.201 | 0.189 | 0.186 | 0.194 | 0.194 | 0.212 |
| | $I_i$ | 0.363 | 0.360 | 0.362 | 0.364 | 0.368 | 0.373 | 0.331 |
| 5 | $c_i$ | 0.527 | 0.559 | 0.535 | 0.522 | 0.502 | 0.574 | 0.513 |
| | $G_i$ | 0.168 | 0.175 | 0.193 | 0.188 | 0.190 | 0.221 | 0.193 |
| | $G_i$* | 0.187 | 0.194 | 0.215 | 0.215 | 0.211 | 0.239 | 0.224 |
| | $H_i$ | 0.393 | 0.393 | 0.393 | 0.384 | 0.366 | 0.440 | 0.364 |
| | $H_i$* | 0.187 | 0.178 | 0.196 | 0.195 | 0.181 | 0.181 | 0.234 |
| | $I_i$ | 0.374 | 0.383 | 0.368 | 0.354 | 0.361 | 0.418 | 0.366 |
| 6 | $c_i$ | 0.534 | 0.534 | 0.539 | 0.526 | 0.505 | 0.593 | 0.490 |
| | $G_i$ | 0.152 | 0.172 | 0.185 | 0.183 | 0.188 | 0.206 | 0.187 |
| | $G_i$* | 0.173 | 0.207 | 0.207 | 0.206 | 0.216 | 0.225 | 0.217 |
| | $H_i$ | 0.396 | 0.390 | 0.406 | 0.381 | 0.377 | 0.447 | 0.347 |
| | $H_i$* | 0.201 | 0.164 | 0.204 | 0.185 | 0.199 | 0.210 | 0.227 |
| | $I_i$ | 0.370 | 0.375 | 0.376 | 0.358 | 0.365 | 0.410 | 0.380 |
| 7 | $c_i$ | 0.522 | 0.509 | 0.509 | 0.525 | 0.522 | 0.576 | 0.472 |
| | $G_i$ | 0.157 | 0.181 | 0.182 | 0.201 | 0.195 | 0.194 | 0.182 |
| | $G_i$* | 0.182 | 0.209 | 0.209 | 0.223 | 0.218 | 0.214 | 0.200 |
| | $H_i$ | 0.377 | 0.384 | 0.374 | 0.394 | 0.375 | 0.432 | 0.347 |
| | $H_i$* | 0.197 | 0.174 | 0.191 | 0.214 | 0.206 | 0.213 | 0.215 |
| | $I_i$ | 0.353 | 0.371 | 0.369 | 0.384 | 0.381 | 0.403 | 0.363 |
| 8 | $c_i$ | 0.525 | 0.500 | 0.513 | 0.526 | 0.519 | 0.575 | 0.476 |
| | $G_i$ | 0.182 | 0.191 | 0.201 | 0.209 | 0.193 | 0.190 | 0.162 |
| | $G_i$* | 0.208 | 0.214 | 0.223 | 0.234 | 0.216 | 0.207 | 0.186 |
| | $H_i$ | 0.399 | 0.385 | 0.393 | 0.412 | 0.402 | 0.428 | 0.339 |
| | $H_i$* | 0.216 | 0.190 | 0.193 | 0.208 | 0.209 | 0.206 | 0.214 |

| | | Column | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| | $I_i$ | 0.387 | 0.386 | 0.381 | 0.397 | 0.406 | 0.406 | 0.341 |
| 9 | $c_i$ | 0.521 | 0.495 | 0.536 | 0.539 | 0.518 | 0.568 | 0.484 |
| | $G_i$ | 0.199 | 0.195 | 0.205 | 0.207 | 0.198 | 0.199 | 0.175 |
| | $G_i$* | 0.229 | 0.220 | 0.225 | 0.233 | 0.225 | 0.223 | 0.207 |
| | $H_i$ | 0.422 | 0.412 | 0.405 | 0.403 | 0.415 | 0.431 | 0.321 |
| | $H_i$* | 0.214 | 0.205 | 0.170 | 0.197 | 0.213 | 0.202 | 0.195 |
| | $I_i$ | 0.408 | 0.395 | 0.401 | 0.398 | 0.405 | 0.397 | 0.346 |
| 10 | $c_i$ | 0.509 | 0.503 | 0.490 | 0.512 | 0.493 | 0.555 | 0.476 |
| | $G_i$ | 0.207 | 0.203 | 0.188 | 0.202 | 0.190 | 0.184 | 0.167 |
| | $G_i$* | 0.235 | 0.225 | 0.220 | 0.222 | 0.224 | 0.219 | 0.207 |
| | $H_i$ | 0.420 | 0.414 | 0.377 | 0.422 | 0.398 | 0.405 | 0.314 |
| | $H_i$* | 0.206 | 0.203 | 0.194 | 0.198 | 0.205 | 0.202 | 0.191 |
| | $I_i$ | 0.413 | 0.396 | 0.375 | 0.392 | 0.395 | 0.376 | 0.326 |
| 11 | $c_i$ | 0.506 | 0.524 | 0.506 | 0.494 | 0.479 | 0.540 | 0.486 |
| | $G_i$ | 0.190 | 0.199 | 0.197 | 0.193 | 0.178 | 0.193 | 0.166 |
| | $G_i$* | 0.214 | 0.228 | 0.224 | 0.223 | 0.210 | 0.211 | 0.195 |
| | $H_i$ | 0.398 | 0.410 | 0.409 | 0.395 | 0.387 | 0.407 | 0.310 |
| | $H_i$* | 0.184 | 0.195 | 0.194 | 0.192 | 0.212 | 0.205 | 0.198 |
| | $I_i$ | 0.381 | 0.392 | 0.393 | 0.369 | 0.359 | 0.379 | 0.328 |
| 12 | $c_i$ | 0.510 | 0.536 | 0.532 | 0.517 | 0.510 | 0.554 | 0.455 |
| | $G_i$ | 0.201 | 0.203 | 0.200 | 0.191 | 0.195 | 0.190 | 0.154 |
| | $G_i$* | 0.223 | 0.225 | 0.232 | 0.222 | 0.215 | 0.212 | 0.181 |
| | $H_i$ | 0.395 | 0.393 | 0.380 | 0.386 | 0.384 | 0.414 | 0.299 |
| | $H_i$* | 0.224 | 0.213 | 0.183 | 0.188 | 0.171 | 0.226 | 0.182 |
| | $I_i$ | 0.380 | 0.389 | 0.374 | 0.373 | 0.387 | 0.390 | 0.322 |
| 13 | $c_i$ | 0.566 | 0.571 | 0.576 | 0.559 | 0.543 | 0.576 | 0.501 |
| | $G_i$ | 0.199 | 0.201 | 0.215 | 0.206 | 0.198 | 0.203 | 0.173 |
| | $G_i$* | 0.215 | 0.231 | 0.242 | 0.220 | 0.217 | 0.223 | 0.196 |
| | $H_i$ | 0.408 | 0.414 | 0.421 | 0.416 | 0.410 | 0.460 | 0.347 |
| | $H_i$* | 0.230 | 0.216 | 0.209 | 0.208 | 0.194 | 0.228 | 0.226 |
| | $I_i$ | 0.374 | 0.382 | 0.399 | 0.387 | 0.378 | 0.404 | 0.352 |
| 14 | $c_i$ | 0.486 | 0.482 | 0.510 | 0.482 | 0.469 | 0.548 | 0.431 |
| | $G_i$ | 0.164 | 0.184 | 0.191 | 0.182 | 0.167 | 0.176 | 0.160 |
| | $G_i$* | 0.194 | 0.214 | 0.212 | 0.206 | 0.197 | 0.205 | 0.193 |
| | $H_i$ | 0.308 | 0.333 | 0.326 | 0.315 | 0.316 | 0.337 | 0.244 |
| | $H_i$* | 0.179 | 0.214 | 0.210 | 0.210 | 0.195 | 0.222 | 0.154 |
| | $I_i$ | 0.313 | 0.344 | 0.351 | 0.328 | 0.332 | 0.352 | 0.307 |

Figure B.38 Empirical Power Based on Queen Pattern Variance-Covariance Matrix Using Queen Connectivity Case for a 14x14 Study Area

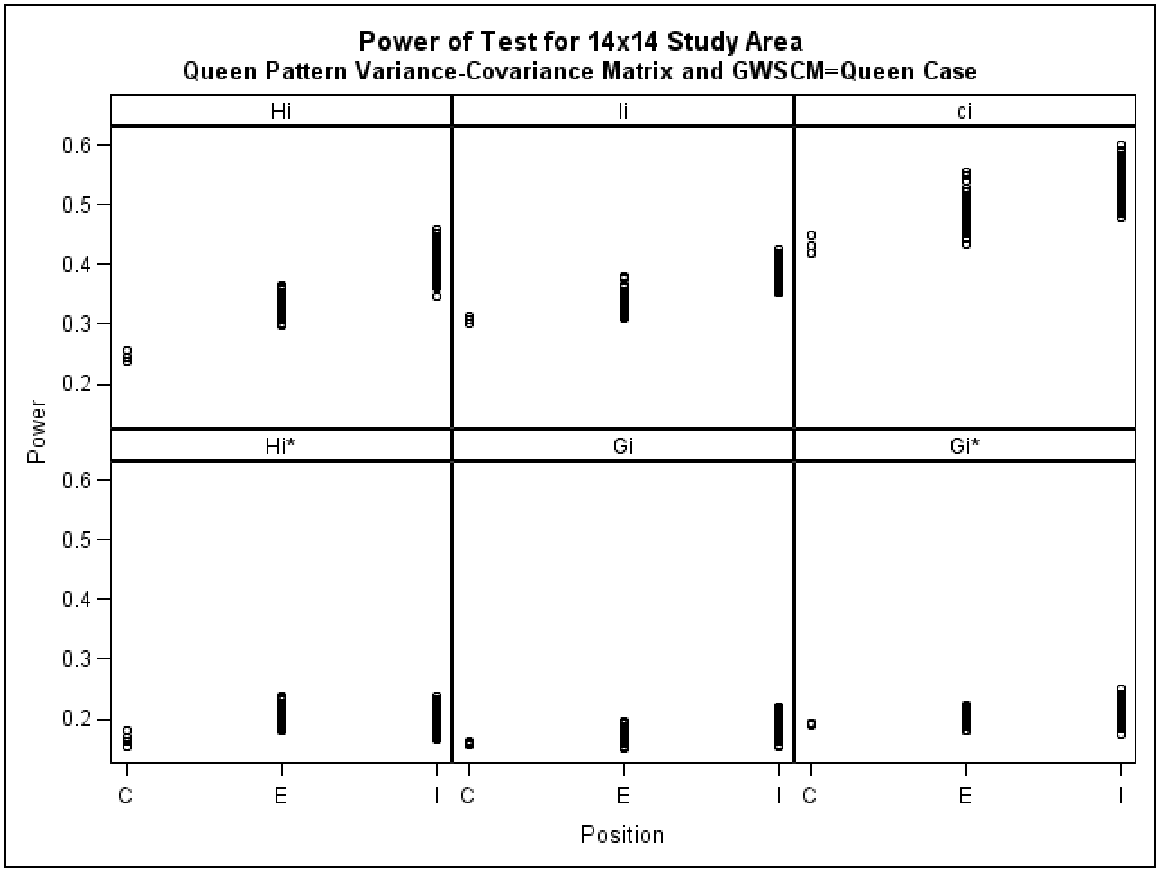


Table B.39 Empirical Power Based on Queen Pattern Variance-Covariance Matrix

Using CWF Connectivity Case for a 14x14 Study Area

| | | Column | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1 | $c_i$ | 0.492 | 0.533 | 0.476 | 0.493 | 0.469 | 0.480 | 0.476 |
| | $G_i$ | 0.202 | 0.210 | 0.209 | 0.210 | 0.195 | 0.199 | 0.208 |
| | $G_i$* | 0.206 | 0.224 | 0.228 | 0.210 | 0.221 | 0.209 | 0.217 |
| | $H_i$ | 0.263 | 0.344 | 0.310 | 0.324 | 0.313 | 0.317 | 0.341 |
| | $H_i$* | 0.136 | 0.195 | 0.169 | 0.148 | 0.145 | 0.151 | 0.156 |
| | $I_i$ | 0.362 | 0.381 | 0.389 | 0.384 | 0.369 | 0.384 | 0.378 |
| 2 | $c_i$ | 0.557 | 0.603 | 0.557 | 0.567 | 0.548 | 0.561 | 0.547 |
| | $G_i$ | 0.207 | 0.219 | 0.226 | 0.227 | 0.219 | 0.214 | 0.226 |
| | $G_i$* | 0.236 | 0.239 | 0.244 | 0.246 | 0.234 | 0.225 | 0.237 |
| | $H_i$ | 0.333 | 0.424 | 0.398 | 0.408 | 0.383 | 0.401 | 0.392 |
| | $H_i$* | 0.154 | 0.196 | 0.209 | 0.170 | 0.179 | 0.183 | 0.171 |
| | $I_i$ | 0.405 | 0.445 | 0.440 | 0.442 | 0.430 | 0.433 | 0.433 |
| 3 | $c_i$ | 0.516 | 0.567 | 0.540 | 0.535 | 0.550 | 0.554 | 0.522 |
| | $G_i$ | 0.213 | 0.224 | 0.227 | 0.226 | 0.231 | 0.233 | 0.220 |
| | $G_i$* | 0.234 | 0.241 | 0.245 | 0.241 | 0.245 | 0.242 | 0.231 |
| | $H_i$ | 0.330 | 0.414 | 0.393 | 0.412 | 0.400 | 0.402 | 0.390 |
| | $H_i$* | 0.158 | 0.177 | 0.183 | 0.166 | 0.156 | 0.162 | 0.147 |
| | $I_i$ | 0.393 | 0.459 | 0.442 | 0.454 | 0.437 | 0.448 | 0.431 |
| 4 | $c_i$ | 0.495 | 0.551 | 0.517 | 0.519 | 0.544 | 0.539 | 0.541 |
| | $G_i$ | 0.198 | 0.202 | 0.210 | 0.215 | 0.237 | 0.225 | 0.226 |
| | $G_i$* | 0.200 | 0.217 | 0.223 | 0.231 | 0.246 | 0.243 | 0.243 |
| | $H_i$ | 0.336 | 0.386 | 0.389 | 0.391 | 0.411 | 0.418 | 0.406 |
| | $H_i$* | 0.149 | 0.182 | 0.176 | 0.184 | 0.171 | 0.181 | 0.161 |
| | $I_i$ | 0.382 | 0.421 | 0.426 | 0.437 | 0.450 | 0.443 | 0.446 |
| 5 | $c_i$ | 0.480 | 0.519 | 0.504 | 0.535 | 0.514 | 0.503 | 0.518 |
| | $G_i$ | 0.197 | 0.205 | 0.215 | 0.211 | 0.219 | 0.205 | 0.227 |
| | $G_i$* | 0.214 | 0.217 | 0.222 | 0.221 | 0.231 | 0.220 | 0.234 |
| | $H_i$ | 0.329 | 0.387 | 0.398 | 0.403 | 0.380 | 0.379 | 0.380 |
| | $H_i$* | 0.151 | 0.148 | 0.162 | 0.170 | 0.154 | 0.146 | 0.156 |
| | $I_i$ | 0.371 | 0.420 | 0.436 | 0.421 | 0.421 | 0.409 | 0.434 |
| 6 | $c_i$ | 0.459 | 0.542 | 0.517 | 0.546 | 0.538 | 0.516 | 0.500 |
| | $G_i$ | 0.207 | 0.215 | 0.213 | 0.210 | 0.211 | 0.201 | 0.196 |
| | $G_i$* | 0.218 | 0.234 | 0.225 | 0.225 | 0.223 | 0.215 | 0.211 |
| | $H_i$ | 0.305 | 0.385 | 0.376 | 0.391 | 0.394 | 0.378 | 0.383 |
| | $H_i$* | 0.138 | 0.179 | 0.146 | 0.154 | 0.150 | 0.159 | 0.159 |
| | $I_i$ | 0.375 | 0.429 | 0.420 | 0.417 | 0.422 | 0.407 | 0.429 |
| 7 | $c_i$ | 0.491 | 0.540 | 0.520 | 0.552 | 0.564 | 0.553 | 0.524 |
| | $G_i$ | 0.205 | 0.227 | 0.230 | 0.223 | 0.232 | 0.206 | 0.211 |
| | $G_i$* | 0.221 | 0.246 | 0.244 | 0.239 | 0.242 | 0.230 | 0.228 |
| | $H_i$ | 0.334 | 0.420 | 0.403 | 0.429 | 0.424 | 0.392 | 0.402 |
| | $H_i$* | 0.163 | 0.155 | 0.172 | 0.177 | 0.170 | 0.169 | 0.177 |
| | $I_i$ | 0.400 | 0.469 | 0.449 | 0.465 | 0.470 | 0.428 | 0.440 |
| 8 | $c_i$ | 0.494 | 0.538 | 0.541 | 0.546 | 0.551 | 0.559 | 0.522 |

| | | Column | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | $G_i$ | 0.221 | 0.228 | 0.230 | 0.227 | 0.227 | 0.219 | 0.224 |
| | $G_i$* | 0.226 | 0.245 | 0.244 | 0.238 | 0.238 | 0.229 | 0.235 |
| | $H_i$ | 0.345 | 0.422 | 0.426 | 0.431 | 0.416 | 0.433 | 0.420 |
| | $H_i$* | 0.152 | 0.182 | 0.190 | 0.174 | 0.171 | 0.190 | 0.191 |
| | $I_i$ | 0.409 | 0.476 | 0.473 | 0.464 | 0.460 | 0.459 | 0.460 |
| 9 | $c_i$ | 0.481 | 0.557 | 0.543 | 0.537 | 0.549 | 0.513 | 0.532 |
| | $G_i$ | 0.219 | 0.223 | 0.233 | 0.234 | 0.231 | 0.219 | 0.224 |
| | $G_i$* | 0.231 | 0.241 | 0.247 | 0.243 | 0.244 | 0.230 | 0.240 |
| | $H_i$ | 0.362 | 0.425 | 0.422 | 0.417 | 0.406 | 0.395 | 0.416 |
| | $H_i$* | 0.180 | 0.186 | 0.167 | 0.165 | 0.180 | 0.181 | 0.158 |
| | $I_i$ | 0.414 | 0.454 | 0.464 | 0.464 | 0.462 | 0.452 | 0.453 |
| 10 | $c_i$ | 0.494 | 0.550 | 0.529 | 0.548 | 0.518 | 0.520 | 0.537 |
| | $G_i$ | 0.221 | 0.229 | 0.213 | 0.214 | 0.231 | 0.224 | 0.235 |
| | $G_i$* | 0.236 | 0.234 | 0.225 | 0.225 | 0.244 | 0.241 | 0.255 |
| | $H_i$ | 0.358 | 0.433 | 0.408 | 0.405 | 0.401 | 0.420 | 0.422 |
| | $H_i$* | 0.167 | 0.174 | 0.174 | 0.159 | 0.169 | 0.174 | 0.164 |
| | $I_i$ | 0.414 | 0.453 | 0.441 | 0.442 | 0.457 | 0.450 | 0.456 |
| 11 | $c_i$ | 0.527 | 0.562 | 0.517 | 0.523 | 0.514 | 0.545 | 0.549 |
| | $G_i$ | 0.236 | 0.234 | 0.222 | 0.227 | 0.231 | 0.239 | 0.241 |
| | $G_i$* | 0.257 | 0.253 | 0.237 | 0.236 | 0.244 | 0.263 | 0.256 |
| | $H_i$ | 0.367 | 0.431 | 0.403 | 0.408 | 0.407 | 0.413 | 0.425 |
| | $H_i$* | 0.168 | 0.164 | 0.171 | 0.173 | 0.177 | 0.160 | 0.185 |
| | $I_i$ | 0.426 | 0.473 | 0.436 | 0.445 | 0.444 | 0.462 | 0.455 |
| 12 | $c_i$ | 0.477 | 0.540 | 0.511 | 0.540 | 0.511 | 0.525 | 0.513 |
| | $G_i$ | 0.227 | 0.225 | 0.234 | 0.229 | 0.224 | 0.230 | 0.232 |
| | $G_i$* | 0.227 | 0.249 | 0.236 | 0.244 | 0.236 | 0.237 | 0.243 |
| | $H_i$ | 0.334 | 0.412 | 0.392 | 0.391 | 0.369 | 0.406 | 0.396 |
| | $H_i$* | 0.153 | 0.177 | 0.174 | 0.185 | 0.161 | 0.170 | 0.176 |
| | $I_i$ | 0.394 | 0.435 | 0.432 | 0.444 | 0.410 | 0.436 | 0.446 |
| 13 | $c_i$ | 0.499 | 0.553 | 0.543 | 0.546 | 0.524 | 0.519 | 0.521 |
| | $G_i$ | 0.199 | 0.220 | 0.233 | 0.228 | 0.226 | 0.211 | 0.230 |
| | $G_i$* | 0.219 | 0.245 | 0.250 | 0.250 | 0.243 | 0.226 | 0.241 |
| | $H_i$ | 0.340 | 0.419 | 0.401 | 0.405 | 0.383 | 0.387 | 0.376 |
| | $H_i$* | 0.188 | 0.190 | 0.162 | 0.152 | 0.168 | 0.169 | 0.153 |
| | $I_i$ | 0.380 | 0.431 | 0.444 | 0.445 | 0.426 | 0.413 | 0.410 |
| 14 | $c_i$ | 0.465 | 0.498 | 0.480 | 0.506 | 0.503 | 0.479 | 0.493 |
| | $G_i$ | 0.199 | 0.209 | 0.223 | 0.211 | 0.220 | 0.211 | 0.212 |
| | $G_i$* | 0.208 | 0.232 | 0.238 | 0.229 | 0.235 | 0.232 | 0.223 |
| | $H_i$ | 0.268 | 0.339 | 0.345 | 0.347 | 0.325 | 0.325 | 0.325 |
| | $H_i$* | 0.134 | 0.165 | 0.168 | 0.177 | 0.148 | 0.170 | 0.177 |
| | $I_i$ | 0.355 | 0.397 | 0.405 | 0.384 | 0.372 | 0.369 | 0.374 |

| | | Column | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 1 | $c_i$ | 0.495 | 0.499 | 0.495 | 0.471 | 0.483 | 0.526 | 0.441 |
| | $G_i$ | 0.222 | 0.219 | 0.223 | 0.231 | 0.239 | 0.214 | 0.209 |
| | $G_i$* | 0.246 | 0.239 | 0.242 | 0.254 | 0.251 | 0.230 | 0.221 |
| | $H_i$ | 0.344 | 0.338 | 0.333 | 0.337 | 0.364 | 0.348 | 0.257 |
| | $H_i$* | 0.147 | 0.153 | 0.175 | 0.167 | 0.174 | 0.176 | 0.147 |
| | $I_i$ | 0.386 | 0.386 | 0.376 | 0.399 | 0.408 | 0.379 | 0.356 |
| 2 | $c_i$ | 0.549 | 0.532 | 0.546 | 0.540 | 0.551 | 0.566 | 0.517 |
| | $G_i$ | 0.227 | 0.223 | 0.234 | 0.240 | 0.239 | 0.233 | 0.210 |
| | $G_i$* | 0.246 | 0.241 | 0.257 | 0.263 | 0.266 | 0.248 | 0.233 |
| | $H_i$ | 0.402 | 0.389 | 0.391 | 0.397 | 0.406 | 0.415 | 0.326 |
| | $H_i$* | 0.146 | 0.155 | 0.162 | 0.164 | 0.160 | 0.183 | 0.172 |
| | $I_i$ | 0.434 | 0.421 | 0.406 | 0.425 | 0.443 | 0.419 | 0.385 |
| 3 | $c_i$ | 0.505 | 0.491 | 0.493 | 0.545 | 0.524 | 0.543 | 0.481 |
| | $G_i$ | 0.225 | 0.231 | 0.240 | 0.254 | 0.257 | 0.242 | 0.223 |
| | $G_i$* | 0.244 | 0.240 | 0.263 | 0.266 | 0.275 | 0.263 | 0.246 |
| | $H_i$ | 0.399 | 0.377 | 0.384 | 0.412 | 0.394 | 0.390 | 0.329 |
| | $H_i$* | 0.157 | 0.157 | 0.172 | 0.170 | 0.176 | 0.176 | 0.163 |
| | $I_i$ | 0.440 | 0.411 | 0.418 | 0.448 | 0.439 | 0.426 | 0.380 |
| 4 | $c_i$ | 0.508 | 0.499 | 0.510 | 0.510 | 0.514 | 0.540 | 0.507 |
| | $G_i$ | 0.225 | 0.219 | 0.229 | 0.245 | 0.251 | 0.248 | 0.231 |
| | $G_i$* | 0.230 | 0.227 | 0.242 | 0.256 | 0.266 | 0.268 | 0.242 |
| | $H_i$ | 0.392 | 0.372 | 0.379 | 0.382 | 0.376 | 0.398 | 0.329 |
| | $H_i$* | 0.165 | 0.166 | 0.148 | 0.165 | 0.181 | 0.176 | 0.137 |
| | $I_i$ | 0.439 | 0.419 | 0.424 | 0.418 | 0.424 | 0.435 | 0.381 |
| 5 | $c_i$ | 0.534 | 0.546 | 0.529 | 0.502 | 0.502 | 0.553 | 0.505 |
| | $G_i$ | 0.219 | 0.219 | 0.233 | 0.234 | 0.232 | 0.235 | 0.224 |
| | $G_i$* | 0.228 | 0.227 | 0.241 | 0.244 | 0.252 | 0.248 | 0.243 |
| | $H_i$ | 0.388 | 0.383 | 0.391 | 0.371 | 0.369 | 0.404 | 0.355 |
| | $H_i$* | 0.158 | 0.156 | 0.148 | 0.148 | 0.167 | 0.145 | 0.143 |
| | $I_i$ | 0.430 | 0.436 | 0.428 | 0.413 | 0.417 | 0.435 | 0.407 |
| 6 | $c_i$ | 0.543 | 0.545 | 0.529 | 0.503 | 0.515 | 0.583 | 0.524 |
| | $G_i$ | 0.201 | 0.221 | 0.230 | 0.225 | 0.225 | 0.247 | 0.232 |
| | $G_i$* | 0.207 | 0.241 | 0.242 | 0.231 | 0.238 | 0.257 | 0.246 |
| | $H_i$ | 0.396 | 0.397 | 0.397 | 0.376 | 0.392 | 0.435 | 0.373 |
| | $H_i$* | 0.182 | 0.133 | 0.164 | 0.155 | 0.182 | 0.158 | 0.183 |
| | $I_i$ | 0.425 | 0.431 | 0.433 | 0.420 | 0.415 | 0.461 | 0.435 |
| 7 | $c_i$ | 0.520 | 0.519 | 0.510 | 0.514 | 0.532 | 0.560 | 0.498 |
| | $G_i$ | 0.212 | 0.218 | 0.215 | 0.230 | 0.255 | 0.235 | 0.221 |
| | $G_i$* | 0.223 | 0.233 | 0.237 | 0.247 | 0.258 | 0.244 | 0.221 |
| | $H_i$ | 0.385 | 0.371 | 0.381 | 0.397 | 0.418 | 0.436 | 0.366 |
| | $H_i$* | 0.165 | 0.147 | 0.152 | 0.166 | 0.190 | 0.194 | 0.173 |
| | $I_i$ | 0.418 | 0.410 | 0.413 | 0.431 | 0.456 | 0.457 | 0.410 |
| 8 | $c_i$ | 0.507 | 0.514 | 0.503 | 0.524 | 0.532 | 0.553 | 0.488 |
| | $G_i$ | 0.227 | 0.223 | 0.231 | 0.246 | 0.240 | 0.227 | 0.206 |
| | $G_i$* | 0.240 | 0.237 | 0.245 | 0.257 | 0.255 | 0.240 | 0.213 |
| | $H_i$ | 0.410 | 0.382 | 0.394 | 0.420 | 0.416 | 0.419 | 0.341 |
| | $H_i$* | 0.183 | 0.157 | 0.166 | 0.170 | 0.173 | 0.167 | 0.169 |

| | | Column | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| | $I_i$ | 0.436 | 0.422 | 0.426 | 0.459 | 0.463 | 0.459 | 0.395 |
| 9 | $c_i$ | 0.517 | 0.502 | 0.524 | 0.515 | 0.542 | 0.545 | 0.487 |
| | $G_i$ | 0.234 | 0.238 | 0.246 | 0.243 | 0.239 | 0.222 | 0.210 |
| | $G_i$* | 0.252 | 0.252 | 0.248 | 0.258 | 0.251 | 0.243 | 0.231 |
| | $H_i$ | 0.417 | 0.410 | 0.409 | 0.416 | 0.419 | 0.398 | 0.336 |
| | $H_i$* | 0.172 | 0.152 | 0.151 | 0.146 | 0.166 | 0.171 | 0.167 |
| | $I_i$ | 0.463 | 0.453 | 0.445 | 0.459 | 0.462 | 0.437 | 0.393 |
| 10 | $c_i$ | 0.515 | 0.523 | 0.490 | 0.506 | 0.519 | 0.548 | 0.494 |
| | $G_i$ | 0.243 | 0.248 | 0.248 | 0.253 | 0.245 | 0.217 | 0.207 |
| | $G_i$* | 0.253 | 0.262 | 0.256 | 0.267 | 0.259 | 0.238 | 0.225 |
| | $H_i$ | 0.412 | 0.420 | 0.414 | 0.417 | 0.409 | 0.393 | 0.318 |
| | $H_i$* | 0.168 | 0.156 | 0.151 | 0.156 | 0.166 | 0.173 | 0.153 |
| | $I_i$ | 0.465 | 0.457 | 0.465 | 0.454 | 0.457 | 0.432 | 0.383 |
| 11 | $c_i$ | 0.519 | 0.530 | 0.513 | 0.490 | 0.490 | 0.526 | 0.490 |
| | $G_i$ | 0.233 | 0.244 | 0.236 | 0.233 | 0.239 | 0.217 | 0.200 |
| | $G_i$* | 0.239 | 0.258 | 0.244 | 0.248 | 0.242 | 0.229 | 0.225 |
| | $H_i$ | 0.395 | 0.412 | 0.405 | 0.402 | 0.405 | 0.402 | 0.315 |
| | $H_i$* | 0.162 | 0.184 | 0.154 | 0.176 | 0.181 | 0.162 | 0.156 |
| | $I_i$ | 0.436 | 0.462 | 0.445 | 0.435 | 0.439 | 0.427 | 0.373 |
| 12 | $c_i$ | 0.516 | 0.539 | 0.525 | 0.527 | 0.507 | 0.530 | 0.486 |
| | $G_i$ | 0.249 | 0.243 | 0.246 | 0.251 | 0.251 | 0.231 | 0.213 |
| | $G_i$* | 0.260 | 0.258 | 0.258 | 0.260 | 0.256 | 0.240 | 0.218 |
| | $H_i$ | 0.404 | 0.409 | 0.393 | 0.404 | 0.388 | 0.411 | 0.316 |
| | $H_i$* | 0.199 | 0.177 | 0.158 | 0.166 | 0.150 | 0.183 | 0.160 |
| | $I_i$ | 0.441 | 0.454 | 0.435 | 0.447 | 0.438 | 0.444 | 0.390 |
| 13 | $c_i$ | 0.553 | 0.560 | 0.563 | 0.552 | 0.552 | 0.585 | 0.529 |
| | $G_i$ | 0.229 | 0.243 | 0.241 | 0.248 | 0.246 | 0.229 | 0.201 |
| | $G_i$* | 0.243 | 0.249 | 0.263 | 0.258 | 0.262 | 0.241 | 0.224 |
| | $H_i$ | 0.397 | 0.415 | 0.402 | 0.401 | 0.408 | 0.435 | 0.343 |
| | $H_i$* | 0.187 | 0.170 | 0.170 | 0.174 | 0.175 | 0.191 | 0.179 |
| | $I_i$ | 0.428 | 0.444 | 0.442 | 0.449 | 0.440 | 0.441 | 0.390 |
| 14 | $c_i$ | 0.507 | 0.509 | 0.508 | 0.498 | 0.508 | 0.537 | 0.462 |
| | $G_i$ | 0.221 | 0.227 | 0.239 | 0.236 | 0.225 | 0.207 | 0.204 |
| | $G_i$* | 0.232 | 0.239 | 0.247 | 0.242 | 0.234 | 0.230 | 0.213 |
| | $H_i$ | 0.325 | 0.332 | 0.352 | 0.335 | 0.330 | 0.339 | 0.266 |
| | $H_i$* | 0.170 | 0.154 | 0.152 | 0.161 | 0.163 | 0.160 | 0.135 |
| | $I_i$ | 0.387 | 0.395 | 0.407 | 0.388 | 0.393 | 0.388 | 0.356 |

Figure B.39 Empirical Power Based on Queen Pattern Variance-Covariance Matrix Using CWF Connectivity Case for a 14x14 Study Area

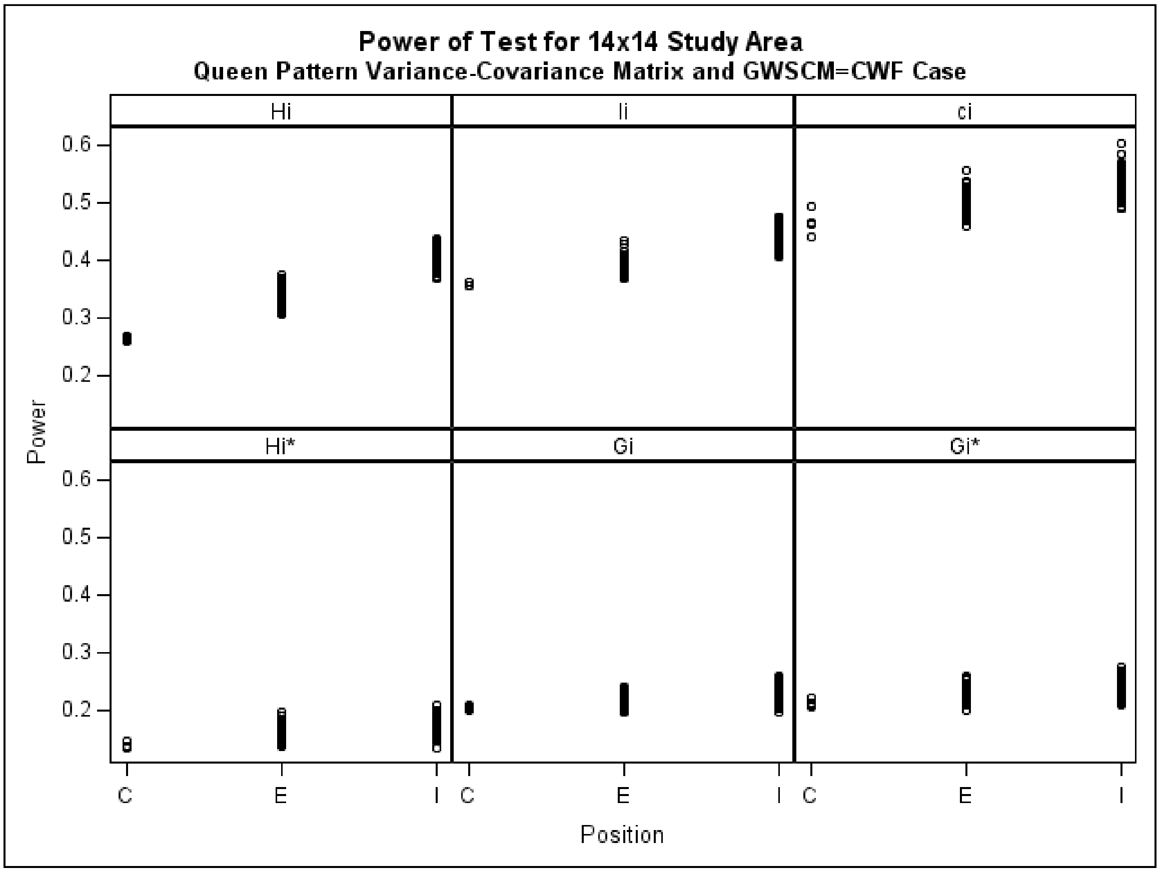


Table B.40 Empirical Power Based on Hot-Spot Pattern Variance-Covariance Matrix

Using Rook Connectivity Case for a 14x14 Study Area

| | | Column | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1 | $c_i$ | 0.079 | 0.066 | 0.071 | 0.063 | 0.072 | 0.071 | 0.083 |
| | $G_i$ | 0.059 | 0.080 | 0.066 | 0.081 | 0.081 | 0.074 | 0.081 |
| | $G_i$* | 0.087 | 0.091 | 0.071 | 0.084 | 0.077 | 0.083 | 0.096 |
| | $H_i$ | 0.059 | 0.060 | 0.068 | 0.064 | 0.069 | 0.078 | 0.075 |
| | $H_i$* | 0.067 | 0.056 | 0.061 | 0.049 | 0.054 | 0.061 | 0.064 |
| | $I_i$ | 0.079 | 0.089 | 0.065 | 0.087 | 0.094 | 0.089 | 0.095 |
| 2 | $c_i$ | 0.079 | 0.091 | 0.091 | 0.103 | 0.096 | 0.086 | 0.087 |
| | $G_i$ | 0.087 | 0.087 | 0.074 | 0.096 | 0.074 | 0.084 | 0.081 |
| | $G_i$* | 0.099 | 0.095 | 0.083 | 0.106 | 0.094 | 0.098 | 0.094 |
| | $H_i$ | 0.065 | 0.069 | 0.068 | 0.095 | 0.093 | 0.080 | 0.082 |
| | $H_i$* | 0.054 | 0.053 | 0.060 | 0.067 | 0.065 | 0.067 | 0.059 |
| | $I_i$ | 0.087 | 0.076 | 0.086 | 0.101 | 0.113 | 0.103 | 0.104 |
| 3 | $c_i$ | 0.081 | 0.075 | 0.074 | 0.044 | 0.040 | 0.040 | 0.031 |
| | $G_i$ | 0.077 | 0.095 | 0.076 | 0.043 | 0.047 | 0.034 | 0.052 |
| | $G_i$* | 0.091 | 0.097 | 0.073 | 0.048 | 0.059 | 0.043 | 0.053 |
| | $H_i$ | 0.075 | 0.071 | 0.063 | 0.049 | 0.049 | 0.059 | 0.044 |
| | $H_i$* | 0.065 | 0.058 | 0.057 | 0.046 | 0.048 | 0.056 | 0.050 |
| | $I_i$ | 0.091 | 0.096 | 0.090 | 0.040 | 0.048 | 0.048 | 0.047 |
| 4 | $c_i$ | 0.081 | 0.069 | 0.042 | 0.078 | 0.165 | 0.182 | 0.182 |
| | $G_i$ | 0.096 | 0.090 | 0.040 | 0.028 | 0.031 | 0.039 | 0.054 |
| | $G_i$* | 0.100 | 0.089 | 0.044 | 0.037 | 0.062 | 0.066 | 0.073 |
| | $H_i$ | 0.069 | 0.066 | 0.051 | 0.073 | 0.087 | 0.104 | 0.123 |
| | $H_i$* | 0.054 | 0.056 | 0.042 | 0.075 | 0.105 | 0.122 | 0.140 |
| | $I_i$ | 0.106 | 0.092 | 0.042 | 0.049 | 0.070 | 0.087 | 0.098 |
| 5 | $c_i$ | 0.089 | 0.079 | 0.031 | 0.155 | 0.498 | 0.476 | 0.482 |
| | $G_i$ | 0.090 | 0.088 | 0.045 | 0.039 | 0.115 | 0.114 | 0.110 |
| | $G_i$* | 0.093 | 0.086 | 0.046 | 0.075 | 0.146 | 0.139 | 0.146 |
| | $H_i$ | 0.076 | 0.084 | 0.052 | 0.101 | 0.209 | 0.198 | 0.202 |
| | $H_i$* | 0.061 | 0.055 | 0.050 | 0.113 | 0.213 | 0.207 | 0.213 |
| | $I_i$ | 0.101 | 0.106 | 0.043 | 0.083 | 0.228 | 0.238 | 0.230 |
| 6 | $c_i$ | 0.070 | 0.091 | 0.043 | 0.169 | 0.475 | 0.477 | 0.468 |
| | $G_i$ | 0.069 | 0.089 | 0.048 | 0.049 | 0.114 | 0.109 | 0.121 |
| | $G_i$* | 0.078 | 0.111 | 0.063 | 0.074 | 0.150 | 0.139 | 0.143 |
| | $H_i$ | 0.063 | 0.083 | 0.062 | 0.093 | 0.214 | 0.206 | 0.195 |
| | $H_i$* | 0.052 | 0.065 | 0.056 | 0.098 | 0.227 | 0.207 | 0.201 |
| | $I_i$ | 0.091 | 0.108 | 0.058 | 0.086 | 0.230 | 0.235 | 0.236 |
| 7 | $c_i$ | 0.084 | 0.088 | 0.038 | 0.151 | 0.488 | 0.473 | 0.457 |
| | $G_i$ | 0.081 | 0.085 | 0.040 | 0.047 | 0.115 | 0.121 | 0.111 |
| | $G_i$* | 0.081 | 0.087 | 0.055 | 0.071 | 0.144 | 0.143 | 0.143 |
| | $H_i$ | 0.072 | 0.082 | 0.049 | 0.109 | 0.205 | 0.209 | 0.220 |
| | $H_i$* | 0.058 | 0.060 | 0.046 | 0.126 | 0.210 | 0.218 | 0.219 |
| | $I_i$ | 0.097 | 0.102 | 0.063 | 0.086 | 0.229 | 0.234 | 0.227 |
| 8 | $c_i$ | 0.068 | 0.070 | 0.034 | 0.189 | 0.506 | 0.468 | 0.493 |

