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Spatial Patterns of Crime in Cape Town

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An economic analysis of the relationship between property crime rates and proximity to neighborhoods with high violent crime

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Abstract

South Africa is among the most crime-ridden and crime-concerned countries in the world (UN-ODC 2002). Situated in the Western Cape, Cape Town has one of the highest rates of violent, property and commercial crime in the country. The apartheid government left both physical and social legacies unique to South Africa that complicate questions of crime patterns and make current literature on crime inadequate to explain Cape Town. This thesis uses an economic model of crime where individuals weigh the expected costs of committing a crime against the expected benefits to explore whether proximity to a high-violent-crime neighborhood increases property crime in middle and upper class suburbs. Using linear regression techniques, this thesis finds that contrary to popular belief, suburbs *furthest* away from violent neighborhoods experience higher property crime rates even after holding income and other neighborhood variables constant.

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Introduction

South Africa is considered among the most crime-ridden and crime-concerned countries in the world (UN-ODC 2002). Situated in the Western Cape, Cape Town has some of the highest rates of violent, property and commercial crime in the country. Despite growing expenditures for safety and justice, reaching R617 million (US$92 million) per year, the expectations that high crime rates would subside following the first democratic elections of 1994 have failed to materialize (UN-DOC 2002; Haskins 2007). South Africa has gone from GDP growth rates of -0.6 percent shortly following the end of the apartheid to positive rates of 2.2 percent by 2001 (UN-DOC 2002). Despite this growth, per capita income remains low (US$2,900) and the country is characterized by unusually high and growing income inequality with Gini coefficient estimates ranging from 0.56 to 0.73 (Hoogeveen and Özler 2006; Leibbrandt, Poswell, et al. 2006). Extreme inequality is arguably linked to crime (Ehrlich 1973; Chiu and Madden 1998; Bourguignon 2001) because such disparities situate the underprivileged in close proximity to the wealth of the upper classes.

The apartheid government left both physical and social legacies unique to South Africa. Like other urban areas across the country, Cape Town's landscape today includes a rigid system of underdeveloped black townships and poor colored neighborhoods that are remnant of the Group Areas Act of 1950.[1] Most western literature reports on patterns of concentrated crime rates in city centers and poor areas (Shaw and Mckay 1942; Boggs 1965; Andresen 2006) but

[1] The term "colored" is used to refer to an ethnic group of people who possess some degree of sub-Saharan ancestry but were classified as distinct from black populations by the apartheid government because of their European, Indonesian, or Indian ancestry. Despite having negative connotations in the United States, the term "colored" does not carry the same history in South Africa and is still commonly used today alongside "white" and "black" to describe the other two prominent races.

less attention is given to the interaction of poor neighborhoods with their wealthy neighbors. For this reason, the current crime literature cannot fully explain the crime patterns in Cape Town. The uniqueness of Cape Town calls for an in-depth analysis of crime to fill the gaps left by western scholars.

Property crime concerns both entrepreneurs and residents. Cape Town businesses cited crime as the biggest challenge facing the city while residents rated it second, especially in the non-township suburbs (Benjamin, 2007). Likewise, potential investors cite crime as the biggest deterrent to investment in South Africa (EIU 1999-2000)[2] and firm surveys indicate that employers consider crime as the most important constraint to growth (Bhorat and Kanbur 2006). While statistics show that whites are more likely to be victims of property crime (UN-OCD 2002), expression of their fear of crime is criticized as having racial undertones. In a Political Report to the National Conference of the ANC, President Nelson Mandela compared the "white fear" of crime to the political strategy used by whites around the time of transition,

> "The prophets of doom have re-emerged in our country. In 1994, these predicted that the transition to democracy would be attended by a lot of bloodshed... (Now) their task is to spread messages about an impending economic collapse, escalating corruption in the public service, rampant and uncontrollable crime…" (Political Report of the President, 1997).

The racial currents that run through these debates are clear legacies of the era where race was the defining characteristic of one's identity. This paper does not set out to test the fears that crime rates with increase across the city with the end of the apartheid. Instead, this paper acknowledges the new mobility of black and coloreds, and simply looks at where those crimes are being committed. By introducing another approach to analyze crime patterns in Cape Town, the current

[2] As cited in UN-DOC 2002.

study will help determine whether the debated "white fear" of those closest to black and colored neighborhoods is based in truth. In other words, by asking the question, "Does proximity to high violent crime neighborhood have a greater effect on property crime rates than income in middle and upper class neighborhoods in Cape Town?," I hope to uncover the significance of location to determine who is really at risk.

A spatial analysis of crime in Cape Town has the potential to benefit policy makers in their pursuit of more effective policies and efficient resource allocation that come from better anticipation of crime targets. Beyond Cape Town policy makers, the results will also be helpful for city planners everywhere by shedding light on consequences of segregation and the dangers of extreme inequality.

This paper is divided into six sections. Section I describes Cape Town's physical landscape and provides other background information that will better familiarize the reader with the present situation. Section II summarizes the current literature on both the economic and spatial explanations for crime while section III introduces the theoretical framework that supports my question and shapes the model for estimation. Section IV details the data and variable definitions. This section also presents summary statistics and preliminary analysis based on what those numbers suggest. Section V presents the regression results and interpretation of the coefficients. Finally, Section VI concludes by summarizing my findings and suggesting directions for further research.

I. Cape Town Description

Cape Town sits at the top of a peninsula that extends 50 kilometers south from the city center and ends with the Cape of Good Hope, the symbolic eastward turn for Portuguese colonialists. Table Mountain, the prominent landmark that sits in the middle of the Cape Town metropolitan area, begins a small mountainous terrain that winds down the middle of the peninsula. Nestled in between the mountains and the shoreline is beach property with large homes that are owned by both locals as well as foreigners who use them as vacations homes. **Figure 1** shows an example of these properties along the coast. The Cape Town metro area consists of the Cape Town City Center as well as individual residential suburbs that spread in all directions from the city center.

The city center looks and operates much like downtown areas in the United States: it has tall skyscrapers that host offices and corporate headquarters; government buildings, hotels and hostels; handicraft shops and open air markets; as well as prominent night life destinations. **Figure 2** is a photograph shot from the edge of the downtown area with Table Mountain in the background. In addition to the bustle created by the commercial activity, the city center also serves as a public transportation hub because of its position between the beach suburbs and the rest of Cape Town. Finally, the waterfront area borders the downtown area and attracts many tourists because of its shops, seaside restaurants, and the loading dock for ferry trips out the Robben Island, the infamous prison where Nelson Mandela served the majority of his 27 year prison term.

The suburbs that radiate away from the city center each have a distinct history and character. The suburbs immediately outside the city center are densely populated wealthy suburbs that have, as a consequence of its proximity to the beaches, a significant amount of

rental property for young professionals as well as developed lots for established locals. Located just east of the downtown area is the historic District Six, which was a former black and colored community that was forcibly removed and transplanted to townships on the outskirts of town at the height of the apartheid government. Today, District Six blends in as part of the wealthier Cape Town landscape. Further from the city center the suburbs are middle and working class neighborhoods. During apartheid, these would have been primarily white neighborhoods because of their proximity to the city center and nice views of the mountain. Today, they remain mostly white neighborhoods but are home to a growing number of middle class blacks and coloreds. **Figure 3** and **Figure 4** show an example of homes in a middle class neighborhood, Mowbray, which is approximately 6 kilometers from the city center. The pattern of very few street level windows and barred doors should be noted as one possible example of how high rates of property crime influence local architecture.

More inland and away from the mountain, the landscape is dominated by black and colored townships. The townships themselves were created as another means for racial segregation and oppression; their design and layout therefore reflect that objective. Hoping to contain the sprawl and growth of these neighborhoods, government officials used physical boundaries such as highways and train tracks to define the official township spaces. As a result of this design, and increased urban migration since the end of the apartheid, informal settlements- entire neighborhoods of shacks- are squeezed right up against the freeways that run into Cape Town, as can be seen in **Figure 5** and **Figure 6**. Given the hierarchy of racial status during the apartheid, the black townships were maintained at a much lower living standard than the colored neighborhoods, which do not typically have informal housing systems. While many improvements have been made since the end of the apartheid, these neighborhoods are still

characterized by poor living standards, poverty, unemployment rates as high as 50 percent, high rates of disease and illiteracy, and infamously high rates of violent crime.

