Chapter 4

Presentation of the Available Greek Crime Data

4.1 Offenses under consideration

The available data is crimes reported over the periods 1982-1997 for annual counts and 1987-1997 for monthly counts. Annual data is tabulated as crime counts by crime for the period 1982-1997 and as crime counts by location for the period 1987-1997. Monthly data is only tabulated as crime counts by crime. However, information about the exact date or time and location of each crime occurrence was not available.

The offenses used in our analyses are the following:

- *Commonly dangerous crimes*. According to the Greek Penal Code commonly dangerous crimes include
  - arson and arson in forests,
  - debacle,
  - explosion,
  - illegal manufacturing, supply, or possession of explosives,
  - intentional severe damage of anything that can put man in danger,
  - arsis of safety habitations in mines, plants and other locations putting the workers' lives in jeopardy,
  - wrecking,
  - poisoning of founts or foods,
  - adulteration of foods, drinks, medical material or other items whose usage could harm the health of human beings,
  - poisoning of rangelands, grasslands, lakes or other watering places,
  - infection of animals,

- violation of measures about diseases' forestalling,
- violation of measures about epizootic diseases' forestalling,
- violation of building instructions,
- violation of provisioning contracts,
- prevention of action necessary to avoid or suppress existing or imminent danger and omission of providing assistance in case of an accident or common danger.

- *Offenses against life*. According to the Greek Penal Code offenses against life include
  - premeditated killing of a person,
  - acquiescent murder,
  - homicide participation,
  - homicide by misadventure,
  - infanticide,
  - abortion,
  - physical injury of a fetus or neonate,
  - promotion of abortion means,
  - exposition to danger,
  - omission of rescuing a human life.
- *Physical injuries*. According to the Greek Penal Code commonly dangerous crimes include:
  - simple physical injury,
  - unprovoked physical injury,
  - critical physical injury,
  - severe physical injury,
  - fatal physical injury,
  - juveniles' physical injury,
  - encounter,
  - physical injury by misadventure.
- *Property crimes*. According to the Greek Penal Code commonly dangerous crimes include:
  - larceny,
  - grand larceny,
  - defalcation,

- concealment of finding,
- worthless larceny and defalcation,
- abstraction,
- robbery,
- damage of foreign property,
- grand damage,
- quelling damage which provoke the public feeling.

- *Beggary and vagrancy*. Vagrancy was abolished in 1994. Therefore, counts of beggary and vagrancy in our tables concern only beggary from 1994 on.
- Illegal possession and usage of fire guns.
- Illegal possession of explosives.
- Offenses concerning antiquities.
- Drug offenses.
- Smuggling offenses.
- Arsons.
- Arsons in forests.
- Murder.
- Homicide by misadventure.
- Caused death by car.
- Physical injury of a person by car.
- Simple, unprovoked and dangerous physical injury.
- Physical injury by misadventure.
- Cases of one taking the law into one's own hands.
- Larceny.
- Robbery.
- Rape. Rape is recorded as an individual offense only after 1988. Therefore, rape counts are available from 1988 to 1997, both in annual and in monthly data.

4.2 Preliminary examination of Greek crime data

4.2.1 Annual data

A first examination of the data shows a general increase of crime activity.

Commonly dangerous crimes (figure 1) appear to have increased by almost 64% since 1982, although there was a peak in 1988 where the crimes reported where about two and a half times as many as in 1997 (increased by 148.57% since 1987).

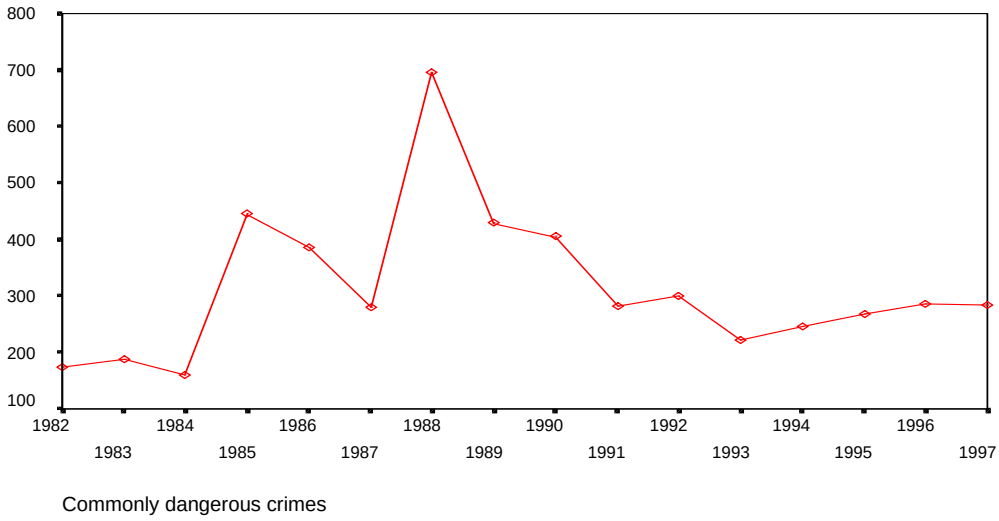

Figure 1. Annual counts of commonly dangerous crimes for the period 1982-1997.

Offenses against life (figure 2) seem to be steadily increasing since 1982, with a few small fluctuations, to reach a 22.66% increase in 1997.

Physical injuries (figure 3) have shown several fluctuations since 1982 to increase only by 7.72% in 1997.

Property crimes (figure 4) are one of the offenses with the highest increase. They have been increasing to reach 90583 offenses in 1997, almost four times as many as they were in 1982 (23423 offenses in 1982).

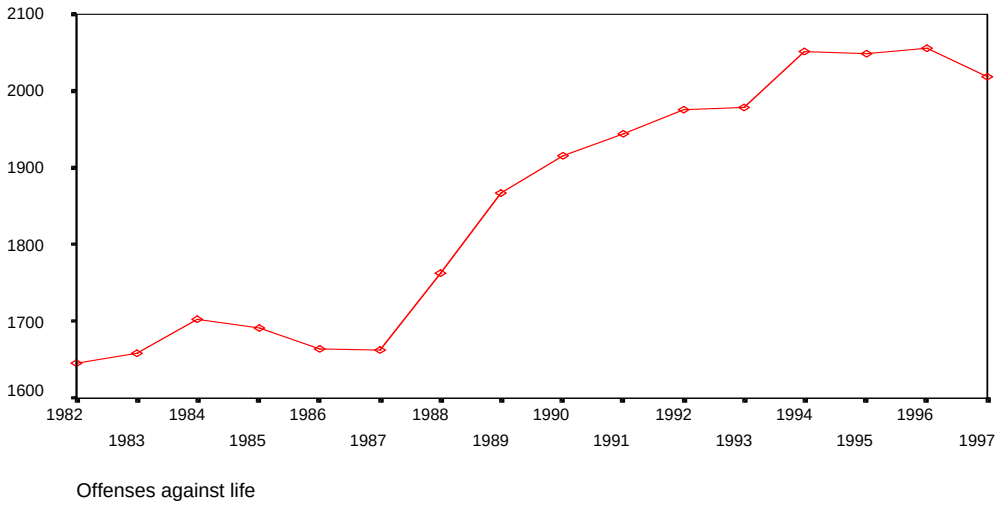

Figure 2. Annual counts of offenses against life for the period 1982-1997.

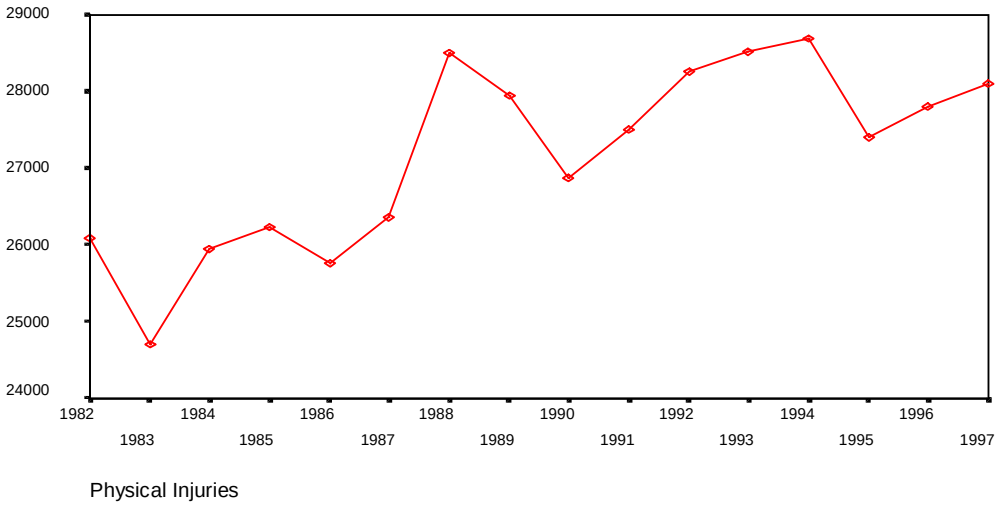

Figure 3. Annual counts of physical injuries for the period 1982-1997.

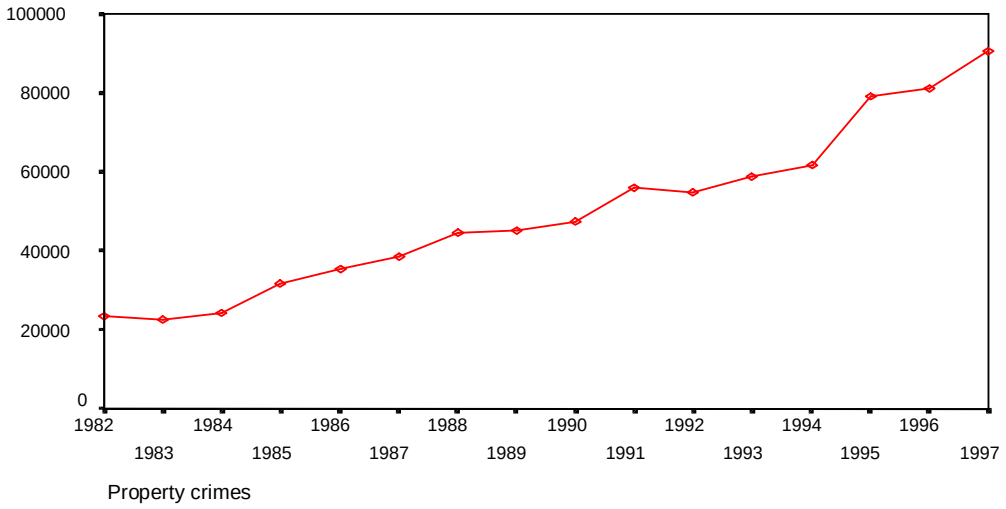

Figure 4. Annual counts of property crimes for the period 1982-1997.

Beggary and vagrancy (figure 5) show some considerable fluctuation from 1982 to 1992 on a generally decreasing pattern, but from 1992 and on it has a clear increasing pattern with an impressive rate. There were 200 reported beggary and vagrancy offenses in 1992 (decreased by 14.89% since 1982) to increase in 907 offenses in 1997 (a 285.96% increase since 1982). We have to notice that the highest increase appeared in 1993 when the reported beggary and vagrancy offenses were 437, more than twice as many as in 1992. However, one would expect that since vagrancy was abolished in 1994 the reported offenses would be decreasing after 1994. In fact there was a 22.59% decrease from 1994 to 1995. Unfortunately, it was only a short backward that did not last. The increasing course of reported offenses found once more its way in 1996.

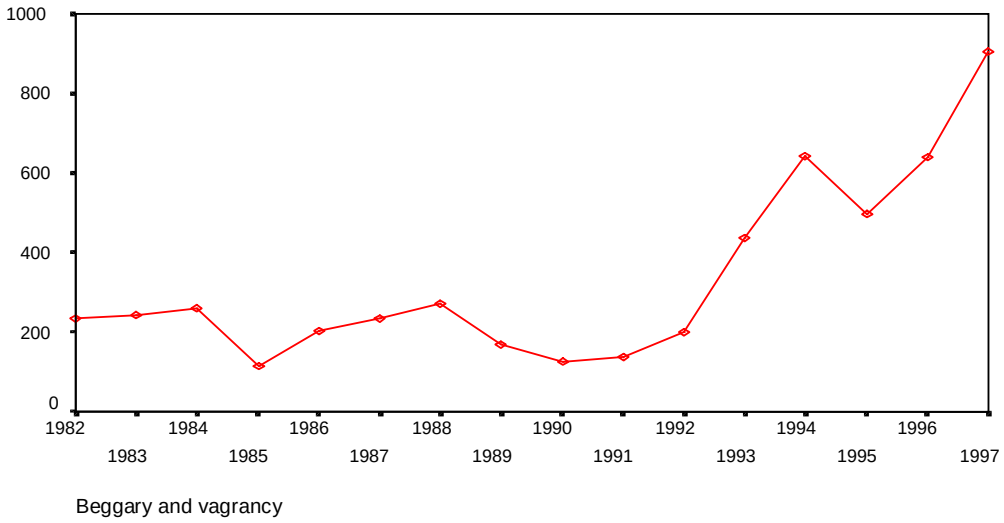

Figure 5. Annual counts of beggary and vagrancy for the period 1982-1997.

Illegal possession and usage of fire guns (figure 6) also had an almost steadily increasing pattern from 1982 to 1997, with some small backward in 1984-1985, in 1990 and in 1993. As a result reported offenses where 1390 in 1997, increased by 232.54% since 1982.

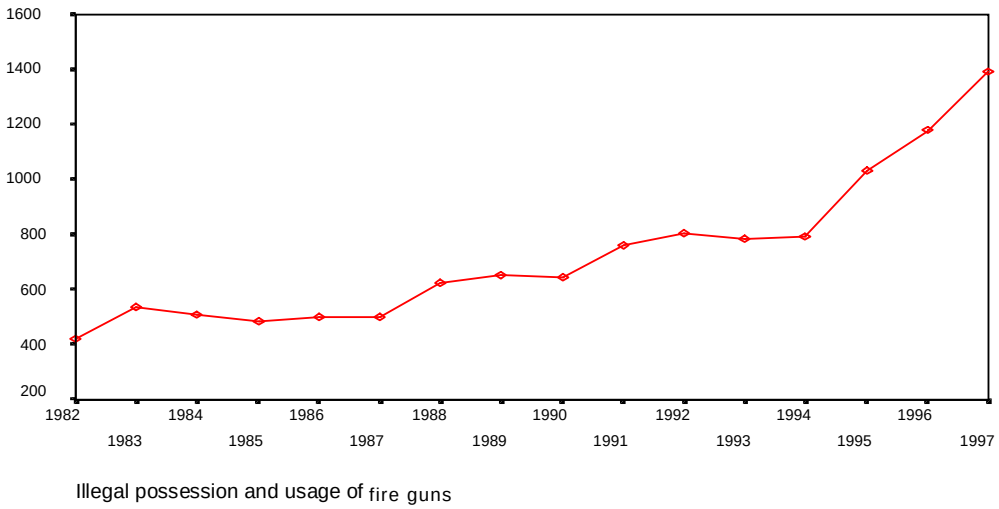

Figure 6. Annual counts of illegal possession and usage of fire guns for the period 1982-1997.

Illegal possession of explosives (figure 7) after reaching its peak in 1991 where the number of offenses was four and a half times larger than the number of reported offenses in 1982, shows a decreasing pattern since then, to reach the 153 offenses in 1997 (decreased by 48.66% since 1991). However, these offenses are still twice as many as in 1982.

