

Expectations and Crime: One Hour of Irrational Behavior?*

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Abstract: We investigate the effect of two types of violation of expectancies, which generate the emotions of frustration and euphoria, on violent crime. Our designs exploit differential expectations (as measured by the odds of soccer games in the betting market) while maintaining the outcome unchanged (a loss in a soccer game for frustration, a win in a soccer game for euphoria). We find that frustration is followed by a spike in violent crime whereas euphoria is followed by a reduction in violent crime. The two effects are concentrated in a narrow time window after the end of the game: one hour.

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I. Introduction

When something unexpected occurs, subjects are exposed to an emotional reaction. If reality is worse than expected the resulting emotion is called frustration and if reality is better than expected the resulting emotion is called euphoria or elation (Amsel 1992; Flaherty 1996).

Lab experiments have been the main procedure to study the impact of frustration and euphoria. A typical experiment on frustration or euphoria involves two phases. First, subjects are trained to respond for a reward of a constant value, creating the expectancy of the same reward in the future. Second, the reward is diminished (frustration) or increased (euphoria) without prior notice, so that expectancies are violated. Finally, the effect of frustration or euphoria is addressed by comparing the behavior of subjects in the treated group to those in a control group that are not exposed to a violation in expectancies.

Typically, in lab experiments on frustration and euphoria, the subjects are animals. After a surprising shift in reward magnitude animals show significant changes in physiology (Tranel 1983; Otis and Ley 1993; Scheirer et al. 2002; Papini 2003), neural activity (Abler, Walter, and Erk 2005), and behavior (Crespi 1942; Weinstein 1981; Vacca and Phillips 2005). In particular, an unexpected downward shift in reward causes an increase in aggressive behavior for birds (Dantzer, Arnone, and Mormede 1980), pigs (Duncan and Wood-Gus 1971), and rats (Tomie, Carelli, and Wagner 1993).

In humans, the potential causal relationship between frustration and aggression (the so called frustration-aggression hypothesis) has been present in the literature of experimental psychology for more than seventy years (Dollard et al. 1939; Berkowitz 1969), but empirical support for it is meager (Whitley and Kite 2010), probably because it is difficult and ethically problematic to induce experimental subjects to behave aggressively (Gottfredson and Hirschi 1993; Baumeister et al. 2010).

To overcome these difficulties we designed two natural experiments that allow us to explore the causal effect of frustration and euphoria on violent crime using real crime data. Our natural experiments exploit a unique database that includes the exact time of all crimes reported in Montevideo, Uruguay, between 2002 and 2010. We focus on property crime, which has two categories: theft (property crime without violence) and robbery (property crime with violence). We combined these data on crime with a database that includes the results of all soccer games played by the main Uruguayan teams in that period, and with a database that includes the odds in

the betting market. The combination of information from the betting market and the actual result of the game allow us to categorize periods as being of predominant frustration, euphoria, or no-surprise. We find that frustration is followed by a spike in violent crime whereas euphoria is followed by a reduction in violent crime. The spike in violent crime after an unexpected loss and the dampening in violent crime after an unexpected win are concentrated in a narrow time window after the end of the game: one hour.

Our work relates to a small literature on the link between sports and violence. Gantz, Bradley, and Wang (2006) report higher rates of violence on NFL game days. Rees and Schnepel (2009) find increases in assaults, vandalism, arrests for disorderly conduct, and arrests for alcohol-related offenses on NFL game days. Priks (2010) show that soccer team's bad performance in Sweden lead to unruly supporter behavior. Closer to our approach, Card and Dahl (2011) report that upset losses by the home professional football team lead to an increase in police reports of at-home male-on-female intimate partner violence. We go beyond these studies in many important dimensions. First, we follow an experimental approach that exploits differential expectations while maintaining constant the outcome (a loss in a soccer game for frustration, a win in a soccer game for euphoria). Our experimental design allows us to distinguish the effect of frustration and euphoria from other related emotions arising from the outcome of the game (such as disappointment after a loss or happiness after a win). Second, we focus on property crime, which is the type of crime more likely to be driven by rational analysis (compared, for example, to domestic crime), allowing us to interpret the results in the light of a rational model of crime. Third, we use population data, avoiding potential sample selection biases. Fourth, by exploiting data on violent and non-violent crime we provide a more complete picture of the effects of a violation of expectancies. In addition, we are able to test for the potential problem of over reporting of crime due to emotional cues. Fifth, we estimate the duration of the effect of the emotional reaction.