Given this layout of the city, public transportation plays a critical role in bringing the low skilled workers from the townships to the wealthier suburbs where they work. For that reason, the Cape Town transportation network includes above-ground rail trains that service routes leading into downtown and the residential suburbs, as well as some of the beachfront areas. The taxis, or minibuses, operate in addition to the trains and are often the preferable means of transportation because of their flexible routes. Less commonly used are cabs that function much like taxis and cabs do in the US: a driver transports an individual or a group to a specific destination and charges by the distance traveled. Cabs in Cape Town are relatively more expensive so very few locals use this mode of transportation.

II. *Literature Review*

Although many factors affect crime, it is inherently an economic phenomenon. Economic models of crime have their origin in Gary Becker (1968). In this seminal work, Becker proposes an occupational choice model that considers the differential gains from legal and illegal pursuits. Hellman and Apler (1993) restate this model to suggest that the number of offenses is a function of the potential gains from the crime weighed against the probability of being arrested times the cost of being convicted. In addition to the costs of being arrested, these models imply that criminals also consider the direct costs of travel to high income areas and weigh them against their potential gains. In Cape Town, travel costs can include a walk across a busy street into a neighboring middle class neighborhood or a train or taxi ride across the city.

The literature on spatial patterns of crime started with Guerry (1831)[3] who used crime statistics for different areas of France to show that property crime was concentrated in high income areas while violent crime was more common in low income areas. These findings support Becker's economic model: the gains from property crime are greater where high income households can afford more valuable property. Shaw and Mackay (1942) build off of this finding and study criminal offense patterns in Chicago over time. They find a similar distribution of property and violent crime as Guerry and add that these rates persisted amid population changes. They conclude that three urban conditions contribute to crime: heterogeneity (economic and social), mobility, and poverty. Another early study by Boggs (1966) divided crime into narrower categories and looked at patterns across those categories. The results suggested a pattern wherein rates of business robbery, non-residential burglary, auto-theft, and grand larceny are higher in high social rank areas adjacent to low social rank areas where the offenders live. In terms of Cape Town, there is very little debate that offenders of property crime reside in townships (Demombynes and Özler 2006; Weir-Smith 2004) and seek targets outside their neighborhood where the returns are potentially greater.

Evolving from the empirical studies described above, the *routine activity theory* explains crime patterns as being linked to routine activity spheres of individual victims and offenders (Cohen and Felson, 1979). The theory predicts that victimization is explained by daily routines of an individual, which in turn is influenced by demographic variables. Given that different socio-demographic and socio-economic conditions exist in different places at the same time and therefore exhibit different routine activities, criminal victimization is said to be neither random

[3] As cited in Johnson, et al. 2007.

nor uniform across neighborhoods (Mustaine and Tewksbury 1998). Weir-Smith (2004) uses interviews with substance abusers and offense statistics to test routine activity theory in South Africa. The findings challenge the theory and contend that substance abuse criminals operate beyond their routine activity sphere- implying significant travel distances. Weir-Smith concludes that South Africa does not fit into theories created to explain crime patterns in the developed world because criminals are more mobile and less community-bound than the theory predicts. While the present study does not explicitly test *routine activity,* we might expect the predictions of Wier-Smith to explain the spatial patterns of property crime in Cape Town and how they are different from common patterns in the developed world.

While many empirical studies consider spatial crime patterns with relation to nearby impoverished neighborhoods in developed countries (Andresen, 2006; Ceccato, Haining and Signoretta, 2002; Martin, 2002; Wang and Minor, 2002), few analyze the situation in low- and middle-income countries. Portnov and Rattner (2003) study crime patterns in Israel using an index of relative income among neighboring localities as an explanatory variable. They find that affluent neighborhoods surrounded by poor neighborhoods tend to exhibit higher rates of property crime than poor neighborhoods surrounded by wealthier localities. They predict that wealthy areas may become magnets for the 'crime-prone' residents of nearby low-income neighborhoods. They also find that as the distance between neighborhoods increased, the interaction between residents declines. This conclusion supports 'distance-decay' theory that as the distance between towns grows the interaction of the respective residents declines. Given that the present study also explores spatial crime patterns in a developing country, we might expect to see similar results in Cape Town.

What remains is a gap in the literature that unites these branches of research and looks at spatial patterns of crime in Cape Town. Weir-Smith's (2004) study of drug trafficking and leisure patterns claims to be the first to use South Africa crime statistics and GIS analysis to better understand criminal behavior in broader South Africa. This paper takes an even more local approach to see the ways in which Cape Town crime patterns are different and similar to what the literature predicts.

III. *Theory*

Rational criminals will commit a crime if the benefits exceed the cost of the crime (Becker 1968; O'Sullivan 2007; Hellman and Alper 1993). Given the uncertain nature of crime, the calculation of costs and benefits is based on expected values and therefore must consider the likelihood of different outcomes. For criminals considering property crime, the benefit is measured by the value of the property obtained. The costs, on the other hand, are more complex. A criminal will consider the physical costs required (a gun or knife, clothing disguises, and travel costs), the cost of being arrested (fines, prison times, and probation costs), and the probability of being arrested (Hellman and Alper 1993). These costs and benefits differ for each crime so each crime decision is made on the margin, with the criminal weighing the additional benefits against the additional costs.

A simple measure of the marginal benefit (MB) of a crime is the potential resale value of the property. Such resale value will, in equilibrium, equal the value of the total potential utility that could be derived from the property if kept by the thief. I assume that the criminal is unable to systematically target high-profit targets first so the benefit of any potential crime is its

expected value, which does not vary across targets. For this reason, the criminal faces a flat marginal benefit curve as a function of number of offenses.

Because there are more people interested in his arrest and an increased likelihood that they can describe him, the marginal cost (MC) of a crime will increase as a criminal commits more offenses. For that reason, the criminal faces an upward sloping MC curve. **Figure 7** shows a simple equilibrium that combines the two effects just described. The criminal maximizes the net benefits of crime by choosing the number of offenses so that the marginal benefit of committing the last crime equals its marginal cost (at the intersection of the MB and MC). A smaller number of offenses results in forgone positive net benefits, while any crime committed beyond the optimal number has expected costs that exceed the expected resale value.

The expected costs and benefits of a crime vary spatially across the city of Cape Town. **Figure 8.1** compares the marginal benefit of crime in a low-income neighborhood versus a high-income neighborhood. Since property held by individuals or households in high-income areas is likely to be of a greater expected value, the marginal benefit of committing a crime in that neighborhood is greater than that in the low-income neighborhood. **Figure 8.1** depicts this, holding marginal costs constant: the marginal benefit curve for the high income neighborhood intersects the marginal cost curve farther to the right and results in a higher number of offenses in that neighborhood. In other words, if a criminal is going to steal outside his community I expect him to opt for wealthy neighborhoods because the net benefit is greater.

Holding marginal benefit constant, an offense in a distant neighborhood will require greater travel costs than a neighborhood adjacent to the criminal's neighborhood. Consistent with taxi and train fares and walking time in Cape Town, I assume that travel costs increase linearly

with distance traveled. As **Figure 8.2** illustrates, this greater marginal cost (represented by the leftmost MC curve) results in an equilibrium with fewer offenses. In Cape Town, we expect to see more offenses occurring in neighborhoods close to where the criminals live.

Given that these two effects are in place, I hope to determine the relative magnitudes of these effects. Is it the increased marginal benefit from a high income area or the decreased marginal cost from an adjacent neighborhood that provides greater motivation for a crime?

