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2015

18th Annual High School Mathematical Contest in Modeling (HiMCM)

Summary Sheet

(Please attach a copy of this page to your Solution Paper.)

Team Control Number: 5473

Problem Chosen: B

Crimes are permanently something closely associated with the safeness of one place, and safeness must be one of the most primary factors that citizens concern. It should be apparent that higher crime rate represents less safety; yet assigning a certain safety rating to one city cannot be achieved by simply considering the amount of crimes. In this paper, we are going to determine a safety rating for My City, a metropolis with a population of 2.8 million.

In the first place, we make attempts to weigh the impact of different crime categories by both the level of fear and the cost of crimes. In the fear approach, we create an index scale to evaluate the relative level of safety of My City compared to other cities in the United States. Using a weighted arithmetic average and results of a survey from Mark Warr's essay *Fear of Victimization*, we can calculate the relative level of fear in My City as a reasonable safety rating of My City. In the cost approach, we will use the crime numbers per 1000 people to evaluate the total cost of all crimes per 1000 people. In the end, we will compare the two models and give a general conclusion for the safety rating in My City.

Furthermore, a model which used to measure the interior safeness in terms of regions inside My City is also developed. We firstly re-divide the entire cities

into 22 regions according to original beats number given by dataset, and then combine the fear approach with the probability of the occurrence of a specific crime category in order to come up with the danger ratings of each regions.

Based on these two major models and other basic data analysis, we draw up a letter to the mayor of My City in the end of this paper, in order to inform him or her about the security circumstance inside city and to provide some advice.

Catalogue

Abstract

Crimes are permanently something closely associated with the safeness of one place, and safeness must be one of the most primary factors that citizens concern. It should be apparent that higher crime rate represents less safety; yet assigning a certain safety rating to one city cannot be achieved by simply considering the amount of crimes. In this paper, we are going to determine a safety rating for My City, a metropolis with a population of 2.8 million.

In the first place, we make attempts to weigh the impact of different crime categories by both the level of fear and the cost of crimes. In the fear approach, we create an index scale to evaluate the relative level of safety of My City compared to other cities in the United States. Using a weighted arithmetic average and results of a survey from Mark Warr's essay *Fear of Victimization*, we can calculate the relative level of fear in My City as a reasonable safety rating of My City. In the cost approach, we will use the crime numbers per 1000 people to evaluate the total cost of all crimes per 1000 people. In the end, we will compare the two models and give a general conclusion for the safety rating in My City.

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Based on these two major models and other basic data analysis, we draw up a letter to the mayor of My City in the end of this paper, in order to inform him or her about the security circumstance inside city and to provide some advice.

Keywords: Crime, fear of victimization, cost of crime, safety rating, interior safeness

Restatement

My City is a big international city with 2.8 million of population, which also can be impacted by an adjacent metropolitan area that possesses a population up to 6 million. In such a densely populated city, safety and crime issues are always concerned by not only citizens but also governments. With a detailed crime report of My City in 2014 at hand, we are asked to create a mathematical model to indicate the safety rating of this city. The crime report we have received contains information about date, categories of crimes, detailed description of cases, the location, the domestic condition and the beat number. Our safety rating should engage consideration of this information provided and represent the degree of safety of My City in comparison with other cities in the United States, as well as the interior circumstances regarding security in different beats.

Assumption

Assumption one: Safety rating is mostly influenced by the more serious and damaging crimes.

Justification:

There are many different types of crime in the data we received. In order to simplify the model while still creating a reasonable safety rating of My City, we decide to pick 8 essential types of crime as the indicator of the safety level. This is fairly reasonable because the essential crimes we pick are far more damaging than other crimes. They also have much higher costs and level of fear by comparison. According to the Uniform Crime Report released annually by the FBI, the numbers of **Criminal Homicide, Forcible Rape, Robbery, Aggravated Assault, Burglary, Larceny theft, Motor vehicle theft, and Arson** are the major indicator of the safety rating. These crimes are also much better recorded every year and it's easy to make comparison between My City and other cities in the United States. Therefore, in this essay, we will adopt the standard of the Uniform Crime Report

and only consider the 8 essential types of crime in the creation of the safety rating in My City.

We will also divide the essential crimes into two groups according to the standard of the Uniform Crime Report. Homicide, Rape, Robbery, and Assault are considered as violent crimes while Burglary, Larceny theft, Motor vehicle theft, and Arson are regarded as property crimes.

Assumption two: The area of and the police power in each beat region is similar.

Justification:

A beat is a territory that one police officer is able to completely patrol on foot or bicycles in certain amount of time, which indicates that extent of beats will not diverge from one another too much. Though beats in metropolis would be relatively small areas but in suburbs much larger, beats in one city tend to possess similar size because the population density is relatively even. Simultaneously, according to the beats map of several American cities and towns as well as to our dataset, the quantity of beats with the same first two figures is very close. Therefore, we are able to assume that the area of each region is similar.

Since the size of each beats is close according to the first assumptions, the time that each police officer take to patrol and numbers of daily shift should be fixed. Based what we have stated in the justification of the first assumptions that each region will include similar amount of beats, the police power that government has allocated to each regions will be close in quantity.

Assumption three: The domestic situation and arrested situation in a Region have minor or little effect on the safety rating of a region.

Justification:

The amount of domestic-involved cases can not directly expose whether a region is safe or not. Primarily, domestic situation is more likely to happen in apartments or residence instead of streets or office building, so the high frequency of domestic-involved crimes could be caused by larger amount of apartments in one region instead of the low safety rating of this region. Furthermore, most of the

citizens pay more attention to public security instead of whether all family in this region is harmonious or not. Similarly, the arrested ratio is related to other factors as well. For example, the criminals of theft might be easier to arrest than the criminal of an arson case. Also, a criminal could be arrested by police officers from an adjacent region. In this way, high arrested ratio cannot clearly stand for a safe region.

Variables:

S_{Crime} The number of a certain type of crime committed in every 1000 people,

N_{Crime} The number of a certain type of crime committed in a year

I_{Crime} The relative value of a city on the index scale of a certain type of crime

F_{Crime} The numerical evaluation of the fear of a certain type of crime according to Mark Warr's essay

C_{Crime} The total cost of a certain type of crime in every 1000 people

$A(x)$ The amount of a certain crime x taking place in my city in 13 days
$A(x,y)$ The amount of a certain crime x taking place in region y in 13 days
$K(x)$ The fear index of a certain crime x
$r(y)$ The danger rating of region y

Part One: The Analysis of Crime Data in My City

There were 11162 crimes taking place in My City during the time period of 14 days, from July 5th to July 18th in 2014. As the data is so large, categorizing and analyzing the data will be the first step to gain substantial understanding about the safety condition in My City.

(1) Analysis of Daily Crime

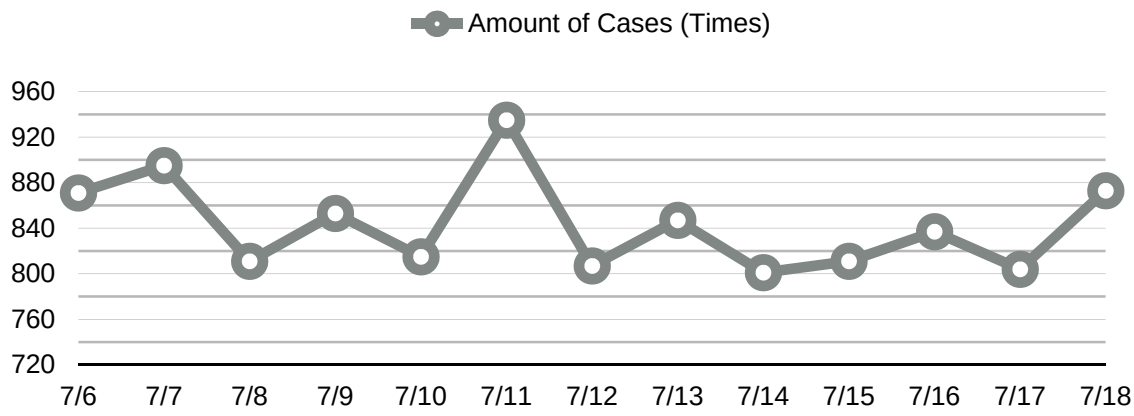


Chart 1.1 Daily Quantities of Crimes in My City (7/6/2014-7/18/2014)

For the reason that the quantity of crimes occurred in the first day (7/5/2014) was so different (had a magnitude of 202 while all the other day had crimes amount >800) from other data, we decide to discard all the data under this date in the following analysis and mathematical modeling. Therefore, the average amount of cases was 843/day due to the large amount of cases happening in the following days. The fluctuation of cases amount in My City was slight according to the Chart 1. Concerned the date July 6th to July 18th, over 800 crimes appeared every day in this city with population of 2.8 million, which stands for a really high crime frequency compared with the other similar-scale cities in America.

