The Dynamics of Violent Crimes in New York City: a 50-Year Perspective

Daniel Sánchez de la Nieta Guisado

Master's Degree in System Dynamics
University of Bergen
dani.sng18@gmail.com

Abstract: *The present study shows both a causal loop diagram and a stock and flow diagram of a system dynamics model that seeks to explain the trend change in violent crimes in New York City over a period of 50 years. It combines four important factors that have been used to explain the big increase and subsequent fall in these kind of crimes: demographics, differential association theory, law enforcement, and drugs. It also tests and evaluates a policy to decrease further the number of violent crimes. Limitations of the model are also discussed.*

*Keywords: crime, New York City, policy, system dynamics.*

Introduction

Crime in New York City has been falling since the early nineties against most predictions (Levitt, 2004; Fox, 1996). It had been slowly increasing since the 60's but in the 90's, it started falling sharply. The extent of the drop is so meaningful that, while during the 60's-90's period, NYC was one of the most dangerous cities, it has gradually become one of the safest cities in the USA (Venkatesh, 2006). This fact makes important to understand why this happened to see whether it is possible to replicate the good results.

Many discussions, debates and hypotheses about why crime has followed this pattern have been offered. Analyzing the 10 main reasons that the scientific literature uses to explain why crime fell in the USA (Levitt, 2004), Dianiati and Happach (2012) found that almost all of them are based on econometrics and data regression and they seem to be looking for one only cause. We agree with these authors that this mode of analyzing data may hide some insights about the problems. There may not be only one cause and the cause-effect relationship may not be near in time. Thus, with a System Dynamics approach, we try to explain which factors may have contributed to the rise and fall of crime in New York City during a period of 52 year (1960-2012), putting emphasis on a holistic and dynamic point of view.

Dynamic problem

In this paper, we focus on NYC reported violent crime rate. We analyze violent crimes because, given their seriousness, they are more likely to be reported (Levitt, 2004). In this category, we include murder, forcible rape, robbery and aggravated assault and we exclude familiar-related violence (i.e. domestic violence). The reason for this exclusion is mainly that they have been declining during the whole period so the dynamics of family-related violence must be of a different nature (Donohue, 1998).
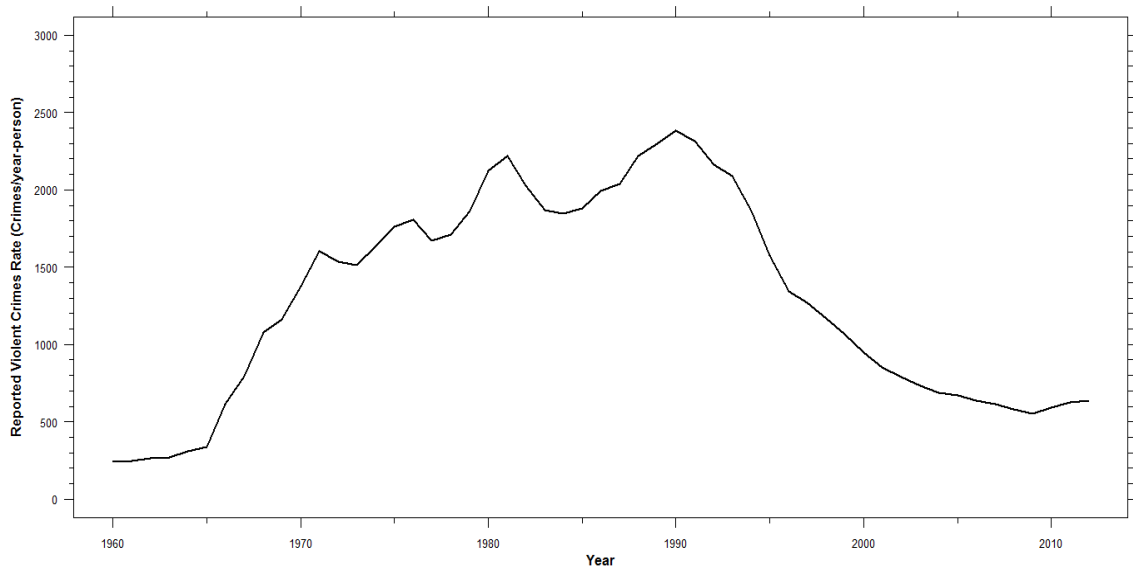
Figure 1. Reference mode.

Figure 1 shows the development of the reported violent crimes rate from 1960 until 2012. This will be our reference mode. Throughout the paper, we are going to suggest not only explanations for the period of increase but also for the period of decrease using the same key factors.

Theoretical background

Many reasons have been argued to explain why violent crimes rose and fell. While many authors consider that the main cause is economical (Neumayer, 2003; Freeman, 1996), others have argued about the important role of changing of demographics (Donohue & Levitt, 2001), guns, and drugs (Wallman & Blumstein, 2000; Marvell, 2001).

We acknowledge that all these reasons have had some influence on crime and some authors may have mixed correlation and causality. In the same vein, many criminological theories try to explain crime and all of them take a particular approach and do not see the whole picture, with the exception of the integrated and developmental life course theories (Cullen & Agnew, 2002). Due to space limits, we have to restrict our analysis to a few theories that we consider most relevant in the present case.

The first one is the rational choice theory. This theory presumes that people are rational beings and they outweigh costs (fear of punishment; Levitt, 1998) and benefits (money, fun, easy immediate satisfaction; Clarke, 1997). Thus, when costs are bigger than benefits, people do not commit crimes, *ceteris paribus*.

The second one is differential association theory (Matsueda, 1988). In this theory, Sutherland proposes that crime is a learned behavior like many others. When people have more anti-social experiences (such as, rationalizations, justifications, motives, how to do it, etc.) than prosocial ones, they are more likely to start criminal activities. We consider it to be a kind of contagion theory.

The third theory is what we may call the "demographic theory". Criminologists generally agree that age and sex is a determinant of criminal behavior (Hirschi & Gottfredson, 1983). Thus, the young male population has significantly more risk of becoming a violent criminal than people in other sex and age group.