In addition to the marginal cost and benefit, the criminal's decision to commit a crime depends on other characteristics of each neighborhood. Proponents of *social disorganization* theory argue that a high degree of social and economic deprivation and population turnover in a neighborhood contribute to social disorganization and creates an environment conducive to crime (Andresen 2006). I control for this effect by including unemployment rates, population density, ethnic composition, education levels, and home ownership for each neighborhood in the model. I expect a positive relationship between crime and social disorganization variables.

Given the nature of the city center as a transportation hub and an area of high economic activity that attracts people from all over Cape Town, proximity to it might increase crime rates in nearby suburbs. Adding an additional variable that measures the distance from each suburb to the city center will allow the possibility that criminals make their decision with the city center as their starting point because of its centrality and easy access point to other suburbs. For this reason, I expect a negative relationship between distance to the city center and property crime rates.

Finally, physical neighborhood characteristics also matter (Anselin, 2000; Boggs, 1965). A measurement of land use (commercial and residential) in each neighborhood will approximate the amount of economic and residential activity, the number of pedestrians and the number of parked cars. I expect to see more crime in residential and commercial areas.

Simply written, the model to be estimated is:

$$\text{Property Crime Rate} = \alpha + \beta_1 \text{Marginal Benefit} + \beta_2 \text{Marginal Cost} + \beta_3 \text{Social Disorganization Variables} + \beta_4 \text{Land Use} + e$$

Where α is a constant and the β are slope terms to be estimated and e is an error term which is normally distributed around a mean of zero.

IV. *Data and Summary Statistics*

Given the complexity of crime, there are many ways to approach this question. Ideally, measures of train and taxi travel times, fares, and routes and the resale value of the property stolen would appear in the data set. Such measurements would more accurately describe the decision that criminals face. Additionally, the probability of arrest in the subject suburbs would control for the varying riskiness of those neighborhoods. Unfortunately, the available data falls short of this ideal and therefore alternative measurements and variables are used.

The original sample includes 161 suburbs but is reduced to 137 because of missing data, industrial areas or ambiguous aggregating in the ArcGIS shape files of areas on the outskirts of the metropolitan area[4].

In order to perform the analysis, the remaining sample needs to be divided into two groups: one group of subject suburbs whose proximity to the second group is tested for explanatory power on the crime rates. The task of categorizing the sample into two groups could be done in several ways. Ideally, we would have data on the exact location of residence for all Cape Town criminals who commit a crime outside their neighborhood and would use those neighborhoods that produce the most criminals as our second category. In the absence of that data, other means must be considered. Following from the social disorganization literature, variables that reflect a breakdown in the local cohesiveness of a neighborhood would be a reasonable measure for categorization. As pioneers of delinquency theory, Shaw and McKay (1942) found that the slum areas of Chicago were the breeding grounds for delinquency due to weak social control. As a result of that weak social control, both violent and property crime emerge as a new system of rule with criminal traditions being passed onto fellow members of the community, known as cultural transmission. Following from this, I make the assumption that neighborhoods that report high violent crime rates subscribe to a criminal culture that would

[4] The following suburbs are omitted from the sample because of missing data: Acacia Park, Cape of Good Hope, Somerset West Non-Urban, Table Mountain, Ysterplaat, Fistankraal. The following are industrial areas and therefore have no residential data: Epping, Erinvale Montague Gardens. These suburbs were reported in the census but were aggregated with other suburbs in the GIS shapefile, most of these suburbs fall on the outskirts of the metropolitan area: Atlantis Non-Urban, Belleville Non-Urban, Capri Village, Coniston Park, Dreyersdal, Doornbach, , Fairways, Firgrove, Frogmore Estate, Imizamo Yethu, Marina Da Gama, Milnerton Non-Urban, Phillipi Non-Urban, Red Hill, Schaap Kraal, Sheraton Park, Silvertown, Steenberg, Vissershok, Youngsfield. Robben Island is excluded because it is an island. The total population of these omitted suburbs is 60,810 with an average size of 2,027. The overall population for Cape Town, as reported in the census, is 2,856,659.

necessitate and celebrate property crime. For this reason, I categorize the suburbs based on those in the top 25th percentile of violent crime rate as the criminal base group while the rest are the subject suburbs of interest.[5] Under this categorization, there are 101 subject suburbs and 36 violent crime neighborhoods. **Figure 9** maps the distribution of the subject suburbs (in yellow), the violent crime neighborhoods (in pink) and the omitted suburbs (in beige).

The omission of certain suburbs could bias my estimates. Given that many of the omitted suburbs are on the outskirts of town, it is possible that the coefficient on distance will be biased depending on the crime patterns in these suburbs. If crime rates are high in these areas, for example, the model would underestimate the coefficient on distance because the distance variable for those suburbs would be large. Without those suburbs included, the model would under predict crimes in suburbs with larger distance variables. **Figure 9** shows a large area north of the city which initially might cause of concern, but this is mostly non-urban, agricultural land that has little residential area.

The data for this analysis come from two main sources. First, the crime data are collected by the South African Police Service (SAPS) and are aggregated by the police district within which the crime occurred. I aggregate eight categories of 2001 property crime data and exclude crimes without a clear property gain.[6] The data are in raw numbers for each police district. To

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[5] Violent crime was defined as murder, rape, attempted murder, assault with the intent to inflict grievous bodily harm, common assault, indecent assault, kidnapping, abduction, neglect and ill-treatment of children, culpable homicide, public violence, and arson.

[6] The following categories were defined as property crime and aggregated together for each suburb: Robbery with aggravating circumstances, common robbery, carjacking, burglary at residential premises, burglary at business premises, theft of motor vehicle and motorcycle, theft out of or from motor vehicle, all theft not mentioned elsewhere. Those that are not considered property crime with a gain, and therefore left out of the crime statistic include: murder, rape, attempted murder, assault with the intent to inflict grievous harm, common assault, indecent

achieve a crime rate per suburb, I distribute them to the suburbs within each district according to their relative population. Those police districts that are perfectly aligned with a suburb's boundaries are left alone. In cases where a suburb is divided between two or three police districts, I weight the crime statistics by population by relative area of that police district. Suburbs are assigned to police districts using shapefiles provided by the City of Cape Town's Corporate GIS for suburbs and police districts as organized in 2001.[7] The first two rows of **Table 1** and **Table 2** show the distribution of property crime in the total sample and subject suburbs, respectively.

Second, the socio-economic data are taken from the Cape Town 2001 census that was collected by Statistics South Africa but is made available through the City of Cape Town. **Table 1** gives the summary statistics for each variable for the entire city of Cape Town, and **Table 2** and **Table 3** summarize the data for the subject suburbs and violent crime neighborhoods, respectively. A comparison of the statistics suggests that the subject suburbs experience a slightly higher rate of property crime (152 per thousand people) than the entire sample (119 per thousand people). More whites concentrate in the subject suburbs (56.97 percent), compared to full sample (41.96 percent). Likewise, the income distribution shows an increase in the percentage of households in the top income bracket (from 8.74 to 11.32 percent) and a reduction

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assault, kidnapping, abduction, neglect and ill-treatment of children, culpable homicide, public violence, truck hijacking, bank robbery, robbery of cash in transit, arson, malicious damage to property, crimen injuria, illegal possession of firearms and ammunition, drug related crime, and driving under the influence. Truck hijacking was excluded because trucks are used for transporting and the theft of one in a certain neighborhood does not reflect on the suburb itself.Commericial crime and shoplifting were left out because of missing data for a significant number of suburbs in the data set. Stock theft was not included because there were no reported cases in the subject suburbs.

[7] The original shapefile contained 538 polygon shapes so the smaller localities were assigned to a suburb as listed in the census and their boundaries were dissolved to arrive at the map of suburbs used in this analysis.

of those in the lowest income bracket (from 25.92 to 19.55 percent) when the subject suburbs are isolated. These differences are even more dramatic when compared to the violent crime neighborhoods where the average percentage of lowest income households reaches 43.77, while an average of only 1.51 percent of households are in the highest income bracket.