II. Data and methods

Data on crime

The database on crime was obtained from the Police Department of Montevideo and includes more than 835,000 felonies occurred in Montevideo from January 2002 to December 2010 (Montevideo, the capital of Uruguay, has a population of 1.5 million of inhabitants, half of

the population of the country). It comprises the universe of criminal incidents recorded, with information on the date and the exact hour of the incident.

A critical feature of the database is that includes real-time information. The time of the offense is recorded as soon as the crime is reported. Under the usual procedure, the police officer takes detailed information from the victim that includes the time of the incident. Given the precision required for our research, this is a key advantage relative to other source of crime information such as victimization surveys. Although victimization surveys avoid the usual under-reporting problem of police-recorded offenses, the exact time of the occurrence is generally missed since the victim is asked to recall the details of an event that occurs several months ago.

We focus on property crime, which encompass the two most frequent types of crime: theft and robbery. Theft is defined as depriving a person of property without the use of violence (60 percent of all police-recorded offenses in Montevideo in the period 2002 to 2010), whereas robbery is defined as depriving a person of property with the use of violence or threat of violence (10 percent of the offenses in our database). Violence is defined as an intentional use of physical force or power.

Figure 1 depicts the weekly and daily cycle of thefts and robberies in Montevideo for the period 2002 to 2010. The two types of crime present a similar pattern during the day: low levels of criminal activity early in the morning, a steady increase since 5-7am leading to a peak at 8pm. Throughout the week, thefts and robberies look relatively flat from Monday to Thursday, present a peak on Friday, and a decrease during the weekend.

Data on soccer results and odds in the betting market

Aside from crime data, our database also includes information on the date, the exact hour, and the results of every official game played either by *Peñarol* or *Nacional* (the two Uruguayan biggest teams) between 2002 and 2010. Our focus on soccer games is motivated by the fact that in Uruguay most of the population feels strong emotional attachment to one of these two teams. According to a recent poll, in Montevideo 80 percent of the population supports either *Peñarol* or *Nacional* (approximately 40 percent for each team), around ten percent support one of the multiple small teams, and the remaining ten percent have no preference for any soccer team.¹

¹ MPC Consultores: “Peñarol y Nacional son dos de las tres instituciones en el mundo con mayor número de hinchas en relación a la población de su país.”

Finally, the database incorporates the information on the complete record of odds in the betting market for all the games played by *Peñarol* and *Nacional* since 2005. We use the odds in the betting market as a proxy for fans' expectations. The bets provide relatively accurate predictions of the final result of the matches: the correlation between being the favorite team according to the bets and winning the game is 0.40 (significantly different from zero at the 1 percent level).

In order to increase the statistical power we include games played between 2002 and 2005, assuming that for international games the favorite is always the home team. This is consistent with the patterns of the bets for the period 2005-2010 since 96 percent of the home teams were the favorites in the odds.

Statistical methods

To explore the effect of frustration and euphoria on crime we track the number of thefts and robberies in Montevideo in the 9-hour window centered on the end of games played by *Nacional* and *Peñarol*. For a given soccer match, we define hour zero as the hour in which the end of the game effectively occurs (thus hour zero is not always the same chronological hour). Hour one is then defined as the hour immediately following the end of the game, hour minus one is the hour preceding the end of the game, and so on. This event-study methodology is well known in empirical finance (Fama et al. 1969; Browman 1983; MacKinlay 1997).

We define crime to be unusually high (low) when the number of crimes in a given hour in the window around the end of the game is significantly higher (lower) to the one observed the same day at the same hour in the previous week. That is, we say that crime is unusually high when the number of crimes on Sunday 16 November 2008 at 5pm is significantly higher in statistical terms than the number of crimes on Sunday 9 November 2008 at 5pm. By computing weekly variations, we control for the daily and weekly cycles observed in crime (one week is a relatively short period of time in order to have variations in crime levels). In addition, we compute the change in crime with respect to a control group in order to account for the fact that games are massive events that can directly affect crime (for example, through a re-allocation of police forces).