(2) Analysis of Crime Categories and Arrested Condition

Among 27 categories of crimes, Theft occurred most frequently with quantity up to 2618. Battery, Narcotic and Criminal Damage ranked subsequently, all occurred for over 1000 times in two weeks. For 16 crime categories only had the crime amount less than 300 times in 7/6/2014-7/18/2014 and could not have vital influence in our data analysis, we use “OTHER CATEGORIES” to stand for these categories in the following table and chart. Throughout all these crimes, the arrested ratios of each category (arrested case/ cases amount) range from 0.067 to 1.000, with the average ratio of 0.417, which means that criminals of 417 cases will be arrested in 1000 cases. The local police did a good job in dealing with Narcotic, Prostitution, Interference with Public Officers, Gambling and Liquor Law Violation, all of which criminals in these 5 types of crime were successfully arrested in two weeks. Yet, Motor Vehicle Theft should be noticed for it had the lowest arrested ratio 0.067, though the crime itself would not bring so much loss.

(More detailed information about crime categories can be viewed in the appendix)

THEFT	**2618**	**287**	**0.110**
BATTERY	**2002**	**488**	**0.244**
NARCOTIC	**1153**	**1152**	**0.999**
CRIMINAL DAMAGE	**1068**	**85**	**0.080**
ASSAULT	**701**	**181**	**0.258**
OTHER OFFENSE	**636**	**145**	**0.228**
BURGLARY	**560**	**41**	**0.073**
DECEPTIVE PRACTICE	**508**	**49**	**0.096**
ROBBERY	**394**	**36**	**0.091**
MOTOR VEHICLE THEFT	**374**	**25**	**0.067**
CRIMINAL TRESPASS	**304**	**222**	**0.730**
OTHER CATEGORIES	**642**	**437**	**0.681**
Average			**0.417**

Table 1.1 Quantity of Crimes Committed in My City.

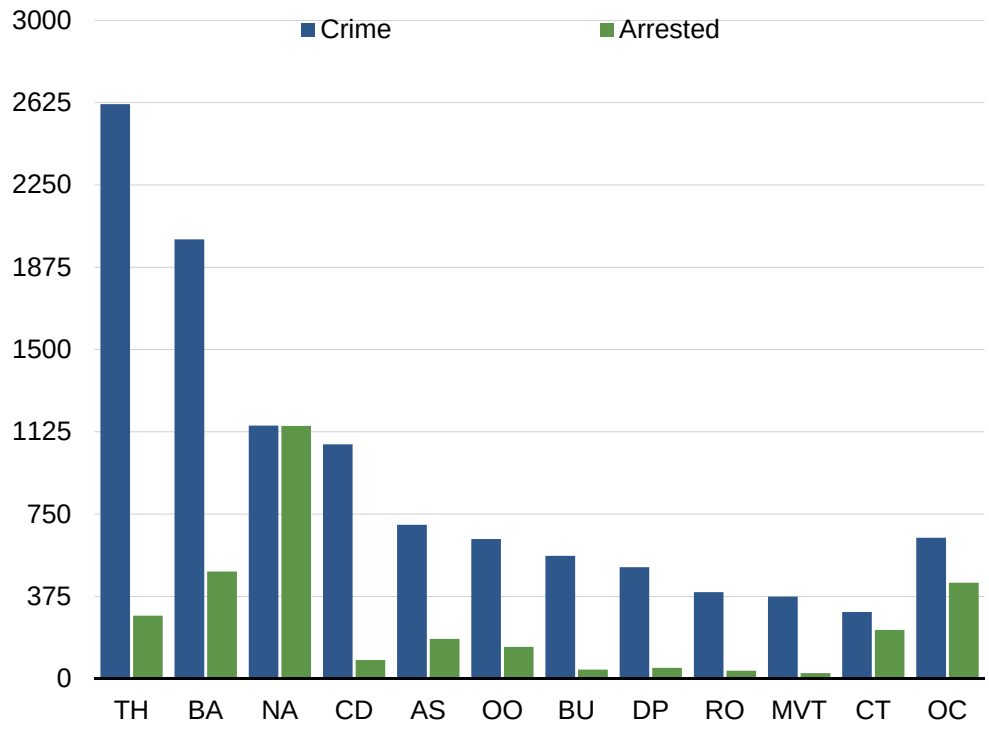


Chart 1.2 - Quantity of Crime Categories and Arrested Amount

NOTE: We use abbreviation in Chart 1.2 to represent each category due to the

lack of space. Here is the illustration of every abbreviation.

TH: Theft	*BU: Burglary*	*MVT: Motor Vehicle Theft*
BA: Battery	*DP: Deceptive Practice*	*CT: Criminal Trespass*
NA: Narcotic	*RO: Robbery*	*OC: Other Crimes*
CD: Criminal Damage	*AS: Assault*	*OO: Other Offense*

(3)Analysis of Domestic Crime Situation

Among the totally 10960 crimes, crimes which had domestic situation involved occupied about 14.58%, with the amount of 1598. According to the data provided by America Bar Association (ABA) the domestic violence made up 20% of all the crime experienced last year. Thus, the domestic crime ratio is kind of acceptable in My City.

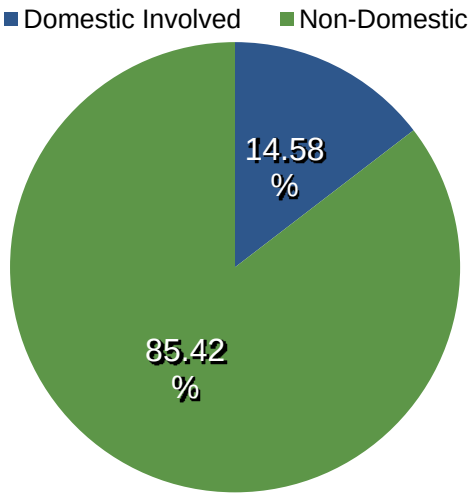


Chart 1.3 - Ratio of Non-domestic and Domestic-involved Crimes

(4) Comparison between National Circumstances

Based on the 2014 America crime rate, we come up with a rough comparison between the crime condition in My City and in the whole country. The FBI UCR Annual Crime Report only gets 9 items which also exist in our dataset, so our consideration could not consider all categories of crime included in the My City dataset. The processed data we used to compare is the amount of crimes that occurred in every 100,000 people. Generally, the crime condition in My City is worse than that of entire America, especially when we notice the large difference in Robbery, Assault and Theft. Only the occurrence of Liquor Law Violation is less than that in America, which might demonstrate the local liquor control, is stricter.

NOTE: We use abbreviation in Chart 1.4 to represent each category due to the lack of space. Here is the illustration of every abbreviation.

LLV: Liquor Law Violation *HO: Homicide* *MVT: Motor Vehicle Theft*

CSA: Crim Sexual Assault *RO: Robbery* *AS: Assault*

NA: Narcotic *BU: Burglary* *TH: Theft*

Crime Category	Crimes per 100,000 people in My City	Crimes per 100,000 people in Entire America
Narcotic	**41.2**	**35.5**
Liquor Law Violation	**0.8**	**12.2**
Homicide	**0.7**	**0.2**
Crim Sexual Assault	**1.5**	**0.9**
Robbery	**14.1**	**3.6**
Assault	**25**	**8.3**
Burglary	**20.0**	**19.3**
Theft	**93.5**	**65.4**
Motor Vehicle Theft	**13.4**	**7.7**

Table 1.2 Crime occurrences of 9 categories per 100,000 people in My City and in America.