The fourth theory is related to drugs. People who consume drugs are more likely to commit violent crimes because either they are desperate for money in order to buy more drugs (Levitt & Venkatesh, 2000; Bolesa & Miottoa, 2003;White et al., 1999) or the pharmacological effects of the drugs makes them more likely to be violent than in normal conditions ((Ernest, 1977; Goldstein et al., 1991)

Finally, we have to consider what relevant policies where applied during the period we are analyzing. One of the most important and widely known is the zero-tolerance policy by the mayor Giuliani (Langan & Durose, 2004). That policy increased the number of police dramatically between 1993 and 2000. Many politicians and mass media attribute the decrease of crimes to the high number of police. Nevertheless, we must note that crime started falling before 1993 (Bowling, 1999), so it is not likely to be the one and only explanation of the decrease on crime.

Dynamic hypothesis

Our hypothesis of what happened in New York City from 1960 until 2012 is the following: a sudden increase in the young male population, i.e. at-risk population, occurred after World War II. Some of these young adults associated with violent criminals and got antisocial experiences, thus becoming potential violent criminals. This association theory can be deemed as a contagion effect (or a reinforcing effect), so that violent criminals are infected and potential violent criminals are "infected". A few of them committed crimes and became violent criminals. At that time, the law enforcement was not growing fast enough to counteract this reinforcing loop (it takes some time to perceive the need of increasing the police force and to actually do it) with more arrests, that is, they were not putting the infected persons into quarantine (i.e. prison) fast enough to avoid an epidemic. Moreover, an increase on the consumption of drugs (namely, heroin and cocaine) reduced further the fear of punishment (also known as deterrence effect) that arrests cause (Wright et al., 2004). Continuing with the epidemic metaphor, consuming drugs increases the probabilities of showing symptoms and the arrests made by the police have the opposite effect (they decrease them). While the violent criminal population was growing, the police force was also being increased and more arrests were made, increasing the deterrence effect. However, the extent of this effect was not enough to stop the epidemic.

During the late 80's and early 90's, the factors changed. Firstly, the young male population growth started declining and there was less at-risk population to be infected (i.e. potential violent criminal). Secondly, the consumption of drugs was reduced or changed to marijuana (this drug is less likely to cause violent behavior) (Zimring, 2012; Ernest, 1977) which affected positively to the probability of committing a violent crime, thus becoming violent criminals. Thirdly, when this declining dynamic was already occurring (there were fewer young male adults and, therefore, fewer potential violent criminals and violent criminals), Mayor Giuliani increased the growth rate of the police

force (implementing his well-known zero-tolerance policy; for more information, see Langan & Durose, 2004). So the number of arrests made was increasing faster, and that accelerated the *decline* of the epidemic.

In short, the net effect of these factors produced the rise in crime (more "contagion" effect due to more at-risk population, more consumption of drugs and police not growing fast enough to counteract). These same factors changed with time and their combined dynamics produced a rapidly decline (less "contagion" effect due to less at-risk population, more police force that produced more arrests and thus decreased further the "contagion" effect by taking violent criminals from streets and less consumption of drugs).

Causal loop diagram

Based on our review of the literature, we build a causal loop diagram in order to show the interactions that exist among the different hypotheses for the decline in New York crime.

In our model, we are trying to explain the variable "reported crime rate". This is a ratio of the number of reported crimes per 100.000 inhabitants (figure 2).
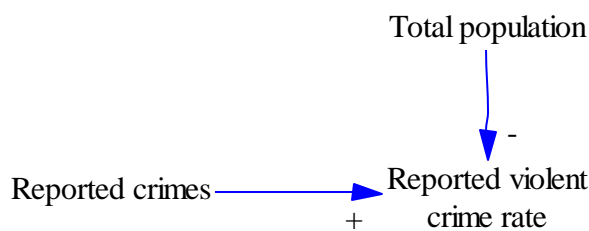

Figure 2. Reported crime rate.

The number of reported crimes is a fraction of the total crimes committed and violent criminals are the ones who commit crimes (figure 3)
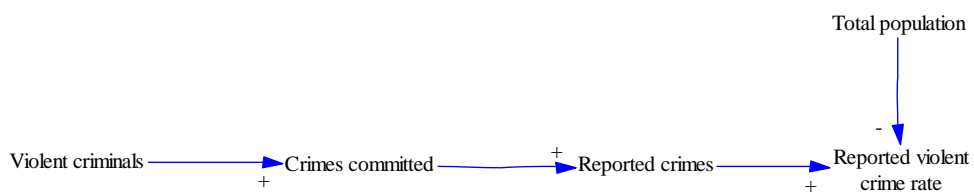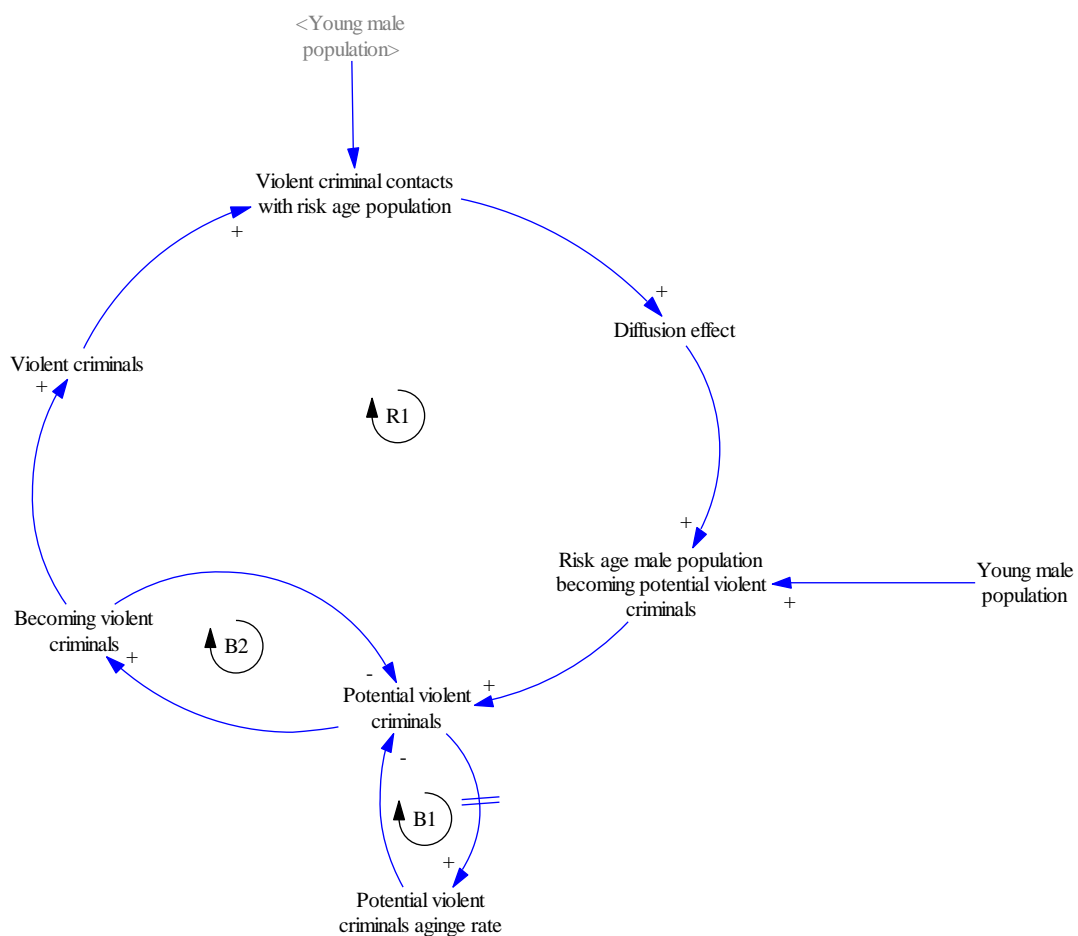

