When All Miles Are Not the Same: Spatial Non-Stationarity Impacts of Educational Travel Time Requirements

Jeremy L. Sage
Washington State University
(jlsage@wsu.edu)

Research has demonstrated that metropolitan areas are highly differentiated across space, not only in terms of socioeconomic status, but also along availability of public resources that are of substantial importance to economic and educational opportunity. Of these public resources, the location of colleges and universities in relation to residence has been suggested to be significant, especially for socioeconomically disadvantaged families. Utilizing 2007-2008 enrollment rosters from all Community and Technical Colleges of Washington State, this paper implements Geographically Weighted Regression (GWR) to spatially examine the intricacies of the variation of the effects of required travel time on student enrollment rates by census block group. Washington is a diverse state, thus accounting for spatial non-stationarity in responses to travel time requirements, permits a more locally valid interpretation of those impacts over their global estimate counterparts. We show that significant differences exist in enrollment patterns in both high and low socioeconomic status students, for urban and rural settings, based on the travel time to the associated campuses. These apparent variations in willingness/ability to travel suggest that equal opportunity access to Community and Technical Colleges necessarily must include a geographic dimension.

Key Words: Geographically Weighted Regression, Geography of Opportunity, SES, Community Colleges.

INTRODUCTION

In 2006, the Washington State Board for Community and Technical Colleges (SBCTC) produced a report in which they assessed the socioeconomic well-being of Washington State. The assessment sought to describe who attends community and technical colleges and whether the enrolled students reflect the entire population of the state. Employing multiple decades (1990 and 2000) of Census information, the report develops a quintile grouping of all census identified block groups in Washington by socioeconomic status (SES). With rosters of all community and technical colleges in Washington at their disposal, they assign all enrolled students to these block groups by their reported home address and thus to the SES of their associated block group. Through this quintile grouping, the authors found that community and technical colleges provide equal access and opportunity for every SES quintile and that these students closely resemble the state population as a whole in their SES makeup. They additionally found that racial variation of participation was near or at par with that of their representation at the state level (SBCTC, 2006). These are quite positive results for the community and technical college system, to be reassured that they are reaching a large breadth of the population of Washington.

The SBCTC report aptly identifies the traditional components that many educational researchers have identified as markers of attendance rates in higher education such as gender, age, race, English as a Second Language (ESL) needs, purpose of seeking a community or technical college, and ultimately SES (SBCTC, 2006). However, a key component may be getting lost as the report aggregates the SES quintiles and their associated information to the state level. This aggregation, assumes that all block groups within a given quintile indeed have equal opportunity and access to a community college regardless of how far they are from a suitable campus with an educational program that meets the individual needs of the block group population. This is a rather large assumption when considering a state as large and diverse as Washington. This paper extends the earlier work by spatially examining the
relationship between the geographic location of Community and Technical Colleges in Washington State, the enrolled student population, and whether the resource is equitably distributed across the socioeconomic range, at a level consistent with the demographic variability across Washington. This is established through the utilization of Geographically Weighted Regression (GWR).

LITERATURE REVIEW

The role and value of community colleges has been a topic of debate in the educational literature since its inception. An historical glance demonstrates an open enrollment system that has sought to attract those students who have been under represented in traditional higher education pathways. These students predominately include women (59%), minorities (40%), low-income (26%), and older students (24%) (US Department of Education, 2006). The emergence of the Community College system has been viewed within the educational structure as a key element of social mobility, with the belief that there should be educational equality for all, without regard for family background or social status (Brint and Karabel, 1989). Alternatively, others have argued that their creation is a continuation of disparity between classes, as it seeks to protect four-year institutions from the aspirations of the masses (Dougherty, 1994). Dougherty further contends that community college administrators recognized their ‘structural subordination’ in the higher education system and by 1985 had shifted a major proportion of its focus away from that of academic transfer to a local industry-oriented vocational approach. Currently, over half of community college students are participating in these types of programs (Townsend and Wilson, 2006) and they have been embraced by governmental programs like Work-First who place the very poor and marginalized citizens into vocational programs deemed, by some, as less valuable than pursuing academic credentials (Shaw and Goldrick-Rab, 2006).

