Soumyo D. Moitra:
Crimes and Punishments —
A Comparative Study of Temporal Variations

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Foreword

This book reports the results of a research project that I carried out at the Max-Planck-Institute for Foreign and International Penal Law in Freiburg in 1984-85. I had long been interested in the topic of this research, which is the study of temporal patterns in criminal justice data, starting with a research project I did for my Master's thesis at Syracuse University under Carl Harris. Then I did further work on time series analysis for my Ph.D. dissertation under Alfred Blumstein. All this was with data from within the U.S., and I was interested in extending the research to include data from other countries. I felt that a comparative analysis of crime trends and the responses of different criminal justice systems would be interesting and important in criminology and criminal justice. On one hand it is only sensible to compare social theories across societies; on the other hand, comparing very disparate societies brings up so many issues and potential control variables, that comparisons become meaningless. The countries of Europe seemed a natural choice for inclusion in a comparative analysis since they were more similar to the U.S., all being western, industrialized countries, and it was also interesting for me personally, having lived there previously. The opportunity came when I contacted Hans-Jörg Albrecht at the Max-Planck-Institute about my proposal for a comparative time series study, and he was interested in my doing the project there. Then I was awarded a fellowship by the Alexander von Humboldt Foundation in Bonn, and I was able to undertake the project.

While this research focuses on criminal justice data, the issue in the broadest sense is change in societies and how societies respond to change. We are usually curious about what kinds of change are occurring around us, what are they related to, and even whether it is real or only apparent. In an increasingly technological age, we tend to subsume change as the normal order of things, but in fact we might well question why some things are not changing even more rapidly. In many respects, while technological changes seem to be occurring rapidly, many other facets of society are changing more slowly, and it may be interesting to explore this difference. Perhaps it is related in a fundamental way to cultural constraints and limitations to the speed of human adaptation, and this in turn brings up the question of how

human organizations respond and adapt to changes in the environment. This study explores a small part of this issue by examining trends in criminal justice statistics, looking at the interrelations among them and how they are related to other socioeconomic indicators. To explore these issues and adaptation, we must necessarily examine data over time, and we have to utilize the appropriate tools for such an analysis.

It would appear self-evident that we need empirical and quantitative methods to explore trends in society, to verify (or disprove as the case may be) hypotheses about social changes; and to establish the generality of theories. Such analyses are also needed for the further development and elaboration of social theories. Unfortunately, however, there still appears to be some hostility towards using sophisticated quantitative techniques in the social sciences and public policy in general and in criminology and criminal justice in particular. This is expressed in a variety of ways, most often in the view that social reality is much too complex for data analysis and mathematical models to be adequate. According to this view, quantitative analysis omits important aspects, for example the legal system or organizational changes, which can only be taken into account qualitatively. This view misses the point that many aspects of social reality can be explored quantitatively, if sufficiently precise theories have been developed, and that empirical investigation can often reveal that some theories cannot be supported at all from the evidence, or that they are incorrect in their current forms. In other words, the real usefulness of empirical analysis often lies in their ability to disprove a theory. Of course, mathematical models do not reflect all the complexities of reality (nor do qualitative models for that matter), but they can provide insights on which further theories can be developed. But unfortunately the "qualitative temptation" could well force good quantitative analyses to be watered down before it is published. Another variant of this hostility and mistrust of quantitative methods is the argument that the data analysed is inadequate or even invalid. There is some validity to this argument, since in the social sciences, it is virtually impossible to get perfect data. However, this argument misses the other point that there is nevertheless much that can be learned about social phenomena through good analyses of available data, and allowances can be made for the various sources of errors

and biases. Finally, the argument is often invoked against quantitative analysis that it is largely irrelevant to actual policy making, because political considerations and social preferences will inevitably outweigh any suggestions made on the basis of empirical research. This may in fact be true, and perhaps most empirical and quantitative analyses are fated to be ignored until a time when policy makers will (or can) take greater cognizance of such analyses. On the other hand, the last few decades have witnessed a slightly greater acceptance of analyses in policy making in many countries, but whether the trend will continue, or level off ,or reverse itself, remains to be seen.

This scepticism (at best) and hostility (at worst) have had some unfortunate effects. Criminologists have often tended to remain ignorant of sophisticated mathematical and statistical methods, some of which might well have helped them, and as a consequence also ignore the more quantitative studies. However, these studies often have many other interesting aspects than the ones the author focusses on. For example, the data or the graphs or the analysis might be relevant for some other research or could be interpreted from a very different perspective. But these opportunities are often missed. Fear and/or ignorance of quantitative analysis leads not only to bad research being produced (when such analysis has to be done), but also to bad quantitative research being consumed, since few can distinguish it from good. But the obvious lack of quality leads to the self-fullfilment of the prophecy that quantitative research is necessarily inadequate. On the other hand, I am (still) continually surprised how readily people will accept the results of any quantitative analysis (however indifferent in quality) when it supports their inclinations or prejudices. Needless to say, both these uncritical rejections and acceptances do a great deal of real harm in stifling progress, and thus this issue is not just a "straw man".

While a considerable part of this study comprises simple graphical analyses of time series, I have used other quantitative techniques as appropriate. Indeed, it was a most enjoyable research project for me as it combined several areas of interest to me: time series analysis, criminal justice and cross-national comparisons. I particularly enjoyed the opportunity the reflect on the various differences (and similarities)

in societies. In the course of the project I often came across social data other than just criminal justice statistics, and it was very interesting to note how different societies report data and what data a given society considers important. I should perhaps add a note on my own style of writing and reporting results. (I have omitted constant references to reviews of the literature. Thus, the reader is reminded that wherever I rediscuss some idea or theory, further details will be found in the sources I have cited previously. Many theories and findings have been reviewed subsequently, and I have usually referred to these reviews collectively rather than each individual article or book. While the literature review is necessarily incomplete, the interested reader will be able to find most of the related literature in following up on the reviews). Also, I have tried to keep this report reasonably short and thus have tended to avoid repetition and elaboration. Too much expansiveness, I believe, often leads to obfuscation. I would hope that this book will be of interest to all criminologists and criminal justice researchers interested in temporal patterns and the relationship of crime to punishment. I hope moreover that social scientists interested in comparative studies or in time series analysis will be interested in this study. All analyses and results are amply described in words, so none should be discouraged by the quantitative sections.

It is a great pleasure to acknowledge the help and encouragement that I have received from many people and which made this project possible. I would like to thank the Alexander von Humboldt-Stiftung not only for a fellowship to do this project, but also for the excellent care they take of their fellows and which made my stay that much more enjoyable; and the director of the Max-Planck-Institute, Prof. Kaiser, for letting me do the project there. The excellent library at the Institute facilitated my research considerably and thanks are due to Frau Biele and Frau Schreiber for their friendly help in finding materials in the library. Learning German and getting to know Germany was made far pleasanter through the friendship of Juana Presman and Akiko Miyake, both of whom I met while studying German at the Goethe Institute and stayed in touch with during my stay, even though we were all living in different cities. The last part of the book was written after I came back to the U.S. The difficulties of resettling here

again were made easier through the kindness and friendship of James and Dorothy Guyot, who put me up at their home when I returned and were most supportive in every way. Thanks are due to David Greenberg with whom I discussed project proposal and who took an interest throughout; and to Frau Geng for her care in typing the manuscript.

My stay in Freiburg during the research project was a particularly happy and enjoyable one, and I am deeply grateful to Barbara Huber, Frieder and Gertraude Dünkel, and Hans-Jörg Albrecht for making it so. Both in my work and outside of it, their help and friendship made that time very pleasant and memorable indeed. It is also due to them that I was also able to enjoy the beautiful countryside around Freiburg. Thanks are also due to Hans-Jörg Albrecht for his continual help in tracking down German data sources and explaining their various facets to me.

It is customary at this point for the author to absolve others from any mistakes and take on the blame for them himself. I am inclined to deviate from tradition and absolve myself from all blame. Inaccuracies in the data are clearly due to wrong figures in reports or misleading headings on tables; substantive errors obviously come from other authors whom I have read or because someone else told me something incorrectly; stylistic errors are naturally the responsibility of the copy editor; all other errors have been carefully planted to test the reader's attentiveness and accuity.

New York/Freiburg i.Br., im Februar 1987 Soumyo D. Moitra

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Part 1:

I. INTRODUCTION

Social observers have long had an interest in the changes in sociological variables over time. The continuing interest is based on a number of reasons. There is for example the historical interest in finding out how societies have changed in their various aspects over the course of history. Such studies of change often focus on the degree of stability or instability social variables exhibit. Socio-economic variables display the whole spectrum of variations from remaining virtually constant to exhibiting enormous fluctuations. However, the majority of socio-economic variables have a certain amount of regularity and even predictability in their values from one year to another. There is no immutable law why it should be so. For example, it is possible that in a given year, all women decide not to have any babies. The birth rate would plummet to zero, but such abrupt variations are rarely observed. It is also conceivable that in a given year, every European (who could) decided to take a vacation in the U.S. Again, it is an unlikely event. The number of babies born in any given year does not vary very much from the number born in the previous year, and the number of European tourists in the U.S., also does not change very dramatically from year to year (in spite of currency fluctuations!). As early as 1835, Quetelet (Mailly, 1875) pointed out how surprising such regularities in fact were. Demographers too, have always predicted population changes on the assumption of a regularity in birth rates. Thus, while there are indeed changes in many or most socio-economic variables, the variations tend to be gradual, and even sudden fluctuations (except for war and natural catastrophes) tend to be relatively small.

However, these **patterns** of variations can be very complex, and changes in different social factors are often linked through intricate relationships. This is another reason for the interest in studying change. In order to understand societies and historical trends better (that is, what **kinds** of changes have occurred), we need to study the interrelationships between social variables, and for this it is important

to see how the respective changes over time are correlated. Along with this interest in discovering historical patterns more accurately, there has been an increasing emphasis on analyzing data over time[1]. This empirical approach of studying time-series data is of course particularly important for verifying various hypotheses that are developed from theories of social change.

There is the further interest in discovering what factors explain observed changes. That is, we would often like to develop **explanatory** models that explain changes in some social variable (say, birth-rate or thefts) in terms of other socio-economic (including technological) variables (for example, economic growth or urbanization). Time-series analysis is particularly important in studying explanatory models because of the implied causality. If there are causal relationships, then the variables have to be observed over a period of time both to verify the hypothesized causal link and to estimate its strength. Even then, causal analysis is frought with problems[2], but time-series analysis is certainly a necessary first step. Knowledge of past patterns and evidence of causal factors open up the possibility of predicting future conditions. Indeed, in much of economic and political decision-making, forecasting in some form or another is extremely important, and this is yet another reason for the interest in time-series analysis[3].

In criminology and criminal justice there has also been a corresponding interest in studying the temporal variations in crime statistics. Criminologists, along with other social scientists, have examined trends and variations in crime rates to assess the various theories on the causes of crime. There is now a substantial literature in historical criminology ranging from qualitative descriptions to quantitative analysis of the little data that is available from past centuries. Here again, there has been an increasing interest in gathering historical data, and in trying to explain observed or inferred changes over time[4]. As discussed in the literature review below, numerous models have been proposed to explore and explain changes in crime, arrest, or imprisonment rates, or other indicators related to crime and corrections. Among these are models that hypothesize cyclical variations of crime or imprisonment rates over years, corresponding to economic

cycles, and shorter, seasonal variations for certain crimes have also been considered. Even the absence of change over time calls for an explanation. Given the enormous societal changes that have taken place certainly since the end of World War II, it is astonishing when crime rates are found to have remained nearly constant (as in the case of Japan). In such cases one would like to identify the factors that helped produce this constancy, which contrasts sharply with the majority of countries which have experienced increasing crime rates over the last two decades or more[5].

For criminal justice policy analysis, the study of time-series has been important, for example in assessing the impact of new laws or new methods of law-enforcement[6]. Researchers studying police response to changing crime patterns and variations in clearance rates also need to look at time-series data. Those studying the prosecutorial process are often interested in changes and trends in the proportion of arrests brought to court (or a plea-bargaining), and in the conviction rates over time for different crimes. In the administration of courts and corrections, projections of future caseloads, or prison population is important for planning. Such projections depend on the analysis of past trends in court cases, sentencing rates, etc. In general, the impact of changing resource levels on the effectiveness at all levels of the criminal justice system has become an increasingly important question, given greater demands for accountability and efficient management in the public sector. In all such research, time-series analysis in some form or another is (or should be) employed.

To better understand the overall dynamics of the criminal justice system, that is, the interactions among the different components (police, prosecutors, courts, etc.), one has to study the raltionships among the different crime statistics and indicators over time, for example the relationships between changes in crime rates for different offences and changes in their arrest rates, or the relationship between crime rates and imprisonment rates[7]. Models to explore such relationships are discussed in detail below. Such relationships help reveal how the criminal justice system behaves, and how it responds to changes in the environment or in one of its components. A more comprehensive analysis and understanding of the dynamics of the

criminal justice system is clearly desirable, especially given the current concern about crime and the concurrent demand to develop more effective crime control policies. Such analyses are also useful for comparative criminology, because they provide models with which to compare different criminal justice systems. For example the models might suggest that the criminal justice systems of some countries respond in a similar way to an increase in crime rates, while another group of countries has a different mode of response. This in turn might indicate a possible significance (or insignificance) of some social factors (or interactions among them) for the functioning of the criminal justice system, and such findings would further the development of criminological theories. Comparative research is obviously important in this context, since we need to observe the effects of variations in cultural and socio-economic factors. In general it is rather difficult because of the problems of comparability of data (see below), but developing models of time-series data provide a method of comparing **patterns** of variations across societies.