Figure 3. Violent criminals.

According to our diagram (figure 4), criminals come from a reinforcing loop (R1). This contagion effect loop (R1) shows us that when the at-risk population contacts violent criminals, they are likely to become potential violent criminals. According to the

literature (Hirschi & Gottfredson, 1983), males between 18 and 35 years old are the ones more likely to become criminals so we could also say that they are even more likely to become potential violent criminals. In NYC, during the sixties, there was a large growth of the young male population, due to the post World War II, so this will translate into an important increase of at-risk population. However, in order to become a potential violent criminal, the at-risk population needs to have some criminal contacts, as we have defined before. If they did not need this, then crime would just vary depending on demographics which is not the case. Once the potential criminals age out (B1), they are less likely to engage in criminal behavior. The loop B2 shows that when potential violent criminals are becoming violent criminals, then they are no longer potential violent criminals.

Figure 4. Differential association and demographics.

Given this structure, the reinforcing loop R1 is going to increase the number of violent criminals until there is no at-risk population. This would create an increase in the number of crimes committed. However, a reduction in the number of violent criminals would reduce the diffusion effect, thus diminishing the strength of the loop. In case R1 was debilitated, then B1 would gain strength and there will be less and less potential violent criminals and, therefore, less and less violent criminals. However, what can reduce the strength of R1 in a sufficient manner to allow a dominance shift?

Violent criminals are arrested and, if guilty, then they go to prison. After a delay, they get out of jail and may start committing crimes again or be back to become potential violent criminals (R2 and R3, respectively) (figures 5 and 6).
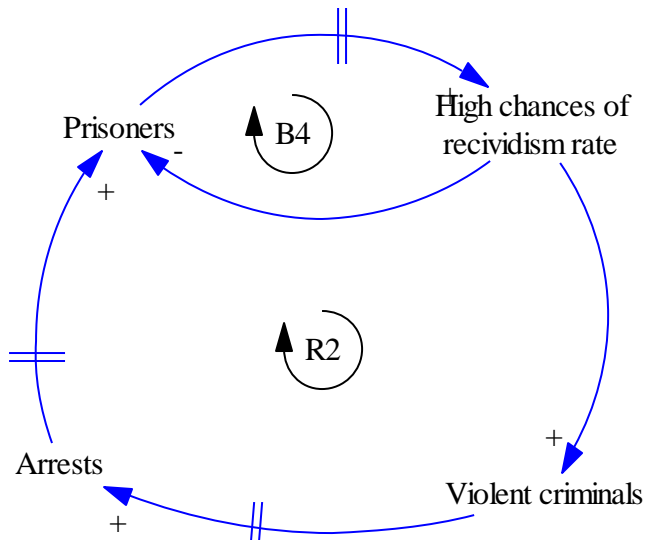
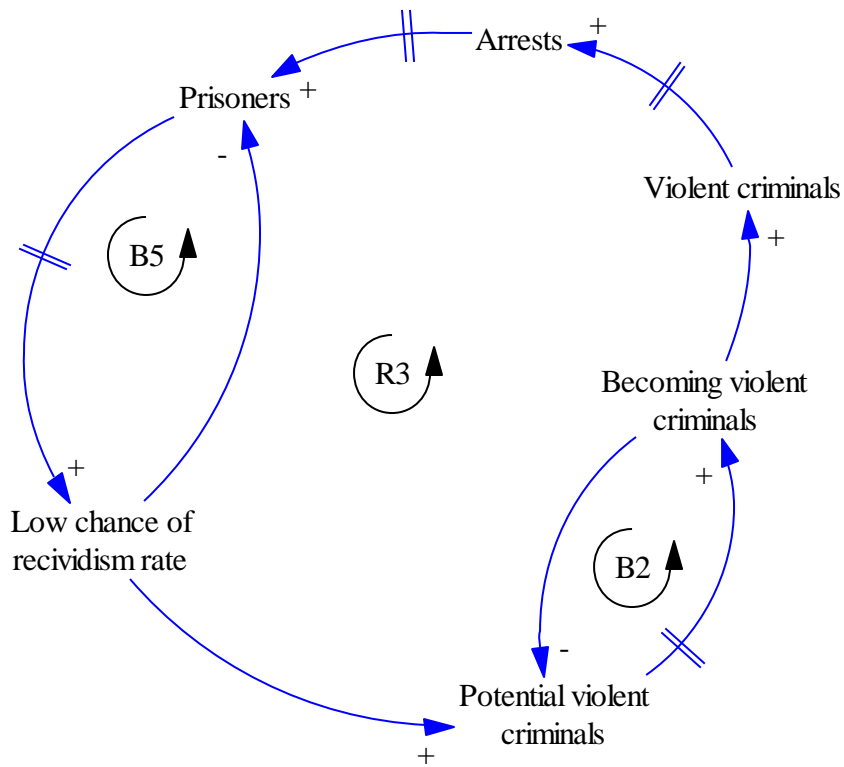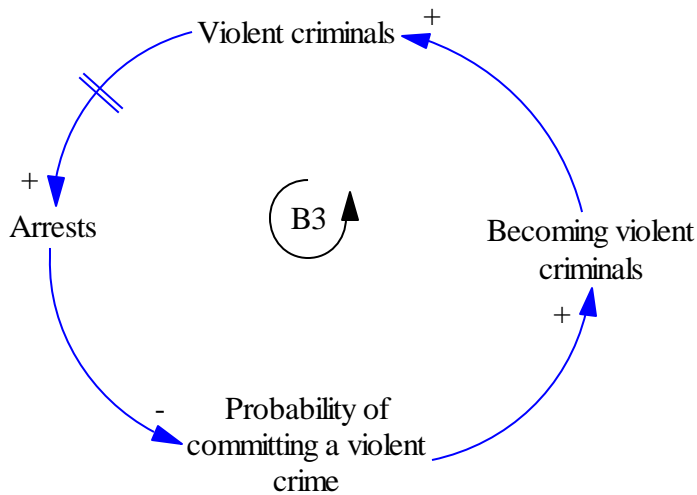**Figure 5. Ex-convicts with high chances of recidivism.**