Figure 10 and **Figure 11** aggregates this data to illustrate the relationship between property crime and income. **Figure 11** focuses on the band of middle income suburbs that are closest to the violent crime neighborhoods where theory would predict the most crimes to occur. The figure should also be looked at with respect to income and crime. Theory would predict higher crime rates in areas of greatest income. The absence of a strong pattern between crime and income or location calls the theoretical predictions into question and further motivates an empirical analysis of the spatial distribution of crime.

The distance variable is measured by determining the distance from the center point of each subject suburb to the center point of its *closest* violent crime neighbor. ArcGIS generates a centroid for each suburb and employs Hawth's Point-to-Point distance tool to create a matrix of distances between those points. This method has the potential to misrepresent exact distances because the size of the suburb affects the distance measurement. In other words, two small suburbs next to each other will report a much smaller distance variable than two large suburbs also right next to each other. While this issue could be problematic, it is less of a concern in this study because the variation in distances is large enough and there is not a significant number of either extremely small or extremely large suburbs. The distance to the city center is determined using the same method. **Table 4** summarizes both distance variables for the subject suburbs and

shows that on average, subject suburbs are within 6.53 kilometers of a violent crime neighborhood but are much further from the city center (average of 15.57 kilometers).

The income variable is the percentage of households with an income above R307, 201 ($41,457, 2008 USD) in the subject suburbs. Income percentages were found by combining the top two (the fourth and the fifth) income brackets reported by the census, with R307,201 being the bottom of the fourth bracket.

A preliminary analysis comparing 25th and 75th percentile values suggests an interesting relationship. For both distance and income, **Table 5** reports the values for the given percentile as well as an average with one value on either side of the observation to avoid the influence of an outlier. Without controlling for other important variables, this analysis suggests that suburbs that are closer to violent crime neighborhoods experience greater crime rates than those that are further away. For income, however, the table suggests a relationship that contradicts theory: suburbs with a fewer households in the top income brackets host greater property crime rates.

The gap between the ideal and available data creates room for error. Firstly, by nature, crime statistics are never entirely accurate. A benefit of analyzing property crime is that victims are more likely to report these crimes for insurance purposes. Additionally, the hope that the stolen property will be recovered might motivate reporting. If underreporting occurs in a systematic way, a selection bias might arise. For example, if street muggings that result in the theft of a cell phone are considered insignificant by the majority of victims, the model will be unable to predict to occurrence of these important crime events. Therefore, if street muggings are typically done by younger criminals who target nearby suburbs, the model would under predict property crime in neighborhoods close by and would therefore bias the coefficient on distance

downward. Additionally, conclusions drawn from the results might not reflect the true spatial patterns of crime if one significant category of crime, like street muggings, is underreported.

Local analysts (Spinks 2001) suggest that crime rate statistics in Cape Town have been politicized which raises even more doubt about their accuracy. Such doubt, however, is not reason to abandon analysis of crime in Cape Town. Rather I apply MacDonald's (2002) assumption that the reported data are simply a proportion of actual crimes committed and still useful for determining trends.[8]

Second, while the process used to assign crime statistics is systematic, it creates a large potential for inaccuracy. This process assumes some proportionality between crime occurrence and population but fails to consider other suburb level factors that might influence the location of crime. For this reason, the model may overestimate the frequency of crime in some areas with greater populations and underestimate crime in areas with smaller populations. Population, however, does not seem to be correlated with income (-0.14, p value of 0.1523) or the distance variable (-0.17, p value of 0.0896) which reduces the potential for a significant bias. None of the police districts cover significantly different neighborhoods in terms of socio-economic characteristics. In other words, many of the violent crime neighborhoods have a police district of their own and most of the overlap occurred among the subject suburbs. Third, the distance variable may be an imperfect measurement of travel costs because fares do not necessarily increase proportionally with distance. Travel time, however, does increase with distance as well as other obstacles like familiarity with the area. For that reason, the distance measure is a close

[8] MacDonald (2002) finds that an average of 39 percent of crimes in Europe, the UK and the United States are reported and justifies further crime studies based on the consistency of this proportion.

approximate for the burden of committing a crime in a distant suburb. A final concern is that of ecological fallacy, or the situation whereby concentrations of crime *within* a suburb are not revealed in the aggregated crime data but whose location can be explained by local factors. By using the smallest unit available and controlling for land use, I hope to limit this effect while still recognizing that the exact location of crime is unknown.

V. *Results*

An OLS estimating method is used to predict the relative magnitudes of the effects of distance and income on crime while controlling for local confounding variables. **Table 6** reports the results. The distance coefficient is significant but the sign contradicts theory. A positive coefficient suggests that the subject suburbs experience 13.05 more crimes per thousand people for every additional kilometer between them and the nearest violent crime neighborhood. In other words, suburbs that are further from neighborhoods with high rates of violent crime have a greater occurrence of crime per person than suburbs that are closest to violent crime neighborhoods. Such a result is surprising given the higher cost of traveling to far away suburbs.

This positive relationship might exist because households in suburbs near low income neighborhoods have invested in tighter security measures (taller fences and gates, dogs, alarm systems) to protect themselves from the perceived heightened risk of their neighbors. Likewise, perhaps residents of and visitors to more remote suburbs feel safer and are less likely to be on guard which makes them attractive targets. Another possibility is that criminals chose to travel further to commit their crime so that their escape destination is further away where they can hide more easily and decrease the chance of being caught. Finally, it may be that distance is an

incomplete measure of costs, as public transportation allows cheap travel across longer distances so that the relationship between distance and cost of travel is not a proportionally linear.

The positive sign on the income variable is consistent with what theory predicts, though this result falls just short of being statistically significant. Rational criminals seek the highest return and expect to maximize that return in wealthier neighborhoods where property is more valuable. The result suggests that as the percentage of households in the top two categories increases by one, 1.75 more crimes per thousand people occur.

Another interesting result is the negative and significant coefficient on distance to city center. As predicted, suburbs that are nearest to the city center experience higher crime rates- crime falls by 4.94 crimes per thousand people for every additional kilometer between the suburb and the city center. This suggests that criminals might also be making their decision of where to commit a crime using the city center as a starting point. Given its function as the center of economic activity, the city center also hosts the biggest public transportation hub with all train routes and many taxi routes leading straight to the city. It is also possible that given its position at the base of the mountain that divides the beach areas from the main metropolitan area, it serves as a transfer site for criminals targeting the beach areas and better explains crime rates than the distance to the nearest violent crime neighborhood.

The other coefficient that reports a significant and expected result is percent of business land use which predicts an increase in crime rates when a greater percentage of land is used for business purposes. This result supports both social disorganization theory and routine activity theory. In other words, for reasons of neighborhood cohesiveness, anonymity, and increased pedestrian and vehicle traffic, criminals target areas with greater business activity. The

coefficient on percentage of residential land use is positive but insignificant. The variable for home ownership shows an insignificant effect on crime rates. While surprising, it may be explained by Cape Town's history of apartheid and land reform so that ownership status does not accurately reflect neighborhood stability.

Given the amount of discretion in categorizing the suburbs into two groups, I test the robustness of the results to with two alternative specifications. Following from the social disorganization theory, I chose two other variables that might characterize the delinquent areas of Cape Town. First, income is used as a proxy for poverty, unemployment, and limited education opportunities in neighborhoods that therefore are, according to theory, conducive to criminal activity. Second, race is a particularly appropriate variable in Cape Town because while middle income suburbs have experienced some racial integration since the end of apartheid, the townships and colored neighborhoods remain segregated pockets of those two ethnic groups. I apply a method similar to that used for determining high violent crime neighborhoods, but for income and race. For the income category specification, I determine the 25^{th} percentile for the entire sample for the percentage of households in the bottom income category (less than R19,201, $2,258 US$2001). For the race specification, I find the 25^{th} percentile of the percent white population. **Figures 12** and **13** show how the suburbs of Cape Town are divided under the two other specifications. Comparing Figures 5-7 shows a cluster of neighborhoods that all fall in the category from which criminals are assumed to reside, with only a few neighborhoods that change position relative to others between the different specifications. As with the original specification, I estimate a linear regression model for each of the two and report the results side by side with the original results in **Table 7**. The results of the two additional specifications lend strong support to the patterns suggested by the original specification. With the exception of

minor changes in the magnitude of each coefficient, the direction and significance of each variable does not change across specifications.