| | | Column | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | $G_i$ | 0.076 | 0.066 | 0.040 | 0.041 | 0.119 | 0.126 | 0.122 |
| | $G_i$* | 0.087 | 0.080 | 0.049 | 0.070 | 0.147 | 0.153 | 0.152 |
| | $H_i$ | 0.073 | 0.056 | 0.042 | 0.118 | 0.216 | 0.216 | 0.208 |
| | $H_i$* | 0.057 | 0.052 | 0.040 | 0.129 | 0.224 | 0.212 | 0.220 |
| | $I_i$ | 0.089 | 0.077 | 0.043 | 0.089 | 0.230 | 0.249 | 0.247 |
| 9 | $c_i$ | 0.072 | 0.079 | 0.034 | 0.164 | 0.474 | 0.506 | 0.498 |
| | $G_i$ | 0.082 | 0.087 | 0.040 | 0.061 | 0.112 | 0.114 | 0.117 |
| | $G_i$* | 0.081 | 0.085 | 0.049 | 0.088 | 0.150 | 0.146 | 0.162 |
| | $H_i$ | 0.068 | 0.075 | 0.054 | 0.117 | 0.211 | 0.203 | 0.216 |
| | $H_i$* | 0.053 | 0.066 | 0.050 | 0.135 | 0.207 | 0.210 | 0.234 |
| | $I_i$ | 0.095 | 0.099 | 0.041 | 0.099 | 0.242 | 0.240 | 0.236 |
| 10 | $c_i$ | 0.085 | 0.082 | 0.027 | 0.152 | 0.480 | 0.504 | 0.519 |
| | $G_i$ | 0.081 | 0.089 | 0.052 | 0.039 | 0.118 | 0.123 | 0.127 |
| | $G_i$* | 0.089 | 0.091 | 0.055 | 0.069 | 0.147 | 0.142 | 0.157 |
| | $H_i$ | 0.059 | 0.081 | 0.041 | 0.102 | 0.203 | 0.245 | 0.226 |
| | $H_i$* | 0.054 | 0.072 | 0.042 | 0.114 | 0.183 | 0.232 | 0.203 |
| | $I_i$ | 0.095 | 0.103 | 0.049 | 0.088 | 0.239 | 0.246 | 0.243 |
| 11 | $c_i$ | 0.084 | 0.084 | 0.038 | 0.068 | 0.168 | 0.171 | 0.165 |
| | $G_i$ | 0.087 | 0.086 | 0.043 | 0.026 | 0.053 | 0.048 | 0.050 |
| | $G_i$* | 0.089 | 0.087 | 0.047 | 0.032 | 0.078 | 0.075 | 0.082 |
| | $H_i$ | 0.066 | 0.070 | 0.047 | 0.059 | 0.113 | 0.112 | 0.111 |
| | $H_i$* | 0.045 | 0.052 | 0.045 | 0.080 | 0.125 | 0.127 | 0.118 |
| | $I_i$ | 0.100 | 0.080 | 0.048 | 0.038 | 0.111 | 0.090 | 0.101 |
| 12 | $c_i$ | 0.076 | 0.087 | 0.103 | 0.048 | 0.039 | 0.036 | 0.033 |
| | $G_i$ | 0.085 | 0.074 | 0.094 | 0.046 | 0.033 | 0.046 | 0.034 |
| | $G_i$* | 0.092 | 0.093 | 0.106 | 0.049 | 0.043 | 0.053 | 0.049 |
| | $H_i$ | 0.082 | 0.077 | 0.080 | 0.058 | 0.043 | 0.053 | 0.045 |
| | $H_i$* | 0.066 | 0.054 | 0.060 | 0.041 | 0.037 | 0.043 | 0.040 |
| | $I_i$ | 0.100 | 0.089 | 0.109 | 0.062 | 0.044 | 0.055 | 0.037 |
| 13 | $c_i$ | 0.083 | 0.100 | 0.074 | 0.089 | 0.098 | 0.084 | 0.088 |
| | $G_i$ | 0.084 | 0.087 | 0.084 | 0.091 | 0.092 | 0.082 | 0.079 |
| | $G_i$* | 0.081 | 0.105 | 0.097 | 0.098 | 0.106 | 0.083 | 0.082 |
| | $H_i$ | 0.072 | 0.069 | 0.070 | 0.069 | 0.081 | 0.063 | 0.068 |
| | $H_i$* | 0.058 | 0.053 | 0.059 | 0.057 | 0.061 | 0.060 | 0.057 |
| | $I_i$ | 0.099 | 0.087 | 0.097 | 0.093 | 0.113 | 0.089 | 0.084 |
| 14 | $c_i$ | 0.075 | 0.089 | 0.092 | 0.093 | 0.079 | 0.073 | 0.078 |
| | $G_i$ | 0.070 | 0.082 | 0.098 | 0.078 | 0.071 | 0.069 | 0.080 |
| | $G_i$* | 0.074 | 0.093 | 0.099 | 0.095 | 0.092 | 0.086 | 0.087 |
| | $H_i$ | 0.068 | 0.077 | 0.079 | 0.075 | 0.076 | 0.064 | 0.057 |
| | $H_i$* | 0.053 | 0.055 | 0.064 | 0.061 | 0.060 | 0.054 | 0.053 |
| | $I_i$ | 0.084 | 0.104 | 0.114 | 0.104 | 0.085 | 0.081 | 0.085 |

| | | Column | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 1 | $c_i$ | 0.083 | 0.079 | 0.082 | 0.083 | 0.083 | 0.095 | 0.075 |
| | $G_i$ | 0.084 | 0.087 | 0.081 | 0.111 | 0.064 | 0.080 | 0.066 |
| | $G_i*$ | 0.094 | 0.089 | 0.101 | 0.098 | 0.076 | 0.083 | 0.074 |
| | $H_i$ | 0.070 | 0.076 | 0.079 | 0.068 | 0.060 | 0.078 | 0.077 |
| | $H_i*$ | 0.050 | 0.056 | 0.061 | 0.054 | 0.050 | 0.053 | 0.065 |
| | $I_i$ | 0.101 | 0.098 | 0.095 | 0.113 | 0.077 | 0.091 | 0.082 |
| 2 | $c_i$ | 0.085 | 0.083 | 0.110 | 0.074 | 0.076 | 0.077 | 0.076 |
| | $G_i$ | 0.100 | 0.095 | 0.098 | 0.081 | 0.092 | 0.085 | 0.062 |
| | $G_i*$ | 0.114 | 0.089 | 0.111 | 0.097 | 0.090 | 0.085 | 0.080 |
| | $H_i$ | 0.076 | 0.081 | 0.092 | 0.071 | 0.074 | 0.084 | 0.072 |
| | $H_i*$ | 0.060 | 0.061 | 0.072 | 0.053 | 0.052 | 0.078 | 0.061 |
| | $I_i$ | 0.106 | 0.091 | 0.105 | 0.093 | 0.095 | 0.096 | 0.072 |
| 3 | $c_i$ | 0.036 | 0.034 | 0.044 | 0.036 | 0.063 | 0.088 | 0.078 |
| | $G_i$ | 0.044 | 0.045 | 0.042 | 0.055 | 0.079 | 0.096 | 0.088 |
| | $G_i*$ | 0.047 | 0.047 | 0.056 | 0.057 | 0.081 | 0.095 | 0.099 |
| | $H_i$ | 0.047 | 0.040 | 0.054 | 0.053 | 0.066 | 0.070 | 0.076 |
| | $H_i*$ | 0.043 | 0.036 | 0.042 | 0.043 | 0.044 | 0.049 | 0.068 |
| | $I_i$ | 0.039 | 0.042 | 0.047 | 0.049 | 0.094 | 0.105 | 0.088 |
| 4 | $c_i$ | 0.186 | 0.201 | 0.183 | 0.070 | 0.037 | 0.092 | 0.073 |
| | $G_i$ | 0.049 | 0.050 | 0.059 | 0.025 | 0.048 | 0.085 | 0.090 |
| | $G_i*$ | 0.078 | 0.080 | 0.083 | 0.037 | 0.048 | 0.095 | 0.081 |
| | $H_i$ | 0.105 | 0.123 | 0.112 | 0.065 | 0.054 | 0.086 | 0.063 |
| | $H_i*$ | 0.113 | 0.132 | 0.135 | 0.077 | 0.052 | 0.060 | 0.046 |
| | $I_i$ | 0.088 | 0.091 | 0.097 | 0.049 | 0.051 | 0.102 | 0.091 |
| 5 | $c_i$ | 0.481 | 0.500 | 0.501 | 0.187 | 0.025 | 0.075 | 0.073 |
| | $G_i$ | 0.114 | 0.117 | 0.115 | 0.055 | 0.049 | 0.084 | 0.082 |
| | $G_i*$ | 0.153 | 0.145 | 0.150 | 0.085 | 0.051 | 0.099 | 0.096 |
| | $H_i$ | 0.209 | 0.216 | 0.192 | 0.122 | 0.043 | 0.081 | 0.074 |
| | $H_i*$ | 0.235 | 0.214 | 0.201 | 0.145 | 0.048 | 0.049 | 0.053 |
| | $I_i$ | 0.225 | 0.232 | 0.231 | 0.101 | 0.044 | 0.098 | 0.087 |
| 6 | $c_i$ | 0.504 | 0.519 | 0.493 | 0.155 | 0.027 | 0.091 | 0.089 |
| | $G_i$ | 0.113 | 0.123 | 0.116 | 0.039 | 0.048 | 0.102 | 0.088 |
| | $G_i*$ | 0.142 | 0.154 | 0.139 | 0.072 | 0.054 | 0.103 | 0.086 |
| | $H_i$ | 0.223 | 0.225 | 0.219 | 0.111 | 0.046 | 0.071 | 0.075 |
| | $H_i*$ | 0.227 | 0.233 | 0.208 | 0.127 | 0.038 | 0.057 | 0.067 |
| | $I_i$ | 0.229 | 0.244 | 0.239 | 0.084 | 0.043 | 0.103 | 0.089 |
| 7 | $c_i$ | 0.481 | 0.516 | 0.493 | 0.163 | 0.035 | 0.080 | 0.082 |
| | $G_i$ | 0.125 | 0.117 | 0.113 | 0.043 | 0.045 | 0.089 | 0.067 |
| | $G_i*$ | 0.152 | 0.147 | 0.145 | 0.073 | 0.056 | 0.094 | 0.085 |
| | $H_i$ | 0.212 | 0.208 | 0.215 | 0.115 | 0.049 | 0.077 | 0.075 |
| | $H_i*$ | 0.213 | 0.219 | 0.220 | 0.134 | 0.042 | 0.062 | 0.060 |
| | $I_i$ | 0.238 | 0.232 | 0.234 | 0.099 | 0.046 | 0.101 | 0.082 |
| 8 | $c_i$ | 0.472 | 0.468 | 0.490 | 0.184 | 0.044 | 0.105 | 0.079 |
| | $G_i$ | 0.121 | 0.111 | 0.119 | 0.037 | 0.051 | 0.069 | 0.076 |
| | $G_i*$ | 0.153 | 0.138 | 0.147 | 0.066 | 0.052 | 0.074 | 0.083 |
| | $H_i$ | 0.215 | 0.211 | 0.196 | 0.117 | 0.052 | 0.086 | 0.052 |
| | $H_i*$ | 0.232 | 0.211 | 0.206 | 0.132 | 0.049 | 0.071 | 0.047 |

| | | Column | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| | $I_i$ | 0.244 | 0.232 | 0.234 | 0.091 | 0.058 | 0.102 | 0.084 |
| 9 | $c_i$ | 0.489 | 0.471 | 0.493 | 0.183 | 0.043 | 0.091 | 0.086 |
| | $G_i$ | 0.114 | 0.134 | 0.116 | 0.039 | 0.038 | 0.087 | 0.071 |
| | $G_i$* | 0.154 | 0.157 | 0.152 | 0.082 | 0.043 | 0.084 | 0.076 |
| | $H_i$ | 0.229 | 0.230 | 0.220 | 0.113 | 0.039 | 0.078 | 0.058 |
| | $H_i$* | 0.227 | 0.216 | 0.208 | 0.134 | 0.033 | 0.067 | 0.052 |
| | $I_i$ | 0.228 | 0.246 | 0.249 | 0.094 | 0.038 | 0.099 | 0.078 |
| 10 | $c_i$ | 0.472 | 0.486 | 0.494 | 0.173 | 0.046 | 0.107 | 0.087 |
| | $G_i$ | 0.122 | 0.116 | 0.133 | 0.046 | 0.048 | 0.089 | 0.082 |
| | $G_i$* | 0.152 | 0.148 | 0.163 | 0.077 | 0.047 | 0.095 | 0.088 |
| | $H_i$ | 0.206 | 0.229 | 0.221 | 0.107 | 0.063 | 0.076 | 0.060 |
| | $H_i$* | 0.215 | 0.228 | 0.218 | 0.108 | 0.058 | 0.054 | 0.047 |
| | $I_i$ | 0.239 | 0.244 | 0.251 | 0.092 | 0.037 | 0.111 | 0.095 |
| 11 | $c_i$ | 0.169 | 0.157 | 0.179 | 0.071 | 0.034 | 0.082 | 0.074 |
| | $G_i$ | 0.057 | 0.047 | 0.047 | 0.028 | 0.040 | 0.106 | 0.087 |
| | $G_i$* | 0.081 | 0.073 | 0.071 | 0.038 | 0.044 | 0.099 | 0.086 |
| | $H_i$ | 0.113 | 0.116 | 0.100 | 0.063 | 0.048 | 0.082 | 0.073 |
| | $H_i$* | 0.129 | 0.123 | 0.113 | 0.078 | 0.044 | 0.065 | 0.058 |
| | $I_i$ | 0.095 | 0.093 | 0.091 | 0.050 | 0.039 | 0.102 | 0.094 |
| 12 | $c_i$ | 0.031 | 0.028 | 0.028 | 0.040 | 0.101 | 0.074 | 0.082 |
| | $G_i$ | 0.049 | 0.039 | 0.046 | 0.044 | 0.096 | 0.098 | 0.086 |
| | $G_i$* | 0.056 | 0.052 | 0.046 | 0.052 | 0.103 | 0.099 | 0.098 |
| | $H_i$ | 0.053 | 0.053 | 0.042 | 0.048 | 0.078 | 0.065 | 0.066 |
| | $H_i$* | 0.052 | 0.039 | 0.033 | 0.037 | 0.057 | 0.060 | 0.054 |
| | $I_i$ | 0.046 | 0.036 | 0.038 | 0.053 | 0.104 | 0.099 | 0.086 |
| 13 | $c_i$ | 0.087 | 0.086 | 0.087 | 0.093 | 0.093 | 0.091 | 0.085 |
| | $G_i$ | 0.095 | 0.083 | 0.085 | 0.093 | 0.094 | 0.097 | 0.085 |
| | $G_i$* | 0.099 | 0.102 | 0.102 | 0.111 | 0.094 | 0.112 | 0.101 |
| | $H_i$ | 0.070 | 0.070 | 0.087 | 0.094 | 0.081 | 0.072 | 0.079 |
| | $H_i$* | 0.061 | 0.050 | 0.075 | 0.067 | 0.067 | 0.059 | 0.058 |
| | $I_i$ | 0.100 | 0.095 | 0.099 | 0.109 | 0.105 | 0.097 | 0.103 |
| 14 | $c_i$ | 0.080 | 0.071 | 0.082 | 0.084 | 0.079 | 0.069 | 0.076 |
| | $G_i$ | 0.091 | 0.087 | 0.089 | 0.082 | 0.072 | 0.082 | 0.081 |
| | $G_i$* | 0.088 | 0.084 | 0.076 | 0.076 | 0.083 | 0.088 | 0.094 |
| | $H_i$ | 0.064 | 0.072 | 0.067 | 0.086 | 0.062 | 0.056 | 0.089 |
| | $H_i$* | 0.045 | 0.055 | 0.043 | 0.075 | 0.045 | 0.045 | 0.074 |
| | $I_i$ | 0.095 | 0.098 | 0.078 | 0.085 | 0.084 | 0.081 | 0.093 |

Figure B.40 Empirical Power Based on Hot-Spot Pattern Variance-Covariance Matrix Using Rook Connectivity Case for a 14x14 Study Area

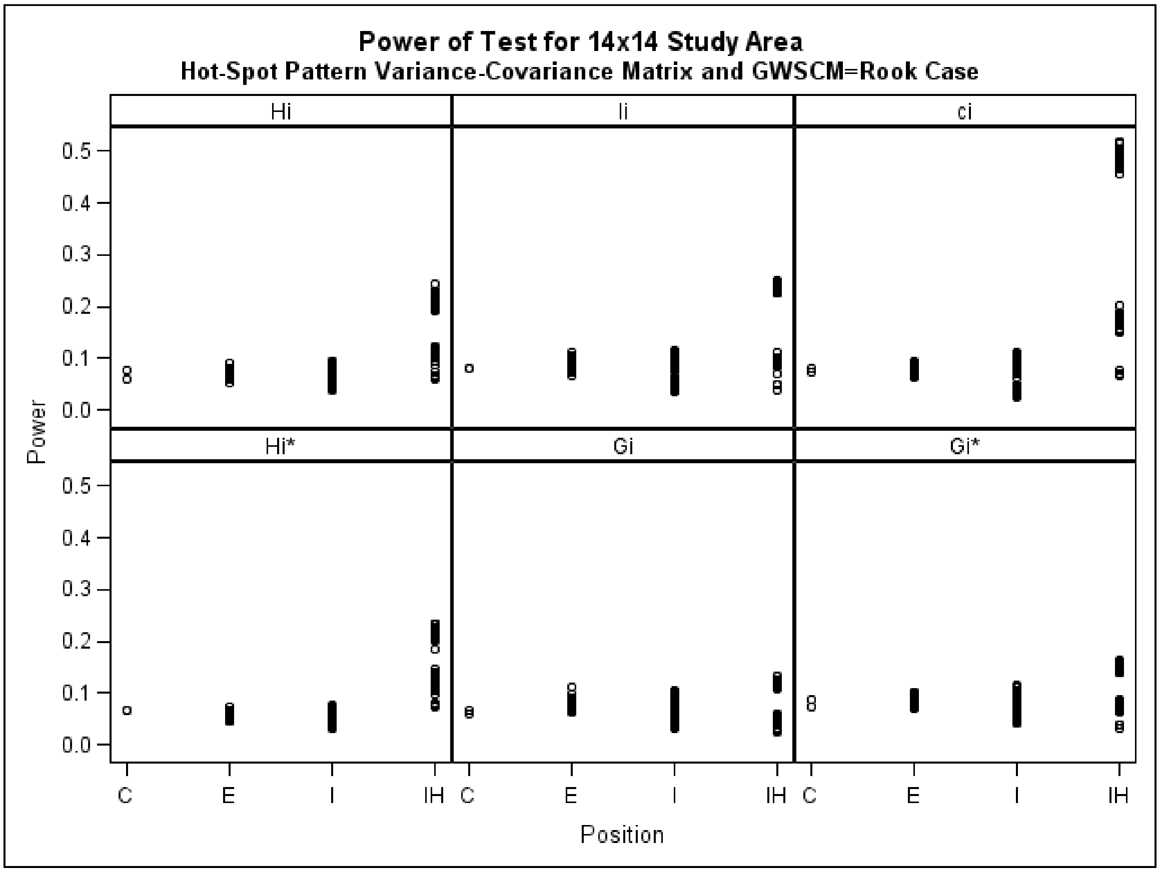


Table B.41 Empirical Power Based on Hot-Spot Pattern Variance-Covariance Matrix Using Queen Connectivity Case for a 14x14 Study Area

| | | Column | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1 | $c_i$ | 0.082 | 0.089 | 0.095 | 0.102 | 0.101 | 0.105 | 0.102 |
| | $G_i$ | 0.065 | 0.088 | 0.082 | 0.097 | 0.101 | 0.096 | 0.091 |
| | $G_i$* | 0.085 | 0.083 | 0.098 | 0.096 | 0.097 | 0.095 | 0.112 |
| | $H_i$ | 0.073 | 0.080 | 0.061 | 0.082 | 0.088 | 0.097 | 0.080 |
| | $H_i$* | 0.051 | 0.071 | 0.051 | 0.059 | 0.056 | 0.066 | 0.052 |
| | $I_i$ | 0.087 | 0.112 | 0.083 | 0.109 | 0.116 | 0.114 | 0.122 |
| 2 | $c_i$ | 0.101 | 0.123 | 0.108 | 0.107 | 0.106 | 0.108 | 0.103 |
| | $G_i$ | 0.098 | 0.119 | 0.103 | 0.107 | 0.110 | 0.129 | 0.112 |
| | $G_i$* | 0.104 | 0.119 | 0.105 | 0.123 | 0.121 | 0.120 | 0.125 |
| | $H_i$ | 0.084 | 0.112 | 0.085 | 0.128 | 0.109 | 0.119 | 0.109 |
| | $H_i$* | 0.065 | 0.080 | 0.049 | 0.080 | 0.067 | 0.071 | 0.066 |
| | $I_i$ | 0.114 | 0.140 | 0.115 | 0.145 | 0.145 | 0.152 | 0.142 |
| 3 | $c_i$ | 0.097 | 0.102 | 0.055 | 0.037 | 0.038 | 0.035 | 0.036 |
| | $G_i$ | 0.085 | 0.116 | 0.073 | 0.037 | 0.036 | 0.030 | 0.029 |
| | $G_i$* | 0.105 | 0.123 | 0.067 | 0.049 | 0.039 | 0.035 | 0.033 |
| | $H_i$ | 0.095 | 0.102 | 0.072 | 0.051 | 0.041 | 0.028 | 0.037 |
| | $H_i$* | 0.066 | 0.063 | 0.056 | 0.052 | 0.045 | 0.028 | 0.036 |
| | $I_i$ | 0.098 | 0.132 | 0.080 | 0.050 | 0.038 | 0.030 | 0.030 |
| 4 | $c_i$ | 0.105 | 0.098 | 0.038 | 0.048 | 0.178 | 0.169 | 0.193 |
| | $G_i$ | 0.102 | 0.126 | 0.050 | 0.027 | 0.052 | 0.055 | 0.058 |
| | $G_i$* | 0.107 | 0.129 | 0.048 | 0.027 | 0.075 | 0.074 | 0.081 |
| | $H_i$ | 0.093 | 0.104 | 0.048 | 0.035 | 0.104 | 0.109 | 0.113 |
| | $H_i$* | 0.058 | 0.059 | 0.047 | 0.049 | 0.110 | 0.107 | 0.103 |
| | $I_i$ | 0.116 | 0.148 | 0.041 | 0.041 | 0.104 | 0.102 | 0.104 |
| 5 | $c_i$ | 0.101 | 0.125 | 0.037 | 0.182 | 0.842 | 0.829 | 0.829 |
| | $G_i$ | 0.102 | 0.113 | 0.040 | 0.054 | 0.208 | 0.208 | 0.203 |
| | $G_i$* | 0.103 | 0.125 | 0.042 | 0.074 | 0.228 | 0.218 | 0.225 |
| | $H_i$ | 0.079 | 0.102 | 0.035 | 0.107 | 0.320 | 0.324 | 0.327 |
| | $H_i$* | 0.056 | 0.066 | 0.034 | 0.103 | 0.300 | 0.275 | 0.287 |
| | $I_i$ | 0.120 | 0.124 | 0.032 | 0.103 | 0.415 | 0.410 | 0.422 |
| 6 | $c_i$ | 0.110 | 0.131 | 0.046 | 0.175 | 0.831 | 0.820 | 0.833 |
| | $G_i$ | 0.082 | 0.123 | 0.038 | 0.064 | 0.211 | 0.201 | 0.208 |
| | $G_i$* | 0.099 | 0.120 | 0.045 | 0.078 | 0.225 | 0.220 | 0.220 |
| | $H_i$ | 0.084 | 0.121 | 0.056 | 0.125 | 0.316 | 0.328 | 0.324 |
| | $H_i$* | 0.060 | 0.078 | 0.044 | 0.112 | 0.289 | 0.311 | 0.282 |
| | $I_i$ | 0.108 | 0.151 | 0.045 | 0.112 | 0.418 | 0.405 | 0.411 |
| 7 | $c_i$ | 0.094 | 0.123 | 0.047 | 0.187 | 0.835 | 0.834 | 0.836 |
| | $G_i$ | 0.093 | 0.106 | 0.045 | 0.062 | 0.214 | 0.200 | 0.213 |
| | $G_i$* | 0.102 | 0.114 | 0.044 | 0.089 | 0.220 | 0.222 | 0.233 |
| | $H_i$ | 0.083 | 0.109 | 0.042 | 0.131 | 0.307 | 0.320 | 0.339 |
| | $H_i$* | 0.064 | 0.063 | 0.034 | 0.115 | 0.285 | 0.288 | 0.276 |
| | $I_i$ | 0.124 | 0.149 | 0.046 | 0.116 | 0.411 | 0.408 | 0.422 |
| 8 | $c_i$ | 0.078 | 0.106 | 0.043 | 0.169 | 0.841 | 0.829 | 0.834 |

| | | Column | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | $G_i$ | 0.088 | 0.104 | 0.035 | 0.059 | 0.207 | 0.223 | 0.217 |
| | $G_i$* | 0.090 | 0.099 | 0.028 | 0.086 | 0.222 | 0.230 | 0.233 |
| | $H_i$ | 0.076 | 0.105 | 0.037 | 0.121 | 0.315 | 0.324 | 0.329 |
| | $H_i$* | 0.052 | 0.072 | 0.042 | 0.110 | 0.290 | 0.297 | 0.301 |
| | $I_i$ | 0.107 | 0.121 | 0.032 | 0.109 | 0.413 | 0.438 | 0.432 |
| 9 | $c_i$ | 0.086 | 0.109 | 0.028 | 0.171 | 0.846 | 0.838 | 0.874 |
| | $G_i$ | 0.087 | 0.114 | 0.033 | 0.063 | 0.210 | 0.209 | 0.214 |
| | $G_i$* | 0.077 | 0.115 | 0.033 | 0.086 | 0.228 | 0.226 | 0.232 |
| | $H_i$ | 0.085 | 0.102 | 0.038 | 0.113 | 0.333 | 0.332 | 0.330 |
| | $H_i$* | 0.068 | 0.074 | 0.028 | 0.110 | 0.277 | 0.285 | 0.305 |
| | $I_i$ | 0.100 | 0.141 | 0.038 | 0.115 | 0.427 | 0.431 | 0.425 |
| 10 | $c_i$ | 0.097 | 0.113 | 0.025 | 0.161 | 0.848 | 0.856 | 0.831 |
| | $G_i$ | 0.099 | 0.111 | 0.030 | 0.056 | 0.209 | 0.213 | 0.207 |
| | $G_i$* | 0.105 | 0.118 | 0.037 | 0.083 | 0.226 | 0.230 | 0.224 |
| | $H_i$ | 0.071 | 0.114 | 0.031 | 0.104 | 0.316 | 0.347 | 0.340 |
| | $H_i$* | 0.052 | 0.081 | 0.029 | 0.107 | 0.280 | 0.326 | 0.303 |
| | $I_i$ | 0.104 | 0.136 | 0.033 | 0.107 | 0.419 | 0.430 | 0.429 |
| 11 | $c_i$ | 0.104 | 0.116 | 0.034 | 0.041 | 0.156 | 0.172 | 0.193 |
| | $G_i$ | 0.095 | 0.117 | 0.039 | 0.034 | 0.061 | 0.069 | 0.080 |
| | $G_i$* | 0.113 | 0.117 | 0.049 | 0.035 | 0.077 | 0.088 | 0.097 |
| | $H_i$ | 0.077 | 0.108 | 0.063 | 0.039 | 0.122 | 0.127 | 0.156 |
| | $H_i$* | 0.056 | 0.072 | 0.066 | 0.058 | 0.119 | 0.113 | 0.128 |
| | $I_i$ | 0.096 | 0.125 | 0.047 | 0.041 | 0.128 | 0.128 | 0.146 |
| 12 | $c_i$ | 0.086 | 0.118 | 0.078 | 0.053 | 0.033 | 0.036 | 0.034 |
| | $G_i$ | 0.091 | 0.113 | 0.077 | 0.038 | 0.035 | 0.036 | 0.034 |
| | $G_i$* | 0.097 | 0.115 | 0.084 | 0.049 | 0.033 | 0.035 | 0.033 |
| | $H_i$ | 0.082 | 0.106 | 0.074 | 0.058 | 0.047 | 0.033 | 0.039 |
| | $H_i$* | 0.068 | 0.075 | 0.053 | 0.046 | 0.038 | 0.030 | 0.043 |
| | $I_i$ | 0.096 | 0.145 | 0.083 | 0.062 | 0.042 | 0.036 | 0.032 |
| 13 | $c_i$ | 0.095 | 0.105 | 0.118 | 0.102 | 0.112 | 0.110 | 0.106 |
| | $G_i$ | 0.100 | 0.119 | 0.118 | 0.128 | 0.105 | 0.108 | 0.120 |
| | $G_i$* | 0.109 | 0.129 | 0.123 | 0.144 | 0.121 | 0.109 | 0.118 |
| | $H_i$ | 0.096 | 0.120 | 0.120 | 0.102 | 0.103 | 0.081 | 0.088 |
| | $H_i$* | 0.063 | 0.064 | 0.082 | 0.061 | 0.068 | 0.057 | 0.065 |
| | $I_i$ | 0.121 | 0.138 | 0.142 | 0.142 | 0.126 | 0.134 | 0.128 |
| 14 | $c_i$ | 0.080 | 0.093 | 0.099 | 0.096 | 0.090 | 0.099 | 0.094 |
| | $G_i$ | 0.084 | 0.101 | 0.096 | 0.096 | 0.080 | 0.087 | 0.095 |
| | $G_i$* | 0.086 | 0.095 | 0.102 | 0.115 | 0.106 | 0.098 | 0.102 |
| | $H_i$ | 0.087 | 0.093 | 0.086 | 0.083 | 0.078 | 0.079 | 0.080 |
| | $H_i$* | 0.063 | 0.055 | 0.074 | 0.058 | 0.050 | 0.064 | 0.060 |
| | $I_i$ | 0.105 | 0.128 | 0.115 | 0.112 | 0.107 | 0.107 | 0.100 |

| | | Column | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 1 | $c_i$ | 0.099 | 0.088 | 0.104 | 0.082 | 0.101 | 0.101 | 0.084 |
| | $G_i$ | 0.113 | 0.115 | 0.101 | 0.112 | 0.082 | 0.081 | 0.075 |
| | $G_i$* | 0.106 | 0.118 | 0.120 | 0.118 | 0.087 | 0.099 | 0.076 |
| | $H_i$ | 0.093 | 0.085 | 0.084 | 0.080 | 0.078 | 0.078 | 0.068 |
| | $H_i$* | 0.062 | 0.056 | 0.053 | 0.057 | 0.064 | 0.055 | 0.061 |
| | $I_i$ | 0.117 | 0.112 | 0.121 | 0.106 | 0.101 | 0.107 | 0.095 |
| 2 | $c_i$ | 0.106 | 0.102 | 0.101 | 0.102 | 0.097 | 0.113 | 0.109 |
| | $G_i$ | 0.119 | 0.132 | 0.119 | 0.116 | 0.117 | 0.102 | 0.087 |
| | $G_i$* | 0.136 | 0.135 | 0.125 | 0.141 | 0.126 | 0.111 | 0.089 |
| | $H_i$ | 0.108 | 0.099 | 0.111 | 0.112 | 0.090 | 0.097 | 0.098 |
| | $H_i$* | 0.081 | 0.059 | 0.069 | 0.081 | 0.061 | 0.067 | 0.065 |
| | $I_i$ | 0.137 | 0.131 | 0.130 | 0.142 | 0.118 | 0.129 | 0.111 |
| 3 | $c_i$ | 0.057 | 0.043 | 0.043 | 0.038 | 0.060 | 0.109 | 0.103 |
| | $G_i$ | 0.035 | 0.045 | 0.040 | 0.049 | 0.060 | 0.103 | 0.100 |
| | $G_i$* | 0.036 | 0.042 | 0.046 | 0.057 | 0.079 | 0.116 | 0.106 |
| | $H_i$ | 0.050 | 0.036 | 0.044 | 0.053 | 0.067 | 0.120 | 0.096 |
| | $H_i$* | 0.037 | 0.034 | 0.035 | 0.046 | 0.047 | 0.081 | 0.068 |
| | $I_i$ | 0.029 | 0.034 | 0.035 | 0.051 | 0.080 | 0.143 | 0.129 |
| 4 | $c_i$ | 0.195 | 0.171 | 0.169 | 0.050 | 0.046 | 0.110 | 0.092 |
| | $G_i$ | 0.056 | 0.059 | 0.062 | 0.044 | 0.054 | 0.120 | 0.098 |
| | $G_i$* | 0.075 | 0.084 | 0.084 | 0.048 | 0.059 | 0.120 | 0.102 |
| | $H_i$ | 0.115 | 0.108 | 0.124 | 0.055 | 0.044 | 0.110 | 0.084 |
| | $H_i$* | 0.126 | 0.124 | 0.126 | 0.064 | 0.048 | 0.060 | 0.072 |
| | $I_i$ | 0.104 | 0.105 | 0.112 | 0.060 | 0.049 | 0.139 | 0.111 |
| 5 | $c_i$ | 0.835 | 0.847 | 0.839 | 0.179 | 0.033 | 0.101 | 0.097 |
| | $G_i$ | 0.212 | 0.205 | 0.213 | 0.059 | 0.041 | 0.111 | 0.087 |
| | $G_i$* | 0.224 | 0.220 | 0.234 | 0.079 | 0.035 | 0.105 | 0.105 |
| | $H_i$ | 0.310 | 0.336 | 0.312 | 0.111 | 0.033 | 0.087 | 0.080 |
| | $H_i$* | 0.281 | 0.313 | 0.280 | 0.098 | 0.035 | 0.059 | 0.056 |
| | $I_i$ | 0.404 | 0.403 | 0.408 | 0.114 | 0.031 | 0.122 | 0.109 |
| 6 | $c_i$ | 0.849 | 0.850 | 0.826 | 0.161 | 0.028 | 0.109 | 0.090 |
| | $G_i$ | 0.212 | 0.218 | 0.212 | 0.064 | 0.038 | 0.143 | 0.107 |
| | $G_i$* | 0.225 | 0.227 | 0.223 | 0.082 | 0.040 | 0.142 | 0.113 |
| | $H_i$ | 0.324 | 0.334 | 0.313 | 0.127 | 0.035 | 0.105 | 0.094 |
| | $H_i$* | 0.305 | 0.300 | 0.282 | 0.130 | 0.037 | 0.071 | 0.073 |
| | $I_i$ | 0.425 | 0.432 | 0.429 | 0.122 | 0.037 | 0.138 | 0.115 |
| 7 | $c_i$ | 0.850 | 0.845 | 0.837 | 0.170 | 0.044 | 0.106 | 0.094 |
| | $G_i$ | 0.212 | 0.208 | 0.214 | 0.045 | 0.027 | 0.094 | 0.097 |
| | $G_i$* | 0.222 | 0.225 | 0.219 | 0.071 | 0.034 | 0.114 | 0.096 |
| | $H_i$ | 0.305 | 0.347 | 0.321 | 0.109 | 0.025 | 0.097 | 0.082 |
| | $H_i$* | 0.296 | 0.294 | 0.276 | 0.113 | 0.029 | 0.073 | 0.057 |
| | $I_i$ | 0.423 | 0.418 | 0.419 | 0.109 | 0.027 | 0.130 | 0.107 |
| 8 | $c_i$ | 0.828 | 0.834 | 0.857 | 0.193 | 0.038 | 0.125 | 0.085 |
| | $G_i$ | 0.210 | 0.216 | 0.209 | 0.056 | 0.033 | 0.113 | 0.090 |
| | $G_i$* | 0.231 | 0.222 | 0.221 | 0.074 | 0.034 | 0.114 | 0.095 |
| | $H_i$ | 0.321 | 0.326 | 0.341 | 0.109 | 0.046 | 0.125 | 0.070 |
| | $H_i$* | 0.300 | 0.293 | 0.299 | 0.104 | 0.035 | 0.069 | 0.053 |

| | | Column | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| | $I_i$ | 0.420 | 0.423 | 0.426 | 0.117 | 0.047 | 0.160 | 0.106 |
| 9 | $c_i$ | 0.836 | 0.828 | 0.847 | 0.181 | 0.048 | 0.122 | 0.099 |
| | $G_i$ | 0.217 | 0.214 | 0.210 | 0.052 | 0.023 | 0.119 | 0.089 |
| | $G_i$* | 0.235 | 0.233 | 0.225 | 0.076 | 0.030 | 0.118 | 0.096 |
| | $H_i$ | 0.335 | 0.326 | 0.338 | 0.113 | 0.039 | 0.111 | 0.078 |
| | $H_i$* | 0.292 | 0.293 | 0.317 | 0.113 | 0.048 | 0.072 | 0.065 |
| | $I_i$ | 0.422 | 0.421 | 0.414 | 0.108 | 0.030 | 0.155 | 0.103 |
| 10 | $c_i$ | 0.830 | 0.836 | 0.832 | 0.186 | 0.052 | 0.128 | 0.118 |
| | $G_i$ | 0.212 | 0.214 | 0.221 | 0.069 | 0.025 | 0.109 | 0.089 |
| | $G_i$* | 0.228 | 0.230 | 0.231 | 0.093 | 0.038 | 0.118 | 0.100 |
| | $H_i$ | 0.321 | 0.334 | 0.334 | 0.127 | 0.036 | 0.104 | 0.095 |
| | $H_i$* | 0.292 | 0.283 | 0.302 | 0.107 | 0.042 | 0.061 | 0.071 |
| | $I_i$ | 0.432 | 0.429 | 0.414 | 0.128 | 0.025 | 0.143 | 0.106 |
| 11 | $c_i$ | 0.180 | 0.165 | 0.195 | 0.043 | 0.029 | 0.099 | 0.099 |
| | $G_i$ | 0.071 | 0.056 | 0.059 | 0.024 | 0.053 | 0.125 | 0.101 |
| | $G_i$* | 0.094 | 0.082 | 0.071 | 0.030 | 0.053 | 0.122 | 0.110 |
| | $H_i$ | 0.132 | 0.124 | 0.134 | 0.047 | 0.052 | 0.103 | 0.091 |
| | $H_i$* | 0.097 | 0.114 | 0.126 | 0.061 | 0.047 | 0.069 | 0.066 |
| | $I_i$ | 0.127 | 0.099 | 0.124 | 0.044 | 0.050 | 0.136 | 0.108 |
| 12 | $c_i$ | 0.034 | 0.034 | 0.035 | 0.038 | 0.066 | 0.104 | 0.086 |
| | $G_i$ | 0.038 | 0.044 | 0.038 | 0.051 | 0.076 | 0.137 | 0.106 |
| | $G_i$* | 0.044 | 0.045 | 0.041 | 0.055 | 0.086 | 0.138 | 0.111 |
| | $H_i$ | 0.036 | 0.032 | 0.041 | 0.058 | 0.068 | 0.111 | 0.088 |
| | $H_i$* | 0.035 | 0.023 | 0.039 | 0.046 | 0.053 | 0.065 | 0.065 |
| | $I_i$ | 0.033 | 0.031 | 0.025 | 0.051 | 0.072 | 0.157 | 0.111 |
| 13 | $c_i$ | 0.113 | 0.099 | 0.115 | 0.120 | 0.116 | 0.114 | 0.109 |
| | $G_i$ | 0.108 | 0.111 | 0.110 | 0.125 | 0.127 | 0.142 | 0.102 |
| | $G_i$* | 0.127 | 0.128 | 0.110 | 0.132 | 0.123 | 0.145 | 0.122 |
| | $H_i$ | 0.104 | 0.095 | 0.101 | 0.117 | 0.100 | 0.115 | 0.090 |
| | $H_i$* | 0.062 | 0.060 | 0.068 | 0.079 | 0.060 | 0.067 | 0.067 |
| | $I_i$ | 0.138 | 0.128 | 0.129 | 0.155 | 0.142 | 0.144 | 0.117 |
| 14 | $c_i$ | 0.095 | 0.082 | 0.092 | 0.091 | 0.091 | 0.099 | 0.089 |
| | $G_i$ | 0.106 | 0.107 | 0.121 | 0.100 | 0.094 | 0.104 | 0.090 |
| | $G_i$* | 0.114 | 0.109 | 0.105 | 0.102 | 0.092 | 0.118 | 0.095 |
| | $H_i$ | 0.078 | 0.073 | 0.078 | 0.088 | 0.078 | 0.082 | 0.066 |
| | $H_i$* | 0.052 | 0.053 | 0.052 | 0.067 | 0.052 | 0.056 | 0.054 |
| | $I_i$ | 0.116 | 0.121 | 0.112 | 0.110 | 0.097 | 0.122 | 0.098 |

