

# *Geospatial Analysis of Female Labor Outcomes: Spatial Entrapment*

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**Abstract** — *The seminal literature of feminist and critical geographers has proven that women live in a constrain pattern of space-time that stops her to discover her opportunities to work and travel. Using the available data in the Census Public Use Microdata Sample and Areas, with the tools of Spatial Science, we set out to visualize the effect of gender role on mobility to work. The application of a mixed method empirical approach, to the spatial entrapment hypothesis in Puerto Rico yielded results of a correlation between social-economic characteristics, space and mobility to work. Leading to the conclusion of gender inequality in the workplace and in the household.*

**Key Terms** — *Commuting, Feminist Geography, Gender Gap, Spatial Entrapment.*

## **INTRODUCTION**

It's a documented fact that labor market accessibility for women is limited [1]. Such a statement comes from the assessment that a person's residential history is likely to play a role by shaping awareness of employment opportunities [2].

We looked to understand how women's location affects labor markets outcomes, such as labor market participation, occupational status and wages. Since their entry to the labor market, women's participation in the labor force depends on: marital status, presence or absence of children, educational level, ethnicity and accessibility to appropriate jobs. 'Appropriate jobs' in the 1960's and 1970's were those in which women predominated, such as, cashier, secretaries, school teachers and nurses. Nowadays, women are present in every level of the labor market but as will be discussed here, women work closer to home than their male counterpart and that the closer women work to home the higher the probability to fill an appropriate job in the market [2].

A similar conclusion was found in the spatial entrapment hypothesis. It generally argues that women's traditional gender roles (i.e., children, housework, errands) inhibit their labor markets status by constraining their space-time budgets [3].

Not first in the scene, but certainly trying to balanced theories of the past with technology of the presence, are Susan Hanson and Geraldine Pratt with their book *Gender, Work and Space* in 1995. They resurrected the segmented labor market theory, from its eclipsed counterpart of neo-liberal researchers and demonstrated beyond any reasonable doubt, that labor markets are unfairly structured to the disadvantage of women, the manual working class, the poorest people and racial minorities. Give in detailed the host of forces at work on the life of women, including gender, class, division of labor, parenting, community, geography and race.

In later years, Hanson et al [4], re-wrote the methodological issues of the book, crafting an approach that identified different groups of women and defined a geographic scale appropriate to each woman. They assessed methodological issues of other researchers, as all previous studies established that the characteristics of the area in which people live (local context) affects people's labor market outcomes, analysis that yielded very little support for the notion that location affects employment outcomes. Study that yielded results unexpected, even to the researches, that locally available employment opportunities are important to single moms with part-times and high educational level.

Such space-time studies of all over the world shows similar results indicating that home and work for women are concentrated in small areas of regions studied, making more but shorter trips (in both time and distance), exhibiting a higher propensity to trip chain and undertake more child-and-home-oriented travel.

In a more contemporary approach, Rapino & Cooke [5] take the study of commuting and gender roles a step further making a national model with same sex couple as a control group. Leaving nothing to chance, they use Public Use Microdata Sample of the 2000 U.S. Census, that is individual level data of 3,000,000 correspondents and to control the over- or under predicted spatial structure, they the Bureau of Economic Analysis component economic areas as spatial fixed effect, a parameter estimate to better predict regional spatial variation. Using the spatial entrapment hypothesis, they directly identified the influence of gender roles and successfully used same sex partners as benchmark to compare commuting times, to infer the effects of gender roles on mobility to work. Suggesting that in the absence of traditional gender roles or a more balance division of labor within the home, women's commuting patterns can mimic men's.

We looked at the academy of feminist geography for the validation of social justice and the Geographic Information Systems/Science for the tools to encompassed visualization and understanding of spatial aspect of human activity, as many have done before us. But unlike the previous researchers, we are approaching concepts like municipio an exclusive measure used in Puerto Rico. A place with complex social-economic and demographic tendencies, where the discussed literature results are a given, taken at face value, with little to null in-depth research. Statistics where easily found, but a research or investigation with a model or analysis of the pertinent information was not found in the last year of research.