The argument of the value of the community college system to those traditionally under represented was taken up by Rouse (1995), who sought to understand whether community colleges
divert otherwise qualified students from 4-year universities or whether they democratize the 
educational system by opening it up to the masses. Using the notion that increased accessibility and 
closer proximity should decrease costs, she examined whether proximity influenced the likelihood that 
an individual attends college. The results suggested that closer two-year college proximity, based on 
distance from students’ high school to a campus, was associated with higher rates of college attendance 
based on average number of years attended but did not increase the likelihood of attaining a bachelor’s 
degree.

Several researchers have identified a multi-stage set of choices that occurs for students when 
deciding to attend college, beginning with whether or not to seek to attend, followed by where to 
attend (Hossler and Gallagher, 1987), and ultimately whether to finish (Manski and Wise, 1983). The 
latter two decisions are heavily influenced by the opportunity structure presented to the students and 
their communities (Galster and Killen, 1995). Turley (2009) identifies large gaps of consideration 
regarding opportunity disparity in both the sociological and educational literature. The gaps she 
identifies revolve about a geographic context, thus she sought to begin to fill those gaps by exploring 
students’ “geography of opportunity”.

Geography of opportunity has been used to describe the importance of residential location in 
determining educational opportunity across the SES spectrum. The distribution of public resources 
across geographic regions relative to lower income neighborhoods has been a topic of interest in the 
housing literature for several decades now (Rosenbaum, 1995). Turley (2006) identified 54 percent of 
parents of high school seniors as indicating that the ability for their student to stay at home while 
attending college was important. With increasing costs of attendance, despite availability of financial 
aid, students of low SES families are less likely to leave home for college (Mulder and Clark, 2002). 
Turley’s (2009) findings suggest that college choice cannot be evaluated independent of the geographic 
context of both the student and the institution.
Acknowledging the growing role community colleges are playing in the education of older students seeking either as a first degree or job retraining, it must additionally be recognized that these non-traditional students are likely both place and time bound. These constraints will significantly limit the student’s ability to travel to any campus, but more so to distant campuses. Several studies have shown that both an individual’s SES and the built environment in which they reside and/or work play integral roles in explaining their travel behavior (e.g. Chen and McKnight, 2007; Cervero, 2002). Chen and McKnight found that differences exist in travel patterns between individuals from various types of neighborhoods. They attribute at least some of these differences to the built environment; however, much more significant was SES. Time availability has also been found to be influential in determining travel willingness and patterns (Kitamura et al., 2001). Time spent at a place of employment and/or post high school education places significant time and spatial constraints on an individual, as they must be at a certain location for a specified duration (Chen and McKnight, 2007). As time required to be in a certain location increases, the free time allotted after accounting for travel time is diminished (Burns, 1979).

THE STUDY

Research Questions

This study seeks to more fully develop and expand our understanding of the balance of attendance at Community Colleges in regards to SES. Community colleges often play integral roles in their relation to the communities around them. In contrast to the four-year University system, it is often the intent of the Community College system to meet the educational and retraining needs of the immediate community at hand. As such, most attendees of the Community College system do not move to a new area to attend that school. Young students often continue to reside with family while attending college. Additionally, older students typically attend college while continuing to work.
Given the constraints on mobility of Community College students, the location of a campus relative to the surrounding community should be understood; however, little attention has been paid to how travel time requirements affect attendance rates. To address this deficiency, this study investigates the relative and geographic impact of increasing travel time requirements on students of varying SES status. Specifically this study investigates the degree of disparity (if any) between travel time requirements throughout the state and the extent to which it may create a disadvantage to some students. To breakdown the potential contributing components of SES, each attribute is examined as an individual variable.

**Data and Methods**

The SBCTC provided information and data files for every enrolled student in the community college system along with which campus(es) they attended in the 2007-08 academic year (approx 302,000 entries). Students were mapped into their respective block groups based on reported home addresses. Using the geocoding tools supplied within ArcGIS, approximately 80% of the students were successfully matched. The second round of matching was done based on zip-codes. Many of these matches were the result of students having only a PO Box or living, for example, on a military base where they likewise have a common mailing center. Utilizing these methods, in excess of 95% of the students were mapped. The remaining unmatched addresses are assumed to be randomly distributed throughout the state thus limiting any bias of these results. This assumption is based on the fact that unmatched addresses were simply a result of data entry error. In a similar fashion, the SBCTC provided the addresses of its campuses. Using the same technique as for the student addresses, these sites were all successfully mapped. This study incorporated only those campuses with at least 100 students attending, leaving 58 campuses to be considered. This assigned student minimum thus excludes small
satellite locations servicing only a few students, typically by means other than direct instructor contact (e.g. e-Learning).