II. REVIEW OF PREVIOUS RESEARCH AND THEORIES ON CRIME TRENDS

II.1. Historical and comparative studies

There has been a great number of studies on crime trends with a variety of different interests and viewpoints. Theres is now a number of historical studies on crime trends in one or several countries, particularly in the United Kingdom[8]. In general, there have been three broad (sometimes overlapping) approaches. One is the historical approach where the long-term trends in one country are estimated by examining historical records and described in detail. The second or comparative approach where trends in two or more countries are studied. The third approach has been to explore a variety of socio-economic variables, to see how societal changes might have influenced crime trends. Most studies, however, combine these approaches. Brantingham and Brantingham (1984) discuss crime trends in the U.K., U.S., and Canada in great detail. They find evidence for cyclic patterns in crime rates for the U.K. and the U.S. and a different trend for Canada. They note that the crime mix has changed dramatically with a trend towards less violent offences and more property offences. They conclude with discussion of structural changes in society and how they may have influenced crime trends. In a review article, Gurr (1981) reviews a number of such studies for violent crimes. He summarizes observed historical patterns in terms of an extended U-shaped curve: long-run decline followed by an upturn since the 1960's. However, as he points out, there are a number of exceptions. He also summarizes a variety of theories proposed to explain crime trends. Zehr (1976) compared patterns of criminality in nineteenth century Germany and France and considered a number of economic indices, and in a cross-national study Archer and Gartner (1984) examined homicide trends in 110 countries and 44 cities. Both Brantingham and Brantingham (1984) and Gurr (1981) summarize a number of similar studies, and Zehr (1976) also considers a variety of socio-economic indices. Mukherjee (1981) undertakes a comprehensive analysis of crime data for Australia. Following a historical description of crime statistics, he explores both long-term and short-term correlates of crime. This is an important distinction. While there may well be

specific factors associated with long-term trends in crime rates, it is crucial to note that, given changes in the nature of society, the same socio-economic factors will influence the rates of different crimes differently in different time periods.

Given that there are different causes of crime, and different motivations for different crime-types, some social factors may be more relevant under given social conditions while under other social conditions, very different social factors may be relevant. For example, in a developing economy, the rate of urbanization may be most significant in explaining property crime, while later, when the economy has matured, the unemployment rate may be the most significant. In order to assess the relationship between social variables and criminal justice variables, the time periods should be segmented into shorter periods where the society remains relatively stable and no major discontinuities or upheavals occur. Mukkerjee (1981) develops a procedure to segment the total time period and does indeed find changing relationships between the variables over time. For example, the relationship between violent offences and GNP per capita changed gradually from a moderately negative to a highly positive one[9].

Other studies focussing on specific countries include Christie (1963) where imprisonment rates for the Scandinavian countries are compared, Tornudd (1978) where crime trends in Finland are described, Sperling (1980) where sentencing rates and policing are discussed in terms of social control, and Pilgram (1980) where trends in crime rates in Austria are discussed[10].

II.2. The stability of imprisonment hypothesis

There has been a particular interest in the temporal patterns in the imprisonment levels in various societies. The significance of imprisonment lies in the fact that, short of the death penalty, imprisonment represents the harshest punishment that courts in most modern societies impose on convicted offenders, and the imprisonment rate is the level at which society metes out the punishment (through its criminal justice system). It is thus an important sociological barometer of the collective reaction to serious crime and the punitiveness of a society. Durkheim

(1964a) originally hypothesized that the amount of crime that a society recognizes (and presumably is willing to punish) should be stable over time. He pointed out that even if there was a community of saints, with no one committing the usual offences, minor deviations from norms would appear to be significant infractions and would be treated as such. He also considered crime as an integral part of any society, and that the recognition and censure of acts that society viewed as criminal reinforced social solidarity (Durkheim, 1964b). Erickson (1966) developed this notion, and demonstrated that in colonial Massachusetts the level of punishment in a society remained stable: if the crime rate went down, marginal offences previously not punished were punished; and if the crime rate went up, those marginal offences were again left unpunished.

This hypothesis of the stability of punishment in a society was developed and tested in more detail by Blumstein and Cohen (1973) and Blumstein, Cohen and Nagin (1977). They found that the national imprisonment rates for the U.S., Canada, and Norway were indeed generally stable. Blumstein and Moitra (1979) analyzed the time-series of the imprisonment rates of the states of the U.S. and also found stability in the majority of the states. This study utilized ARIMA models developed by Box and Jenkins (1976), and found distinct regional groupings among the states as well. That is, states from similar regions had similar structures in their imprisonment rate time-series. The issue of stability of punishment has also been explored by Waller and Chan (1974), Rauma (1981), and Berk, et. al. (1981). Waller and Chan examined imprisonment rates for Canada, the United Kingdom, and Australia and concluded that they were not stable, although no time-series models were developed or tested. Rauma and Berk, et. al. examined the time-series of prison admissions in California, and also concluded that stability was not present[11].

The concept of stability of punishment is at once general and complex, and great care is needed to assess it properly. It hypothesizes that the imprisonment rate will vary **around** a stable level. It is never expected that the imprisonment rate will remain constant, and in fact, the rate may well deviate substantially from the stable level from time to time. This is probably the greatest source of confusion, since many

seem to take the hypothesis in its narrowest sense, that is, that the imprisonment rate should be constant. The stability hypothesis allows for varia ions in the rates. It simply predicts that when the imprisonment rate begins to go down (as a result perhaps of various socio-economic changes), after a while, forces within and without the criminal justice system will begin to act to restore the level of punishment back to the stable level. Similarly, if the imprisonment rate were to increase over time, social and political forces would again be generated to dampen the trend and bring it down to its stable value (Blumstein and Cohen, 1973).

Clearly, we cannot expect stability of punishment in every single society or jurisdiction. Developing societies for example, or other societies undergoing major transformations will probably have unstable imprisonment rates for extensive periods of time. The data in Christie (1963) show that the change from the practice of corporal punishment to imprisonment produced an enormous increase in imprisonment in Norway and other Scandinavian countries. Subsequently stabilizing forces (in the form of criminal law amendments) brought the imprisonment rate down to its previous level (and the closeness to the previous level is in itself remarkable) and then it remained stable for a long period of time, corresponding to a stabilization in society itself. From time to time, major changes in social norms or values, or in the functioning of the criminal justice system may result in step changes in the stable level itself. For example, a punitive response to increasing crime may result in an upward shift in the imprisonment level that society is willing to accept. The current increase in jail and prison populations in a number of countries including the United States, while partly demographic, may also be partly an indication of such an increase in punitiveness. The stability hypothesis would predict that in this case, future imprisonment rates will vary around this **new** stable level. Some indications that this may have occurred in the United States in the past is discussed in Blumstein and Moitra (1980) which reanalyzes data in Cahalan (1979)[12].

All this implies that in practice it can sometimes be difficult to identify stability or stationarity in a time-series, a problem well known in statistics. Box and Jenkins (1976) for example, discuss a case where it

is extremely problematic to decide on stationarity. Similar problems in identifying time-series are discussed in Granger and Newbold (1977). The nature and timing of these changes and responses will determine the pattern of variations that are actually observed and of course they will vary greatly among societies. Some variations may be approximately cyclic, while some may have very irregular peaks and valleys. In addition there will probably be other influences superposed on this process. Thus, even in the context of an overall stability in the punishment level, we should expect not only very different patterns of variations across societies, but also significant temporary deviations from the stable level. This is because the temporal pattern of imprisonment rates, like the variations of any other economic or social indicator, can be viewed as a stochastic process, and it is in the nature of such processes that chance events (concertedly) may produce quite large deviations for a considerable length of time, as demonstrated in McCleary and Hay (1980).

Sometimes theoretical considerations may help with identification, but then it is possible that quite different theories will predict very similar (or even identical) models which are equally supported by the data. In such cases, it is extremely difficult to choose between competing theories, a problem well known in the social sciences[13]. It is best to keep an open mind and not reject the hypothesis of stability summarily, and on the other hand, accept instability where many indications point to it. In Blumstein and Moitra (1979) for example, it was recognized that some states in the United States did indeed have unstable or non-stationary imprisonment rates.

In testing for stability of punishment, it is important to keep in mind that punishment (when it is imprisonment) has two components. One is the sentencing rate, that is, the proportion of individuals sent to prison, and the other is the length of sentence. It is the two together that determine the level of punishment. In other words, if Q = probability of imprisonment and S = time served, QS is the expected punishment given conviction. The two components (certainty and severity) can be mutually adjusted, with certainty going up for example and severity going down, and the resulting level of punishment remaining constant. Thus, prison admissions may well be

unstable when the punishment level is stable, because it is possible that sentence lengths are adjusted accordingly. In other words, a self-compensating policy may be followed where the end result is that the expected punishment, given conviction, is stable, even though each component (namely, the certainty and the severity) may be unstable over considerable periods of time. This means that the stability hypothesis cannot be tested with data on admissions. It is the imprisonment rate that is crucial. There is a further reason why admissions may be unstable when imprisonment is stable. In situations where the imprisonment rate has deviated (for any number of reasons) from the stable value, the admission rate may itself be adjusted to bring about stability in the imprisonment rate, that is, to bring it back to its stable value. An example of this would be increasing diversionary policies or non-prison sentences when there is increasing overcrowding in prisons. Thus, admissions may be unstable for this very reason - to achieve stability in punishment[14]. Another point to be remembered is that the sentences are very different for different crime types and often change over the course of time (corresponding to changing social values), and these changes also have a significant impact on the imprisonment rate. The admission rates may be the same, but if say, the sentence lengths for robbery increase, this will increase the prison population in the long run. The significance of varying sentence lengths for different crimes can be seen in the enormous discrepancy between the proportion of homicide offenders in the admission rate and in the prison population. Because of their longer sentences, they comprise a much larger proportion of the prison population than of the admitted population. Their low admission rates do not mean that society punishes them at a low rate. The stability of punishment hypothesis suggests that certainty or severity or both can be adjusted to maintain stability.

The stability of punishment hypothesis does not postulate any simple causal mechanism that produces stability. Rather, it hypothesizes a complicated social and cultural process by which society arrives at a collective decision on the amount of punishment it should mete out to devaints within it. This involves a complex tradeoff between the perceived need and benefits of punishment[15], and the social and economic costs of that punishment, including the moral dilemma over

the incarceration of individuals. The stable level of imprisonment can thus be seen as a reflection of this tradeoff. Given a stable social structure and value system, if the imprisonment rates increase too much, there will be increasing social and moral strains in society resulting in pressures to decrease it. And if it decreases too much, there may well be a perception that the criminal justice system is being too lax, and again pressures will be generated for a harder line to be taken against criminals. Such an adjustment process will involve time lags and also will operate at the boundaries of tolerance, rather than continously for any deviance from the stable level. (In the short term, prison capacity will act as an upper boundary, albeit a flexible one, since capacity can be adjusted to some extent by placing more or fewer people per cell). Again, the complexity of such a socio-cultural process makes it difficult to be identified by simple causal models (however statistically sophisticated), so absence of statistical significance need not necessarily imply absence of such a stability. The point of this discussion is not to defend the universality of the stability hypothesis (it is certainly **not** universal), but rather to suggest that the degree of its prevalence is still an open question, and a great deal of comparative research needs to be done to establish or reject its generality and validity.

What is clearly evident, however, that in just about all societies, the imprisonment rate is more stable over time relative to the crime rate. Indeed, the crime rate (even with lags) is a very poor indicator of the imprisonment rate[16]. This implies that there is some adjustment or adaptation within the criminal justice system. It may be that the police make more arrests for minor offences when the crime rate is low, and vice versa; or prosecutors may make decisions on proceeding with a case or not depending on their caseloads; judges may vary their use of non-prison alternatives in sentencing, and parole-boards may adjust early releases based on prison overcrowding. This process of adaptation has so far not been studied very much, but it is an important one for the functioning of the criminal justice system. In this analysis, we study the time-series of crime and criminal justice statistics to evaluate the evidence for such adaptations, and we attempt to locate the level within the criminal justice system where any given adaptation may be taking place, and the nature of this

adaptation. However, a thorough analysis of the adaptation mechanism is beyond the scope of this study, which focuses on temporal patterns.