### **Objectives & Purposes**

The main objective of this study was to determine if the distribution of labor opportunities in the studied area affected the female participation in labor markets and occupation status, with the intention to re-represent a phenomenon, to put into question its dominant interpretation, by demonstrating what happens when you have to abandon conventional urban measure to complex and individual structures.

The purpose of this investigation is to contribute to the understanding of how people relate to their surroundings, depending in their perspective. Mapping, alongside with GIS, are an analytical tool to visualize patterns of space and events, which depending on experience and academic field are interpreted.

### **Research Questions**

When developing research questions, their focus was to evaluate the impact, if any, and at what scales was location and space in the everyday life of females and their labor force outcomes.

1. Does location affect the probability that a woman is employed or that employed, she will work in an appropriate job?
2. At what geographical scale does place affect labor market outcome?

### **THEORETICAL FRAMEWORK**

The framework use is similar to those in other investigations, geospatial science, and feminist geography. It was chosen this way to re-represents a phenomenon and to question the dominant interpretation.

#### **Spatial Science: "Mapping Spatial Relations"**

One geographic paradigm that relates to this kind of research is Spatial Science. It lies on objectivity and generalization to study causal relations and adopt empirical support. It also adopts what is said to be a 'realist approach to representation'. Its analytical approaches rest in descriptive and multivariate statistical analysis; mathematical analysis; simulation; GIS overlay; survey research; behavioral modeling; and carbon dating. Its data approach can vary between Census data, field methods and remote sensing.

Present day interpretation of spatial science is melted into Geographic Information Systems/Science and later molded into a computer program that has the theory but it's not tangible to those non-GIS academics. This means that spatial analysis has broken the chains of inter-disciplinary approach to a multi-disciplinary approach; it has

become a universally applicable tool for analysis [6]. None the less, spatial analysis which focuses on measurements of properties and relationships that incorporates or is expressed in space is still inclined to view observations in the traditional way.

### **Feminist Geography**

From the realm of Critical Geography, feminist geography is the forefront in questioning the dualist philosophy that underlies the notion of the objective self. Although its practitioners recognize and seek to problematize the disembodied deployment of geospatial technologies, yet, simultaneously acknowledge the possibility for feminist visualization within the confines of masculinity techno-science in ways that both capture and further our understanding of "differences and subjectivities" [7].

Feminist geographers built new ways of understanding gender division of labor exploring why women undertake the majority of domestic labor and caring for dependents, why men and women do different jobs in the labor markets, under different conditions and for different rewards, but also began to ask how assumptions into job descriptions, embedded within the cultural practices of capitalist organizations and reflected in different rates of financial remuneration [8].

Feminist geographers use spatial analysis to further goals of social justice; to produce knowledge on the nature of social inequality, through oppression, discrimination, objectification, patriarchies, stereotypes and art; examine the social role of women and her experiences, interests and practices. It studies the real/emotional experiences of individuals and/or groups in their place and their relation to the space and places surrounding them. Its linking the transformation of public urban space to class and gender processes occurring within private spaces and households.

Their analytical and data approach lies in field methods beyond standard data sets, since they are inherently biased and influences research questions and outcomes and statistical analysis.

### **Theory Laden**

The research approach chosen is based on a priori knowledge. Even though we ask questions and understand that what we find is shaped by the theoretical framework we adopt, it's not determinate by it. The theory we use to interpret a particular situation or a set of '*facts*' certainly shapes how we view them and what we understand them to be but it does not determine what we find.

### **METHODOLOGY**

For the purpose of the study a mixed method empirical approach was used. When concern with female labor outcomes, and using the theoretical framework of feminist geography we needed a local spatial scale with an individual level context of data of qualitative nature. Such as marital status, race, household income, gender, same sex partners, age, presence/ absence of children, type of work, travel time to work, trip-chained, and the likes, (*see Table 1*). Later, they were given a value, so we can turn a qualitative analysis into a statistical verify one.