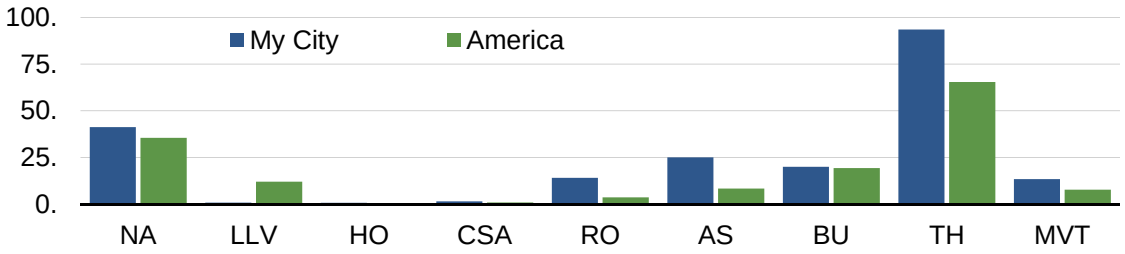


Chart 1.4 Differences Between Crime Occurrence per 100,000 People in My City and in America

Part Two: Fear Model – How much are the people afraid of the crime in the city?

1. Introduction

When a city is filled with criminals and dangerous illegal activities, people who live in the city are afraid. Measuring the fear of victimization is a good way to indicate the safety rating in the city. It's reasonable to use a model that illustrates the level of fear to create a safety rating for My City.

However, this model faces two major challenges. The first is that the level of fear people have against different crimes is different. For example, people generally are more afraid of rape, assault, and murder. Having your wallet stolen is quite annoying, yet it does not make you afraid.

In order to solve the first challenge, it is necessary to add different weight to different crimes. Considering that the crimes don't overlap with each other and that they do not have the same importance, using a weighted arithmetical average is reasonable. But how can we decide how much weight we should give to different crimes?

Mark Warr examined in his paper, *Fear of Victimization*, the cause of group difference of the fear to be victim of crimes. He also included a 1983 survey with a numerical evaluation of how people are afraid about becoming the victims of several types of crime. Using this as the weight, we can effectively evaluate the safety of a city by evaluating how fear people feel to be a potential victim of crimes.

The second challenge the model will certainly face is that the frequencies of different crimes are different. In the same time period, the number of theft cases is certainly much larger than the number of murder cases. However, people may still be more afraid of murder. How do we adjust the frequency of different crimes and combine them into a single index?

In order to solve the second challenge, we will develop an index scale which compares My City with other cities in the United States. We will then calculate the relative value of My City on the index scale. The comparison between different cities will solve the second challenge because the index scale eliminates the difference in numbers of crime committed. Although there are much less murders than there are Larceny-thefts, both of them will receive a similar comparative index on the index scale. Yet, the index

scale still represents the level of safety of My City since it compares My City with other cities.

In the following model, we will first establish the comparative index scale for the different crimes. Then we will add weight to the indices of different crimes and combine them into a single safety rating.

2. Create a comparative index scale

2.1 Establish the standard of comparison

In order to create the index scale for different crimes and compare My City with other cities, we need to create a standard of comparison. It's essential to make sure that the standard of comparison is the same all across the board. As stated in our assumption, we will use only the essential crimes to determine the safety rating of My City compared to other cities in the United States. The essential crimes include the following:

Criminal Homicide, Forcible Rape, Robbery, Aggravated Assault,

Burglary, Larceny theft, Motor vehicle theft, Arson

(a)

We will use the number of crimes committed in every 1000 people, **S**, as the standard of comparison between cities.

$$S = \frac{The\ number\ of\ crimes\ in\ a\ year}{The\ population\ of\ the\ city} \times 1000$$

The reason of using S as the standard of comparison is to eliminate the influence of population on the safety rating in the city. For example, New York may have more reported crimes every week than Chicago, yet it may be safer to live in New York because the population in New York is larger.

(b)

We will use the data in the *2014 Uniform Crime Report* released annually by the Federal Bureau of Investigation for the index scale. The full list of data can be found on the website of "FBI – Uniform Crime Report." We will include the link to the page in the Reference page. The data table in the Uniform Crime Report includes the number of the

essential crimes that are committed during 2014 for all cities in the United States. Every city in the data table has information about its population and the numbers of essential crimes committed in 2014. The following is an example of Detroit:

City	Population	Murder	Rape	Robbery	Aggravated assault	Burglary	Larceny-theft	Motor vehicle theft	Arson[3]
Detroit	**684,694**	**298**	**557**	**3,570**	**9,191**	**9,177**	**13,723**	**10,083**	**490**

Table 2.1 - The data of Detroit in the 2014 Uniform Crime Report.

Uniform Crime Report is the compilation of such data from all cities in the United States.

My City has a population of 2.8 million and is impacted by a metropolitan area of 6 million. It's a comparatively large city with dense population and urban environment. Therefore, in this essay we will only compare My City with cities that have more than 100K of population. There are 284 cities in the *2014 Uniform Crime Report* that have more than 100K of population.

(c)

Since essential crimes have a larger influence on the safety rating and are better recorded, it's reasonable to use the data of essential crimes to compare the level of safety between My City and other cities in the United States.

Therefore, we will compare My City's data of essential crimes with that of other cities. In order to compare the two sets of data, the categories of crime in the two data table have to match. Thus, we pick eight categories in *My_City_Crime_Data* to match the essential crimes data in the *2014 Uniform Crime Report*.

The matches between the categories in *My_City_Crime_Data* and the essential crimes are in the following table:

My_City_Crime_Data	Uniform Crime Report
Homicide	**Murder**
Crim Sexual Assault	**Rape**
Robbery	**Robbery**
Assault	**Aggravated Assault**
Burglary	**Burglary**
Theft	**Larceny Theft**
Motor Vehicle Theft	**Motor Vehicle Theft**
Arson	**Arson**

Table 2.2 – matches between categories between two crime report

We assume that standard of data collection under the categories on the left side is the same with that under the categories on the right side. For example, we assume that the data collected under the definition of Homicide on the left side is the same with that of Murder on the right side. In other words, if 10 cases of Homicide are recorded in My_City_Crime_Data, the number of Murder in Uniform Crime report will also be 10.

(d)

In the *2014 Uniform Data Table*, some of the cities are using the legacy definition of rape while some other cities are using the new (revised) of rape. In order to make comparison of rape numbers between cities, we calculate a conversion ratio between the number of rape under legacy definition and that under revised definition. The ratio is approximately 1.3, with the equation:

$$Estimated\ number\ of\ rape(revised) = 1.3\ \times numberof\ rape(legacy)$$

Since the procedure of acquiring the ratio is quite complex, we will put it in the Additional Model Part in order to maintain the flow of our essay.

(e)

According to the analysis in Part One, the number of crimes committed every day is roughly the same (with the exception of the first day). Therefore, we can assume that the number of crimes committed in a year in My City N equals to:

$$N = \frac{The\ number\ of\ crimes\ in\ My\ City}{Time\ (In\ days)} \times 365$$

The time period in My City Crime Data is fourteen days. However, as we stated in Part One, the data on the first day (July 5th, 2014) is unusual. We therefore only consider the time period from July 6th, 2014 to July 18th, 2014. "365" is the number of days in 2014. If C_y is not an integer, we will round it to the nearest integer.

The estimated assaults in My City for a whole year are:

$$N_{Assault} = \frac{The\ number\ of\ assaults\ in\ My\ City}{Time\ (In\ days)} \times 365 \approx 19682$$

In the equation, $N_{Assault}$ is the estimated number of assault in My City in a year. According to the data in Part One, the number of assaults in My City from July 6th, 2014 to July 18th, 2014 is 2618. The time period is thirteen days ($18 - 12 + 1 = 13$). We round the result of the calculation to the nearest integer.

Using the same method, we can calculate the estimated number of other crimes in My City in a year. We will calculate the value of *N* (the estimated number of a specific crime in 2014) for all essential crimes. We put the result into a table for better viewing

Murder	***CSA***	***Robbery***	***Assault***	***Burglary***	***Theft***	***Motor Theft***	***Arson***
533	**1151**	**11062**	**19682**	**15723**	**73505**	**10501**	**646**

(CSA = Criminal Sexual Assault)

Table 2.3 - estimated number of different crimes in My City in 2014.