II.3. Relationships between the imprisonment rate and other variables

There are obviously other approaches to explaining the temporal variations in the imprisonment rate. The most obvious explanatory variable is of course the crime rate, and a number of studies have focussed on the relationships between the crime rate and the imprisonment rate. However, all these studies find that imprisonment rates are not related to crime rates in general. For example, Biles (1982, 1983) found that crime rates and imprisonment rates in Australia are not related to each other, and Bowker (1981) found the same is true for the U.S. data. In both cases, there were periods where crime was increasing and imprisonment rates were declining. Bowker cites other studies with similar findings. Biles (1983), however, finds a consistent relationship between the two rates for U.K. data. However, there are a number of flaws in these studies. For example, demographic factors are not taken into account. In fact, Blumstein, Cohen and Miller (1980) have pointed out that the lack of correlation can be attributed to the fact that the increase in crime (in the United States) in the sixties and seventies was due in part to juveniles (from the baby boom) who could not be sent to prison, and even when they became adults, they would still need time to accumulate a conviction record before they would be sent to prison[17]. Thus, because of the demographic composition, one could observe increasing crime along with stable or decreasing imprisonment rates; and later, decreasing crime (as many of these juveniles age out of crime) along with increasing imprisonment rates, as those who persisted in crime begin to get prison sentences.

Another problem is of course that it is total crime rate that is typically considered, and increases in it can well be due to minor crimes for which offenders are not sent to prison. Even if only violent crimes and prison population are considered (Biles, 1982), the measures are still to aggregate, and from stability or capacity considerations, the proportion of minor offenders sentenced to prison could well vary (inversely) in relation to the number of serious offenders who are sent

to prison. As will be discussed later, there are other problems with these studies, but overall, no clear relationship has been found to date between crime and imprisonment.

A different approach to explaining imprisonment rates has been in terms of economic indicators and unemployment in particular. Greenberg (1977), for example, showed in a very careful analysis that while crime rates did not explain imprisonment rates in the United States or Canada, unemployment rates and imprisonment rates were closely correlated. He reviews various theories that might explain such a relationship. Similar suggestions have been made by Rusche & Kirchheimer (1939), Yaeger (1979) and Joubert et al. (1981). However, as Greenberg points out, the causal mechanism has yet to be satisfactorily explained.

The relationship between crime and unemployment (or economic conditions) is also an apparently obvious one, but in a review of the research, Freeman (1983) concludes that while there appears to be some connection, the evidence is by no means clear cut. One reason may be that the motivations to commit different crimes are very different, and perhaps difficult economic conditions promote property crimes only. On the other hand, it could also promote violent crime through frustration. In neither case is there a strong link. In a study of West German data, Bednarzik & Heiland (1984) also conclude that there is no clear relationship between the two.

II.4. Research on crime trends

There has been a wide variety of models put forward to explain crime trends. These range from very broad theories like the effects of war, or urbanization to specific theories like the opportunity to commit crimes, for example, the availability of unattended homes, or unlocked cars. Gurr (1981), Shelley (1981), and Mukherjee (1981) summarize many of these theories, and the opportunity theory is developed in Cohen and Felson (1979), and Cohen and Land (1980) and applied to Swedish data in Stock (1982). Wolpin (1979) analyzed a number of time-series for California, England & Wales, and Japan, and found evidence of environmental and cultural influence on crime rates. There

has also been an interest in discovering which socio-economic variables help in forecasting, Fox (1978).

Time-series analysis has been utilized to test specific hypotheses, for example the effects of new laws, or seasonal effects on crime. In particular, almost all the following studies have used ARIMA models (Box and Jenkins, 1976), mentioned previously and which are described below. Time-series analysis is particularly relevant in the study of the deterrent effects of new laws or stricter police enforcement because of the question of causality, and the need to examine the temporal patterns before and after an intervention. A number of studies has examined the impact of drinking and driving laws, for example, Ross, et. al. (1970), Aaronson, et. al. (1978), Ross (1982), and Phillips, Ray and Votey (1984). While there is sometimes evidence of some deterrent effect, there are a significant number of methodological problems, and it is not easy to arrive at firm conclusions. See for example Cohen (1984) and the rejoinder of Phillips, Ray and Votey following it. Gun control has been another subject of such analysis, for example, Zimmring (1975), Deutsch and Alt (1977), and Deutsch (1981). Again, there are methodological problems in interpreting the conclusions. See Hay and McCleary (1979) for a comment on the Deutsch and Alt paper, and the rejoinder following it. Glass, et al. (1975) attempted to assess the efforts of a neighbourhood crime prevention program (Project Whistlestop), again using time-series analysis. McDowall and Loftin (1982) discuss the problems of causality and ways of testing for it. McCleary, et. al. (1982) utilize time-series analysis to explore the relationship between changes in organization structure and crime rates.

The issue of seasonality and crime has also been raised, with the hypothesis that some crimes may be easier to commit during particular seasons rather than others and here too, time-series analyses are particular suitable. However, the results are again perplexing in general. While there are clear findings of seasonality variations in crime rate (Banks and Vatz, 1976; Lamp 1983), and in the imprisonment rate (Moitra, 1977), it is rather difficult to interpret them theoretically. Vigderhaus (1978) found a seasonal pattern in homicide rates but found they were associated with unemployment for only long cycles.

McPeters and Stronge (1974) using a different method (spectral analysis) also found seasonality as well as very short periodicities, but offered no theoretical interpretation.

II.5. Assessment of the current state of research and extensions needed

In light of the relatively little empirical research done so far, it would be useful to further explore the hypothesis of the stability of punishment by examining the time series of the imprisonment rates of other countries, and even separate jurisdictions within a country. If stability is generally prevalent, the theory itself could then be further developed to include explanatory mechanisms. If stability is mostly absent, it would be of interest to examine the trends and variations in the imprisonment rate to see if they can be explained in terms of other variables. It should be remembered that in studies where the crime rate was used to explain or predict imprisonment rates, aggregate rates were used. It would be of interest to examine the relationship between crime and imprisonment by crime type. In addition, we need to investigate the impact or other socio-economic variables on both the crime rates and imprisonment rates. This would help in the development of criminological theory, and if done across countries, of comparative criminology. International comparisons provide insights into the effects of cultural and socio-economic variables on crime and the response of criminal justice systems. Further, similarity of temporal patterns or responses by different criminal justice systems would suggest groupings of different societies or jurisdictions. Such groupings were found for example among the states of the USA (Blumstein & Moitra, 1979). Such findings in turn should help in developing comparative theories of criminology and the criminal justice system. The issue of adaptation within the criminal justice system also needs to be studied further. Crime, arrests, convictions, and imprisonment rates represent respectively a response of some component of the criminal justice system, and we need to observe the relationships between them to see where adaptations take place, and how the different components of the criminal justice system respond to changes.

The results of time-series studies have a number of important policy

implications. For example, whether new laws or law enforcement methods are effective or not is important for future policy making. The issue of deterrence is particularly relevant given the concern over crime, and we need more time-series analyses to better estimate its effects before we develop policies. In planning at any level in the criminal justice system, we need some forecasting. Decisions on resource allocation (for example, building new prisons), also depend heavily on projections. Finally, if there is indeed stability in the imprisonment rates and evidence of adaptation in the criminal justice system, time-series analyses of crime and conviction rates for the different crime types may help in developing more systematic sentencing policies, taking organizational and other constraints into account.

Going beyond the issue of general long-term stability, we need to examine the temporal patterns in crime rates and imprisonment rates. Such patterns would include fluctuations, short term trends, and cyclic patterns or periodicities. By fluctuations, we mean sudden, relatively large changes. These are of course quite common in time-series data, and they sometimes arise from random or accidental factors and sometimes as a result of sudden changes in society or in technology. Thus, it is of interest to note such fluctuations and attempt to find explanations for them. In criminal justice systems, such fluctuations could also arise from policy changes, which are also important to note.

Trends represent consistent and steady changes and can be either long term or short term. Mukherjee (1981) makes an useful distinction between these two types of trend. Further, in terms of the kinds of social factors and mechanisms involved, long term trends naturally require several decades of observations, and if found, negate the hypothesis of stability. Short term trends are quite compatible with the hypothesis of stability, but still require explanations. Periodicities are another form of temporal patterns, and again, it is important to investigate them, both in order to attempt explaining them in terms of cyclic variations in other socio-economic factors, and in order to make more accurate projections. In summary, analyzing temporal patterns in crime data can give us a more accurate picture of past criminality in a society; it gives us a clearer perspective on the current level of

criminality in that society; it can suggest possible explanations of and correlates to crime; and it can guide us in the development of future policy.

III. RESEARCH OBJECTIVES AND HYPOTHESES TO BE EXPLORED

III.1. Overview

The research reported here addresses a number of specific issues and hypotheses about the temporal patterns in criminal justice statistics. First of all we extend previous explorations of the stability of imprisonment hypothesis to a number of other countries. This is an important step, since previous studies have been limited to very few countries, and to truly generalize stability of imprisonment hypothesis, it is necessary to test for it across a variety of different societies. To this end, we explore the stability hypothesis for various European countries as well as Australia and Canada. This will reveal how prevalent stability of imprisonment actually is, and will thus identify those countries that exhibit stability and those that do no. As discussed above, the hypothesis of stability of imprisonment has a number of theoretical and policy implications. Essentially it is the simplest starting hypothesis (analogous to the null hypothesis) in that it postulates no change. This in itself calls for an explanation, and for those countries where imprisonment is indeed stable, theories need to be developed to explain this stability. Such theories should also explain why other countries do not have stable imprisonment rates. However, before such theories can be developed, countries have to be identified according to whether or not they exhibit this stability, and this research is concerned with this issue.

In the case of the U.S., such an analysis has been carried out for the individual states as well, and here we wish to extend such an analysis, that is, a comparison of imprisonment trends in different but related jurisdictions, by comparing the different states (Länder) of West Germany. Such an analysis will also be useful in identifying similarities and differences in the imprisonment trends in these states in a systematic way. For example, in the U.S., distinct and understandable groupings were found from the analysis, and a similar analysis for West Germany would help both in understanding imprisonment policy in the different states, and also in comparing the patterns with those of the U.S. states. To this end we do a time series analysis of imprisonment rates of West Germany and its individual states and

compare the results with the U.S. and some selected U.S. states.

Next we examine trends in the crime rates, as well as in the arrest and imprisonment rates. This allows us to examine the relationships between these variables and helps us to understand the response of the different components of the criminal justice system to changes in crime rates. In particular, we examine the relationship between the crime rate and the imprisonment rates, since as we have seen, a number of hypotheses have been proposed that involve the relationship between crime and imprisonment.

The past findings of little direct or consistent relationship between crime and imprisonment could be explained by a number of factors. It could simply be that crime rates and sentencing rates are driven by very different variables, with, for example, crime being driven by the prevalence of economic inequality or the opportunities to commit crimes, and sentencing policy by the perceived unemployability of convicted offenders, or by prison capacity. Alternatively it might be that increases in the aggregate crime rate may be mostly due to minor crimes which are not punishable with imprisonment. Or it is possible that increases in crime (at least in the U.S.) were caused by juvenile delinquency as a result of the baby boom (Fox, 1976); Blumstein, Cohen and Miller (1980). These juveniles could not be sent to prison and thus would not be reflected in the imprisonment rate (until much later, and only if they persisted as adults). An increase in the individual offending rate could also have a similar effect, since the same people would be committing more crimes but would be counted only once when imprisoned. In a similar vein, it must be remembered that the sentencing rate or the imprisonment rate reflects only those who are caught and punished. If the crime rate is driven by those who evade arrest and/or conviction, crime rates and imprisonment rates would again be uncorrelated. An observed lack of relationship could also be caused by changes in police recording or classification practices, for example, if the police began to record less serious crimes more frequently, or began to classify reported crimes in a different way.

What is clear, however, is that while the crime rate has gone up

sharply in most countries, in no case has imprisonment gone up to the same extent. That is, the imprisonment rate has always been more stable relative to the crime rate. Since arrest and conviction rates have also increased sharply, including those for serious crimes, it suggests that the criminal justice system may have adapted to these increases by focusing prison sentences on the more serious crimes and imposing non-prison sentences on the less serious crimes. To explore whether there is adaptation in the criminal justice system, or whether any other relationships exist between crime and sentencing, we need to examine the time series of these rates disaggregated by crime type. It is not enough to consider violent crimes and imprisonment, since some crimes included in this category may not be punished by imprisonment while many non-violent crimes are. Thus there would be no reason to expect any close relationship between violent crime and imprisonment rates. It is necessary to take individual crime types as disaggregated as possible, since sentencing policy is different for different crime types, and sentencing may well have different impacts on the incidence of different crimes. For example, it may deter some crimes but not others. Therefore different relationships may well hold for different crime types. For some crime types there may well be a close relationship between the crime and sentencing rates, while for others there may be none, or even a negative one, if indeed there is adaptation or deterrence. Therefore, before concluding that there are no clear relationships between crime and imprisonment in general, we should analyse the rates for individual crime types to see if any meaningful relationships exist at the disaggregated level.

Using the series analysis we can explore alternative hypotheses about the relationships between crime and imprisonment rates for different crime types. Broadly speaking, we can distinguish between four hypotheses. **One hypothesis** is that **imprisonment** would be **directly related** to **crime rates.** If the probabilities of arrest, prosecution and conviction remained constant, we would expect that an increase in the crime rate will result in an increase in the sentencing and imprisonment rate. This relationship of crime rates driving imprisonment is what we would expect if the criminal justice system was responding rationally to changes in crime and can therefore be called the "rational response" hypothesis. Under this hypothesis, the crime

rate would be positively correlated with subsequent sentencing. That is, we would find positive correlations between sentencing or imprisonment rates and lagged crime rates (since crime rates are influencing or driving sentencing rates), and we will call such lags positive.