#### **Methodological Design**

Since this research is of an exploratory nature, and we wanted to better comprehend an event and so, we developed a transversal exploratory design of correlation between variables. Our objective was to determine and describe the relation between variables, if one may exists at one moment in time. Two stage approached was taken; first with the exploratory stage conducted using descriptive and inference statistics then logistic regression analysis of spatial statistics.

#### **Data Source & Study Area**

The data used to pursue an investigation into spatial entrapment hypothesis came from the Public Use Microdata Sample. Which in turned are a sample of the actual responses to the American Community Survey & Puerto Rico Community Survey of the U.S. Census. This is a nationwide survey design to provide communities with reliable

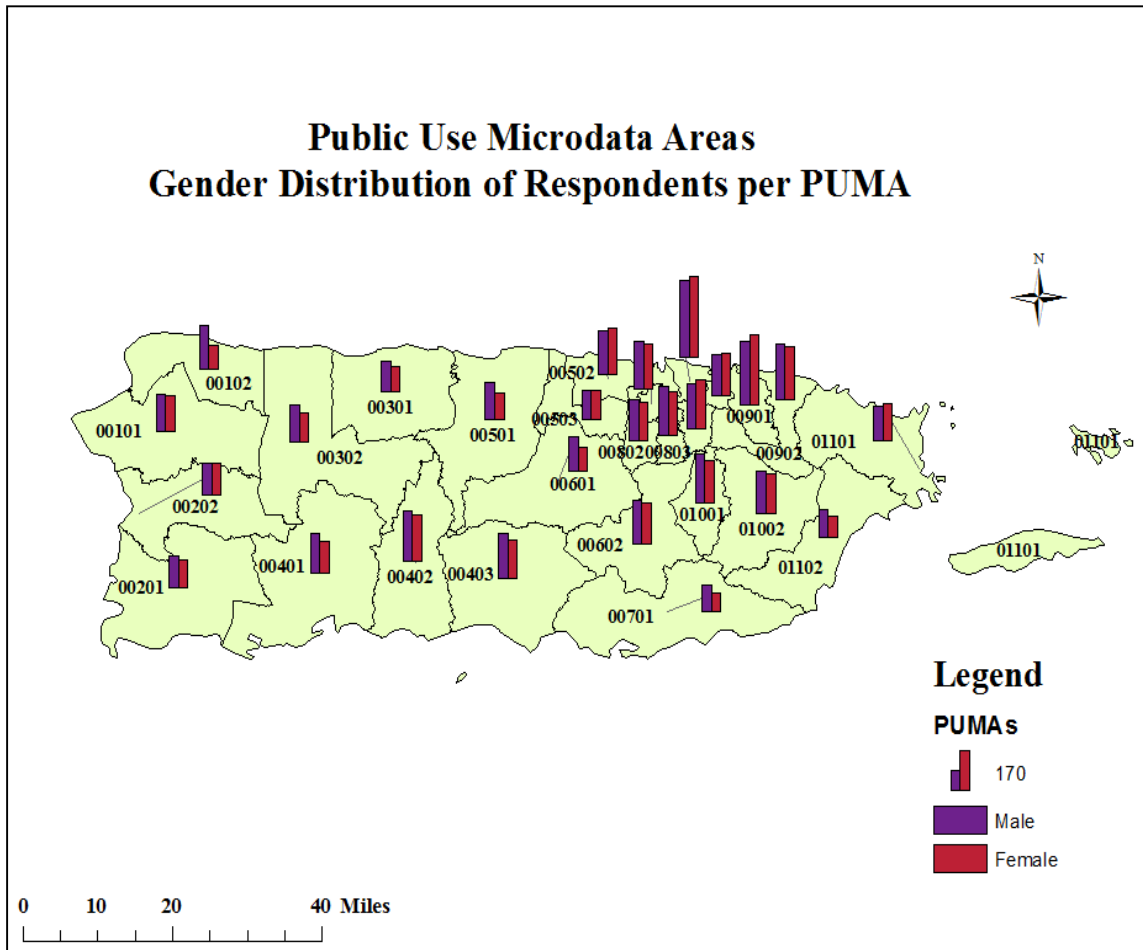
and timely demographic, social, economic and housing data every year.