Census 2000 block group data was obtained from the ESRI issued data disks for ArcGIS 9.3. Block groups were selected as the scale of analysis given the previous work done by the SBCTC in classifying the block groups into SES quintiles. The SES proxy developed by the SBCTC in conjunction with the Columbia University Community College Research Center (CCRC) was determined by statistically combining three census variables representing median household income, educational attainment (percent of adults with at least a bachelor’s degree), and occupation (percent of population 16 or older employed in professional or managerial jobs) (SBCTC, 2006). The number of students from each block group attending each campus were calculated and added to the attribute table. There exists a time lag of 7 years between when the census data was collected and block groups delineated and the student enrollment numbers. This lag should not have substantial effects on the majority of block groups. We tested enrollment rates using the 2000 Census’ 2007 population estimates and found very similar results to those of the population counts.

Travel time from every campus to all block group centroids within 120 minutes was calculated in ArcMAP using the closest facility tool with the streets layer from StreetMap NA. A weighted average travel time was then assigned to each block group using the number of students travelling from that block group to each respective campus as the weight. It was observed that students do not necessarily choose the campus closest to their residence. This observation is likely related to each Community College offering varying programs, thus many students needing to search beyond the nearest campus find a suitable degree program to match their interests and needs. Tuition is set by the SBCTC for all Community Colleges, thus any additional minor fees are not expected to make considerable differences in where a student will choose to attend. Using the population attributes from the block groups, rates of attendance for each respective block group were calculated. Attendance rates were calculated based
on the population of 18-64 year olds on the 2000 census (Attendance Rate = [number of students / population 18-64]*100).

Multiple regression modeling is often used to establish a relationship between several explanatory variables and a dependent variable. In its most basic form, a regression takes the form of an Ordinary Least Squares (OLS) equation:

\[ y = \beta_0 + \beta_i x_i + \epsilon, \]  

where \( y \) is the dependent variable of interest and the vector of \( x_i \)'s are the explanatory (independent) variables and \( \beta_i \)'s are the parameters to be estimated, with a normally distributed error term \( \epsilon \).

However, one major assumption of OLS is the independence of the observations; an assumption which is not likely to stand when considering geographic data. In addition to the independence assumption being likely to fail, a second shortcoming of traditional OLS is that the parameters must be fixed throughout the study area. In other words, a given stimulus must provoke the same response each time. For the purposes of this study, a changing travel time requirement must produce similar changes in attendance rates throughout the state. This is not likely to occur given the large variability across Washington. To overcome this spatial non-stationarity, GWR has been employed (Fotheringham, Brunsden, and Charlton, 2002). In a GWR regression, the parameters are allowed to take on locally specific values:

\[ y(g) = \beta_0(g) + \beta_i(g) x_i + \epsilon, \]  

where \( g \) denotes the allowance of parameters to be estimated at each location \( g \). Analytically, the OLS parameter estimate is a creation of:

\[ \beta = (X'X)^{-1}X'Y \quad (3) \]

and becomes a weighted scheme of:

\[ \beta(g) = (X'W(g)X)^{-1}X'W(g)Y, \quad (4) \]
in GWR, where the weights (W) are chosen such that other observations nearer the point of interest are
given more weight than those further away. In this study, we use a Gaussian weighting scheme of:

\[ w_i(g) = \exp(-d/h)^2 \]  \hspace{1cm} (5)

where \( d \) is the Euclidean distance between observation \( j \) and location \( g \) and \( h \) is the bandwidth. Given
Washington’s diverse landscape and varying census block group size and density, we have employed an
adaptive bandwidth that seeks to minimize the Akaike Information Criterion (AIC). To test whether
enough spatial variability exists to justify the use of GWR, a Monte Carlo significance test was used.