2.2 Calculate the standard of comparison S for every city

In order to create a fair, objective comparison, we will develop an index scale according to the data in the *2014 Uniform Crime Report*.

As we stated above, we will use the number of crimes committed every 1000 people (represented by the symbol *S*) as the standard of comparison. *S* is calculated as

$$S = \frac{The\ number\ of\ crimes\ in\ a\ year}{The\ population\ of\ the\ city} \times 1000$$

We will calculate the *S* value of My City for each of the eight essential crimes.

$$S = \frac{The\ number\ of\ assaults\ in\ My\ City\ in\ 2014}{The\ population\ of\ My\ City} \times 1000 = 11.5814$$

S represents the estimated number of assaults committed in My City in 2014 in every 1000 people. The estimated number of assaults in My City is 701, as calculated before. My City has a population of 2.8 million. Therefore, according to our estimation, there will be 11.5814 assaults committed in every 1000 people in My City.

The similar method can be applied to all other essential crimes. We calculated the estimated number of all essential crimes committed in every 1000 people in My City and put them into the table below.

Murder	***Rape***	***Robbery***	***Assault***	***Burglary***	***Theft***	***Motor Theft***	***Arson***
0.1903571	**0.4110714**	**3.9507143**	**7.0292857**	**5.6153571**	**26.251786**	**3.7503571**	**0.2307143**

Table 2.4 - the value of S for all essential crimes.

We will also process the data of other cities in *2014 Uniform Crime Report* with the same method to apply the standard of comparison we established in the former section. We will calculate the estimated number of a specific crime in every 1000 people in a specific city, just as we calculate those in My City. The equation for the calculation:

$$S = \frac{The\ number\ of\ crime\ in\ the\ City\ in\ 2014}{Population\ of\ the\ City} \times 1000$$

We will calculate all eight categories of essential crimes in the 284 cities we select from the *Uniform Crime Report*. To illustrate this, we will process the data of Detroit as an example of what we will do to the data we have in *Uniform Crime Report.*

$$S = \frac{The\ number\ of\ Murder\ in\ Detroit\ in\ 2014}{The\ population\ of\ Detroit} \times 1000$$

As we can learn from *Uniform Crime Report*, the number of Murder in Detroit in 2014 is 298. The population of Detroit is 684694. Therefore, the number of murder in every 1000 people in Detroit is:

$$S = \frac{298}{684694} \times 1000 = 0.4352309$$

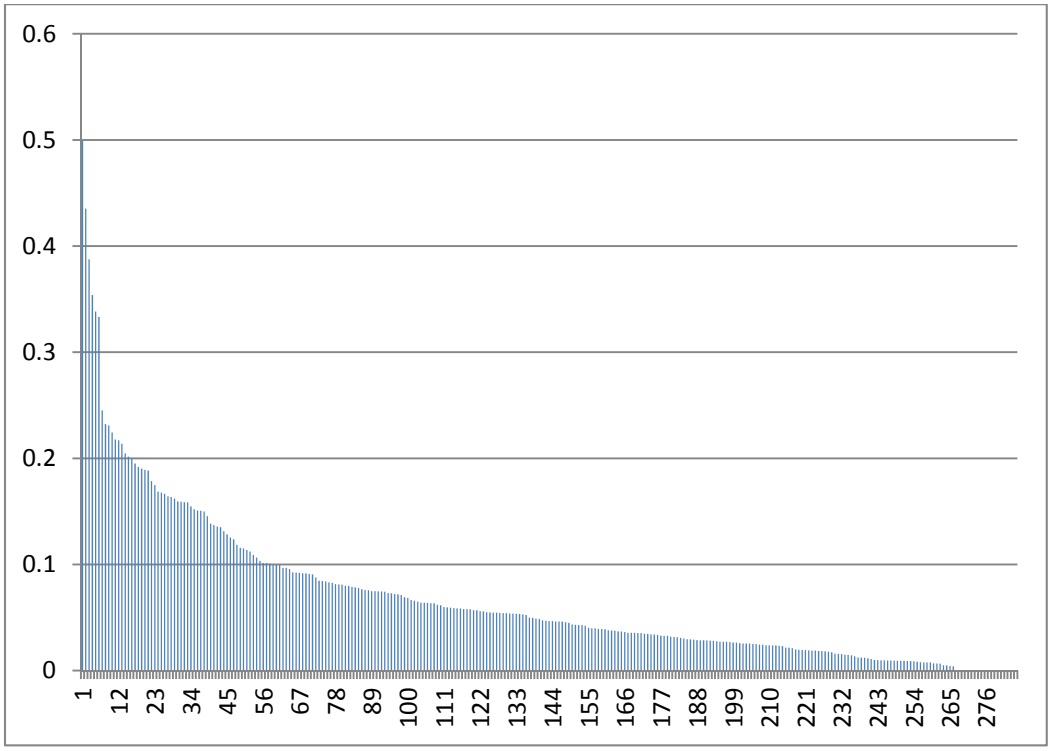
Similarly, we can acquire value of S of other crimes in Detroit. In this way, we process the data of all cities using the same method and acquire the S for every category of crimes in every city. We will create an index scale in the next section and compare the S value of My City with those of other cities.

2.2 Create the index scale for each crime

Using the S values (the number of crimes committed in every 1000 people) calculated from the section above, we can now create an index scale to compare the safety level in My City with other cities that have more than 100K population in the United States.

We will set the 1st quartile and the 3rd quartile of the S values (the number of crimes committed in every 1000 people) of a certain type of crime in all 284 cities as the 0 and 1 on our index scale. The benefit of using lower and upper quartile instead of the

maximum and minimum value is that we can eliminate the effect of extreme high or low S values. It's possible for the index to be larger than one or smaller than zero if we set the lower quartile as the zero point and the upper quartile as the one. However, this does not influence the comparison between cities. If the city has an index much larger than one, then it means that there are significantly more crimes in the city than the other 75 percent of cities. Therefore, the level of fear in the city will be higher. On the other hand, if the city has an index much smaller than zero, it means that the city has significantly less crime than the other 75 percent of cities. Then the level of fear in the city will be lower.



Graph 2.1 - the column chart of S values of murder in all 284 cities

The graph above depicts the S values of murder in all 284 cities sorted from larger values to smaller values. Y axis is the S value of murder in every city. We can see that there are some columns that have extremely high S values. Using the 1st quartile and the 3rd quartile as the 0 and 1 on the index scale can eliminate the effect of these points on the index scale.

Using Excel, we can find the lower quartile and upper quartile of the S values of all categories of crimes in all cities. After acquiring the upper and lower quartile, we can calculate the relative value of any city on the index scale with the equation:

$$I = \frac{1}{Upper\ Quartile - Lower\ Quartile} \times (S - Lower\ Quartile) + 0$$

In the equation, I is the index of the city on the index scale of the crime. The Upper Quartile and Lower Quartile value are the 1st quartile and 3rd quartile value of the S value of a specific crime in all 284 cities. S is the city's S value of the crime.

Using the equation and the value of lower quartile and upper quartile of each set U, we are able to calculate the Index of My City on the index scale of each essential crime.

Murder	***Rape***	***Robbery***	***Assault***	***Burglary***	***Theft***	***Motor Theft***	***Arson***
2.6392373	**0.4584152**	**2.0973032**	**2.3880499**	**0.3232021**	**0.7137235**	**0.6580595**	**0.9999977**

Table 2.5 -the index I of different crimes in My City on the index scale.

The data in the table comes from the equation above. We can see that My City has indices much higher than one in Murder, Robbery, and Assault. Here it's reasonable to argue that My City is more dangerous than most cities that have a population larger than 100K in the United States. All data are calculated by computer software.

In order to compare My City with other cities and analyze the safety level of My City, we also apply the same calculation to all other cities that have more than 100K population in the United States. In the next section, we will use the indices of different cities to calculate the level of fear for each city.