A **second hypothesis** is that **imprisonment** has **criminogenic effects.** This supposes that offenders become more crime prone after being in prison and therefore when these prisoners are released, their increased criminal activity will cause the crime rate to go up. This is a case where (prison) sentencing would drive future crime rates. This hypothesis can also be examined through time series analysis, and we would expect that in this case crime rates would be related to past sentencing rates. That is, we would get positive correlations with sentencing lagged behind crime (since in this case, sentencing is driving crime), and we will refer to such lags as negative lags.

The **third hypothesis** is that of **deterrence**, which presumes that greater punishments (for example, increased sentencing) will deter both the punished and potential criminals, and will thus reduce the crime rate. This is also a case of sentencing driving crime, but in this case the correlation would be negative, since crime would decrease as sentencing increased and vice versa. Under this hypothesis, we would expect the crime rate to be negatively correlated to past sentencing, that is, sentencing will lag behind crimes (negative lags).

The **fourth hypothesis** is that the criminal justice system **adapts** to **changes in the crime rate.** This hypothesis was suggested by Blumstein and Cohen[18], and Biles also found it to be the most plausible explanation for his findings. It considers the capacity of the criminal justice system to be constrained, and if the crime rate increased beyond a certain limit, the workload of the system will exceed its capacity, and it will not be able to respond as before. For example, if crime rates increased sharply, the system may not be able to make arrests, press charges, get convictions, or sentence convicted offenders to prisons at proportionately higher levels, and would adapt by focusing more on the relatively serious crimes, and paying less attention to the relatively minor crimes. Such an adaptation could take

the form of the police making fewer arrests for the minor crimes, prosecutors not pressing charges, or judges imposing non-prison sentences. An example of such a capacity constraint is that of prison space. Faced with a greater number of convicted offenders, judges would presumably continue to sentence the serious offenders as before, and then, with insufficient prison space left, would tend to impose non-prison sentences on the less serious offenders. Under this hypothesis, crime rates would be driving sentencing and the rates would be positively correlated for the more serious crimes, but would be negatively related for the less serious crimes, because due to lack of prison space, the sentencing rate for these offenses would decrease, even as their incidence increased.

It is important to be cautious at this point in concluding that a particular, empirically obtained relationship implies that a particular hypothesis is valid. There are inevitably too much shortcomings in the data to make such conclusions. Rather, we can only suggest that a particular hypothesis would **correspond** to a certain empirically observable pattern. However, that observed pattern would not be unique to that hypothesis because there could be other confounding factors which might also produce a similar pattern.

While there have been a number of hypotheses put forward to explain crime rates and imprisonment rates in terms of other socio-economic variables, the empirical exploration of these hypotheses have been limited to only a few countries, and very little comparative analysis has been undertaken. One major study that does address these issues (Mukherjee, 1984) focusses on Australia and makes some comparisons with the U.S. But another problem with previous studies has been the fact that they tend to use aggregate data, and as we have noted, relationships will very likely be different for different crime types, and it is essential that we examine these explanatory models by individual crime type, to explain either crime rates or imprisonment rates. In this study, we focus on West German data, and explore and develop a variety of models expressing the relationship between the crime or imprisonment rate on one hand, and other socio-economic variables on the other. We then compare these results with those obtained for Australia and the U.S. Throughout we attempt to mainfain

a comparative perspective, and try to compare temporal trends in as many different countries as possible, within the (often severe) limitations of availability and comparability of the data. The main limitation here is the availability of data at the required level of disaggregation. Such data is generally unavailable, but it was possible to collect the necessary data for West Germany. It was also possible to collect similar data for California, the United Kingdom, Australia and (to a lesser extent), for Finland, Norway and Sweden. Thus our analysis of the relationships between crime rates and imprisonment rates for individual crime types will be limited to these countries.

III.2. Outline of Book

In Part 2, we examine the crime, arrest, and imprisonment rates of West Germany, to explore the issue of stability in imprisonment, and other patterns of variations in the time series of these variables. We analyze the rates for West Germany and some selected individual states (Länder), and compare the findings with the U.S. and some selected U.S. states. Then we proceed to explore the relationships between the crime rates, arrest rates and imprisonment rates for the Federal Republic of Germany and California (since California was the only U.S. state for which the author could get the necessary data).

In Part 3, we analyse trends in criminal data from other selected European countries, and Australia, compare them with Germany. In pursuing our objective of comparing criminal justice trends, we would like to extend our analysis to as many countries as possible. But as noted above, the data must be available and comparable. For these reasons, the West European countries are a natural group to investigate, since substantial data from some of these countries are available from published reports, and, although of course different in many ways, they are linked by similar cultural, social, and bureaucratic traditions (at least much more so than any other group of countries), and this makes the trends in their crime data reasonably comparable. For the same reasons, Australian data are also comparable, and we particularly wish to include Australia since detailed data for it are available, and similar analyses have already been

done with them.

Part 4 focuses on exploring and developing explanatory models for crime and imprisonment rates in West Germany in terms of other socio-economic variables. In the next section we describe the data analysed in this research, and the methodologies employed.

IV. DATA DESCRIPTION AND METHODOLOGY

IV.1. Description of the data collected

Since the aim of this project was to study the temporal patterns in criminal justice statistics for the Federal Republic of Germany, the U.S., and other European countries, and to understand the response of their criminal justice systems to changes in crime rates over time, data were needed on crime rates, arrest rates, conviction rates, and imprisonment rates over time[19] and since this involves time series analysis, the data should be over as long a time period as possible. Also, since the patterns vary by crime type, and since the response of the criminal justice system is different for different crimes, data disaggregated by crime type were essential, in addition to aggregate national data. As mentioned earlier, such data are not generally available for most countries. In undertaking this project, strenuous efforts were made to collect as much of such data as are publicly available. In addition, data were sought from various official agencies wherever possible[20]. This project was undertaken at the Max Planck Institute for Foreign and International Penal Law, and most of the data analyzed here were collected directly from the publications in the excellent library of the Institute[21]. Thus, all the data are obtainable from public sources, and hence are not reproduced here.

For the Federal Republic of Germany, data were collected on crime rates, arrest rates, and imprisonment rates by individual crime type. Data were also collected on conviction rates, prison capacity, and prison admission rates at aggregate levels, but it was not always possible to utilize these data in the analysis carried out in this project. Aggregate crime rates were collected for the country as a whole as well as by crime type. The aggregate and individual crime rates were also collected for each state (Land). The aggregate crime rates for the Federal Republic of Germany were available from 1953 to 1983, while disaggregated data were available from 1955 to 1983. For the individual states, the first year for which data was available varied from one state to another[22]. It was not possible to consider every single crime type, because for one thing, the level of disaggregation varied over the years (the tendency being to report

data at more and more disaggregated levels over the years), and also, some new crime types appeared from time to time. More importantly, not all crimes were equally significant. Since we were interested in the response of the criminal justice system, we took into account crimes that were either relatively serious or, which accounted for a significant proportion of the imprisonment rate[23].

Time series data for arrest rates were obtained for the whole country for the same years and for the same crime types as for crime rates. However, disaggregated arrest rates for individual states could not be obtained[24]. It was difficult to get conviction data for analysis for a number of reasons. First of all it was not reported in disaggregated form in the earlier years, and it is necessary to have reasonably long time periods for this analysis. Secondly, even when reported in disaggregated form, the crime categories do not match with either the police statistics on crime and arrests nor with prison statistics on imprisonment rates. Thirdly, the crime classification system changed sometimes, thus rendering earlier statistics imcomparable with later statistics. For this reason, relatively little analysis was possible with conviction rates[25].

Time series data on imprisonment rates for the whole country were also obtained; both the aggregate and for individual crime types. Actually, two aggregate rates are reported for the prison population. One is the total prison population and the other is the sentenced prison population. The total prison population includes the sentenced population plus those incarcerated for public safety or for investigation. The disaggregated data thus relates to the sentenced population, but the time series of the total prison population is also discussed here. These data are available from 1961 to 1983[26]. There were, however, a number of problems that had to be resolved before the imprisonment data could be analyzed. There were some changes in the reporting system, but they did not affect the time series analysis seriously since they were mainly changes that occurred only once, between one year and the next, with following years having a consistent system. The one major change that did affect the analysis, was a policy change in 1971 when convicted offenders who would have received a prison sentence of less than six months, no longer went to prison but were fined instead.

This policy change naturally had a significant effect by drastically decreasing the prison population. One point to remember about these imprisonment figures is that they are reported for one day of the year, January 1. However, the prison population on this day is artificially low, because a number of prisoners are allowed leave to visit their families over Christmas and New Year. However, though the absolute number is lower than that during the year, the reduction is quite systematic from one year to the next, and thus the results of the analysis are not altered. The overall temporal pattern is the same.

Another difficulty that arose in analyzing the time series of sentenced population was that there were difficulties in comparing the crime categories with those in the police statistics. There were two problems here. One is that even when no changes occurred in the classification scheme, it was sometimes difficult to ascertain which categories in the prison reports corresponded to which categories in the police reports. However, these were eventually resolved[27]. The second kind of difficulty arose when the classification system changed at some point in time. This happened for example in the cases of burglary and fraud and rape. It was possible to resolve them for burglary and fraud by combining fractions from different categories[28], but even this could not be done for the rape statistics, and for this reason, rape had to be ommitted from this analysis.

Finally, the prison capacity and the aggregate prison admissions were obtained for the whole country and for each state from 1961 to 1983. Unfortunately, the data on prison admissions is not reported in disaggregated form before 1973, and thus could not be analyzed.

The data analyzed for the U.S. were simply the crime rates from the Uniform Crime reports (1963-1983) and the imprisonment rates[29]. In general, it is difficult to obtain disaggregated imprisonment data for the U.S. but California reports prison admissions disaggregated by crime type, and these were used in the analysis[30].

Attempts were made to obtain data from other countries as well. However, due to difficulties of availability as well as limitations on the time available, the data discussed here had to be limited to the United

Kingdom, Australia, Finland, Norway, Sweden and Austria[31]. Particularly good time series data for Australia is available in the Sourcebook of Australian Statistics by Mukherjee, et. al. (1981).

IV.2. Issues in comparative analysis in criminal justice

At the expense of repetition, it is worth emphasizing again the need for comparative studies in criminology and criminal justice. Since many theories about crime and criminality are based on social variables, it is obviously important to compare crime and criminality across different societies to observe the effect of variations in social factors. Even theories that suggest social variables do not influence crime should also be tested across different societies to check whether indeed it is so. It is only through such empirical research on criminality in different societies that relevant theories can be developed and verified. An initial step in comparative criminology should be an analysis of trends in crimes and other criminal justice statistics of different countries. This would allow us to identify and group countries that have similar patterns in these trends. It would also allow us to group countries according to the kinds of responses they have made to changes in crime rates. If two countries with similar crime trends also have time series for their imprisonment rates, that might suggest that the criminal justice systems in the two countries have responded similarly, or that similar societal processes are at work. If on the other hand, the two countries have widely different time series for their imprisonment rates, then that would suggest that their responses were quite different.

Such an identification of groups of countries, or groups of regions (for example, states) within a country, would help in understanding crime and criminal justice systems by focussing attention on what factors are similar within each group, and also on what factors differ systematically from one group to another. It is precisely this kind of knowledge that is needed to further develop theories and understanding of criminal justice systems and their influence on crime.

However, important as comparative analysis is, it is also necessary to be aware of the variety of problems that inevitably arise in com-

parative studies. The first problem that arises in comparing criminal statistics is that the definitions of criminal acts vary from one society to another. Some acts that are considered criminal in one society are not considered so in another society. Further, in the same category of deviant behaviour, just where the threshold of criminality is set varies from country to country, and sometimes even from region to region. Then of course, even within the set of criminal acts, different legal systems classify crimes differently. For example, what might be considered as an aggravated assault in one jurisdiction, may be classified as a simple assault in another. Or what is recorded as a larceny in one jurisdiction may be classified as a petty offence in another, or may not even be officially counted[32].

With regard to official statistics, it is useful to introduce the distinction between reported crimes and recorded crimes. Reported crimes refer to those crimes reported **to** the police by the public; recorded crimes are those that are officially recorded **by** the police and which form part of the official statistics. The distinction is important because reporting habits vary a great deal between different population groups, and also by type of crime. For example, serious crimes are reported far more often than minor crimes; also people in one society may report minor crimes (like theft) more often than those in another society. These reporting rates can be investigated only through victimization studies, since official statistics cannot reflect those crimes that are unknown to the police.