The PUMS sample was selected from the full sample of ACS records to include one percent of the housing units and one percent of the person records in the U.S and P.R. The sample size was based on the Population Estimates Program. The systematic method used was sampling intervals, determined by the ratio of the number of interviewed records available for sampling and the required sample size [9].

To protect confidentiality of individuals, they limited the geographic area codes available on the PUMS files. The only geographic codes available are those of the Public Use Microdata Areas (PUMAs), designed as areas with 100,000 residents

or more based on population report form 2000 U.S. Census. For the 2012 PUMS person records, our study data, the PUMAs are based on the population report of the 2010 U.S. Census. Now Puerto Rico has 27 PUMAs, instead of nine like the PUMAs of the 2000 (See Figure 1).

The 2012 PUMS sample of one percent for all of Puerto Rico is 33,057. They were 17,737 female correspondent and 15,684 male correspondents. Of those numbers, 5,765 records were either empty or not relevant to the studied population of 16 and older in the labor market. Only 4,691 males and 4,307 females have the dependent variable. We used the data relevant and important of the studied population and dependent variable.



**Figure 1.**  
Map of Gender Correspondents per PUMAs in Puerto Rico

**Table 1**  
**Variables Description**

Dependent Variable	Travel Time
Sample group variables	Marital Status Gender
Socioeconomic Characteristics	Household Income Age Children > 5 Children <5
Educational Level	High School/GED College
Transportation Variable	Personal Vehicle
Industry/Occupation	Manufacturing Producer services Consumer services Construction Social services Distributive services
Work Hours	Full Time Part Time
Spatial Structure	Puerto Rico Public Use Microdata Area

## STATISTICAL ANALYSIS

Statistical analysis has techniques to summaries and describes numeric data to facilitate their interpretation [10].

### Descriptive Statistics

- Frequencies - For establishing tendencies and similarities of variables
- Arithmetic Mean - Highly used technique for the average of the distribution of sample obtain.
- Standard Deviation - Average deviation of the points in the mean results.

### Inference Statistics

- Pearson Coefficient- Indicates the existence or non existence of correlation between variables by calculating the relations between them.

### Spatial Statistics

- Regression Analysis - allows to model, examine and explore spatial relationships, finding linear relationship between a dependent variable and set of exploratory variables.

- Ordinary Least Squares - global and local regression model
- Spatial Autocorrelation (Global Moran's Index): measures spatial autocorrelation (clustering or dispersion) based on feature locations and attribute values.
- Cluster and Outlier Analysis (Anselin's Local Moran's Index): identifies clusters of high or low values as well as spatial outliers.

## Instruments

The instruments used for this research were the U.S. Census PUMS, and the software's use to pursue the exploratory stage of the research was Microsoft Office Excel plug-in Data Analysis. For interactive terms and the spatial analysis of regression and OLS we used the open source software of GeoDa regression toolset, due to its approach for social science statistics and ESRI's ArcMap-Spatial Statistics toolset for the geographic or spatial relevance.

## RESULTS

Many of the results from the demographic and socioeconomic variables were expected and conform to previous studies. In terms of socioeconomic characteristics, household income has a significant effect on commuting time. Interestingly, having children under the age of five years is not significant, but children age five and older is significant. Using a personal vehicle is relatively significant to commuting times and but surprisingly, typically female dominated occupations found in the social services industry were of significance non to the model.

### Basic Effect - Exploratory Analysis

Marital Status is significantly linked to commuting time, as well as college education or careerists to commute for work. Surprising and unexpected was the negative significant of age, meaning that age is a limitation to commute. Additionally, worked hours in full time jobs are important to commute times. (See Table 2.)

When studying the spatial entrapment hypothesis, we propose that women's labor market and travel to work areas are limited as a result of the constraining effect of the household. But a quick observation to Table 3 basic statistic summary by gender, there is little difference in the commute distances of men and women and that the assumptions of the spatial entrapment hypothesis are outdated.