Figure B.41 Empirical Power Based on Hot-Spot Pattern Variance-Covariance Matrix Using Queen Connectivity Case for a 14x14 Study Area

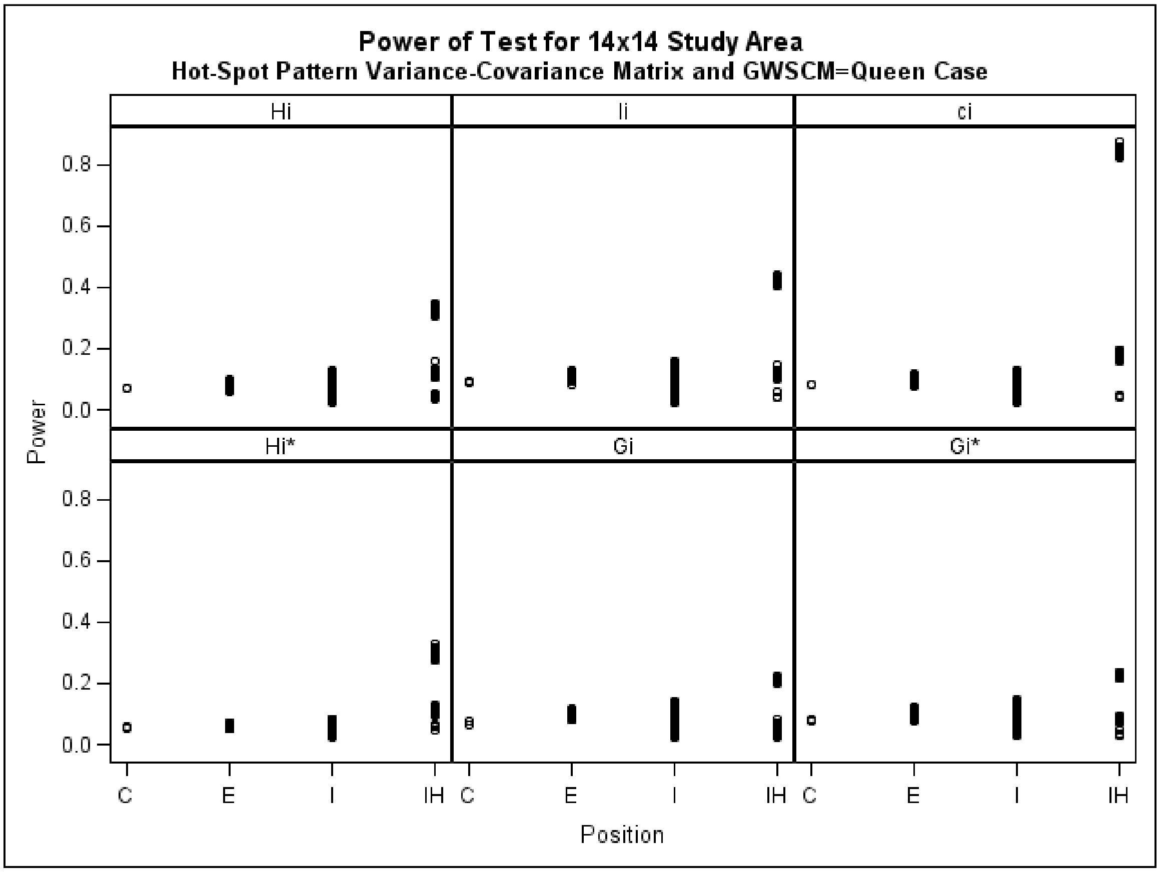


Table B.42 Empirical Power Based on Hot-Spot Pattern Variance-Covariance Matrix Using CWF Connectivity Case for a 14x14 Study Area

| | | Column | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1 | $c_i$ | 0.128 | 0.132 | 0.123 | 0.118 | 0.108 | 0.123 | 0.123 |
| | $G_i$ | 0.098 | 0.131 | 0.117 | 0.123 | 0.138 | 0.120 | 0.133 |
| | $G_i$* | 0.105 | 0.112 | 0.130 | 0.131 | 0.129 | 0.131 | 0.139 |
| | $H_i$ | 0.102 | 0.118 | 0.099 | 0.126 | 0.118 | 0.119 | 0.120 |
| | $H_i$* | 0.064 | 0.068 | 0.069 | 0.082 | 0.071 | 0.060 | 0.068 |
| | $I_i$ | 0.129 | 0.159 | 0.135 | 0.155 | 0.156 | 0.152 | 0.159 |
| 2 | $c_i$ | 0.132 | 0.132 | 0.123 | 0.117 | 0.097 | 0.091 | 0.089 |
| | $G_i$ | 0.125 | 0.151 | 0.133 | 0.110 | 0.094 | 0.098 | 0.097 |
| | $G_i$* | 0.136 | 0.142 | 0.134 | 0.120 | 0.105 | 0.103 | 0.107 |
| | $H_i$ | 0.119 | 0.148 | 0.130 | 0.132 | 0.102 | 0.104 | 0.088 |
| | $H_i$* | 0.074 | 0.074 | 0.070 | 0.068 | 0.055 | 0.062 | 0.053 |
| | $I_i$ | 0.148 | 0.184 | 0.145 | 0.144 | 0.118 | 0.124 | 0.112 |
| 3 | $c_i$ | 0.132 | 0.129 | 0.096 | 0.041 | 0.051 | 0.042 | 0.049 |
| | $G_i$ | 0.133 | 0.139 | 0.096 | 0.046 | 0.034 | 0.027 | 0.038 |
| | $G_i$* | 0.137 | 0.141 | 0.100 | 0.053 | 0.039 | 0.041 | 0.035 |
| | $H_i$ | 0.125 | 0.125 | 0.107 | 0.060 | 0.042 | 0.040 | 0.027 |
| | $H_i$* | 0.068 | 0.075 | 0.082 | 0.051 | 0.042 | 0.043 | 0.040 |
| | $I_i$ | 0.157 | 0.161 | 0.129 | 0.057 | 0.039 | 0.038 | 0.025 |
| 4 | $c_i$ | 0.129 | 0.102 | 0.042 | 0.057 | 0.212 | 0.334 | 0.380 |
| | $G_i$ | 0.132 | 0.123 | 0.051 | 0.021 | 0.070 | 0.123 | 0.143 |
| | $G_i$* | 0.134 | 0.123 | 0.058 | 0.021 | 0.101 | 0.151 | 0.164 |
| | $H_i$ | 0.131 | 0.118 | 0.053 | 0.022 | 0.143 | 0.236 | 0.253 |
| | $H_i$* | 0.086 | 0.085 | 0.044 | 0.037 | 0.098 | 0.138 | 0.132 |
| | $I_i$ | 0.156 | 0.150 | 0.049 | 0.030 | 0.148 | 0.240 | 0.277 |
| 5 | $c_i$ | 0.138 | 0.112 | 0.044 | 0.231 | 0.739 | 0.910 | 0.927 |
| | $G_i$ | 0.144 | 0.107 | 0.034 | 0.064 | 0.218 | 0.266 | 0.282 |
| | $G_i$* | 0.127 | 0.114 | 0.042 | 0.094 | 0.228 | 0.276 | 0.285 |
| | $H_i$ | 0.124 | 0.107 | 0.035 | 0.139 | 0.411 | 0.444 | 0.453 |
| | $H_i$* | 0.073 | 0.064 | 0.036 | 0.110 | 0.288 | 0.343 | 0.360 |
| | $I_i$ | 0.170 | 0.126 | 0.033 | 0.142 | 0.443 | 0.521 | 0.543 |
| 6 | $c_i$ | 0.132 | 0.103 | 0.066 | 0.341 | 0.911 | 0.974 | 0.971 |
| | $G_i$ | 0.113 | 0.104 | 0.042 | 0.119 | 0.268 | 0.311 | 0.319 |
| | $G_i$* | 0.125 | 0.105 | 0.045 | 0.141 | 0.273 | 0.305 | 0.312 |
| | $H_i$ | 0.124 | 0.114 | 0.050 | 0.242 | 0.455 | 0.497 | 0.479 |
| | $H_i$* | 0.077 | 0.059 | 0.044 | 0.155 | 0.372 | 0.422 | 0.404 |
| | $I_i$ | 0.157 | 0.137 | 0.041 | 0.243 | 0.535 | 0.598 | 0.610 |
| 7 | $c_i$ | 0.128 | 0.093 | 0.061 | 0.385 | 0.912 | 0.975 | 0.982 |
| | $G_i$ | 0.113 | 0.090 | 0.045 | 0.129 | 0.267 | 0.313 | 0.321 |
| | $G_i$* | 0.124 | 0.109 | 0.052 | 0.149 | 0.277 | 0.309 | 0.318 |
| | $H_i$ | 0.117 | 0.115 | 0.052 | 0.257 | 0.440 | 0.501 | 0.477 |
| | $H_i$* | 0.081 | 0.078 | 0.047 | 0.152 | 0.349 | 0.409 | 0.414 |
| | $I_i$ | 0.159 | 0.121 | 0.042 | 0.267 | 0.531 | 0.607 | 0.612 |
| 8 | $c_i$ | 0.110 | 0.084 | 0.050 | 0.390 | 0.923 | 0.978 | 0.970 |

| | | Column | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | $G_i$ | 0.125 | 0.089 | 0.038 | 0.127 | 0.277 | 0.304 | 0.320 |
| | $G_i$* | 0.121 | 0.095 | 0.042 | 0.160 | 0.280 | 0.305 | 0.318 |
| | $H_i$ | 0.123 | 0.094 | 0.036 | 0.253 | 0.450 | 0.473 | 0.490 |
| | $H_i$* | 0.071 | 0.054 | 0.042 | 0.149 | 0.351 | 0.417 | 0.417 |
| | $I_i$ | 0.139 | 0.104 | 0.041 | 0.264 | 0.545 | 0.607 | 0.625 |
| 9 | $c_i$ | 0.104 | 0.088 | 0.043 | 0.357 | 0.904 | 0.975 | 0.979 |
| | $G_i$ | 0.124 | 0.094 | 0.041 | 0.142 | 0.267 | 0.310 | 0.318 |
| | $G_i$* | 0.117 | 0.103 | 0.038 | 0.165 | 0.276 | 0.305 | 0.312 |
| | $H_i$ | 0.122 | 0.102 | 0.036 | 0.265 | 0.460 | 0.477 | 0.497 |
| | $H_i$* | 0.079 | 0.062 | 0.040 | 0.145 | 0.357 | 0.396 | 0.432 |
| | $I_i$ | 0.143 | 0.122 | 0.035 | 0.273 | 0.540 | 0.597 | 0.614 |
| 10 | $c_i$ | 0.117 | 0.091 | 0.038 | 0.219 | 0.758 | 0.908 | 0.931 |
| | $G_i$ | 0.127 | 0.101 | 0.036 | 0.084 | 0.234 | 0.272 | 0.283 |
| | $G_i$* | 0.129 | 0.117 | 0.037 | 0.110 | 0.246 | 0.277 | 0.281 |
| | $H_i$ | 0.117 | 0.108 | 0.037 | 0.155 | 0.427 | 0.466 | 0.468 |
| | $H_i$* | 0.065 | 0.077 | 0.034 | 0.112 | 0.286 | 0.375 | 0.364 |
| | $I_i$ | 0.154 | 0.128 | 0.040 | 0.158 | 0.466 | 0.543 | 0.555 |
| 11 | $c_i$ | 0.131 | 0.111 | 0.037 | 0.042 | 0.181 | 0.376 | 0.402 |
| | $G_i$ | 0.128 | 0.114 | 0.044 | 0.030 | 0.085 | 0.148 | 0.145 |
| | $G_i$* | 0.123 | 0.119 | 0.044 | 0.028 | 0.108 | 0.154 | 0.167 |
| | $H_i$ | 0.127 | 0.113 | 0.055 | 0.042 | 0.173 | 0.258 | 0.268 |
| | $H_i$* | 0.083 | 0.070 | 0.050 | 0.063 | 0.123 | 0.149 | 0.165 |
| | $I_i$ | 0.152 | 0.131 | 0.051 | 0.038 | 0.177 | 0.276 | 0.287 |
| 12 | $c_i$ | 0.133 | 0.136 | 0.094 | 0.044 | 0.041 | 0.048 | 0.053 |
| | $G_i$ | 0.122 | 0.126 | 0.107 | 0.036 | 0.032 | 0.044 | 0.045 |
| | $G_i$* | 0.121 | 0.145 | 0.107 | 0.058 | 0.047 | 0.048 | 0.047 |
| | $H_i$ | 0.123 | 0.126 | 0.097 | 0.053 | 0.044 | 0.038 | 0.036 |
| | $H_i$* | 0.074 | 0.078 | 0.074 | 0.053 | 0.050 | 0.032 | 0.039 |
| | $I_i$ | 0.147 | 0.168 | 0.112 | 0.056 | 0.042 | 0.044 | 0.033 |
| 13 | $c_i$ | 0.120 | 0.132 | 0.132 | 0.103 | 0.106 | 0.085 | 0.085 |
| | $G_i$ | 0.128 | 0.144 | 0.134 | 0.129 | 0.093 | 0.097 | 0.100 |
| | $G_i$* | 0.132 | 0.149 | 0.139 | 0.127 | 0.106 | 0.091 | 0.105 |
| | $H_i$ | 0.113 | 0.135 | 0.146 | 0.115 | 0.108 | 0.090 | 0.095 |
| | $H_i$* | 0.073 | 0.082 | 0.086 | 0.058 | 0.067 | 0.077 | 0.065 |
| | $I_i$ | 0.158 | 0.165 | 0.166 | 0.142 | 0.114 | 0.108 | 0.102 |
| 14 | $c_i$ | 0.109 | 0.114 | 0.127 | 0.122 | 0.124 | 0.121 | 0.121 |
| | $G_i$ | 0.108 | 0.135 | 0.133 | 0.128 | 0.120 | 0.122 | 0.134 |
| | $G_i$* | 0.108 | 0.128 | 0.145 | 0.135 | 0.141 | 0.128 | 0.137 |
| | $H_i$ | 0.108 | 0.132 | 0.127 | 0.127 | 0.124 | 0.113 | 0.116 |
| | $H_i$* | 0.059 | 0.078 | 0.088 | 0.076 | 0.071 | 0.080 | 0.084 |
| | $I_i$ | 0.123 | 0.173 | 0.161 | 0.160 | 0.155 | 0.139 | 0.143 |

| | | Column | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 1 | $c_i$ | 0.115 | 0.116 | 0.124 | 0.114 | 0.136 | 0.120 | 0.112 |
| | $G_i$ | 0.127 | 0.144 | 0.126 | 0.144 | 0.126 | 0.127 | 0.093 |
| | $G_i$* | 0.132 | 0.138 | 0.138 | 0.133 | 0.130 | 0.124 | 0.100 |
| | $H_i$ | 0.119 | 0.117 | 0.127 | 0.105 | 0.107 | 0.117 | 0.090 |
| | $H_i$* | 0.084 | 0.061 | 0.061 | 0.070 | 0.075 | 0.065 | 0.067 |
| | $I_i$ | 0.140 | 0.145 | 0.158 | 0.151 | 0.149 | 0.152 | 0.121 |
| 2 | $c_i$ | 0.083 | 0.093 | 0.093 | 0.092 | 0.105 | 0.133 | 0.126 |
| | $G_i$ | 0.108 | 0.119 | 0.119 | 0.124 | 0.140 | 0.136 | 0.111 |
| | $G_i$* | 0.108 | 0.121 | 0.126 | 0.136 | 0.143 | 0.132 | 0.113 |
| | $H_i$ | 0.105 | 0.108 | 0.109 | 0.121 | 0.106 | 0.132 | 0.115 |
| | $H_i$* | 0.071 | 0.076 | 0.072 | 0.075 | 0.068 | 0.088 | 0.069 |
| | $I_i$ | 0.118 | 0.117 | 0.118 | 0.146 | 0.145 | 0.168 | 0.142 |
| 3 | $c_i$ | 0.055 | 0.053 | 0.039 | 0.038 | 0.080 | 0.122 | 0.115 |
| | $G_i$ | 0.041 | 0.044 | 0.040 | 0.049 | 0.102 | 0.133 | 0.132 |
| | $G_i$* | 0.039 | 0.049 | 0.052 | 0.068 | 0.108 | 0.135 | 0.132 |
| | $H_i$ | 0.035 | 0.030 | 0.042 | 0.050 | 0.109 | 0.133 | 0.127 |
| | $H_i$* | 0.036 | 0.034 | 0.039 | 0.042 | 0.075 | 0.082 | 0.080 |
| | $I_i$ | 0.035 | 0.035 | 0.035 | 0.056 | 0.120 | 0.167 | 0.168 |
| 4 | $c_i$ | 0.397 | 0.352 | 0.215 | 0.050 | 0.035 | 0.106 | 0.123 |
| | $G_i$ | 0.141 | 0.144 | 0.084 | 0.044 | 0.055 | 0.104 | 0.142 |
| | $G_i$* | 0.171 | 0.165 | 0.120 | 0.047 | 0.063 | 0.124 | 0.129 |
| | $H_i$ | 0.260 | 0.253 | 0.164 | 0.056 | 0.052 | 0.116 | 0.123 |
| | $H_i$* | 0.155 | 0.161 | 0.111 | 0.052 | 0.047 | 0.080 | 0.087 |
| | $I_i$ | 0.272 | 0.261 | 0.162 | 0.060 | 0.054 | 0.133 | 0.154 |
| 5 | $c_i$ | 0.916 | 0.911 | 0.725 | 0.207 | 0.034 | 0.092 | 0.119 |
| | $G_i$ | 0.283 | 0.277 | 0.231 | 0.090 | 0.052 | 0.091 | 0.116 |
| | $G_i$* | 0.294 | 0.282 | 0.241 | 0.110 | 0.039 | 0.106 | 0.124 |
| | $H_i$ | 0.463 | 0.466 | 0.427 | 0.164 | 0.032 | 0.094 | 0.116 |
| | $H_i$* | 0.364 | 0.369 | 0.301 | 0.096 | 0.041 | 0.061 | 0.067 |
| | $I_i$ | 0.545 | 0.535 | 0.458 | 0.162 | 0.031 | 0.113 | 0.152 |
| 6 | $c_i$ | 0.979 | 0.975 | 0.889 | 0.359 | 0.041 | 0.077 | 0.100 |
| | $G_i$ | 0.317 | 0.302 | 0.277 | 0.127 | 0.036 | 0.105 | 0.136 |
| | $G_i$* | 0.312 | 0.309 | 0.278 | 0.146 | 0.042 | 0.109 | 0.126 |
| | $H_i$ | 0.479 | 0.493 | 0.450 | 0.248 | 0.036 | 0.087 | 0.121 |
| | $H_i$* | 0.410 | 0.424 | 0.352 | 0.143 | 0.045 | 0.059 | 0.070 |
| | $I_i$ | 0.612 | 0.595 | 0.531 | 0.251 | 0.033 | 0.107 | 0.152 |
| 7 | $c_i$ | 0.982 | 0.979 | 0.923 | 0.392 | 0.059 | 0.078 | 0.125 |
| | $G_i$ | 0.315 | 0.314 | 0.283 | 0.125 | 0.038 | 0.086 | 0.111 |
| | $G_i$* | 0.319 | 0.310 | 0.287 | 0.156 | 0.041 | 0.105 | 0.127 |
| | $H_i$ | 0.489 | 0.499 | 0.454 | 0.258 | 0.040 | 0.107 | 0.106 |
| | $H_i$* | 0.411 | 0.422 | 0.368 | 0.142 | 0.041 | 0.085 | 0.063 |
| | $I_i$ | 0.619 | 0.604 | 0.550 | 0.257 | 0.043 | 0.111 | 0.140 |
| 8 | $c_i$ | 0.981 | 0.971 | 0.922 | 0.393 | 0.064 | 0.112 | 0.122 |
| | $G_i$ | 0.317 | 0.307 | 0.278 | 0.134 | 0.043 | 0.089 | 0.121 |
| | $G_i$* | 0.317 | 0.310 | 0.288 | 0.158 | 0.039 | 0.095 | 0.117 |
| | $H_i$ | 0.489 | 0.467 | 0.457 | 0.266 | 0.044 | 0.113 | 0.105 |
| | $H_i$* | 0.427 | 0.408 | 0.374 | 0.139 | 0.051 | 0.074 | 0.066 |

| | | Column | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| | $I_i$ | 0.625 | 0.603 | 0.541 | 0.284 | 0.048 | 0.122 | 0.151 |
| 9 | $c_i$ | 0.975 | 0.972 | 0.909 | 0.365 | 0.071 | 0.107 | 0.130 |
| | $G_i$ | 0.319 | 0.305 | 0.265 | 0.134 | 0.031 | 0.103 | 0.120 |
| | $G_i$* | 0.318 | 0.309 | 0.271 | 0.164 | 0.043 | 0.099 | 0.116 |
| | $H_i$ | 0.494 | 0.487 | 0.463 | 0.254 | 0.039 | 0.108 | 0.126 |
| | $H_i$* | 0.415 | 0.423 | 0.364 | 0.132 | 0.038 | 0.070 | 0.077 |
| | $I_i$ | 0.606 | 0.590 | 0.522 | 0.270 | 0.038 | 0.131 | 0.151 |
| 10 | $c_i$ | 0.922 | 0.905 | 0.760 | 0.214 | 0.054 | 0.108 | 0.130 |
| | $G_i$ | 0.286 | 0.277 | 0.244 | 0.084 | 0.035 | 0.089 | 0.120 |
| | $G_i$* | 0.285 | 0.289 | 0.251 | 0.108 | 0.041 | 0.112 | 0.131 |
| | $H_i$ | 0.475 | 0.462 | 0.421 | 0.162 | 0.038 | 0.110 | 0.124 |
| | $H_i$* | 0.387 | 0.364 | 0.300 | 0.108 | 0.051 | 0.059 | 0.072 |
| | $I_i$ | 0.554 | 0.537 | 0.454 | 0.163 | 0.031 | 0.131 | 0.153 |
| 11 | $c_i$ | 0.410 | 0.358 | 0.212 | 0.052 | 0.043 | 0.095 | 0.121 |
| | $G_i$ | 0.150 | 0.141 | 0.086 | 0.026 | 0.050 | 0.130 | 0.145 |
| | $G_i$* | 0.177 | 0.157 | 0.106 | 0.034 | 0.057 | 0.135 | 0.141 |
| | $H_i$ | 0.273 | 0.258 | 0.170 | 0.046 | 0.048 | 0.116 | 0.123 |
| | $H_i$* | 0.123 | 0.146 | 0.107 | 0.051 | 0.037 | 0.079 | 0.081 |
| | $I_i$ | 0.289 | 0.270 | 0.164 | 0.042 | 0.062 | 0.144 | 0.148 |
| 12 | $c_i$ | 0.050 | 0.041 | 0.031 | 0.037 | 0.092 | 0.117 | 0.127 |
| | $G_i$ | 0.047 | 0.040 | 0.035 | 0.058 | 0.115 | 0.145 | 0.138 |
| | $G_i$* | 0.048 | 0.043 | 0.043 | 0.067 | 0.121 | 0.153 | 0.151 |
| | $H_i$ | 0.044 | 0.035 | 0.038 | 0.061 | 0.105 | 0.133 | 0.128 |
| | $H_i$* | 0.045 | 0.044 | 0.041 | 0.045 | 0.060 | 0.078 | 0.077 |
| | $I_i$ | 0.039 | 0.028 | 0.029 | 0.059 | 0.127 | 0.174 | 0.156 |
| 13 | $c_i$ | 0.090 | 0.091 | 0.094 | 0.106 | 0.136 | 0.129 | 0.119 |
| | $G_i$ | 0.090 | 0.098 | 0.097 | 0.128 | 0.141 | 0.156 | 0.135 |
| | $G_i$* | 0.109 | 0.110 | 0.110 | 0.134 | 0.141 | 0.158 | 0.147 |
| | $H_i$ | 0.093 | 0.085 | 0.098 | 0.123 | 0.144 | 0.127 | 0.124 |
| | $H_i$* | 0.068 | 0.066 | 0.080 | 0.078 | 0.082 | 0.077 | 0.071 |
| | $I_i$ | 0.117 | 0.104 | 0.115 | 0.163 | 0.174 | 0.160 | 0.155 |
| 14 | $c_i$ | 0.117 | 0.123 | 0.114 | 0.121 | 0.121 | 0.128 | 0.117 |
| | $G_i$ | 0.130 | 0.144 | 0.135 | 0.135 | 0.123 | 0.135 | 0.116 |
| | $G_i$* | 0.135 | 0.124 | 0.125 | 0.138 | 0.137 | 0.140 | 0.123 |
| | $H_i$ | 0.123 | 0.120 | 0.105 | 0.110 | 0.121 | 0.115 | 0.106 |
| | $H_i$* | 0.073 | 0.076 | 0.060 | 0.081 | 0.075 | 0.080 | 0.069 |
| | $I_i$ | 0.154 | 0.157 | 0.137 | 0.157 | 0.143 | 0.153 | 0.138 |

Figure B.42 Empirical Power Based on Hot-Spot Pattern Variance-Covariance Matrix Using CWF Connectivity Case for a 14x14 Study Area

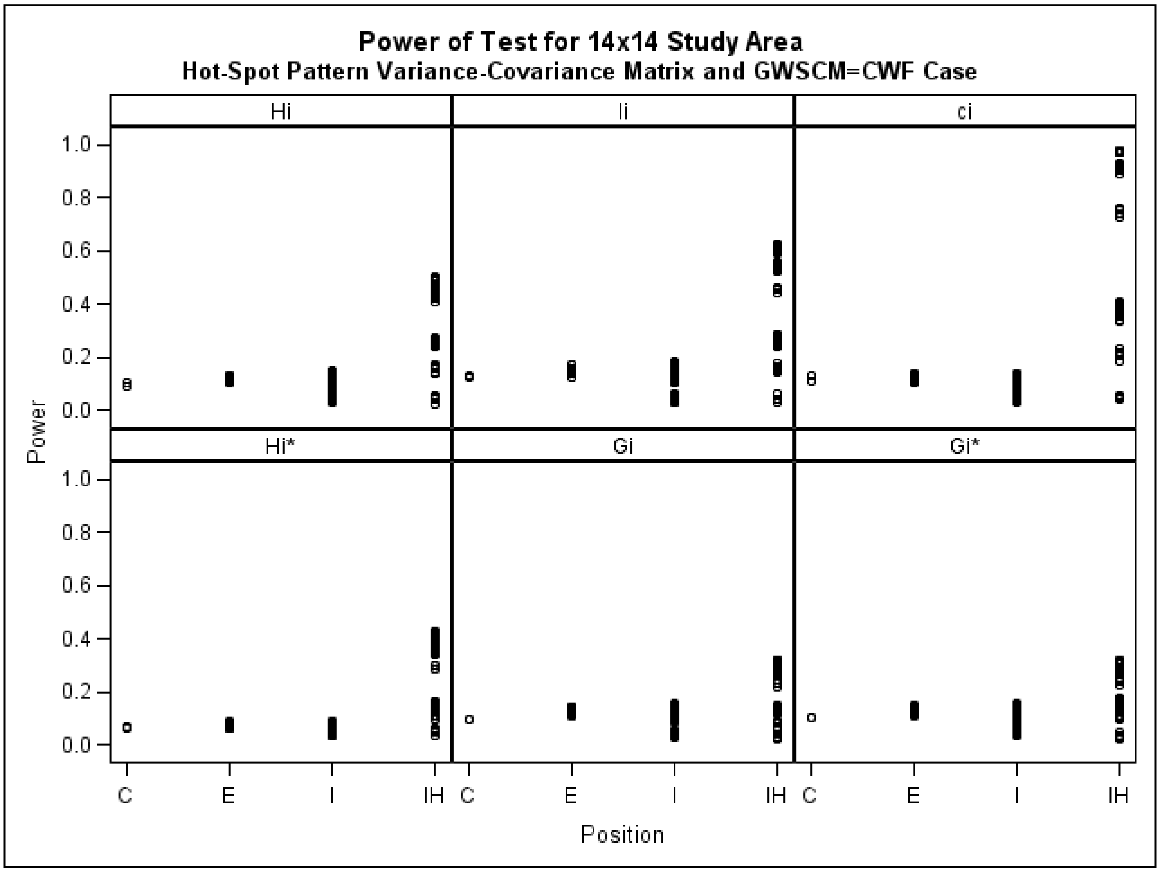


Table B.43 Empirical Power Based on CWF Pattern Variance-Covariance Matrix Using Rook Connectivity Case for a 14x14 Study Area

| | | Column | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1 | $c_i$ | 0.256 | 0.348 | 0.315 | 0.349 | 0.312 | 0.302 | 0.336 |
| | $G_i$ | 0.111 | 0.126 | 0.106 | 0.108 | 0.112 | 0.104 | 0.109 |
| | $G_i$* | 0.161 | 0.175 | 0.155 | 0.154 | 0.146 | 0.160 | 0.165 |
| | $H_i$ | 0.201 | 0.288 | 0.276 | 0.260 | 0.268 | 0.251 | 0.292 |
| | $H_i$* | 0.155 | 0.220 | 0.212 | 0.177 | 0.184 | 0.176 | 0.210 |
| | $I_i$ | 0.205 | 0.233 | 0.216 | 0.212 | 0.210 | 0.216 | 0.225 |
| 2 | $c_i$ | 0.363 | 0.447 | 0.440 | 0.427 | 0.408 | 0.397 | 0.419 |
| | $G_i$ | 0.138 | 0.152 | 0.133 | 0.133 | 0.135 | 0.130 | 0.133 |
| | $G_i$* | 0.190 | 0.203 | 0.188 | 0.176 | 0.184 | 0.174 | 0.180 |
| | $H_i$ | 0.292 | 0.372 | 0.345 | 0.338 | 0.347 | 0.358 | 0.360 |
| | $H_i$* | 0.207 | 0.249 | 0.236 | 0.212 | 0.242 | 0.246 | 0.212 |
| | $I_i$ | 0.260 | 0.283 | 0.254 | 0.268 | 0.273 | 0.282 | 0.281 |
| 3 | $c_i$ | 0.340 | 0.446 | 0.418 | 0.395 | 0.431 | 0.415 | 0.408 |
| | $G_i$ | 0.131 | 0.154 | 0.139 | 0.137 | 0.141 | 0.132 | 0.133 |
| | $G_i$* | 0.176 | 0.191 | 0.170 | 0.163 | 0.187 | 0.174 | 0.174 |
| | $H_i$ | 0.280 | 0.373 | 0.353 | 0.331 | 0.342 | 0.357 | 0.349 |
| | $H_i$* | 0.182 | 0.255 | 0.237 | 0.220 | 0.224 | 0.228 | 0.229 |
| | $I_i$ | 0.241 | 0.291 | 0.282 | 0.275 | 0.285 | 0.278 | 0.278 |
| 4 | $c_i$ | 0.327 | 0.387 | 0.408 | 0.414 | 0.414 | 0.416 | 0.401 |
| | $G_i$ | 0.125 | 0.138 | 0.131 | 0.128 | 0.127 | 0.122 | 0.124 |
| | $G_i$* | 0.172 | 0.172 | 0.163 | 0.163 | 0.171 | 0.157 | 0.162 |
| | $H_i$ | 0.281 | 0.326 | 0.343 | 0.343 | 0.324 | 0.340 | 0.357 |
| | $H_i$* | 0.202 | 0.226 | 0.246 | 0.238 | 0.236 | 0.218 | 0.245 |
| | $I_i$ | 0.237 | 0.264 | 0.254 | 0.267 | 0.262 | 0.268 | 0.267 |
| 5 | $c_i$ | 0.328 | 0.412 | 0.409 | 0.421 | 0.401 | 0.435 | 0.426 |
| | $G_i$ | 0.119 | 0.136 | 0.130 | 0.111 | 0.111 | 0.116 | 0.110 |
| | $G_i$* | 0.159 | 0.167 | 0.172 | 0.157 | 0.150 | 0.149 | 0.146 |
| | $H_i$ | 0.290 | 0.364 | 0.345 | 0.330 | 0.324 | 0.356 | 0.367 |
| | $H_i$* | 0.211 | 0.235 | 0.243 | 0.223 | 0.202 | 0.235 | 0.237 |
| | $I_i$ | 0.235 | 0.274 | 0.254 | 0.242 | 0.258 | 0.285 | 0.271 |
| 6 | $c_i$ | 0.337 | 0.433 | 0.426 | 0.438 | 0.442 | 0.426 | 0.437 |
| | $G_i$ | 0.109 | 0.143 | 0.133 | 0.121 | 0.124 | 0.122 | 0.112 |
| | $G_i$* | 0.149 | 0.188 | 0.180 | 0.167 | 0.161 | 0.147 | 0.150 |
| | $H_i$ | 0.288 | 0.349 | 0.351 | 0.360 | 0.343 | 0.355 | 0.351 |
| | $H_i$* | 0.212 | 0.235 | 0.229 | 0.250 | 0.218 | 0.233 | 0.222 |
| | $I_i$ | 0.228 | 0.293 | 0.271 | 0.277 | 0.278 | 0.288 | 0.264 |
| 7 | $c_i$ | 0.315 | 0.422 | 0.429 | 0.455 | 0.423 | 0.448 | 0.409 |
| | $G_i$ | 0.109 | 0.145 | 0.144 | 0.144 | 0.138 | 0.138 | 0.134 |
| | $G_i$* | 0.162 | 0.184 | 0.182 | 0.179 | 0.180 | 0.182 | 0.166 |
| | $H_i$ | 0.293 | 0.381 | 0.376 | 0.381 | 0.361 | 0.364 | 0.353 |
| | $H_i$* | 0.217 | 0.237 | 0.231 | 0.238 | 0.243 | 0.247 | 0.217 |
| | $I_i$ | 0.234 | 0.304 | 0.302 | 0.307 | 0.295 | 0.283 | 0.288 |
| 8 | $c_i$ | 0.329 | 0.427 | 0.424 | 0.410 | 0.433 | 0.424 | 0.394 |