Recording practices by the police can vary enormously from country to country, and this introduces yet another disparity in the statistics from different countries. One source of this disparity is the discretion exercised by the police on whether to record crime or not. It may be that in some countries (or regions) the police are under pressure to record all reported crimes, verified or unverified. In other countries the police may not record acts (without verification) when they seriously doubt that they took place. In countries where the police tend to rely more on informal procedures (cautioning, or talking to parents of juvenile delinquents), they may also choose not to officially record all reported misdemeanours. Such discrepancies in police behaviour will clearly influence police statistics, and any comparative

analysis should take this into consideration. A second source of disparity is the discretion police have in classifying criminal acts. The same act may be judged to be one type of crime in one jurisdiction, and another type in another jurisdiction. Or police of different countries may include rather different acts under the same category[33]. It is important to remember this point, since quite small differences in recording habits can have a very big difference in police statistics even when there is no difference in the distribution of criminal acts committed in two societies. For example, if serious thefts are classified as thefts in one country and as robbery in another, it would artificially inflate the robbery rate in the second country relative to the first, especially if (as is usual) thefts are much more prevalent than robbery. Thus, the traditional recording behaviour of different police forces need to be considered alongside the police statistics. Finally, the process of transfer of the contents of the "rap- sheet" records in individual police stations to national statistics should also be considered, since the process varies considerably from one country to another, as does the accuracy, both partly influenced by the technology used. A related problem is that the compilation of the national statistics is done typically by a central agency (The FBI for the U.S. and the Bundeskriminalamt in Wiesbaden for the Federal Republic of Germany), and this agency has to depend on (sometimes voluntary) compliance by local agencies to their requests for data. Thus for example, the earlier Uniform Crime Reports lack data from many localities, particularly rural ones. As a result, they reflect urban crime rates more than national crime rates as a whole.

Sometimes arrest and clearance statistics are given separately for adults and juveniles. In such cases it is important to note the cut-off age for juveniles, that is, the age from which they are considered adults. These cut-off ages vary across countries, and Germany for instance has three groups, adults (ages 21 and over), "young adults" (ages 18 to 20) and juveniles (17 years or younger). Differences in these cut-off ages can be particularly significant when comparing court or prison data, since some countries may have laws prohibiting juveniles of certain ages being tried in (adult) courts or sent to (adult) jails and prisons, while in other countries, juveniles of the same age are tried as adults and sentenced to prison. In such cases,

the court cases and the imprisonment rate will be artifactually higher in the second group of countries. When comparing data from countries with such differences, some correction should be made before any conclusions are drawn.

The differential use of various forms of detention centers must also be explored. Convicted offenders (and sometimes suspects) can be held in jails, prisons, juvenile institutions, half-way houses, or mental institutions. Different countries have very different practices of detention, and looking at the population in one type of institution may result in a very biased picture. For example, the jail population in the U.S. is relatively large (almost as large as the prison population) and thus the prison statistics do not fully reflect the total number of people incarcerated. A related issue is the differential use of fines, probation and parole as further alternatives to incarceration. All the available options, and their differential uses should be considered for each country that is included in a comparative analysis of incarceration rates.

The above points merely summarize the main sources of possible errors that could arise when criminal justice data are compared across countries. There are of course many other sources of errors. In particular, in doing time series analyses, changes in the reporting systems for official statistics must be identified. For example changes in the classification of crimes, in the grouping of crime-types under the various categories, or changes in the compilation system of the statistics, all can have significant effects on the results of time series analysis. A one-time change will generally not have much impact, but successive changes may introduce an apparent instability in the data when in fact conditions have remained stable. Similarly, changes in the reporting behaviour or in the recording behaviour of the police can also have a major effect on time series analysis. Increasing willingness on the part of women to report rape, can appear as an increase in the crime rate for rape, or more detailed record-keeping by the police through computerization of their operations, may result in more petty offences being recorded, even if their commission rate remains stable. Finally, changes in statutes or sentencing practices or parole decisions can also have an impact on time series data. Thus,

the best solution in time series analysis is to examine the data graphically first, identify possible discontinuities in the time series, make appropriate corrections, and do the simpler analyses first, before jumping into any sophisticated statistical analysis.

While these obstacles to comparative studies in criminal justice may seem quite formidible, it is still possible to do a great deal of such research provided one proceeds carefully and attempts to alleviate these problems. Also, one's conclusions should be qualified appropriately, and policy recommendations should be made with due care. As a first precaution one should limit such studies to societies that are reasonably comparable. For example, the western industrialized countries have similar enough cultural, social, political, and legal traditions to make comparisons among them meaningful. Many of these countries also have relatively detailed and well-defined criminal justice data. Thus data from these countries can be analysed with some confidence, and differences in definitions, collection and reporting methods can be identified and taken into account. For these reasons, data from the U.S., the Federal Republic of Germany, and other selected West European countries were collected and analysed. Canada and Australia were also included since they are very similar to these countries, and because there are detailed data for Australia over a large number of years[34].

Selecting similar countries with workable data is one way in which we have attempted to reduce the problems of comparison. Furthermore, attempts were made to identify similar crime types and label or group them accordingly so that there is reasonable uniformity in the classification used here. For example, when we discuss robbery here, we are discussing a group of crimes that are defined similarly, even though individual countries may categorize or group these crimes differently.

More importantly, however, the methodology used in the research reported here focusses on **models** of temporal variations of criminal justice indicators, and not at all on the raw numbers or even rates. That means that the analysis is concerned with the **patterns** of change over time of crime rates, or arrest rates, or any other criminal justice variable, rather than with the absolute values of these variables.

The advantage of such an approach is that while there may be many reasons why the absolute values cannot be compared, the patterns of change can certainly be compared with greater validity. We develop models to fit these patterns of change, and then see if these models are similar or not, and whether there are groups of countries that have similar models. In this research we also investigate such time series models to see what kinds of relationships exist between different criminal justice variables (for example, between crime rate and imprisonment rates) in the same country, and then we can observe the different kinds of relationships that exist between different variables for different crime types and also across different countries. This gives us the opportunity to observe both similarities and differences between countries (or states within a country) in their temporal patterns for crime rates and the responses of their criminal justice systems to changes. We wish to arrive at a better understanding of the temporal changes in criminal statistics, and how criminal justice systems in different countries have responded to them. To this end, we employ a variety of time series analyses, and it is to a discussion of the methodology that we now turn.

IV.3. Methodology

There are now a variety of methodologies for doing time series analysis, but here we shall be using only a limited number based on relevance to the investigation, and applicability to the data available and to the analysis desired. It should be remembered that an important aspect of this study is the comparative approach, and our emphasis will be on whatever method provides the most insights into the comparisons. The most basic analysis in time series is to plot the data and inspect them visually. While this graphical approach is the most elementary, it can actually be the most important in time series analysis. It provides an overview of the patterns of variation (cycles, trends, changes in trends etc.), it can often point to possible discrepancies in the data (inexplicable jumps in the levels, sudden changes, obviously incorrect values or trends, etc.), it can indicate possible pitfalls in using certain methodologies, and it can guide us to the most appropriate statistical analyses. Graphical analysis is also very useful in comparing different time series, especially when there

are more than two. Visual inspection is thus an essential first step. Very often it is also the most appropriate analysis in comparing time series, and in fact we shall be doing mostly descriptive analyses here, rather than relying on the various sophisticated statistical analyses.

Probably the most common statistical procedure for analysing time series is regression. Im simple regression, the criminal justice variable of interest would be the dependent variable, and time would be the independent variable, while in multiple regression, other independent variables would be included[35]. The significance of having time as an independent (or explanatory) variable is not that we suppose time by itself to influence the dependent variable, but rather we are taking time as a proxy for changes in other variables that might be influencing the dependent variable. Such a regression model is useful to explore linear trends, that is, fairly steady increases or decreases in the crime rates, or arrest rates, etc. The slope of the regression line (in simple regression; the coefficient for time in multiple regression) would give the long run rate of change in the criminal justice variable being considered. In particular, regression can be used to determine whether or not the trend is significantly greater than zero, in order to explore the existence of stability. The absence of any significant trend would of course conform to the hypothesis of stability, although there can be cases where regression results are misleading, and in fact, regression has only limited use in time series analysis for a number of reasons. First of all, time series data have a high degree of autocorrelation, and while corrections can be made, it can still be a problem. Secondly, if there are periodicities or other non-linearities, then the assumptions of linearity in regression are violated and regression can give misleading results. In some cases, this can be overcome by transforming the data, but constructing and justifying a suitable transformation is generally very difficult or impossible[36]. In some cases, data with non-linear trends can be partitioned into shorter intervals, each with linear trends (spline analysis)[37]. This would be appropriate in cases where the time series exhibits step changes or turning points[38]. These could well be very significant aspects of the temporal patterns, and should be carefully noted and interpreted. Perhaps such changes could be related to identifiable changes in other variables which could lead to their

explanation. The importance of such analyses lies in the fact that different factors may be significant as explanatory variables at different points in time, as Mukherjee (1981) has shown. Thus it might be worthwhile do undertake such an analysis, but then we may end up with intervals too short for any meaningful results. Thus, while we shall occasionally use regression, it will not be very often.

To explore the relationship between two time series, the most useful approach is to estimate the correlation between them. The correlation is a measure of how closely changes in one time series are related to changes in the other[39]. But the correlation is not always very reliable in that there can be spurious correlations arising from artifacts in the data, or through the effects of some other unobserved variable. However, correlations can be used to explore causal relationships between two variables. This is done by lagging the causal variable behind the variable it is hypothesised to influence. Thus we can explore how the value of the causal variable influences subsequent values of the other variable. This analysis can be done in both directions to explore causal relationships going both ways. The results in general will not be symmetric, but will reveal asymmetric causal links.

The range of values that the correlations would take for different lags under each of these hypotheses is shown in Figure 1.1. The top right quadrant, corresponding to positive correlations for positive lags (crime driving imprisonment), represents the rational response hypothesis. That is, if the rational response hypothesis were true, we would expect to see significant correlations in this quadrant. The top left quadrant, corresponding to positive correlations for negative lags (imprisonment driving crime), represents the criminogenic hypothesis. Under this hypothesis, we would expect significant correlations in this area. The bottom left quadrant, corresponding to negative correlations for negative lags, represents the deterrence hypothesis, since we would expect significant correlations here if increasing sentencing rates were followed by decreasing crime rates. The bottom right quadrant, corresponding to negative correlations for positive lags, represents the adaptation hypothesis, since we would expect such correlations for the minor crimes if there was adaptation. (For the serious crimes, we

would expect the rational response). The exact value of the lags (positive or negative), at which significant correlations appear, would depend on the nature and timing of the responses of offenders to the sentencing policy, and of the criminal justice system to crime. Thus for each hypothesis we would observe a variety of different patterns of correlations.

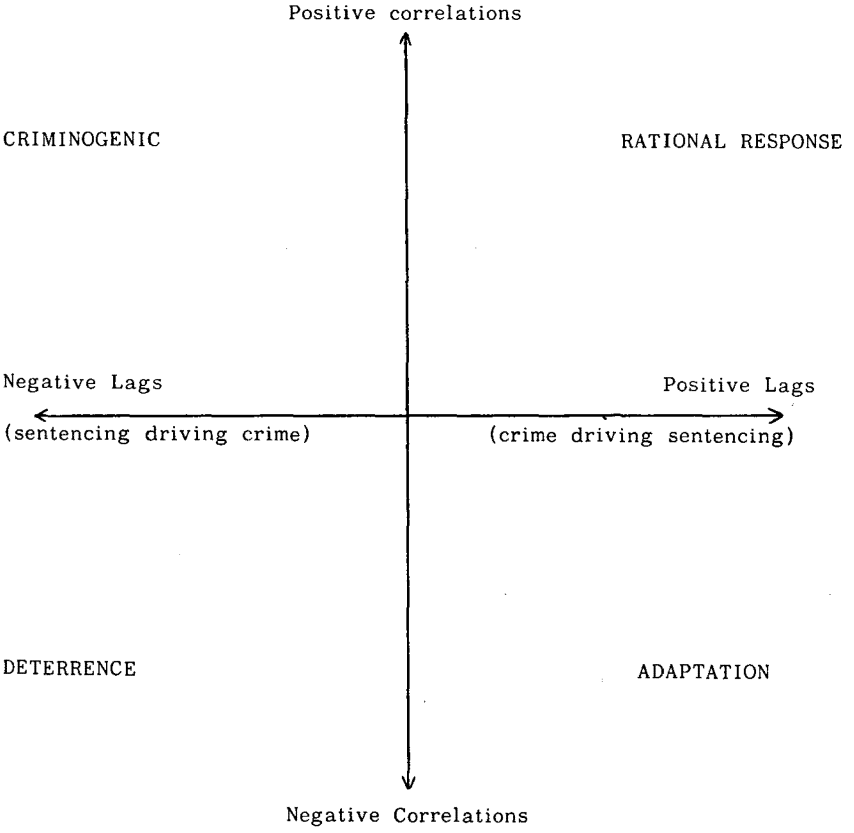
But again, these results should be interpreted with caution since for time series, lagged correlations are often inflated by the autocorrelation that exists in each series. This problem can be corrected for by "prewhitening" both the series, a procedure we shall discuss below. In any case, the main point worth emphasizing again is that the time series should be first plotted before their correlations are interpreted.

In exploring the relationship between two time series, we need to examine the correlations between them at different lags. However, if there happens to be a significant correlation between the series at zero lag, then correlations at other lags will tend to be artificially large because there tends to be autocorrelation within a time series, and thus lagged values of one time series may appear to be correlated to values of another time series, simply because each are correlated to non-lagged values of the first time series. To correct for this, one has to remove the autocorrelation within each series. This process is called filtering or prewhitening. After this process, we may proceed to correlate the prewhitened time series, and these correlations will indicate what causal relations might exist between them[40]. In other words, in order to see how much of the variation in one variable can be explained by another, we should eliminate all the variations in each that can be explained by its own past values[41]. While this is a useful and often necessary procedure, one requires longer time series. In the absence of data over long periods of time, one may have to limit oneself to simple correlations.