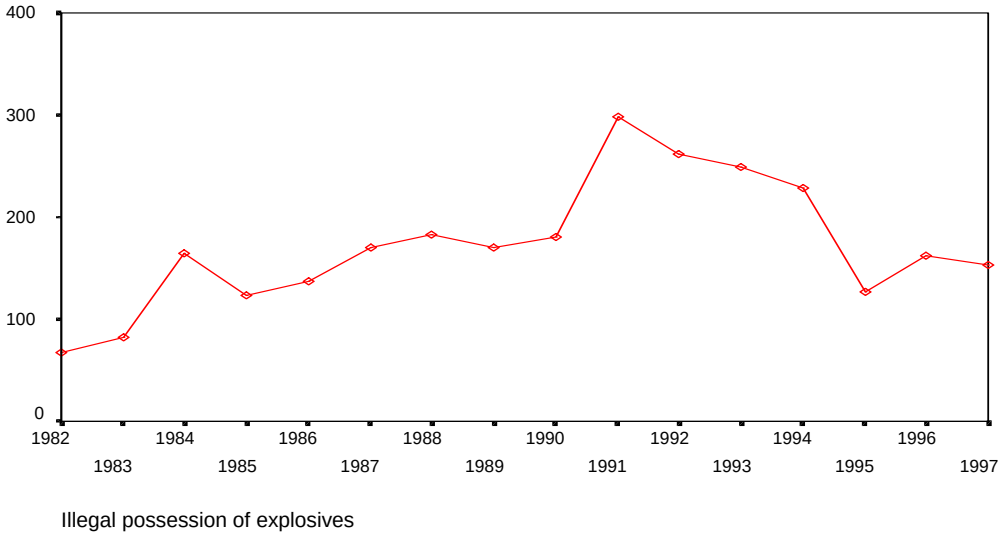

Figure 7. Annual counts of illegal possession of explosives for the period 1982-1997.

The offenses concerning antiquities (figure 8) show a similar pattern. After reaching their peak in the period 1993-1994 (with a 460% increase since 1982) they are decreasing since then, to be 139 in 1997, showing a 223.26% increase since 1982 (decreased by 42% since 1994).

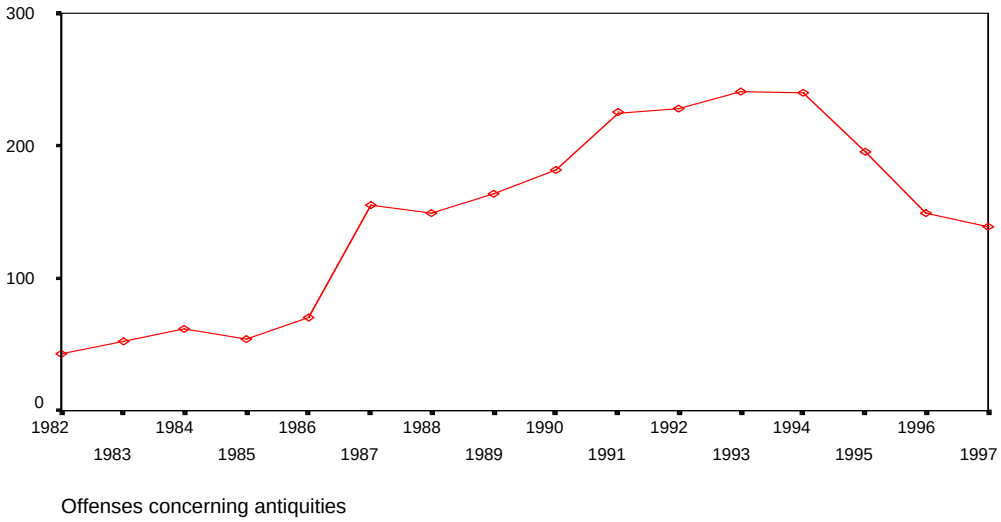

Figure 8. Annual counts of offenses concerning antiquities for the period 1982-1997.

Another impressive pattern is that of the drug offenses (figure 9). It is clear that there is a dramatic increase since 1993. Although there was a 22% decrease from 1992 to 1993 the general pattern is upward reaching a 1082% increase from 1982 to 1997.

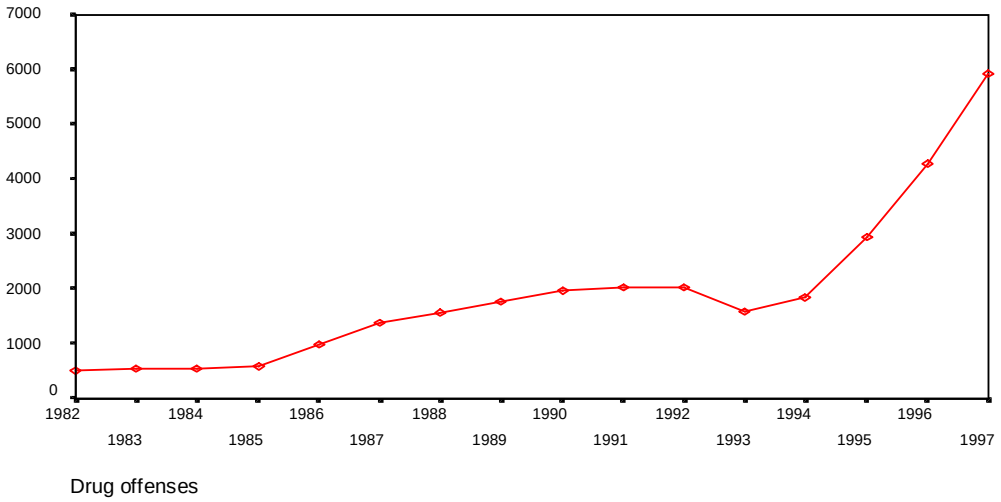

Figure 9. Annual counts of drug offenses for the period 1982-1997.

Smuggling (figure 10) also has an interesting pattern. There were just 11 reported smuggling offenses in 1982 to reach the 161 offenses in 1987 increased by 1363.64%. They were decreasing from 1987 to 1989 to reach the 54 offenses in 1989 and start increasing again to count 198 offenses in 1992 (an 1700% increase since 1982). Although there was a considerable

fluctuation from 1992 to 1997, the reported smuggling offenses were 220 in 1997, with a total increase of 1900% since 1982.

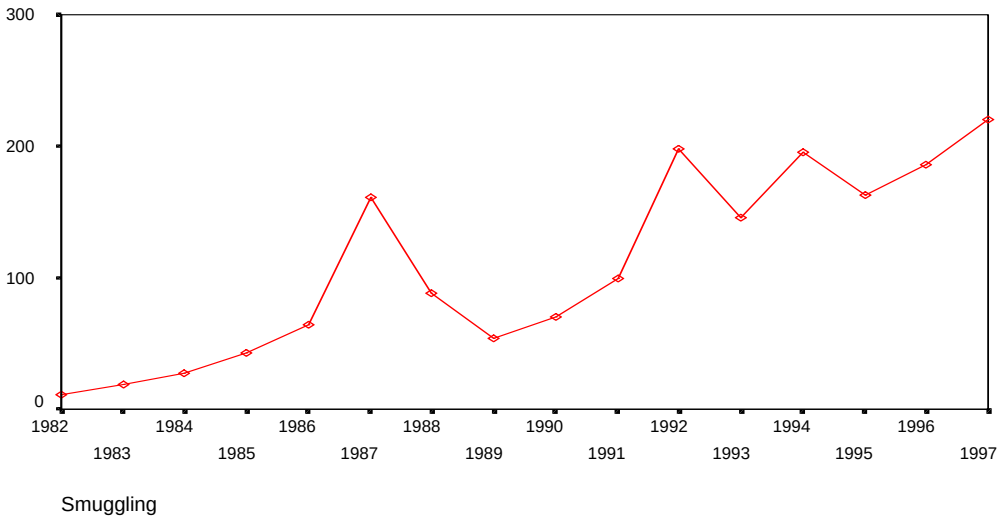

Figure 10. Annual counts of smuggling for the period 1982-1997.

Arsons (figure 11) show a rather fluctuating pattern. They increase from 1982 to 1983 to decrease in 1984, and suddenly they blast off at 306 offenses in 1985, increased by 209% since 1982 (218.75% since 1984). During the next two years, 1986-1987, they decrease again to make a new impressive jump to 511 offenses in 1988, increased by 185.47% in one year, resulting in a 416.16% increase since 1982. Fortunately, they decreased from 1988 to 1993 (with only a small upward in 1992) to 134 offenses (a 73.78% decrease since 1988). The period from 1993 to 1997 they start increasing again to reach the 212 offenses, which may be twice as many as in 1982, yet they are less than half of the arsons reported in 1988.

Unfortunately, we have to mention that both jumps in reported arsons coincide with similar jumps in reported arsons in forests (figure 12). While the reported arsons in forests were 19 in 1982, they become 97 in 1985, increased by 410.53% (with an increase of 288% in one year). Moreover, the reported offenses were decreased in 46 in 1987 to jump at 135 in 1988, increased by 610.53% since 1982. Hopefully from 1992 to 1997 they have decreased (with only one upward in 1996) to reach the 16 reported arsons in 1997, decreased by 15.79% since 1982.

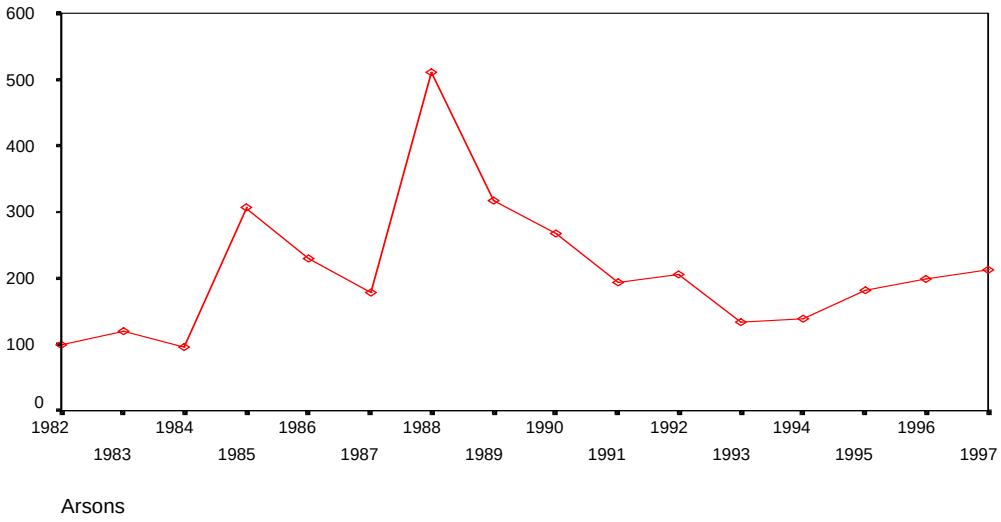

Figure 11. Annual counts of arsons for the period 1982-1997.

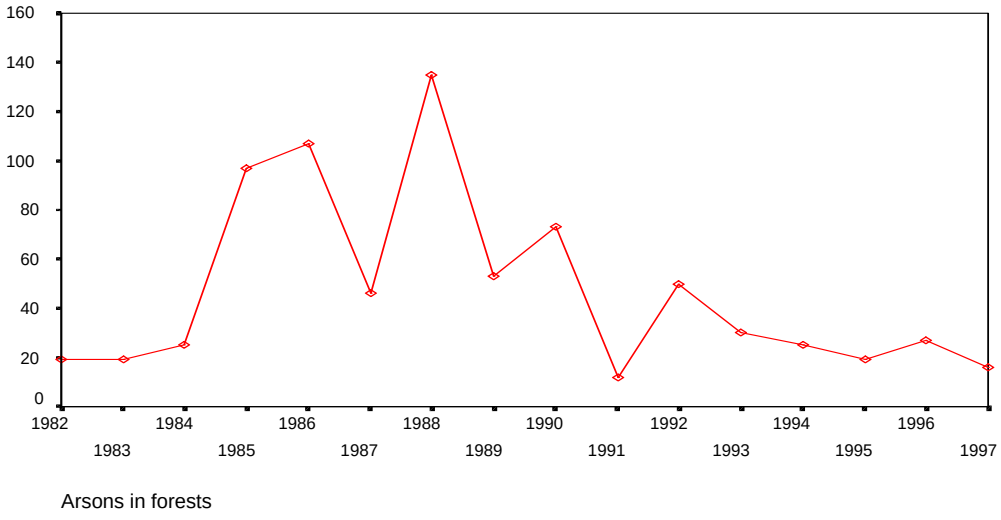

Figure 12. Annual counts of arsons in forests for the period 1982-1997.

Murder has an almost steadily increasing pattern, without exceeding the 13% annual increase of 1988. As a result the reported murders are 350 in 1997, increased by 105.88% since 1982.

Homicide by misadventure (figure 13) shows a decreasing pattern since 1987 to increase from 1987 to 1989 and show a rather fluctuating pattern since then. Hopefully, the reported homicides are 28 in 1997, decreased by 24.32% and 17.65% since 1982 and 1996 respectively.

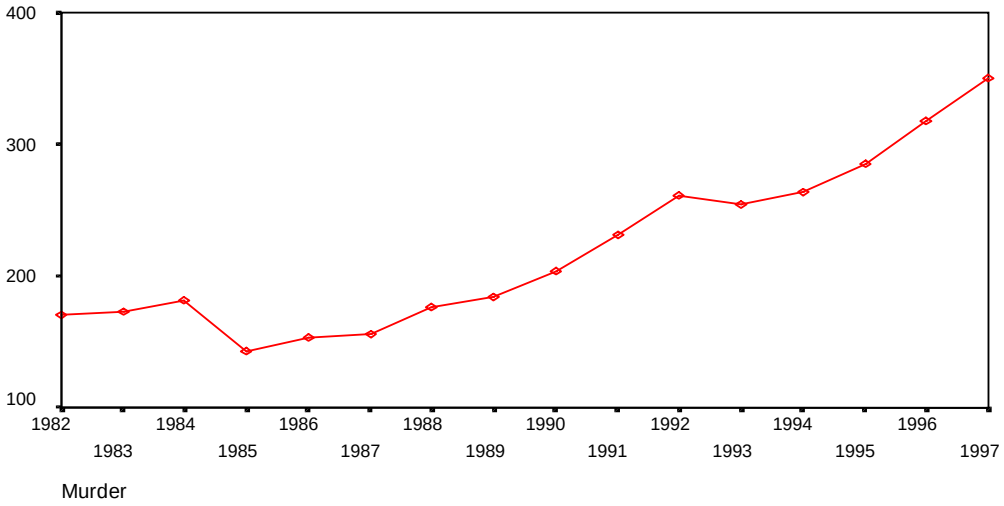

Figure 13. Annual counts of murder for the period 1982-1997.