| | | Column | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | $G_i$ | 0.115 | 0.145 | 0.135 | 0.144 | 0.149 | 0.151 | 0.144 |
| | $G_i$* | 0.167 | 0.184 | 0.176 | 0.176 | 0.182 | 0.193 | 0.183 |
| | $H_i$ | 0.295 | 0.373 | 0.362 | 0.357 | 0.371 | 0.361 | 0.348 |
| | $H_i$* | 0.195 | 0.223 | 0.228 | 0.236 | 0.215 | 0.234 | 0.227 |
| | $I_i$ | 0.250 | 0.308 | 0.296 | 0.295 | 0.302 | 0.302 | 0.290 |
| 9 | $c_i$ | 0.345 | 0.425 | 0.392 | 0.385 | 0.423 | 0.417 | 0.407 |
| | $G_i$ | 0.120 | 0.137 | 0.127 | 0.138 | 0.146 | 0.143 | 0.135 |
| | $G_i$* | 0.166 | 0.188 | 0.165 | 0.176 | 0.182 | 0.186 | 0.175 |
| | $H_i$ | 0.299 | 0.363 | 0.355 | 0.347 | 0.377 | 0.343 | 0.338 |
| | $H_i$* | 0.199 | 0.234 | 0.227 | 0.236 | 0.225 | 0.220 | 0.225 |
| | $I_i$ | 0.250 | 0.293 | 0.273 | 0.275 | 0.287 | 0.283 | 0.272 |
| 10 | $c_i$ | 0.330 | 0.403 | 0.434 | 0.434 | 0.392 | 0.407 | 0.423 |
| | $G_i$ | 0.115 | 0.125 | 0.136 | 0.139 | 0.142 | 0.133 | 0.136 |
| | $G_i$* | 0.160 | 0.171 | 0.179 | 0.174 | 0.175 | 0.180 | 0.179 |
| | $H_i$ | 0.298 | 0.354 | 0.346 | 0.354 | 0.352 | 0.340 | 0.340 |
| | $H_i$* | 0.208 | 0.234 | 0.202 | 0.250 | 0.246 | 0.234 | 0.229 |
| | $I_i$ | 0.245 | 0.279 | 0.287 | 0.283 | 0.286 | 0.264 | 0.265 |
| 11 | $c_i$ | 0.342 | 0.421 | 0.446 | 0.449 | 0.444 | 0.414 | 0.416 |
| | $G_i$ | 0.127 | 0.142 | 0.138 | 0.147 | 0.143 | 0.136 | 0.131 |
| | $G_i$* | 0.172 | 0.189 | 0.182 | 0.181 | 0.186 | 0.176 | 0.166 |
| | $H_i$ | 0.285 | 0.361 | 0.354 | 0.360 | 0.358 | 0.343 | 0.334 |
| | $H_i$* | 0.214 | 0.247 | 0.229 | 0.228 | 0.221 | 0.225 | 0.225 |
| | $I_i$ | 0.247 | 0.281 | 0.284 | 0.297 | 0.286 | 0.292 | 0.270 |
| 12 | $c_i$ | 0.363 | 0.405 | 0.401 | 0.399 | 0.425 | 0.429 | 0.433 |
| | $G_i$ | 0.119 | 0.143 | 0.133 | 0.145 | 0.139 | 0.130 | 0.125 |
| | $G_i$* | 0.171 | 0.180 | 0.177 | 0.180 | 0.180 | 0.173 | 0.163 |
| | $H_i$ | 0.297 | 0.341 | 0.315 | 0.366 | 0.365 | 0.373 | 0.343 |
| | $H_i$* | 0.204 | 0.227 | 0.215 | 0.251 | 0.225 | 0.236 | 0.248 |
| | $I_i$ | 0.237 | 0.271 | 0.259 | 0.284 | 0.300 | 0.282 | 0.269 |
| 13 | $c_i$ | 0.361 | 0.416 | 0.408 | 0.397 | 0.404 | 0.437 | 0.445 |
| | $G_i$ | 0.121 | 0.156 | 0.134 | 0.133 | 0.139 | 0.130 | 0.138 |
| | $G_i$* | 0.169 | 0.192 | 0.170 | 0.179 | 0.182 | 0.175 | 0.184 |
| | $H_i$ | 0.279 | 0.366 | 0.341 | 0.339 | 0.331 | 0.360 | 0.342 |
| | $H_i$* | 0.187 | 0.261 | 0.244 | 0.220 | 0.227 | 0.227 | 0.218 |
| | $I_i$ | 0.255 | 0.294 | 0.270 | 0.271 | 0.280 | 0.285 | 0.291 |
| 14 | $c_i$ | 0.246 | 0.358 | 0.339 | 0.317 | 0.331 | 0.349 | 0.344 |
| | $G_i$ | 0.096 | 0.133 | 0.121 | 0.124 | 0.123 | 0.102 | 0.110 |
| | $G_i$* | 0.146 | 0.180 | 0.170 | 0.172 | 0.178 | 0.153 | 0.161 |
| | $H_i$ | 0.211 | 0.303 | 0.288 | 0.276 | 0.304 | 0.306 | 0.288 |
| | $H_i$* | 0.165 | 0.204 | 0.203 | 0.189 | 0.225 | 0.219 | 0.211 |
| | $I_i$ | 0.200 | 0.256 | 0.233 | 0.238 | 0.255 | 0.234 | 0.237 |

| | | Column | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 1 | $c_i$ | 0.337 | 0.350 | 0.328 | 0.331 | 0.346 | 0.340 | 0.264 |
| | $G_i$ | 0.116 | 0.128 | 0.125 | 0.136 | 0.124 | 0.117 | 0.101 |
| | $G_i$* | 0.170 | 0.168 | 0.172 | 0.182 | 0.171 | 0.168 | 0.150 |
| | $H_i$ | 0.295 | 0.298 | 0.291 | 0.299 | 0.295 | 0.293 | 0.234 |
| | $H_i$* | 0.201 | 0.195 | 0.217 | 0.221 | 0.211 | 0.221 | 0.164 |
| | $I_i$ | 0.240 | 0.245 | 0.236 | 0.248 | 0.242 | 0.257 | 0.212 |
| 2 | $c_i$ | 0.426 | 0.427 | 0.425 | 0.434 | 0.404 | 0.434 | 0.373 |
| | $G_i$ | 0.145 | 0.159 | 0.158 | 0.157 | 0.156 | 0.154 | 0.127 |
| | $G_i$* | 0.199 | 0.202 | 0.189 | 0.201 | 0.197 | 0.193 | 0.183 |
| | $H_i$ | 0.359 | 0.359 | 0.358 | 0.351 | 0.373 | 0.388 | 0.312 |
| | $H_i$* | 0.220 | 0.222 | 0.257 | 0.225 | 0.259 | 0.265 | 0.224 |
| | $I_i$ | 0.275 | 0.289 | 0.276 | 0.282 | 0.300 | 0.312 | 0.266 |
| 3 | $c_i$ | 0.382 | 0.413 | 0.414 | 0.427 | 0.422 | 0.426 | 0.350 |
| | $G_i$ | 0.126 | 0.143 | 0.149 | 0.158 | 0.149 | 0.144 | 0.118 |
| | $G_i$* | 0.165 | 0.195 | 0.190 | 0.198 | 0.185 | 0.181 | 0.160 |
| | $H_i$ | 0.342 | 0.352 | 0.340 | 0.368 | 0.361 | 0.357 | 0.286 |
| | $H_i$* | 0.234 | 0.231 | 0.218 | 0.229 | 0.235 | 0.231 | 0.195 |
| | $I_i$ | 0.264 | 0.276 | 0.276 | 0.288 | 0.290 | 0.305 | 0.245 |
| 4 | $c_i$ | 0.396 | 0.404 | 0.402 | 0.396 | 0.408 | 0.394 | 0.329 |
| | $G_i$ | 0.135 | 0.113 | 0.139 | 0.139 | 0.149 | 0.150 | 0.111 |
| | $G_i$* | 0.175 | 0.173 | 0.175 | 0.192 | 0.190 | 0.188 | 0.161 |
| | $H_i$ | 0.313 | 0.302 | 0.319 | 0.352 | 0.367 | 0.377 | 0.291 |
| | $H_i$* | 0.195 | 0.203 | 0.215 | 0.205 | 0.226 | 0.236 | 0.213 |
| | $I_i$ | 0.258 | 0.226 | 0.253 | 0.280 | 0.311 | 0.318 | 0.236 |
| 5 | $c_i$ | 0.427 | 0.416 | 0.381 | 0.416 | 0.449 | 0.433 | 0.366 |
| | $G_i$ | 0.133 | 0.131 | 0.134 | 0.147 | 0.147 | 0.146 | 0.121 |
| | $G_i$* | 0.180 | 0.184 | 0.177 | 0.192 | 0.184 | 0.198 | 0.173 |
| | $H_i$ | 0.359 | 0.327 | 0.331 | 0.362 | 0.357 | 0.370 | 0.307 |
| | $H_i$* | 0.244 | 0.227 | 0.234 | 0.242 | 0.222 | 0.230 | 0.209 |
| | $I_i$ | 0.271 | 0.248 | 0.257 | 0.286 | 0.297 | 0.298 | 0.252 |
| 6 | $c_i$ | 0.415 | 0.408 | 0.414 | 0.445 | 0.408 | 0.413 | 0.314 |
| | $G_i$ | 0.138 | 0.133 | 0.146 | 0.146 | 0.150 | 0.162 | 0.135 |
| | $G_i$* | 0.174 | 0.173 | 0.191 | 0.179 | 0.194 | 0.198 | 0.176 |
| | $H_i$ | 0.359 | 0.337 | 0.325 | 0.364 | 0.343 | 0.356 | 0.292 |
| | $H_i$* | 0.216 | 0.218 | 0.224 | 0.235 | 0.221 | 0.215 | 0.209 |
| | $I_i$ | 0.283 | 0.263 | 0.273 | 0.303 | 0.299 | 0.311 | 0.237 |
| 7 | $c_i$ | 0.415 | 0.447 | 0.442 | 0.409 | 0.412 | 0.430 | 0.329 |
| | $G_i$ | 0.147 | 0.144 | 0.143 | 0.147 | 0.147 | 0.139 | 0.118 |
| | $G_i$* | 0.191 | 0.185 | 0.191 | 0.192 | 0.187 | 0.180 | 0.178 |
| | $H_i$ | 0.362 | 0.365 | 0.373 | 0.355 | 0.369 | 0.358 | 0.286 |
| | $H_i$* | 0.233 | 0.237 | 0.236 | 0.216 | 0.221 | 0.223 | 0.221 |
| | $I_i$ | 0.294 | 0.284 | 0.278 | 0.297 | 0.301 | 0.288 | 0.233 |
| 8 | $c_i$ | 0.428 | 0.413 | 0.403 | 0.409 | 0.411 | 0.432 | 0.347 |
| | $G_i$ | 0.137 | 0.154 | 0.132 | 0.132 | 0.136 | 0.129 | 0.114 |
| | $G_i$* | 0.183 | 0.194 | 0.178 | 0.179 | 0.179 | 0.175 | 0.160 |
| | $H_i$ | 0.369 | 0.360 | 0.340 | 0.335 | 0.343 | 0.351 | 0.296 |
| | $H_i$* | 0.231 | 0.214 | 0.225 | 0.209 | 0.207 | 0.206 | 0.204 |

| | | Column | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| | $I_i$ | 0.285 | 0.290 | 0.261 | 0.273 | 0.291 | 0.287 | 0.236 |
| 9 | $c_i$ | 0.433 | 0.405 | 0.411 | 0.426 | 0.420 | 0.423 | 0.347 |
| | $G_i$ | 0.139 | 0.139 | 0.141 | 0.144 | 0.135 | 0.123 | 0.112 |
| | $G_i$* | 0.189 | 0.183 | 0.172 | 0.189 | 0.174 | 0.167 | 0.154 |
| | $H_i$ | 0.346 | 0.333 | 0.355 | 0.347 | 0.352 | 0.353 | 0.297 |
| | $H_i$* | 0.226 | 0.216 | 0.232 | 0.222 | 0.226 | 0.237 | 0.206 |
| | $I_i$ | 0.276 | 0.266 | 0.274 | 0.276 | 0.277 | 0.278 | 0.239 |
| 10 | $c_i$ | 0.428 | 0.439 | 0.411 | 0.451 | 0.437 | 0.407 | 0.347 |
| | $G_i$ | 0.143 | 0.149 | 0.153 | 0.154 | 0.142 | 0.136 | 0.114 |
| | $G_i$* | 0.179 | 0.192 | 0.193 | 0.199 | 0.183 | 0.169 | 0.150 |
| | $H_i$ | 0.336 | 0.340 | 0.338 | 0.386 | 0.374 | 0.367 | 0.280 |
| | $H_i$* | 0.209 | 0.225 | 0.225 | 0.254 | 0.249 | 0.234 | 0.216 |
| | $I_i$ | 0.279 | 0.274 | 0.277 | 0.292 | 0.296 | 0.295 | 0.246 |
| 11 | $c_i$ | 0.396 | 0.398 | 0.415 | 0.430 | 0.419 | 0.416 | 0.350 |
| | $G_i$ | 0.139 | 0.158 | 0.167 | 0.157 | 0.162 | 0.156 | 0.117 |
| | $G_i$* | 0.180 | 0.210 | 0.213 | 0.197 | 0.202 | 0.183 | 0.155 |
| | $H_i$ | 0.325 | 0.350 | 0.366 | 0.356 | 0.376 | 0.378 | 0.300 |
| | $H_i$* | 0.220 | 0.230 | 0.229 | 0.240 | 0.253 | 0.243 | 0.214 |
| | $I_i$ | 0.265 | 0.290 | 0.294 | 0.284 | 0.300 | 0.315 | 0.247 |
| 12 | $c_i$ | 0.417 | 0.430 | 0.428 | 0.414 | 0.427 | 0.424 | 0.337 |
| | $G_i$ | 0.139 | 0.167 | 0.163 | 0.155 | 0.146 | 0.154 | 0.139 |
| | $G_i$* | 0.180 | 0.203 | 0.203 | 0.190 | 0.192 | 0.197 | 0.179 |
| | $H_i$ | 0.340 | 0.354 | 0.373 | 0.374 | 0.356 | 0.367 | 0.291 |
| | $H_i$* | 0.240 | 0.236 | 0.254 | 0.236 | 0.221 | 0.236 | 0.197 |
| | $I_i$ | 0.271 | 0.306 | 0.303 | 0.300 | 0.289 | 0.299 | 0.269 |
| 13 | $c_i$ | 0.434 | 0.424 | 0.437 | 0.398 | 0.416 | 0.426 | 0.329 |
| | $G_i$ | 0.148 | 0.165 | 0.156 | 0.154 | 0.150 | 0.161 | 0.146 |
| | $G_i$* | 0.187 | 0.208 | 0.192 | 0.196 | 0.190 | 0.214 | 0.199 |
| | $H_i$ | 0.382 | 0.366 | 0.353 | 0.361 | 0.353 | 0.343 | 0.297 |
| | $H_i$* | 0.251 | 0.230 | 0.246 | 0.246 | 0.228 | 0.215 | 0.210 |
| | $I_i$ | 0.285 | 0.306 | 0.289 | 0.296 | 0.298 | 0.301 | 0.260 |
| 14 | $c_i$ | 0.354 | 0.348 | 0.317 | 0.340 | 0.342 | 0.348 | 0.224 |
| | $G_i$ | 0.124 | 0.127 | 0.122 | 0.117 | 0.128 | 0.142 | 0.122 |
| | $G_i$* | 0.170 | 0.183 | 0.166 | 0.168 | 0.177 | 0.183 | 0.173 |
| | $H_i$ | 0.290 | 0.294 | 0.276 | 0.284 | 0.305 | 0.312 | 0.212 |
| | $H_i$* | 0.207 | 0.212 | 0.213 | 0.205 | 0.226 | 0.223 | 0.159 |
| | $I_i$ | 0.238 | 0.228 | 0.216 | 0.225 | 0.255 | 0.255 | 0.208 |

Figure B.43 Empirical Power Based on CWF Pattern Variance-Covariance Matrix Using Rook Connectivity Case for a 14x14 Study Area

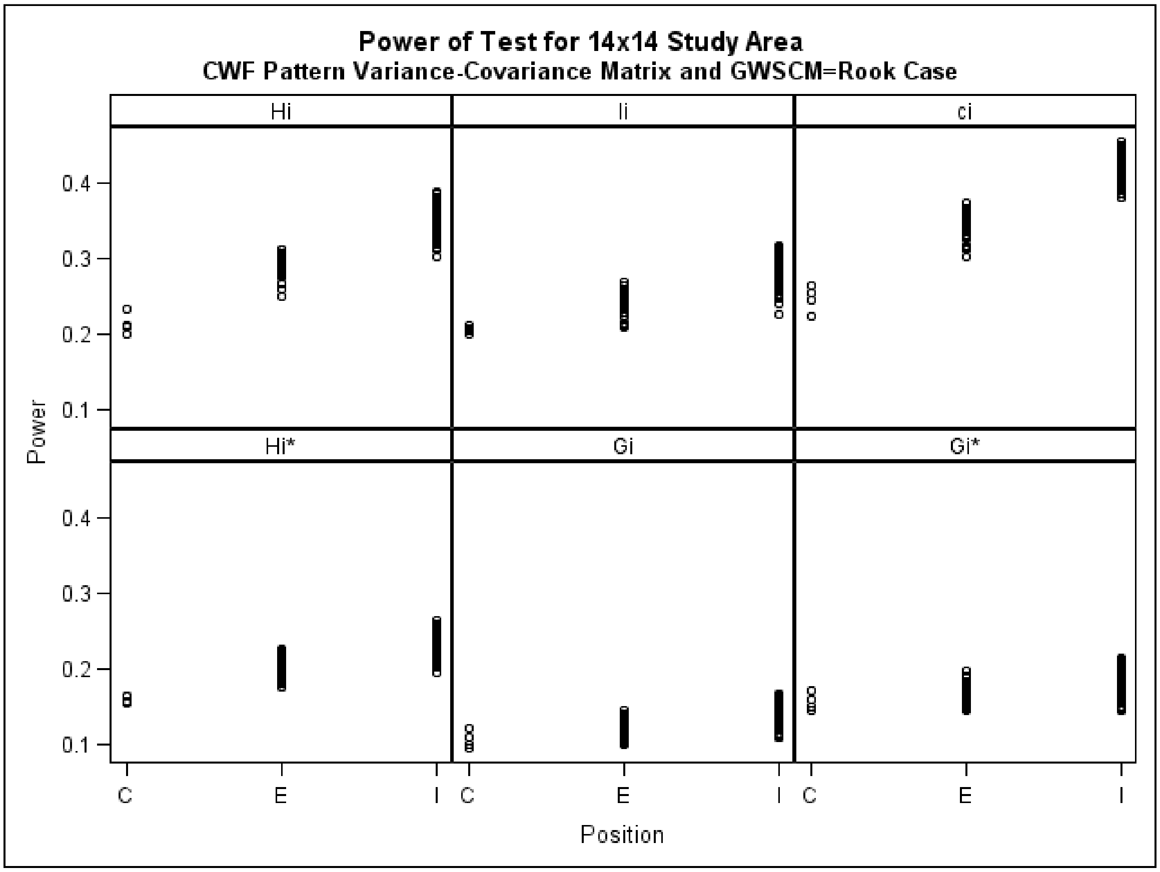


Table B.44 Empirical Power Based on CWF Pattern Variance-Covariance Matrix Using Queen Connectivity Case for a 14x14 Study Area

| | | Column | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1 | $c_i$ | 0.370 | 0.464 | 0.431 | 0.443 | 0.416 | 0.422 | 0.452 |
| | $G_i$ | 0.158 | 0.182 | 0.160 | 0.155 | 0.163 | 0.170 | 0.162 |
| | $G_i$* | 0.188 | 0.213 | 0.197 | 0.187 | 0.183 | 0.193 | 0.190 |
| | $H_i$ | 0.224 | 0.298 | 0.283 | 0.277 | 0.272 | 0.282 | 0.314 |
| | $H_i$* | 0.149 | 0.192 | 0.175 | 0.176 | 0.181 | 0.170 | 0.182 |
| | $I_i$ | 0.286 | 0.340 | 0.315 | 0.299 | 0.301 | 0.340 | 0.335 |
| 2 | $c_i$ | 0.469 | 0.565 | 0.538 | 0.518 | 0.513 | 0.514 | 0.513 |
| | $G_i$ | 0.194 | 0.221 | 0.199 | 0.198 | 0.192 | 0.190 | 0.203 |
| | $G_i$* | 0.226 | 0.238 | 0.225 | 0.223 | 0.219 | 0.220 | 0.221 |
| | $H_i$ | 0.313 | 0.418 | 0.387 | 0.372 | 0.389 | 0.400 | 0.403 |
| | $H_i$* | 0.165 | 0.230 | 0.210 | 0.192 | 0.211 | 0.210 | 0.194 |
| | $I_i$ | 0.365 | 0.431 | 0.392 | 0.386 | 0.387 | 0.397 | 0.423 |
| 3 | $c_i$ | 0.455 | 0.566 | 0.550 | 0.521 | 0.519 | 0.517 | 0.506 |
| | $G_i$ | 0.176 | 0.216 | 0.191 | 0.186 | 0.194 | 0.190 | 0.188 |
| | $G_i$* | 0.213 | 0.243 | 0.213 | 0.210 | 0.221 | 0.214 | 0.212 |
| | $H_i$ | 0.291 | 0.411 | 0.391 | 0.383 | 0.384 | 0.400 | 0.383 |
| | $H_i$* | 0.172 | 0.225 | 0.225 | 0.197 | 0.194 | 0.217 | 0.199 |
| | $I_i$ | 0.322 | 0.410 | 0.393 | 0.390 | 0.400 | 0.398 | 0.390 |
| 4 | $c_i$ | 0.406 | 0.512 | 0.526 | 0.504 | 0.520 | 0.510 | 0.531 |
| | $G_i$ | 0.172 | 0.207 | 0.187 | 0.184 | 0.179 | 0.181 | 0.176 |
| | $G_i$* | 0.194 | 0.227 | 0.208 | 0.204 | 0.201 | 0.197 | 0.203 |
| | $H_i$ | 0.288 | 0.371 | 0.382 | 0.366 | 0.379 | 0.378 | 0.383 |
| | $H_i$* | 0.157 | 0.201 | 0.213 | 0.215 | 0.217 | 0.203 | 0.238 |
| | $I_i$ | 0.321 | 0.400 | 0.385 | 0.374 | 0.388 | 0.388 | 0.388 |
| 5 | $c_i$ | 0.434 | 0.532 | 0.502 | 0.522 | 0.520 | 0.550 | 0.537 |
| | $G_i$ | 0.166 | 0.195 | 0.185 | 0.176 | 0.165 | 0.174 | 0.169 |
| | $G_i$* | 0.199 | 0.222 | 0.201 | 0.202 | 0.198 | 0.197 | 0.188 |
| | $H_i$ | 0.274 | 0.389 | 0.366 | 0.355 | 0.361 | 0.384 | 0.382 |
| | $H_i$* | 0.192 | 0.210 | 0.221 | 0.204 | 0.203 | 0.220 | 0.215 |
| | $I_i$ | 0.324 | 0.400 | 0.375 | 0.371 | 0.382 | 0.394 | 0.394 |
| 6 | $c_i$ | 0.428 | 0.527 | 0.535 | 0.553 | 0.549 | 0.538 | 0.517 |
| | $G_i$ | 0.174 | 0.198 | 0.197 | 0.192 | 0.180 | 0.177 | 0.179 |
| | $G_i$* | 0.197 | 0.226 | 0.217 | 0.221 | 0.205 | 0.195 | 0.203 |
| | $H_i$ | 0.286 | 0.400 | 0.400 | 0.401 | 0.397 | 0.392 | 0.380 |
| | $H_i$* | 0.177 | 0.201 | 0.225 | 0.222 | 0.197 | 0.220 | 0.196 |
| | $I_i$ | 0.331 | 0.403 | 0.402 | 0.413 | 0.411 | 0.393 | 0.405 |
| 7 | $c_i$ | 0.424 | 0.507 | 0.535 | 0.537 | 0.534 | 0.555 | 0.523 |
| | $G_i$ | 0.177 | 0.202 | 0.199 | 0.190 | 0.201 | 0.195 | 0.185 |
| | $G_i$* | 0.201 | 0.219 | 0.219 | 0.211 | 0.218 | 0.218 | 0.205 |
| | $H_i$ | 0.316 | 0.427 | 0.410 | 0.414 | 0.403 | 0.416 | 0.387 |
| | $H_i$* | 0.199 | 0.233 | 0.222 | 0.214 | 0.210 | 0.224 | 0.196 |
| | $I_i$ | 0.356 | 0.423 | 0.426 | 0.414 | 0.423 | 0.409 | 0.392 |
| 8 | $c_i$ | 0.441 | 0.527 | 0.528 | 0.515 | 0.525 | 0.545 | 0.505 |

| | | Column | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | $G_i$ | 0.174 | 0.195 | 0.183 | 0.193 | 0.198 | 0.204 | 0.205 |
| | $G_i$* | 0.205 | 0.223 | 0.212 | 0.217 | 0.214 | 0.241 | 0.216 |
| | $H_i$ | 0.298 | 0.405 | 0.391 | 0.384 | 0.397 | 0.400 | 0.393 |
| | $H_i$* | 0.180 | 0.222 | 0.202 | 0.213 | 0.199 | 0.204 | 0.207 |
| | $I_i$ | 0.352 | 0.400 | 0.398 | 0.410 | 0.397 | 0.419 | 0.409 |
| 9 | $c_i$ | 0.448 | 0.526 | 0.517 | 0.495 | 0.539 | 0.515 | 0.516 |
| | $G_i$ | 0.173 | 0.208 | 0.181 | 0.197 | 0.200 | 0.196 | 0.195 |
| | $G_i$* | 0.209 | 0.226 | 0.197 | 0.225 | 0.217 | 0.214 | 0.218 |
| | $H_i$ | 0.316 | 0.413 | 0.375 | 0.378 | 0.389 | 0.388 | 0.385 |
| | $H_i$* | 0.177 | 0.203 | 0.202 | 0.218 | 0.202 | 0.187 | 0.200 |
| | $I_i$ | 0.354 | 0.414 | 0.375 | 0.390 | 0.386 | 0.399 | 0.393 |
| 10 | $c_i$ | 0.425 | 0.498 | 0.538 | 0.521 | 0.519 | 0.511 | 0.524 |
| | $G_i$ | 0.163 | 0.201 | 0.200 | 0.198 | 0.205 | 0.190 | 0.192 |
| | $G_i$* | 0.185 | 0.220 | 0.222 | 0.217 | 0.229 | 0.220 | 0.216 |
| | $H_i$ | 0.322 | 0.397 | 0.379 | 0.386 | 0.401 | 0.382 | 0.381 |
| | $H_i$* | 0.190 | 0.218 | 0.196 | 0.226 | 0.213 | 0.208 | 0.192 |
| | $I_i$ | 0.336 | 0.402 | 0.392 | 0.398 | 0.408 | 0.388 | 0.378 |
| 11 | $c_i$ | 0.456 | 0.543 | 0.548 | 0.559 | 0.546 | 0.550 | 0.528 |
| | $G_i$ | 0.181 | 0.206 | 0.199 | 0.193 | 0.198 | 0.194 | 0.189 |
| | $G_i$* | 0.205 | 0.226 | 0.227 | 0.217 | 0.225 | 0.212 | 0.212 |
| | $H_i$ | 0.292 | 0.390 | 0.381 | 0.386 | 0.404 | 0.387 | 0.369 |
| | $H_i$* | 0.178 | 0.221 | 0.202 | 0.212 | 0.210 | 0.206 | 0.207 |
| | $I_i$ | 0.345 | 0.403 | 0.390 | 0.400 | 0.409 | 0.396 | 0.384 |
| 12 | $c_i$ | 0.480 | 0.521 | 0.508 | 0.517 | 0.518 | 0.540 | 0.525 |
| | $G_i$ | 0.175 | 0.212 | 0.195 | 0.202 | 0.198 | 0.194 | 0.187 |
| | $G_i$* | 0.209 | 0.227 | 0.221 | 0.222 | 0.222 | 0.210 | 0.207 |
| | $H_i$ | 0.299 | 0.387 | 0.361 | 0.407 | 0.399 | 0.405 | 0.383 |
| | $H_i$* | 0.172 | 0.216 | 0.187 | 0.230 | 0.218 | 0.217 | 0.216 |
| | $I_i$ | 0.341 | 0.407 | 0.388 | 0.408 | 0.418 | 0.423 | 0.393 |
| 13 | $c_i$ | 0.446 | 0.532 | 0.507 | 0.478 | 0.502 | 0.525 | 0.533 |
| | $G_i$ | 0.186 | 0.221 | 0.195 | 0.203 | 0.196 | 0.189 | 0.209 |
| | $G_i$* | 0.211 | 0.244 | 0.213 | 0.226 | 0.224 | 0.222 | 0.226 |
| | $H_i$ | 0.310 | 0.403 | 0.366 | 0.365 | 0.372 | 0.394 | 0.389 |
| | $H_i$* | 0.159 | 0.225 | 0.202 | 0.185 | 0.195 | 0.230 | 0.193 |
| | $I_i$ | 0.364 | 0.424 | 0.382 | 0.388 | 0.408 | 0.407 | 0.417 |
| 14 | $c_i$ | 0.358 | 0.452 | 0.442 | 0.411 | 0.424 | 0.434 | 0.438 |
| | $G_i$ | 0.158 | 0.193 | 0.172 | 0.176 | 0.165 | 0.167 | 0.167 |
| | $G_i$* | 0.196 | 0.222 | 0.197 | 0.202 | 0.199 | 0.198 | 0.194 |
| | $H_i$ | 0.232 | 0.309 | 0.317 | 0.306 | 0.318 | 0.315 | 0.303 |
| | $H_i$* | 0.145 | 0.190 | 0.186 | 0.165 | 0.200 | 0.193 | 0.189 |
| | $I_i$ | 0.298 | 0.359 | 0.338 | 0.339 | 0.340 | 0.349 | 0.335 |

| | | Column | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 1 | $c_i$ | 0.445 | 0.445 | 0.442 | 0.451 | 0.428 | 0.453 | 0.362 |
| | $G_i$ | 0.184 | 0.183 | 0.190 | 0.184 | 0.177 | 0.175 | 0.139 |
| | $G_i$* | 0.204 | 0.209 | 0.211 | 0.214 | 0.211 | 0.206 | 0.179 |
| | $H_i$ | 0.316 | 0.291 | 0.293 | 0.304 | 0.306 | 0.332 | 0.233 |
| | $H_i$* | 0.204 | 0.185 | 0.174 | 0.203 | 0.194 | 0.212 | 0.163 |
| | $I_i$ | 0.336 | 0.335 | 0.348 | 0.330 | 0.344 | 0.355 | 0.291 |
| 2 | $c_i$ | 0.531 | 0.540 | 0.530 | 0.520 | 0.523 | 0.547 | 0.468 |
| | $G_i$ | 0.216 | 0.219 | 0.224 | 0.223 | 0.222 | 0.223 | 0.183 |
| | $G_i$* | 0.239 | 0.240 | 0.251 | 0.246 | 0.248 | 0.241 | 0.213 |
| | $H_i$ | 0.388 | 0.392 | 0.412 | 0.377 | 0.394 | 0.421 | 0.323 |
| | $H_i$* | 0.197 | 0.203 | 0.242 | 0.214 | 0.234 | 0.233 | 0.198 |
| | $I_i$ | 0.405 | 0.397 | 0.412 | 0.394 | 0.419 | 0.435 | 0.364 |
| 3 | $c_i$ | 0.501 | 0.521 | 0.508 | 0.524 | 0.527 | 0.518 | 0.417 |
| | $G_i$ | 0.196 | 0.208 | 0.206 | 0.218 | 0.202 | 0.205 | 0.168 |
| | $G_i$* | 0.224 | 0.234 | 0.223 | 0.246 | 0.227 | 0.228 | 0.189 |
| | $H_i$ | 0.369 | 0.375 | 0.372 | 0.406 | 0.399 | 0.404 | 0.304 |
| | $H_i$* | 0.215 | 0.204 | 0.211 | 0.220 | 0.209 | 0.219 | 0.186 |
| | $I_i$ | 0.372 | 0.381 | 0.386 | 0.413 | 0.402 | 0.423 | 0.359 |
| 4 | $c_i$ | 0.508 | 0.522 | 0.493 | 0.494 | 0.534 | 0.510 | 0.416 |
| | $G_i$ | 0.192 | 0.188 | 0.197 | 0.214 | 0.201 | 0.206 | 0.165 |
| | $G_i$* | 0.214 | 0.211 | 0.223 | 0.232 | 0.229 | 0.222 | 0.194 |
| | $H_i$ | 0.361 | 0.348 | 0.368 | 0.386 | 0.396 | 0.396 | 0.300 |
| | $H_i$* | 0.181 | 0.193 | 0.195 | 0.202 | 0.211 | 0.206 | 0.177 |
| | $I_i$ | 0.378 | 0.349 | 0.370 | 0.399 | 0.412 | 0.415 | 0.340 |
| 5 | $c_i$ | 0.542 | 0.537 | 0.494 | 0.515 | 0.534 | 0.535 | 0.455 |
| | $G_i$ | 0.192 | 0.188 | 0.195 | 0.203 | 0.208 | 0.219 | 0.177 |
| | $G_i$* | 0.217 | 0.221 | 0.209 | 0.227 | 0.234 | 0.236 | 0.212 |
| | $H_i$ | 0.382 | 0.365 | 0.378 | 0.399 | 0.419 | 0.413 | 0.320 |
| | $H_i$* | 0.223 | 0.209 | 0.212 | 0.215 | 0.220 | 0.223 | 0.184 |
| | $I_i$ | 0.385 | 0.376 | 0.380 | 0.399 | 0.421 | 0.432 | 0.356 |
| 6 | $c_i$ | 0.522 | 0.508 | 0.523 | 0.531 | 0.514 | 0.519 | 0.413 |
| | $G_i$ | 0.206 | 0.189 | 0.206 | 0.220 | 0.209 | 0.222 | 0.187 |
| | $G_i$* | 0.220 | 0.209 | 0.229 | 0.231 | 0.229 | 0.235 | 0.214 |
| | $H_i$ | 0.403 | 0.388 | 0.383 | 0.404 | 0.387 | 0.379 | 0.299 |
| | $H_i$* | 0.203 | 0.221 | 0.220 | 0.217 | 0.210 | 0.198 | 0.178 |
| | $I_i$ | 0.417 | 0.389 | 0.398 | 0.426 | 0.415 | 0.419 | 0.344 |
| 7 | $c_i$ | 0.532 | 0.555 | 0.548 | 0.523 | 0.529 | 0.515 | 0.433 |
| | $G_i$ | 0.210 | 0.206 | 0.216 | 0.203 | 0.211 | 0.207 | 0.172 |
| | $G_i$* | 0.225 | 0.239 | 0.236 | 0.230 | 0.234 | 0.228 | 0.204 |
| | $H_i$ | 0.402 | 0.396 | 0.419 | 0.402 | 0.406 | 0.395 | 0.319 |
| | $H_i$* | 0.214 | 0.210 | 0.217 | 0.209 | 0.203 | 0.197 | 0.213 |
| | $I_i$ | 0.413 | 0.398 | 0.425 | 0.416 | 0.407 | 0.408 | 0.335 |
| 8 | $c_i$ | 0.522 | 0.526 | 0.505 | 0.503 | 0.515 | 0.516 | 0.462 |
| | $G_i$ | 0.203 | 0.208 | 0.197 | 0.201 | 0.216 | 0.197 | 0.170 |
| | $G_i$* | 0.226 | 0.235 | 0.226 | 0.227 | 0.237 | 0.232 | 0.196 |
| | $H_i$ | 0.407 | 0.395 | 0.379 | 0.370 | 0.395 | 0.400 | 0.302 |
| | $H_i$* | 0.204 | 0.187 | 0.203 | 0.188 | 0.203 | 0.191 | 0.193 |

| | | Column | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| | $I_i$ | 0.404 | 0.391 | 0.395 | 0.401 | 0.429 | 0.411 | 0.354 |
| 9 | $c_i$ | 0.533 | 0.523 | 0.498 | 0.519 | 0.523 | 0.532 | 0.435 |
| | $G_i$ | 0.201 | 0.202 | 0.199 | 0.204 | 0.200 | 0.181 | 0.161 |
| | $G_i*$ | 0.228 | 0.224 | 0.218 | 0.226 | 0.215 | 0.206 | 0.189 |
| | $H_i$ | 0.387 | 0.373 | 0.383 | 0.384 | 0.386 | 0.385 | 0.300 |
| | $H_i*$ | 0.197 | 0.198 | 0.202 | 0.216 | 0.208 | 0.216 | 0.179 |
| | $I_i$ | 0.395 | 0.382 | 0.372 | 0.404 | 0.400 | 0.393 | 0.343 |
| 10 | $c_i$ | 0.522 | 0.546 | 0.522 | 0.551 | 0.542 | 0.539 | 0.449 |
| | $G_i$ | 0.195 | 0.221 | 0.219 | 0.215 | 0.208 | 0.197 | 0.161 |
| | $G_i*$ | 0.214 | 0.238 | 0.235 | 0.234 | 0.226 | 0.219 | 0.185 |
| | $H_i$ | 0.370 | 0.378 | 0.376 | 0.418 | 0.394 | 0.399 | 0.307 |
| | $H_i*$ | 0.189 | 0.199 | 0.207 | 0.230 | 0.213 | 0.210 | 0.196 |
| | $I_i$ | 0.388 | 0.398 | 0.401 | 0.413 | 0.413 | 0.415 | 0.350 |
| 11 | $c_i$ | 0.514 | 0.521 | 0.525 | 0.535 | 0.540 | 0.529 | 0.444 |
| | $G_i$ | 0.193 | 0.228 | 0.230 | 0.218 | 0.214 | 0.205 | 0.174 |
| | $G_i*$ | 0.219 | 0.251 | 0.255 | 0.239 | 0.227 | 0.226 | 0.199 |
| | $H_i$ | 0.367 | 0.398 | 0.401 | 0.395 | 0.415 | 0.406 | 0.317 |
| | $H_i*$ | 0.213 | 0.204 | 0.209 | 0.208 | 0.212 | 0.224 | 0.195 |
| | $I_i$ | 0.373 | 0.410 | 0.411 | 0.408 | 0.416 | 0.420 | 0.358 |
| 12 | $c_i$ | 0.529 | 0.529 | 0.524 | 0.528 | 0.525 | 0.508 | 0.428 |
| | $G_i$ | 0.208 | 0.223 | 0.235 | 0.217 | 0.219 | 0.222 | 0.194 |
| | $G_i*$ | 0.228 | 0.248 | 0.259 | 0.242 | 0.251 | 0.248 | 0.225 |
| | $H_i$ | 0.389 | 0.400 | 0.420 | 0.398 | 0.395 | 0.402 | 0.302 |
| | $H_i*$ | 0.222 | 0.206 | 0.226 | 0.219 | 0.203 | 0.218 | 0.167 |
| | $I_i$ | 0.400 | 0.415 | 0.437 | 0.410 | 0.414 | 0.430 | 0.361 |
| 13 | $c_i$ | 0.542 | 0.540 | 0.517 | 0.532 | 0.523 | 0.523 | 0.440 |
| | $G_i$ | 0.221 | 0.224 | 0.218 | 0.225 | 0.222 | 0.229 | 0.200 |
| | $G_i*$ | 0.240 | 0.254 | 0.240 | 0.242 | 0.242 | 0.254 | 0.236 |
| | $H_i$ | 0.411 | 0.408 | 0.399 | 0.406 | 0.398 | 0.379 | 0.319 |
| | $H_i*$ | 0.225 | 0.217 | 0.222 | 0.210 | 0.202 | 0.178 | 0.188 |
| | $I_i$ | 0.429 | 0.422 | 0.410 | 0.420 | 0.415 | 0.408 | 0.366 |
| 14 | $c_i$ | 0.457 | 0.429 | 0.423 | 0.442 | 0.441 | 0.450 | 0.339 |
| | $G_i$ | 0.182 | 0.195 | 0.181 | 0.179 | 0.188 | 0.199 | 0.157 |
| | $G_i*$ | 0.200 | 0.225 | 0.211 | 0.207 | 0.222 | 0.228 | 0.212 |
| | $H_i$ | 0.300 | 0.294 | 0.277 | 0.301 | 0.312 | 0.328 | 0.203 |
| | $H_i*$ | 0.195 | 0.181 | 0.180 | 0.185 | 0.202 | 0.199 | 0.139 |
| | $I_i$ | 0.343 | 0.333 | 0.325 | 0.335 | 0.344 | 0.351 | 0.282 |