The filtering or prewhitening process mentioned above is really the process of fitting a time series model to the data such that the residuals are white noise, that is, normally distributed with mean zero. This process is a general one, and such time series models can be used to analyse and forecast any time series. The models provide a

Figure 1.1

Predicted Regions for Lagged Correlation Values According to Alternative Hypotheses about the Relationship Between Crime and Sentencing Rates.



structure for the time series by relating its value at a point in time to its previous values and to the random fluctuations (or shocks) that it had experienced in the past. There are basically two types of time series models: time-domain models and frequency-domain models. In the research reported here, we shall use only time-domain models (also known as Box-Jenkins models) since both types provide essentially the same information and the time-domain models appear to be more intuitive and easier to interpret. The most general (ARIMA) model comprises three simpler models: the autoregressive (AR) model, the integrative model (I) and the moving average (MA) model. ARIMA modeling is based on the structure of the autocorrelation function and the partial autocorrelation function of the time series. Details of these functions, how they are estimated and how they are used to develop ARIMA models are given in the appendix. The basic idea behind these models is to discover how the observed time series could have arisen from neutral, random fluctuation which are called white noise because they have no special characteristics (or colour). Thus white noise can be thought of as random fluctuations over time with no pattern whatsoever. Then in order to see how the patterns in the observed time series could have arisen from a white noise process, we construct a transform or a filter that would convert a white noise process to the observed time series. The model can be illustrated schematically as

where Ψ is the transform. It is this transform that is the ARIMA model. To describe the ARIMA model we use the following terminology:

The time series is represented by $(z_t: t= 1, 2, \ldots)$
and the white noise process is represented by $(a_t; t= 1, 2, \ldots)$
We define two operators, B and D,

$$B^k z_t = z_{t-k}$$

$$D^k = (1-B)^k$$

then the AR process (of order p) is given by

$$z_t - \phi_1 z_{t-1} - \phi_2 z_{t-2} - \cdots\cdots\cdots - \phi_p z_{t-p} = a_t$$

or,

$$z_t - \phi_1 B z_t - \phi_2 B^2 z_t - \cdots\cdots\cdots - \phi_p B^p z_t = a_t$$

or

$$\phi(B)\ z_t = a_t$$

where ϕ (B) is called the autoregressive operator.

The interpretation of the autoregressive process is that it is a weighted linear sum of a limited number of its past values, and the current shock a. Since z is regressed on its own past values, it is called an autoregressive process. An example (from Granger and Newbold, 1977) of an autoregressive process of order 1 is where the total number of unemployed people in a given month is a fixed proportion of those unemployed the previous month (the rest having found jobs) plus a new group of people seeking jobs. This new group corresponds to the random fluctuation or shock, and thus these additions form the white noise series.

The moving average process is given by

$$z_t = a_t - \theta_1 a_{t-1} - \theta_2 a_{t-2} - \cdots\cdots\cdots - \theta_r a_{t-r}$$

or

$$z_t = \theta(B)\ a_t$$

Here θ (B) is the MA operator, and is of order q. Thus in the moving average model, it is the past values of a_t, that is the random shocks, that are responsible for the current value of z_t, and since the a_t's alter or move the average value of the series, the process is called moving average. An economic interpretation of this process could be in terms of some economic variable which is in equilibrium, but is moved from equilibrium by a series of buffeting effects from unpredictable

events. If the effects of these random shocks are not absorbed immediately, but rather have residual effects up to the next q time periods, then such a process would give rise to a moving order process of order q, (Granger and Newbold, 1977).

Finally, the process giving rise to the time series could be non-stationary, that is, its level shifts. This would of course be the case when the process is not stable, and in these cases, the time series should be differenced, that is, the differences between the successive values should be taken rather the original values. This can be represented as

$$Dz_t = (1-B)z_t$$
$$= z_t - z_{t-1}$$

Usually after this differencing, the time series will become statinary. However, when there is very strong non-stationarity, as for example, when there is a quadratic trend[42], then the series may have to be differenced once again. In general, a series can be differenced d times by the operator

$$D^d = (1-B)^d.$$

However, in most cases of non-stationarity one or two differencings suffice. The most general ARIMA model can therefore be represented as follows[43]:

$$\phi(B)\, D^d Z_t = \theta(B) a_t$$

or

$$Z_t = \Psi(B) a_t$$

It is this transfer function $\Psi(B)$ that provides important information about the time series, in terms of trends and other patterns and thus the analysis of time series through their transfer function provides valuable insights into their nature, and the relationships between them. We get a model that gives the structure of the detailed pattern

of variations in a time series, and we can group different time series according to whether they have the same structure or not. For example, Blumstein and Moitra (1979) found that there were distinct (and easily interpretable) groupings among the states of the U.S., and we wish to further explore groupings among the European countries and among the states of the Federal Republic of Germany. ARIMA modeling allows for a more dependable test of stability (that is, stationarity or non-stationarity) than regression analysis[44], and we can also avoid the pitfalls that occur in regression analysis when there are periodicities. In ARIMA analysis, the existence of periodicities as well as their time lengths, are easily discernible from analysing the autocorrelation and partial autocorrelation functions. Finally, ARIMA analyses are useful in forecasting, although in this study, we do not attempt to do so. The reason for that is that ARIMA analysis in general, and forecasting in particular, require relatively large time series, at least thirty time periods, and most authors recommend having at least 50 data points. However, in spite of this disadvantage, we will pursue ARIMA modeling in order to arrive at a better understanding of the patterns of variations in the various time series through their autocorrelation and partial autocorrelation functions.

So far we have discussed univariate models, that is, models for only one time series. While comparisons of these models for different time series can tell us which ones are similar to which, they do not tell us much about the relationship between one variable and another. To further explore relationships between the time series of different variables, we shall need multivariate models, or at least, bivariate models, which will allow us to explore the relationships between two time series. These models can be represented as

$$y(t) = \Psi(B)x(t) + e(t)$$

where $\Psi(B)$ represents the transfer function that relates the first time series x(t), to the second (which could be the dependent) time series y(t). The identification of the transfer function is based on the analysis of the cross-correlation function (CCF), which is correlation between two time series computed as a function of the lag between the series. Thus the value of the CCF at lag k is the correlation between y (t) and x (t-k), which is a measure of how closely x (t-k) and y (t) vary together[45]. The transfer function thus reveals the details of

the pattern or structure of the relationship between the two time series and can point to many new aspects of the relationship. For example, it will indicate the lags at which the cross-correlations are significant. This is particularly significant, since the lags can be in either direction, and the CCF is a function of both positive and negative lags. In general, the correlations for positive lags will be very different from those for negative lags, and the significant correlations will indicate the direction of the influence, that is, whether x is influencing y or y is influencing x (since both could be theoretically possible in many cases). Thus these lagged correlations can suggest the direction of causality and the magnitude of the lag, that is, after what time lag does the "causing" variable influence the "caused" variable. Finally the transfer function can indicate the strength of the relationship between two variables at different lags. Thus the interpretation of the transfer function provides us with a great deal of information about the relationship between two variables, and its use will be illustrated mainly with Australian data. The reason why it cannot be applied to other time series very well is because rather long time series are required, and Australia is the only country for which we have comparatively long time series. This brings up another limitation of the use of transfer functions which is that the relationship between the two variables is necessarily assumed to have remained constant over the time period being analysed (since it is the same transfer function that is characterizing the relationship at all times), and this of course is very often not true in public policy. However, as we shall see, we can still discover differences among the relationships between different time series, for example for the relationship between crime and sentencing rates in the case of petty offences as opposed to the relationship in the case of violent crimes.

The analysis of more than two variables through multivariate ARIMA models can be quite complex, and no computer programs are available on any of the standard packages that adequately handle such analysis, so we shall not attempt to carry out such analysis here. However, we shall explore the relationships between several variables through multiple regressions. There are still complications with such regression models, since the conditions under which linear regression should be done are rarely satisfied, but in addition, and especially in criminal

justice, many of the variables could be influencing each other directly and indirectly, rather than a set of independent variables explaining only one dependent variable. For such cases we need to develop structural models to represent the relationships, and these involve simultaneous regression equations involving more that one independent (endogenous) variable, rather than a single multiple regression equation[46]. A simple example of such a model would be

$$A(t) = a + b_1 NP(t) + e_1(t)$$
$$V(t) = a + b_2 NP(t) + b_3 A(t) + e_2(t).$$

Here it is postulated that the arrest rate A depends on the number of police NP, and the conviction rate V depends both the number of police and the arrest rate. Here A influences V directly as well as indirectly through NP. It is important to use such structural equations rather than one single equation because it is very likely that the error term will be correlated with one of the endogenous variables, and thus will lead to biased and inconsistent estimators of the regression coefficients. Secondly, the interrelationships between the endogenous variables are often of substantive importance, and the only way to discover those relationships is through structural modeling. Thirdly, it might often be necessary to estimate the structural equations to distinguish between competing theories, since it is possible that different structural theories could lead to the same reduced form equation[47]. Fourthly, if the underlying structure changes and we wish to predict the effect of those changes, we have to use the structural equations since otherwise the predictions will be wrong and misleading.

Finally, there can be cases where some variables mutually influence each other. An example of that is

$$I(t) = C(t) + X(t) + \underline{Z}(t) + e_1(t)$$
$$C(t) = I(t) + Y(t) + \underline{Z}(t) + e_2(t).$$

Here in the first equation, the imprisonment rate is being influenced by the crime rate, by X, and by a set of variables $\underline{Z}$. In the second equation, the crime rate is being influenced by the imprisonment rate,

by a different variable Y, which is not included in the first equation, and also by the common set of variables $\underline{Z}$. Such a set of equations are called simultaneous equations (because variables are influencing each other simultaneously) and they are particularly important to elucidate causal relationships in regression models. In the absence of the simultaneaty, it is quite possible to infer causality when it is absent and vice versa. Causal analysis can also be carried out using "panel models" when the data pertains to a fixed sample that has been measured two or more times at regular intervals[48].

To conclude this discussion of the methodology, it must be emphasized that it had to be extremely brief and therefore necessarily incomplete. It was simply a quick tour of the models and terminology that will be utilized in the following sections. However, sufficient references have been given to the literature for the reader interested in further reading. It is perhaps worth recapitulating that this is a preliminary analysis, and much further work remains to be done, including the evaluation of the relevance of the models used, and further refinement of the methodology. It is however a start in the direction of using a variety of time series models to examine criminal justice data and comparing the data along several different dimensions. We compare data from different countries, we compare data pertaining to different components within the criminal justice system (for example arrests, convictions, imprisonment), and we compare the temporal patterns by individual crime type. From the broadest perspectives, we wish to arrive at a better understanding of the responses of different criminal justice systems to changes. Such an analysis, on this scale, has not been attempted before, so inevitably there will be mistakes and misinterpretations. It is only to be hoped that the shortcomings of this research will spur others to explore these issues further and develop more complete theories in comparative criminal justice.

Part 2:

THE IMPRISONMENT RATES AND CRIME RATES OF THE FEDERAL REPUBLIC OF GERMANY AND THE UNITED STATES: A COMPARATIVE ANALYSIS.

V. Analysis of the time-series of imprisonment rates:

We begin our exploration of the time-series with the total prison population and the sentenced population in the FRG. These are presented in figure 2.1. From visual inspection, we can see that both can be described by an extended V-shaped curve with a decline during the sixties, a minimum in 1971, and an increase during the seventies and early eighties. The sharp decrease between 1969-1971 that is observed in both cases, is mainly due to a change in the sentencing law and practice where short sentences (less than six months) were largely replaced by fines. For a discussion of this change and its impact see Albrecht (1981, 1984). The subsequent rise in both is partly a reflection of the increased crime rate (discussed later), partly perhaps due to longer sentences, and also partly the result of a higher sentencing rate for drug offences, Albrecht (1986), Dünkel (1984).

However, some differences can be seen in the trends of the two time-series. Between 1961 and 1969, there is a slight but very erratic decline in the sentenced population rate, while the total prison population declines steadily except for a sharp dip in 1966. After 1971, the prison population rose much more sharply than the sentenced population. That is, the proportion of individuals detained for investigation or for security reasons, increased. This can probably be attributed to the availability of extra prison capacity resulting from the decline in prison population. From 1973, the total prison population increased only slightly, while the sentenced population increased steadily and significantly since 1975.