That is, to detect abnormal crime we compute a double difference: difference with respect to the previous week plus difference with respect to a control group.

III. Results

We first identify the causal effect of frustration on crime by comparing the number of crimes after an unexpected loss (the treated group) to the number of crimes after an expected loss (the control group). By exploiting differential expectations while maintaining the outcome unchanged, this design allows us to distinguish frustration from other related emotions arising from just losing a game.

This first natural experiment is based on the games that *Peñarol* and *Nacional* lost against other teams. In our sample period there are 58 games where the odds anticipated the big teams to be winners but they finally lost (the group exposed to frustration, or treated group), and 19 cases in where the big teams were expected to be defeated and they lost the game (the control group).

As observed in the top panels of Table 1 and of Figure 2, violent crime shows a significant jump after a frustrating loss.² The increase in violent crime after frustration is quantitatively important: robberies rise 71 percent respect to the control group. This figure has the same sign but is bigger than the one reported in Card and Dahl (2011). The smaller effect found in Card and Dahl (2011) could arise because of the sample data they use (in their study participation of police agencies in the sample is voluntary and relatively low). If police agencies with lower violent crime rates are more likely to self-select into the sample, this could introduce a downward bias in the estimated magnitude of the effect (for example, less violent people could react less vigorously to a violation in expectations). Our data includes the population of police agencies in Montevideo, avoiding this kind of potential bias.

The effect of frustration on violent crime is short-termed, being statistically reliable for the first hour from the game end.

Given that our data is on reported crime, a potential concern is the possibility that the result is driven by an over reporting of crime due to emotional cues. If that were the case, we would expect an increase in total property crime after a frustrating loss. As shown in Figure 2, this is not the case: there is no statistically significant variation in total crime against the property. This, combined with the fact that the number of thefts presents a non-significant

² To identify in a visual way statistically significant changes in weekly variation in crime, in Figure 2 we include 95 percent confidence intervals. We assume that the weekly variations in police-recorded offenses are independently and identically distributed. Given that we cannot reject the null hypothesis that weekly variations in police-recorded offenses follow a normal distribution, the computation of confidence intervals using that distribution is valid even in small samples.

decrease for the first hour from the game end (a decrease that is similar in absolute magnitude to the observed increase in robberies), suggests that violent crime is substituting non-violent crime.³

Is the increase in violent crime explained exclusively by fans attending the game? To address this question we exclude from the sample those crimes committed in the jurisdiction of the stadium where the game was played (Montevideo has 24 jurisdictions), and we find similar results. This indicates that the increase in violent crime is not explained exclusively by unruly behavior of fans attending the game. Instead, the spike in violence spreads over the entire city.

In the second natural experiment we identify the causal effect of euphoria on crime by comparing the number of crimes after an unexpected win to the number of crimes after an expected win. By exploiting differential expectations while maintaining the outcome unchanged, this design allows us to distinguish euphoria from other related emotions arising from winning a game.

The second natural experiment is based on the games that *Peñarol* and *Nacional* won against other teams. In our sample period there are 18 games where the odds anticipated the big teams to lose but they finally won (the group exposed to euphoria, or treated group), and 205 cases in where the big teams were expected to win and they won the game (the control group).

As observed in the lower panels of Table 1 and of Figure 2, euphoria has the effect of reducing violent crime, a reduction that, again, is only detectable for one hour. The peak reduction in robberies was 42 percent relative to the control group. As in the previous experiment, there is no statistically significant variation in total crime against the property (the number of thefts presents a non-significant increase for the first hour from the game end).

The smaller effect on crime of euphoria compared to that of frustration (42 percent vis-à-vis 71 percent) is compatible with subjects presenting risk aversion in the domain of gains and risk seeking in the domain of losses, a pattern labeled “reflection effect”, that has been found both in humans and in animals (Kahneman and Tversky 1979; Marsh and Kacelnik 2002) and that is consistent with a reference-dependent utility maximization framework where expectations are endogenously determined (Koszegi and Rabin 2006).

IV. Conclusions and discussion

³ By computing total property crime we also account for the influence of other factors affecting crime, such as weather conditions.