Figure 6. Ex-convicts with low-chances of recidivism.

Also, the deterrent effect or fear of punishment is showed by B3 loop (figure 7). The more arrests there are the more fear potential violent criminals have of committing crimes and thereby they are less likely to do so.

Figure 7. Deterrence effect.

Politicians and the law enforcement establish a desired change in crime rate expressed as a percentage (25% reduction of crimes) for each year. When crimes go up, the desired change in crime rate (there are more crimes to prevent in order to accomplish the same percentage) so more arrests are needed. Then, the desired police force increases due to the policy emphasis on arrests. Finally, after a delay, more police officers are hired and thus, the arrests are increased (B6). Moreover, this increase in arrests will exert a negative influence on the probability of committing a violent crime that will reduce the number of potential violent criminals actually becoming criminals (figure 8).
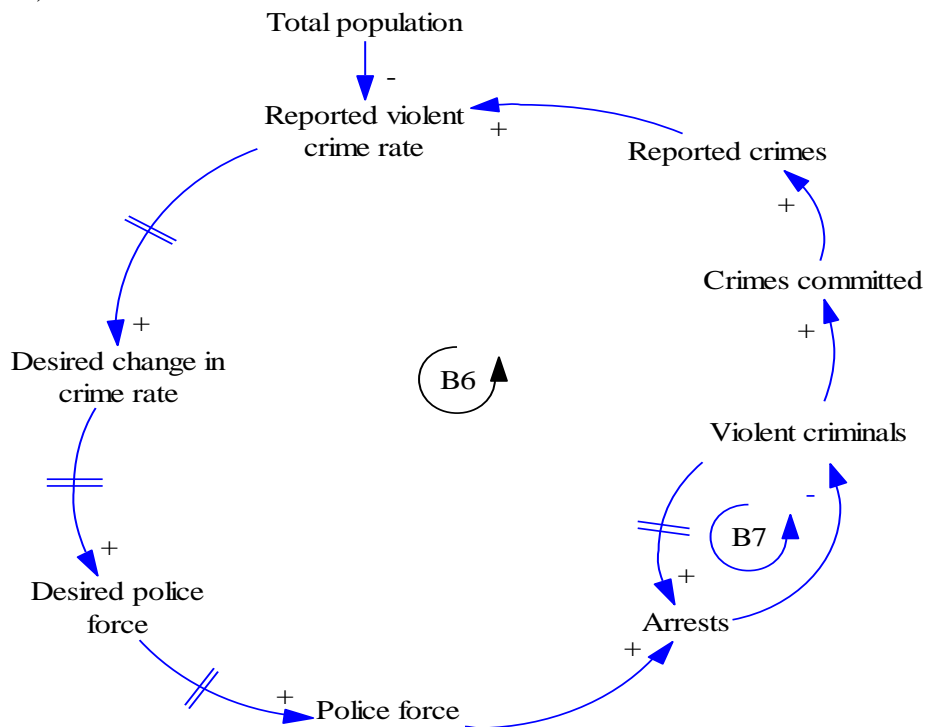
Figure 8. Enforcement law loop (B6).

Police also reduce the drug stock since they confiscate drugs when they caught the dealers. On the other hand, drugs are consumed by some potential violent criminals, which increases the probability of committing a violent crime (B8) (figure 9).
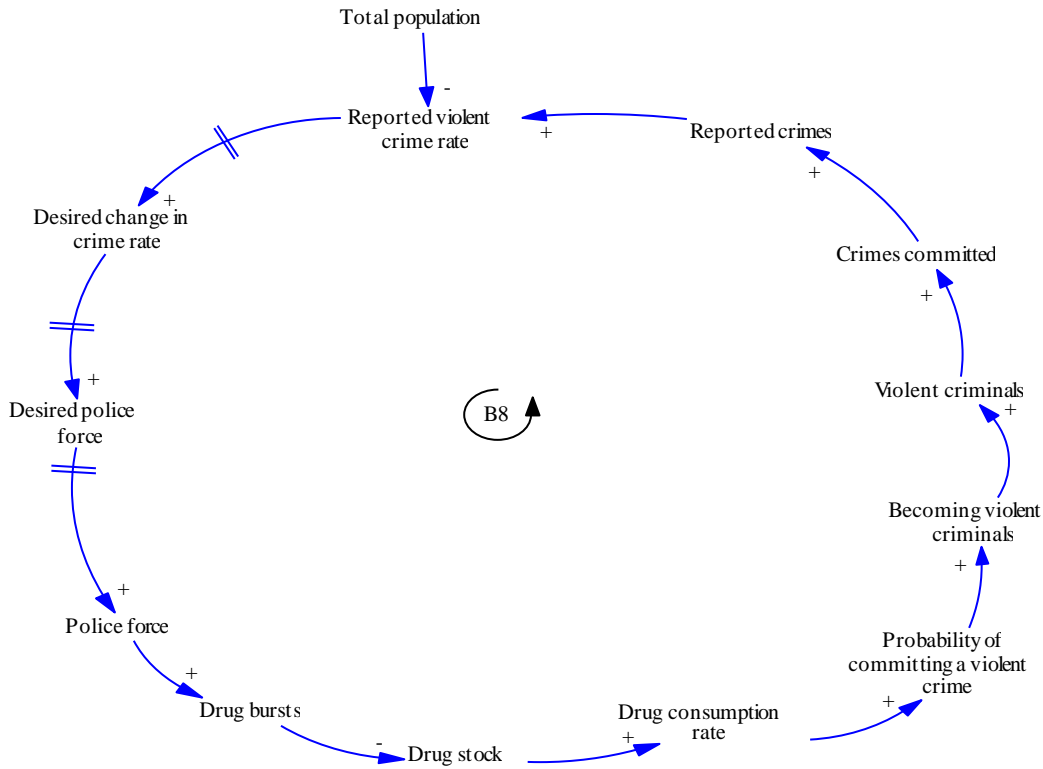

Figure 9. Drug loop.