As far as the stability hypothesis is concerned, the time-series for the prison population does appear to fluctuate a great deal. However, the series is too short to make a judgment or a statistical test. It should be noted that the rates are increasing back to levels before 1968, so

Figure 2.1a

Total prison population rates for the Federal Republic of Germany

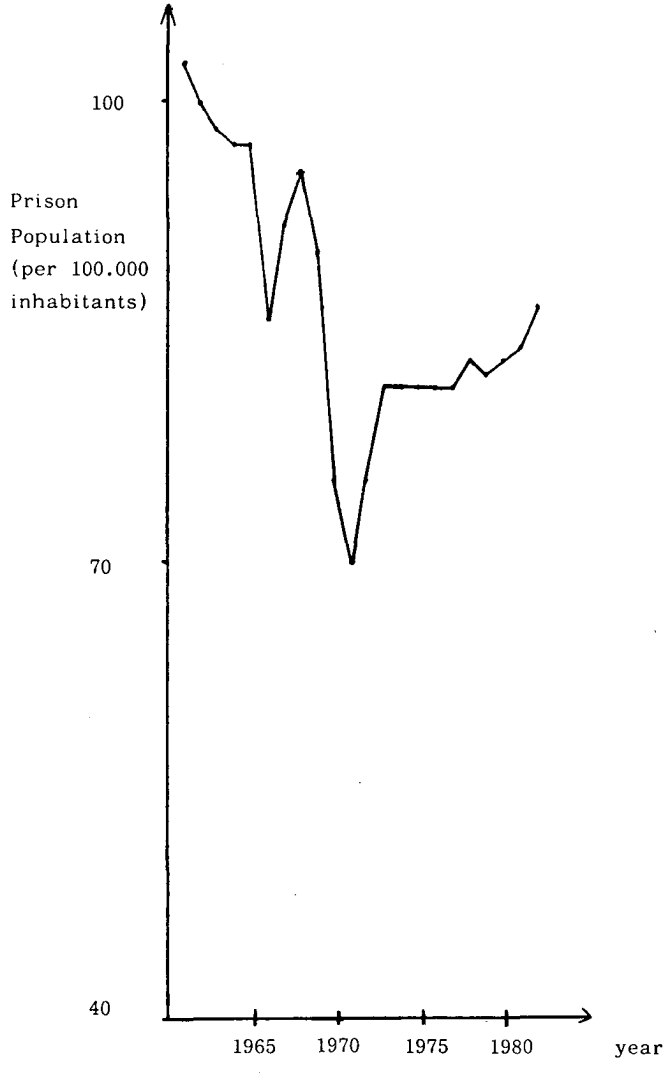


Figure 2.1b

Imprisonment Rates for the sentenced population
for the Federal Republic of Germany: 1961-1982

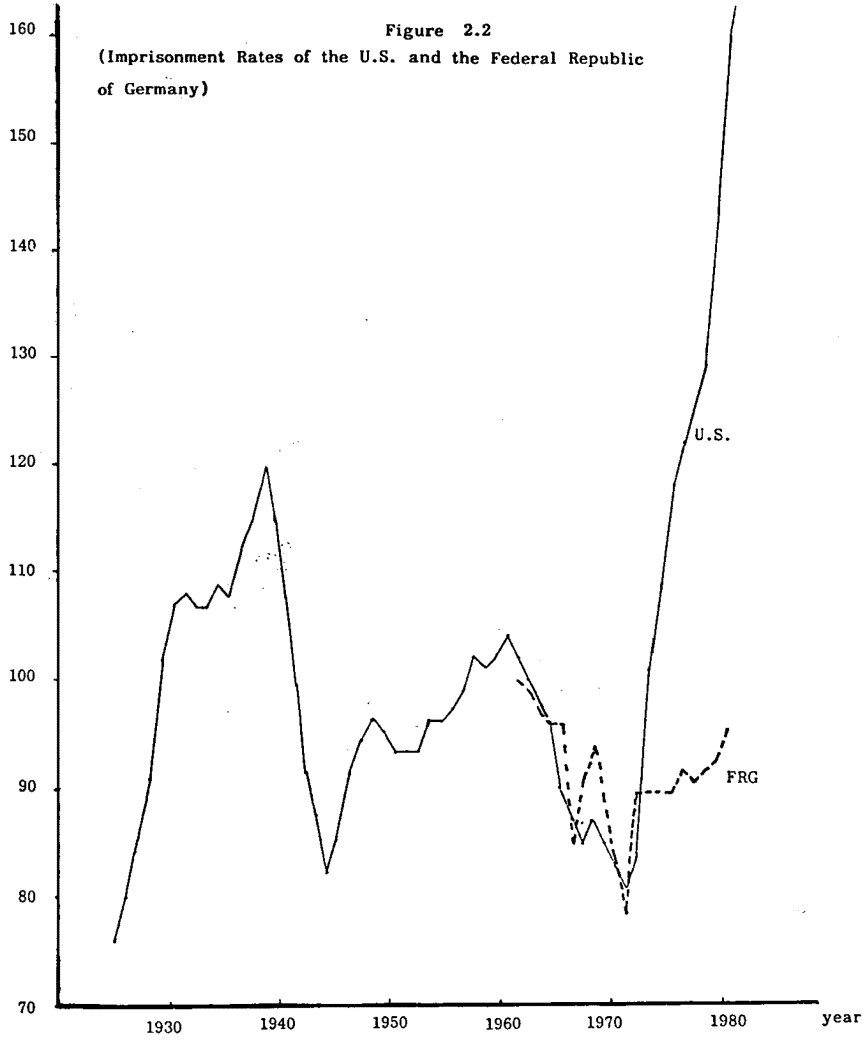
these fluctuations are not at all inconsistent with the stability hypothesis. The same can be said for the time-series for the sentenced population. In fact it appears even closer to stability, with first a downward drift, and then an upward drift back to its previous level.

Since the trends are clearly not linear, linear regression is not appropriate. One could of course do non-linear regression, but there are no intuitive interpretations for the coefficients. Alternatively, one could do piecewise regression (Block and Miller, 1983), but in this case the segments would be too short to get reliable results. From inspections one may perhaps regard the time-series as three linear segments (1961-1969; 1969-1971; 1971-1982).

Turning to the longer time-series for the United States (1926-1983), (figure 2.2), the most striking feature (and the biggest difference from the German data also shown, but on a different scale) is the enormous increase in the imprisonment rate from 1974. There has in fact been much discussion and concern about this increase, and it is largely due to demographic factors since the persistent offenders from the baby-born cohort have reached adulthood, have accumulated a conviction record, and have thus arrived at a "prison-prone" age. It has been predicted that the end of the eighties and early nineties will see a downturn. However, if the level of punitiveness has also increased (as a consequence of a "get-tough" approach), then the imprisonment rate may well stabilize at a much higher level than before. For instance, we see that from 1925 to 1974, the imprisonment rate has remained stable at around 100. (The increases and decreases in the 30s and early 40s are quite consistent with the stability hypothesis, which allows for such variations about the stable level).

An interesting point of comparison is that the decline in the US rates from 1963 to 1973 is very similar to the decline in the sentenced population in the Federal Republic of Germany from 1965 to 1971, as well as the increasing trend since then, although it has been much sharper in the U.S. While the specific reasons may have been different, the mid- and late sixties did witness a decline in prison population in both countries (even though adult arrest rates were increasing), a phenomenon that may be related to the various changes in social

Figure 2.2
(Imprisonment Rates of the U.S. and the Federal Republic of Germany)



attitudes that took place at that time.

In general, however, it is difficult to compare the U.S. and German imprisonment rates. The societies and crime rates are very different, and sentencing practices are also dissimilar. The most obvious difference is in the level of the imprisonment rates. In Germany it has varied from about 55 to 87, while in the U.S. it has varied from a minimum of 75 to a maximum of 165. On the other hand, given the high crime-rate, the imprisonment rate is not that different in the relation to Germany. For example in 1979, the number of sentenced prisoners in Germany per 100 known offenses was 1.20, while for the U.S., the number of prisoners per 100 index offences was actually 1.12. Given the fact that the crime-mix is very different, with Germany having a far smaller proportion of serious crimes, Germany appears to be actually more punitive relative to the prevailing level of crime.

There is of course a great deal of variation across the states of the U.S. (far greater than among the "Länder" or states in Germany) and within that variety one can find a number of states in the U.S. similar to Germany in crime-rates and/or crime mix, for example Wisconsin (WI), Iowa (IA), Vermont, New Hampshire and two states of the U.S., North and South Dakota have crime rates far below that of any of the states of Germany. To make further comparisons, two U.S. states (IA, WI) and 2 German states (Baden-Württemberg, Nordrhein-Westfalen) were selected (because B-W and N-W had the longest time-series data available among the German states), and the imprisonment rates for all four are shown in figure 2.3. Again, because the time-series for the German states are so short, it is difficult to compare long-term trends, but the downward trend in the late sixties and a subsequent upward trend is evident in all the jurisdictions. It should be pointed out that Baden-Württemberg and Nordrhein-Westfalen are far more typical of Germany than Wisconsin and Iowa are for the U.S., the latter two being largely agricultural states. With this overview of the imprisonment rates in the U.S. and Germany, we proceed to explore the relationships between the aggregate crime trends and imprisonment rates.

Figure 2.3a

Imprisonment rates for Baden-Württemberg (BW) and Nordrhein-Westfalen (NW)

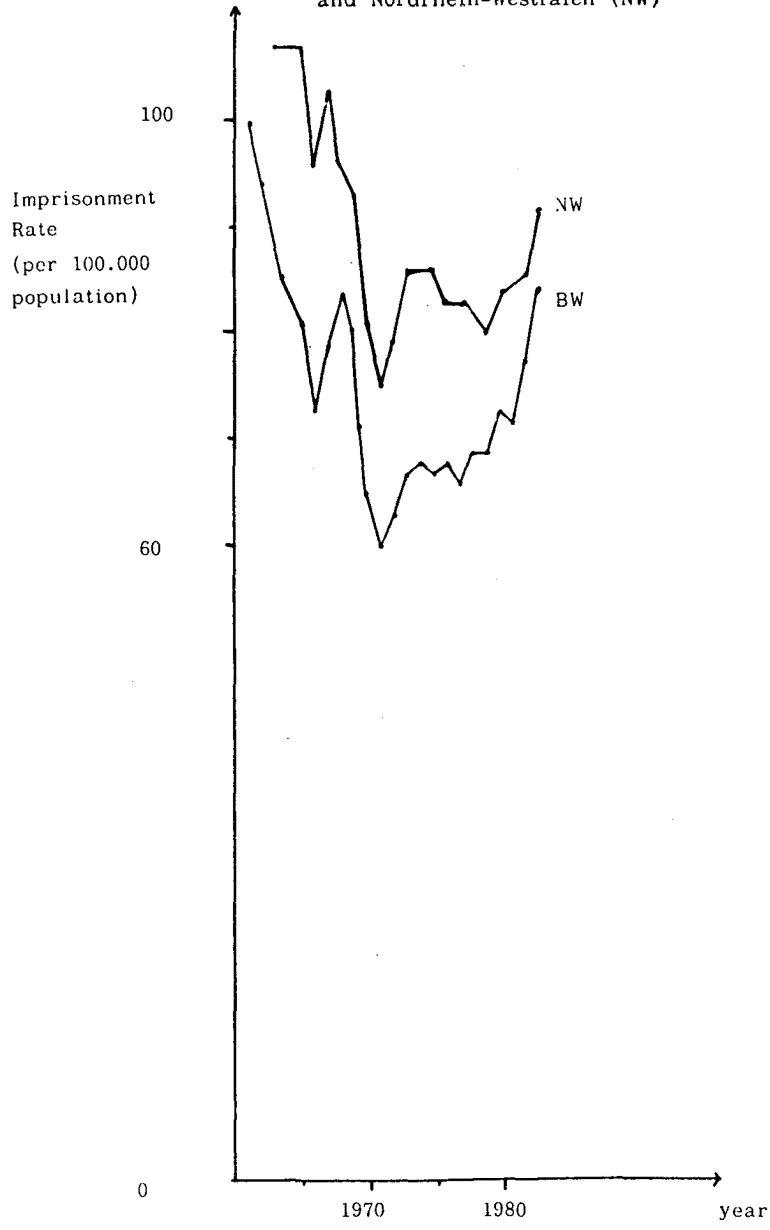


Figure 2.3b


Imprisonment rate for Iowa (I1) and Wisconsin (WI)
Imprison-ment rate for Wiscon-sin per 100.000 population)
Imprisonme rate for Iowa (per 100.000 population
I1
WI
90
65
50
1930
1940
1950
1960
1970
1980
year

Even though the time-series of the Federal Republic of Germany as a whole, as well as Baden-Württemberg and Nordrhein-Westfalen are quite short, ARIMA models were fitted to all the imprisonment rates. The results are given in table 2.1. The first observation is that all the time-series could be fitted by stationary models (d = 0). This may appear rather surprising, given the changes that can be seen in the German data, but the explanation for this is that the series is short, and the changes could still be considered as stochastic fluctuations rather than a change in levels. Stationarity or stability can be properly tested with long time-series only (at least 50 time periods), and at this point we cannot conclude that the German time- series is either stationary or nonstationary.

All the German time-series appear to follow an AR (1) process while the American time-series follow an AR (2) process. Again, the difference could be due to the shortness of German time-series, but several other quite long imprisonment rates follow an AR (1) process, for example, Finland, some states of the U.S., Finland, etc. The coefficients of the German series are very similar, and for the U.S. series, Wisconsin follows the pattern for the U.S. as a whole, while the Iowa has a slightly different pattern. Another characteristic of the ARIMA models, the lag (ko) at which the anticorrelations go down to zero, was also noted. With the exception of Iowa, they are all six or seven. That is, after six or seven time periods, the value of the series is not correlated any more with its past values. For Iowa it is ten, implying that the values appear to be correlated to its past over a longer period.