3 Evaluating the level of fear

3.1 Calculate the level of fear

The index scale helps us solve the challenge that the number of cases is different when the crime is different. All indices show the comparative difference in the number of crimes between two crime categories. For example, My City only has 533 murders in 2014, much less than the number of burglaries in the city. If we multiply the number of murder with the fear index, the result is significantly less than that of burglary. However, this is far from being true. My City has an index of 2.64 for murder and an index of 0.323 for burglary. The two indices both represent the relative position of My City in the index scale of all cities. The problem of murder in My City is apparently much more severe than that of burglary.

With the indices at hand, we can now add weight to the different crimes and calculate the comparative level of fear. As stated in the introduction, it's reasonable to use weighted arithmetic average for the calculation. According to *Fear of Victimization* By Mark Warr, the level of fear for each category of crime is

Murder	Rape	Robbery	Assault	Burglary	Theft	Motor Theft	Arson
3.4	**5.6**	**4.1**	**4.0**	**5.9**	**N/A**	**3.4**	**N/A**

Table 2.6 - the numerical evaluation of fear of victimization

According to Mark Warr's essay, the numerical evaluation comes from a survey done in Seattle. We choose the closest definition in the essay to match the categories of essential crimes. The level of fear, as explained in Mark Warr's essay, is not only influenced by the horror of the crime but also by the incidence of the crime. For example, the level of fear in Murder is the same with that in Motor Theft. Although the horror of being murdered is considerable, the possibility of being murdered is extremely low. This leads to the low level of fear in Murder.

There is no numerical evaluation of fear for Theft and Arson in Mark Warr's essay. Due to the lack of data, we choose to include only Murder, Rape, Robbery, Assault, Burglary, and Motor Theft in our calculation of the level of fear.

Having obtained the weight of level of fear as well as modified indicator of the crimes in each category. A simple arithmetic average would help us see how fear people have to the safety problems in a city. We can do the calculation with the following formula:

$$Level\ of\ Fear = \frac{\sum(F_{Crime} \times I_{Crime})}{\sum I_{Crime}}$$

The equation is the weighted arithmetic average of the indices calculated from the former section. I_{Crime} is the index of a certain type of crime in a specific city. F_{Crime} is the numerical evaluation of the fear of a certain type of crime according to Mark Warr's essay. Therefore, the equation of the calculation of the level of fear for My City is

$$Level\ of\ Fear\ in\ My\ City = \frac{\sum(F_{Crime} \times I_{Crime})}{\sum I_{Crime}} = 1.28$$

All I_{Crime} in the equations are the index of the certain type of crime in My City in 2014. Using the index of My City on the index scale and the numerical evaluation of fear of different crimes, the level of fear of My City, which is considered as the safety rating of My City in this model, is 1.28. We will compare the safety rating of My City with other cities in the next section.

3.2 Comparing My City with other major cities in the U.S.

Using the relative level of fear as the weight to calculate the algorithmic average of the indicators of different types of crime, we obtained:

City	Murder	Rape	Robbery	Aggravated Assault	Burglary	Motor Theft	Level of Fear	Rank
New York	0.25	0.05	0.81	1.24	-0.37	-0.21	0.25	87
Los Angeles	0.68	0.13	0.86	0.83	0.00	0.59	0.45	120
Chicago	2.02	0.68	1.87	1.55	0.27	0.64	1.07	215
Houston	1.35	0.34	2.51	1.63	1.09	1.50	1.32	239
Philadelphia	2.15	1.43	2.43	1.62	0.43	0.63	1.38	245
Las Vegas	0.89	0.72	1.61	1.56	0.99	0.94	1.10	217
Phoenix	0.81	1.12	0.79	1.01	1.02	0.95	0.97	201
San Antonio	0.77	1.38	0.35	1.10	0.88	1.04	0.94	198
San Diego	0.00	0.30	0.17	0.84	-0.02	0.63	0.29	98
Dallas	1.07	1.00	1.50	0.96	0.98	1.21	1.10	221
San Jose	0.13	0.42	0.23	0.58	0.23	1.80	0.51	128
My City	2.64	0.46	2.10	2.39	0.32	0.66	1.28	237

Table 2.7 – The level of fear in My City and other eleven major cities in the U.S.

The arson and larceny-theft are excluded in the graph due to lack of data. The report of Mark Warr's didn't include the level of fear of them. These crimes also tend to scare people less so it would be much a problem to exclude them.

The remaining six categories of crimes are calculated to generate this table. Under each category, 0 indicates a lower quartile while 1 means an upper quartile. While four cities including New York and Los Angeles managed to become the safer half in the 284 cities with a population of over 100k people, the other big cities perform badly.

The median level of fear in the 284 cities is 0.58. Apparently, some cities exceed this by a large rate. Five out of 11 cities in the table (excluding My City) has a level of fear of over 1.

My City is also one of the cities that confronts serious problem. It ranks 237 out of 284 cities with a level of fear at 1.28. It performs badly in three categories: Murder, robbery and aggravated assault. In all three categories, My City is not only in the worst quartile but also have in index over 2. At the same time, the other categories fall between 0 and 1 with relatively mediocre scores. This helps to explain what make people in My

City worry about their security – murder, robbery and aggravated assault. The security agencies in My City should definitely work to alleviate the problem.

4 Conclusion

In this model, we use the fear level of people to evaluate the level of safety of the city. This is a reasonable evaluation since fear level directly influences the daily lives of the citizens. The basic idea for the model is very simple: a weighted arithmetic average for a numerical evaluation of the level of fear for My City. However, we confronted two challenges when calculating the average. The first is the difference in number of cases between different categories of crimes. The second is the difference in the added weight for each category of crimes. We solve the two problems by first creating an index scale for all cities that have over 100K population in the United States. We then find the relative value of My City on the index scale. Using the result of a survey from Mark Warr's essay, *Fear of Victimization*, we are finally able to calculate the level of fear for My City. In the end, we compare the safety rating of My City with eleven major cities in the U.S. to gain a further understanding of how safe My City is comparatively.

According to our model, My City ranks 237 in a list that contains 284 cities that have more than 100K of population. The level of fear in My City is 1.28, much higher than the median 0.58. The result of our model indicates that My City is quite dangerous compared to other cities in the U.S.

Part Three: Cost Approach – How much money do crimes cost?

1. Introduction

Every crime has costs. In this model we will try to evaluate the total costs of all crimes in My City as an indicator of the level of safety. However, crime not only costs money; it also has considerable emotional costs. Having your house burnt down is not only costly in dollars; it also has large emotional impact. When evaluating the safety rating in My City, we have to consider both the real and the emotional cost.

In this model, we will calculate the total costs of all crimes in My City by multiplying the cost of each crime with the crime's S value (the number of a specific crime per 1000 people). We will also calculate the total costs in all other cities that have more than 100K population to make a comparison between My City and other cities. In the end, we will give a conclusive evaluation of the safety level in My City and give a comparison between the cost approach and the fear approach in Part Two.

2. Calculate the total costs of crimes in every 1000 people

While it is true that the emotional cost of a crime is not direct, it is possible to evaluate it. Kathryn E. McCollister and his colleagues in their report *The Cost of Crime to Society: New Crime-Specific Estimates for Policy and Program Evaluation* offers an estimate of these costs. Besides the conventional cost as tangible costs including victim costs, criminal justice system costs and crime career costs, they defined intangible cost as "Indirect losses suffered by crime victims, including pain and suffering, decreased quality of life, and psychological distress."

They calculated the average total cost, intangible or tangible, of each type of crime:

Type of Offense	**Tangible Cost**	**Intangible Cost**	**Total Cost**
Murder	$1,285,146	$8,442,000	$8,982,907
Rape/Sexual Assault	$41,252	$199,642	$240,776
Aggravated Assault	$19,472	$95,023	$107,020
Robbery	$21,373	$22,575	$42,310
Arson	$16,429	$5,133	$21,103
Motor Vehicle Theft	$10,534	$262	$10,772
Stolen Property	$7,974	N/A	$7,974
Household Burglary	$6,169	$321	$6,462
Embezzlement	$5,480	N/A	$5,480
Forgery and Counterfeiting	$5,265	N/A	$5,265
Frau	$5,032	N/A	$5,032
Vandalism	$4,860	N/A	$4,860
Larceny/Theft	$3,523	$10	$3,532

N/A = not available or not applicable.