**Table 2**  
**Pearson's Coefficient**

Variables	Pearson's Coefficient
Marital Status	.0303
Gender	-.0147
Household Income	0.0652
Age	-0.0291
Children > 5	.0217
Children <5	-.021
High School/GED	-0.0556
College	0.094
Personal Vehicle	0.0353
Manufacturing	0.0099
Producer services	0.0278
Consumer services	0.046
Construction	0.0544
Social services	-0.067
Distributive services	0.041
Full Time	0.0287
Part Time	-0.0287

### *Interactions Terms*

The initial regression test ran gave perfect multicollinearity on varies interactions to really give a representative analysis. They were four variables with high Variance Inflation Factors, they were: sex, same sex partners, construction industry and producer industry, implying redundancy among the variables. It also gave a statistical significant Jacque-Bera test, pointing out that the model is missing an explanatory variable. After such results, we ran a second test without the before mention variables and the changes were noticeable.

**Table 3**  
**Comparative statistics between gender**

Variables	Women		Men	
	Mean	Std. Deviation	Mean	Std. Deviation
Travel Time	29	22	30	22

Marital Status	0.41	.049	.51	.50
Household Income	24,358	24,124	28,304	33,160
Age	42.	12.64	42	13.31
Children > 5	.297	.457	0	0
Children <5	.069	.254	0	0
High School/GED	.178	.38	.292	.455
College	.60	.49	.40	.49
Personal Vehicle	.909	.287	.921	.27
Manufacturing	.10	.30	.11	.31
Producer services	.03	.17	.03	.17
Consumer services	.48	.49	.52	.50
Construction	.06	.233	.05	.23
Social services	.29	.456	.28	.45
Distributive services	.042	.201	.034	.18
Full Time	.913	.282	.895	.31
Part Time	.0871	.282	.105	.31

Table 4 displays the overall fit for the regression model. The number of observations is 8,998. The constant for the model is of 36.66 and not significant at  $p < 0.01$ . The  $F$  statistic, which measures the model significance, is 16.4 with a  $p$  value of .188, results of little significant. The measure of how well the estimated values explain the variance in the observe values,  $R^2$ , explains 59 percent of the variations in the dependent variable. The Adjusted  $R^2$  represents 57 meaning that although the explanatory variables do not explain *all* variations in the dependent variable, it not a zero meaning no relation at all. The heteroskedasticity test at 14.23 means there is little dispersion between the observations and that indicates a relationship between soma of the explanatory variables and dependent variable.

**Table 4**  
**Model Result: Overall fit**

Constant	36.66
Observations	8998
$F$ statistic for model	16.42
$p$ value	.188
$R^2$	.592
Adjusted $R^2$	.577
Heteroskedasticity test	14.23
$p$ value	.00005

The linear logistic regression analysis performed with GeoDa regression toolset behave similar to the Coefficient analysis (see Table 2). The explanatory variables of significance are: Transportation, Marital Status, College degree and Income. With coefficients in the following order: 5.8; 2.3; 2.1; 2.9 respectively.

When running the model with ArcGIS Spatial toolset, that has the capability to run as many models as possible with all the variables, we found a high correlation between marital status, age, children older than five years old and the social and consumer industry with the travel time to work.