Finally, figure 10 shows the whole causal loop diagram together.
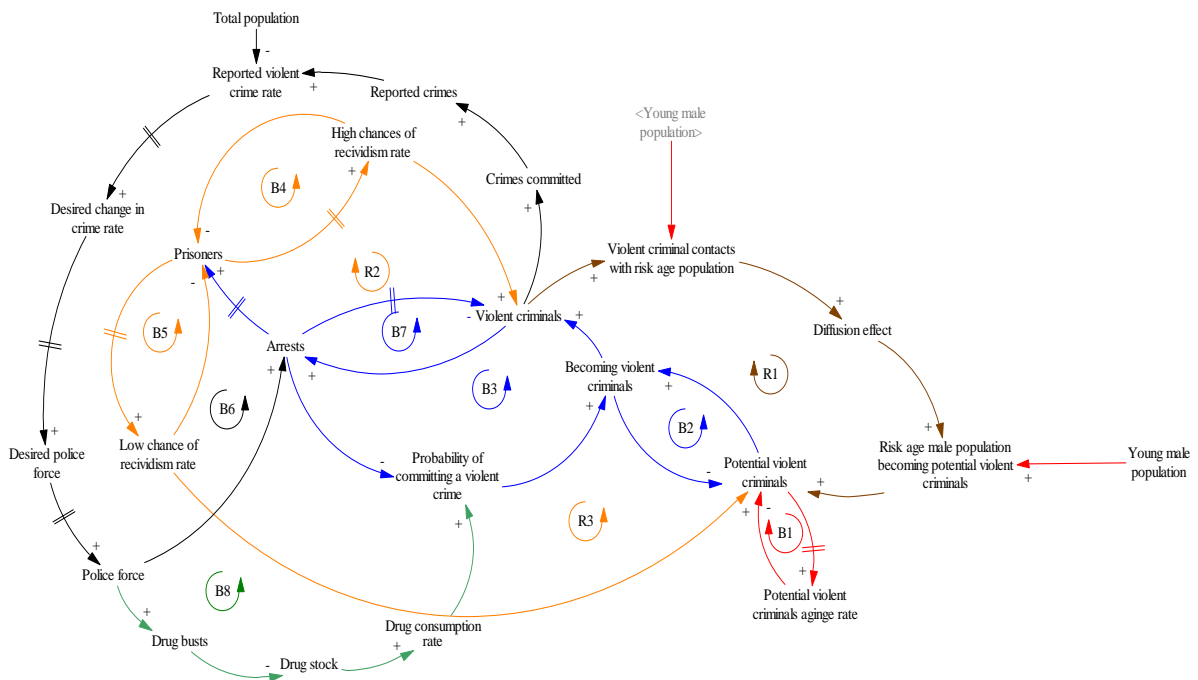

Figure 10. The complete causal loop diagram. Color code: red = demographics, black= law enforcement, orange recidivists loops, brown = differential association theory, blue = criminal career and green = drugs

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Stock and flow structure and behavior

As figure 11 shows, the simulated behavior reproduces the rise and fall of the violent crime rate in NYC. However, it is not a perfect fit. Both behaviors start increases with an S-shape pattern, but they do not match since the simulated behavior grows slower than the historical one. The same happens when the behaviors start decreasing.
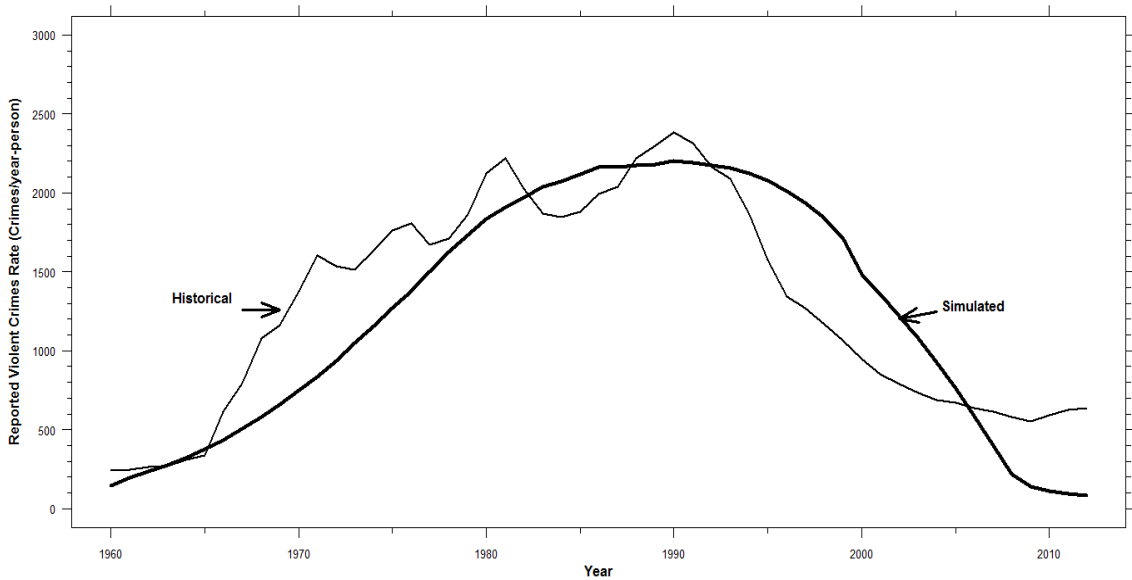

Figure 11. Comparison between historical and simulated behavior.