Table 3.1 - Total Per-Offense Cost for Different Crimes in 2008 Dollars

The total per-offense cost calculated as the sum of tangible cost (excluding the uncorrected risk-of-homicide cost from crime victim cost, when applicable) and intangible cost.

The table provides us the average cost of each crime of different types. Therefore, we can use this to estimate the total cost of crimes in every 1000 people in each city. While cost in dollar may not represent all aspects of safety, it is certainly an objective and important indicator. We denote C_{Crime} as the average cost of a certain type of crime.

The equation for the cost of a certain type of crime in every 1000 people in a city is

$$Cost\ of\ a\ certain\ type\ of\ crime = C_{Crime} \times S_{Crime}$$

Therefore, the equation for the total cost of crimes in every 1000 people in a city is

$$Total\ Cost\ of\ crimes\ in\ every\ 1000\ people = \sum C_{Crime} \times S_{Crime}$$

C_{Crime} is the total cost of a certain type of crime in every 1000 people. S_{Crime} is the number of a certain type of crime in every 1000 people in the city. Using the equation, we can calculate the total cost of all crimes in all 284 cities and compare the costs of crime in My City with those in other cities in the U.S.

3. Compare and Analyze

After calculating the cost of all crimes in every 1000 people in all 284 cities in the United States that have more than 100K of population, we sort the data and rank the cities, giving the first place to the city with the lowest total cost of crimes. In the following table, the numbers under each type of crimes represent the cost of the specific crime in every 1000 people in the city. The total cost represents the cost of all crimes in every 1000 people. Here we are going to compare My City with other cities in the United States to gain insight about the safety level of My City. Since My City is a large city with a high population, we choose eleven major cities that have more than 1 million of population for the comparison.

City	Murder	Rape	Robbery	Assault	Burglary	Theft	Motor Theft	Arson	Total Cost	Rank
San Diego	210020	85120	40743	273123	24149	43072	39398	3222	718850	87
San Jose	284697	95171	44921	194181	33069	41452	80655	2570	776719	97
New York	353000	62226	82788	397318	12137	46727	9818	0	964016	130
Los Angeles	597822	69395	86086	269442	24926	49073	38017	6141	1140906	155
Phoenix	669379	158329	81641	327177	60469	81869	50696	4317	1433880	183
San Antonio	647715	181534	52633	355643	55841	143182	53842	4402	1494795	193
Dallas	818940	147788	128220	311539	59343	74779	59642	6385	1606640	203
Las Vegas	715863	122676	135008	495568	59727	54060	50464	1943	1635313	206
Houston	979247	88070	194136	519110	62959	108389	70083	6806	2028803	236
Chicago	1355290	118703	152271	492293	34483	78573	39633	3563	2274813	247
Philadelphia	1428911	186404	189152	514828	40179	84714	39576	5400	2489168	255
My City	1709960	98976	167154	752274	36286	92721	40398	4868	2902640	268

Table 3.2 – The cost of each type of crimes, the total cost, and the rank of the cities

The table above shows that My City ranks 268, the lowest among the 11 major cities. My City has a total cost of crimes of about 2.9 million dollars. The cost of murder is over 1.7 million, occupying more than half of the total cost. This is due to the high emotional cost of murder estimated in Kathryn E. McCollister's essay. My City also has very high cost in aggravated assault and burglary, indicating that the level of safety in My City is low compared to other cities. My City is not bad with property crimes though, as the cost of all property crimes are comparatively low. However, since property crime seldom has much emotional cost, the better safety condition of property crime is not represented in the total cost. Overall, My City is quite unsafe in this concern and something should be done to alleviate the problem of violent crime.

The total cost of all crimes in every 1000 people in My City is a reasonable indicator of the safety level, as it takes in consideration both the emotional impact and the actual property lost in a criminal process. Compared to the fear approach, the cost evaluation highlights the emotional impact of violent crimes and takes into consideration the real expense of a crime. However, there are some disadvantages as well. For example, in the cost approach, the cost of a single murder in every 1000 people outweighs the cost

of any other types of crimes. A city with high murder rates will have much higher cost than one with low murder rates and high robbery or rape rates. This sometime can be misleading because the actual frequency of murder is very low. People are usually more worried about being robbed or raped than about being murdered.

In the fear approach, the level of fear of murder is not high. The fear model takes into consideration the low frequency of murder as people are not really worried about being murdered. Another advantage the fear model has is the comparative index scale it uses to show the comparative level of safety in different cities. The index scale is better at showing the relative level of safety in My City. Simply looking at the total cost of all crimes in every 1000 people in My City cannot give us an idea of how safe the city is. With the index scale that usually ranges from 0 to 1, we can easily comprehend the level of safety of each crime in My City.

A notable similarity is that in both approach, most of the big cities have low safety ratings. This is reasonable and an expected outcome because the population in a city is dense. More social interaction and denser neighborhood will create high crime rates. From this perspective, both the cost approach and the fear approach prove to be reasonable indicator of the level of safety in My City.

The fear model and the cost model in our essay are two essentially different models. Though sharing the same goal of creating a safety rating for My City, they utilize completely different ideas and methods. The results of the two models are similar, indicating that they are both reasonable and applicable indicator of the safety level in My City. However, there is no better model here. The two approaches are different, and it’s impossible to choose a better model when evaluating the level of safety in My City.

Part Four: Regarding the Safety Rating in Terms of Regions

Introduction

After measuring the safety rating of My City by comparing with other cities, the interior safety circumstance should be considered as well. In this part, safety rating inside My City is measured through the modeling of danger rating. Therefore, higher danger rating implies lower safety rating.

Instead of the trivial method of dividing the city by every beat number, we divide it into totally 22 regions. The rule to stipulate regions is: If two beats possess the same first two figures, they belong to the same Region. For instance, beat 2535 and beat 2534 will both belong to region 25. Our basis of regional division comes from both the maps of several cities in America (including Chicago, San Jose, Longmont and Modesto) and our dataset. These materials suggest that the quantity of beats with the same first two figures in their beat number is close in one city. Further justification has been included in the previous assumption part.

As the dataset has already offered us the beat number of each crimes, we are able to develop a model to determine the whether a region is securer than other beats. Comparing the cost approach and the fear approach, we decide to utilize the fear approach in this part to express the dangerous extent of each crime. The reason is that the cost index of murder (homicide) is so large that it will definitely affect the result of the security of one beat in a abnormally way, since a slight increment in amount of homicide will highly elevate the danger index of a certain beat. However, the fear approach we will use in this part is different from that we have used in the Part 2. Here, we will simply use original fear index listed in the essay *Fear of Victimization* by Mark Warr as the weight of each crime categories, but not convert it or use the weighted average in modeling.

1. Establishing Model of Regional Danger Rating

First of all, we define $P(x,y)$ by the following equation, which helps to illustrate the of the frequency of the occurrence of a specific crime category

$$P(x,y)=\frac{A(x,y)}{A(x)}$$

(Equation a)

For example, in region 25, theft had taken place for 111 times in these 13days and the total amount of theft in the same time period was 2618. Thus,

$$P(theft,25)=\frac{A(theft,25)}{A(theft)}=\frac{111}{2618}=0.0424$$

(Equation b)

Secondly, different categories of crime will have distinct impact on the society. The more dangerous and fear that people feel towards a certain crime category, the more impact this category will exert on the safety rating. Thus, the fear index is used again to suggest the dangerous extent of a crime category.

We denote $s(x,y)$ as the product of $P(x,y)$ and $K(x)$. Thus, the equation will be

$$s(x,y)=P(x,y)\cdot K(x)$$

(Equation c)

Therefore, the overall danger rating $r(y)$ should be

$$r(y)=\sum_{i=1}^{n}s(x_i,y)$$

(Equation d)

where x_i refer to a certain crime.

The ultimate results based on our model elicited a rank of danger ratings among all the 22 regions. From Table x we can see that region 5 and region 6 both obtain danger ratings over 3.00, which represents a relatively unsafe circumstance. The most secure region should be region 22, as its danger rating is only 0.50. (More detailed information can be viewed in the appendix part)

Region Number	Danger Rating
6	**3.55**
5	**3.30**
11	**2.74**
…	**…**
12	**0.95**
14	**0.86**
18	**0.73**
16	**0.59**
20	**0.50**

Table 4.1 Danger Ratings of Each Regions

Yet, not all the fear indexes of crime categories contained in the "My_City_Crime_Data" were successfully found so several items might be lost unfortunately. The categories lack of fear index also included several significant crime with large occurrence: Theft, Criminal Damage, Narcotic, Criminal Trespass and Other Offense.