VI. *Conclusion*

I use a cost-benefit model to predict the spatial patterns of crime in Cape Town suburbs with respect to nearby violent crime neighborhoods. By measuring benefit by income and cost as the distance to the closest violent crime neighborhood, I predict that more crime would happen in neighborhoods close to the criminal's base that have the greatest income.

The results of an OLS estimation model that controls for other neighborhood level contributors to crime suggest an interesting relationship. If distance to a middle or high income neighborhood is a good measurement of the direct costs of committing a crime, it appears that criminals from violent crime neighborhoods travel further to commit property crimes. In addition to contradicting theory, this result is particularly interesting because of the accused "white fear" of townships and violent crime neighborhoods. The common complaints that middle and upper income neighborhoods near violent crime neighborhoods experience greater property crime are not supported by the empirical analysis and suggest ulterior agendas of the complaints.

This result is also relevant for Cape Town policy makers and police forces who must protect a strong tax base in the interest of developing the urban area. It is possible that the relatively lower crime rates in the suburbs near violent crime neighborhoods are a direct outcome of concentrated police and security efforts. If that is the case, the results of this study suggest those measures are effective and should now be applied to those suburbs further away. Policy makers can also look at features of the more distant neighborhoods to try to understand whether there are certain characteristics of those neighborhoods that make the extra travel worthwhile for criminals. Given their proximity to the ocean, the distant suburbs are an attraction for tourists

who are unfamiliar with appropriate security measures. Additionally, policy makers can incorporate the strong relationship between business land use and crime into their strategy and direct resources to these areas.

While these results provide surprising and important insights, the study raises many questions that can be addressed in future research. The question of scale is an important one for any future research into spatial patterns of crime. Rather than using a unit as large as an entire suburb, gathering information on the proximity of certain locations that are common targets of criminals would be more valuable. For example, if local shopping centers attract crime, a measurement of the closest shopping centers to black and colored neighborhoods would reveal more about the traveling patterns of criminals. From a methodological perspective, the income and distance variables should be redefined and retested for robustness. Other explanatory variables, such as other land uses, education, and demographics for each suburb need to be included in regression analysis. As suggested earlier, tourism hot spots could be isolated and tested against other suburbs to see if their presence explains crime rates. Future work should also consider train and taxi routes to measure the accessibility of each suburb.