The CLD showed earlier was a simplified version of a stock and flow model. In order to explain our simulated behavior, we must understand how it arises from the stock and flow structure (Figure 12).
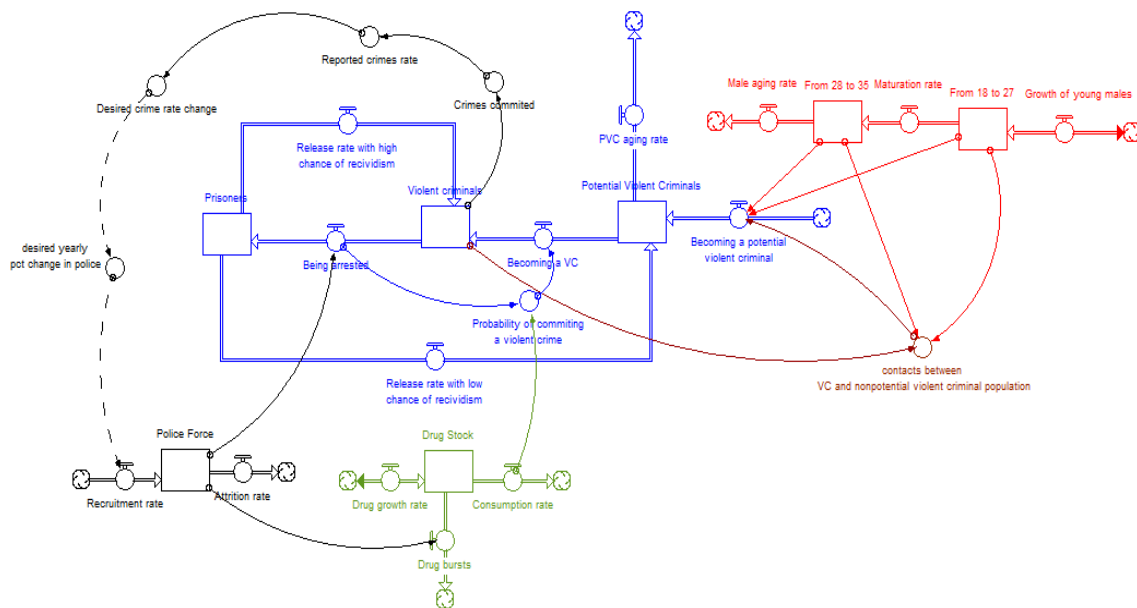

Figure 12. Very simplified version of the stock and flow structure without the policy structure in iThink.

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Although the indicator that we are most concerned about is reported crime rate, its behavior arises from the variable "crimes committed" and, at the same time, both the parameter "violent crimes committed per criminal" and the stock "violent criminals" influences the number of crimes being committed. This stock is what mainly changes the behavior of the variables aforementioned.

The behavior of violent criminals shows a rise and fall pattern which is caused by the interaction of its outflow and inflows. The "becoming violent criminals" rate increases and then decreases exponentially whereas the "being arrested" outflow increases exponentially. On the other hand, the "release rate with high chances of recidivism" increases slowly and constantly. Consequently, the stock of violent criminals rises because the inflows overcome the outflow (being arrested) but, after some time (1990's), the outflow has increased greatly and one of the inflows (becoming a Violent Criminal) starts decreasing which produces a dominance shift. A few years later (2000's), the stock of potential violent criminals increases again (due to a new increase of the at-risk population) but it is not strong enough to produce a new shift in loop dominance (the "being arrested" outflow is higher than the "becoming violent criminals inflow, despite its increase) and the violent criminals stock does not increase. However, given that the recidivist fraction is stable and there are more people in prison, the other inflow (release rate with high chances of recidivism) is increasing steadily. This suggests that, currently, there are fewer "first-time" violent criminals and more recidivists. In this sense, Kazanawa (2008) has already noticed this fact.

The probability of committing a violent crime and the stock of potential violent criminals affect the "becoming a violent criminal" rate. The stock varies according to the demographics. Indeed, the literature suggests that the baby boomers (those born during the post-World War period) aged out, entailing a reduction in the number of criminals because there were fewer people within the risk age range (Zimring, 2012; Hirschi & Gottfredson, 1983). However, it is also influenced by other factors, for example the differential association theory. In order to model this theory, we have been inspired by the contagion model (Sterman, 2000), widely known in system dynamics. The probability of a male youngster (from 18 years old to 35 years old) to become a potential violent criminal depends on the number of contacts with violent criminals. If this number is over the normal contact rate (that is, the contact rate in the 60's) then the probability of becoming a potential violent criminal increases and vice versa. The amount of the increase is an educated guess and we assume that it has a limited effect, that is, the maximum value is twice the normal rate.

Given that we have explained how normal people become potential violent criminals, now it remains to explain why they actually become violent criminals. The probability of committing a violent crime is affected by many different factors, all of them surrounded by a degree of controversy. Unfortunately, most times, criminologists agree to disagree on which factors affect crime and to which extent. However, given the New York City situation, we have taken those that we deemed as having more weight in the decision of becoming a violent criminal. The two factors that we have modelled are the probability of being arrested and the effect of drug consumption on being violent.

The first factor is grounded in the following rationale: if there are many violent criminals being arrested, potential violent criminals will think twice before committing a violent felony. As in all factors, there is some controversy in the literature about this

effect (for example, Bryett & Lewis, 1994). The evolution of arrests of police had to be assumed to a certain extent, given the lack of data. Whereas we have data about how many police officers there were during the period from 1980 to 2002, the rest of it had to be guesstimated. However, we obtained data from the most important period, that is, some years before and after Giuliani became the mayor of New York City. As explained before, Giuliani increased the New York police force, which suggests that this may have affected to the probability of becoming a violent criminal. To test this "Giuliani effect", we have stepped up the maximum percentage of feasible increase of the police force when the New York City mayor started applying his zero-tolerance policy.

There is more agreement about the second factor. If people consume drugs, the pharmacological effects will make them more likely to be violent and, therefore, to commit a violent crime (Bolesa & Miottoa, 2003; White et al., 1999). The drug consumption is quite difficult to measure and quantify and it seems that there is no concrete data for the New York case. However, we do know from the literature that there were three different drug waves in New York City (Zimring, 2012). Given this, we assumed that, from the 60's until the 90's, there were more drugs in New York City and they were consumed at a higher rate than from that period on. Nonetheless, it is important to notice that we are referring to cocaine (Roland et al., 2005) and heroin and we are not including marijuana (that is why there is a decrease in consumption even though consumption of marijuana has been increasing since the 90's) (Gledhill-Hoyt et al., 2000). The reason for this last exclusion is that marijuana is less likely to make someone being violent (Ernest, 1977) than cocaine or heroin (Goldstein et al., 1991). Another factor that we have taken into account is the drug busts made by the police.