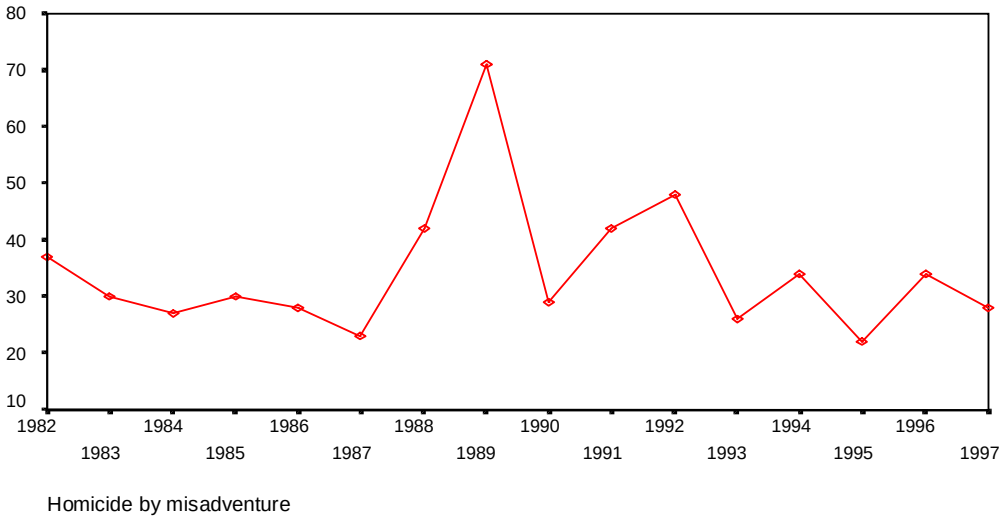

Figure 14. Annual counts of homicide by misadventure for the period 1982-1997.

Caused deaths by car (figure 15) have a pattern with small fluctuations, although the increase rate since 1982 is always positive. Reported offenses are 1561 in 1997, increased by 12.79% since 1982.

Furthermore, physical injuries by car (figure 16) show the most fluctuating pattern with no certain trend. Reported car injuries are 21267 in 1997 just 1.82% increased since 1982. Nevertheless, keeping in mind that the number of cars is also increasing one could probably expect that the increase of the two last mentioned offenses would be higher. Thus, one can conclude that either car drivers are very careful nowadays, or that cars' safety standards are higher than they used to be.

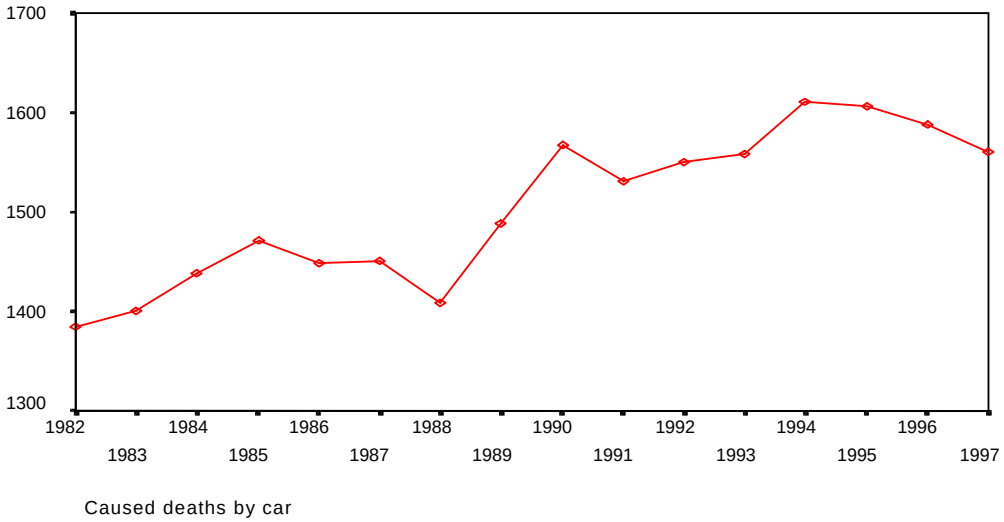

Figure 15. Annual counts of caused deaths by car for the period 1982-1997.

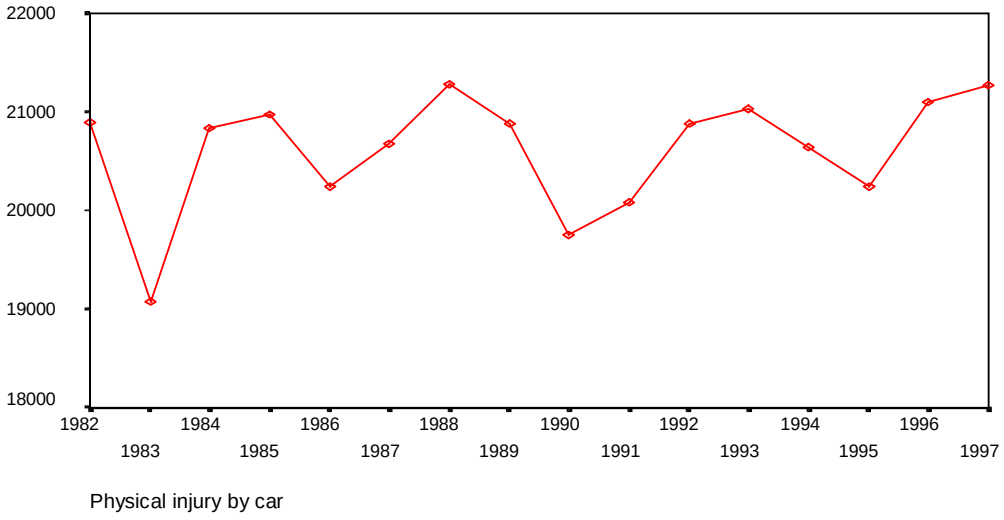

Figure 16. Annual counts of physical injury by car for the period 1982-1997.

Simple, unprovoked and dangerous physical injuries (figure 17) show a slightly fluctuating pattern with an increasing trend. There is a peak in 1994 when 7566 offenses were reported, although the highest increase was from 1987 to 1988 by 24% and 6688 reported offenses. Furthermore, reported offenses were 6582 in 1997, increased by 34.38% since 1982, yet decreased by 13% since 1988.

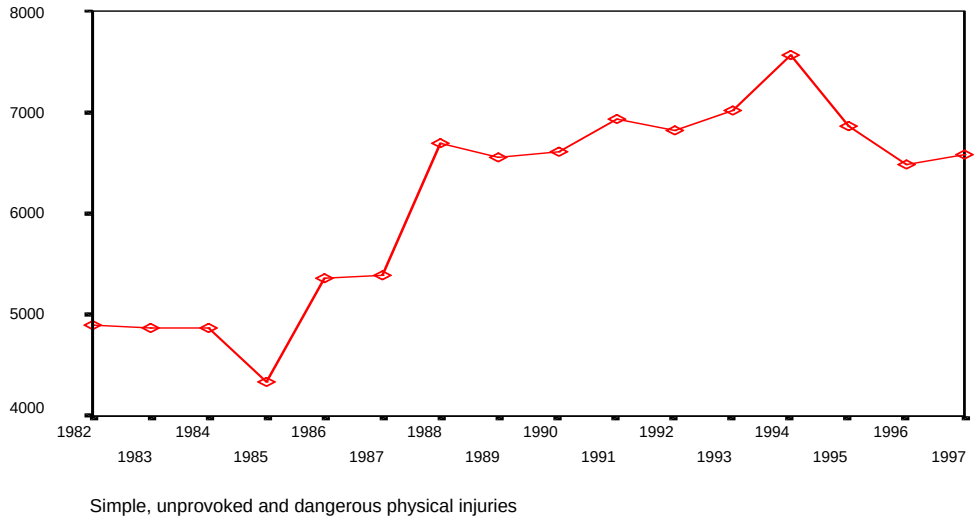

Figure 17. Annual counts of simple, unprovoked and dangerous physical injuries for the period 1982-1997.

Physical injuries by misadventure (figure 18) have a quite fluctuating pattern with a peak in 1983, when 665 offenses were reported, whereas only 186 offenses were reported in 1982. Thus there was a 257.73% increase in one year. A second peak, although lower than the first one, is appeared in 1988. Reported offenses had been decreasing from 1983 to 1987 and jumped to 251 offenses in 1988, increasing by 286.15% in one year. Then they decrease again with an upward in 1992 to decrease again and turn again upwards in 1994. The period from 1994 to 1997 they decrease to count only 87 reported offenses. Thus, there was a 53.23% decrease from 1982 to 1997.

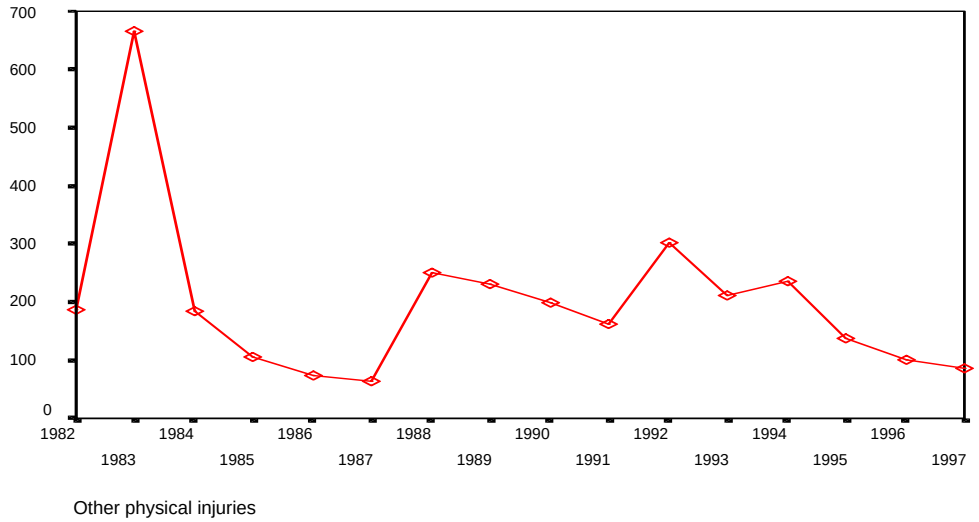

Figure 18. Annual counts of physical injuries by misadventure for the period 1982-1997.

Cases of one taking the law into one's own hands (figure 19) have been increasing since 1982 with a few backwards to reach their peak in 1994 when 1149 offenses where reported, increased by 386.86%. The period from 1994 to 1996 they have decreased to 949 reported offenses. Finally, the reported offenses were 985 in 1997, increased by 317.37% since 1982.

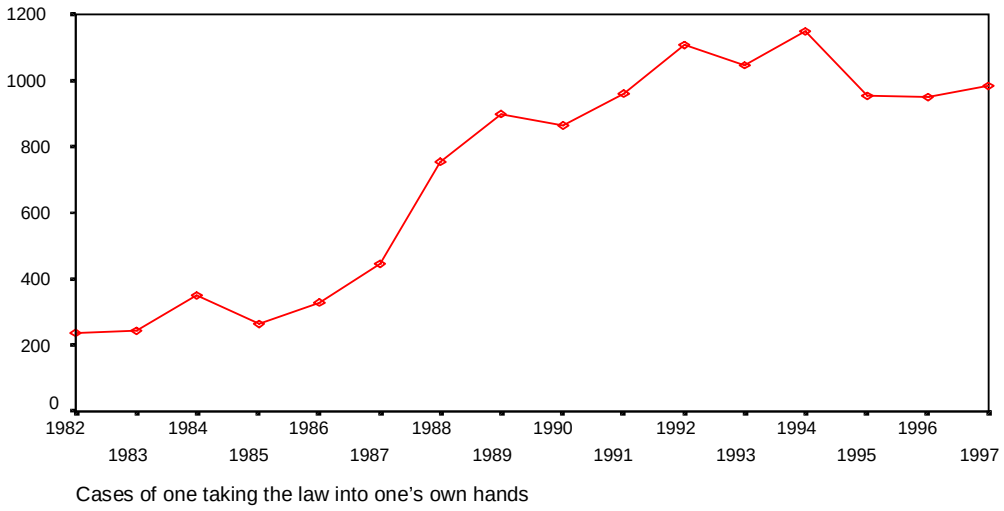

Figure 19. Annual counts of cases of one taking the law into one's own hands for the period 1982-1997.

Larceny (figure 20) has an almost steadily increase since 1982, with two small backwards in 1983 and in 1992. The reported offenses were 85070 in 1997, increased by 287.14% since 1982.

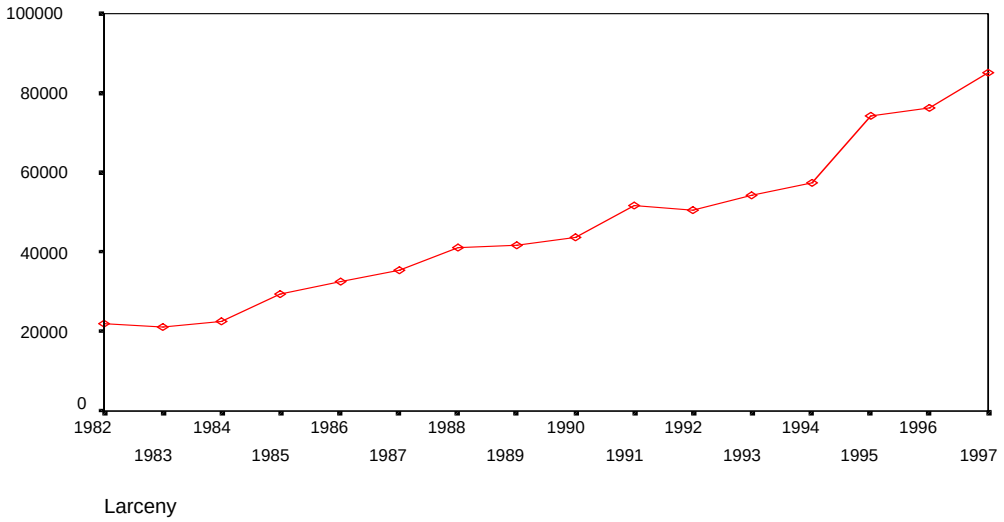

Figure 20. Annual counts of larceny for the period 1982-1997.

Robbery (figure 21) shows a fluctuating pattern especially since 1992. There was a jump in 1988, when the reported robberies reached the 657, showing a 126.55% increase since 1987. Reported offenses were 1967 in 1997, increased by 1357% since 1982.

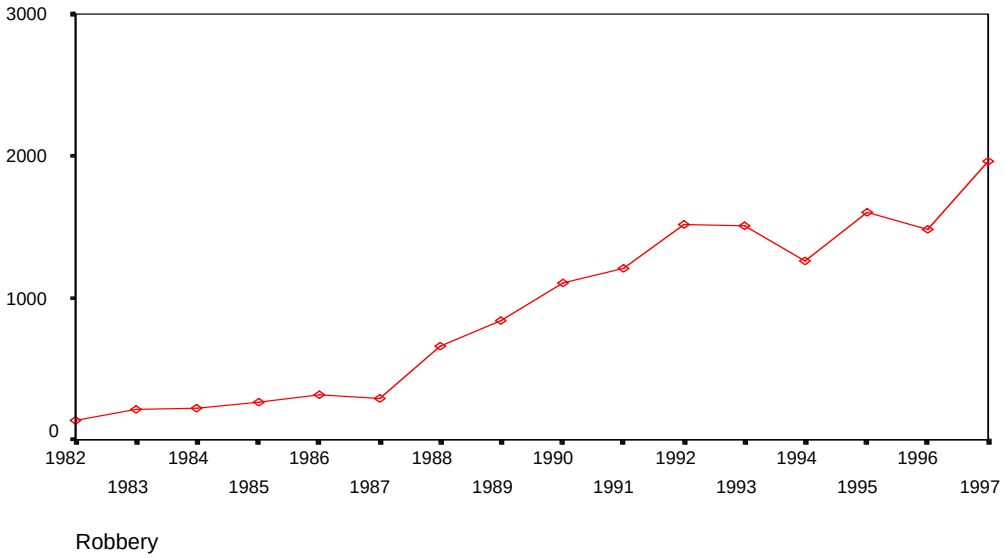

Figure 21. Annual counts of robbery for the period 1982-1997.