RESULTS

Campus Locations

The current distribution and location of Washington State Community and Technical College
campuses are reasonably well situated relative to the address location and density of existing students.
Statewide, this has resulted in relatively short travel and commute times for a large proportion of
students. Over 42 percent of all students travel 10 minutes or less and over 72 percent of all students
travel 20 minutes or less to attend college campuses. Figure 1 depicts the general locations of campuses
Statewide in relation to the distribution of SES block groups. SES groups are reverse ordered, with 1 as
high and 5 as low. As evident from the figure, the Puget Sound region contains the highest population
density and thus also the most campuses.
Figure 1. Campus Locations and SES Distribution

Student Distribution

The students under consideration for this study are displaced temporally by seven years from the census to which they are being compared, making in necessary to demonstrate that the observations made by the SBCTC (2006) regarding 2001-02 students still holds at a statewide level for the 2007-08 students. Table 1 displays that the 2007-08 students mirror the census population in distribution about the assigned SES quintiles.

Table 1. SES distributions for both 2000 census population and 2007-08 student population

<table>
<thead>
<tr>
<th>SES</th>
<th>Population 18-64yrs</th>
<th>% of total</th>
<th>Enrolled Students</th>
<th>% of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>707,516</td>
<td>19.19</td>
<td>42,810</td>
<td>20.38</td>
</tr>
<tr>
<td>4</td>
<td>743,667</td>
<td>20.17</td>
<td>42,973</td>
<td>20.46</td>
</tr>
<tr>
<td>3</td>
<td>756,590</td>
<td>20.52</td>
<td>45,886</td>
<td>21.85</td>
</tr>
<tr>
<td>2</td>
<td>761,643</td>
<td>20.65</td>
<td>44,573</td>
<td>21.22</td>
</tr>
<tr>
<td>1</td>
<td>718,378</td>
<td>19.48</td>
<td>33,775</td>
<td>16.08</td>
</tr>
<tr>
<td>Total</td>
<td>3,687,794</td>
<td>100.00</td>
<td>210,017</td>
<td>100.00</td>
</tr>
</tbody>
</table>
High SES (HSES) students’ (block groups 1 and 2) travel time ranged from less than 1 minute up to 114.57 minutes, with a weighted average travel time statewide of 18.58 minutes (\(\text{var} = 222.96\)). Seventeen HSES block groups were found to have no students (combined population of adults ages 18-64 years was 11,566). The average travel time for these 17 block groups is 93.44 minutes to all campuses within 120 minutes. There are additionally 9 HSES block groups that have no campuses within 120 minutes. The average rate of attendance for the HSES block groups is 4.66 percent.

Low SES (LSES) students’ (block groups 4 and 5) possessed a similar range of travel time, also less than one minute up to 111.82 minutes. They were observed to have an average of 23.90 minutes (\(\text{var} = 500.32\)). Forty three LSES block groups had no students (combined population of adults ages 18-64 years was 28435). The average travel time for these block groups to all campuses within 120 minutes was 82.84 minutes. Additionally, there are 23 block groups that are not within 120 minutes of any campuses. The average rate of attendance for the LSES block groups was 5.08 percent. A two sample t-test assuming unequal variances demonstrates that the HSES attendance rate of 4.66 percent is significantly less (\(p<.01\)) than the 5.08 percent observed in the LSES block groups.

**Global Regression Results**

There are certainly many factors that contribute to the rate at which individuals from any given block group will attend Community and Technical Colleges; however, this study was mainly concerned with the degree to which travel time can account for variation in student enrollment rates, and whether that time affects individuals of varying SES status differently. The following OLS regression was conducted to get a base-line, non-spatial, understanding of not only the affects of travel time but also review how population age variation, changes in racial makeup and the propensity of adult workers to use public transportation affect attendance rates.
\[ y_i = \beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + \ldots + \beta_7 x_{7i} + \varepsilon_i \text{ for } i = 1, \ldots, n. \]

where,

\( y = \text{Rate of attendance} \)

\( x_1 = \text{students' mean travel time from campus} \)

\( x_2 = \text{Proportion of workers (age 16+) that use Public Transportation} \)

\( x_3 = \text{Proportion of population that is Black} \)

\( x_4 = \text{Proportion of population that is Hispanic} \)

\( x_5 = \text{Block Group’s Median Income} \)

\( x_6 = \text{Block Group’s Median Age} \)

\( x_7 = \text{Proportion of Workers population (age 25+) who have at least a Bachelors Degree} \)

Note: Proportion of workers (age 16+) employed in Business or Professional position was omitted due to the large Multicollinearity Condition Number (MCN) resulting from models containing it. The omission of this variable did not significantly impact model performance.