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Tables and Figures

Figure 1

Figure 2

Figure 3

Figure 4

Figure 5

Figure 6

Figure 7

Marginal Cost and Marginal Benefit in Equilibrium

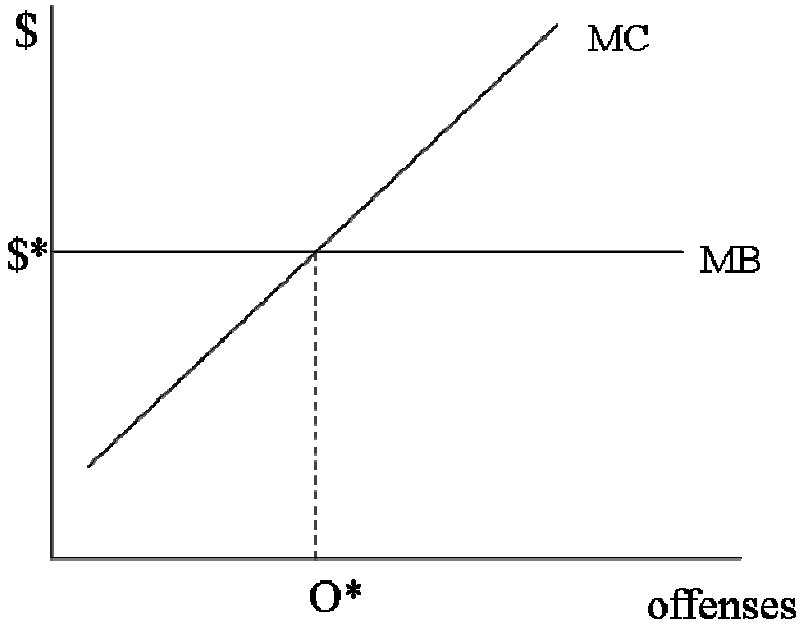


Figure 8.1

Marginal Benefit

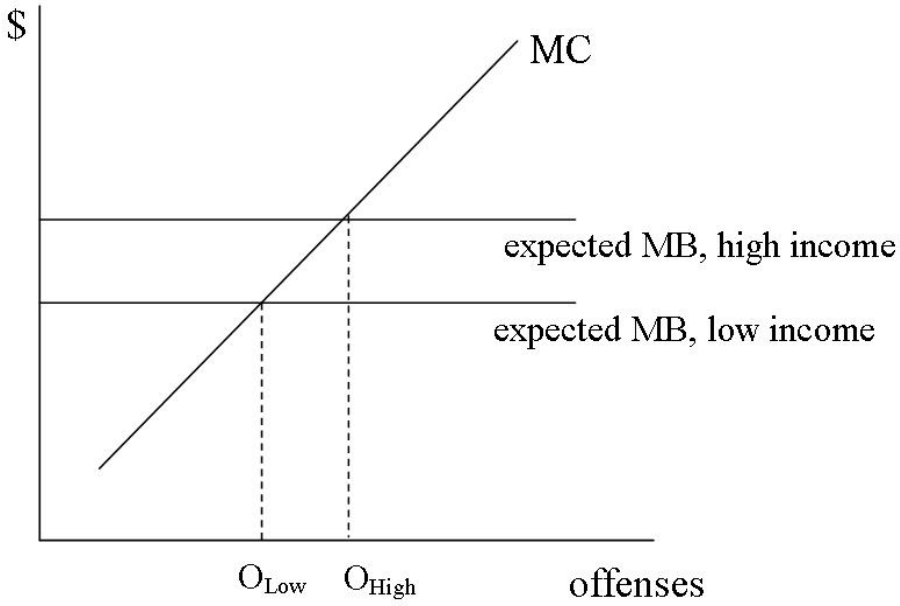


Figure 8.2

Marginal Cost

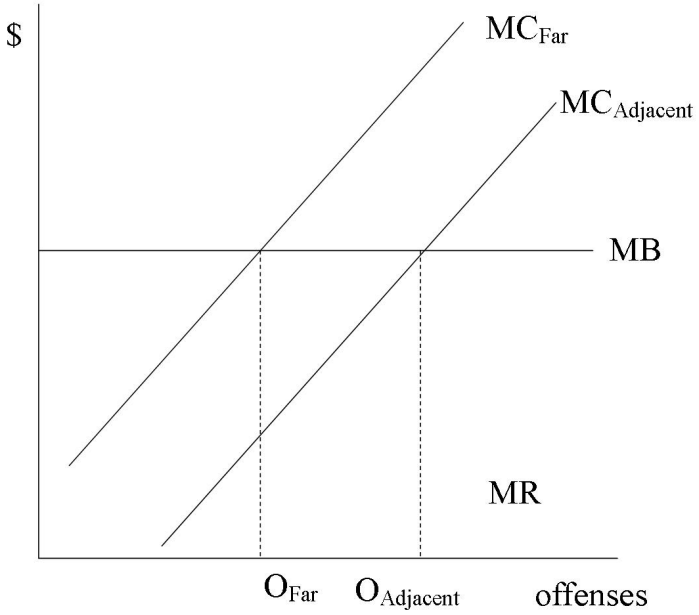


Figure 9

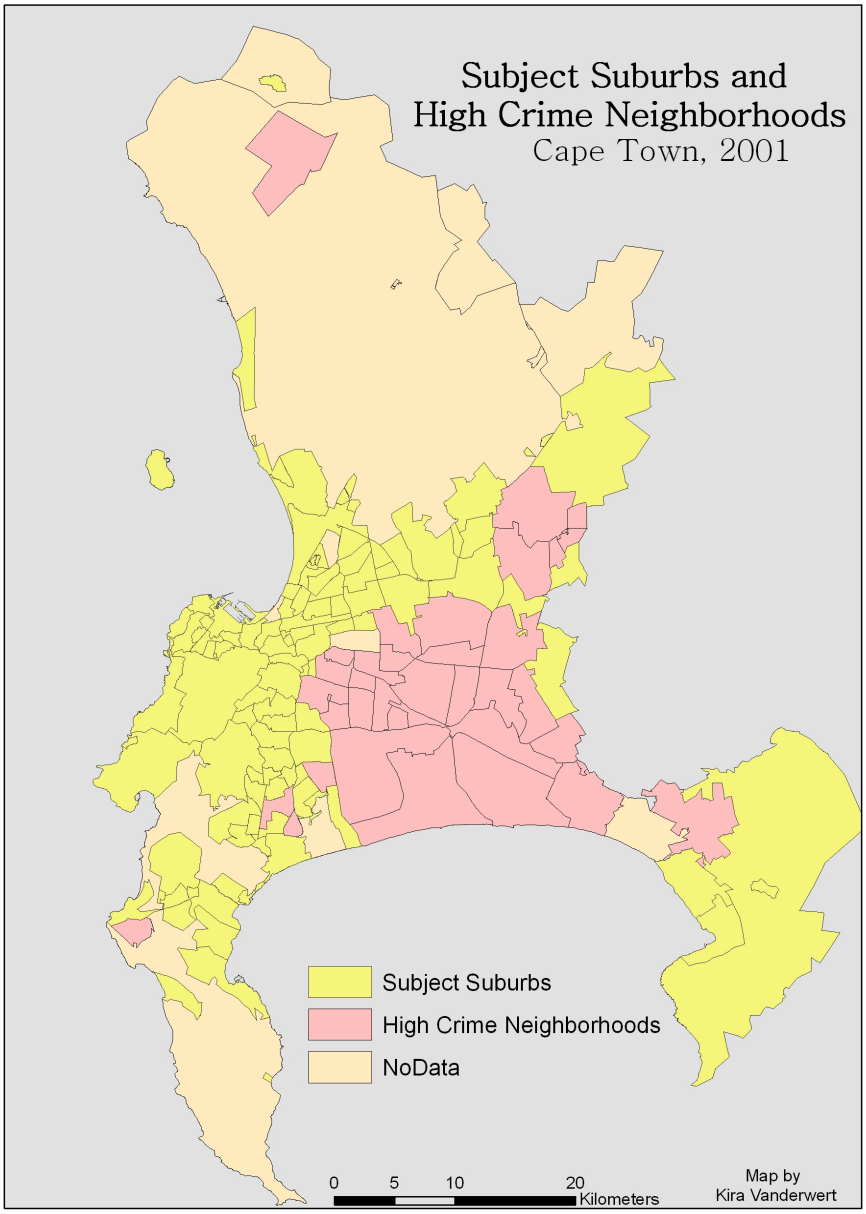

Subject Suburbs and
High Crime Neighborhoods
Cape Town, 2001
Subject Suburbs
High Crime Neighborhoods
NoData
0 5 10 20
Kilometers
Map by
Kira Vanderwert

Figure 10

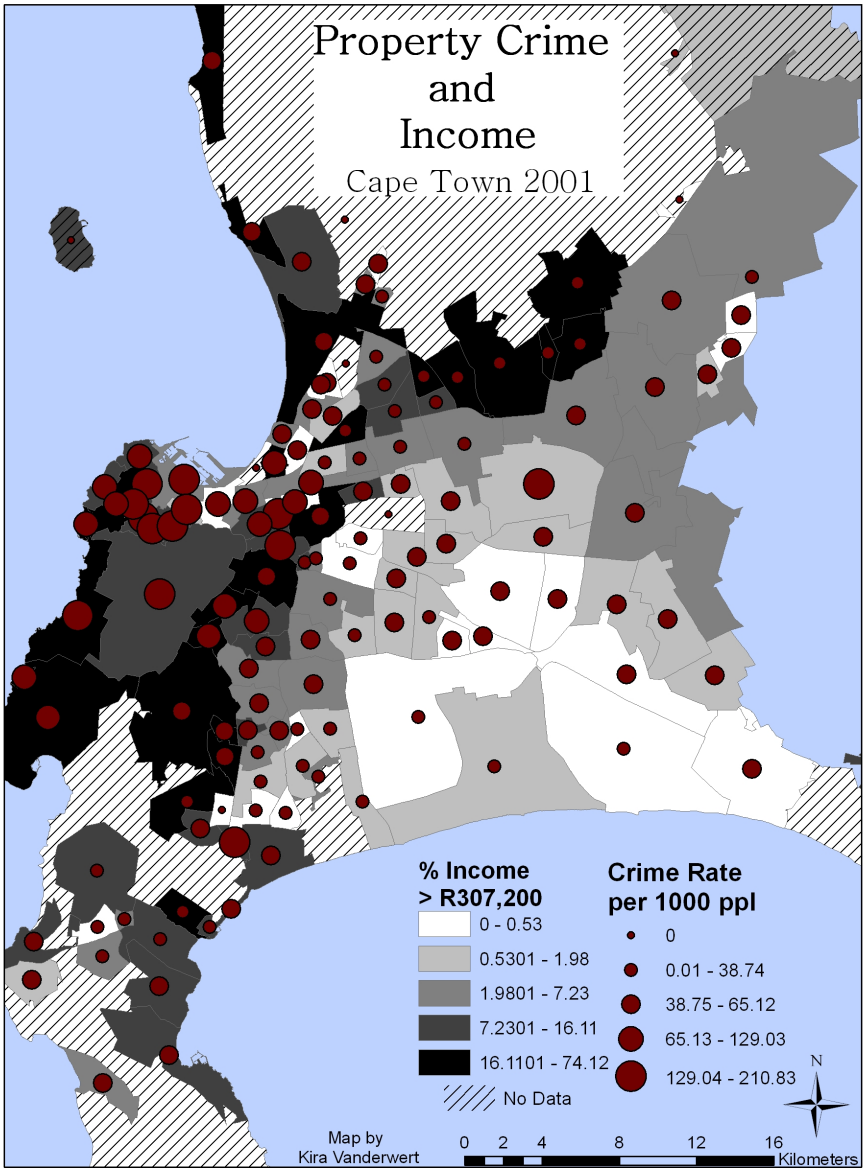

Property Crime
and
Income
Cape Town 2001
% Income
> R307,200
0 - 0.53
0.5301 - 1.98
1.9801 - 7.23
7.2301 - 16.11
16.1101 - 74.12
No Data
Crime Rate
per 1000 ppl
0
0.01 - 38.74
38.75 - 65.12
65.13 - 129.03
129.04 - 210.83
N
Map by
Kira Vanderwert
0 2 4 8 12 16
Kilometers