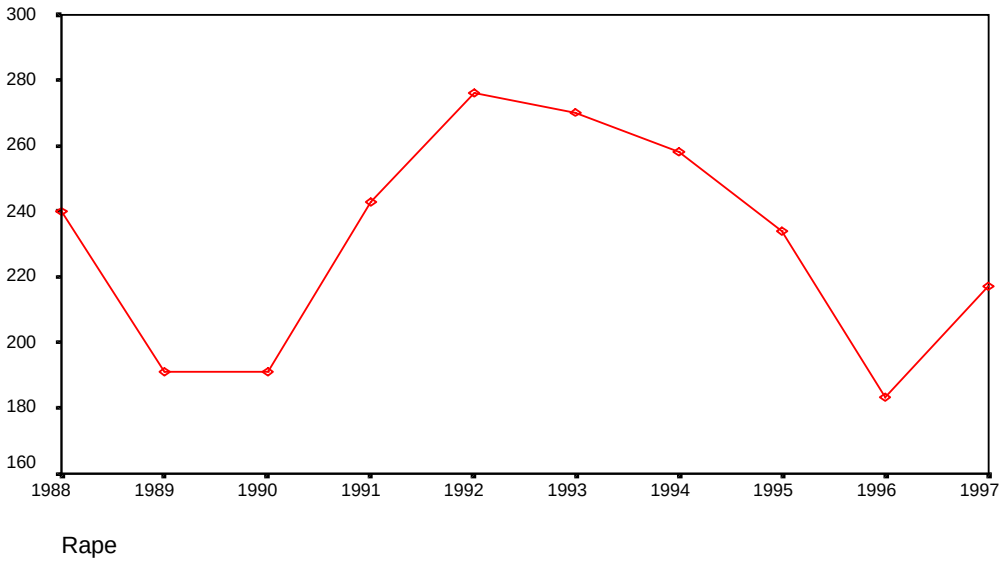

Figure 22. Annual counts of rape for the period 1988-1997.

As far as rape (figure 22) is concerned, we can only draw a picture from 1988 to 1997. This pattern has no obvious trend. Reported rapes show a peak in 1992. The period from 1992 to 1996 they have been decreasing to increase again in 1997 with 217 reported cases of rape, which, however, are still less than 1982 by 9.58%.

4.2.2 Monthly data

An examination of the monthly data gives us a more detailed picture of the crime activity. Monthly data is available for the period 1987-1997. All of the offenses have rather fluctuating patterns with many of them indicating seasonality.

Commonly dangerous crimes (figure 23), smuggling offenses (figure 24), arsons (figure 25), arsons in forests (figure 26) and homicide by misadventure (figure 27) have similar patterns. They all have a peak sometime in the period 1987-1989 and afterwards their fluctuations seem random with an almost non-increasing pattern.

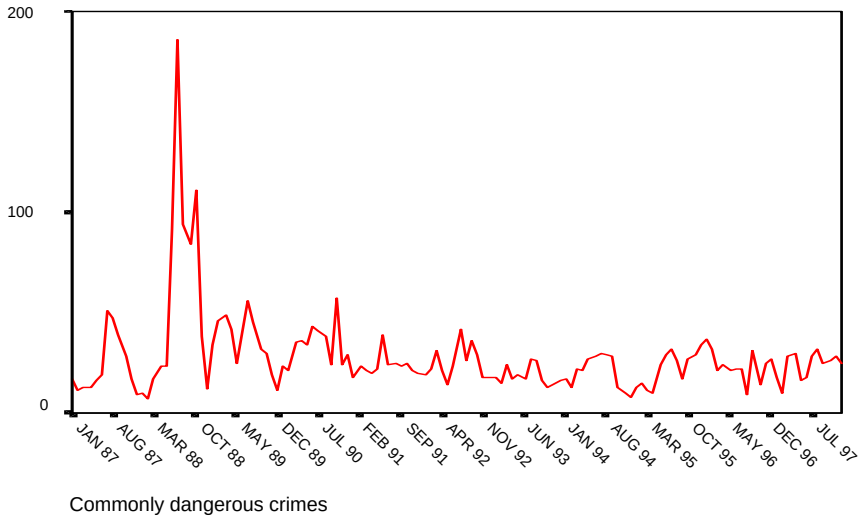

Figure 23. Monthly counts of commonly dangerous crimes for the period 1987-1997

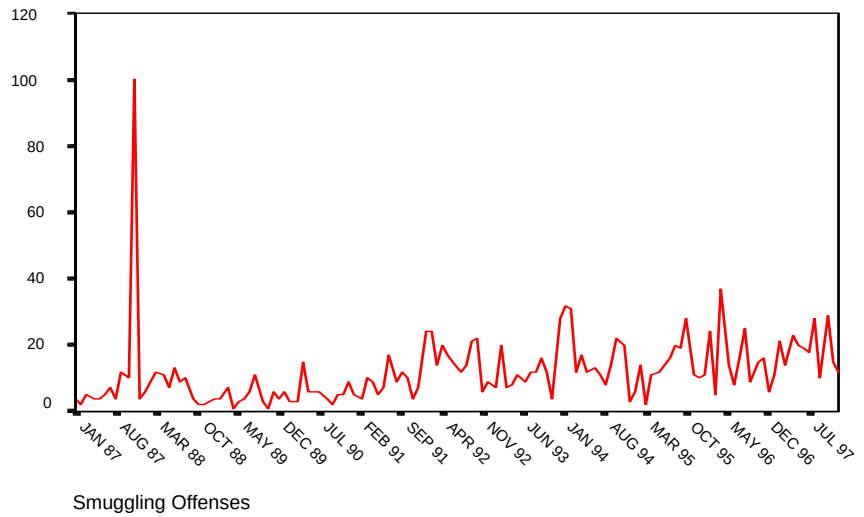

Figure 24. Monthly counts of smuggling offenses for the period 1987-1997

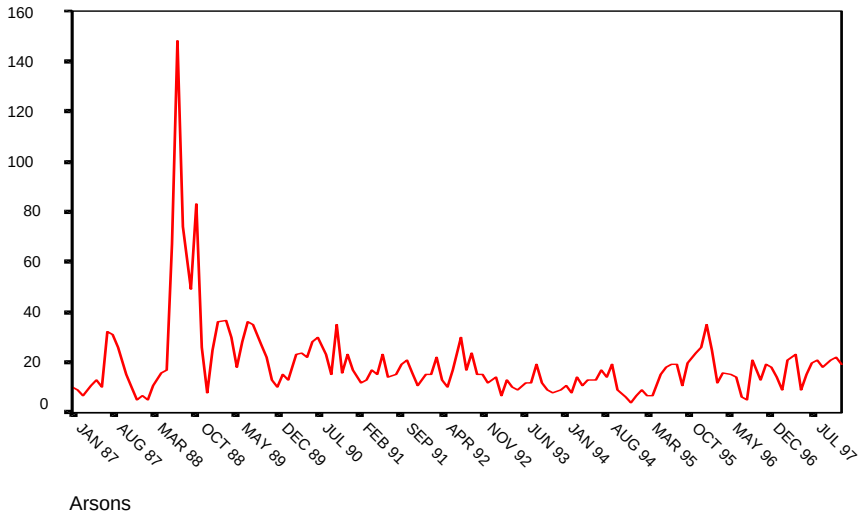

Figure 25. Monthly counts of arsons for the period 1987-1997

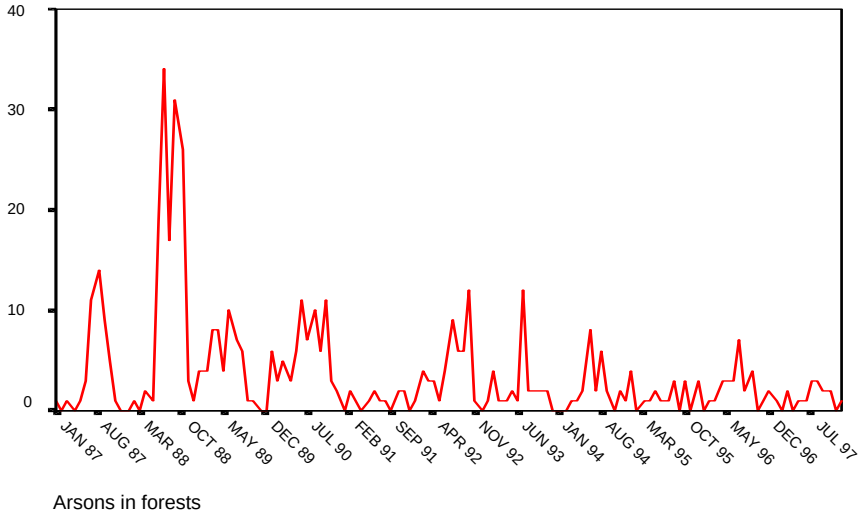

Figure 26. Monthly counts of arsons in forests for the period 1987-1997

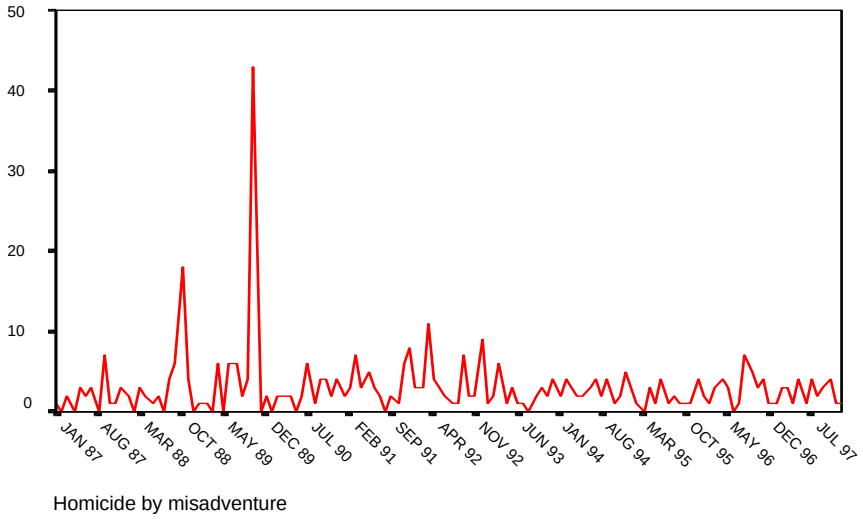

Figure 27. Monthly counts of homicide by misadventure for the period 1987-1997

Another group of offenses that seem to have similar patterns is that consisting of property offenses (figure 28), beggary and vagrancy (figure 29), illegal possession and usage of fire guns (figure 30), drug offenses (figure 31), larceny (figure 32) and robbery (figure 33). Their pattern is clearly increasing. There might be seasonality but the trend of these offenses is the most important characteristic in this case. They increase more rapidly after 1993-1994. All of the above-mentioned offenses, even drug offenses and illegal possession of fire guns, involve wealth. Therefore, one would expect that they should follow similar patterns.

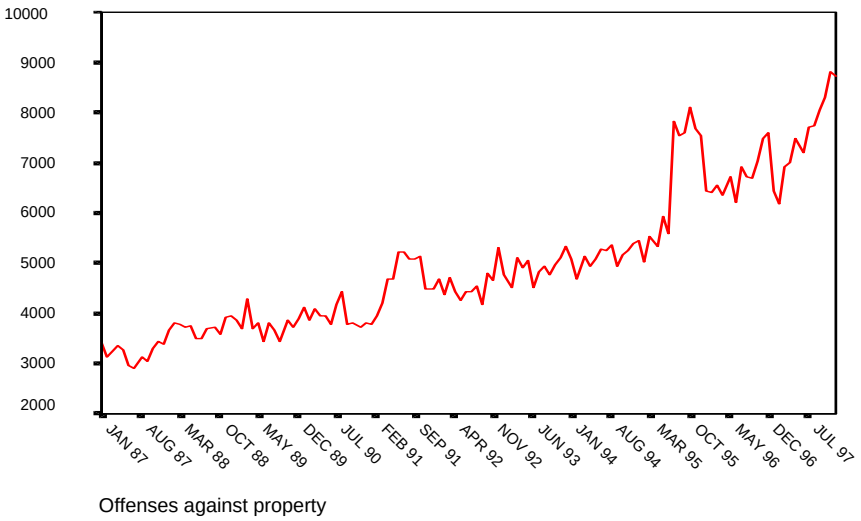

Figure 28. Monthly counts of property offenses for the period 1987-1997

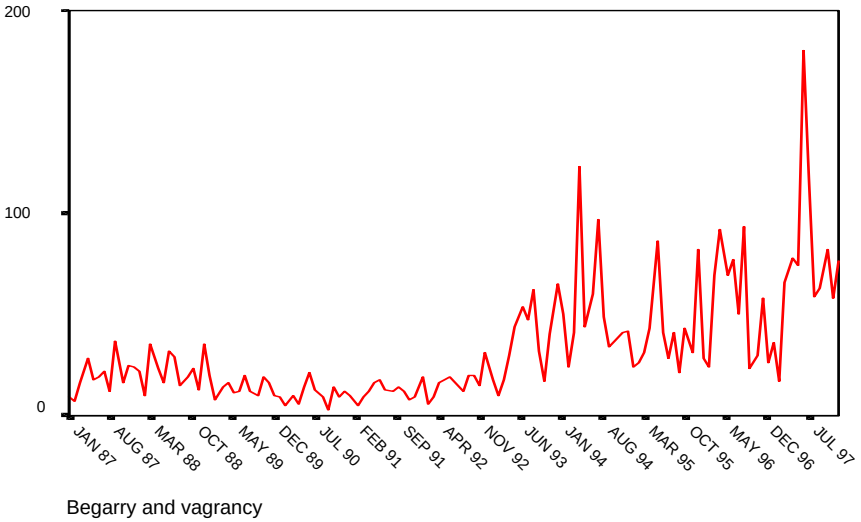

Figure 29. Monthly counts of beggary and vagrancy for the period 1987-1997

At this point we should notice once more that the counts of beggary and vagrancy have increased even after the abolishment of vagrancy in 1994. This shows that the beggary was truly the offense with the rapid increase, which is more related to the other offenses, probably indicating that the need for money and the possible difficult in obtaining it after 1994 have led many people either to stealing or to beggaring.