2. Secondary Factors Analysis

Since last parts only discussed some major factors like crime categories and quantity, several minor factors including domestic and arrested situation are discussed in this part.

We classify the domestic situation into secondary factors because the amount of domestic-involved cases can not directly expose whether this Beat is safe or not. Primarily, domestic situation is more likely to happen in apartment or residence instead of streets or office building, so the high frequency of domestic-involved crimes could be caused by larger amount of apartments in one Beat instead of the low safety rating of this Beat. Furthermore, most of the citizens pay more attention to public security but not whether all family in this Beat is harmonious or not.

Similarly, the arrested ratio is related to other factors as well. For example, the criminals of theft might be easier to arrest than the criminal of an arson case. Also, a criminal could be arrested by police officers from a adjacent Beat. In this way, high arrested ratio cannot clearly stand for a safe Beat.

Due to the reasons above and the limitation of resources, we are going to make a basic analysis on these two factors instead of constructing other mathematical models for them.

(a)Domestic Situation

Among all the beats, region 7 possesses the highest domestic-involved ratio, which is 24.6%, while region 1 possesses the lowest, which is 3.4%. According to the data provided by the America Bar Association (ABA) domestic violence made up 20% of all the crimes taking place in 2014. Thus, the domestic-involved ratios of region 7, which is 24.6%, and Beat 3, which is 23.7%, have exceeded the national average.

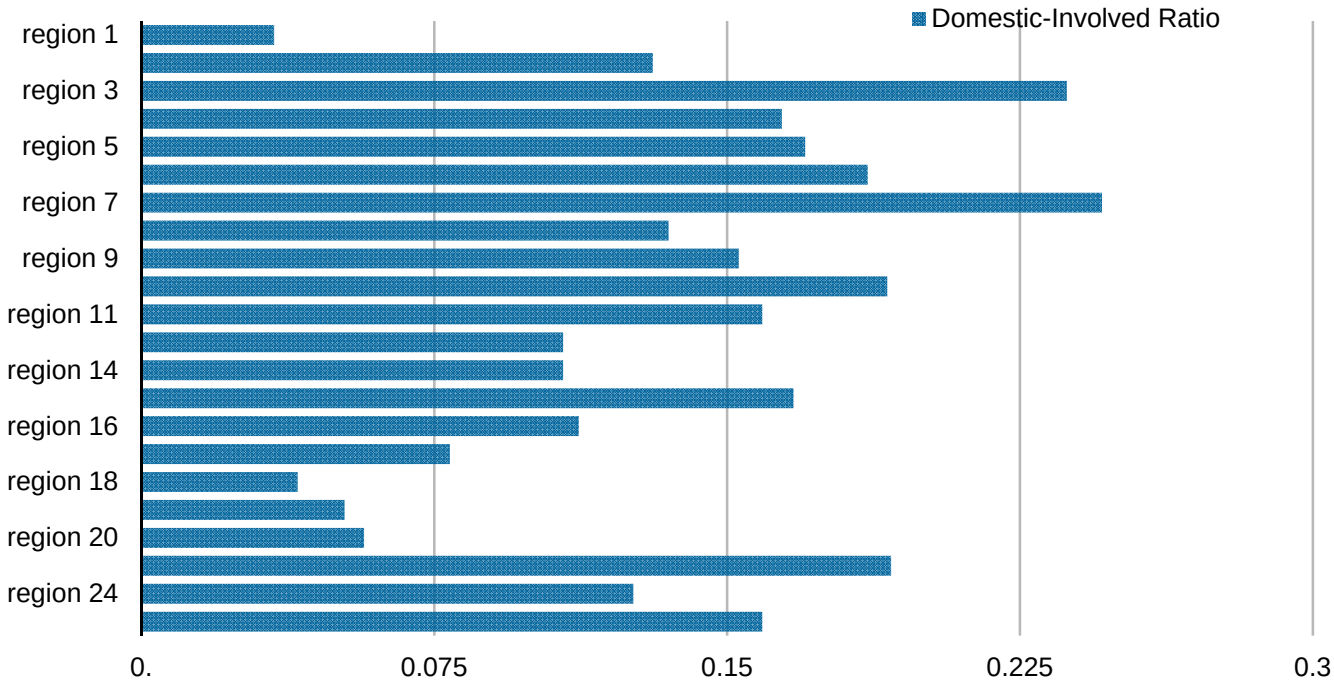


Chart 4.1 Domestic-Involved Ratios of Regions

(b)Arrested Ratio

Through all the regions, the Arrested Ratios range from 0.148 to 0.474. Region11 ranks the first, while region 12 ranks the last. Thus, greater efforts should be made in region 12.

However, region 11 ranks the third in the Danger Rating, which seems to be paradoxical to its Arrested Ratio. After further research, we notice that Narcotics, whose Arrest Ratio is pointed out in the Part 1 analysis to be one of the highest, make up over

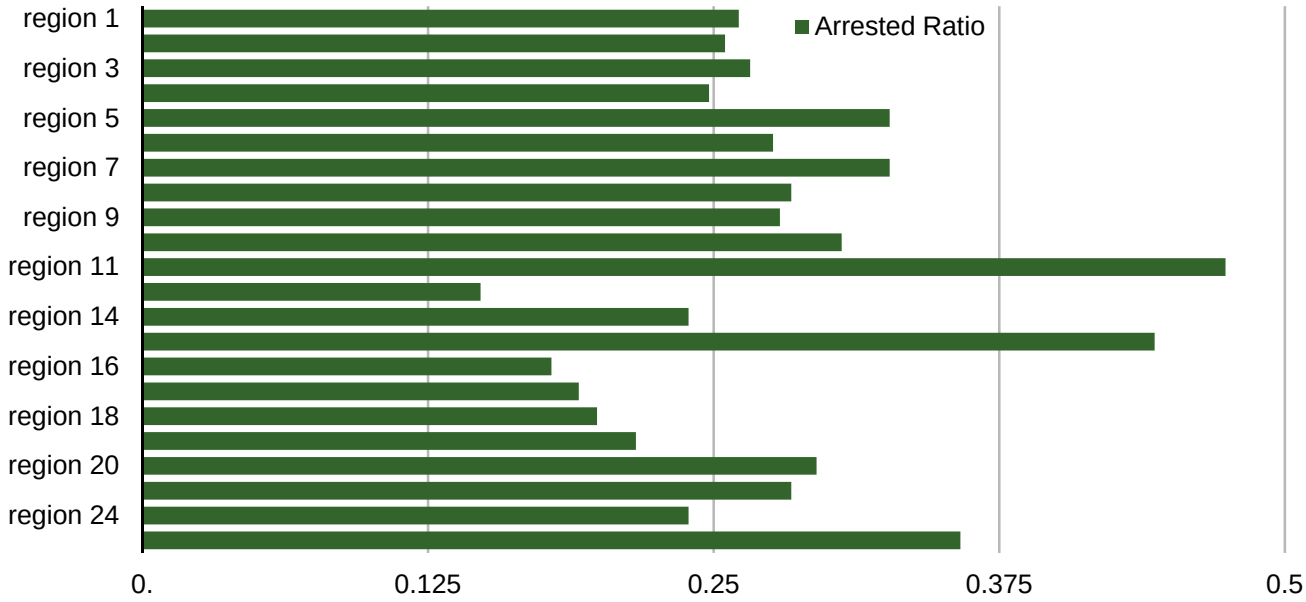


Chart 4.2 Arrested Ratio of Regions

one-third of crimes cases taking place in region 11. Thus, a great amount of Narcotics cases might be credited to the highest Arrested Ratio in region 11.