Our results show that a violation of expectancies has a socially meaningful effect on humans' behavior. In particular, emotional cues associated to an unexpected soccer result produce a significant variation in fans' aggressive behavior, increasing violent crime after an unexpected loss and reducing violent crime after an unexpected win. The finding that frustration increases violent crime provides empirical support to the frustration-aggression hypothesis, which states that thwarted expectations from a reference point tend to lead to violent behavior.

From a policy perspective, our finding that the significant increase on violent crime spreads over the entire city represents a contribution with respect to the previous literature (for instance, Card and Dahl (2011) found no significant effect on away-from-home violence). Hence, our results could inform on the optimal allocation of police forces over the streets of the city, stressing the importance of anticipating events where individuals are potentially exposed to an unexpected bad outcome. The fact that results remain unchanged after excluding from the sample those crimes committed in the streets comprehended in the jurisdiction of the stadium where the game was played indicate that the concentration of police forces around the venue of the potentially frustrating event is not enough to prevent the rise of violent crime due to unexpected emotional cues.

Finally, our findings claim to dig further into the rational choice theory in criminology, which postulates that agents decide whether to engage in criminal activities by comparing the benefits and costs of committing a crime, i.e. agents compare the financial reward from crime to the return from legal work, taking into account the probability of apprehension and the severity of the punishment (Becker 1968). Our focus on property crime, which is more likely to be driven by rational analysis than for example domestic crime, allows interpreting our results in the light of Becker's model. Given that the use of violence in a crime against the property is costly (*ceteris paribus*, punishment is higher for violent crime), our findings indicate that at least a fraction of violent crime against the property (that committed under frustration), would not fit under a rational model of crime, and can be better characterized as a breakdown of control rather than a behavior driven by rational choice. Having said this, the rational model of crime would hold anyway if the violent reaction increased personal utility in a magnitude that more than compensates an expected punishment that is seven times harsher in Uruguay (the effective average sentence length is 0.6 years for thefts and 4.1 years for robberies). Alternatively, our findings will also be compatible with a rational choice model if emotional cues generate a sharp

alteration in subjective discount rates of the agents (if after being exposed to frustration the agents experienced a dramatic shortening in time horizons, a longer sentence length would be ineffective to discourage crime).

Our findings, combined with the previous findings in animals, suggest that the impact of frustration on aggression is a general phenomenon in nature. So, why does frustration promote aggression? Is there any adaptive advantage of reacting aggressively after frustration? As evolutionary biologists have known for a long time, emotions are systems of response that were shaped by natural selection because they increased fitness in certain situations. However, as any other emotion, the emotion of frustration is useful only in certain situations, and therefore it is not surprising to observe a mismatch between our emotional responses and some environments in which they operate. In the context of a rational model of crime, where the individual is assumed to maximize personal utility, emotions would lead to irrational behavior. However, emotions are the result of evolution, and from that perspective they are not fundamentally irrational.

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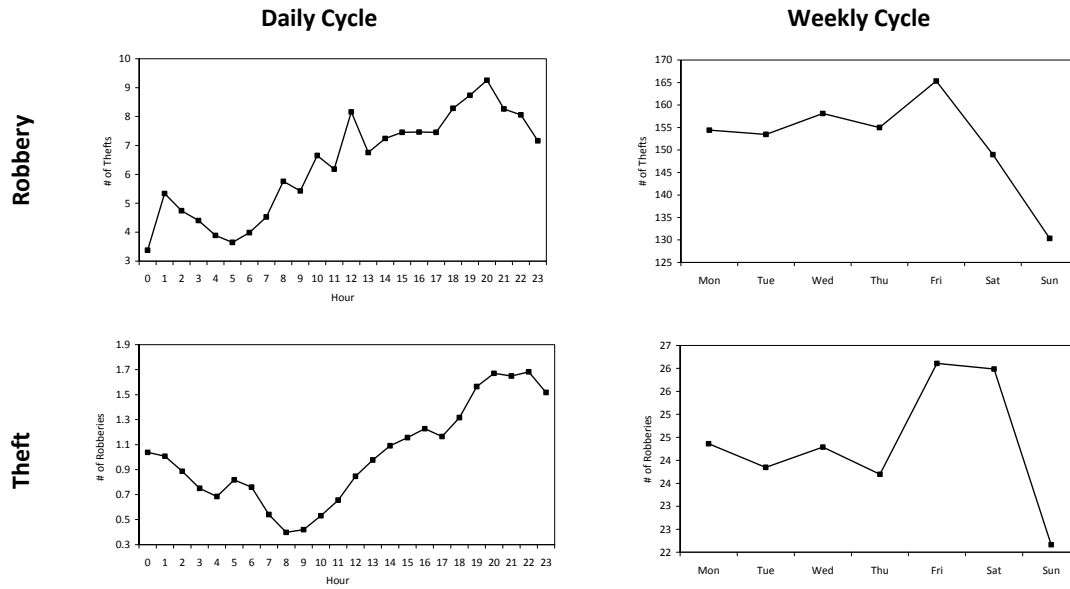
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Table 1. The effect of emotions on crime