To summarize, the net effects of these factors led to an increase of the crime rate between the 60's and the 80's. A sudden increase of at-risk population entailed a growth of potential violent criminals and, consequently, an increase in the number of violent criminals which, in turn, led to a further increase in the number of potential violent criminals due to the contagion effect. Police were not effective enough to avoid this epidemic (they were not doing enough arrests to put in "quarantine" the "infected people, i.e. the violent criminals). In addition, the increase on the consumption of drugs increased the probabilities of a potential violent criminal becoming an actual violent criminal. But, as time went by, the growth of the young male population became slower, the consumption of drugs also declined and the police force had become large enough to arrest a significant number of violent criminals. This produced a dominance shift. Crime was going down very rapidly due to the effect of those factors combined.

Policy and Implementation Model

In the model, we can see different ways to reduce violent crimes. One general policy would be increase police further, but this seems of little use, given that the deterrence effect is probably non-linear and may already have achieved its maximum value. The policy we recommend for consideration is different. We focus on the differential association theory and counteract its diffusion through a program with people who will give prosocial definitions and support to the potential violent criminals and, thus, reduce the number of violent criminals and crimes.

Our policy proposal is a mentoring program. These program would consist in matching ex-convicts (mentees) with pro-social people (mentors) so that they do activities

together and they would develop a friendship. The mentors can provide their mentees with counseling about different problems they may have (e.g. should I quit my job? Should I start taking drugs again?). This kind of counseling would be very personal, that is, not as a professional but as a friend. For more information about this kind of programs, see Taylor et al. (2013), Fletcher, Sherk & Jucovy (2009) and Guiguere (2009).

The reason why we choose only the ex-convicts to be treated is due to its feasibility. . It would not be possible to include in our program all the potential violent criminals in New York City since we do not know who all of them may be. Nevertheless, we do know that ex-convicts are potential violent criminals. Consequently, our policy will be aimed at those people.

The implementation of the policy would be as it can be seen in figure 13. We inform prisoners that are about to be released what are the benefits of joining the program (they would be more able to get a job, to keep in the "right" track, etc.). Some of them will be willing to participate in this program. At the same time, we will start advertising for people who want to volunteer. These unpaid workers are the ones who will be friends with the ex-convicts support them and give them prosocial definitions (rationalizations, code of conduct on formal situations, etc.). They must not be paid, otherwise, prisoners may not consider them friends but professionals and it may not have the same effect. When we know approximately how many prisoners want to join in, we would start matching volunteers (also called life coaches or mentors) and ex-convicts.
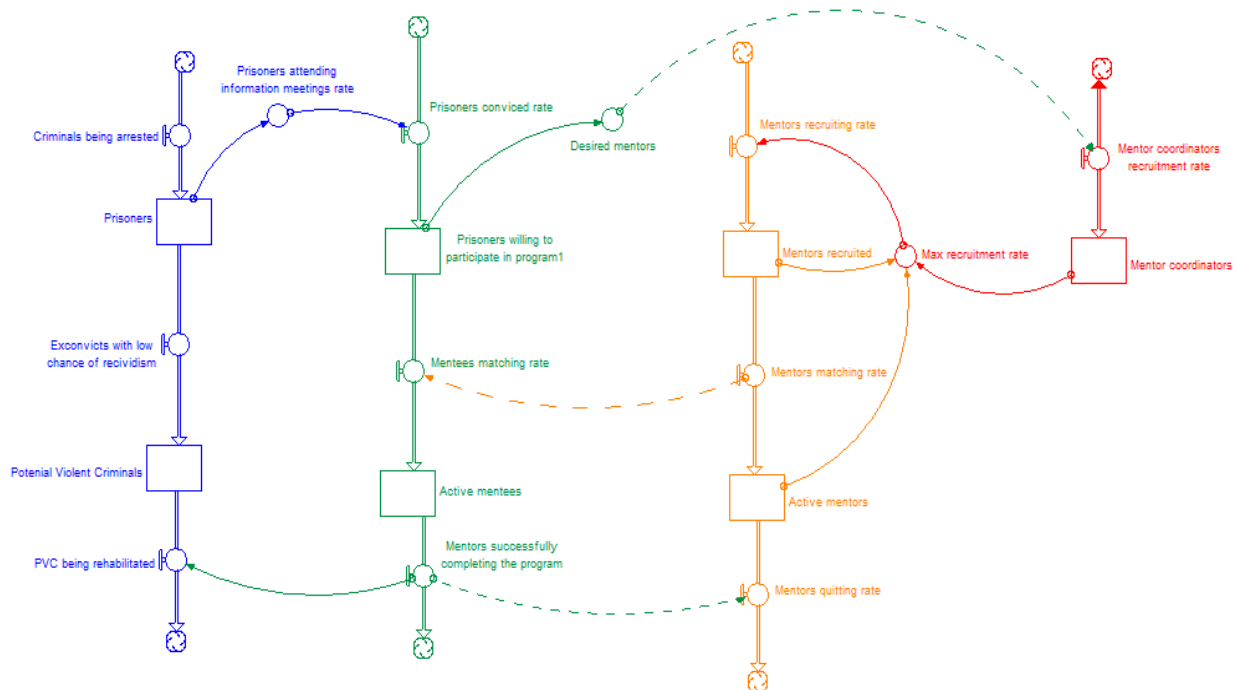
Figure 13. Very simplified version of the policy model in iThink (parts in green, orange and red; the blue part is part of the explanatory stock and flow structure).

They will be in contact and do different activities (going to a football match, cinema, etc.). Most importantly, the volunteer would provide support when the ex-convicts wants to come back to its previous life (consuming drugs, quitting the job, start stealing…). Once the program is finished after six months, a certain percentage of ex-convicts would not recidivate because they do not have risk factors any more so they cannot be considered potential violent criminals and thus crimes would be reduced.