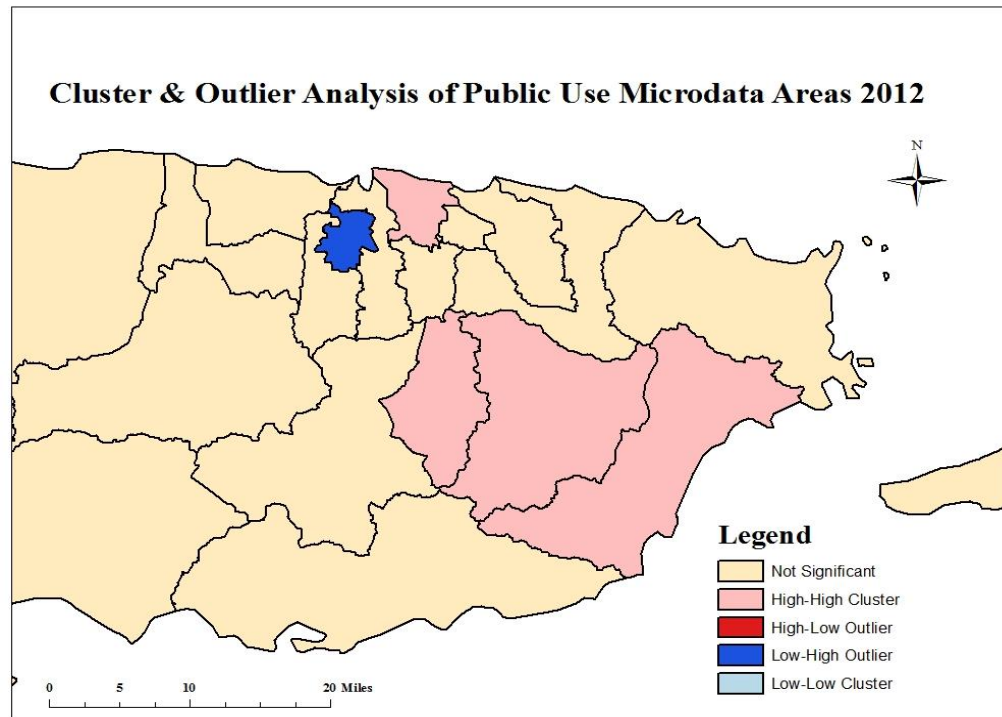
### Spatial Relevance

To observe the correlation between the variables and space, we used the Spatial Autocorrelation tool to interpret this context. We found an Index of .233587; z-score of 1.782 and p-value of .0748. The results of this test were that there is less than ten percent likelihood that this clustered pattern could be the result of random chance. There is not a complete spatial randomness but a likelihood of a pattern.

To observe the likelihood of this clustered pattern, we performed a Cluster and Outlier Analysis, yielding these results. We can observe an outlier in Bayamon, dissimilarity between it and the rest of the neighbors. To the southeast of Puerto Rico we see a high value cluster and similarity between neighbors. Same results with San Juan. We see pronounce random distribution of data between the spatial features and attribute values. There is a high not significant relation but perhaps a 10% chance of correlation.

### DISCUSSION

The results let us to conclude that there is spatial constrains to married, careerist-educated females, with children older than five years old, working in the industries of gendered occupations. Meaning three out of five of the variables of significance are related to socio-economic characteristics, making the spatial entrapment very much relevant. .



**Figure 2**  
Cluster and Outlier Analysis

The results of this study, lead to conclude that, females of Puerto Rico are encountering gender inequality in the home and in the workplace, very much in line with other global models.

### Limitations of study

A limited time frame made other methodological approaches unrealistic. The spatial approach and the study of spatial patterns defined the need for segmented data, setting the availability of PUMS, our primary source of information. But made the geographic/spatial variance limited to PUMAs.

### CONCLUSION

To conclude, does the study answer the research questions? The answer is partly. Does location affect the probability that a woman is employed or that employed, she will work in an appropriate job? At what geographical scale does place affect labor market outcome?

The analysis leads us to understand that there is a relation between married, educated females, with gendered occupations and children older 5 years old with the place their live. By using PUMAs, there is a high value cluster with spatial entrapment. But we also see space of no significance. Possibly meaning that people and especially females, are willing to travel whatever distance, no matter their situation or condition to work.

Because of the short accomplishment obtain with this investigation, it's necessary to develop our own raw data. We need empirical research approach with probabilistic sample of the population and systematic sampling to helps include the people relevant and pertinent to impact the study without the necessity of random selection, using a survey/questionnaire tool that can fit in the theoretical framework. Preferably, places/space with high population density, high housing density, work units.

As mention before, the use of PUMS was imperative, and therefore limiting the geographic variance to PUMAs. This brings the need for segmented data at geographic scale that cover

underrepresented areas, and identifies smaller/entrapped clusters within the U.S. Census and Puerto Rico Community Survey.

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