	t	Treated ¹		Control ²		Difference	
		Robbery	Property Crime	Robbery	Property Crime	Robbery	Property Crime
Frustration	-4	-0.16 (1.73)	-0.57 (4.82)	0.42 (1.77)	0.21 (4.28)	-0.58 (0.47)	-0.78 (1.17)
	-3	0.02 (1.41)	0.74 (4.62)	0.21 (1.93)	0.32 (4.50)	-0.19 (0.48)	0.43 (1.20)
	-2	-0.05 (1.57)	0.19 (4.56)	-0.63 (1.77)	1.42 (5.28)	0.58 (0.46)	-1.23 (1.35)
	-1	0.12 (1.71)	0.40 (3.81)	0.74 (1.59)	0.63 (3.37)	-0.62 (0.43)	-0.24 (0.92)
	0	-0.16 (1.35)	-0.52 (4.07)	-0.37 (1.86)	-0.16 (4.73)	0.21 (0.46)	-0.36 (1.21)
	1	0.38 (1.37)	0.64 (4.91)	-0.68 (1.49)	0.89 (4.71)	1.06*** (0.39)	-0.26 (1.26)
	2	0.10 (1.71)	-0.05 (4.79)	-0.16 (1.21)	0.11 (3.51)	0.26 (0.36)	-0.16 (1.02)
	3	-0.45 (1.84)	-0.98 (94.04)	-0.37 (1.67)	-1.32 (3.82)	-0.08 (0.45)	0.33 (1.02)
	4	-0.09 (1.78)	-0.83 (4.39)	0.11 (1.05)	-1.16 (3.40)	-0.19 (0.34)	0.33 (0.97)
	Euphoria	-4	0.17 (1.50)	-0.33 (4.45)	0.10 (1.23)	-0.09 (4.33)	0.07 (0.37)
-3		0.28 (1.74)	0.28 (3.71)	0.00 (1.51)	0.07 (4.29)	0.28 (0.42)	0.21 (0.92)
-2		0.44 (1.58)	-0.33 (3.43)	0.03 (1.55)	0.34 (4.45)	0.41 (0.39)	-0.67 (0.87)
-1		0.00 (1.88)	-1.11 (3.58)	-0.19 (1.54)	-0.30 (3.99)	0.19 (0.46)	-0.81 (0.89)
0		0.22 (1.59)	-0.89 (3.86)	0.18 (1.68)	0.28 (4.36)	0.04 (0.39)	-1.17 (0.96)
1		-1.00 (1.88)	-0.56 (5.38)	0.02 (1.55)	0.20 (4.50)	-1.02** (0.46)	-0.76 (1.31)
2		-0.44 (1.76)	-0.56 (4.50)	-0.11 (1.87)	0.00 (4.46)	-0.34 (0.43)	-0.56 (1.11)
3		-0.56 (0.98)	-0.89 (3.01)	-0.12 (2.00)	0.17 (4.56)	-0.43 (0.27)	-1.06 (0.78)
4		0.22 (2.07)	-0.78 (3.44)	-0.15 (1.93)	-0.08 (4.75)	0.37 (0.51)	-0.70 (0.88)