The first results column of table 2 depicts the outcome of this basic regression. Average travel time, as should be expected, has a significant (p<.001) negative relationship with our dependant attendance rate. Similarly, the Hispanic population (p<.001), the median age of the population (p<.001), and proportion of the population with at least a bachelors degree (p<.001) have negative relationships with attendance rates. Alternatively, workers’ propensity to use public transportation (p<.05), the black proportion of the population (p<.001), and the block group’s median income (p<.05) have positive relationships with attendance rates when considered on a global level. Diagnostics from the basic model (significant results from Breusch-Pagan and Koenker-Bassett tests) suggest that heteroskedasticity likely exists, thus giving reason to suspect that a model that takes spatial relationships into account may be an improvement over the non-spatial OLS. Both \( R^2 \) and AIC are indicators of goodness of fit of the models and useful in comparing the better model. As model fit increases, \( R^2 \) increases and AIC decreases (a reduction of at least 30 in an improvement). The model
yields an adjusted $R^2$ of 0.194 and AIC of 21720. Thus we are explaining approximately 19% of the variation in attendance rates between census block groups.

### Table 2. OLS Regression Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Estimate</th>
<th>Std Err</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>7.146**</td>
<td>0.239</td>
<td>29.907</td>
</tr>
<tr>
<td>Mean Travel Time</td>
<td>-0.0454**</td>
<td>0.002</td>
<td>-28.121</td>
</tr>
<tr>
<td>Median Age</td>
<td>-0.0311**</td>
<td>0.006</td>
<td>-5.458</td>
</tr>
<tr>
<td>Median Income</td>
<td>5.49e-006*</td>
<td>2.28e-006</td>
<td>2.410</td>
</tr>
<tr>
<td>Proportion of Population that is Black</td>
<td>2.815**</td>
<td>0.632</td>
<td>4.450</td>
</tr>
<tr>
<td>Proportion of Population that is Hispanic</td>
<td>-1.586**</td>
<td>0.367</td>
<td>-4.324</td>
</tr>
<tr>
<td>Proportion of Workers (16+) who use Public Transportation</td>
<td>1.605*</td>
<td>0.631</td>
<td>2.544</td>
</tr>
<tr>
<td>Proportion of Population with at least a Bachelors Degree</td>
<td>-2.632**</td>
<td>0.276</td>
<td>-9.524</td>
</tr>
</tbody>
</table>

*p<.05, **p<.001

**Geographically Weighted Regression (GWR) Results**

The value of GWR lies in its allowance of evaluation and identification of spatial heterogeneity for geographic data, thus improving upon non-spatial estimation techniques that may produce biases and inefficient parameter estimates. To determine whether the parameter coefficients vary significantly over space, and thus whether non-stationarity is a concern, the variability of each coefficient was checked using a Monte Carlo test for spatial variability. Table 3 indicates that for all the listed variables, significant variation is evident. The significance of these differences, especially in that of average travel distance, suggests that there is justification for the consideration of spatial variation.

Further evidence of the value of GWR is observable through the use of ANOVA in which we observe significant improvement in model performance over the global OLS (Table 4). Given that we continue to use the same model of analysis for the GWR as was used in the global model of all block groups, we can compare the goodness of fit to that previously obtained. The GWR model yields an Adjusted-$R^2$ of 0.334.
and an AICc of 21154 which both indicate substantial improvements over the global model.

Additionally, Figure 2 displays the varying level of fit (local $R^2$) for the GWR model throughout the state. Table 5 displays the five number summary of the variability in parameter estimates for the model. To get a better visual indication of the variation of the coefficient on the travel time variable, consider Figure 3 in which variations throughout the state are evident. Most areas have negative coefficients with the exception of several regions in which the coefficients turn positive.