Figure B.44 Empirical Power Based on CWF Pattern Variance-Covariance Matrix Using Queen Connectivity Case for a 14x14 Study Area

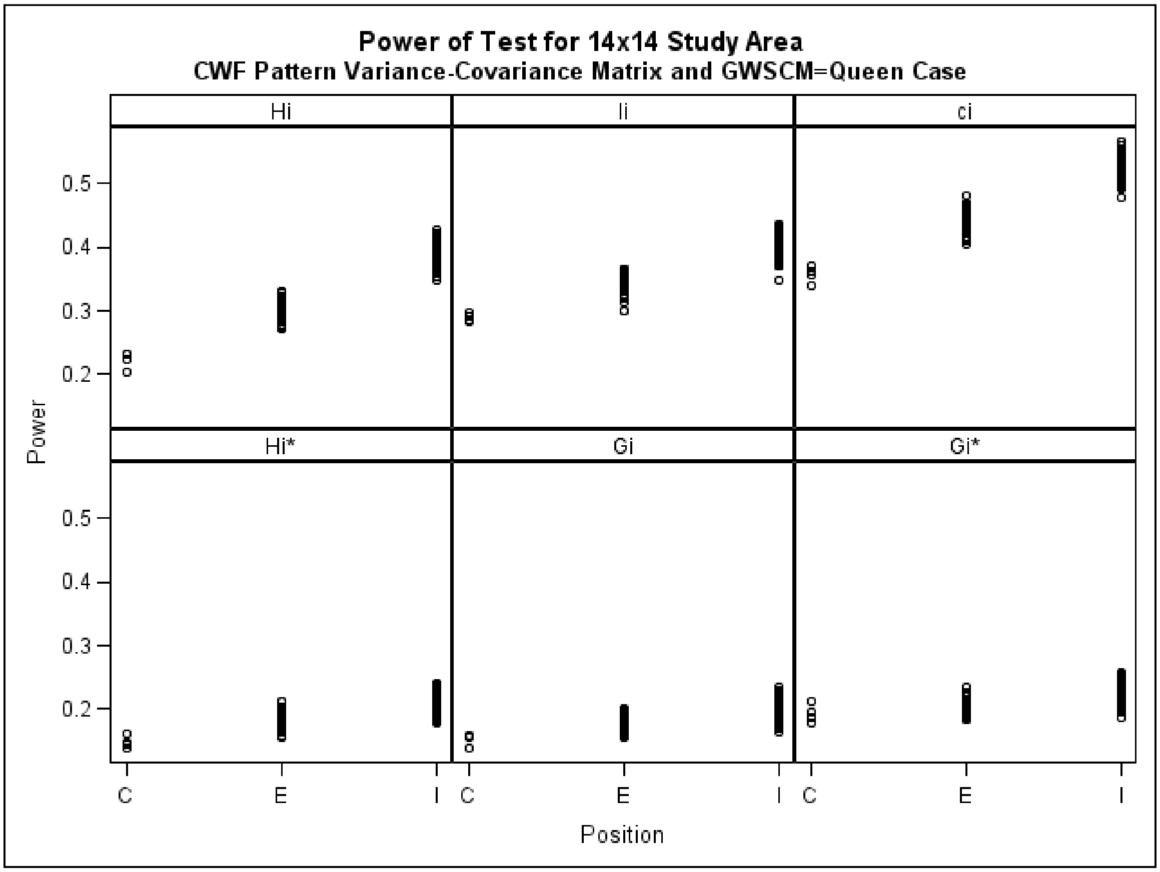


Table B.45 Empirical Power Based on CWF Pattern Variance-Covariance Matrix Using CWF Connectivity Case for a 14x14 Study Area

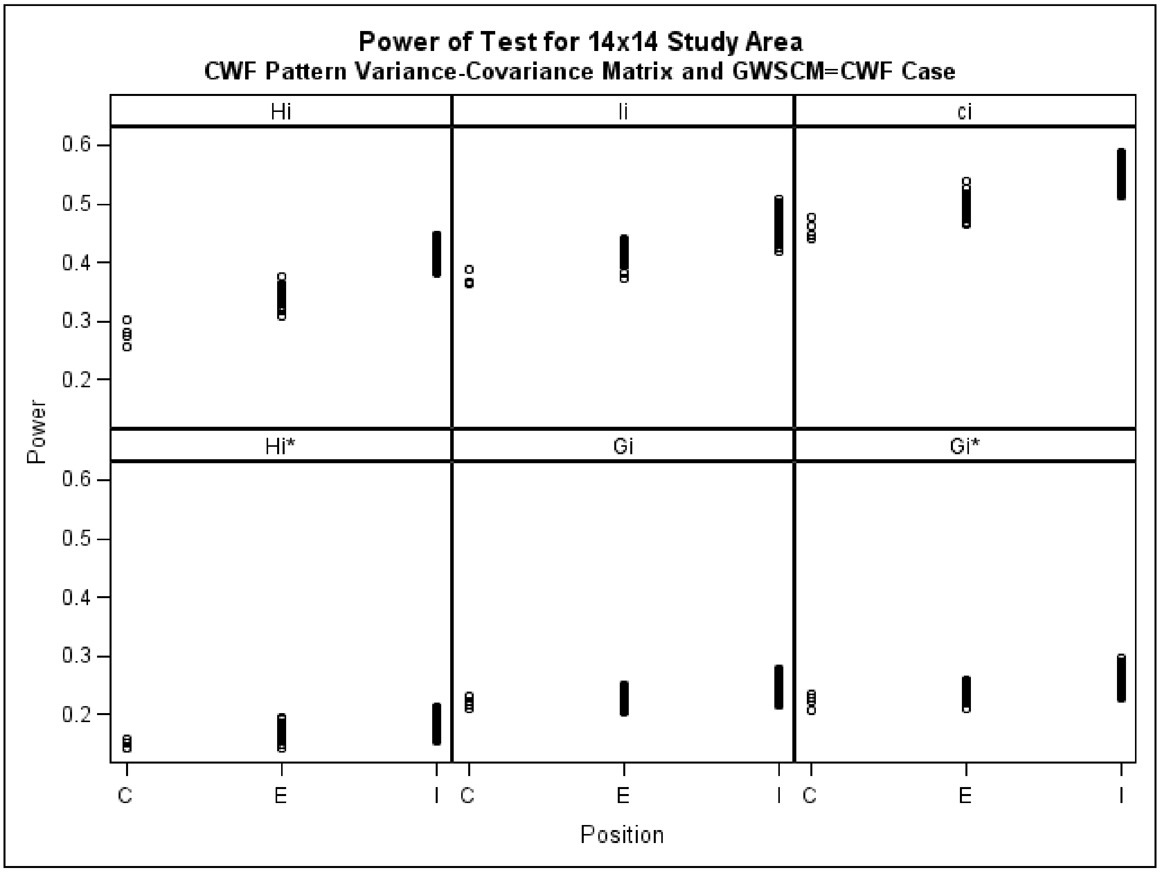
| | | Column | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1 | $c_i$ | 0.476 | 0.512 | 0.499 | 0.480 | 0.467 | 0.469 | 0.515 |
| | $G_i$ | 0.216 | 0.221 | 0.229 | 0.211 | 0.213 | 0.209 | 0.219 |
| | $G_i$* | 0.223 | 0.238 | 0.236 | 0.224 | 0.210 | 0.223 | 0.232 |
| | $H_i$ | 0.276 | 0.323 | 0.320 | 0.310 | 0.318 | 0.323 | 0.365 |
| | $H_i$* | 0.153 | 0.175 | 0.171 | 0.158 | 0.161 | 0.156 | 0.169 |
| | $I_i$ | 0.363 | 0.395 | 0.398 | 0.373 | 0.383 | 0.399 | 0.422 |
| 2 | $c_i$ | 0.538 | 0.582 | 0.573 | 0.547 | 0.540 | 0.540 | 0.552 |
| | $G_i$ | 0.227 | 0.240 | 0.232 | 0.224 | 0.218 | 0.225 | 0.237 |
| | $G_i$* | 0.250 | 0.260 | 0.248 | 0.237 | 0.248 | 0.241 | 0.251 |
| | $H_i$ | 0.348 | 0.406 | 0.399 | 0.385 | 0.400 | 0.421 | 0.413 |
| | $H_i$* | 0.176 | 0.201 | 0.191 | 0.171 | 0.197 | 0.192 | 0.155 |
| | $I_i$ | 0.422 | 0.453 | 0.452 | 0.425 | 0.434 | 0.451 | 0.465 |
| 3 | $c_i$ | 0.525 | 0.572 | 0.575 | 0.552 | 0.558 | 0.552 | 0.553 |
| | $G_i$ | 0.234 | 0.246 | 0.236 | 0.229 | 0.225 | 0.237 | 0.237 |
| | $G_i$* | 0.252 | 0.269 | 0.240 | 0.234 | 0.243 | 0.250 | 0.253 |
| | $H_i$ | 0.340 | 0.417 | 0.417 | 0.409 | 0.399 | 0.436 | 0.423 |
| | $H_i$* | 0.175 | 0.204 | 0.204 | 0.180 | 0.166 | 0.177 | 0.181 |
| | $I_i$ | 0.412 | 0.452 | 0.461 | 0.448 | 0.457 | 0.478 | 0.469 |
| 4 | $c_i$ | 0.486 | 0.557 | 0.550 | 0.543 | 0.547 | 0.549 | 0.561 |
| | $G_i$ | 0.230 | 0.236 | 0.246 | 0.228 | 0.218 | 0.238 | 0.229 |
| | $G_i$* | 0.240 | 0.254 | 0.249 | 0.245 | 0.230 | 0.248 | 0.241 |
| | $H_i$ | 0.333 | 0.399 | 0.422 | 0.404 | 0.402 | 0.418 | 0.403 |
| | $H_i$* | 0.165 | 0.191 | 0.195 | 0.179 | 0.206 | 0.194 | 0.199 |
| | $I_i$ | 0.404 | 0.446 | 0.467 | 0.453 | 0.454 | 0.471 | 0.460 |
| 5 | $c_i$ | 0.474 | 0.543 | 0.541 | 0.537 | 0.556 | 0.560 | 0.562 |
| | $G_i$ | 0.223 | 0.232 | 0.224 | 0.224 | 0.217 | 0.221 | 0.236 |
| | $G_i$* | 0.235 | 0.248 | 0.236 | 0.238 | 0.229 | 0.239 | 0.236 |
| | $H_i$ | 0.333 | 0.404 | 0.401 | 0.403 | 0.401 | 0.415 | 0.437 |
| | $H_i$* | 0.176 | 0.186 | 0.201 | 0.187 | 0.184 | 0.201 | 0.190 |
| | $I_i$ | 0.405 | 0.449 | 0.439 | 0.445 | 0.460 | 0.460 | 0.478 |
| 6 | $c_i$ | 0.487 | 0.544 | 0.572 | 0.587 | 0.559 | 0.580 | 0.565 |
| | $G_i$ | 0.226 | 0.228 | 0.241 | 0.244 | 0.230 | 0.224 | 0.227 |
| | $G_i$* | 0.238 | 0.241 | 0.257 | 0.260 | 0.233 | 0.238 | 0.234 |
| | $H_i$ | 0.351 | 0.416 | 0.433 | 0.448 | 0.429 | 0.443 | 0.428 |
| | $H_i$* | 0.178 | 0.192 | 0.203 | 0.198 | 0.176 | 0.204 | 0.188 |
| | $I_i$ | 0.412 | 0.457 | 0.477 | 0.495 | 0.489 | 0.487 | 0.472 |
| 7 | $c_i$ | 0.493 | 0.548 | 0.551 | 0.565 | 0.586 | 0.567 | 0.549 |
| | $G_i$ | 0.226 | 0.239 | 0.244 | 0.245 | 0.242 | 0.237 | 0.243 |
| | $G_i$* | 0.236 | 0.250 | 0.255 | 0.261 | 0.248 | 0.255 | 0.251 |
| | $H_i$ | 0.362 | 0.439 | 0.440 | 0.437 | 0.445 | 0.432 | 0.428 |
| | $H_i$* | 0.171 | 0.199 | 0.212 | 0.159 | 0.192 | 0.205 | 0.178 |
| | $I_i$ | 0.428 | 0.490 | 0.495 | 0.484 | 0.497 | 0.482 | 0.471 |
| 8 | $c_i$ | 0.512 | 0.563 | 0.545 | 0.543 | 0.565 | 0.559 | 0.534 |

| | | Column | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| | $G_i$ | 0.231 | 0.240 | 0.243 | 0.240 | 0.244 | 0.246 | 0.255 |
| | $G_i$* | 0.244 | 0.253 | 0.241 | 0.240 | 0.251 | 0.253 | 0.264 |
| | $H_i$ | 0.352 | 0.426 | 0.424 | 0.437 | 0.425 | 0.436 | 0.427 |
| | $H_i$* | 0.170 | 0.197 | 0.174 | 0.189 | 0.165 | 0.192 | 0.200 |
| | $I_i$ | 0.432 | 0.476 | 0.471 | 0.480 | 0.476 | 0.477 | 0.482 |
| 9 | $c_i$ | 0.509 | 0.555 | 0.542 | 0.515 | 0.561 | 0.552 | 0.543 |
| | $G_i$ | 0.217 | 0.238 | 0.234 | 0.252 | 0.248 | 0.245 | 0.236 |
| | $G_i$* | 0.230 | 0.253 | 0.246 | 0.263 | 0.261 | 0.242 | 0.254 |
| | $H_i$ | 0.341 | 0.417 | 0.405 | 0.408 | 0.418 | 0.409 | 0.397 |
| | $H_i$* | 0.170 | 0.177 | 0.187 | 0.210 | 0.180 | 0.160 | 0.168 |
| | $I_i$ | 0.415 | 0.464 | 0.460 | 0.474 | 0.470 | 0.459 | 0.446 |
| 10 | $c_i$ | 0.490 | 0.560 | 0.551 | 0.542 | 0.559 | 0.553 | 0.558 |
| | $G_i$ | 0.224 | 0.237 | 0.247 | 0.251 | 0.249 | 0.250 | 0.239 |
| | $G_i$* | 0.220 | 0.247 | 0.260 | 0.261 | 0.262 | 0.258 | 0.249 |
| | $H_i$ | 0.323 | 0.409 | 0.413 | 0.422 | 0.431 | 0.425 | 0.411 |
| | $H_i$* | 0.154 | 0.194 | 0.178 | 0.196 | 0.189 | 0.177 | 0.172 |
| | $I_i$ | 0.398 | 0.448 | 0.461 | 0.467 | 0.494 | 0.476 | 0.468 |
| 11 | $c_i$ | 0.495 | 0.563 | 0.560 | 0.569 | 0.553 | 0.573 | 0.552 |
| | $G_i$ | 0.232 | 0.242 | 0.250 | 0.237 | 0.253 | 0.237 | 0.238 |
| | $G_i$* | 0.242 | 0.261 | 0.261 | 0.252 | 0.265 | 0.262 | 0.247 |
| | $H_i$ | 0.349 | 0.402 | 0.421 | 0.419 | 0.439 | 0.434 | 0.422 |
| | $H_i$* | 0.171 | 0.202 | 0.176 | 0.181 | 0.171 | 0.202 | 0.191 |
| | $I_i$ | 0.418 | 0.461 | 0.457 | 0.460 | 0.494 | 0.474 | 0.462 |
| 12 | $c_i$ | 0.505 | 0.554 | 0.546 | 0.567 | 0.554 | 0.566 | 0.558 |
| | $G_i$ | 0.230 | 0.242 | 0.241 | 0.247 | 0.246 | 0.257 | 0.249 |
| | $G_i$* | 0.238 | 0.258 | 0.262 | 0.266 | 0.259 | 0.253 | 0.256 |
| | $H_i$ | 0.361 | 0.405 | 0.400 | 0.430 | 0.442 | 0.436 | 0.431 |
| | $H_i$* | 0.184 | 0.214 | 0.183 | 0.189 | 0.209 | 0.199 | 0.201 |
| | $I_i$ | 0.421 | 0.448 | 0.455 | 0.473 | 0.493 | 0.509 | 0.479 |
| 13 | $c_i$ | 0.509 | 0.550 | 0.515 | 0.515 | 0.529 | 0.567 | 0.556 |
| | $G_i$ | 0.230 | 0.239 | 0.233 | 0.233 | 0.235 | 0.245 | 0.251 |
| | $G_i$* | 0.245 | 0.249 | 0.247 | 0.244 | 0.252 | 0.255 | 0.264 |
| | $H_i$ | 0.361 | 0.408 | 0.388 | 0.389 | 0.411 | 0.438 | 0.411 |
| | $H_i$* | 0.167 | 0.207 | 0.197 | 0.176 | 0.179 | 0.188 | 0.187 |
| | $I_i$ | 0.411 | 0.445 | 0.437 | 0.438 | 0.457 | 0.485 | 0.475 |
| 14 | $c_i$ | 0.461 | 0.494 | 0.473 | 0.466 | 0.482 | 0.518 | 0.509 |
| | $G_i$ | 0.224 | 0.229 | 0.214 | 0.226 | 0.210 | 0.217 | 0.237 |
| | $G_i$* | 0.229 | 0.241 | 0.228 | 0.234 | 0.228 | 0.235 | 0.245 |
| | $H_i$ | 0.304 | 0.334 | 0.332 | 0.337 | 0.342 | 0.355 | 0.349 |
| | $H_i$* | 0.159 | 0.159 | 0.156 | 0.148 | 0.164 | 0.143 | 0.186 |
| | $I_i$ | 0.387 | 0.400 | 0.401 | 0.415 | 0.404 | 0.433 | 0.425 |

| | | Column | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 1 | $c_i$ | 0.495 | 0.493 | 0.499 | 0.494 | 0.479 | 0.502 | 0.446 |
| | $G_i$ | 0.241 | 0.241 | 0.251 | 0.234 | 0.247 | 0.223 | 0.211 |
| | $G_i$* | 0.251 | 0.242 | 0.251 | 0.246 | 0.254 | 0.242 | 0.207 |
| | $H_i$ | 0.352 | 0.336 | 0.341 | 0.351 | 0.345 | 0.347 | 0.282 |
| | $H_i$* | 0.160 | 0.160 | 0.173 | 0.181 | 0.177 | 0.181 | 0.143 |
| | $I_i$ | 0.419 | 0.400 | 0.412 | 0.399 | 0.424 | 0.419 | 0.368 |
| 2 | $c_i$ | 0.569 | 0.557 | 0.564 | 0.545 | 0.551 | 0.558 | 0.503 |
| | $G_i$ | 0.247 | 0.255 | 0.268 | 0.254 | 0.260 | 0.248 | 0.232 |
| | $G_i$* | 0.262 | 0.275 | 0.272 | 0.270 | 0.273 | 0.258 | 0.239 |
| | $H_i$ | 0.404 | 0.400 | 0.424 | 0.401 | 0.426 | 0.427 | 0.362 |
| | $H_i$* | 0.181 | 0.197 | 0.206 | 0.167 | 0.197 | 0.210 | 0.182 |
| | $I_i$ | 0.460 | 0.448 | 0.460 | 0.445 | 0.479 | 0.475 | 0.431 |
| 3 | $c_i$ | 0.541 | 0.551 | 0.538 | 0.549 | 0.558 | 0.551 | 0.485 |
| | $G_i$ | 0.239 | 0.237 | 0.255 | 0.267 | 0.256 | 0.253 | 0.227 |
| | $G_i$* | 0.253 | 0.252 | 0.258 | 0.278 | 0.271 | 0.258 | 0.235 |
| | $H_i$ | 0.398 | 0.393 | 0.392 | 0.423 | 0.439 | 0.435 | 0.354 |
| | $H_i$* | 0.188 | 0.189 | 0.180 | 0.184 | 0.196 | 0.212 | 0.178 |
| | $I_i$ | 0.449 | 0.419 | 0.448 | 0.477 | 0.489 | 0.493 | 0.430 |
| 4 | $c_i$ | 0.544 | 0.530 | 0.537 | 0.533 | 0.563 | 0.541 | 0.479 |
| | $G_i$ | 0.242 | 0.241 | 0.248 | 0.260 | 0.258 | 0.252 | 0.221 |
| | $G_i$* | 0.255 | 0.258 | 0.261 | 0.273 | 0.280 | 0.260 | 0.232 |
| | $H_i$ | 0.397 | 0.383 | 0.393 | 0.427 | 0.420 | 0.428 | 0.344 |
| | $H_i$* | 0.154 | 0.168 | 0.163 | 0.186 | 0.164 | 0.188 | 0.173 |
| | $I_i$ | 0.457 | 0.426 | 0.439 | 0.466 | 0.484 | 0.491 | 0.422 |
| 5 | $c_i$ | 0.569 | 0.554 | 0.524 | 0.527 | 0.559 | 0.548 | 0.505 |
| | $G_i$ | 0.240 | 0.239 | 0.249 | 0.256 | 0.272 | 0.261 | 0.237 |
| | $G_i$* | 0.250 | 0.252 | 0.254 | 0.264 | 0.283 | 0.274 | 0.257 |
| | $H_i$ | 0.431 | 0.412 | 0.403 | 0.427 | 0.444 | 0.433 | 0.375 |
| | $H_i$* | 0.182 | 0.194 | 0.194 | 0.195 | 0.187 | 0.199 | 0.175 |
| | $I_i$ | 0.467 | 0.458 | 0.460 | 0.464 | 0.500 | 0.485 | 0.431 |
| 6 | $c_i$ | 0.559 | 0.543 | 0.545 | 0.550 | 0.564 | 0.533 | 0.486 |
| | $G_i$ | 0.233 | 0.226 | 0.246 | 0.262 | 0.261 | 0.263 | 0.237 |
| | $G_i$* | 0.239 | 0.235 | 0.258 | 0.272 | 0.263 | 0.270 | 0.247 |
| | $H_i$ | 0.418 | 0.391 | 0.416 | 0.438 | 0.438 | 0.414 | 0.358 |
| | $H_i$* | 0.176 | 0.173 | 0.197 | 0.202 | 0.208 | 0.193 | 0.174 |
| | $I_i$ | 0.470 | 0.449 | 0.467 | 0.490 | 0.483 | 0.487 | 0.437 |
| 7 | $c_i$ | 0.566 | 0.556 | 0.564 | 0.561 | 0.557 | 0.552 | 0.490 |
| | $G_i$ | 0.254 | 0.261 | 0.268 | 0.250 | 0.252 | 0.252 | 0.234 |
| | $G_i$* | 0.265 | 0.269 | 0.280 | 0.266 | 0.264 | 0.273 | 0.248 |
| | $H_i$ | 0.445 | 0.427 | 0.437 | 0.426 | 0.435 | 0.422 | 0.361 |
| | $H_i$* | 0.183 | 0.168 | 0.185 | 0.196 | 0.193 | 0.181 | 0.181 |
| | $I_i$ | 0.500 | 0.481 | 0.492 | 0.471 | 0.477 | 0.470 | 0.422 |
| 8 | $c_i$ | 0.551 | 0.557 | 0.534 | 0.520 | 0.547 | 0.562 | 0.508 |
| | $G_i$ | 0.253 | 0.253 | 0.258 | 0.262 | 0.258 | 0.240 | 0.221 |
| | $G_i$* | 0.257 | 0.261 | 0.273 | 0.275 | 0.270 | 0.253 | 0.232 |
| | $H_i$ | 0.434 | 0.425 | 0.423 | 0.416 | 0.432 | 0.403 | 0.341 |
| | $H_i$* | 0.178 | 0.178 | 0.170 | 0.163 | 0.186 | 0.167 | 0.168 |

| | | Column | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Row | Statistic | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| | $I_i$ | 0.466 | 0.451 | 0.476 | 0.479 | 0.488 | 0.459 | 0.414 |
| 9 | $c_i$ | 0.553 | 0.537 | 0.517 | 0.530 | 0.552 | 0.564 | 0.505 |
| | $G_i$ | 0.257 | 0.249 | 0.259 | 0.255 | 0.250 | 0.234 | 0.205 |
| | $G_i$* | 0.265 | 0.266 | 0.268 | 0.262 | 0.256 | 0.235 | 0.225 |
| | $H_i$ | 0.420 | 0.400 | 0.410 | 0.418 | 0.426 | 0.420 | 0.329 |
| | $H_i$* | 0.173 | 0.187 | 0.185 | 0.196 | 0.205 | 0.205 | 0.165 |
| | $I_i$ | 0.470 | 0.446 | 0.440 | 0.469 | 0.469 | 0.455 | 0.400 |
| 10 | $c_i$ | 0.569 | 0.557 | 0.564 | 0.571 | 0.568 | 0.555 | 0.494 |
| | $G_i$ | 0.249 | 0.259 | 0.257 | 0.256 | 0.236 | 0.246 | 0.224 |
| | $G_i$* | 0.256 | 0.274 | 0.276 | 0.261 | 0.251 | 0.256 | 0.232 |
| | $H_i$ | 0.423 | 0.397 | 0.418 | 0.430 | 0.424 | 0.426 | 0.342 |
| | $H_i$* | 0.189 | 0.182 | 0.182 | 0.207 | 0.194 | 0.198 | 0.178 |
| | $I_i$ | 0.467 | 0.449 | 0.474 | 0.478 | 0.472 | 0.474 | 0.425 |
| 11 | $c_i$ | 0.547 | 0.557 | 0.559 | 0.569 | 0.560 | 0.578 | 0.496 |
| | $G_i$ | 0.240 | 0.265 | 0.274 | 0.269 | 0.258 | 0.255 | 0.242 |
| | $G_i$* | 0.246 | 0.282 | 0.288 | 0.277 | 0.272 | 0.264 | 0.248 |
| | $H_i$ | 0.389 | 0.423 | 0.431 | 0.430 | 0.426 | 0.428 | 0.349 |
| | $H_i$* | 0.182 | 0.194 | 0.196 | 0.192 | 0.190 | 0.189 | 0.165 |
| | $I_i$ | 0.433 | 0.462 | 0.489 | 0.478 | 0.480 | 0.480 | 0.436 |
| 12 | $c_i$ | 0.559 | 0.551 | 0.555 | 0.538 | 0.562 | 0.548 | 0.494 |
| | $G_i$ | 0.256 | 0.258 | 0.277 | 0.272 | 0.278 | 0.267 | 0.250 |
| | $G_i$* | 0.265 | 0.265 | 0.297 | 0.269 | 0.290 | 0.278 | 0.261 |
| | $H_i$ | 0.418 | 0.431 | 0.447 | 0.437 | 0.443 | 0.419 | 0.340 |
| | $H_i$* | 0.196 | 0.178 | 0.203 | 0.180 | 0.176 | 0.189 | 0.150 |
| | $I_i$ | 0.469 | 0.480 | 0.497 | 0.490 | 0.503 | 0.493 | 0.441 |
| 13 | $c_i$ | 0.545 | 0.577 | 0.541 | 0.552 | 0.555 | 0.550 | 0.489 |
| | $G_i$ | 0.260 | 0.262 | 0.264 | 0.268 | 0.271 | 0.261 | 0.243 |
| | $G_i$* | 0.269 | 0.274 | 0.279 | 0.277 | 0.282 | 0.276 | 0.257 |
| | $H_i$ | 0.423 | 0.434 | 0.430 | 0.432 | 0.419 | 0.431 | 0.354 |
| | $H_i$* | 0.192 | 0.189 | 0.198 | 0.205 | 0.171 | 0.179 | 0.175 |
| | $I_i$ | 0.485 | 0.478 | 0.477 | 0.470 | 0.475 | 0.468 | 0.426 |
| 14 | $c_i$ | 0.503 | 0.492 | 0.473 | 0.473 | 0.480 | 0.500 | 0.439 |
| | $G_i$ | 0.236 | 0.237 | 0.232 | 0.246 | 0.243 | 0.246 | 0.233 |
| | $G_i$* | 0.247 | 0.250 | 0.248 | 0.244 | 0.256 | 0.254 | 0.236 |
| | $H_i$ | 0.344 | 0.346 | 0.334 | 0.346 | 0.344 | 0.347 | 0.257 |
| | $H_i$* | 0.194 | 0.168 | 0.166 | 0.166 | 0.162 | 0.193 | 0.143 |
| | $I_i$ | 0.414 | 0.405 | 0.402 | 0.423 | 0.414 | 0.403 | 0.367 |

Figure B.45 Empirical Power Based on CWF Pattern Variance-Covariance Matrix Using CWF Connectivity Case for a 14x14 Study Area



# C. SOFTWARE PROGRAMS

## C.1 R Code for $H_i$ Simulations

Analysis used R software by R Development Core Team (2007) Version 2.6.0.

```
#
##########################################################################
#
# Local Spatial Autocorrelation
#
# Hi Size and Power Simulations
#
##########################################################################
#
# load multivariate normal library for generating random vectors
#
library(mnormt)
#
# order of y values for rxc regular lattice Study Area
# example for 4x4
#   1  2  3  4
#   5  6  7  8
#   9 10 11 12
#  13 14 15 16
#
# size of rxc regular lattice, where r=rows and c=columns
r<-4
c<-4
n<-r*c
# n=r*c for total number of regions
#
set.seed(14729)
#
# ngdist is number of times to generate geographical distributions
#
ngdist<-1000
#
# nresamp is number of times to resample without replacement for empirical p-values
#
nresamp<-1000
#
# initialize variables, matrices, and vectors for outer loop of geographical distributions
# conmat is for GWSCM matrix
# conmatin is for inputting GWSCM matrix
```

```
# spacorr is for spatial autocorrelation (variance-covariance) matrix
# spacorrin is for inputting spatial autocorrelation matrix
# dist is matrix of geographical distributions
# jcm is for vector of ones
# Hipresult is matrix of empirical p-values
# Hisacmeas is matrix of local spatial autocorrelation statistics
# mu is vector of population means
# sigma is population variance-covariance matrix
#
conmat <- matrix(NA,n,n)
conmatin <- matrix(NA,n,n)
spacorr<-matrix(NA,n,n)
spacorrin<-matrix(NA,n,n)
dist<-matrix(NA,ngdist,n)
jcm <- matrix(NA,n,1)
Hipresult<-matrix(NA,ngdist,n)
Hisacmeas<-matrix(NA,ngdist,n)
mu<-matrix(NA,n,1)
sigma<-matrix(NA,n,n)
#
#                    CONTIGUITY MATRIX THAT EXCLUDES pivot point for Hi
#
# read connectivity matrix from file, note location of file
conmatin <- scan(file="c:/data/CM4x4.csv",sep=",")
conmat<-matrix(conmatin,n,n,byrow=TRUE)
#
# create vector of 1's of size r*c=n
#
jcm <- rep(1,n)
#
#                          SPATIAL AUTOCORRELATION MATRIX
#
# read spatial autocorrelation matrix from file, note location of file
#
spacorrin <- scan(file="c:/data/RookPattern4x4.csv",sep=",")
spacorr<-matrix(spacorrin,n,n,byrow=TRUE)
#
#
# obtain random sample of size ngdist from multivariate normal distribution
#
#
mu <- rep(10,n)
#mu
sigma <- spacorr
dist <- rmnorm(ngdist, mu, sigma)
#
```

```
#                                       Start outer loop for Geographic Distributions
for(igd in 1:ngdist){
#
#
ynew<-matrix(NA,n,1)
y <- matrix(NA,n,1)
results<-matrix(NA,nresamp,n)
Hi<-matrix(NA,n,1)
EHi<-matrix(NA,n,1)
psum<-matrix(NA,n,1)
pvalue<-matrix(NA,n,1)
VarsHi<-matrix(NA,n,1)
#
ynew<-dist[igd,]
#set y equal to input data
y <- matrix(ynew,n,1)
#
#
#                              *** Start inner loop to cycle through Geographic Regions ***
#
#
##                                             Compute Hi
#
for(i5A in 1:n){
# set ynew equal to y so first pass for a given region has observed data
ynew<-matrix(y,n,1)  # maintain original data in y
# calculate mean of neighbors and statistic, store statistic in first row of results matrix
ybar <- mean(ynew,na.rm=TRUE)
ycorr<-ynew-ybar*jcm
#
# determine number of neighbors
#numnbor<-sum(conmat[i5A,]>0) replaced on 7-20-2010 with next line for weighted
averages
numnbor<-sum(conmat[i5A,])
zbari<-(conmat[i5A,]%*%ycorr)/numnbor
maxcomp<-max(abs(ycorr[i5A]),abs(zbari))
mincomp<-min(abs(ycorr[i5A]),abs(zbari))
# if both maxcomp equal zero set measure equal to one (since both are zero)
if(maxcomp == 0){Hi[i5A]<- 1}
  else{Hi[i5A]<-as.double((mincomp/maxcomp)*sign(ycorr[i5A]/zbari))}
results[1,i5A]<-Hi[i5A]
# store local SAC measure
Hisacmeas[igd,i5A]<-Hi[i5A]
#
#* START LOOP FOR RESAMPLES WITH CONDITIONAL RANDOMIZATION *
#
```

```
for(ir in 2:nresamp){
#
# create needed matrices then perform conditional randomization
yper<-matrix(NA,n-1,1)
ypernew<-matrix(NA,n-1,1)
#
ynew<-matrix(y,n,1)  # maintain original data in y
#
# Fix y[i5A] and permute remaining n-1 observations for conditional randomization
yper<-matrix(ynew[-i5A],n-1,1)
ypernew<-sample(yper,n-1,replace=FALSE,prob=NULL)
for(k2 in 1:n){if(k2<i5A)ynew[k2]<-ypernew[k2]}
ynew[i5A]<-y[i5A]
for(k2 in 1:n){if(k2>i5A)ynew[k2]<-ypernew[k2-1]}
#
# ynew is now vector based on conditional randomization
#
# ybar is the same as above, calculate local statistics based on new neighbors
#
# ycorr is recomputed for new neighbors, note that ybar is constant for a given set of data
#
ycorr<-ynew-ybar*jcm
# determine number of neighbors
numnbor<-sum(conmat[i5A,])
zbari<-(conmat[i5A,]%*%ycorr)/numnbor
maxcomp<-max(abs(ycorr[i5A]),abs(zbari))
mincomp<-min(abs(ycorr[i5A]),abs(zbari))
# if both maxcomp equal zero set measure equal to one (since both are zero)
if(maxcomp == 0){results[ir,i5A]<- 1}
  else{results[ir,i5A]<-as.double((mincomp/maxcomp)*sign(ycorr[i5A]/zbari))}
#
                    }   # end of ir loop for resamples
#
# now go to next geographic region
#
                 }    # end of i5A loop for geographic regions
#
# find two sided p-values
#
# initialize sum vectors
#
psum<-matrix(NA,n,1)
pupsum<-matrix(NA,n,1)
psamesum<-matrix(NA,n,1)
plowsum<-matrix(NA,n,1)
for(imean in 1:n){EHi[imean]<-mean(results[,imean],na.rm=TRUE)}
```

```
for(izero in 1:n){psum[izero] <- 0
                pupsum[izero]<- 0
                psamesum[izero]<- 0
                plowsum[izero]<- 0
                }
for(ip in 2:nresamp){
        for(jp in 1:n){
    if(results[1,jp]>EHi[jp])
       (if(results[ip,jp]>=results[1,jp])(pupsum[jp]<-pupsum[jp]+1))
    else
    if(results[1,jp]<EHi[jp])
       (if(results[ip,jp]<=results[1,jp])(plowsum[jp]<-plowsum[jp]+1))
# address degenerate case where all data values are the same
    if(results[1,jp]==EHi[jp])(if(results[ip,jp]==results[1,jp])(psamesum[jp]<-
psamesum[jp]+1))
                     }
             }
for(ivalue in 1:n){
                 if(results[1,ivalue]>EHi[ivalue])(Hipresult[igd,ivalue]<- 1-
(pupsum[ivalue]+1)/nresamp)
                 if(results[1,ivalue]<EHi[ivalue])(Hipresult[igd,ivalue]<-
(plowsum[ivalue]+1)/nresamp)
                 if(results[1,ivalue]==EHi[ivalue])(Hipresult[igd,ivalue]<-
(psamesum[ivalue]+1)/nresamp)
                }
}    # end of igd loop for geographic regions
#

# Get stop time
stoptime<-as.POSIXlt(Sys.time())
# Compute elapsed time
stoptime-starttime
#
#  Now look at numerical results
#
# Counts for p-values
#
pcounts<-matrix(NA,12,n)
for(ipcounti in 1:n){
pcounts[1,ipcounti]<-sum(Hipresult[,ipcounti]<=0.005)
                  }
for(ipcounti in 1:n){
pcounts[2,ipcounti]<-sum(Hipresult[,ipcounti]<=0.01)
                  }
for(ipcounti in 1:n){
pcounts[3,ipcounti]<-sum(Hipresult[,ipcounti]<=0.025)
```

```
                }
for(ipcounti in 1:n){
pcounts[4,ipcounti]<-sum(Hipresult[,ipcounti]<=0.05)
                }
for(ipcounti in 1:n){
pcounts[5,ipcounti]<-sum(Hipresult[,ipcounti]<=0.10)
                }
for(ipcounti in 1:n){
pcounts[6,ipcounti]<-sum(Hipresult[,ipcounti]<=0.25)
                }
for(ipcounti in 1:n){
pcounts[7,ipcounti]<-sum(Hipresult[,ipcounti]>=0.75)
                }
for(ipcounti in 1:n){
pcounts[8,ipcounti]<-sum(Hipresult[,ipcounti]>=0.90)
                }
for(ipcounti in 1:n){
pcounts[9,ipcounti]<-sum(Hipresult[,ipcounti]>=0.95)
                }
for(ipcounti in 1:n){
pcounts[10,ipcounti]<-sum(Hipresult[,ipcounti]>=0.975)
                }
for(ipcounti in 1:n){
pcounts[11,ipcounti]<-sum(Hipresult[,ipcounti]>=0.99)
                }
for(ipcounti in 1:n){
pcounts[12,ipcounti]<-sum(Hipresult[,ipcounti]>=0.995)
                }
#
# display p-values
#
cat(c("P-values <= or >= specificed values","\n"))
cat(c("Rows are .005 .01 .025 .05 .10 .25 .75 .90 .95 .975 .99 .995","\n"))
cat(c("Columns are n geographical regions","\n"))
pcounts
#
#  Now look at graphical results
#
 par(ask=TRUE)
#
 par(mfrow=c(min(4,r),min(4,c)))
#
# histograms of Hi for each region
#
for(k in 1:n){
RegSubTitle<-as.character("Region k Hi")
```

```
RegChar<-as.character(k)
RegTitle<- gsub("k",RegChar,RegSubTitle)
hist(Hisacmeas[,k],main=RegTitle)
        }
#
# look at summary statistics for each data site
#
cat(c(" # Neighbors "," Min    Q1  Median  Mean  Q3  Max"," Variance  ","  Std. Dev. ","    Skewness","    Kurtosis ","\n"))
#
for(k in 1:n){
x <- matrix(NA,ngdist,1)
x <- Hisacmeas[,k]
xmean<-mean(x, na.rm = TRUE)
xvar<-var(x, na.rm = TRUE)
sacm3<-sum((x-xmean)^3)/ngdist
sacs3<-sqrt(xvar)^3
skew<-sacm3/sacs3
sacm4<-sum((x-xmean)^4)/ngdist
sacs4<-xvar^2
kur<-sacm4/sacs4
cat(c(k,summary((x), na.rm = TRUE),xvar,sqrt(xvar),skew,kur,"\n"))
        }
#
```