Figure 11

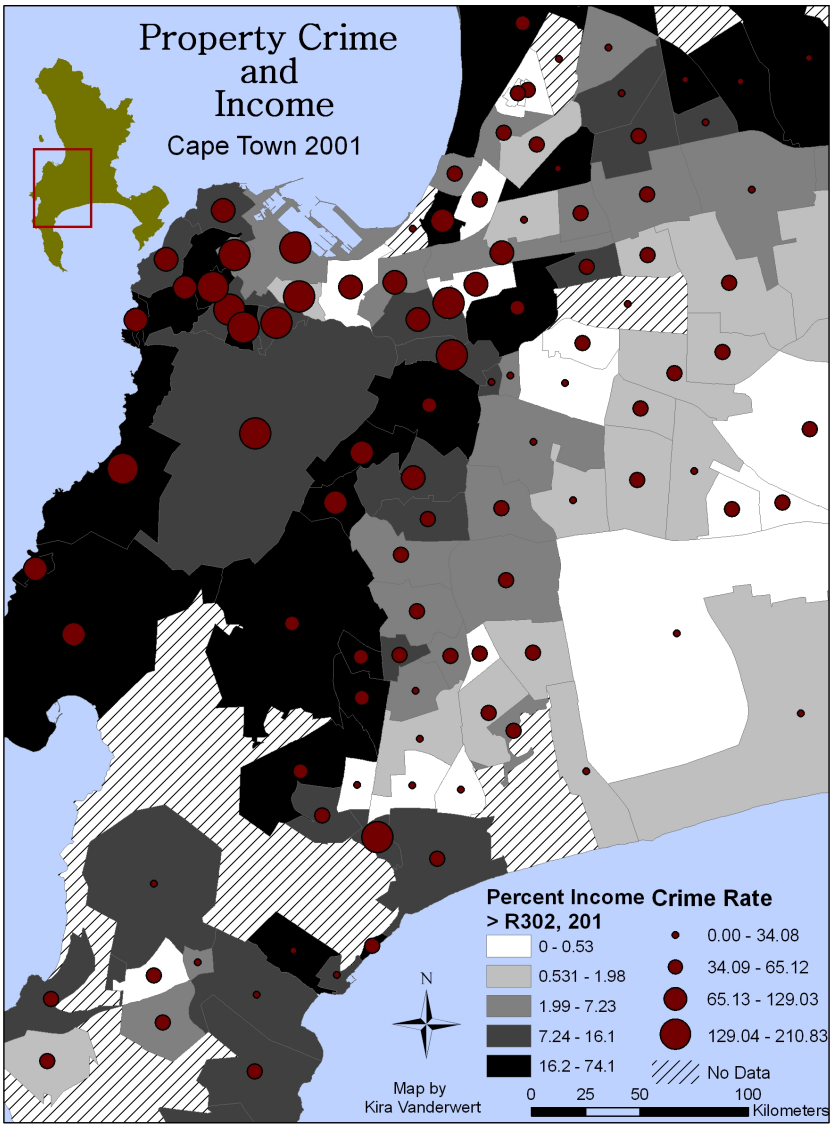
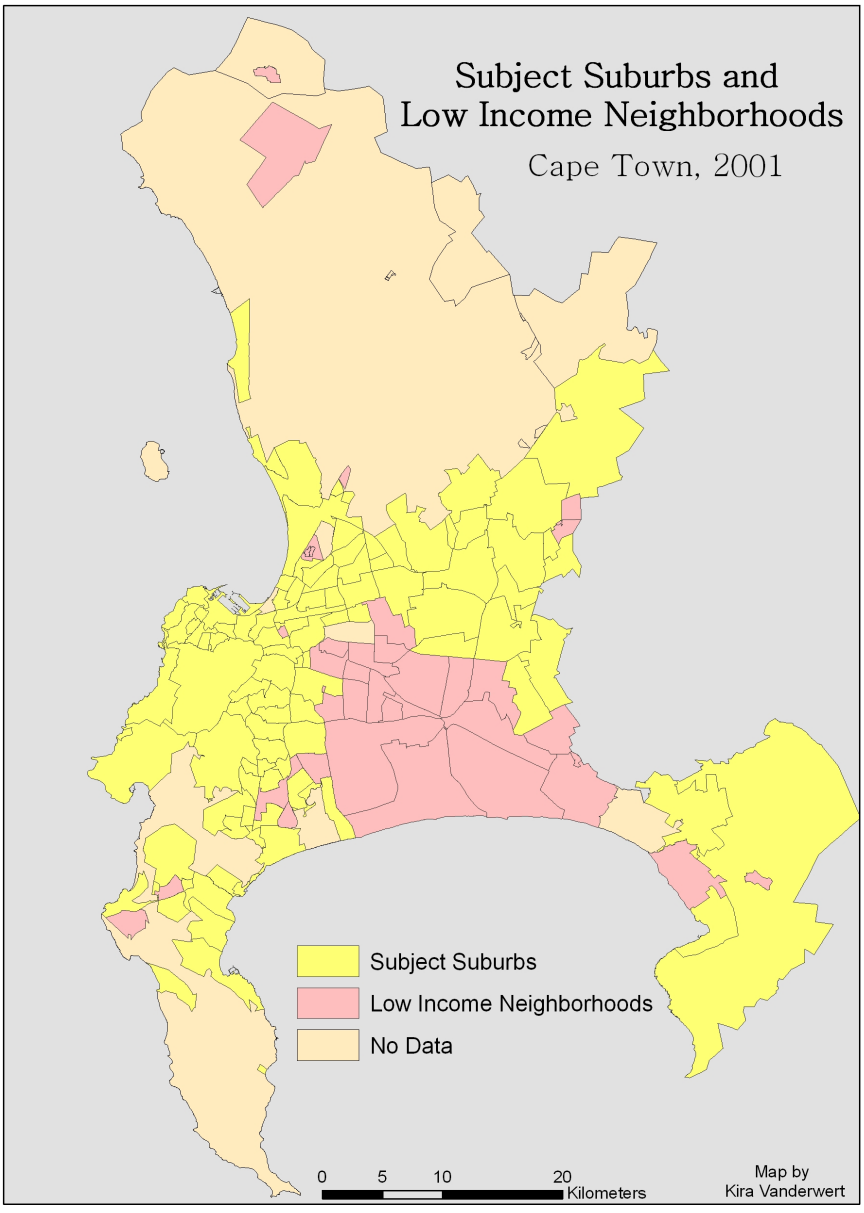

Property Crime and Income
Cape Town 2001
Percent Income > R302, 201
0 - 0.53
0.531 - 1.98
1.99 - 7.23
7.24 - 16.1
16.2 - 74.1
Crime Rate
0.00 - 34.08
34.09 - 65.12
65.13 - 129.03
129.04 - 210.83
No Data
N
Map by
Kira Vanderwert
0 25 50 100
Kilometers

Figure 12


Subject Suburbs and
Low Income Neighborhoods
Cape Town, 2001
Subject Suburbs
Low Income Neighborhoods
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0 5 10 20
Kilometers
Map by
Kira Vanderwert

Figure 13

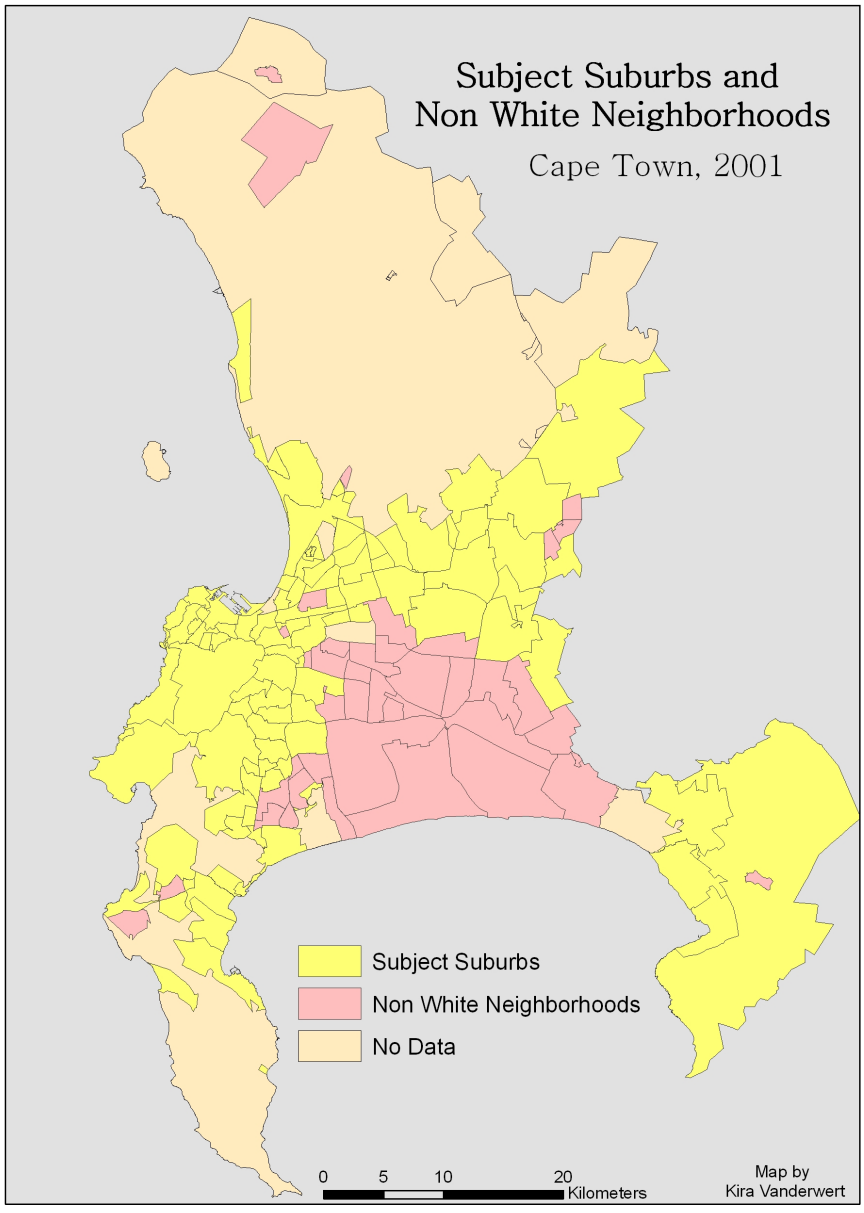
Subject Suburbs and
Non White Neighborhoods
Cape Town, 2001
Subject Suburbs
Non White Neighborhoods
No Data
0 5 10 20
Kilometers
Map by
Kira Vanderwert