### Table 3. Monte Carlo Significance Test for Spatial Variability

<table>
<thead>
<tr>
<th>Parameter</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Travel Time</td>
<td>0.0000</td>
</tr>
<tr>
<td>Median Age</td>
<td>0.0700</td>
</tr>
<tr>
<td>Proportion of Population that is Black</td>
<td>0.0000</td>
</tr>
<tr>
<td>Proportion of Population that is Hispanic</td>
<td>0.0000</td>
</tr>
<tr>
<td>Median Income</td>
<td>0.0000</td>
</tr>
<tr>
<td>Proportion of Workers (16+) who use Public Transportation</td>
<td>0.0000</td>
</tr>
<tr>
<td>Percent of Population with at least a Bachelors Degree</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

### Table 4. ANOVA results.

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>DF</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>OLS Residuals</td>
<td>25389.7</td>
<td>8.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GWR Improvement</td>
<td>5862.3</td>
<td>323.94</td>
<td>17.6109</td>
<td></td>
</tr>
<tr>
<td>GWR Residuals</td>
<td>19527.4</td>
<td>4493.06</td>
<td>4.3461</td>
<td>4.1640</td>
</tr>
</tbody>
</table>

5/24/2010
Table 5. GWR 5-Number Summary

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Minimum</th>
<th>Lwr Quartile</th>
<th>Median</th>
<th>Upr Quartile</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-4.700</td>
<td>5.322</td>
<td>6.359</td>
<td>7.878</td>
<td>12.479</td>
</tr>
<tr>
<td>Mean Travel Time</td>
<td>-0.142</td>
<td>-0.060</td>
<td>-0.037</td>
<td>-0.002</td>
<td>0.466</td>
</tr>
<tr>
<td>Median Age</td>
<td>-0.177</td>
<td>-0.064</td>
<td>-0.038</td>
<td>-0.015</td>
<td>0.149</td>
</tr>
<tr>
<td>Proportion of Population that is Black</td>
<td>-61.320</td>
<td>-4.353</td>
<td>2.962</td>
<td>9.340</td>
<td>105.581</td>
</tr>
<tr>
<td>Proportion of Population that is Hispanic</td>
<td>-56.172</td>
<td>-1.949</td>
<td>1.674</td>
<td>7.163</td>
<td>38.285</td>
</tr>
<tr>
<td>Median Income</td>
<td>-0.0001</td>
<td>-0.00001</td>
<td>0.0001</td>
<td>0.00002</td>
<td>0.0001</td>
</tr>
<tr>
<td>Proportion of Workers (16+) who use Public Transportation</td>
<td>-48.127</td>
<td>-3.411</td>
<td>0.969</td>
<td>5.200</td>
<td>47.893</td>
</tr>
<tr>
<td>Percent of Population with at least a Bachelors Degree</td>
<td>-8.769</td>
<td>-3.325</td>
<td>-1.221</td>
<td>1.037</td>
<td>14.736</td>
</tr>
</tbody>
</table>

Figure 2. Geographical Variation of the Travel Time Coefficient
Differences exist in the average make-up of the two minority groups under consideration between high and low SES block groups. Hispanic and Black proportions are significantly higher (p<.001) among LSES block groups, 10.93 percent and 3.87 percent respectively, as compared to HSES block groups, 3.43 percent and 2.36 percent respectively. Washington has a very small black population with the exception of some urban areas of Seattle and Olympia. Additionally, the Hispanic population is concentrated in the central, agricultural, region of the state. Both regions that possess high concentrations of these two minorities are dominated by LSES block groups. The GWR regression produces highly variable coefficients for both groups (Table 5), from very highly positive relationships to highly negative ones, with the median values for the effects of the increasing proportion of the Black
population having the same sign as that of the global OLS model, while the coefficient for the proportion of the population that is Hispanic changes signs from the median of the GWR as compared to the OLS.

Discussion

This study began following a visual inspection of apparent disparities in location of SES groups in relation to campus sites and the large discrepancies between who attends a campus located in an HSES area like Bellevue, Washington as compared to who attends a campus in a LSES area like Tacoma. This observation in conjunction with the equality of delivery claims made by the SBCTC (SBCTC, 2006) appeared to not offer a complete story. The global statistics tell us that LSES students are travelling on average just more than five minutes more than are HSES students to their respective campuses and attending at a higher overall rate, 5.08 versus 4.66 percent of the adult population (18-64 yrs). The disparities in the variance give some inclination as to the cause of this travel time difference. The HSES students tend to be tightly clustered about the suburban areas of the major metropolitan areas in a general range of 15-20 minutes from campuses, while the LSES students are either very near the campuses in the urban neighborhood, or they are rural and thus needing to drive a significant time to get to campus. The majority of rural areas are classified as LSES block groups and thus have a tendency to skew the mean travel time of that grouping upwards. Despite the statistically significant difference in attendance rates between HSES and LSES Block Groups, when the component parts of the SES determination are broken out to examine their individual effects on attendance rates, it appears that the existing education level of that block group (as modeled here by the proportion of the population with at least a bachelors degree) plays a much larger role in altering the attendance rates than does median income. The lack of substantial deviation (though significant) from zero for the median income parameter likely arises due to the aggregated nature of our student data set. Due to the limited demographic data available on individual students, such as age, we are not able to differentiate