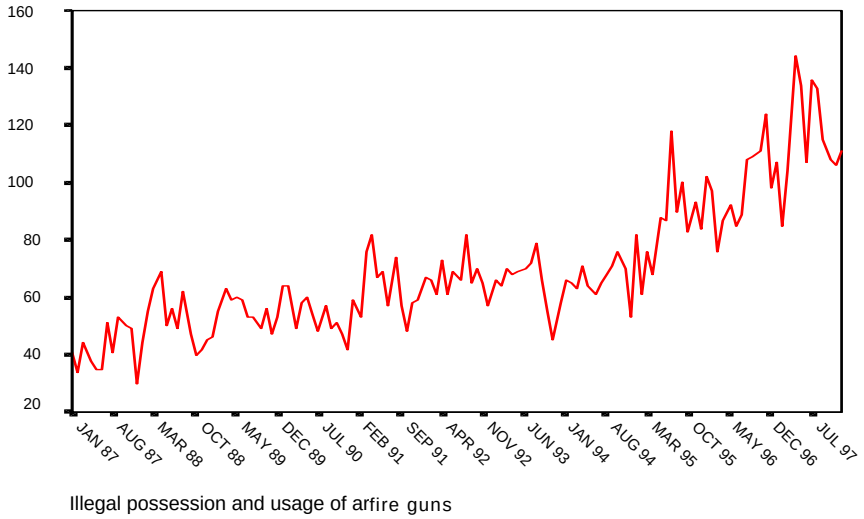

Figure 30. Monthly counts of illegal possession and usage of fire guns for the period 1987-1997

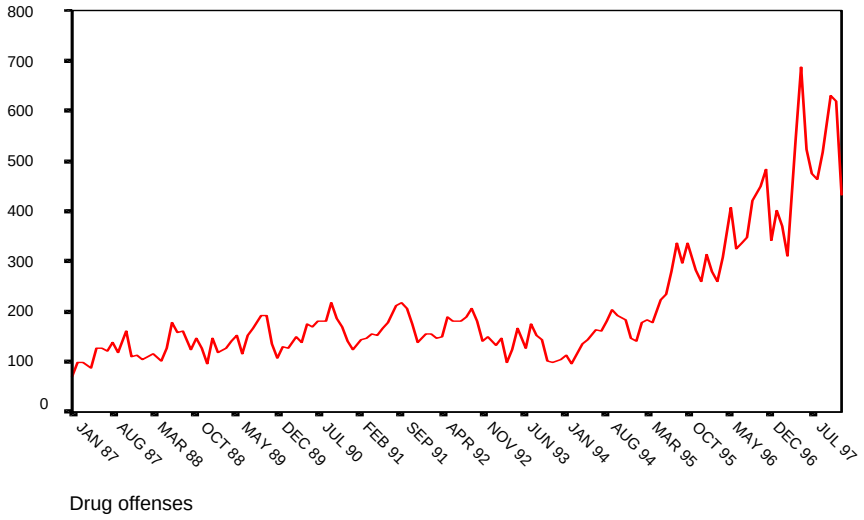

Figure 31. Monthly counts of drug offenses for the period 1987-1997

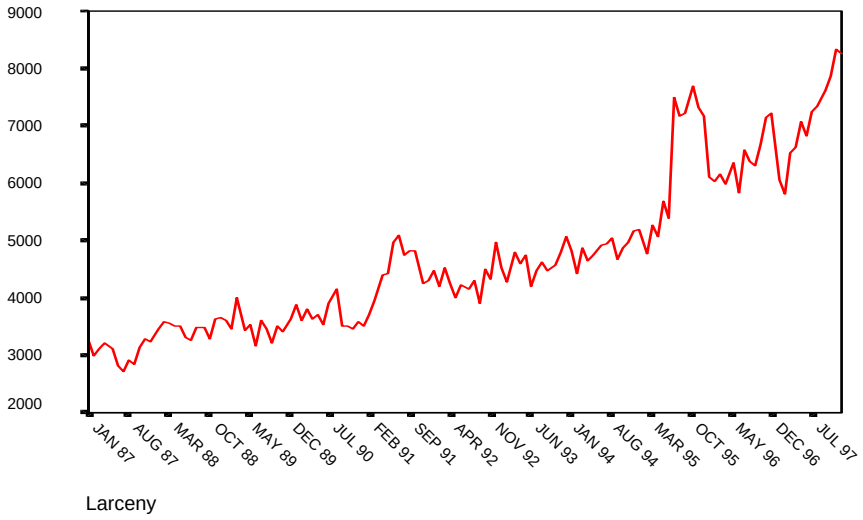

Figure 32. Monthly counts of larceny for the period 1987-1997

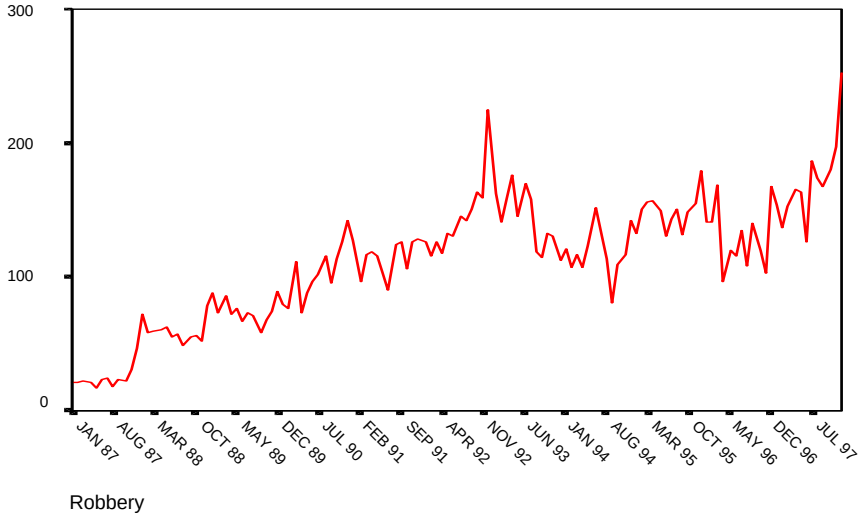

Figure 33. Monthly counts of robbery for the period 1987-1997

Another group of offenses shows periodically patterns. These offenses are those against life (figure 34), physical injuries (figure 35), illegal possession and usage of explosives (figure 36), caused deaths by car (figure 37), simple, unprovoked and dangerous physical injuries (figure 38), physical injuries of a person by car (figure 39) and rape (figure 40). The patterns of these offenses are characterized by periodicity rather than trend, although a slight increase is present for most of them.

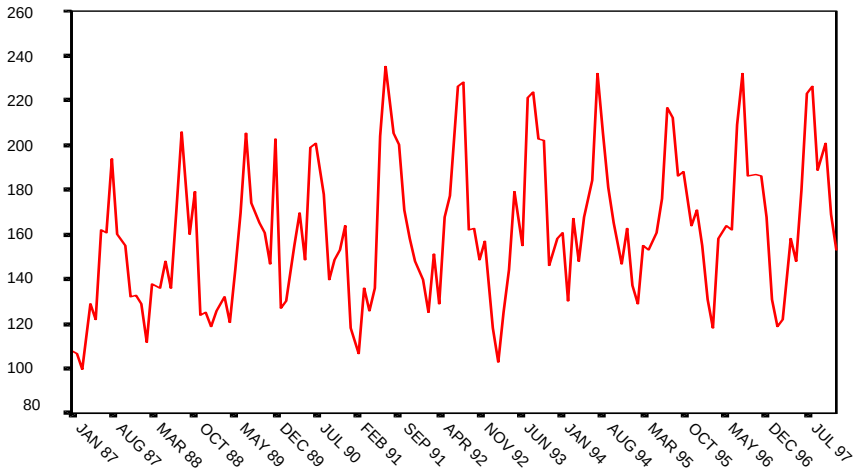

Figure 34. Monthly counts of offenses against life for the period 1987-1997

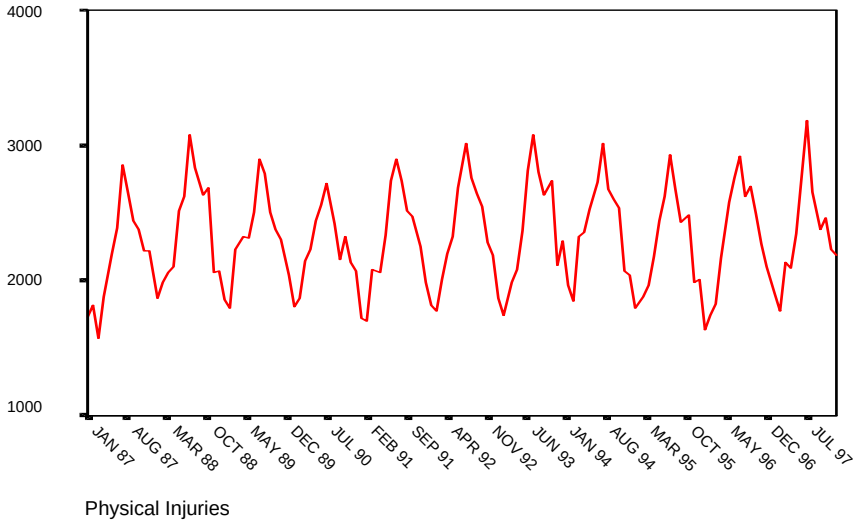

Figure 35. Monthly counts of physical injuries for the period 1987-1997

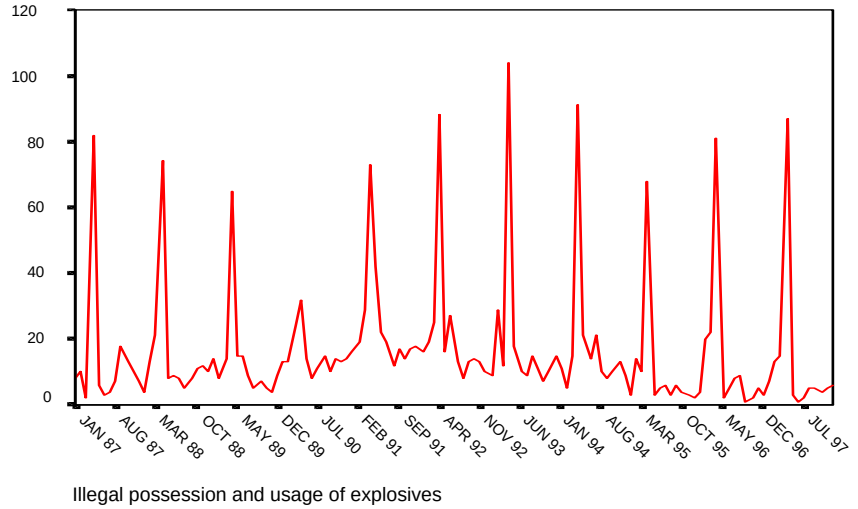

Figure 36. Monthly counts of illegal possession and usage of explosives for the period 1987-1997

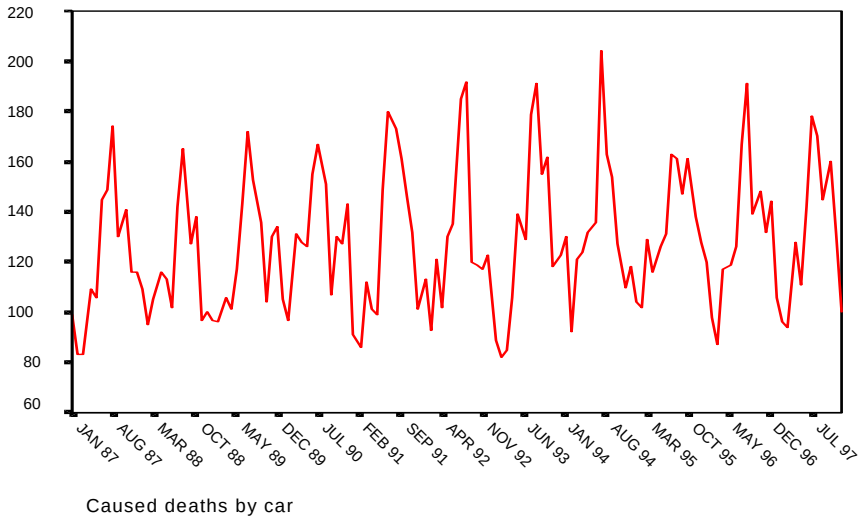

Figure 37. Monthly counts of caused deaths by car for the period 1987-1997

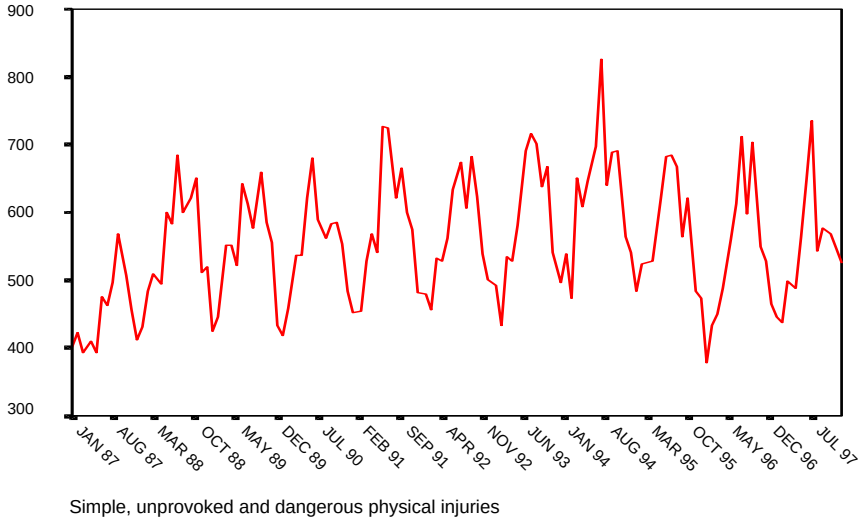

Figure 38. Monthly counts of simple, unprovoked and dangerous physical injuries for the period 1987-1997

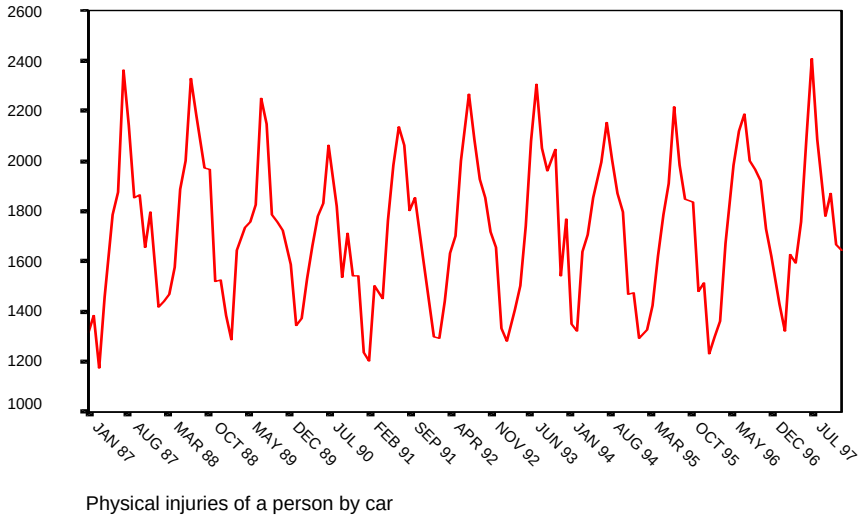

Figure 39. Monthly counts of physical injuries of a person by car for the period 1987-1997

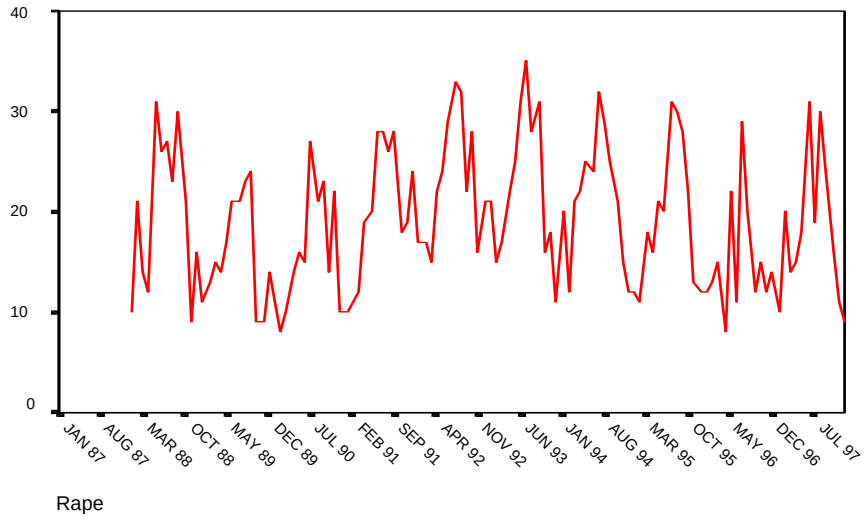

Figure 40. Monthly counts of rapes for the period 1988-1997

Other simple physical injuries (figure 41) show a rather fluctuating pattern with no obvious seasonality or steadily increasing trend. They reach high peaks for some months from March 1988 to May 1994 but they decrease from that point on.