C.2 SAS Code for Panel Graphs for a 4x4 Study Area

This data analysis was generated using SAS software, Version 9.2 of the SAS System for Windows (SAS 2002-2008),

```
DM 'LOG; CLEAR; OUTPUT; CLEAR; ';
OPTIONS LS=100 PS=55 PAGENO=1 NODATE;
TITLE;
FOOTNOTE;
DATA area4x4;
INPUT  Measure $ RookNeighbors QueenNeighbors LocID $ region RookSize
QueenSize CWFSize
      RookAllRookPower RookAllQueenPower RookAllCWFPower
      QueenAllRookPower QueenAllQueenPower QueenAllCWFPower
      HotSpotRookPower HotSpotQueenPower HotSpotCWFPower
      CMDWRookPower CMDWQueenPower CMDWCWFPower;
LABEL LocID='Position' RookSize='Size' QueenSize='Size' CWFSize='Size'
      RookAllRookPower='Power' RookAllQueenPower='Power'
RookAllCWFPower='Power'
      QueenAllRookPower='Power' QueenAllQueenPower='Power'
QueenAllCWFPower='Power'
      HotSpotRookPower='Power' HotSpotQueenPower='Power'
HotSpotCWFPower='Power'
      CMDWRookPower='Power' CMDWQueenPower='Power'
CMDWCWFPower='Power';
DATALINES;
ci      2      3      C      1      0.041  0.055  0.052         0.1688 0.225  0.272
        0.282  0.399  0.438         0.072  0.04   0.058         0.214  0.296  0.373
ci      3      5      E      2      0.038  0.049  0.04          0.1964 0.241  0.264
        0.299  0.432  0.464         0.02   0.033  0.055         0.246  0.319  0.374
ci      3      5      E      3      0.042  0.051  0.04          0.1914 0.22   0.228
        0.294  0.408  0.438         0.037  0.045  0.064         0.23   0.287  0.342
ci      2      3      C      4      0.026  0.039  0.037         0.1628 0.217  0.252
        0.275  0.379  0.424         0.041  0.033  0.063         0.205  0.285  0.328
ci      3      5      E      5      0.048  0.056  0.057         0.1894 0.262  0.269
        0.319  0.43   0.454         0.025  0.049  0.071         0.263  0.341  0.376
ci      4      8      I      6      0.055  0.046  0.052         0.1511 0.249  0.257
        0.25   0.366  0.418         0.153  0.138  0.139         0.221  0.323  0.347
ci      4      8      I      7      0.026  0.044  0.038         0.1632 0.19   0.228
        0.241  0.341  0.393         0.126  0.137  0.132         0.197  0.29   0.301
ci      3      5      E      8      0.05   0.053  0.047         0.1865 0.239  0.268
        0.311  0.444  0.471         0.038  0.051  0.073         0.26   0.343  0.373
ci      3      5      E      9      0.048  0.054  0.042         0.1825 0.227  0.245
        0.303  0.419  0.462         0.02   0.032  0.054         0.236  0.319  0.373
ci      4      8      I      10     0.048  0.045  0.05          0.1555 0.196  0.242
        0.274  0.387  0.428         0.138  0.14   0.146         0.232  0.313  0.354
```

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| ci | 4 | 8 | I | 11 | 0.059 | 0.05 | 0.054 | 0.163 | 0.211 | 0.241 |
| | 0.269 | 0.372 | 0.426 | | 0.128 | 0.156 | 0.153 | 0.218 | 0.314 | 0.344 |
| ci | 3 | 5 | E | 12 | 0.043 | 0.042 | 0.036 | 0.2018 | 0.242 | 0.27 |
| | 0.296 | 0.444 | 0.466 | | 0.026 | 0.042 | 0.055 | 0.257 | 0.362 | 0.379 |
| ci | 2 | 3 | C | 13 | 0.037 | 0.044 | 0.045 | 0.1665 | 0.201 | 0.216 |
| | 0.239 | 0.361 | 0.395 | | 0.053 | 0.024 | 0.055 | 0.185 | 0.261 | 0.325 |
| ci | 3 | 5 | E | 14 | 0.046 | 0.053 | 0.06 | 0.1951 | 0.218 | 0.253 |
| | 0.288 | 0.414 | 0.458 | | 0.026 | 0.043 | 0.073 | 0.23 | 0.327 | 0.38 |
| ci | 3 | 5 | E | 15 | 0.057 | 0.048 | 0.053 | 0.1949 | 0.24 | 0.282 |
| | 0.315 | 0.425 | 0.457 | | 0.029 | 0.041 | 0.07 | 0.254 | 0.317 | 0.37 |
| ci | 2 | 3 | C | 16 | 0.039 | 0.047 | 0.046 | 0.1645 | 0.214 | 0.255 |
| | 0.245 | 0.373 | 0.416 | | 0.049 | 0.033 | 0.053 | 0.2 | 0.285 | 0.356 |
| Gi | 2 | 3 | C | 1 | 0.032 | 0.05 | 0.043 | 0.0762 | 0.145 | 0.17 |
| | 0.153 | 0.208 | 0.246 | | 0.051 | 0.033 | 0.044 | 0.112 | 0.157 | 0.211 |
| Gi | 3 | 5 | E | 2 | 0.04 | 0.047 | 0.047 | 0.0881 | 0.139 | 0.159 |
| | 0.14 | 0.206 | 0.231 | | 0.033 | 0.037 | 0.044 | 0.109 | 0.178 | 0.204 |
| Gi | 3 | 5 | E | 3 | 0.035 | 0.041 | 0.051 | 0.0874 | 0.129 | 0.154 |
| | 0.121 | 0.191 | 0.215 | | 0.028 | 0.042 | 0.047 | 0.108 | 0.164 | 0.183 |
| Gi | 2 | 3 | C | 4 | 0.037 | 0.056 | 0.046 | 0.078 | 0.12 | 0.15 |
| | 0.148 | 0.19 | 0.229 | | 0.065 | 0.035 | 0.055 | 0.108 | 0.143 | 0.181 |
| Gi | 3 | 5 | E | 5 | 0.05 | 0.049 | 0.044 | 0.0847 | 0.158 | 0.166 |
| | 0.141 | 0.201 | 0.233 | | 0.03 | 0.044 | 0.058 | 0.124 | 0.193 | 0.211 |
| Gi | 4 | 8 | I | 6 | 0.054 | 0.059 | 0.058 | 0.0584 | 0.14 | 0.138 |
| | 0.076 | 0.164 | 0.178 | | 0.06 | 0.079 | 0.07 | 0.075 | 0.156 | 0.159 |
| Gi | 4 | 8 | I | 7 | 0.037 | 0.049 | 0.053 | 0.0646 | 0.115 | 0.119 |
| | 0.071 | 0.132 | 0.143 | | 0.044 | 0.075 | 0.081 | 0.068 | 0.133 | 0.139 |
| Gi | 3 | 5 | E | 8 | 0.034 | 0.05 | 0.048 | 0.0844 | 0.119 | 0.136 |
| | 0.14 | 0.192 | 0.208 | | 0.027 | 0.03 | 0.053 | 0.114 | 0.158 | 0.185 |
| Gi | 3 | 5 | E | 9 | 0.05 | 0.053 | 0.054 | 0.0825 | 0.13 | 0.145 |
| | 0.136 | 0.19 | 0.223 | | 0.026 | 0.037 | 0.051 | 0.107 | 0.162 | 0.186 |
| Gi | 4 | 8 | I | 10 | 0.049 | 0.048 | 0.044 | 0.0604 | 0.115 | 0.143 |
| | 0.085 | 0.152 | 0.167 | | 0.066 | 0.073 | 0.073 | 0.081 | 0.152 | 0.16 |
| Gi | 4 | 8 | I | 11 | 0.056 | 0.038 | 0.036 | 0.0656 | 0.119 | 0.127 |
| | 0.074 | 0.138 | 0.146 | | 0.063 | 0.072 | 0.086 | 0.068 | 0.153 | 0.161 |
| Gi | 3 | 5 | E | 12 | 0.036 | 0.039 | 0.043 | 0.0869 | 0.125 | 0.151 |
| | 0.12 | 0.183 | 0.219 | | 0.029 | 0.033 | 0.054 | 0.111 | 0.173 | 0.203 |
| Gi | 2 | 3 | C | 13 | 0.032 | 0.041 | 0.044 | 0.0761 | 0.134 | 0.152 |
| | 0.136 | 0.192 | 0.235 | | 0.063 | 0.031 | 0.049 | 0.094 | 0.157 | 0.201 |
| Gi | 3 | 5 | E | 14 | 0.039 | 0.043 | 0.044 | 0.087 | 0.137 | 0.147 |
| | 0.126 | 0.187 | 0.21 | | 0.026 | 0.04 | 0.054 | 0.119 | 0.166 | 0.2 |
| Gi | 3 | 5 | E | 15 | 0.049 | 0.043 | 0.048 | 0.0825 | 0.15 | 0.16 |
| | 0.13 | 0.177 | 0.194 | | 0.028 | 0.04 | 0.061 | 0.117 | 0.164 | 0.192 |
| Gi | 2 | 3 | C | 16 | 0.036 | 0.036 | 0.046 | 0.0742 | 0.132 | 0.164 |
| | 0.139 | 0.177 | 0.208 | | 0.058 | 0.031 | 0.045 | 0.098 | 0.154 | 0.199 |
| Gi* | 2 | 3 | C | 1 | 0.052 | 0.057 | 0.052 | 0.1516 | 0.178 | 0.193 |
| | 0.217 | 0.242 | 0.269 | | 0.068 | 0.04 | 0.061 | 0.196 | 0.201 | 0.237 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Gi* | 3 | 5 | E | 2 | 0.044 | 0.047 | 0.041 | 0.1488 | 0.169 | 0.188 |
| | 0.203 | 0.245 | 0.264 | | 0.042 | 0.038 | 0.051 | 0.178 | 0.209 | 0.231 |
| Gi* | 3 | 5 | E | 3 | 0.042 | 0.047 | 0.042 | 0.1527 | 0.165 | 0.178 |
| | 0.177 | 0.224 | 0.248 | | 0.027 | 0.041 | 0.052 | 0.163 | 0.191 | 0.213 |
| Gi* | 2 | 3 | C | 4 | 0.041 | 0.056 | 0.05 | 0.152 | 0.156 | 0.179 |
| | 0.221 | 0.239 | 0.262 | | 0.074 | 0.035 | 0.055 | 0.179 | 0.186 | 0.219 |
| Gi* | 3 | 5 | E | 5 | 0.053 | 0.052 | 0.056 | 0.146 | 0.186 | 0.196 |
| | 0.198 | 0.242 | 0.246 | | 0.038 | 0.043 | 0.053 | 0.179 | 0.217 | 0.23 |
| Gi* | 4 | 8 | I | 6 | 0.069 | 0.055 | 0.059 | 0.1098 | 0.156 | 0.169 |
| | 0.134 | 0.196 | 0.209 | | 0.086 | 0.093 | 0.103 | 0.128 | 0.182 | 0.189 |
| Gi* | 4 | 8 | I | 7 | 0.047 | 0.052 | 0.041 | 0.1132 | 0.128 | 0.153 |
| | 0.111 | 0.166 | 0.18 | | 0.07 | 0.093 | 0.107 | 0.103 | 0.155 | 0.163 |
| Gi* | 3 | 5 | E | 8 | 0.044 | 0.045 | 0.052 | 0.1455 | 0.153 | 0.172 |
| | 0.202 | 0.219 | 0.235 | | 0.029 | 0.034 | 0.048 | 0.176 | 0.195 | 0.221 |
| Gi* | 3 | 5 | E | 9 | 0.039 | 0.047 | 0.043 | 0.1444 | 0.162 | 0.186 |
| | 0.195 | 0.228 | 0.244 | | 0.031 | 0.037 | 0.048 | 0.162 | 0.188 | 0.213 |
| Gi* | 4 | 8 | I | 10 | 0.056 | 0.05 | 0.049 | 0.1117 | 0.136 | 0.176 |
| | 0.138 | 0.182 | 0.195 | | 0.098 | 0.088 | 0.104 | 0.13 | 0.178 | 0.196 |
| Gi* | 4 | 8 | I | 11 | 0.048 | 0.032 | 0.043 | 0.1154 | 0.14 | 0.165 |
| | 0.125 | 0.158 | 0.176 | | 0.091 | 0.095 | 0.112 | 0.121 | 0.179 | 0.187 |
| Gi* | 3 | 5 | E | 12 | 0.027 | 0.039 | 0.037 | 0.1467 | 0.158 | 0.173 |
| | 0.184 | 0.221 | 0.232 | | 0.028 | 0.034 | 0.036 | 0.184 | 0.21 | 0.239 |
| Gi* | 2 | 3 | C | 13 | 0.045 | 0.042 | 0.045 | 0.1466 | 0.175 | 0.171 |
| | 0.207 | 0.236 | 0.254 | | 0.081 | 0.039 | 0.055 | 0.157 | 0.189 | 0.214 |
| Gi* | 3 | 5 | E | 14 | 0.046 | 0.044 | 0.044 | 0.1447 | 0.171 | 0.183 |
| | 0.196 | 0.231 | 0.254 | | 0.034 | 0.036 | 0.046 | 0.167 | 0.196 | 0.225 |
| Gi* | 3 | 5 | E | 15 | 0.034 | 0.042 | 0.045 | 0.1393 | 0.179 | 0.178 |
| | 0.184 | 0.207 | 0.224 | | 0.029 | 0.032 | 0.052 | 0.172 | 0.204 | 0.228 |
| Gi* | 2 | 3 | C | 16 | 0.041 | 0.035 | 0.045 | 0.1485 | 0.174 | 0.18 |
| | 0.206 | 0.215 | 0.237 | | 0.057 | 0.025 | 0.041 | 0.18 | 0.197 | 0.221 |
| Hi | 2 | 3 | C | 1 | 0.053 | 0.053 | 0.045 | 0.1863 | 0.198 | 0.257 |
| | 0.269 | 0.306 | 0.39 | | 0.059 | 0.043 | 0.05 | 0.242 | 0.244 | 0.323 |
| Hi | 3 | 5 | E | 2 | 0.045 | 0.052 | 0.046 | 0.2223 | 0.233 | 0.283 |
| | 0.353 | 0.398 | 0.419 | | 0.043 | 0.047 | 0.037 | 0.268 | 0.331 | 0.356 |
| Hi | 3 | 5 | E | 3 | 0.049 | 0.054 | 0.057 | 0.2194 | 0.206 | 0.262 |
| | 0.331 | 0.358 | 0.395 | | 0.048 | 0.039 | 0.037 | 0.271 | 0.292 | 0.331 |
| Hi | 2 | 3 | C | 4 | 0.04 | 0.043 | 0.047 | 0.1894 | 0.169 | 0.228 |
| | 0.27 | 0.284 | 0.358 | | 0.054 | 0.043 | 0.054 | 0.226 | 0.23 | 0.291 |
| Hi | 3 | 5 | E | 5 | 0.049 | 0.057 | 0.049 | 0.2146 | 0.239 | 0.274 |
| | 0.353 | 0.415 | 0.429 | | 0.047 | 0.044 | 0.054 | 0.274 | 0.322 | 0.39 |
| Hi | 4 | 8 | I | 6 | 0.05 | 0.056 | 0.051 | 0.1645 | 0.24 | 0.262 |
| | 0.227 | 0.341 | 0.356 | | 0.117 | 0.124 | 0.145 | 0.218 | 0.305 | 0.334 |
| Hi | 4 | 8 | I | 7 | 0.037 | 0.037 | 0.056 | 0.1726 | 0.19 | 0.221 |
| | 0.208 | 0.311 | 0.314 | | 0.089 | 0.114 | 0.132 | 0.194 | 0.274 | 0.291 |
| Hi | 3 | 5 | E | 8 | 0.05 | 0.051 | 0.052 | 0.2246 | 0.22 | 0.252 |
| | 0.358 | 0.403 | 0.415 | | 0.039 | 0.043 | 0.047 | 0.289 | 0.303 | 0.35 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Hi | 3 | 5 | E | 9 | 0.038 | 0.04 | 0.046 | 0.2155 | 0.211 | 0.243 |
| | 0.329 | 0.383 | 0.41 | | 0.029 | 0.029 | 0.034 | 0.27 | 0.297 | 0.351 |
| Hi | 4 | 8 | I | 10 | 0.043 | 0.053 | 0.049 | 0.1703 | 0.202 | 0.264 |
| | 0.244 | 0.351 | 0.36 | | 0.11 | 0.126 | 0.137 | 0.216 | 0.305 | 0.331 |
| Hi | 4 | 8 | I | 11 | 0.046 | 0.038 | 0.044 | 0.1746 | 0.235 | 0.247 |
| | 0.247 | 0.347 | 0.351 | | 0.103 | 0.126 | 0.161 | 0.21 | 0.317 | 0.342 |
| Hi | 3 | 5 | E | 12 | 0.045 | 0.042 | 0.038 | 0.2307 | 0.208 | 0.258 |
| | 0.337 | 0.396 | 0.412 | | 0.038 | 0.027 | 0.037 | 0.28 | 0.321 | 0.365 |
| Hi | 2 | 3 | C | 13 | 0.037 | 0.043 | 0.047 | 0.1837 | 0.172 | 0.228 |
| | 0.25 | 0.281 | 0.35 | | 0.052 | 0.031 | 0.041 | 0.216 | 0.224 | 0.284 |
| Hi | 3 | 5 | E | 14 | 0.05 | 0.048 | 0.042 | 0.2265 | 0.202 | 0.247 |
| | 0.322 | 0.376 | 0.415 | | 0.04 | 0.041 | 0.046 | 0.263 | 0.308 | 0.348 |
| Hi | 3 | 5 | E | 15 | 0.056 | 0.048 | 0.05 | 0.2212 | 0.244 | 0.271 |
| | 0.345 | 0.399 | 0.416 | | 0.038 | 0.037 | 0.047 | 0.278 | 0.315 | 0.347 |
| Hi | 2 | 3 | C | 16 | 0.036 | 0.054 | 0.042 | 0.1824 | 0.187 | 0.229 |
| | 0.266 | 0.299 | 0.346 | | 0.044 | 0.04 | 0.044 | 0.213 | 0.238 | 0.315 |
| Hi* | 2 | 3 | C | 1 | 0.045 | 0.057 | 0.042 | 0.1261 | 0.126 | 0.096 |
| | 0.157 | 0.154 | 0.158 | | 0.059 | 0.042 | 0.041 | 0.17 | 0.14 | 0.125 |
| Hi* | 3 | 5 | E | 2 | 0.042 | 0.068 | 0.051 | 0.1158 | 0.135 | 0.107 |
| | 0.168 | 0.162 | 0.112 | | 0.044 | 0.051 | 0.053 | 0.164 | 0.159 | 0.116 |
| Hi* | 3 | 5 | E | 3 | 0.044 | 0.043 | 0.055 | 0.1266 | 0.101 | 0.105 |
| | 0.179 | 0.176 | 0.146 | | 0.043 | 0.046 | 0.038 | 0.155 | 0.152 | 0.135 |
| Hi* | 2 | 3 | C | 4 | 0.049 | 0.048 | 0.049 | 0.1269 | 0.107 | 0.094 |
| | 0.152 | 0.144 | 0.12 | | 0.056 | 0.043 | 0.049 | 0.142 | 0.123 | 0.115 |
| Hi* | 3 | 5 | E | 5 | 0.061 | 0.047 | 0.053 | 0.1125 | 0.108 | 0.097 |
| | 0.181 | 0.159 | 0.123 | | 0.049 | 0.046 | 0.059 | 0.155 | 0.149 | 0.13 |
| Hi* | 4 | 8 | I | 6 | 0.05 | 0.049 | 0.044 | 0.0817 | 0.094 | 0.09 |
| | 0.085 | 0.1 | 0.077 | | 0.107 | 0.084 | 0.08 | 0.129 | 0.142 | 0.104 |
| Hi* | 4 | 8 | I | 7 | 0.032 | 0.044 | 0.066 | 0.0821 | 0.09 | 0.066 |
| | 0.106 | 0.128 | 0.105 | | 0.087 | 0.076 | 0.075 | 0.115 | 0.129 | 0.103 |
| Hi* | 3 | 5 | E | 8 | 0.044 | 0.053 | 0.058 | 0.1206 | 0.123 | 0.101 |
| | 0.187 | 0.171 | 0.12 | | 0.037 | 0.048 | 0.037 | 0.164 | 0.157 | 0.124 |
| Hi* | 3 | 5 | E | 9 | 0.054 | 0.042 | 0.049 | 0.1224 | 0.112 | 0.09 |
| | 0.162 | 0.181 | 0.12 | | 0.025 | 0.029 | 0.043 | 0.15 | 0.146 | 0.123 |
| Hi* | 4 | 8 | I | 10 | 0.048 | 0.057 | 0.045 | 0.0831 | 0.081 | 0.071 |
| | 0.075 | 0.106 | 0.078 | | 0.087 | 0.1 | 0.08 | 0.093 | 0.118 | 0.095 |
| Hi* | 4 | 8 | I | 11 | 0.042 | 0.05 | 0.038 | 0.0848 | 0.107 | 0.082 |
| | 0.087 | 0.121 | 0.099 | | 0.082 | 0.082 | 0.079 | 0.117 | 0.143 | 0.115 |
| Hi* | 3 | 5 | E | 12 | 0.048 | 0.049 | 0.049 | 0.1149 | 0.112 | 0.101 |
| | 0.15 | 0.169 | 0.128 | | 0.036 | 0.039 | 0.039 | 0.146 | 0.139 | 0.123 |
| Hi* | 2 | 3 | C | 13 | 0.042 | 0.047 | 0.051 | 0.1299 | 0.105 | 0.105 |
| | 0.14 | 0.13 | 0.127 | | 0.059 | 0.034 | 0.039 | 0.143 | 0.126 | 0.093 |
| Hi* | 3 | 5 | E | 14 | 0.057 | 0.053 | 0.046 | 0.1201 | 0.102 | 0.109 |
| | 0.144 | 0.146 | 0.129 | | 0.042 | 0.043 | 0.041 | 0.142 | 0.127 | 0.118 |
| Hi* | 3 | 5 | E | 15 | 0.064 | 0.054 | 0.039 | 0.1225 | 0.119 | 0.103 |
| | 0.165 | 0.17 | 0.116 | | 0.036 | 0.045 | 0.045 | 0.14 | 0.132 | 0.126 |

```
Hi*     2       3       C       16      0.039   0.036   0.046           0.13    0.111   0.09
        0.159   0.143   0.119           0.043   0.041   0.047           0.15    0.14    0.114
Ii      2       3       C       1       0.032   0.05    0.043           0.1547  0.26    0.297
        0.298   0.395   0.44            0.059   0.035   0.047           0.214   0.306   0.372
Ii      3       5       E       2       0.04    0.047   0.047           0.1733  0.256   0.296
        0.271   0.394   0.436           0.029   0.039   0.042           0.221   0.342   0.381
Ii      3       5       E       3       0.034   0.041   0.051           0.1641  0.24    0.277
        0.238   0.357   0.405           0.02    0.032   0.04            0.204   0.307   0.343
Ii      2       3       C       4       0.037   0.055   0.046           0.1537  0.218   0.261
        0.278   0.357   0.403           0.06    0.03    0.049           0.205   0.27    0.326
Ii      3       5       E       5       0.05    0.049   0.044           0.1666  0.281   0.301
        0.276   0.4        0.444        0.022   0.04    0.05            0.242   0.363   0.408
Ii      4       8       I       6       0.054   0.059   0.058           0.1185  0.254   0.267
        0.168   0.319   0.34            0.119   0.141   0.146           0.155   0.3     0.322
Ii      4       8       I       7       0.037   0.049   0.053           0.128   0.211   0.233
        0.135   0.278   0.299           0.083   0.13    0.135           0.13    0.258   0.28
Ii      3       5       E       8       0.034   0.049   0.048           0.1684  0.246   0.277
        0.275   0.393   0.415           0.026   0.032   0.047           0.236   0.32    0.362
Ii      3       5       E       9       0.048   0.053   0.054           0.1631  0.238   0.272
        0.262   0.384   0.426           0.024   0.031   0.041           0.226   0.317   0.375
Ii      4       8       I       10      0.049   0.048   0.044           0.1232  0.221   0.266
        0.189   0.327   0.354           0.102   0.131   0.135           0.168   0.305   0.325
Ii      4       8       I       11      0.056   0.038   0.036           0.1296  0.239   0.258
        0.178   0.312   0.332           0.112   0.134   0.159           0.145   0.321   0.335
Ii      3       5       E       12      0.035   0.038   0.043           0.1757  0.239   0.279
        0.262   0.384   0.44            0.022   0.024   0.039           0.229   0.343   0.381
Ii      2       3       C       13      0.032   0.041   0.044           0.1517  0.229   0.255
        0.282   0.375   0.418           0.063   0.022   0.036           0.2     0.284   0.353
Ii      3       5       E       14      0.036   0.042   0.044           0.1737  0.246   0.277
        0.26    0.381   0.428           0.029   0.028   0.045           0.229   0.337   0.387
Ii      3       5       E       15      0.05    0.043   0.048           0.168   0.262   0.292
        0.263   0.388   0.419           0.025   0.033   0.052           0.228   0.329   0.37
Ii      2       3       C       16      0.036   0.036   0.046           0.1509  0.236   0.284
        0.284   0.372   0.409           0.06    0.032   0.04            0.2        0.296
        0.362
;
PROC SORT DATA=area4x4;
BY Measure LocID;

data plot;
    set area4x4;
    length Group $ 4;
        if Measure='Hi' then group='  Hi';
    else if Measure='Ii' then group='  Ii';
          else if Measure='ci' then group='  ci';
          else if Measure='Hi*' then group=' Hi*';
```

```
        else if Measure='Gi' then group='Gi';
    else group = 'Gi*';

PROC SORT DATA=plot;
BY group region;

ODS GRAPHICS ON / ANTIALIASMAX=1200 ;

title1 "Size of Test for 4x4 Study Area";
title2 "GWSCM=Rook Connectivity Case";
proc sgpanel data=plot;
  panelby group / columns=3 layout=panel novarname;
  scatter x=LocID y=RookSize;
run;

title1 "Size of Test for 4x4 Study Area";
title2 "GWSCM=Queen Connectivity Case";
proc sgpanel data=plot;
  panelby group / columns=3 layout=panel novarname;
  scatter x=LocID y=QueenSize;
run;

title1 "Size of Test for 4x4 Study Area";
title2 "GWSCM=CWF Connectivity Case";
proc sgpanel data=plot;
  panelby group / columns=3 layout=panel novarname;
  scatter x=LocID y=CWFSize;
run;


title1 "Power of Test for 4x4 Study Area";
title2 "Rook Pattern Variance-Covariance Matrix and GWSCM=Rook Connectivity
Case";
proc sgpanel data=plot;
  panelby group / columns=3 layout=panel novarname;
  scatter x=LocID y=RookAllRookPower;
run;

title1 "Power of Test for 4x4 Study Area";
title2 "Rook Pattern Variance-Covariance Matrix and GWSCM=Queen Connectivity
Case";
proc sgpanel data=plot;
  panelby group / columns=3 layout=panel novarname;
  scatter x=LocID y=RookAllQueenPower;
run;
```

```
title1 "Power of Test for 4x4 Study Area";
title2 "Rook Pattern Variance-Covariance Matrix and GWSCM=CWF Connectivity
Case";
proc sgpanel data=plot;
  panelby group / columns=3 layout=panel novarname;
  scatter x=LocID y=RookAllCWFPower;
run;

title1 "Power of Test for 4x4 Study Area";
title2 "Queen Pattern Variance-Covariance Matrix and GWSCM=Rook Connectivity
Case";
proc sgpanel data=plot;
  panelby group / columns=3 layout=panel novarname;
  scatter x=LocID y=QueenAllRookPower;
run;

title1 "Power of Test for 4x4 Study Area";
title2 "Queen Pattern Variance-Covariance Matrix and GWSCM=Queen Connectivity
Case";
proc sgpanel data=plot;
  panelby group / columns=3 layout=panel novarname;
  scatter x=LocID y=QueenAllQueenPower;
run;

title1 "Power of Test for 4x4 Study Area";
title2 "Queen Pattern Variance-Covariance Matrix and GWSCM=CWF Connectivity
Case";
proc sgpanel data=plot;
  panelby group / columns=3 layout=panel novarname;
  scatter x=LocID y=QueenAllCWFPower;
run;

title1 "Power of Test for 4x4 Study Area";
title2 "Hot-Spot Pattern Variance-Covariance Matrix and GWSCM=Rook Connectivity
Case";
proc sgpanel data=plot;
  panelby group / columns=3 layout=panel novarname;
  scatter x=LocID y=HotSpotRookPower;
run;

title1 "Power of Test for 4x4 Study Area";
title2 "Hot-Spot Pattern Variance-Covariance Matrix and GWSCM=Queen Connectivity
Case";
proc sgpanel data=plot;
  panelby group / columns=3 layout=panel novarname;
  scatter x=LocID y=HotSpotQueenPower;
```

```
run;

title1 "Power of Test for 4x4 Study Area";
title2 "Hot-Spot Pattern Variance-Covariance Matrix and GWSCM=CWF Connectivity
Case";
proc sgpanel data=plot;
  panelby group / columns=3 layout=panel novarname;
  scatter x=LocID y=HotSpotCWFPower;
run;

title1 "Power of Test for 4x4 Study Area";
title2 "CWF Pattern Variance-Covariance Matrix and GWSCM=Rook Connectivity
Case";
proc sgpanel data=plot;
  panelby group / columns=3 layout=panel novarname;
  scatter x=LocID y=CMDWRookPower;
run;

title1 "Power of Test for 4x4 Study Area";
title2 "CWF Pattern Variance-Covariance Matrix and GWSCM=Queen Connectivity
Case";
proc sgpanel data=plot;
  panelby group / columns=3 layout=panel novarname;
  scatter x=LocID y=CMDWQueenPower;
run;

title1 "Power of Test for 4x4 Study Area";
title2 "CWF Pattern Variance-Covariance Matrix and GWSCM=CWF Connectivity
Case";
proc sgpanel data=plot;
  panelby group / columns=3 layout=panel novarname;
  scatter x=LocID y=CMDWCWFPower;
run;

ODS GRAPHICS off;

run;
quit;
```

C.3 MATLAB Code for SDPT3 for Rook Connectivity Case for a 4x4 Study Area

Program ran using MATLAB (MATLAB 2008) Version R2008b.

```
Installmex;
startup;
% Create correlation matrix that is NOT Positive Definite
D=[
1,0.9,0,0,0.9,0,0,0,0,0,0,0,0,0,0,0;
0.9,1,0.9,0,0,0.9,0,0,0,0,0,0,0,0,0,0;
0,0.9,1,0.9,0,0,0.9,0,0,0,0,0,0,0,0,0;
0,0,0.9,1,0,0,0,0.9,0,0,0,0,0,0,0,0;
0.9,0,0,0,1,0.9,0,0,0.9,0,0,0,0,0,0,0;
0,0.9,0,0,0.9,1,0.9,0,0,0.9,0,0,0,0,0,0;
0,0,0.9,0,0,0.9,1,0.9,0,0,0.9,0,0,0,0,0;
0,0,0,0.9,0,0,0.9,1,0,0,0,0.9,0,0,0,0;
0,0,0,0,0.9,0,0,0,1,0.9,0,0,0.9,0,0,0;
0,0,0,0,0,0.9,0,0,0.9,1,0.9,0,0,0.9,0,0;
0,0,0,0,0,0,0.9,0,0,0.9,1,0.9,0,0,0.9,0;
0,0,0,0,0,0,0,0.9,0,0,0.9,1,0,0,0,0.9;
0,0,0,0,0,0,0,0,0.9,0,0,0,1,0.9,0,0;
0,0,0,0,0,0,0,0,0,0.9,0,0,0.9,1,0.9,0;
0,0,0,0,0,0,0,0,0,0,0.9,0,0,0.9,1,0.9;
0,0,0,0,0,0,0,0,0,0,0,0.9,0,0,0.9,1
];
%

% From corrmat.m
  if size(D,1) ~= size(D,2); error('corrmat: matrix must be square'); end;
  n = length(D);
  n2 = n*(n+1)/2;

  blk{1,1} = 's'; blk{1,2} = n;
  for k=1:n; AA{1,k} = spconvert([k,k,1; n,n,0]); end;
  matrepdiag = svec(blk(1,:),AA);
  At{1,1} = [matrepdiag{1},  speye(n2)];

  blk{2,1} = 'q'; blk{2,2} = n2+1;
  At{2,1} = [sparse(n,n2+1); sparse(n2,1), speye(n2)];
  b = [ones(n,1); svec(blk(1,:),D)];
  C{1,1} = sparse(n,n); C{2,1} = [1; zeros(n2,1)];
[Obj,X,y,Z]=sqlp(blk,At,C,b);
% List starting correlation matrix
D
% Desired positive definite matrix is in X{1}
```

```
X{1}
% Also available is X{2}, y, Z{1}, Z{2}
% Export X{1} to a file
dlmwrite('RkAllPD10SignDig.csv',X{1},'precision',10,'newline','pc')

 current directory is:  C:\Users\Gary\Documents\SDPT3-4.0-beta

 Now compiling the mexFunctions in:
 C:\Users\Gary\Documents\SDPT3-4.0-beta\Solver\Mexfun
 mex  -O -largeArrayDims  mexProd2.c
 mex  -O -largeArrayDims  mexProd2nz.c
 mex  -O -largeArrayDims  mexinprod.c
 mex  -O -largeArrayDims  mexmat.c
 mex  -O -largeArrayDims  mexsmat.c
 mex  -O -largeArrayDims  mexsvec.c
 mex  -O -largeArrayDims  mexschur.c
 mex  -O -largeArrayDims  mexqops.c
 mex  -O -largeArrayDims  mexexpand.c
 mex  -O -largeArrayDims  mexskron.c
 mex  -O -largeArrayDims  mexnnz.c
 mex  -O -largeArrayDims  mexschurfun.c
 mex  -O -largeArrayDims  mexMatvec.c
 mex  -O -largeArrayDims  mextriang.c
 mex  -O -largeArrayDims  mextriangsp.c

 num. of constraints = 152
 dim. of sdp    var  = 16,   num. of sdp  blk  =  1
 dim. of socp   var  = 137,   num. of socp blk  =  1
*******************************************************************
   SDPT3: Infeasible path-following algorithms
*******************************************************************
 version  predcorr  gam  expon  scale_data
   HKM      1      0.000   1        0
it pstep dstep pinfeas dinfeas  gap      mean(obj)   cputime
-------------------------------------------------------------------
 0|0.000|0.000|1.0e+001|9.6e+000|1.4e+003| 1.170470e+001| 0:0:00| chol  1  1
 1|0.989|0.963|1.2e-001|4.4e-001|8.9e+001|-1.356157e+001| 0:0:00| chol  1  1
 2|1.000|0.932|5.5e-007|3.9e-002|6.6e+000| 2.230575e+000| 0:0:00| chol  1  1
 3|0.690|0.920|1.8e-007|4.0e-003|1.5e+000| 2.492405e+000| 0:0:00| chol  1  1
 4|0.857|0.848|3.7e-008|7.0e-004|2.8e-001| 2.690457e+000| 0:0:01| chol  1  1
 5|0.850|0.866|5.9e-009|1.0e-004|4.5e-002| 2.710678e+000| 0:0:01| chol  1  1
 6|0.920|0.870|6.8e-010|1.4e-005|6.0e-003| 2.709396e+000| 0:0:01| chol  1  1
 7|0.971|0.972|9.2e-011|4.9e-007|1.8e-004| 2.709698e+000| 0:0:01| chol  1  1
 8|0.961|0.972|2.5e-011|1.4e-008|6.0e-006| 2.709710e+000| 0:0:01| chol  1  1
 9|0.868|0.981|7.7e-012|2.6e-010|4.7e-007| 2.709710e+000| 0:0:01| chol  1  1
10|0.955|0.992|5.8e-011|3.5e-012|2.4e-008| 2.709710e+000| 0:0:01|
```

```
 stop: max(relative gap, infeasibilities) < 1.00e-008
-------------------------------------------------------------------
 number of iterations   = 10
 primal objective value =  2.70971022e+000
 dual   objective value =  2.70971019e+000
 gap := trace(XZ)       = 2.40e-008
 relative gap           = 3.74e-009
 actual relative gap    = 3.76e-009
 rel. primal infeas     = 5.82e-011
 rel. dual   infeas     = 3.49e-012
 norm(X), norm(y), norm(Z) = 7.1e+000, 1.2e+000, 1.8e+000
 norm(A), norm(b), norm(C) = 1.8e+001, 9.4e+000, 2.0e+000
 Total CPU time (secs)  = 0.6
 CPU time per iteration = 0.1
 termination code       =  0
 DIMACS: 2.4e-010  0.0e+000  3.5e-012  0.0e+000  3.8e-009  3.7e-009
-------------------------------------------------------------------
```