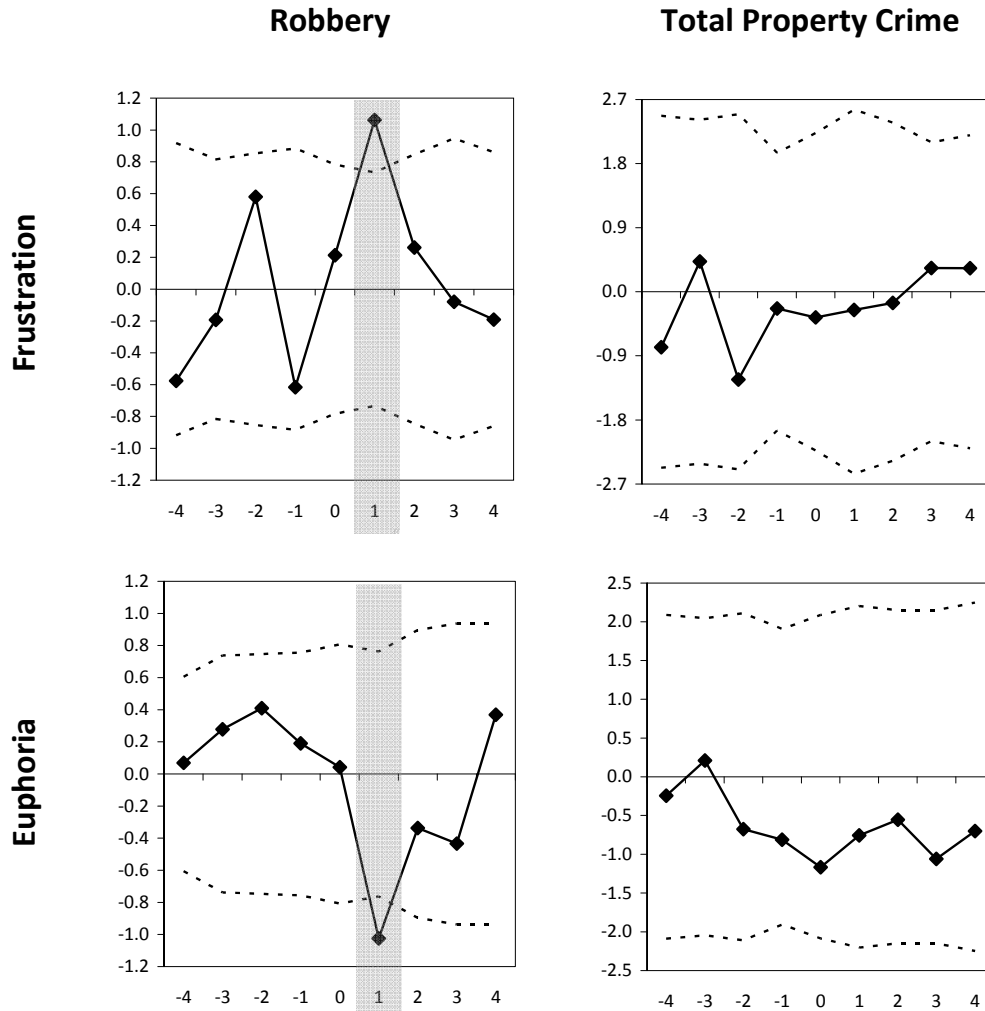
Notes: Standard deviations in parentheses. ** Denotes significance at 5 percent level. *** Denotes significance at 1 percent level. ¹Big team expected to win but loses (n=58). ²Big team expected to lose and loses (n=18). ³Big team expected to lose but wins (n=19). ⁴Big team expected to win and wins (n=205).

Figure 1. Daily and weekly cycle of robberies and thefts (average 2002-2010)



Notes: Robbery is defined as depriving a person of property with the use of violence or threat of violence (10 percent of all police-recorded offenses in Montevideo in the period 2002 to 2010). Theft is defined as depriving a person of property without the use of violence (60 percent of all police-recorded offenses in Montevideo in the period 2002 to 2010).

Figure 2. Change in weekly variation in robberies and total property crime



Notes: The weekly variation is measured compared to the control group. In the case of Frustration: *Treatment Group* (big team expected to win but loses, n=58) and *Control Group* (big team expected to lose and loses, n=19). In the case of Euphoria: *Treatment Group* (big team expected to lose but wins, n=18) and *Control Group* (big team expected to win and wins, n=205). Horizontal axes refer to hours, with 0 indicating the end of the matches. Dotted lines indicate 95 percent confidence interval. Total property crime is the sum of robberies and thefts. Robbery is defined as depriving a person of property with the use of violence or threat of violence. Theft is defined as depriving a person of property without the use of violence.