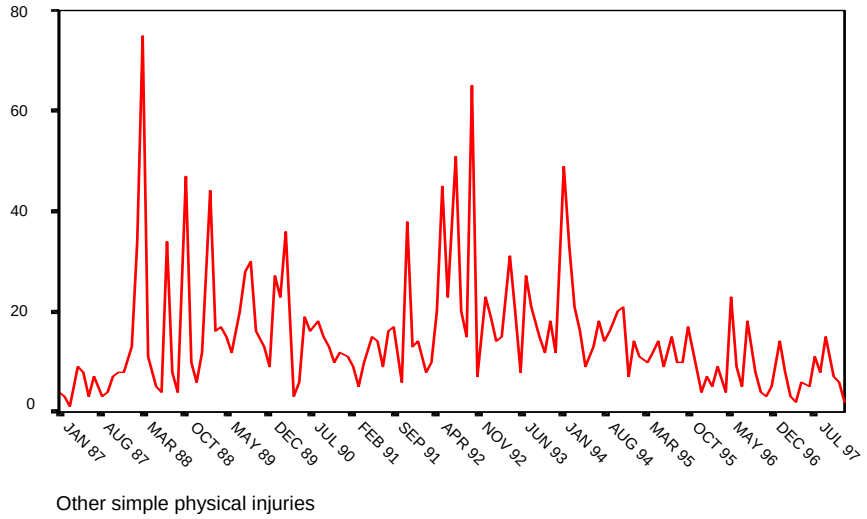

Figure 41. Monthly counts of other simple physical injuries for the period 1987-1997

The cases of someone taking the law into one's own hand (figure 42) show a rather fluctuating pattern with a clearly increasing trend from 1987 to May 1989, but only a slight increase after that, with no obvious seasonality.

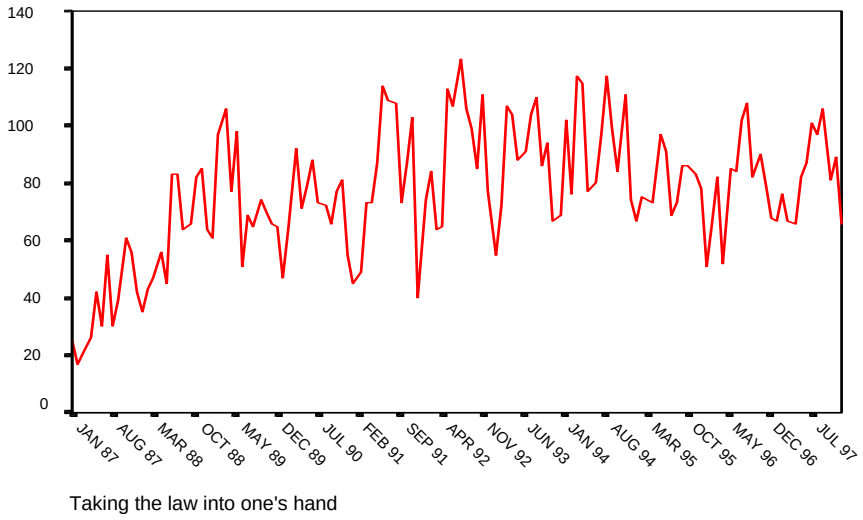

Figure 42. Monthly counts of cases that one took the law into one's hand for the period 1987-1997

Offenses concerning antiquities (figure 43) reach their highest values between April 1991 and April 1994, and they are decreasing since then.

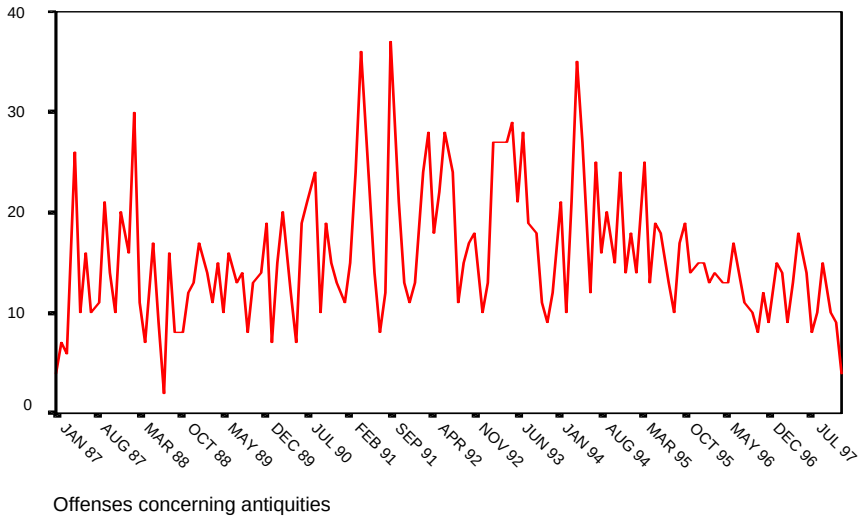

Figure 43. Monthly counts of offenses concerning antiquities for the period 1987-1997

Murders (figure 44) show a steadily increasing, yet too fluctuating, pattern.

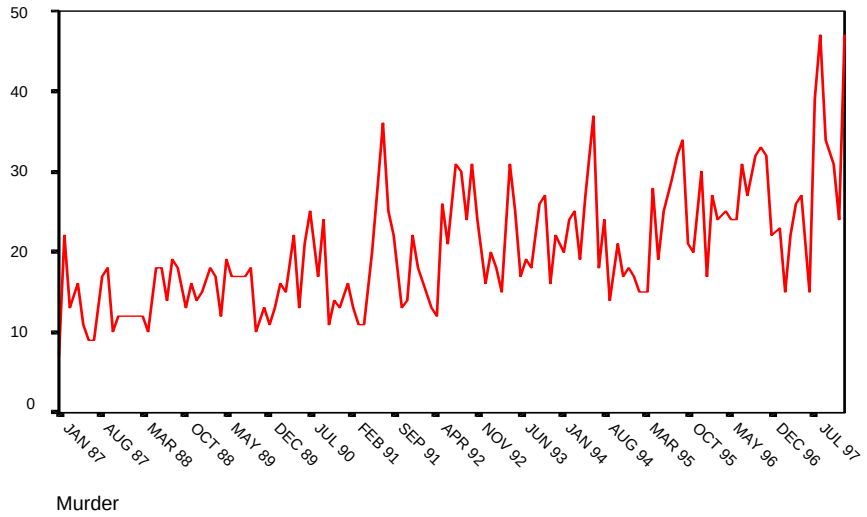

Figure 44. Monthly counts of murders for the period 1987-1997

4.3 Principal Components Analysis

Given a set of *n* observations on *p* variables, the purpose of Principal Components Analysis (PCA) is to determine *r* new variables, where *r* is small relative to *p*. The *r* new variables called *principal components* must together account for most of the variation in the *p* original variables. The components are linear transformations of the original variables and are mutually orthogonal. The principal components can be used to give an approximation for the data matrix.

Both annual and monthly data were analyzed using Principal Components Analysis. Its results can give us information about the relationships of the behavior of the above-mentioned offenses through time. As far as the annual data is concerned the time period under consideration is from 1982 to 1997. Rape is excluded from this analysis since there are available counts for rape only after 1988. Nevertheless, as far as the monthly data is concerned, a PCA analysis can be employed to all crime-variables for the time period from 1988 to 1997. In the following paragraphs we present the results of the two PCA analyses.

4.3.1 PCA Analysis of the annual data

The PCA analysis of the annual data resulted in four interesting uncorrelated components, which account for the 88.6% of the total variation. In table 1 the percentages of variance explained by each of the four components for the annual data are presented. The criterion used to determine the number of components is the eigenvalue-one-criterion (see Jobson, 1992). However, the scree test criterion (see Jobson, 1992) indicates that only three components should be retained (figure 45).

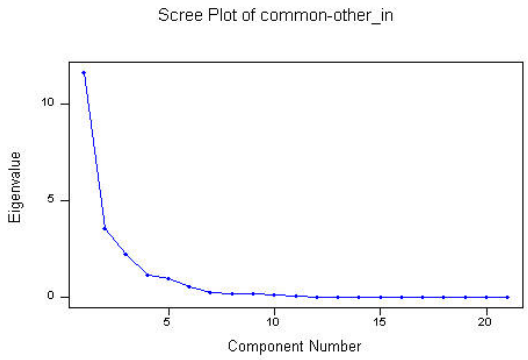

Figure 45. Scree plot of the PCA analysis of the annual data

TABLE 1

Variance explained by the four most important components of the annual data by PCA analysis

Component	Total	% of Variance	Cumulative %
1	11.656	55.5	55.5
2	3.549	16.9	72.4
3	2.224	10.6	83.2
4	1.179	5.6	88.6

In table 2 the correlations between variables and the four principal components from the corresponding correlation matrix are given.

For reasons of convenience the three largest positive correlations for each component are green-colored whereas the three largest negative correlations are red-colored.

TABLE 2

Correlation coefficients between offenses and the first four principal components for the annual data (1982-1997)

	Component			
	1	**2**	**3**	**4**
Robbery	0.972	-0.019	-0.054	0.097
Offenses against life	0.961	-0.019	-0.163	0.068
Offenses against property	0.961	-0.052	0.211	0.097
Larceny	0.957	-0.065	0.222	0.103
Murders	0.931	-0.279	0.105	0.122
Taking the law into one's hands	0.924	0.223	-0.300	0.018
Illegal possession and usage of fire guns	0.901	-0.189	0.281	0.221
Caused deaths by car	0.886	-0.089	-0.145	-0.064
Smuggling offenses	0.882	-0.053	0.096	-0.148
Simple, unprovoked and dangerous physical injuries	0.854	0.278	-0.344	0.056
Drug offenses	0.838	-0.116	0.402	0.213
Physical injuries	0.823	0.457	-0.094	-0.131
Offenses concerning antiquities	0.779	0.248	-0.500	-0.164
Beggary and Vagrancy	0.728	-0.367	0.411	0.100
Commonly dangerous crimes	-0.045	0.917	0.267	0.231
Arsons	0.003	0.904	0.281	0.282
Arsons in forests	-0.348	0.795	0.295	0.049
Homicides by misadventure	0.035	0.553	-0.331	0.206
Illegal possession and usage of explosives	0.545	0.348	-0.551	-0.365
Physical injury of a person by car	0.330	0.358	0.495	-0.467
Other physical injuries	-0.282	-0.162	-0.537	0.651

The first component of the annual data is positively correlated with most of the variables. It is negatively correlated with the arsons in forests and the other physical injuries while it is nearly uncorrelated with the commonly dangerous crimes, the arsons and the homicides by misadventure. In this point it is useful to the reader to note that commonly dangerous crimes include arsons and arsons in forests. Trying to interpret this component we notice that all the crimes except the latter five have been increasing from 1982 since 1997.

On the contrary, commonly dangerous crimes, arsons, homicides by misadventure and especially arsons in forests and other physical injuries have been decreasing after reaching their peak in the years 1988, 1987, 1989, 1987 and 1992, respectively. The value of –0.348 for the arsons in forests is explained by the fact that it is the offense that has shown the most decreasing

pattern the last years. Thus, it is obvious that the first component of the annual data measures the general increase of crime.

The second component of the annual data shows the higher correlations with the commonly dangerous crimes, arsons, arsons in forests and homicide by misadventure. Thus, it shows the higher correlations with the offenses that, as mentioned before, have decreasing patterns from a breaking point after. On the other hand, the absolute larger negative correlations appear with beggary, premeditated murder and illegal possession of fire guns, which have been steadily increasing and with an increasing rate. Therefore, the second component of the annual data might be interpreted as an index of an offense having a decreasing trend.

The third component of the annual data has the higher correlations, although negative ones, with the illegal possession and usage of explosives, other physical injuries and offenses concerning antiquities, whereas the largest positive correlations, yet not too strong, are those with physical injuries of a person by car, beggary and drug offenses. However, it is not clear what this component represents.

The interpretation of the fourth component is even more difficult and it will not be attempted.

The squares of the correlation coefficients given in table 3 describe the portion of the total variance in an offense variable that is explained by the principal component.

TABLE 3

Proportions of the variance explained by each of the first four principal components and communalities for the annual data

	Component				Communalities
	1	2	3	4	
Robbery	94.48%	0.04%	0.29%	0.94%	95,51%
Offenses against life	92.35%	0.04%	2.66%	0.46%	98,02%
Offenses against property	92.35%	0.27%	4.45%	0.94%	98,00%
Larceny	91.58%	0.42%	4.93%	1.06%	97,05%
Murders	86.68%	7.78%	1.10%	1.49%	99,38%
Taking the law into one's hands	85.38%	4.97%	9.00%	0.03%	97,53%
Illegal possession and usage of fire guns	81.18%	3.57%	7.90%	4.88%	81,80%
Caused deaths by car	78.50%	0.79%	2.10%	0.41%	81,19%
Smuggling offenses	77.79%	0.28%	0.92%	2.19%	92,81%
Simple, unprovoked and dangerous physical injuries	72.93%	7.73%	11.83%	0.31%	92,27%
Drug offenses	70.22%	1.35%	16.16%	4.54%	91,22%
Physical injuries	67.73%	20.88%	0.88%	1.72%	94,52%
Offenses concerning antiquities	60.68%	6.15%	25.00%	2.69%	84,36%
Beggary and Vagrancy	53.00%	13.47%	16.89%	1.00%	96,76%
Commonly dangerous crimes	0.20%	84.09%	7.13%	5.34%	97,57%
Arsons	0.00%	81.72%	7.90%	7.95%	84,26%
Arsons in forests	12.11%	63.20%	8.70%	0.24%	45,90%
Homicides by misadventure	0.12%	30.58%	10.96%	4.24%	85,50%
Illegal possession and usage of explosives	29.70%	12.11%	30.36%	13.32%	70,02%
Physical injury of a person by car	10.89%	12.82%	24.50%	21.81%	81,79%
Other physical injuries	7.95%	2.62%	28.84%	42.38%	95,75%

The first component accounts for 94.48% $[(0.972^2) = 0.944784]$ of the total variation in robbery variable. This is the largest (in absolute magnitude) correlation coefficient between the first principal component and any of the offenses; however, the first component explains the largest portion of the total variation for the most of the offenses. The sum of squares of the four correlation coefficients for each offense variable is the communality or variance explained by the retained components (Jobson 1992). This adding is allowable because the principal components are mutually uncorrelated. The

obtained communalities for the annual data given in table 3 show that the four components together explain sufficiently the variation in the offenses, with an exception for the arsons in forests, whose communality is only 45.90%.

The component scores for the four principal components are given in table 4, and in figure 46 the scatter-plot of the component scores for the first two principal components of the annual data is shown.