Additional Model: Two definitions of rape

In *Uniform Crime Report*, the definition of rape cases is different in different cities. The new definition of rape is introduced by the government in 2012 and in effect in 2013 to include more cases of sexual violation. This standard, however, is not yet fully adopted by all city agencies. Thus, two different types of data are used in the database of FBI to indicate the number of rapes. While they indicated similar things, the different standard generated a significant change of number that makes direct comparison impossible. Therefore, it's necessary for us to design a procedure to convert the number under the old definition into estimation under the new standard.

It's reasonable to assume that the ratio of rape numbers under two definitions is the same. This assumption is the foundation of our following rule of conversion

To convert, we will use data of the cities which use different standard in different years. We will follow a detailed procedure to estimate the ratio of rape numbers under different standards. In this procedure, we consider both the change of different years as well as different definitions.

Procedure to generate the estimated number of Rape (Revised Definition) for the cities where only number of Rape (legacy definition) is provided:

1. Get a list of cities which used the legacy definition in 2012 and revised definition in 2013.

2. Calculate the number of all violent crimes except that of rape.

3. Calculate the percentage of change in the number of all violent crimes except that of rape.

4. Use the percentage of change to predict the number of rapes under the legacy definition in 2013.

5. Calculate the ratio comparing the predicted number of rape under the old definition in 2013 and the actual number of rape under the new definition.

Having obtained the conversion ratio, it's possible for us to estimate the number of rape (revised definition) with the number of rape (legacy definition) using the following conversion equation:

$$Estimated\ number\ of\ rape(revised) = the\ ratio\ \times numberof\ rape(legacy)$$

So we are able to make comparison of all cities in revised number of rape, regardless of which standard they are using.

The result of our calculation shows that the ratio is approximately 1.3, which we used to transform the number of rape cases under legacy definition into that under revised definition in our model.

Strength and Weakness

There are both strength and weakness in our two approaches. Our strength makes our model reasonable and applicable while we still realize the limitation of some of the methods we used in the modeling process.

Strength:

1. We formulate two approaches with actual meaning: cost and fear. They are directly connected with a concept that evaluates the city safety.
2. In our fear approach, we used a research that not only evaluates the tangible costs but also the intangible cost such as the emotional cost of the victims.
3. In our fear approach, we use a method to eliminate the effect of the difference in number so that we can combine data from different categories together.
4. We compare the safety of My City with the cities with a population of >100 thousand in the nation to get a better idea how safe/unsafe My City is. We also included the 11 cities with most population which are similar to My City in population size to have a direct compare in safety rating.
5. Besides evaluating the safety comparing with other cities, we evaluated the safety rating within the My City to see the safe and unsafe areas.

Weakness

1. We ignore the crimes that are not offense, they may still contribute, through maybe only a minor part, to the unsafety of the city.
2. In the fear approach, we used a 1983 survey which may be different from people's opinions now.
3. The interior of the city is quite limited. We don't have sufficient data to make more reliable analysis of the safety rating in beats.

Conclusion

Through evaluation of the emotional trauma (fear approach) and the property loss (cost approach), we have devised two mathematical models to calculate the safety rating both in terms of My City and regions inside it.

After first analyzing the data, we use data from Uniform Crime Report to create an index scale for each type of crime in Part two. With the numerical evaluation of fear of victimization from Mark Warr's essay, we calculate the level of fear in each city that has more than 100K of population. In the end, by comparing My City with other cities, our group gains a general understanding of the level of fear in My City. We use the cost of crimes per 1000 people as the indicator of safety in Part three. The cost of crimes includes both the emotional toil and the property lost. My City ranks low in both approach in comparison with other cities and has very severe crime issues in murder, robbery, and assault.

In Part four, we firstly re-divide totally 22 regions inside My City based on the original beat number from My_City_Data. Then we applied both fear approach and the possibility of each crime categories to generate the danger rating of each region, in order to use the extent of danger to represent the safety rating. Consequently, the processed data the highest danger rating (the lease safe region) is 3.55, and the lowest (the safest region) one is 0.50.

A letter to the Mayor

Mr. Mayor

We are the mathematical modeling team of the city. Several days ago, we received some criminal data from the police department and were asked to create a safety rating for My City. We first analyze the data and gain a simple understanding of the city. After thorough consideration, we decide to use two different indicators to evaluate the level of safety in My City: the cost of the crimes and the fear of victimization in the city. We also include analysis for the level of safety inside the different region in My City. The result of our mathematical modeling shows that My City is relatively an unsafe city in the United States and better crime control policies are needed.

According to our analysis of the data, Theft, Narcotic, Battery, and Criminal Damage are among the most frequent crimes taking place in the city. Compared to the national average, the crime situation in My City is worse than that of the whole nation. The number of Homicide, Robbery, and Assault cases per 100,000 people in My City is significantly larger than the national average.

The fear of victimization in My City is also comparatively high. Comparing My City with other cities that have a population of more than 100K, My City ranks 237 among the 284 cities. Our fear model shows that the fear of Murder, Robbery, and Assault in My City is very high - higher than that of 75 percent of all 284 cities. The fear of Rape, Burglary, and Motor Vehicle Theft is reasonable among the citizens.

The cost of crimes in My City is also high. The cost of crimes includes both the property cost and the emotional cost in our model. The result shows that the total cost of all crimes per 1000 people is approximately 3 million dollars, ranking 268^{th} among all 284 cities. The results of the cost approach also indicate that Murder, Robbery, and Assault are the most severe criminal problems in My City.

In the end, our mathematical modeling team also analyzes the level of safety inside My City. The result shows that the region in which beat numbers starts with 6 (or 06) are the most dangerous area in My City. Therefore, it’s reasonable to send more

police power or law enforcement force to that specific area to help with the rampant criminal activities there.

Our analysis and our two different approaches indicate that the level of safety in My City is low compared to other cities in the United States. Problem of murder, assault, and robbery is especially serious and noteworthy. Inside the city, the region with beat numbers start with 6 also has very high fear of victimization and more police force should be sent. In conclusion, our team believes that more crime control policy and police power is needed to improve the condition.

Mathematical Modeling Team

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Appendix

(1)Crime Amount and Arrested Condition of Each Crime Categories

Crime Categories	Amount (Times)	Arrested Cases (Times)	Arrested Ratio
THEFT	**2618**	**287**	**0.110**
BATTERY	**2002**	**488**	**0.244**
NARCOTIC	**1153**	**1152**	**0.999**
CRIMINAL DAMAGE	**1068**	**85**	**0.080**
ASSAULT	**701**	**181**	**0.258**
OTHER OFFENSE	**636**	**145**	**0.228**
BURGLARY	**560**	**41**	**0.073**
DECEPTIVE PRACTICE	**508**	**49**	**0.096**
ROBBERY	**394**	**36**	**0.091**
MOTOR VEHICLE THEFT	**374**	**25**	**0.067**
CRIMINAL TRESPASS	**304**	**222**	**0.730**
WEAPON VIOLATION	**139**	**113**	**0.813**
PUBLIC PEACE VIOLATION	**113**	**97**	**0.858**
PROSTITUTION	**86**	**86**	**1.000**
OFFENSE INVOLVING CHILDREN	**69**	**10**	**0.145**
INTERFERENCE WITH PUBLIC OFFICER	**61**	**61**	**1.000**
CRIM SEXUAL ASSAULT	**41**	**3**	**0.073**
GAMBLING	**24**	**3**	**0.125**
ARSON	**23**	**23**	**1.000**
SEX OFFENSE	**21**	**7**	**0.333**
LIQUOR LAW VIOLATION	**21**	**21**	**1.000**
HOMICIDE	**19**	**7**	**0.368**
KIDNAPPING	**11**	**1**	**0.091**
STALKING	**7**	**3**	**0.429**
INTIMIDATION	**5**	**1**	**0.200**
CONCEALED CARRY LICENSE VIOLATION	**1**	**0**	**0.000**

Region Number	Unfasten Rating
6	**3.55**
5	**3.30**
11	**2.74**
7	**2.73**
8	**2.40**
4	**2.20**
3	**1.65**
10	**1.63**
25	**1.59**
15	**1.52**
22	**1.51**
17	**1.40**
19	**1.36**
9	**1.34**
2	**1.33**
24	**1.22**
1	**1.19**
12	**0.95**
14	**0.86**
18	**0.73**
16	**0.59**
20	**0.50**

(2)Danger Rating of Each Regions