D =

Columns 1 through 9

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1.0000 | 0.9000 | 0 | 0 | 0.9000 | 0 | 0 | 0 | 0 |
| 0.9000 | 1.0000 | 0.9000 | 0 | 0 | 0.9000 | 0 | 0 | 0 |
| 0 | 0.9000 | 1.0000 | 0.9000 | 0 | 0 | 0.9000 | 0 | 0 |
| 0 | 0 | 0.9000 | 1.0000 | 0 | 0 | 0 | 0.9000 | 0 |
| 0.9000 | 0 | 0 | 0 | 1.0000 | 0.9000 | 0 | 0 | 0.9000 |
| 0 | 0.9000 | 0 | 0 | 0.9000 | 1.0000 | 0.9000 | 0 | 0 |
| 0 | 0 | 0.9000 | 0 | 0 | 0.9000 | 1.0000 | 0.9000 | 0 |
| 0 | 0 | 0 | 0.9000 | 0 | 0 | 0.9000 | 1.0000 | 0 |
| 0 | 0 | 0 | 0 | 0.9000 | 0 | 0 | 0 | 1.0000 |
| 0 | 0 | 0 | 0 | 0 | 0.9000 | 0 | 0 | 0.9000 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0.9000 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.9000 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.9000 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Columns 10 through 16

| | | | | | | |
|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.9000 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0.9000 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0.9000 | 0 | 0 | 0 | 0 |
| 0.9000 | 0 | 0 | 0.9000 | 0 | 0 | 0 |

```
    1.0000    0.9000         0         0    0.9000         0         0
    0.9000    1.0000    0.9000         0         0    0.9000         0
         0    0.9000    1.0000         0         0         0    0.9000
         0         0         0    1.0000    0.9000         0         0
    0.9000         0         0    0.9000    1.0000    0.9000         0
         0    0.9000         0         0    0.9000    1.0000    0.9000
         0         0    0.9000         0         0    0.9000    1.0000

ans =
  Columns 1 through 9
    1.0000    0.6407    0.1091   -0.0108    0.6407    0.2468   -0.0606   -0.0206    0.1091
    0.6407    1.0000    0.6111    0.1091    0.2470    0.5393    0.2365   -0.0604   -0.0604
    0.1091    0.6111    1.0000    0.6407   -0.0604    0.2365    0.5393    0.2470   -0.0330
   -0.0108    0.1091    0.6407    1.0000   -0.0206   -0.0606    0.2468    0.6407    0.0311
    0.6407    0.2470   -0.0604   -0.0206    1.0000    0.5393    0.0862    0.0236    0.6111
    0.2468    0.5393    0.2365   -0.0606    0.5393    1.0000    0.5493    0.0862    0.2365
   -0.0606    0.2365    0.5393    0.2468    0.0862    0.5493    1.0000    0.5393   -0.0241
   -0.0206   -0.0604    0.2470    0.6407    0.0236    0.0862    0.5393    1.0000   -0.0305
    0.1091   -0.0604   -0.0330    0.0311    0.6111    0.2365   -0.0241   -0.0305    1.0000
   -0.0606    0.0862   -0.0241   -0.0326    0.2365    0.5493    0.2094   -0.0241    0.5393
   -0.0326   -0.0241    0.0862   -0.0606   -0.0241    0.2094    0.5493    0.2365    0.0862
    0.0311   -0.0330   -0.0604    0.1091   -0.0305   -0.0241    0.2365    0.6111    0.0236
   -0.0108   -0.0206    0.0311   -0.0051    0.1091   -0.0606   -0.0326    0.0311    0.6407
   -0.0206    0.0236   -0.0305    0.0311   -0.0604    0.0862   -0.0241   -0.0330    0.2470
    0.0311   -0.0305    0.0236   -0.0206   -0.0330   -0.0241    0.0862   -0.0604   -0.0604
   -0.0051    0.0311   -0.0206   -0.0108    0.0311   -0.0326   -0.0606    0.1091   -0.0206
  Columns 10 through 16
   -0.0606   -0.0326    0.0311   -0.0108   -0.0206    0.0311   -0.0051
    0.0862   -0.0241   -0.0330   -0.0206    0.0236   -0.0305    0.0311
   -0.0241    0.0862   -0.0604    0.0311   -0.0305    0.0236   -0.0206
   -0.0326   -0.0606    0.1091   -0.0051    0.0311   -0.0206   -0.0108
    0.2365   -0.0241   -0.0305    0.1091   -0.0604   -0.0330    0.0311
    0.5493    0.2094   -0.0241   -0.0606    0.0862   -0.0241   -0.0326
    0.2094    0.5493    0.2365   -0.0326   -0.0241    0.0862   -0.0606
   -0.0241    0.2365    0.6111    0.0311   -0.0330   -0.0604    0.1091
    0.5393    0.0862    0.0236    0.6407    0.2470   -0.0604   -0.0206
    1.0000    0.5493    0.0862    0.2468    0.5393    0.2365   -0.0606
    0.5493    1.0000    0.5393   -0.0606    0.2365    0.5393    0.2468
    0.0862    0.5393    1.0000   -0.0206   -0.0604    0.2470    0.6407
    0.2468   -0.0606   -0.0206    1.0000    0.6407    0.1091   -0.0108
    0.5393    0.2365   -0.0604    0.6407    1.0000    0.6111    0.1091
    0.2365    0.5393    0.2470    0.1091    0.6111    1.0000    0.6407
   -0.0606    0.2468    0.6407   -0.0108    0.1091    0.6407    1.0000
% Printed values only have four decimal places, but file contains 10 decimal places
```

# D. GLOBALLY WEIGHTED SPATIAL CONNECTIVITY MATRICES

## D.1 Rook Connectivity Case for a 4x4 Study Area that Excludes Pivot Point

| Column/ Row | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 8 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 9 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| 10 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| 11 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 |
| 12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| 13 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 15 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 |
| 16 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 |

## D.2 Queen Connectivity Case for a 4x4 Study Area that Excludes Pivot Point

| Column/ Row | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| 7 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |
| 8 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 |
| 9 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 |
| 10 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0 |
| 11 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 |
| 12 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 |
| 13 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| 14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| 15 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 1 |
| 16 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 |

D.3 CWF Connectivity Case for a 4x4 Study Area that Excludes Pivot Point

| Column/ Row | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.000 | 0.726 | 0.278 | 0.056 | 0.726 | 0.527 | 0.202 | 0.041 |
| 2 | 0.726 | 0.000 | 0.726 | 0.278 | 0.527 | 0.726 | 0.527 | 0.202 |
| 3 | 0.278 | 0.726 | 0.000 | 0.726 | 0.202 | 0.527 | 0.726 | 0.527 |
| 4 | 0.056 | 0.278 | 0.726 | 0.000 | 0.041 | 0.202 | 0.527 | 0.726 |
| 5 | 0.726 | 0.527 | 0.202 | 0.041 | 0.000 | 0.726 | 0.278 | 0.056 |
| 6 | 0.527 | 0.726 | 0.527 | 0.202 | 0.726 | 0.000 | 0.726 | 0.278 |
| 7 | 0.202 | 0.527 | 0.726 | 0.527 | 0.278 | 0.726 | 0.000 | 0.726 |
| 8 | 0.041 | 0.202 | 0.527 | 0.726 | 0.056 | 0.278 | 0.726 | 0.000 |
| 9 | 0.278 | 0.202 | 0.077 | 0.016 | 0.726 | 0.527 | 0.202 | 0.041 |
| 10 | 0.202 | 0.278 | 0.202 | 0.077 | 0.527 | 0.726 | 0.527 | 0.202 |
| 11 | 0.077 | 0.202 | 0.278 | 0.202 | 0.202 | 0.527 | 0.726 | 0.527 |
| 12 | 0.016 | 0.077 | 0.202 | 0.278 | 0.041 | 0.202 | 0.527 | 0.726 |
| 13 | 0.056 | 0.041 | 0.016 | 0.003 | 0.278 | 0.202 | 0.077 | 0.016 |
| 14 | 0.041 | 0.056 | 0.041 | 0.016 | 0.202 | 0.278 | 0.202 | 0.077 |
| 15 | 0.016 | 0.041 | 0.056 | 0.041 | 0.077 | 0.202 | 0.278 | 0.202 |
| 16 | 0.003 | 0.016 | 0.041 | 0.056 | 0.016 | 0.077 | 0.202 | 0.278 |
| Column/ Row | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| 1 | 0.278 | 0.202 | 0.077 | 0.016 | 0.056 | 0.041 | 0.016 | 0.003 |
| 2 | 0.202 | 0.278 | 0.202 | 0.077 | 0.041 | 0.056 | 0.041 | 0.016 |
| 3 | 0.077 | 0.202 | 0.278 | 0.202 | 0.016 | 0.041 | 0.056 | 0.041 |
| 4 | 0.016 | 0.077 | 0.202 | 0.278 | 0.003 | 0.016 | 0.041 | 0.056 |
| 5 | 0.726 | 0.527 | 0.202 | 0.041 | 0.278 | 0.202 | 0.077 | 0.016 |
| 6 | 0.527 | 0.726 | 0.527 | 0.202 | 0.202 | 0.278 | 0.202 | 0.077 |
| 7 | 0.202 | 0.527 | 0.726 | 0.527 | 0.077 | 0.202 | 0.278 | 0.202 |
| 8 | 0.041 | 0.202 | 0.527 | 0.726 | 0.016 | 0.077 | 0.202 | 0.278 |
| 9 | 0.000 | 0.726 | 0.278 | 0.056 | 0.726 | 0.527 | 0.202 | 0.041 |
| 10 | 0.726 | 0.000 | 0.726 | 0.278 | 0.527 | 0.726 | 0.527 | 0.202 |
| 11 | 0.278 | 0.726 | 0.000 | 0.726 | 0.202 | 0.527 | 0.726 | 0.527 |
| 12 | 0.056 | 0.278 | 0.726 | 0.000 | 0.041 | 0.202 | 0.527 | 0.726 |
| 13 | 0.726 | 0.527 | 0.202 | 0.041 | 0.000 | 0.726 | 0.278 | 0.056 |
| 14 | 0.527 | 0.726 | 0.527 | 0.202 | 0.726 | 0.000 | 0.726 | 0.278 |
| 15 | 0.202 | 0.527 | 0.726 | 0.527 | 0.278 | 0.726 | 0.000 | 0.726 |
| 16 | 0.041 | 0.202 | 0.527 | 0.726 | 0.056 | 0.278 | 0.726 | 0.000 |

D.4 Rook Connectivity Case for a 9x9 Study Area that Excludes Pivot Point

Let $GWSCM_{ij}$ represent the $ij^{th}$ element of this ***GWSCM*** matrix. The main diagonal has $GWSCM_{ii} = 0$ for i=1, 2, … , 81. The upper right triangular elements are defined as:

$$GWSCM_{ij} = 1 \text{ when } i = 1, \ldots, 72 \text{ and } j = i + 1, i + 9,$$

$$GWSCM_{ij} = 1 \text{ when } i = 73, \ldots, 80 \text{ and } j = i + 1, \text{ and}$$

$$GWSCM_{ij} = 0 \text{ otherwise when } j > i.$$

Since ***GWSCM*** matrices are symmetrical, the lower right triangular elements are the transpose of the upper right triangular elements.

D.5 Queen Connectivity Case for a 9x9 Study Area that Excludes Pivot Point

Let $GWSCM_{ij}$ represent the $ij^{th}$ element of this ***GWSCM*** matrix. The main diagonal has $GWSCM_{ii} = 0$ for i=1, 2, … , 81. The upper right triangular elements are defined as:

$$GWSCM_{ij} = 1 \text{ when } i = 1, 10, 19, 28, 37, 46, 55, 64 \text{ and } j = i + 1, i + 9, i + 10,$$

$$GWSCM_{ij} = 1 \text{ when } i = 9, 18, 27, 36, 45, 54, 63, 72 \text{ and } j = i + 8, i + 9,$$

$$GWSCM_{ij} = 1 \text{ when } i = 2, \ldots, 8, 11, \ldots, 17, 20, \ldots, 26, 29, \ldots, 35, 38, \ldots, 44, 47, \ldots, 53, 56, \ldots, 62, 65, \ldots, 71, \text{ and } j = i + 1, i + 8, i + 9, i + 10,$$

$$GWSCM_{ij} = 1 \text{ when } i = 73, \ldots, 80 \text{ and } j = i + 1, \text{ and}$$

$$GWSCM_{ij} = 0 \text{ otherwise when } j > i.$$

Since ***GWSCM*** matrices are symmetrical, the lower right triangular elements are the transpose of the upper right triangular elements.

D.6 CWF Connectivity Case for a 9x9 Study Area that Excludes Pivot Point

Let $GWSCM_{ij}$ represent the $ij^{th}$ element and $\boldsymbol{GWSCM_i}$ represent the $i^{th}$ block of elements, where each symmetric block has dimension 9x9, of this ***GWSCM*** matrix. The main diagonal has $GWSCM_{ii} = 0$ for i=1, 2, … , 81. The blocks are arranged as:

| Block Column/ Row | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| 1 | ***A*** | ***B*** | ***C*** | ***D*** | ***E*** | ***F*** | ***0*** | ***0*** | ***0*** |
| 2 | ***B*** | ***A*** | ***B*** | ***C*** | ***D*** | ***E*** | ***F*** | ***0*** | ***0*** |
| 3 | ***C*** | ***B*** | ***A*** | ***B*** | ***C*** | ***D*** | ***E*** | ***F*** | ***0*** |
| 4 | ***D*** | ***C*** | ***B*** | ***A*** | ***B*** | ***C*** | ***D*** | ***E*** | ***F*** |
| 5 | ***E*** | ***D*** | ***C*** | ***B*** | ***A*** | ***B*** | ***C*** | ***D*** | ***E*** |
| 6 | ***F*** | ***E*** | ***D*** | ***C*** | ***B*** | ***A*** | ***B*** | ***C*** | ***D*** |
| 7 | ***0*** | ***F*** | ***E*** | ***D*** | ***C*** | ***B*** | ***A*** | ***B*** | ***C*** |
| 8 | ***0*** | ***0*** | ***F*** | ***E*** | ***D*** | ***C*** | ***B*** | ***A*** | ***B*** |
| 9 | ***0*** | ***0*** | ***0*** | ***F*** | ***E*** | ***D*** | ***C*** | ***B*** | ***A*** |

where ***A*** =

| Column/ Row | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.0000 | 0.7261 | 0.2780 | 0.0561 | 0.0060 | 0.0003 | 0.0000 | 0.0000 | 0.0000 |
| 2 | 0.7261 | 0.0000 | 0.7261 | 0.2780 | 0.0561 | 0.0060 | 0.0003 | 0.0000 | 0.0000 |
| 3 | 0.2780 | 0.7261 | 0.0000 | 0.7261 | 0.2780 | 0.0561 | 0.0060 | 0.0003 | 0.0000 |
| 4 | 0.0561 | 0.2780 | 0.7261 | 0.0000 | 0.7261 | 0.2780 | 0.0561 | 0.0060 | 0.0003 |
| 5 | 0.0060 | 0.0561 | 0.2780 | 0.7261 | 0.0000 | 0.7261 | 0.2780 | 0.0561 | 0.0060 |
| 6 | 0.0003 | 0.0060 | 0.0561 | 0.2780 | 0.7261 | 0.0000 | 0.7261 | 0.2780 | 0.0561 |
| 7 | 0.0000 | 0.0003 | 0.0060 | 0.0561 | 0.2780 | 0.7261 | 0.0000 | 0.7261 | 0.2780 |
| 8 | 0.0000 | 0.0000 | 0.0003 | 0.0060 | 0.0561 | 0.2780 | 0.7261 | 0.0000 | 0.7261 |
| 9 | 0.0000 | 0.0000 | 0.0000 | 0.0003 | 0.0060 | 0.0561 | 0.2780 | 0.7261 | 0.0000 |

***B*** =

| Column/ Row | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.7261 | 0.5273 | 0.2019 | 0.0408 | 0.0043 | 0.0002 | 0.0000 | 0.0000 | 0.0000 |
| 2 | 0.5273 | 0.7261 | 0.5273 | 0.2019 | 0.0408 | 0.0043 | 0.0002 | 0.0000 | 0.0000 |
| 3 | 0.2019 | 0.5273 | 0.7261 | 0.5273 | 0.2019 | 0.0408 | 0.0043 | 0.0002 | 0.0000 |
| 4 | 0.0408 | 0.2019 | 0.5273 | 0.7261 | 0.5273 | 0.2019 | 0.0408 | 0.0043 | 0.0002 |
| 5 | 0.0043 | 0.0408 | 0.2019 | 0.5273 | 0.7261 | 0.5273 | 0.2019 | 0.0408 | 0.0043 |
| 6 | 0.0002 | 0.0043 | 0.0408 | 0.2019 | 0.5273 | 0.7261 | 0.5273 | 0.2019 | 0.0408 |
| 7 | 0.0000 | 0.0002 | 0.0043 | 0.0408 | 0.2019 | 0.5273 | 0.7261 | 0.5273 | 0.2019 |
| 8 | 0.0000 | 0.0000 | 0.0002 | 0.0043 | 0.0408 | 0.2019 | 0.5273 | 0.7261 | 0.5273 |
| 9 | 0.0000 | 0.0000 | 0.0000 | 0.0002 | 0.0043 | 0.0408 | 0.2019 | 0.5273 | 0.7261 |

***C*** =

| Column/ Row | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.2780 | 0.2019 | 0.0773 | 0.0156 | 0.0017 | 0.0001 | 0.0000 | 0.0000 | 0.0000 |
| 2 | 0.2019 | 0.2780 | 0.2019 | 0.0773 | 0.0156 | 0.0017 | 0.0001 | 0.0000 | 0.0000 |
| 3 | 0.0773 | 0.2019 | 0.2780 | 0.2019 | 0.0773 | 0.0156 | 0.0017 | 0.0001 | 0.0000 |
| 4 | 0.0156 | 0.0773 | 0.2019 | 0.2780 | 0.2019 | 0.0773 | 0.0156 | 0.0017 | 0.0001 |
| 5 | 0.0017 | 0.0156 | 0.0773 | 0.2019 | 0.2780 | 0.2019 | 0.0773 | 0.0156 | 0.0017 |
| 6 | 0.0001 | 0.0017 | 0.0156 | 0.0773 | 0.2019 | 0.2780 | 0.2019 | 0.0773 | 0.0156 |
| 7 | 0.0000 | 0.0001 | 0.0017 | 0.0156 | 0.0773 | 0.2019 | 0.2780 | 0.2019 | 0.0773 |
| 8 | 0.0000 | 0.0000 | 0.0001 | 0.0017 | 0.0156 | 0.0773 | 0.2019 | 0.2780 | 0.2019 |
| 9 | 0.0000 | 0.0000 | 0.0000 | 0.0001 | 0.0017 | 0.0156 | 0.0773 | 0.2019 | 0.2780 |

***D*** =

| Column/ Row | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.0561 | 0.0408 | 0.0156 | 0.0032 | 0.0003 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 2 | 0.0408 | 0.0561 | 0.0408 | 0.0156 | 0.0032 | 0.0003 | 0.0000 | 0.0000 | 0.0000 |
| 3 | 0.0156 | 0.0408 | 0.0561 | 0.0408 | 0.0156 | 0.0032 | 0.0003 | 0.0000 | 0.0000 |
| 4 | 0.0032 | 0.0156 | 0.0408 | 0.0561 | 0.0408 | 0.0156 | 0.0032 | 0.0003 | 0.0000 |
| 5 | 0.0003 | 0.0032 | 0.0156 | 0.0408 | 0.0561 | 0.0408 | 0.0156 | 0.0032 | 0.0003 |
| 6 | 0.0000 | 0.0003 | 0.0032 | 0.0156 | 0.0408 | 0.0561 | 0.0408 | 0.0156 | 0.0032 |
| 7 | 0.0000 | 0.0000 | 0.0003 | 0.0032 | 0.0156 | 0.0408 | 0.0561 | 0.0408 | 0.0156 |
| 8 | 0.0000 | 0.0000 | 0.0000 | 0.0003 | 0.0032 | 0.0156 | 0.0408 | 0.0561 | 0.0408 |
| 9 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0003 | 0.0032 | 0.0156 | 0.0408 | 0.0561 |

***E*** =

| Column/ Row | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.0060 | 0.0043 | 0.0017 | 0.0003 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 2 | 0.0043 | 0.0060 | 0.0043 | 0.0017 | 0.0003 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 3 | 0.0017 | 0.0043 | 0.0060 | 0.0043 | 0.0017 | 0.0003 | 0.0000 | 0.0000 | 0.0000 |
| 4 | 0.0003 | 0.0017 | 0.0043 | 0.0060 | 0.0043 | 0.0017 | 0.0003 | 0.0000 | 0.0000 |
| 5 | 0.0000 | 0.0003 | 0.0017 | 0.0043 | 0.0060 | 0.0043 | 0.0017 | 0.0003 | 0.0000 |
| 6 | 0.0000 | 0.0000 | 0.0003 | 0.0017 | 0.0043 | 0.0060 | 0.0043 | 0.0017 | 0.0003 |
| 7 | 0.0000 | 0.0000 | 0.0000 | 0.0003 | 0.0017 | 0.0043 | 0.0060 | 0.0043 | 0.0017 |
| 8 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0003 | 0.0017 | 0.0043 | 0.0060 | 0.0043 |
| 9 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0003 | 0.0017 | 0.0043 | 0.0060 |

and ***F*** =

| Column/ Row | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.0003 | 0.0002 | 0.0001 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 2 | 0.0002 | 0.0003 | 0.0002 | 0.0001 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 3 | 0.0001 | 0.0002 | 0.0003 | 0.0002 | 0.0001 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 4 | 0.0000 | 0.0001 | 0.0002 | 0.0003 | 0.0002 | 0.0001 | 0.0000 | 0.0000 | 0.0000 |
| 5 | 0.0000 | 0.0000 | 0.0001 | 0.0002 | 0.0003 | 0.0002 | 0.0001 | 0.0000 | 0.0000 |
| 6 | 0.0000 | 0.0000 | 0.0000 | 0.0001 | 0.0002 | 0.0003 | 0.0002 | 0.0001 | 0.0000 |
| 7 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0001 | 0.0002 | 0.0003 | 0.0002 | 0.0001 |
| 8 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0001 | 0.0002 | 0.0003 | 0.0002 |
| 9 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0001 | 0.0002 | 0.0003 |

D.7 Rook Connectivity Case for a 14x14 Study Area that Excludes Pivot Point

Let $GWSCM_{ij}$ represent the $ij^{th}$ element of this ***GWSCM*** matrix. The main diagonal has $GWSCM_{ii} = 0$ for i=1, 2, … , 196. The upper right triangular elements are defined as:

$$GWSCM_{ij} = 1 \text{ when } i = 1, \ldots, 182 \text{ and } j = i + 1, i + 14,$$

$$GWSCM_{ij} = 1 \text{ when } i = 183, \ldots, 195 \text{ and } j = i + 1, \text{ and}$$

$$GWSCM_{ij} = 0 \text{ otherwise when } j > i.$$

Since ***GWSCM*** matrices are symmetrical, the lower right triangular elements are the transpose of the upper right triangular elements.

D.8 Queen Connectivity Case for a 14x14 Study Area that Excludes Pivot Point

Let $GWSCM_{ij}$ represent the $ij^{th}$ element of this ***GWSCM*** matrix. The main diagonal has $GWSCM_{ii} = 0$ for i=1, 2, … , 196. The upper right triangular elements are defined as:

$GWSCM_{ij} = 1$ when i = 1, 15, 29, 43, 57, 71, 85, 99, 113, 127, 141, 155, 169

and $j = i + 1, i + 14, i + 15$,

$GWSCM_{ij} = 1$ when i = 14, 28 , 42, 56, 70, 84, 98, 112, 126, 140, 154, 168, 182

and $j = i + 13, i + 14$,

$GWSCM_{ij} = 1$ when i = 2, … , 13, 16, … , 27, 30, … , 41, 44, … , 55, 58, … , 69, 72, … , 83, 86, … , 97, 100, … , 111, 114, … , 125, 128, … , 139, 142, … , 153, 156, … , 167, 170, … , 181 and $j = i + 1, i + 13, i + 14, i + 15$,

$GWSCM_{ij} = 1$ when i = 183, … , 195 and $j = i + 1$, and

$GWSCM_{ij} = 0$ otherwise when $j > i$.

Since ***GWSCM*** matrices are symmetrical, the lower right triangular elements are the transpose of the upper right triangular elements.

D.9 CWF Connectivity Case for a 14x14 Study Area that Excludes Pivot Point

Let $GWSCM_{ij}$ represent the $ij^{th}$ element and $\boldsymbol{GWSCM}_i$ represent the $i^{th}$ block of elements, where each symmetric block has dimension 14x14, of this ***GWSCM*** matrix. The main diagonal has $GWSCM_{ii} = 0$ for i=1, … , 196. The blocks are arranged as:

| Block Column/ Row | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ***A*** | ***B*** | ***C*** | ***D*** | ***E*** | ***F*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** |
| 2 | ***B*** | ***A*** | ***B*** | ***C*** | ***D*** | ***E*** | ***F*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** |
| 3 | ***C*** | ***B*** | ***A*** | ***B*** | ***C*** | ***D*** | ***E*** | ***F*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** |
| 4 | ***D*** | ***C*** | ***B*** | ***A*** | ***B*** | ***C*** | ***D*** | ***E*** | ***F*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** |
| 5 | ***E*** | ***D*** | ***C*** | ***B*** | ***A*** | ***B*** | ***C*** | ***D*** | ***E*** | ***F*** | ***0*** | ***0*** | ***0*** | ***0*** |
| 6 | ***F*** | ***E*** | ***D*** | ***C*** | ***B*** | ***A*** | ***B*** | ***C*** | ***D*** | ***E*** | ***F*** | ***0*** | ***0*** | ***0*** |
| 7 | ***0*** | ***F*** | ***E*** | ***D*** | ***C*** | ***B*** | ***A*** | ***B*** | ***C*** | ***D*** | ***E*** | ***F*** | ***0*** | ***0*** |
| 8 | ***0*** | ***0*** | ***F*** | ***E*** | ***D*** | ***C*** | ***B*** | ***A*** | ***B*** | ***C*** | ***D*** | ***E*** | ***F*** | ***0*** |
| 9 | ***0*** | ***0*** | ***0*** | ***F*** | ***E*** | ***D*** | ***C*** | ***B*** | ***A*** | ***B*** | ***C*** | ***D*** | ***E*** | ***F*** |
| 10 | ***0*** | ***0*** | ***0*** | ***0*** | ***F*** | ***E*** | ***D*** | ***C*** | ***B*** | ***A*** | ***B*** | ***C*** | ***D*** | ***E*** |
| 11 | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***F*** | ***E*** | ***D*** | ***C*** | ***B*** | ***A*** | | ***C*** | ***D*** |
| 12 | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***F*** | ***E*** | ***D*** | ***C*** | ***B*** | ***A*** | ***B*** | ***C*** |
| 13 | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***F*** | ***E*** | ***D*** | ***C*** | ***B*** | ***A*** | ***B*** |
| 14 | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***F*** | ***E*** | ***D*** | ***C*** | ***B*** | ***A*** |

where $\boldsymbol{A}$=

| Column/ Row | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| 1 | 0.0000 | 0.7261 | 0.2780 | 0.0561 | 0.0060 | 0.0003 | 0.0000 |
| 2 | 0.7261 | 0.0000 | 0.7261 | 0.2780 | 0.0561 | 0.0060 | 0.0003 |
| 3 | 0.2780 | 0.7261 | 0.0000 | 0.7261 | 0.2780 | 0.0561 | 0.0060 |
| 4 | 0.0561 | 0.2780 | 0.7261 | 0.0000 | 0.7261 | 0.2780 | 0.0561 |
| 5 | 0.0060 | 0.0561 | 0.2780 | 0.7261 | 0.0000 | 0.7261 | 0.2780 |
| 6 | 0.0003 | 0.0060 | 0.0561 | 0.2780 | 0.7261 | 0.0000 | 0.7261 |
| 7 | 0.0000 | 0.0003 | 0.0060 | 0.0561 | 0.2780 | 0.7261 | 0.0000 |
| 8 | 0.0000 | 0.0000 | 0.0003 | 0.0060 | 0.0561 | 0.2780 | 0.7261 |
| 9 | 0.0000 | 0.0000 | 0.0000 | 0.0003 | 0.0060 | 0.0561 | 0.2780 |
| 10 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0003 | 0.0060 | 0.0561 |
| 11 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0003 | 0.0060 |
| 12 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0003 |
| 13 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 14 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

| Column/ Row | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|
| 1 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 2 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 3 | 0.0003 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 4 | 0.0060 | 0.0003 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 5 | 0.0561 | 0.0060 | 0.0003 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 6 | 0.2780 | 0.0561 | 0.0060 | 0.0003 | 0.0000 | 0.0000 | 0.0000 |
| 7 | 0.7261 | 0.2780 | 0.0561 | 0.0060 | 0.0003 | 0.0000 | 0.0000 |
| 8 | 0.0000 | 0.7261 | 0.2780 | 0.0561 | 0.0060 | 0.0003 | 0.0000 |
| 9 | 0.7261 | 0.0000 | 0.7261 | 0.2780 | 0.0561 | 0.0060 | 0.0003 |
| 10 | 0.2780 | 0.7261 | 0.0000 | 0.7261 | 0.2780 | 0.0561 | 0.0060 |
| 11 | 0.0561 | 0.2780 | 0.7261 | 0.0000 | 0.7261 | 0.2780 | 0.0561 |
| 12 | 0.0060 | 0.0561 | 0.2780 | 0.7261 | 0.0000 | 0.7261 | 0.2780 |
| 13 | 0.0003 | 0.0060 | 0.0561 | 0.2780 | 0.7261 | 0.0000 | 0.7261 |
| 14 | 0.0000 | 0.0003 | 0.0060 | 0.0561 | 0.2780 | 0.7261 | 0.0000 |

***B***=

| Column/ Row | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| 1 | 0.7261 | 0.5273 | 0.2019 | 0.0408 | 0.0043 | 0.0002 | 0.0000 |
| 2 | 0.5273 | 0.7261 | 0.5273 | 0.2019 | 0.0408 | 0.0043 | 0.0002 |
| 3 | 0.2019 | 0.5273 | 0.7261 | 0.5273 | 0.2019 | 0.0408 | 0.0043 |
| 4 | 0.0408 | 0.2019 | 0.5273 | 0.7261 | 0.5273 | 0.2019 | 0.0408 |
| 5 | 0.0043 | 0.0408 | 0.2019 | 0.5273 | 0.7261 | 0.5273 | 0.2019 |
| 6 | 0.0002 | 0.0043 | 0.0408 | 0.2019 | 0.5273 | 0.7261 | 0.5273 |
| 7 | 0.0000 | 0.0002 | 0.0043 | 0.0408 | 0.2019 | 0.5273 | 0.7261 |
| 8 | 0.0000 | 0.0000 | 0.0002 | 0.0043 | 0.0408 | 0.2019 | 0.5273 |
| 9 | 0.0000 | 0.0000 | 0.0000 | 0.0002 | 0.0043 | 0.0408 | 0.2019 |
| 10 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0002 | 0.0043 | 0.0408 |
| 11 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0002 | 0.0043 |
| 12 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0002 |
| 13 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 14 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

| Column/ Row | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|
| 1 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 2 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 3 | 0.0002 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 4 | 0.0043 | 0.0002 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 5 | 0.0408 | 0.0043 | 0.0002 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 6 | 0.2019 | 0.0408 | 0.0043 | 0.0002 | 0.0000 | 0.0000 | 0.0000 |
| 7 | 0.5273 | 0.2019 | 0.0408 | 0.0043 | 0.0002 | 0.0000 | 0.0000 |
| 8 | 0.7261 | 0.5273 | 0.2019 | 0.0408 | 0.0043 | 0.0002 | 0.0000 |
| 9 | 0.5273 | 0.7261 | 0.5273 | 0.2019 | 0.0408 | 0.0043 | 0.0002 |
| 10 | 0.2019 | 0.5273 | 0.7261 | 0.5273 | 0.2019 | 0.0408 | 0.0043 |
| 11 | 0.0408 | 0.2019 | 0.5273 | 0.7261 | 0.5273 | 0.2019 | 0.0408 |
| 12 | 0.0043 | 0.0408 | 0.2019 | 0.5273 | 0.7261 | 0.5273 | 0.2019 |
| 13 | 0.0002 | 0.0043 | 0.0408 | 0.2019 | 0.5273 | 0.7261 | 0.5273 |
| 14 | 0.0000 | 0.0002 | 0.0043 | 0.0408 | 0.2019 | 0.5273 | 0.7261 |

***C***=

| Column/ Row | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| 1 | 0.2780 | 0.2019 | 0.0773 | 0.0156 | 0.0017 | 0.0001 | 0.0000 |
| 2 | 0.2019 | 0.2780 | 0.2019 | 0.0773 | 0.0156 | 0.0017 | 0.0001 |
| 3 | 0.0773 | 0.2019 | 0.2780 | 0.2019 | 0.0773 | 0.0156 | 0.0017 |
| 4 | 0.0156 | 0.0773 | 0.2019 | 0.2780 | 0.2019 | 0.0773 | 0.0156 |
| 5 | 0.0017 | 0.0156 | 0.0773 | 0.2019 | 0.2780 | 0.2019 | 0.0773 |
| 6 | 0.0001 | 0.0017 | 0.0156 | 0.0773 | 0.2019 | 0.2780 | 0.2019 |
| 7 | 0.0000 | 0.0001 | 0.0017 | 0.0156 | 0.0773 | 0.2019 | 0.2780 |
| 8 | 0.0000 | 0.0000 | 0.0001 | 0.0017 | 0.0156 | 0.0773 | 0.2019 |
| 9 | 0.0000 | 0.0000 | 0.0000 | 0.0001 | 0.0017 | 0.0156 | 0.0773 |
| 10 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0001 | 0.0017 | 0.0156 |
| 11 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0001 | 0.0017 |
| 12 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0001 |
| 13 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 14 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

| Column/ Row | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|
| 1 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 2 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 3 | 0.0001 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 4 | 0.0017 | 0.0001 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 5 | 0.0156 | 0.0017 | 0.0001 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 6 | 0.0773 | 0.0156 | 0.0017 | 0.0001 | 0.0000 | 0.0000 | 0.0000 |
| 7 | 0.2019 | 0.0773 | 0.0156 | 0.0017 | 0.0001 | 0.0000 | 0.0000 |
| 8 | 0.2780 | 0.2019 | 0.0773 | 0.0156 | 0.0017 | 0.0001 | 0.0000 |
| 9 | 0.2019 | 0.2780 | 0.2019 | 0.0773 | 0.0156 | 0.0017 | 0.0001 |
| 10 | 0.0773 | 0.2019 | 0.2780 | 0.2019 | 0.0773 | 0.0156 | 0.0017 |
| 11 | 0.0156 | 0.0773 | 0.2019 | 0.2780 | 0.2019 | 0.0773 | 0.0156 |
| 12 | 0.0017 | 0.0156 | 0.0773 | 0.2019 | 0.2780 | 0.2019 | 0.0773 |
| 13 | 0.0001 | 0.0017 | 0.0156 | 0.0773 | 0.2019 | 0.2780 | 0.2019 |
| 14 | 0.0000 | 0.0001 | 0.0017 | 0.0156 | 0.0773 | 0.2019 | 0.2780 |

***D***=

| Column/ Row | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| 1 | 0.0561 | 0.0408 | 0.0156 | 0.0032 | 0.0003 | 0.0000 | 0.0000 |
| 2 | 0.0408 | 0.0561 | 0.0408 | 0.0156 | 0.0032 | 0.0003 | 0.0000 |
| 3 | 0.0156 | 0.0408 | 0.0561 | 0.0408 | 0.0156 | 0.0032 | 0.0003 |
| 4 | 0.0032 | 0.0156 | 0.0408 | 0.0561 | 0.0408 | 0.0156 | 0.0032 |
| 5 | 0.0003 | 0.0032 | 0.0156 | 0.0408 | 0.0561 | 0.0408 | 0.0156 |
| 6 | 0.0000 | 0.0003 | 0.0032 | 0.0156 | 0.0408 | 0.0561 | 0.0408 |
| 7 | 0.0000 | 0.0000 | 0.0003 | 0.0032 | 0.0156 | 0.0408 | 0.0561 |
| 8 | 0.0000 | 0.0000 | 0.0000 | 0.0003 | 0.0032 | 0.0156 | 0.0408 |
| 9 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0003 | 0.0032 | 0.0156 |
| 10 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0003 | 0.0032 |
| 11 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0003 |
| 12 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 13 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 14 | | | | | | | |

| Column/ Row | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|
| 1 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 2 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 3 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 4 | 0.0003 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 5 | 0.0032 | 0.0003 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 6 | 0.0156 | 0.0032 | 0.0003 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 7 | 0.0408 | 0.0156 | 0.0032 | 0.0003 | 0.0000 | 0.0000 | 0.0000 |
| 8 | 0.0561 | 0.0408 | 0.0156 | 0.0032 | 0.0003 | 0.0000 | 0.0000 |
| 9 | 0.0408 | 0.0561 | 0.0408 | 0.0156 | 0.0032 | 0.0003 | 0.0000 |
| 10 | 0.0156 | 0.0408 | 0.0561 | 0.0408 | 0.0156 | 0.0032 | 0.0003 |
| 11 | 0.0032 | 0.0156 | 0.0408 | 0.0561 | 0.0408 | 0.0156 | 0.0032 |
| 12 | 0.0003 | 0.0032 | 0.0156 | 0.0408 | 0.0561 | 0.0408 | 0.0156 |
| 13 | 0.0000 | 0.0003 | 0.0032 | 0.0156 | 0.0408 | 0.0561 | 0.0408 |
| 14 | 0.0000 | 0.0000 | 0.0003 | 0.0032 | 0.0156 | 0.0408 | 0.0561 |

***E***=

| Column/ Row | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| 1 | 0.0060 | 0.0043 | 0.0017 | 0.0003 | 0.0000 | 0.0000 | 0.0000 |
| 2 | 0.0043 | 0.0060 | 0.0043 | 0.0017 | 0.0003 | 0.0000 | 0.0000 |
| 3 | 0.0017 | 0.0043 | 0.0060 | 0.0043 | 0.0017 | 0.0003 | 0.0000 |
| 4 | 0.0003 | 0.0017 | 0.0043 | 0.0060 | 0.0043 | 0.0017 | 0.0003 |
| 5 | 0.0000 | 0.0003 | 0.0017 | 0.0043 | 0.0060 | 0.0043 | 0.0017 |
| 6 | 0.0000 | 0.0000 | 0.0003 | 0.0017 | 0.0043 | 0.0060 | 0.0043 |
| 7 | 0.0000 | 0.0000 | 0.0000 | 0.0003 | 0.0017 | 0.0043 | 0.0060 |
| 8 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0003 | 0.0017 | 0.0043 |
| 9 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0003 | 0.0017 |
| 10 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0003 |
| 11 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 12 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 13 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 14 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

| Column/ Row | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|
| 1 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 2 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 3 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 4 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 5 | 0.0003 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 6 | 0.0017 | 0.0003 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 7 | 0.0043 | 0.0017 | 0.0003 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 8 | 0.0060 | 0.0043 | 0.0017 | 0.0003 | 0.0000 | 0.0000 | 0.0000 |
| 9 | 0.0043 | 0.0060 | 0.0043 | 0.0017 | 0.0003 | 0.0000 | 0.0000 |
| 10 | 0.0017 | 0.0043 | 0.0060 | 0.0043 | 0.0017 | 0.0003 | 0.0000 |
| 11 | 0.0003 | 0.0017 | 0.0043 | 0.0060 | 0.0043 | 0.0017 | 0.0003 |
| 12 | 0.0000 | 0.0003 | 0.0017 | 0.0043 | 0.0060 | 0.0043 | 0.0017 |
| 13 | 0.0000 | 0.0000 | 0.0003 | 0.0017 | 0.0043 | 0.0060 | 0.0043 |
| 14 | 0.0000 | 0.0000 | 0.0000 | 0.0003 | 0.0017 | 0.0043 | 0.0060 |

and ***F***=

| Column/ Row | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| 1 | 0.0003 | 0.0002 | 0.0001 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 2 | 0.0002 | 0.0003 | 0.0002 | 0.0001 | 0.0000 | 0.0000 | 0.0000 |
| 3 | 0.0001 | 0.0002 | 0.0003 | 0.0002 | 0.0001 | 0.0000 | 0.0000 |
| 4 | 0.0000 | 0.0001 | 0.0002 | 0.0003 | 0.0002 | 0.0001 | 0.0000 |
| 5 | 0.0000 | 0.0000 | 0.0001 | 0.0002 | 0.0003 | 0.0002 | 0.0001 |
| 6 | 0.0000 | 0.0000 | 0.0000 | 0.0001 | 0.0002 | 0.0003 | 0.0002 |
| 7 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0001 | 0.0002 | 0.0003 |
| 8 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0001 | 0.0002 |
| 9 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0001 |
| 10 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 11 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 12 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 13 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 14 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

| Column/ Row | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|
| 1 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 2 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 3 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 4 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 6 | 0.0001 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 7 | 0.0002 | 0.0001 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 8 | 0.0003 | 0.0002 | 0.0001 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 9 | 0.0002 | 0.0003 | 0.0002 | 0.0001 | 0.0000 | 0.0000 | 0.0000 |
| 10 | 0.0001 | 0.0002 | 0.0003 | 0.0002 | 0.0001 | 0.0000 | 0.0000 |
| 11 | 0.0000 | 0.0001 | 0.0002 | 0.0003 | 0.0002 | 0.0001 | 0.0000 |
| 12 | 0.0000 | 0.0000 | 0.0001 | 0.0002 | 0.0003 | 0.0002 | 0.0001 |
| 13 | 0.0000 | 0.0000 | 0.0000 | 0.0001 | 0.0002 | 0.0003 | 0.0002 |
| 14 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0001 | 0.0002 | 0.0003 |