Table 1

Summary Statistics: Total Sample

Variable	Mean	Minimum	Maximum	Standard Deviation
Property Crime Rate (per 1000 people)	132.32	18.75	895.36	147.09
Property Crime Frequency	1,403.94	5.85	12,273.34	1,607.05
Violent Crime Rate (per 1000 people)	20.25	3.71	87.99	12.76
Violent Crime Frequency	406.72	0.77	5312	728.79
Population	20,597	30	329,000	40,207
Percent White	43.48	0	99.00	37.40
Percent Black	17.10	0	99.55	26.33
Percent Coloured	37.30	0.41	98.67	34.89
Unemployment Rate	16.36	0	66.86	15.70
Percent Income <R19,200[a]	25.92	0	89.98	20.47
Percent Income >R307,201[b]	8.74	0	74.12	10.33
Percent Completed High School	42.37	3.10	80.00	18.43
Percent with Masters/ PhD	3.08	0	29.39	4.70
Percent Home Ownership	60.44	0	90.58	20.52

a: Equivalent to $2,258 (US, 2001)
b: Equivalent to $36,141 (US , 2001)

Table 2

Summary Statistics: Subject Suburbs

Variable	Mean	Minimum	Maximum	Standard Deviation
Property Crime Rate (per thousand people)	152.48	33.38	809.57	149.03
Property Crime Frequency	977.08	5.78	4720.16	1077.96
Violent Crime Rate (per 1000 people)	29.33	5.38	107.72	19.42
Violent Crime Frequency	201.02	1.19	1844	237.75
Population	8,329	30	74,422	11,034
Percent White	56.97	0.04	97.26	33.19
Percent Black	12.59	0	97.12	17.94
Percent Coloured	27.99	1.09	98.67	28.34
Unemployment Rate	10.42	0	58.91	10.81
Percent Income <R19,200[a]	19.55	0	81.52	15.26
Percent Income >R307,201[b]	11.32	0	74.12	10.84
Percent Completed High School	49.15	10.04	80	15.21
Percent with Masters/ PhD	4.08	0	58.91	5.14
Percent Home Ownership	61.54	0	90.58	21.26
Percent Residential Land	84.00	0	100	18.40
Percent Business Land	2.0	0	20.00	3.42

a: Equivalent to $2,258 (US, 2001)
b: Equivalent to $36,141 (US , 2001)

Table 3

Summary Statistics: High Violent Crime Neighborhoods

Variable	Mean	Minimum	Maximum	Standard Deviation
Property Crime Rate (per 1000 people)	53.91	18.75	252.77	37.58
Property Crime Frequency	2,473	69	12,273	2,177.21
Violent Crime Rate (per 1000 people)	24.00	9.39	88.00	13.13
Violent Crime Frequency	1,184	37	5,312	1,069.24
Population	55,457	1,661	329,000	65,487
Percent White	6.80	0	83.05	19.07
Percent Black	28.98	1.21	99.55	39.59
Percent Coloured	62.96	0.41	98.28	39.17
Unemployment Rate	32.35	6.20	66.86	15.78
Percent Households with Income <R19,200[a]	43.77	7.56	89.98	22.78
Percent Households with Income >R307,201[b]	1.51	0	13.16	2.43
Percent Completed High School	24.34	3.10	62.98	12.86
Percent with Masters/ PhD	0.38	0.01	5.14	0.89
Percent Home Ownership	56.61	6.48	83.81	18.20

a: Equivalent to $2,258 (US, 2001)
b: Equivalent to $36,141 (US , 2001)

Table 4

Summary Statistics: Distances for Subject Suburbs

Variable	Mean	Minimum	Maximum	Standard Deviation
Distance to nearest violent crime neighborhood (kilometers)	6.53	1.54	17.26	3.74
Distance to City Center	15.57	0	50.76	11.00

Table 5

Rank Analysis: Distance to Violent Crime Neighborhood and Income with respect to Property Crime

Variable		Property Crime Rate (per 1000 ppl)	Property Crime Events
Distance (km)			
25th percentile	3.853	79.5	2381
average[a]	3.856	**135.1**[b]	**1045**
75th percentile	8.29	104.4	98
average	8.295	88.4	513
Income			
25th percentile	3.148	36.6	305
average	3.131	**246.00**	**1689**
75th percentile	18.27	91.00	157
average	18.063	73.00	171

[a] The average is determined by averaging the reported observation for the given percentile with one value above and below that observation. This was done in order to avoid the influence of an outlier.

[b] The values in bold are the highest property crime statistics for both the distance analysis and the income analysis. They should be interpreted by looking at where they occur in the distribution of the sample. For distance, the highest rate occurs in the bottom of the distribution which suggests that suburbs that are closest to violent crime neighborhoods experience more property crime. Similarly, the table suggests that more crimes occur in suburbs that fall in the bottom 25th percentile of the income distribution.

Table 6

Estimation Results: Property Crime (per 1000 people)

Variable	Coefficient (t-statistic)[a]	Standard Error
Distance to Violent Neighborhood (km)	13.05 (4.03)**	3.24
Income	1.75 (1.58)	1.11
Distance to City Center (kilometers)	-4.94 (4.02)**	1.22
Residential Land (percent)	62.48 (0.91)	68.40
Business Land (percent)	2218.15 (5.49)**	403.89
Percent Home Ownership	-0.91 (1.26)	0.724
Constant	90.80 (1.12)	80.91
N	96	
Adjusted R^2	0.56	
F(6, 89)	21.37	

a: Reported in absolute value

** Denotes significance at the 95% level

Table 7

Estimation Results By Specification: Property Crime (per 1000 people)

Specification	By Violent Crime	By Income	By Race
Variable		Coefficient (t-statistic)	
Distance to nearest (kilometers)	13.05 (4.03)**	16.17 (4.24)**	14.20 (4.23)**
Income	1.75 (1.58)	0.39 (0.37)	0.38 (0.35)
Distance to City Center (kilometers)	-4.94 (4.02)**	-5.95 (4.92)**	-6.14 (5.28)**
Residential Land (percent)	62.48 (0.91)	57.70 (0.80)	49.04 (0.81)
Business Land (percent)	2218.15 (5.49)**	1601.15 (4.31)**	1542.41 (4.10)**
Percent Home Ownership	-0.91 (1.26)	-1.48 (1.85)	-1.61 (2.16)
Constant	90.80 (1.12)	173.29 (2.40)	203.67 (2.99)
N	96	96	91
Adjusted R^2	0.56	0.59	0.58
F(6, 89)	21.37	23.97	22.29

Note: Items in parentheses are reported in absolute value
** Denotes significance at the 95% level