TABLE 4

Component Score Coefficient Matrix for the annual data

	Component			
	1	**2**	**3**	**4**
Commonly dangerous crimes	-0.004	0.258	0.120	0.196
Offenses against life	0.082	-0.005	-0.073	0.058
Physical injuries	0.071	0.129	-0.042	-0.111
Offenses against property	0.082	-0.015	0.095	0.082
Beggary and Vagrancy	0.062	-0.104	0.185	0.085
Illegal possession and usage of fire guns	0.077	-0.053	0.126	0.187
Illegal possession and usage of explosives	0.047	0.098	-0.248	-0.309
Offenses concerning antiquities	0.067	0.070	-0.225	-0.139
Drug offenses	0.072	-0.033	0.181	0.181
Smuggling offenses	0.076	-0.015	0.043	-0.126
Arsons	0.000	0.255	0.126	0.239
Arsons in forests	-0.030	0.224	0.133	0.042
Murders	0.080	-0.079	0.047	0.103
Homicides by misadventure	0.003	0.156	-0.149	0.174
Caused deaths by car	0.076	-0.025	-0.065	-0.055
Physical injury of a person by car	0.028	0.101	0.223	-0.396
Taking the law into one's hands	0.079	0.063	-0.135	0.016
Larceny	0.082	-0.018	0.100	0.088
Robbery	0.083	-0.005	-0.024	0.083
Simple, unprovoked and dangerous physical injuries	0.073	0.078	-0.155	0.048
Other physical injuries	-0.024	-0.046	-0.242	0.552

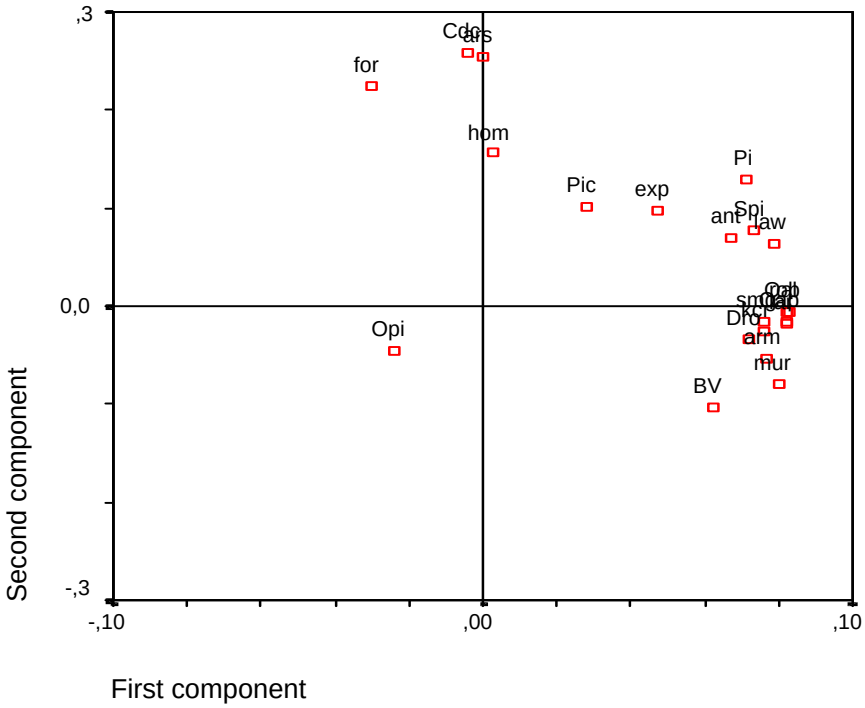

Figure 46. Scatter plot of component scores for the first two principal components of the annual data

4.3.2 PCA Analysis of the monthly data

The PCA analysis of the monthly data resulted in five important components, which account for the 74.7% of the total variation. In table 5 the percentages of variance explained by each of the five components for the monthly data are presented. The criterion used to determine the number of components is again the eigenvalue-one-criterion. However, as in the case of the annual data, the scree test criterion indicates that only three components should be retained (figure 47).

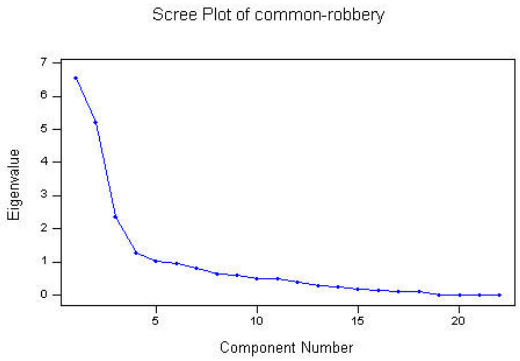

Figure 47. Scree plot of the PCA analysis of the monthly data

TABLE 5

Variance explained by the five most important components of the monthly data by PCA analysis

Component	Total	% of Variance	Cumulative %
1	6.536	29.7	29.7
2	5.203	23.6	53.4
3	2.377	10.8	64.2
4	1.285	5.8	70.0
5	1.042	4.7	74.7

In table 6 the correlation coefficients between variables and the five principal components from the corresponding correlation matrix are given.

For reasons of convenience the three largest positive correlations for each component are green-colored whereas the three largest negative correlations are red-colored.

The first component of the monthly data is positively correlated with most of the offenses (table 6), as in the analysis of the annual data. The higher correlation coefficients are those of offenses against life, property, larceny, murder, illegal possession of fire guns, non-negligent killing of a person by car and drug offenses. In our attempt to interpret this component we notice that these offenses are those who have a clear steadily increasing pattern although fluctuation is present. The negative correlations of illegal possession of explosives, homicide by misadventure and other physical injuries can (as in the case of the annual data) be explained because of the

fact that these offenses have decreased the last few years (last months as well). Hence, the first component of the monthly data can again be interpreted as measuring the increase of crime activity.

TABLE 6

Correlation coefficients between offenses and the first five principal components for the monthly data (1988-1997)

	Component				
	1	**2**	**3**	**4**	**5**
Offenses against life	0.770	0.436	-0.165	-0.221	0.021
Offenses against property	0.759	-0.557	0.219	0.009	-0.019
Larceny	0.758	-0.557	0.215	0.010	-0.023
Murders	0.757	-0.163	0.041	-0.003	-0.226
Illegal possession and usage of fire guns	0.713	-0.507	0.241	0.134	0.054
Caused deaths by car	0.700	0.488	-0.191	-0.197	-0.007
Drug offenses	0.697	-0.413	0.395	0.013	0.084
Physical injuries of a person by car	0.682	0.653	-0.028	-0.073	0.126
Beggary and vagrancy	0.626	-0.253	0.073	0.242	0.284
Taking the law into one's hand	0.512	0.244	-0.376	0.189	-0.120
Smuggling Offenses	0.477	-0.304	-0.044	0.405	-0.058
Arsons in forests	-0.050	0.739	0.477	0.255	-0.079
Commonly dangerous crimes	-0.028	0.701	0.623	0.273	-0.029
Physical Injuries	0.664	0.688	-0.097	-0.062	0.122
Simple, unprovoked and dangerous physical injuries	0.578	0.633	-0.266	-0.051	0.153
Total cases of rape	0.482	0.544	-0.352	0.124	-0.124
Robbery	0.519	-0.531	-0.091	0.068	-0.153
Offenses concerning antiquities	-0.103	-0.016	-0.676	0.341	0.166
Arsons	-0.045	0.646	0.656	0.267	-0.042
Illegal possession and usage of explosives	-0.212	-0.138	-0.237	0.669	0.381
Homicide by misadventure	-0.136	0.140	0.137	-0.226	0.673
Other simple physical injuries	-0.181	0.333	-0.251	0.249	-0.392

The second component of the monthly data is highly correlated with the commonly dangerous crimes, arsons in forests, physical injuries, arsons and physical injuries of a person by car. All of these offenses have a very fluctuating pattern, with evidence of seasonality. Arsons and arsons in forests, which have decreased the last years, also have a periodical pattern in a

monthly base, with higher frequencies for the months June to October. Moreover, it is negatively correlated with offenses that appear to have no seasonality, such as offenses against property, larceny and robbery. Thus, the second component of the monthly data might be interpreted as an index of periodicity in crime activity.

The third component of the monthly data has the largest positive correlations with arsons, commonly dangerous crimes and arsons in forests, whereas the largest negative correlations appear with offenses concerning antiquities, cases of one taking the law into one's hand and rape. However, it is difficult to find an interpretation of this component from these correlations.

The interpretation of the other components is even more difficult and it will not be attempted.

The squares of the correlation coefficients given in table 7 describe the portion of the total variance in an offense variable that is explained by each of the principal components.

The first component accounts for 59.29% $[(0.770^2) = 0.5929]$ of the total variation in offenses against life variable. This is the largest (in absolute magnitude) correlation coefficient between the first principal component and any of the offenses. As one can easily see from the values given in table 7, the portions of variance explained by the first component for the monthly data are not as high as in the case of the annual data. However, the communalities of variance explained by the retained components, also given in table 7, show that the five components together explain quite sufficiently the variation for most of the offenses. The offenses with the smaller communalities are other simple physical injuries (42.23%), smuggling offenses (48.93%), taking the law into one's hand (51.32%), homicide by misadventure (56.09%) and robbery (58.76%).

TABLE 7

Proportions of the variance explained by each of the first five principal components and communalities for the monthly data

	Component					Communalities
	1	2	3	4	5	
Offenses against life	59.29%	19.01%	2.72%	4.88%	0.04%	85.95%
Offenses against property	57.61%	31.02%	4.80%	0.01%	0.04%	93.47%
Larceny	57.46%	31.02%	4.62%	0.01%	0.05%	93.17%
Murders	57.30%	2.66%	0.17%	0.00%	5.11%	65.24%
Illegal possession and usage of fire guns	50.84%	25.70%	5.81%	1.80%	0.29%	84.44%
Caused deaths by car	49.00%	23.81%	3.65%	3.88%	0.00%	80.35%
Drug offenses	48.58%	17.06%	15.60%	0.02%	0.71%	81.96%
Physical injuries of a person by car	46.51%	42.64%	0.08%	0.53%	1.59%	91.35%
Beggary and vagrancy	39.19%	6.40%	0.53%	5.86%	8.07%	60.04%
Taking the law into one's hand	26.21%	5.95%	14.14%	3.57%	1.44%	51.32%
Smuggling Offenses	22.75%	9.24%	0.19%	16.40%	0.34%	48.93%
Arsons in forests	0.25%	54.61%	22.75%	6.50%	0.62%	84.74%
Commonly dangerous crimes	0.08%	49.14%	38.81%	7.45%	0.08%	95.57%
Physical Injuries	44.09%	47.33%	0.94%	0.38%	1.49%	94.24%
Simple, unprovoked and dangerous physical injuries	33.41%	40.07%	7.08%	0.26%	2.34%	83.15%
Total cases of rape	23.23%	29.59%	12.39%	1.54%	1.54%	68.29%
Robbery	26.94%	28.20%	0.83%	0.46%	2.34%	58.76%
Offenses concerning antiquities	1.06%	0.03%	45.70%	11.63%	2.76%	61.17%
Arsons	0.20%	41.73%	43.03%	7.13%	0.18%	92.27%
Illegal possession and usage of explosives	4.49%	1.90%	5.62%	44.76%	14.52%	71.29%
Homicide by misadventure	1.85%	1.96%	1.88%	5.11%	45.29%	56.09%
Other simple physical injuries	3.28%	11.09%	6.30%	6.20%	15.37%	42.23%

The component scores for the four principal components are given in table 8, and in figure 48 the scatter-plot of the component scores for the first two principal components of the annual data is shown.

TABLE 8

Component Score Coefficient Matrixfor the monthly data

	Component				
	1	**2**	**3**	**4**	**5**
Commonly dangerous crimes	-0.004	0.135	0.262	0.212	-0.028
Offenses against life	0.118	0.084	-0.070	-0.172	0.020
Physical Injuries	0.102	0.132	-0.041	-0.049	0.117
Offenses against property	0.116	-0.107	0.092	0.007	-0.018
Beggary and vagrancy	0.096	-0.049	0.031	0.189	0.273
Illegal possession and usage of fire guns	0.109	-0.097	0.101	0.104	0.052
Illegal possession and usage of explosives	-0.032	-0.027	-0.100	0.521	0.365
Offenses concerning antiquities	-0.016	-0.003	-0.284	0.266	0.159
Drug offenses	0.107	-0.079	0.166	0.010	0.080
Smuggling Offenses	0.073	-0.059	-0.019	.315	-0.056
Arsons	-0.007	0.124	0.276	0.208	-0.040
Arsons in forests	-0.008	0.142	0.201	0.199	-0.076
Caused deaths by car	0.107	0.094	-0.080	-0.153	-0.007
Homicide by misadventure	-0.021	0.027	0.058	-0.176	0.646
Simple, unprovoked and dangerous physical injuries	0.088	0.122	-0.112	-0.040	0.147
Physical injuries of a person by car	0.104	0.125	-0.012	-0.057	0.121
Other simple physical injuries	-0.028	0.064	-0.106	0.194	-0.376
Taking the law into one's hand	0.078	0.047	-0.158	0.147	-0.115
Total cases of rape	0.074	0.105	-0.148	0.097	-0.119
Murders	0.116	-0.031	0.017	-0.002	-0.216
Larceny	0.116	-0.107	0.091	0.008	-0.022
Robbery	0.079	-0.102	-0.038	0.053	-0.146

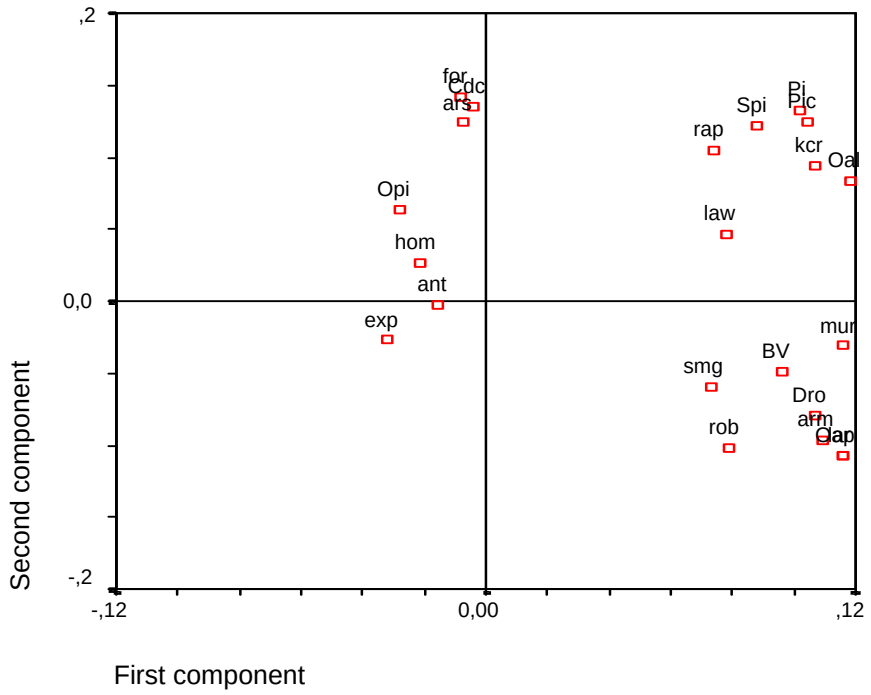

Figure 48. Scatter plot of component scores for the first two principal components of the monthly data

4.4 Clustering of the offenses according to their behavior through time

Clustering methods can also be employed in order to classify the above-mentioned offenses according to their behavior over the giving time period. In this paragraph we will only give some hierarchical clustering methods (see Everitt, 1993).

In order to determine the most appropriate number of clusters for the data there are several stopping rules (objective criteria), which indicate where to 'cut' the dendrogram (see Everitt, 1993, and Jobson 1992). For reasons of simplicity, since these are only preliminary analyses, we will not get deeper into the selection criteria. In order to obtain the appropriate number of clusters we will use the scree-test criterion. A red line on the following dendrograms indicates where one should 'cut' the dendrograms in order to get the most representative partition for the data.

4.4.1 Annual data

The offenses used for the subsequent analyses are commonly dangerous crimes, homicides by misadventure, physical injuries, illegal possession and usage of explosives, offenses concerning antiquities, cases of one taking the law into one's hand, offenses against life, offenses against property, beggary and vagrancy, illegal possession and usage of fire guns, drug offenses, smuggling offenses, murder, larceny and robbery.