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between those students who are traditional college students and attending right out of high school and those older students who are returning for more education or retraining. As such, we cannot determine if there are differences in regards to who is attending from the varying levels of SES. For example, one could feasibly expect that the students from the LSES areas are a mix older and returning to school adults along with younger traditional students while the students from HSES areas are likely only young traditional students. The 2006 SBCTC report found that participation rates for younger students (18-24 yrs) in the LSES block groups were outpaced by those in the HSES groups. The trend is reversed when evaluating older (25+ yrs) students. Further examination is needed to comb this out.

The travel time necessities are demonstrated in this study to be important variables for determining the rate at which all adult residents actually enroll in higher education at the community college level. When broken down to the level evaluated by GWR, to assess non-stationarity, we did not find as clear of evidence of disparities between high and low SES. In fact, when overlaying the SES block groups with the regions that have highly negative coefficients for the travel time requirements there is no consistent pattern of impacts, suggesting that SES is not the dominant factor in determining who is most affected by increased travel times.

In addition to not knowing students’ ages, we also did not have racial characteristics. To make up for this deficiency, we included variables pertaining to the make-up of a block group by two major minority groups. Proportions of the population that are black had rather large positives estimates of the coefficients at very significant levels. The areas that do have a high black proportion are also areas that have short average travel times to campus, thus provoking the questions sought by Rouse (1995) as to whether this is a democratization event or a diversion. In other words, do the positive outcomes derived by being in close proximity to a Community or Technical College increase overall education rates of the population, or does it divert potential students away from a 4-year institution despite their potential ability to have been able to successfully navigate the university track, as they seek the
community college route that may not get them to the same endpoint. Though this study does not
directly address her question, it does provide future fodder for the argument.

In opposition to the observations of the black population, Hispanics showed a significant
negative relationship to attendance rates for the block group in the OLS regression and a largely variable
relationship when looking through the GWR lens. The variation coincided with variation in SES of the
block groups, with the LSES block groups producing the majority of the negatively related coefficients
and the HSES block groups producing the positive relationships. The LSES finding has been observed in
previous studies. Kaufman, Alt, and Chapman (2001) found that Latinos have the lowest rates of college
enrollment along with the highest high school and college attrition rates of all major ethnic groups in the
US. Thus we would expect to see total enrollment rates drop in a block group as the Hispanic population
increases. Though not directly discernable here, the discrepancy between high and low SES groups has
been previously demonstrated by Bohon, Johnson, and Gorman (2006) who found difference in
aspirations and expectations among the various groups classified as Hispanic in the 2000 census. For
instance, Mexicans and Puerto Ricans are more likely to belong to the impoverished underclass and
show vast differences in expectation and enrollment as compared to Cubans who are often middle class.
Thus when viewing the results of this study it may prove vital to understand the nature of ‘Hispanic’ that
is being considered. Further, this negative relationship with the LSES groups will likely prove to be a
substantial issue in the years to come as the Latino population is the fastest growing minority group in
the US and are severely underrepresented in the educational systems.

Though we do not achieve a large explanatory power of the variation in enrollment rates, this
study does account for a significant chunk of it that has been predominantly left out of the higher
education literature. Future effort, with more complete and timely (as related to census collection
year) data, should examine not only differences between SES groups, but also differences between rural
and urban populations as well as compounding effects of travel time and public transportation access in

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urban areas. As community colleges appear to be an attractive option for LSES black populations, we must further consider the diversion versus democratization debate, to minimize the potential shortchanging of those students.

The geographically weighted regression techniques used here demonstrate the high variability in population reactions to increasing travel requirements that were they to be only considered from a global model would be glossed over. Subsequently, when seeking to consider the local affects of transportation and more importantly the spatial relationship of institutions and services like community colleges to the populations they seek to serve, researchers and the models they choose should be spatially sensitive to potential spatial mismatches based on unequal responses to stimuli.
LITERATURE CITED


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