# E. VARIANCE-COVARIANCE MATRICES

## E.1 Rook Pattern Variance-Covariance Matrix for a 4x4 Study Area

| Column/ Row | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| 1 | 1.0000000000 | 0.640710752 | 0.109091308 | -0.010834071 |
| 2 | 0.640710752 | 1.0000000000 | 0.61110162 | 0.109091308 |
| 3 | 0.109091308 | 0.61110162 | 1.0000000000 | 0.640710752 |
| 4 | -0.010834071 | 0.109091308 | 0.640710752 | 1.0000000000 |
| 5 | 0.640710752 | 0.247011407 | -0.060390154 | -0.020623841 |
| 6 | 0.246829513 | 0.539334154 | 0.236518568 | -0.06062094 |
| 7 | -0.06062094 | 0.236518568 | 0.539334154 | 0.246829513 |
| 8 | -0.020623841 | -0.060390154 | 0.247011407 | 0.640710752 |
| 9 | 0.109091308 | -0.060390154 | -0.033023327 | 0.031135498 |
| 10 | -0.06062094 | 0.086196906 | -0.024104063 | -0.032588896 |
| 11 | -0.032588896 | -0.024104063 | 0.086196906 | -0.06062094 |
| 12 | 0.031135498 | -0.033023327 | -0.060390154 | 0.109091308 |
| 13 | -0.010834071 | -0.020623841 | 0.031135498 | -0.00505247 |
| 14 | -0.020623841 | 0.023587463 | -0.030542485 | 0.031135498 |
| 15 | 0.031135498 | -0.030542485 | 0.023587463 | -0.020623841 |
| 16 | -0.00505247 | 0.031135498 | -0.020623841 | -0.010834071 |
| Column/ Row | 5 | 6 | 7 | 8 |
| 1 | 0.640710752 | 0.246829513 | -0.06062094 | -0.020623841 |
| 2 | 0.247011407 | 0.539334154 | 0.236518568 | -0.060390154 |
| 3 | -0.060390154 | 0.236518568 | 0.539334154 | 0.247011407 |
| 4 | -0.020623841 | -0.06062094 | 0.246829513 | 0.640710752 |
| 5 | 1.0000000000 | 0.539334154 | 0.086196906 | 0.023587463 |
| 6 | 0.539334154 | 1.0000000000 | 0.549348116 | 0.086196906 |
| 7 | 0.086196906 | 0.549348116 | 1.0000000000 | 0.539334154 |
| 8 | 0.023587463 | 0.086196906 | 0.539334154 | 1.0000000000 |
| 9 | 0.61110162 | 0.236518568 | -0.024104063 | -0.030542485 |
| 10 | 0.236518568 | 0.549348116 | 0.209405243 | -0.024104063 |
| 11 | -0.024104063 | 0.209405243 | 0.549348116 | 0.236518568 |
| 12 | -0.030542485 | -0.024104063 | 0.236518568 | 0.61110162 |
| 13 | 0.109091308 | -0.06062094 | -0.032588896 | 0.031135498 |
| 14 | -0.060390154 | 0.086196906 | -0.024104063 | -0.033023327 |
| 15 | -0.033023327 | -0.024104063 | 0.086196906 | -0.060390154 |
| 16 | 0.031135498 | -0.032588896 | -0.06062094 | 0.109091308 |

| Column/ Row | 9 | 10 | 11 | 12 |
|---|---|---|---|---|
| 1 | 0.109091308 | -0.06062094 | -0.032588896 | 0.031135498 |
| 2 | -0.060390154 | 0.086196906 | -0.024104063 | -0.033023327 |
| 3 | -0.033023327 | -0.024104063 | 0.086196906 | -0.060390154 |
| 4 | 0.031135498 | -0.032588896 | -0.06062094 | 0.109091308 |
| 5 | 0.61110162 | 0.236518568 | -0.024104063 | -0.030542485 |
| 6 | 0.236518568 | 0.549348116 | 0.209405243 | -0.024104063 |
| 7 | -0.024104063 | 0.209405243 | 0.549348116 | 0.236518568 |
| 8 | -0.030542485 | -0.024104063 | 0.236518568 | 0.61110162 |
| 9 | 1.0000000000 | 0.539334154 | 0.086196906 | 0.023587463 |
| 10 | 0.539334154 | 1.0000000000 | 0.549348116 | 0.086196906 |
| 11 | 0.086196906 | 0.549348116 | 1.0000000000 | 0.539334154 |
| 12 | 0.023587463 | 0.086196906 | 0.539334154 | 1.0000000000 |
| 13 | 0.640710752 | 0.246829513 | -0.06062094 | -0.020623841 |
| 14 | 0.247011407 | 0.539334154 | 0.236518568 | -0.060390154 |
| 15 | -0.060390154 | 0.236518568 | 0.539334154 | 0.247011407 |
| 16 | -0.020623841 | -0.06062094 | 0.246829513 | 0.640710752 |
| Column/ Row | 13 | 14 | 15 | 16 |
| 1 | -0.010834071 | -0.020623841 | 0.031135498 | -0.00505247 |
| 2 | -0.020623841 | 0.023587463 | -0.030542485 | 0.031135498 |
| 3 | 0.031135498 | -0.030542485 | 0.023587463 | -0.020623841 |
| 4 | -0.00505247 | 0.031135498 | -0.020623841 | -0.010834071 |
| 5 | 0.109091308 | -0.060390154 | -0.033023327 | 0.031135498 |
| 6 | -0.06062094 | 0.086196906 | -0.024104063 | -0.032588896 |
| 7 | -0.032588896 | -0.024104063 | 0.086196906 | -0.06062094 |
| 8 | 0.031135498 | -0.033023327 | -0.060390154 | 0.109091308 |
| 9 | 0.640710752 | 0.247011407 | -0.060390154 | -0.020623841 |
| 10 | 0.246829513 | 0.539334154 | 0.236518568 | -0.06062094 |
| 11 | -0.06062094 | 0.236518568 | 0.539334154 | 0.246829513 |
| 12 | -0.020623841 | -0.060390154 | 0.247011407 | 0.640710752 |
| 13 | 1.0000000000 | 0.640710752 | 0.109091308 | -0.010834071 |
| 14 | 0.640710752 | 1.0000000000 | 0.61110162 | 0.109091308 |
| 15 | 0.109091308 | 0.61110162 | 1.0000000000 | 0.640710752 |
| 16 | -0.010834071 | 0.109091308 | 0.640710752 | 1.0000000000 |

E.2  Queen Pattern Variance-Covariance Matrix for a 4x4 Study Area

| Column/ Row | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| 1 | 1.0000000000 | 0.7863351990 | 0.1716088320 | -0.0889314353 |
| 2 | 0.7863351990 | 1.0000000000 | 0.6507821097 | 0.1716088320 |
| 3 | 0.1716088320 | 0.6507821097 | 1.0000000000 | 0.7863351990 |
| 4 | -0.0889314353 | 0.1716088320 | 0.7863351990 | 1.0000000000 |
| 5 | 0.7863351990 | 0.6632102222 | 0.1426261252 | -0.0917890252 |
| 6 | 0.6390270116 | 0.8351451558 | 0.5452762295 | 0.1478252602 |
| 7 | 0.1478252602 | 0.5452762295 | 0.8351451558 | 0.6390270117 |
| 8 | -0.0917890252 | 0.1426261251 | 0.6632102222 | 0.7863351990 |
| 9 | 0.1716088320 | 0.1426261252 | 0.0118268769 | -0.0225678321 |
| 10 | 0.1478252603 | 0.2232563508 | 0.1395765813 | 0.0184194442 |
| 11 | 0.0184194442 | 0.1395765813 | 0.2232563508 | 0.1478252602 |
| 12 | -0.0225678321 | 0.0118268769 | 0.1426261252 | 0.1716088320 |
| 13 | -0.0889314353 | -0.0917890252 | -0.0225678321 | 0.0222460407 |
| 14 | -0.0917890252 | -0.1107605405 | -0.0701935802 | -0.0225678321 |
| 15 | -0.0225678321 | -0.0701935802 | -0.1107605405 | -0.0917890252 |
| 16 | 0.0222460407 | -0.0225678321 | -0.0917890252 | -0.0889314353 |
| Column/ Row | 5 | 6 | 7 | 8 |
| 1 | 0.7863351990 | 0.6390270116 | 0.1478252602 | -0.0917890252 |
| 2 | 0.6632102222 | 0.8351451558 | 0.5452762295 | 0.1426261251 |
| 3 | 0.1426261252 | 0.5452762295 | 0.8351451558 | 0.6632102222 |
| 4 | -0.0917890252 | 0.1478252602 | 0.6390270117 | 0.7863351990 |
| 5 | 1.0000000000 | 0.8351451558 | 0.2232563508 | -0.1107605405 |
| 6 | 0.8351451558 | 1.0000000000 | 0.6619268848 | 0.2232563508 |
| 7 | 0.2232563508 | 0.6619268848 | 1.0000000000 | 0.8351451558 |
| 8 | -0.1107605405 | 0.2232563508 | 0.8351451558 | 1.0000000000 |
| 9 | 0.6507821097 | 0.5452762295 | 0.1395765813 | -0.0701935802 |
| 10 | 0.5452762295 | 0.6619268848 | 0.4329241224 | 0.1395765813 |
| 11 | 0.1395765813 | 0.4329241224 | 0.6619268848 | 0.5452762295 |
| 12 | -0.0701935802 | 0.1395765813 | 0.5452762295 | 0.6507821097 |
| 13 | 0.1716088320 | 0.1478252602 | 0.0184194442 | -0.0225678321 |
| 14 | 0.1426261251 | 0.2232563508 | 0.1395765813 | 0.0118268770 |
| 15 | 0.0118268769 | 0.1395765813 | 0.2232563508 | 0.1426261252 |
| 16 | -0.0225678321 | 0.0184194442 | 0.1478252602 | 0.1716088320 |

| Column/ Row | 9 | 10 | 11 | 12 |
|---|---|---|---|---|
| 1 | 0.1716088320 | 0.1478252603 | 0.0184194442 | -0.0225678321 |
| 2 | 0.1426261252 | 0.2232563508 | 0.1395765813 | 0.0118268769 |
| 3 | 0.0118268769 | 0.1395765813 | 0.2232563508 | 0.1426261252 |
| 4 | -0.0225678321 | 0.0184194442 | 0.1478252602 | 0.1716088320 |
| 5 | 0.6507821097 | 0.5452762295 | 0.1395765813 | -0.0701935802 |
| 6 | 0.5452762295 | 0.6619268848 | 0.4329241224 | 0.1395765813 |
| 7 | 0.1395765813 | 0.4329241224 | 0.6619268848 | 0.5452762295 |
| 8 | -0.0701935802 | 0.1395765813 | 0.5452762295 | 0.6507821097 |
| 9 | 1.0000000000 | 0.8351451558 | 0.2232563508 | -0.1107605405 |
| 10 | 0.8351451558 | 1.0000000000 | 0.6619268848 | 0.2232563508 |
| 11 | 0.2232563508 | 0.6619268848 | 1.0000000000 | 0.8351451558 |
| 12 | -0.1107605405 | 0.2232563508 | 0.8351451558 | 1.0000000000 |
| 13 | 0.7863351990 | 0.6390270116 | 0.1478252602 | -0.0917890252 |
| 14 | 0.6632102222 | 0.8351451558 | 0.5452762295 | 0.1426261252 |
| 15 | 0.1426261252 | 0.5452762295 | 0.8351451558 | 0.6632102222 |
| 16 | -0.0917890252 | 0.1478252603 | 0.6390270117 | 0.7863351990 |
| Column/ Row | 13 | 14 | 15 | 16 |
| 1 | -0.0889314353 | -0.0917890252 | -0.0225678321 | 0.0222460407 |
| 2 | -0.0917890252 | -0.1107605405 | -0.0701935802 | -0.0225678321 |
| 3 | -0.0225678321 | -0.0701935802 | -0.1107605405 | -0.0917890252 |
| 4 | 0.0222460407 | -0.0225678321 | -0.0917890252 | -0.0889314353 |
| 5 | 0.1716088320 | 0.1426261251 | 0.0118268769 | -0.0225678321 |
| 6 | 0.1478252602 | 0.2232563508 | 0.1395765813 | 0.0184194442 |
| 7 | 0.0184194442 | 0.1395765813 | 0.2232563508 | 0.1478252602 |
| 8 | -0.0225678321 | 0.0118268770 | 0.1426261252 | 0.1716088320 |
| 9 | 0.7863351990 | 0.6632102222 | 0.1426261252 | -0.0917890252 |
| 10 | 0.6390270116 | 0.8351451558 | 0.5452762295 | 0.1478252603 |
| 11 | 0.1478252602 | 0.5452762295 | 0.8351451558 | 0.6390270117 |
| 12 | -0.0917890252 | 0.1426261252 | 0.6632102222 | 0.7863351990 |
| 13 | 1.0000000000 | 0.7863351990 | 0.1716088320 | -0.0889314353 |
| 14 | 0.7863351990 | 1.0000000000 | 0.6507821097 | 0.1716088320 |
| 15 | 0.1716088320 | 0.6507821097 | 1.0000000000 | 0.7863351990 |
| 16 | -0.0889314353 | 0.1716088320 | 0.7863351990 | 1.0000000000 |

E.3 Hot-Spot Pattern Variance-Covariance Matrix for a 4x4 Study Area

| Column/ Row | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| 1 | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2 | 0.0 | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 3 | 0.0 | 0.0 | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 4 | 0.0 | 0.0 | 0.0 | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 5 | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | 0.0 | 0.0 | 0.0 |
| 6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | 0.9 | 0.0 |
| 7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.9 | 1.0 | 0.0 |
| 8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 |
| 9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 10 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.9 | 0.9 | 0.0 |
| 11 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.9 | 0.9 | 0.0 |
| 12 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 13 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 16 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Column/ Row | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| 1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 6 | 0.0 | 0.9 | 0.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 7 | 0.0 | 0.9 | 0.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 9 | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 10 | 0.0 | 1.0 | 0.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 11 | 0.0 | 0.9 | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 12 | 0.0 | 0.0 | 0.0 | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 13 | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | 0.0 | 0.0 | 0.0 |
| 14 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | 0.0 | 0.0 |
| 15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | 0.0 |
| 16 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 |

E.4  CWF Pattern Variance-Covariance Matrix for a 4x4 Study Area

| Column/ Row | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| 1 | 1.000 | 0.726 | 0.278 | 0.056 | 0.726 | 0.527 | 0.202 | 0.041 |
| 2 | 0.726 | 1.000 | 0.726 | 0.278 | 0.527 | 0.726 | 0.527 | 0.202 |
| 3 | 0.278 | 0.726 | 1.000 | 0.726 | 0.202 | 0.527 | 0.726 | 0.527 |
| 4 | 0.056 | 0.278 | 0.726 | 1.000 | 0.041 | 0.202 | 0.527 | 0.726 |
| 5 | 0.726 | 0.527 | 0.202 | 0.041 | 1.000 | 0.726 | 0.278 | 0.056 |
| 6 | 0.527 | 0.726 | 0.527 | 0.202 | 0.726 | 1.000 | 0.726 | 0.278 |
| 7 | 0.202 | 0.527 | 0.726 | 0.527 | 0.278 | 0.726 | 1.000 | 0.726 |
| 8 | 0.041 | 0.202 | 0.527 | 0.726 | 0.056 | 0.278 | 0.726 | 1.000 |
| 9 | 0.278 | 0.202 | 0.077 | 0.016 | 0.726 | 0.527 | 0.202 | 0.041 |
| 10 | 0.202 | 0.278 | 0.202 | 0.077 | 0.527 | 0.726 | 0.527 | 0.202 |
| 11 | 0.077 | 0.202 | 0.278 | 0.202 | 0.202 | 0.527 | 0.726 | 0.527 |
| 12 | 0.016 | 0.077 | 0.202 | 0.278 | 0.041 | 0.202 | 0.527 | 0.726 |
| 13 | 0.056 | 0.041 | 0.016 | 0.003 | 0.278 | 0.202 | 0.077 | 0.016 |
| 14 | 0.041 | 0.056 | 0.041 | 0.016 | 0.202 | 0.278 | 0.202 | 0.077 |
| 15 | 0.016 | 0.041 | 0.056 | 0.041 | 0.077 | 0.202 | 0.278 | 0.202 |
| 16 | 0.003 | 0.016 | 0.041 | 0.056 | 0.016 | 0.077 | 0.202 | 0.278 |
| Column/ Row | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| 1 | 0.278 | 0.202 | 0.077 | 0.016 | 0.056 | 0.041 | 0.016 | 0.003 |
| 2 | 0.202 | 0.278 | 0.202 | 0.077 | 0.041 | 0.056 | 0.041 | 0.016 |
| 3 | 0.077 | 0.202 | 0.278 | 0.202 | 0.016 | 0.041 | 0.056 | 0.041 |
| 4 | 0.016 | 0.077 | 0.202 | 0.278 | 0.003 | 0.016 | 0.041 | 0.056 |
| 5 | 0.726 | 0.527 | 0.202 | 0.041 | 0.278 | 0.202 | 0.077 | 0.016 |
| 6 | 0.527 | 0.726 | 0.527 | 0.202 | 0.202 | 0.278 | 0.202 | 0.077 |
| 7 | 0.202 | 0.527 | 0.726 | 0.527 | 0.077 | 0.202 | 0.278 | 0.202 |
| 8 | 0.041 | 0.202 | 0.527 | 0.726 | 0.016 | 0.077 | 0.202 | 0.278 |
| 9 | 1.000 | 0.726 | 0.278 | 0.056 | 0.726 | 0.527 | 0.202 | 0.041 |
| 10 | 0.726 | 1.000 | 0.726 | 0.278 | 0.527 | 0.726 | 0.527 | 0.202 |
| 11 | 0.278 | 0.726 | 1.000 | 0.726 | 0.202 | 0.527 | 0.726 | 0.527 |
| 12 | 0.056 | 0.278 | 0.726 | 1.000 | 0.041 | 0.202 | 0.527 | 0.726 |
| 13 | 0.726 | 0.527 | 0.202 | 0.041 | 1.000 | 0.726 | 0.278 | 0.056 |
| 14 | 0.527 | 0.726 | 0.527 | 0.202 | 0.726 | 1.000 | 0.726 | 0.278 |
| 15 | 0.202 | 0.527 | 0.726 | 0.527 | 0.278 | 0.726 | 1.000 | 0.726 |
| 16 | 0.041 | 0.202 | 0.527 | 0.726 | 0.056 | 0.278 | 0.726 | 1.000 |

E.5 Rook Pattern Variance-Covariance Matrix for a 9x9 Study Area

Let $\boldsymbol{GWSCM_{Rook}}$ represent the ***GWSCM*** matrix for the Rook Connectivity Case as defined in Appendix D.4. Let $V_{ij}$ represent the $ij^{th}$ element and ***V*** represent this variance-covariance matrix. Then $\boldsymbol{V_{Rook}}$ is derived using the following procedure:

$$\text{Let } \boldsymbol{D}=\boldsymbol{I} + \rho\, \boldsymbol{GWSCM_{Rook}}$$

where $\rho$ is the magnitude of spatial autocorrelation with $-1 < \rho < 1$, and ***I*** is an 81x81 Identity matrix. Now use ***D*** as the input matrix for the SDPT3 program given in Appendix C.3. The closest positive definite matrix to ***D*** is in ***X***.

$$\text{So } \boldsymbol{V_{Rook}} = \boldsymbol{X}.$$

E.6 Queen Pattern Variance-Covariance Matrix for a 9x9 Study Area

Let $\boldsymbol{GWSCM_{Queen}}$ represent the ***GWSCM*** matrix for the Queen Connectivity Case as defined in Appendix D.5. Let $V_{ij}$ represent the $ij^{th}$ element and ***V*** represent this variance-covariance matrix. Then $\boldsymbol{V_{Queen}}$ is derived using the following procedure:

$$\text{Let } \boldsymbol{D}=\boldsymbol{I} + \rho\, \boldsymbol{GWSCM_{Queen}}$$

where $\rho$ is the magnitude of spatial autocorrelation with $-1 < \rho < 1$, and ***I*** is an 81x81 Identity matrix. Now use ***D*** as the input matrix for the SDPT3 program given in Appendix C.3. The closest positive definite matrix to ***D*** is in ***X***.

$$\text{So } \boldsymbol{V_{Queen}} = \boldsymbol{X}.$$

E.7 Hot-Spot Pattern Variance-Covariance Matrix for a 9x9 Study Area

$V_{ij}$ represent the $ij^{th}$ element and $\boldsymbol{V}_i$ represent the $i^{th}$ block of elements, where each symmetric block has dimension 9x9, of this variance-covariance matrix. The main diagonal has $V_{ii}$ = 1 for i=1, 2, … , 81. The blocks are arranged as:

| Block Column/ Row | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| 1 | ***A*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** |
| 2 | ***0*** | ***A*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** |
| 3 | ***0*** | ***0*** | ***B*** | ***C*** | ***C*** | ***C*** | ***C*** | ***0*** | ***0*** |
| 4 | ***0*** | ***0*** | ***C*** | ***B*** | ***C*** | ***C*** | ***C*** | ***0*** | ***0*** |
| 5 | ***0*** | ***0*** | ***C*** | ***C*** | ***B*** | ***C*** | ***C*** | ***0*** | ***0*** |
| 6 | ***0*** | ***0*** | ***C*** | ***C*** | ***C*** | ***B*** | ***C*** | ***0*** | ***0*** |
| 7 | ***0*** | ***0*** | ***C*** | ***C*** | ***C*** | ***C*** | ***B*** | ***0*** | ***0*** |
| 8 | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***A*** | ***0*** |
| 9 | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***A*** |

where ***A*** =

| Column/ Row | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 5 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 6 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 7 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

***B*** =

| Column/ Row | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 0 | 0 | 1 | 0.9 | 0.9 | 0.9 | 0.9 | 0 | 0 |
| 4 | 0 | 0 | 0.9 | 1 | 0.9 | 0.9 | 0.9 | 0 | 0 |
| 5 | 0 | 0 | 0.9 | 0.9 | 1 | 0.9 | 0.9 | 0 | 0 |
| 6 | 0 | 0 | 0.9 | 0.9 | 0.9 | 1 | 0.9 | 0 | 0 |
| 7 | 0 | 0 | 0.9 | 0.9 | 0.9 | 0.9 | 1 | 0 | 0 |
| 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

and ***C*** =

| Column/ Row | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 0 | 0 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0 | 0 |
| 4 | 0 | 0 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0 | 0 |
| 5 | 0 | 0 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0 | 0 |
| 6 | 0 | 0 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0 | 0 |
| 7 | 0 | 0 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0 | 0 |
| 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

E.8 CWF Pattern Variance-Covariance Matrix for a 9x9 Study Area

Let $V_{ij}$ represent the $ij^{th}$ element and $\boldsymbol{V}_i$ represent the $i^{th}$ block of elements, where each symmetric block has dimension 9x9, of this variance-covariance matrix. The main diagonal has $V_{ii}$ = 1 for i=1, 2, … , 81. The blocks are arranged as:

| Block Column/ Row | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| 1 | ***A*** | ***B*** | ***C*** | ***D*** | ***E*** | ***F*** | ***0*** | ***0*** | ***0*** |
| 2 | ***B*** | ***A*** | ***B*** | ***C*** | ***D*** | ***E*** | ***F*** | ***0*** | ***0*** |
| 3 | ***C*** | ***B*** | ***A*** | ***B*** | ***C*** | ***D*** | ***E*** | ***F*** | ***0*** |
| 4 | ***D*** | ***C*** | ***B*** | ***A*** | ***B*** | ***C*** | ***D*** | ***E*** | ***F*** |
| 5 | ***E*** | ***D*** | ***C*** | ***B*** | ***A*** | ***B*** | ***C*** | ***D*** | ***E*** |
| 6 | ***F*** | ***E*** | ***D*** | ***C*** | ***B*** | ***A*** | ***B*** | ***C*** | ***D*** |
| 7 | ***0*** | ***F*** | ***E*** | ***D*** | ***C*** | ***B*** | ***A*** | ***B*** | ***C*** |
| 8 | ***0*** | ***0*** | ***F*** | ***E*** | ***D*** | ***C*** | ***B*** | ***A*** | ***B*** |
| 9 | ***0*** | ***0*** | ***0*** | ***F*** | ***E*** | ***D*** | ***C*** | ***B*** | ***A*** |

where ***A***, ***B***, ***C***, ***D***, ***E***, and ***F*** are defined in Appendix D.6 except the zeroes on the main diagonal are replaced by ones.

E.9 Rook Pattern Variance-Covariance Matrix for a 14x14 Study Area

Let $\boldsymbol{GWSCM_{Rook}}$ represent the ***GWSCM*** matrix for the Rook Connectivity Case as defined in Appendix D.7. Let $V_{ij}$ represent the $ij^{th}$ element and $\boldsymbol{V}$ represent this variance-covariance matrix. Then $\boldsymbol{V_{Rook}}$ is derived using the following procedure:

$$\text{Let } \boldsymbol{D}=\boldsymbol{I} + \rho\ \boldsymbol{GWSCM_{Rook}}$$

where ρ is the magnitude of spatial autocorrelation with $-1 < \rho < 1$, and $\boldsymbol{I}$ is an 196x196 Identity matrix. Now use $\boldsymbol{D}$ as the input matrix for the SDPT3 program given in Appendix C.3. The closest positive definite matrix to $\boldsymbol{D}$ is in $\boldsymbol{X}$.

$$\text{So } \boldsymbol{V_{Rook}} = \boldsymbol{X}.$$

E.10 Queen Pattern Variance-Covariance Matrix for a 14x14 Study Area

Let $\boldsymbol{GWSCM_{Queen}}$ represent the ***GWSCM*** matrix for the Queen Connectivity Case as defined in Appendix D.5. Let $V_{ij}$ represent the $ij^{th}$ element and $\boldsymbol{V}$ represent this variance-covariance matrix. Then $\boldsymbol{V_{Queen}}$ is derived using the following procedure:

$$\text{Let } \boldsymbol{D}=\boldsymbol{I} + \rho\ \boldsymbol{GWSCM_{Queen}}$$

where ρ is the magnitude of spatial autocorrelation with $-1 < \rho < 1$, and $\boldsymbol{I}$ is an 196x196 Identity matrix. Now use $\boldsymbol{D}$ as the input matrix for the SDPT3 program given in Appendix C.3. The closest positive definite matrix to $\boldsymbol{D}$ is in $\boldsymbol{X}$.

$$\text{So } \boldsymbol{V_{Queen}} = \boldsymbol{X}.$$

E.11  Hot-Spot Pattern Variance-Covariance Matrix for a 14x14 Study Area

Let $V_{ij}$ represent the $ij^{th}$ element and $\boldsymbol{V}_i$ represent the $i^{th}$ block of elements, where each symmetric block has dimension 14x14, of this variance-covariance matrix.  The main diagonal has $V_{ii}$ = 1 for i=1, 2, … , 196.  The blocks are arranged as:

| Block Column/ Row | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ***A*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** |
| 2 | ***0*** | ***A*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** |
| 3 | ***0*** | ***0*** | ***A*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** |
| 4 | ***0*** | ***0*** | ***0*** | ***B*** | ***C*** | ***C*** | ***C*** | ***C*** | ***C*** | ***C*** | ***C*** | ***0*** | ***0*** | ***0*** |
| 5 | ***0*** | ***0*** | ***0*** | ***C*** | ***B*** | ***C*** | ***C*** | ***C*** | ***C*** | ***C*** | ***C*** | ***0*** | ***0*** | ***0*** |
| 6 | ***0*** | ***0*** | ***0*** | ***C*** | ***C*** | ***B*** | ***C*** | ***C*** | ***C*** | ***C*** | ***C*** | ***0*** | ***0*** | ***0*** |
| 7 | ***0*** | ***0*** | ***0*** | ***C*** | ***C*** | ***C*** | ***B*** | ***C*** | ***C*** | ***D*** | ***C*** | ***0*** | ***0*** | ***0*** |
| 8 | ***0*** | ***0*** | ***0*** | ***C*** | ***C*** | ***C*** | ***C*** | ***B*** | ***C*** | ***C*** | ***C*** | ***0*** | ***0*** | ***0*** |
| 9 | ***0*** | ***0*** | ***0*** | ***C*** | ***C*** | ***C*** | ***C*** | ***C*** | ***B*** | ***C*** | ***C*** | ***0*** | ***0*** | ***0*** |
| 10 | ***0*** | ***0*** | ***0*** | ***C*** | ***C*** | ***C*** | ***C*** | ***C*** | ***C*** | ***B*** | ***C*** | ***0*** | ***0*** | ***0*** |
| 11 | ***0*** | ***0*** | ***0*** | ***C*** | ***C*** | ***C*** | ***C*** | ***C*** | ***C*** | ***C*** | ***B*** | ***0*** | ***0*** | ***0*** |
| 12 | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***A*** | ***0*** | ***0*** |
| 13 | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***A*** | ***0*** |
| 14 | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***A*** |

where ***A*** =

| Column/ Row | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 3 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 4 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 5 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 6 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 7 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 13 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Column/ Row | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 10 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 11 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 12 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 13 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 14 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

***B*** =

| Column/ Row | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 3 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 4 | 0 | 0 | 0 | 1 | 0.9 | 0.9 | 0.9 |
| 5 | 0 | 0 | 0 | 0.9 | 1 | 0.9 | 0.9 |
| 6 | 0 | 0 | 0 | 0.9 | 0.9 | 1 | 0.9 |
| 7 | 0 | 0 | 0 | 0.9 | 0.9 | 0.9 | 1 |
| 8 | 0 | 0 | 0 | 0.9 | 0.9 | 0.9 | 0.9 |
| 9 | 0 | 0 | 0 | 0.9 | 0.9 | 0.9 | 0.9 |
| 10 | 0 | 0 | 0 | 0.9 | 0.9 | 0.9 | 0.9 |
| 11 | 0 | 0 | 0 | 0.9 | 0.9 | 0.9 | 0.9 |
| 12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 13 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Column/ Row | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | 0.9 | 0.9 | 0.9 | 0.9 | 0 | 0 | 0 |
| 5 | 0.9 | 0.9 | 0.9 | 0.9 | 0 | 0 | 0 |
| 6 | 0.9 | 0.9 | 0.9 | 0.9 | 0 | 0 | 0 |
| 7 | 0.9 | 0.9 | 0.9 | 0.9 | 0 | 0 | 0 |
| 8 | 1 | 0.9 | 0.9 | 0.9 | 0 | 0 | 0 |
| 9 | 0.9 | 1 | 0.9 | 0.9 | 0 | 0 | 0 |
| 10 | 0.9 | 0.9 | 1 | 0.9 | 0 | 0 | 0 |
| 11 | 0.9 | 0.9 | 0.9 | 1 | 0 | 0 | 0 |
| 12 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 13 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 14 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

and **C** =

| Column/ Row | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | 0 | 0 | 0 | 0.9 | 0.9 | 0.9 | 0.9 |
| 5 | 0 | 0 | 0 | 0.9 | 0.9 | 0.9 | 0.9 |
| 6 | 0 | 0 | 0 | 0.9 | 0.9 | 0.9 | 0.9 |
| 7 | 0 | 0 | 0 | 0.9 | 0.9 | 0.9 | 0.9 |
| 8 | 0 | 0 | 0 | 0.9 | 0.9 | 0.9 | 0.9 |
| 9 | 0 | 0 | 0 | 0.9 | 0.9 | 0.9 | 0.9 |
| 10 | 0 | 0 | 0 | 0.9 | 0.9 | 0.9 | 0.9 |
| 11 | 0 | 0 | 0 | 0.9 | 0.9 | 0.9 | 0.9 |
| 12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 13 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Column/ Row | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | 0.9 | 0.9 | 0.9 | 0.9 | 0 | 0 | 0 |
| 5 | 0.9 | 0.9 | 0.9 | 0.9 | 0 | 0 | 0 |
| 6 | 0.9 | 0.9 | 0.9 | 0.9 | 0 | 0 | 0 |
| 7 | 0.9 | 0.9 | 0.9 | 0.9 | 0 | 0 | 0 |
| 8 | 0.9 | 0.9 | 0.9 | 0.9 | 0 | 0 | 0 |
| 9 | 0.9 | 0.9 | 0.9 | 0.9 | 0 | 0 | 0 |
| 10 | 0.9 | 0.9 | 0.9 | 0.9 | 0 | 0 | 0 |
| 11 | 0.9 | 0.9 | 0.9 | 0.9 | 0 | 0 | 0 |
| 12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 13 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

E.12 CWF Pattern Variance-Covariance Matrix for a 14x14 Study Area

Let $V_{ij}$ represent the $ij^{th}$ element and $\boldsymbol{V}_i$ represent the $i^{th}$ block of elements, where each symmetric block has dimension 14x14, of this variance-covariance matrix. The main diagonal has $V_{ii}$ = 1 for $i$=1, … , 196. The blocks are arranged as:

| Block Column/ Row | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ***A*** | ***B*** | ***C*** | ***D*** | ***E*** | ***F*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** |
| 2 | ***B*** | ***A*** | ***B*** | ***C*** | ***D*** | ***E*** | ***F*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** |
| 3 | ***C*** | ***B*** | ***A*** | ***B*** | ***C*** | ***D*** | ***E*** | ***F*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** |
| 4 | ***D*** | ***C*** | ***B*** | ***A*** | ***B*** | ***C*** | ***D*** | ***E*** | ***F*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** |
| 5 | ***E*** | ***D*** | ***C*** | ***B*** | ***A*** | ***B*** | ***C*** | ***D*** | ***E*** | ***F*** | ***0*** | ***0*** | ***0*** | ***0*** |
| 6 | ***F*** | ***E*** | ***D*** | ***C*** | ***B*** | ***A*** | ***B*** | ***C*** | ***D*** | ***E*** | ***F*** | ***0*** | ***0*** | ***0*** |
| 7 | ***0*** | ***F*** | ***E*** | ***D*** | ***C*** | ***B*** | ***A*** | ***B*** | ***C*** | ***D*** | ***E*** | ***F*** | ***0*** | ***0*** |
| 8 | ***0*** | ***0*** | ***F*** | ***E*** | ***D*** | ***C*** | ***B*** | ***A*** | ***B*** | ***C*** | ***D*** | ***E*** | ***F*** | ***0*** |
| 9 | ***0*** | ***0*** | ***0*** | ***F*** | ***E*** | ***D*** | ***C*** | ***B*** | ***A*** | ***B*** | ***C*** | ***D*** | ***E*** | ***F*** |
| 10 | ***0*** | ***0*** | ***0*** | ***0*** | ***F*** | ***E*** | ***D*** | ***C*** | ***B*** | ***A*** | ***B*** | ***C*** | ***D*** | ***E*** |
| 11 | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***F*** | ***E*** | ***D*** | ***C*** | ***B*** | ***A*** | | ***C*** | ***D*** |
| 12 | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***F*** | ***E*** | ***D*** | ***C*** | ***B*** | ***A*** | ***B*** | ***C*** |
| 13 | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***F*** | ***E*** | ***D*** | ***C*** | ***B*** | ***A*** | ***B*** |
| 14 | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***0*** | ***F*** | ***E*** | ***D*** | ***C*** | ***B*** | ***A*** |

where ***A***, ***B***, ***C***, ***D***, ***E***, and ***F*** are defined in Appendix D.9 except the zeroes on the main diagonal are replaced by ones.

VITA

Gary Dan Hatfield

Candidate for the Degree of

Doctor of Philosophy

Dissertation: AN ANALYSIS OF MEASURES OF SPATIAL AUTOCORRELATION

Major Field: Statistics

Biographical:

Education: Received a Bachelor of Science degree in Mathematics from Oklahoma State University, Stillwater, Oklahoma in May 1976; received a Master of Science degree in Statistics from Oklahoma State University, Stillwater, Oklahoma in May 1978. Completed the requirements for the Doctor of Philosophy degree with a major in Statistics at Oklahoma State University in December 2011.

Experience: Employed as a Statistician by Phillips Petroleum Company in Bartlesville, Oklahoma from 1978 to 1981. Employed as a Quality Engineer by Phillips Chemical Company in Borger, Texas from 1981 to 1986. Employed as Manager of Quality Assurance and Statistical Services by Zircoa, Inc. in Solon, Ohio from 1986 to 1991. Employed as a Research Statistician by Phillips Petroleum Company in Bartlesville, Oklahoma from 1991 to 1996. Employed as a Quality Systems Specialist by Phillips Chemical Company in Pasadena, Texas from 1996 to 1998. Employed as Chief Statistician by ConocoPhillips in Bartlesville, Oklahoma from 1998 to 2005. Employed as a Graduate Teaching Associate in the Department of Statistics, Oklahoma State University, Stillwater, Oklahoma from 2005 to 2011.

Professional Memberships: American Statistical Association

Name: Gary Dan Hatfield Date of Degree: December, 2011

Institution: Oklahoma State University Location: Stillwater, Oklahoma

Title of Study: AN ANALYSIS OF MEASURES OF SPATIAL AUTOCORRELATION

Pages in Study: 311 Candidate for the Degree of Doctor of Philosophy

Major Field: Statistics

Scope and Method of Study: Many fields of study are interested in the spatial relationship of data. Spatial autocorrelation is used to measure the strength of spatial relationships. Current measures of local spatial autocorrelation were developed by Anselin, Getis, and Ord. These include $I_i$, $c_i$, $G_i$, and $G_i$*. A limitation of these measures is the difficulty of their interpretation. Researchers would benefit from a statistic that is quickly interpreted without additional analysis or standardization. This research involves the development and analysis of measures of local spatial autocorrelation which are constrained to the interval [-1, +1]. This is the range that is typically used for measures of correlation. When data are from a multivariate normal distribution, the proposed measures have a twice-folded Cauchy distribution which has finite moments. Its parameters are derived as functions of the multivariate normal parameters. Simulations were utilized to investigate size and power, using randomization tests, of two proposed measures and four existing measures. The model used for this study has stationary mean and heterogeneous variance-covariance matrices. Variables investigated for each of six local measures are number of regions in a study area, connectivity of neighbors, and pattern of local spatial autocorrelation.

Findings and Conclusions: Tests of significance for all six measures are size alpha tests for 9x9 and 14x14 study areas, and conservative for a 4x4 study area. One of the current measures, $c_i$, which is underutilized, obtained highest power for many of the scenarios investigated. One of the proposed measures obtains highest or next highest power for most regions in a small study area. This measure identifies regions with local spatial autocorrelation that is overlooked by the most common local measure, $I_i$, and provides a meaningful addition to current measures of local spatial autocorrelation.

ADVISER'S APPROVAL: Dr. Carla L. Goad