The methods that will be presented in this paragraph are the Complete Linkage, the Centroid, and the Ward's method.

Using *Complete Linkage* (figure 50) a three-cluster solution seems to be more appropriate as the corresponding scree plot indicates (figure 49).

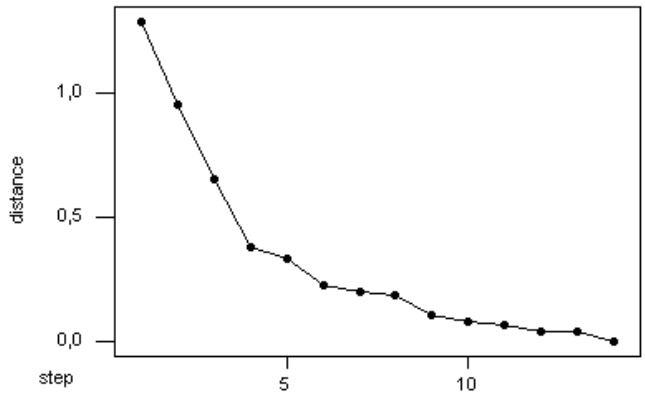

Figure 49. Scree plot of the clustering criterion for the annual data using Complete Linkage method

- The first cluster consists of commonly dangerous crimes and homicides by misadventure.
- The second cluster consists of offenses against life, offenses against property, beggary and vagrancy, illegal possession and usage of fire guns, drug offenses, smuggling offenses, murder, larceny and robbery.
- The third cluster consists of physical injuries, illegal possession and usage of explosives, offenses concerning antiquities and the cases of one taking the law into one's hand.

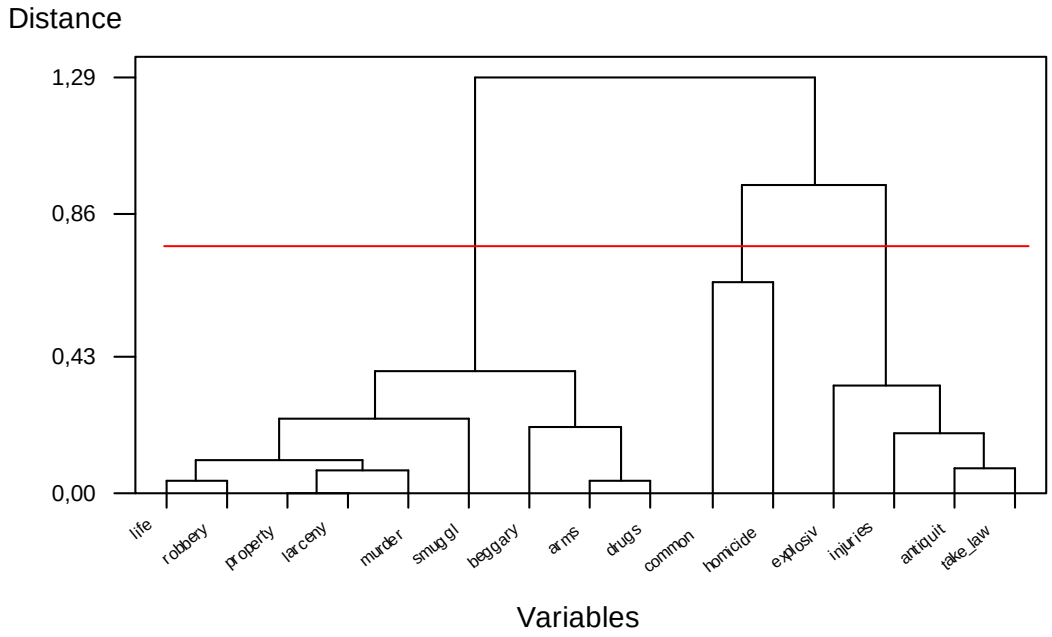

Figure 50. Dendrogram of the annual data using Complete Linkage method

Using *Centroid Method* (figure 52) we again obtain a three-cluster solution as it derives from the corresponding scree plot (figure 51).

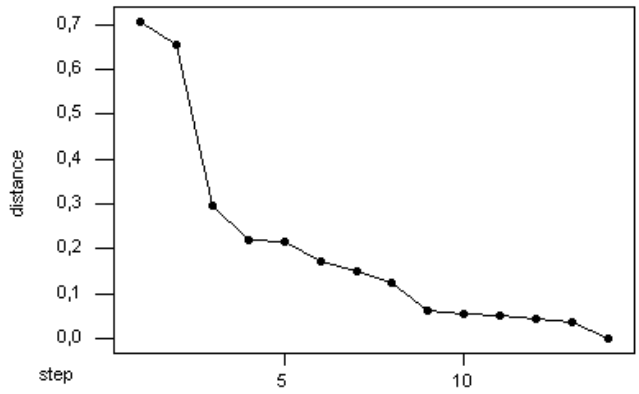

Figure 51. Scree plot of the clustering criterion for the annual data using Centroid method

- The first cluster consists of commonly dangerous crimes.
- The second cluster consists of homicides by misadventure.
- The third cluster consists of offenses against life, offenses against property, beggary and vagrancy, illegal possession and usage of fire guns, drug offenses, smuggling offenses, murder, larceny, robbery, physical injuries, illegal possession and usage of explosives,

offenses concerning antiquities and the cases of one taking the law into one's hand

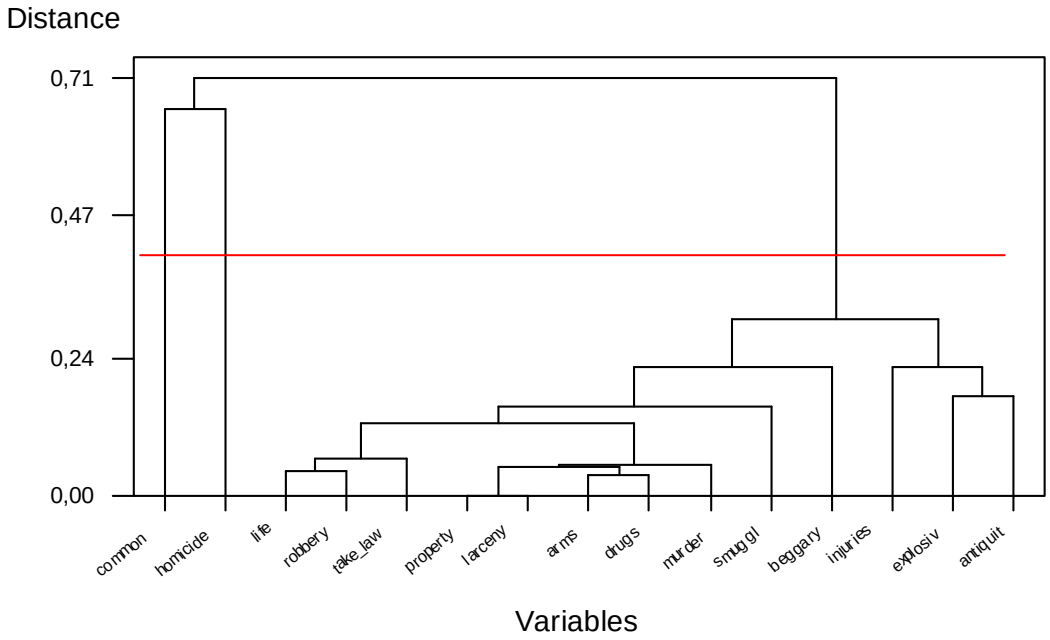

Figure 52. Dendrogram of the annual data using Centroid method

Using *Ward's Method* (figure 54) a three-cluster solution seems to be more appropriate (see also the scree plot in figure 53).

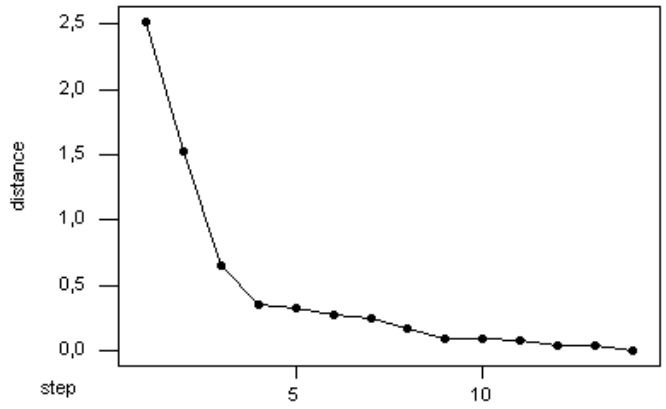

Figure 53. Scree plot of the clustering criterion for the annual data using Ward's method

- The first cluster consists of commonly dangerous crimes and homicides by misadventure.
- The second cluster consists of offenses against life, offenses against property, beggary and vagrancy, illegal possession and usage of fire

guns, drug offenses, smuggling offenses, murder, larceny and robbery.

- The third cluster consists of physical injuries, illegal possession and usage of explosives, offenses concerning antiquities and the cases of one taking the law into one's hand.

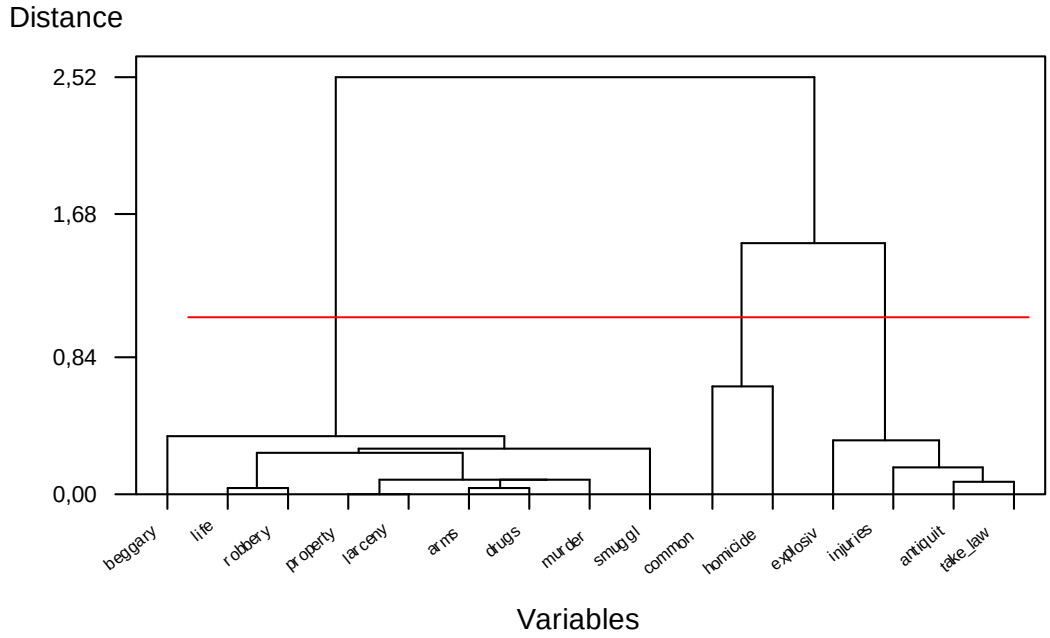

Figure 54. Dendrogram of the annual data using Ward's method.

The Complete Linkage and the Ward's methods led to exactly the same clustering of the annual offenses.

4.4.2 Monthly data

The method that will be presented for the monthly data is only the Ward's method, since the rest of the methods applied could not give a clear cut of the dendrogram.

Using *Ward's Method* (figure 56) a three-cluster solution seems to be more appropriate (see also the corresponding scree plot in figure 55).

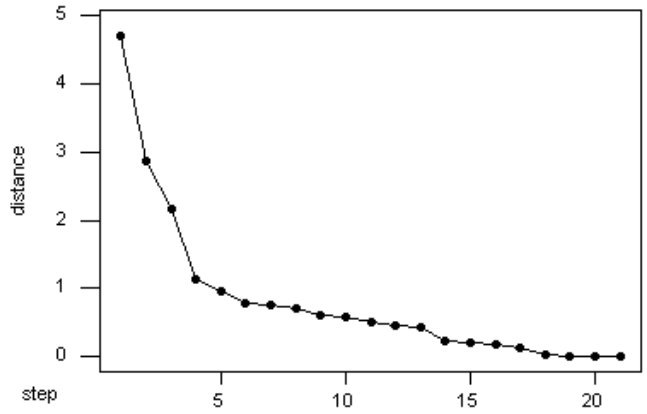

Figure 55. Scree plot of the clustering criterion for the monthly data using Ward's method

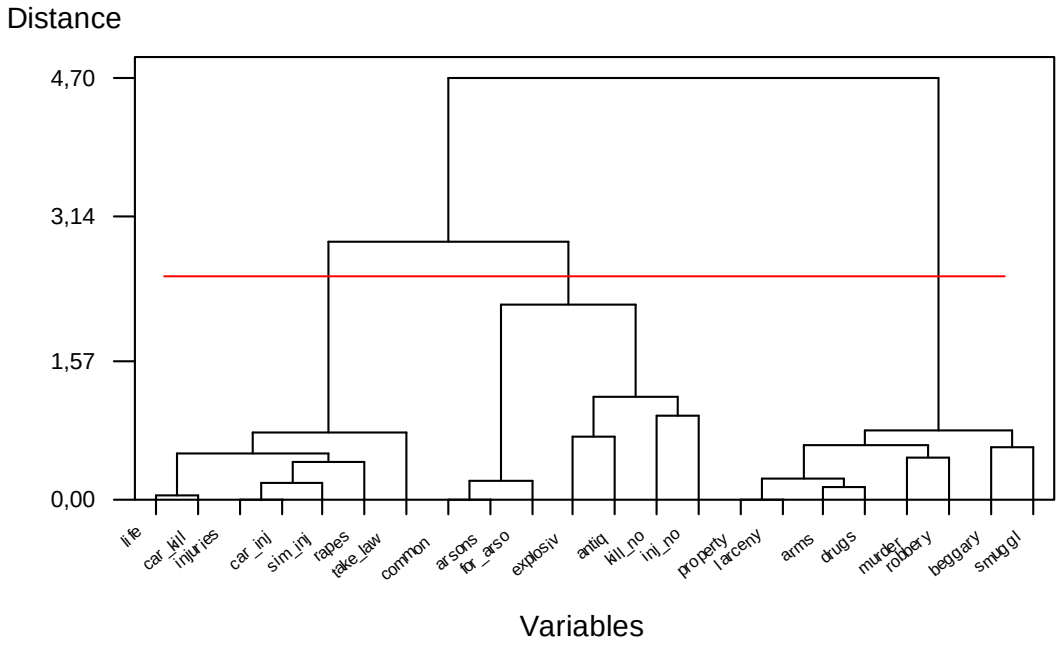

Figure 56. Dendrogram of the monthly data using Ward's method

- The first cluster consists of commonly dangerous crimes, illegal possession and usage of explosives, offenses concerning antiquities, arsons, arsons in forests, homicides by misadventure and other physical injuries.
- The second cluster consists of offenses against life, physical injuries, killing of a person by car, simple, unprovoked and dangerous physical injuries, physical injuries of a person by car, cases of one taking the law into one's hand and rape.

- The third cluster consists of offenses against property, beggary and vagrancy, illegal possession and usage of fire guns, drug offenses, smuggling offenses, murder, larceny and robbery.

Further analyses are yet to be employed in order to obtain a more detailed picture of the crime activity in Greece. So far we have only commented on some analyses employed to crime counts per year or per month. Employment of statistical analyses to crime counts per location will determine the relationships between different types of offenses in certain counties of Greece.