Figure 14 shows how the number of violent crimes per year would be reduced. In 2030, New York City would have 500 violent crimes less per year.
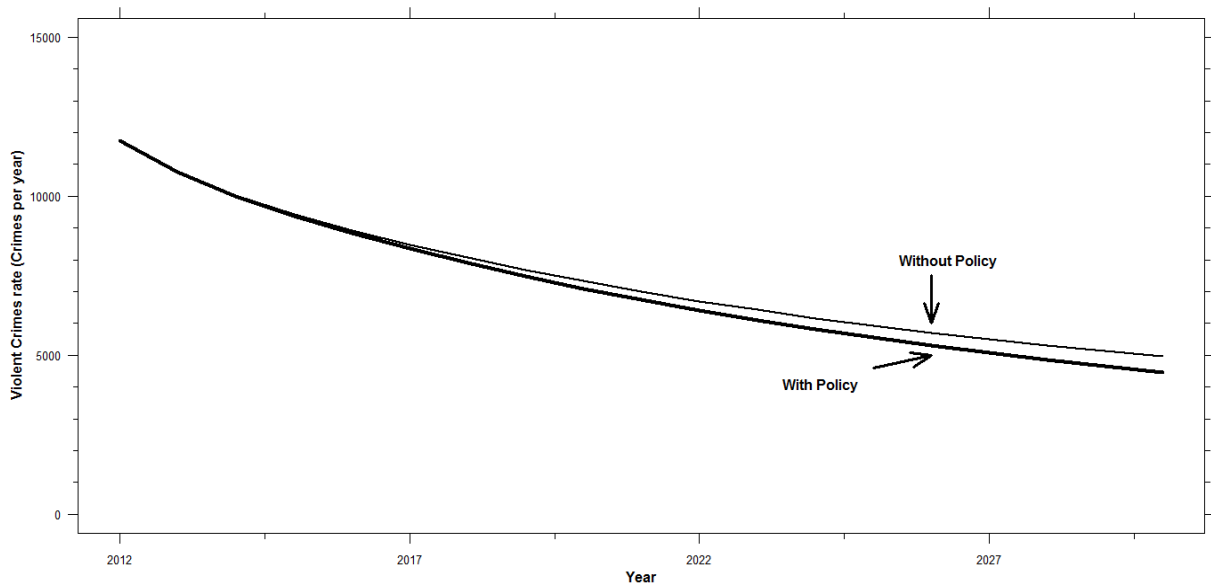
Figure 14.Comparison of crimes committed with and without policy.

Finally, we calculated the net present value of this policy to verify whether it would be cost-effective. Not only did we take into account the costs from parts of our model (police force, prisoners and various staff for the policy) but we also added in other costs (both tangible and intangible costs) found in the literature (McCollister, French & Fang, 2010). Taking into account all of them (pain and suffering costs, criminal justice system costs …), the total cost of a crime can be more than a million of dollars. For example, with the calculations of our model, the average cost of a violent crime in 2012 was 1.391.286 dollars. The discount rate we used in the calculations of the net present value was low (0.04) since we gave more value to a crime committed in the future than one perpetrated today. Given the high cost of violent crimes, the important reduction of violent crimes that we got (500 crimes per year less than if no policy was applied in 2030) and the low discount rate, the results were that the implementation of the policy would save one billion dollars in total for the whole period 2012-2030.

Conclusions

To sum up, we analyzed the rise and fall of reported crimes from 1960 to 2012 in New York City. The model we built shows that each of the factors mentioned in the reviewed literature was important to explain this pattern but none of them explains the pattern by itself. From the System Dynamics point of view, we could say that all of the factors are interrelated and the different causes do not lead to immediate effects (Sterman, 2000).

During the rise of crime, demographics seems to explain part of the rise and the fall of crime, that is, the sudden increase in the at-risk population (young men) caused that there were more people who could be infected and, consequently, become a potential violent criminal. This contagion effect is explained through the differential association theory which we have modelled as the epidemic model. Finally, in order to become a violent criminal (infected), you must commit a violent crime. This decision was largely influenced by the consumption of drugs which increased the probability of perpetrating a crime. During the period of increase, the deterrence effect caused by the arrests was not enough to reduce this probability and avoid the epidemic that occurred (crime increased sharply).

Nonetheless, the factors changed over time. In the 80's and 90's, the at-risk population started growing slower than before so there were fewer people to infect and turn into a potential violent criminal. At the same time, the drug consumption began to decline which made potential violent criminals less likely to commit violent crimes. Police had been growing during the whole period (especially, during the 90's due to the zero-tolerance policy) and the arrests (quarantine) had also gone up. Consequently, the deterrence effect was high which reduced the probability of committing a violent crime. Therefore, all the factors that led to the increase in violent crime during the 60's-80's changed to their opposite, thereby contributing to a rapid decline.

On the other hand, we proposed a mentoring program, grounded on the differential association theory. Ex-convicts would meet their mentors and not only would the latter counsel and advise their mentees (the ex-convicts) but also they would do different activities (go to a game, talk on the phone etc.), in order to become friends or, at least, trust each other. According to our simulation, this program would reduce crime. In 2030, there would be 500 violent crimes per year less than without the policy.

Limitations of the model

We have showed that the model suggests that both our hypothesis and our policy are, at least, on the right track. Nonetheless, we must acknowledge that this is not a perfect model and some limitations have affected to a great extent the validation and usefulness of this model:

- Arbitrary values on some of the parameters. Given the lack of data, we have had to make some assumptions that do not have enough real world support. Exhaustive research must be done.
- The reason why the police force was increased may not be complete and we have not found any real-world data to document this assumption. We may be attributing to politicians too much rationality.

- In the same vein, the way we have captured the perception of crime does not have much clear support. Improvement is needed. Furthermore, we assume that they know the past reported crime rate which may not be the case.
- The drug market is built in a very simplified way and, certainly, it requires further development.
- We assume that violent criminals know the exact number of criminals of their kind being arrested. This is definitively a simplified version of reality and needs more validation or real-world support.
- A better demographics submodel is needed.
- There are more factors to be included. The problem is that, as mentioned earlier, criminologist agree to disagree and there are no clear causes. A careful selection of theories and factors must be done.

As we can see, this model presents many important limitations and the behavior does not match exactly the historical behavior. We could say that this model is wrong. However, as George Box said "Essentially, all models are wrong, but some are useful" (Box & Draper, 1987, p. 424), therefore, although our model is wrong, we hope it will be useful to understand the dynamics of violent crimes in New York City.

Acknowledgements

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