Figure 2.4

Crime and Imprisonment rates for the United States and the Federal Republic of Germany

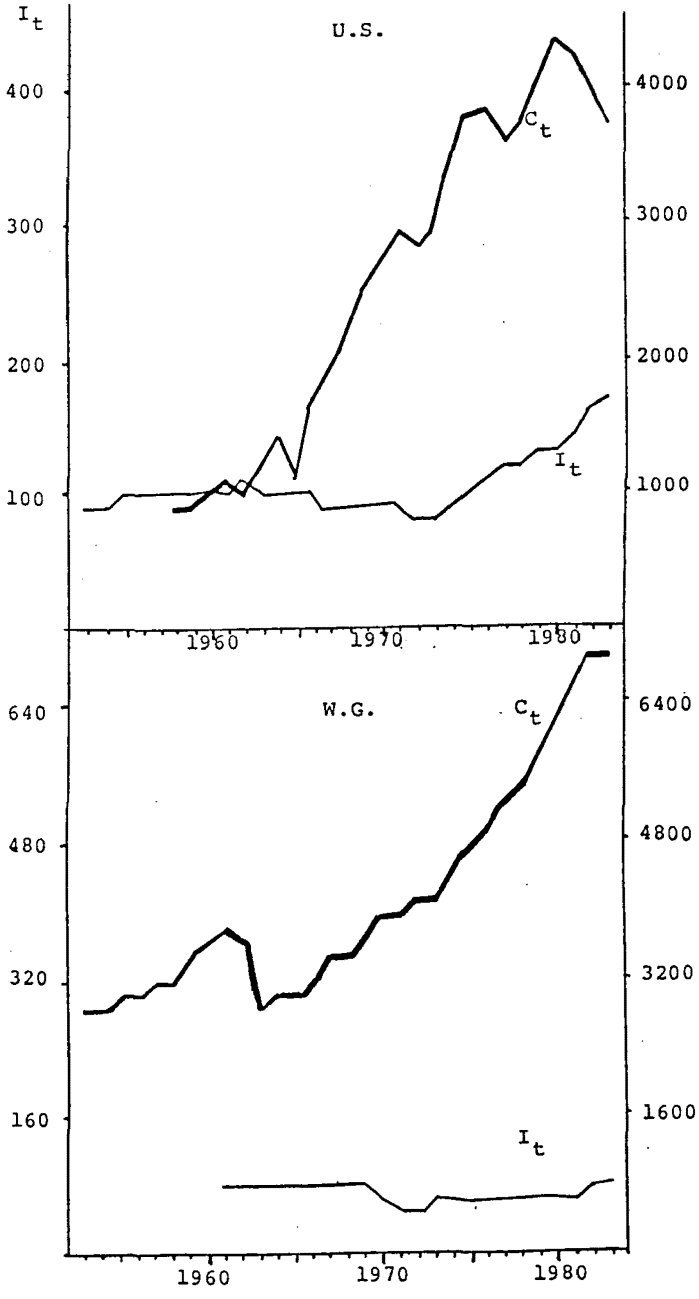


Table 2.1.

Coefficients of the ARIMA models for the imprisonment rates

STATE	d	ϕ_1	ϕ_2	k_o
U.S.	0	1.00	-.22	6
F.R.G.	0	.76	-	6
IA	0	1.27	-.33	10
WI	0	1.00	-.22	6
BW	0	.72	-	7
NW	0	.84	-	6

VI. Analysis of the Time Series of Crime Rates

The time-series for the aggregate crime-rates for the two countries are shown in figure 2.4. The most striking similarity is the sharp increase in both countries during the late sixties and seventies. Interpretation of the U.S. data is complicated by the fact that the definition of larcency was changed in 1973, thus accounting for the jump between 1972 and 1973. For a discussion of this time-series, see Bowker (1982). The earlier data for Germany reveal a cyclic pattern with the crime-rate rising from 1951 to 1961, dropping off sharply and then increasing almost linearly from 1963. Unfortunately, comparable data for the U.S. is not available, but it has been estimated that there was a steady decline in violent crime in the U.S. in the forties and fifties (Brantingham & Brantingham, 1984; Gurr, 1981). That could have helped create a more phlegmatic attitude resulting in the decreasing use of imprisonment during the sixties. However, the relationship between the crime-rate and imprisonment remains problematic when considered in the aggregate. It has already been noted that the two variables appear uncorrelated for Australia (Biles, 1982) and for the U.S. (Bowker, 1981).

Looking at the German data, we find a similar lack of relationship. Except for one major decrease between 1962 and 1963, the crime-rate in Germany was generally increasing, but the imprisonment rate was generally decreasing till 1971, and even after that the rate of increase in imprisonment was far slower than that of crime. One explanation that has been put forward for this anomaly for the U.S. is in terms of demographic structure, as discussed previously (Blumstein, Cohen and Miller, 1980). However, in the case of Germany, this explanation is somewhat unlikely given the relatively long trend in the decline of imprisonment-rates and the change in law in 1972. The increase in crime between 1951 and 1962 does not appear to have had any effect on the sentenced population, and the increase from 1963 on is only reflected after 9 years. The increase is more likely the result of a change in sentencing practice than a demographic effect. Finally, adult arrest rates have increased proportionally to the crime- rate, so the time lag that would have been required for the persistent juvenile offenders to be eligible for sentencing should not exist.

Figure 2.5a: Crime Rates for Baden-Württemberg (BW)

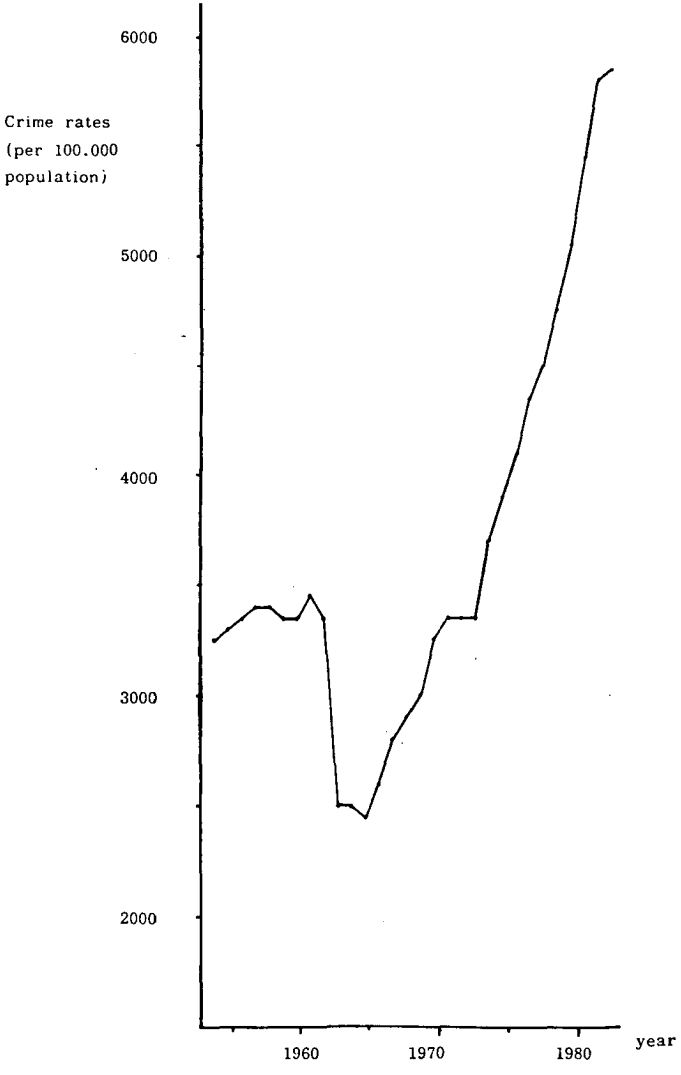


Figure 2.5b: Crime Rates for Nordrhein-Westfalen (NW)

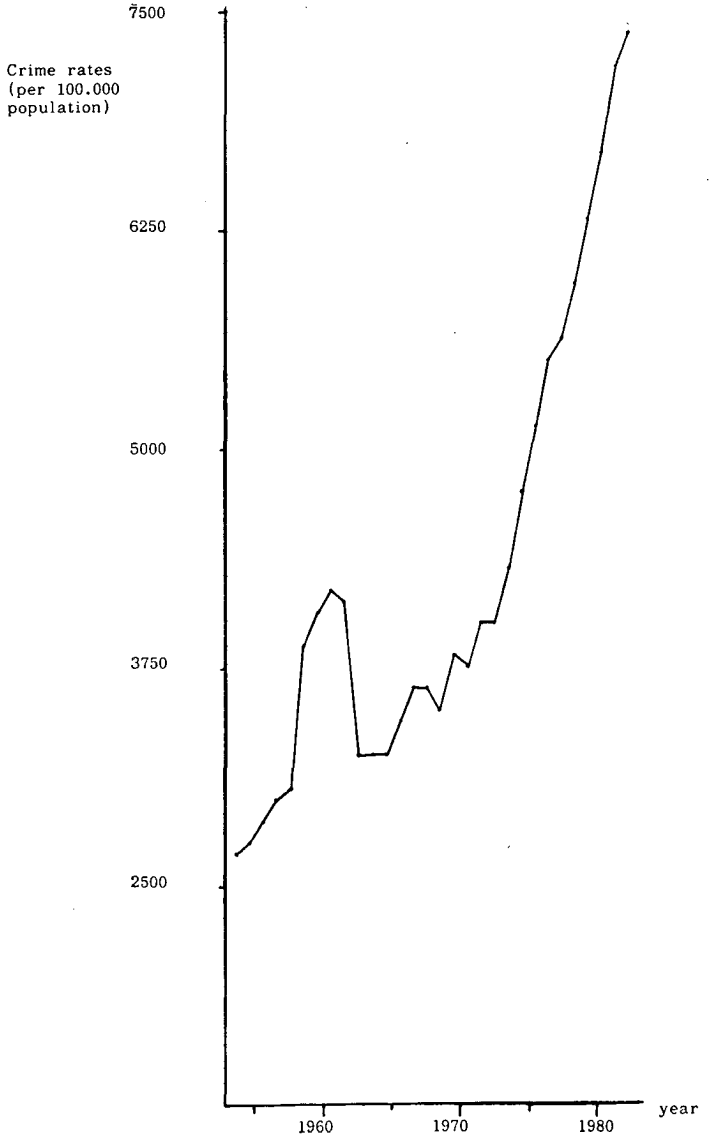


Figure 2.5c: Crime Rates for Iowa (I1)

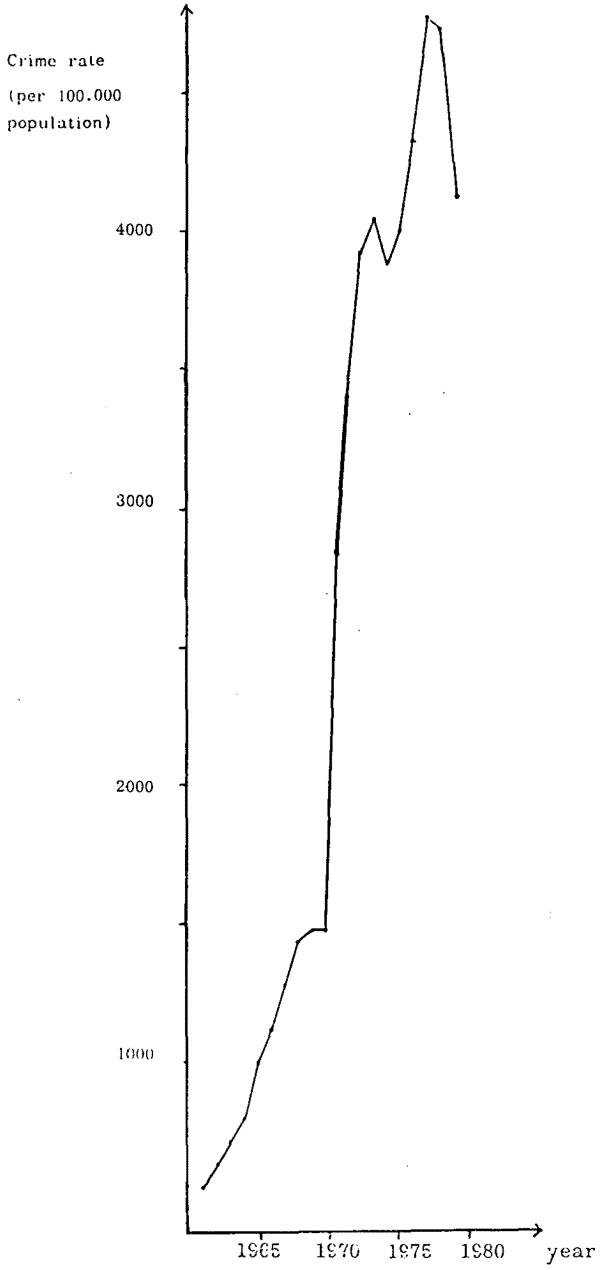
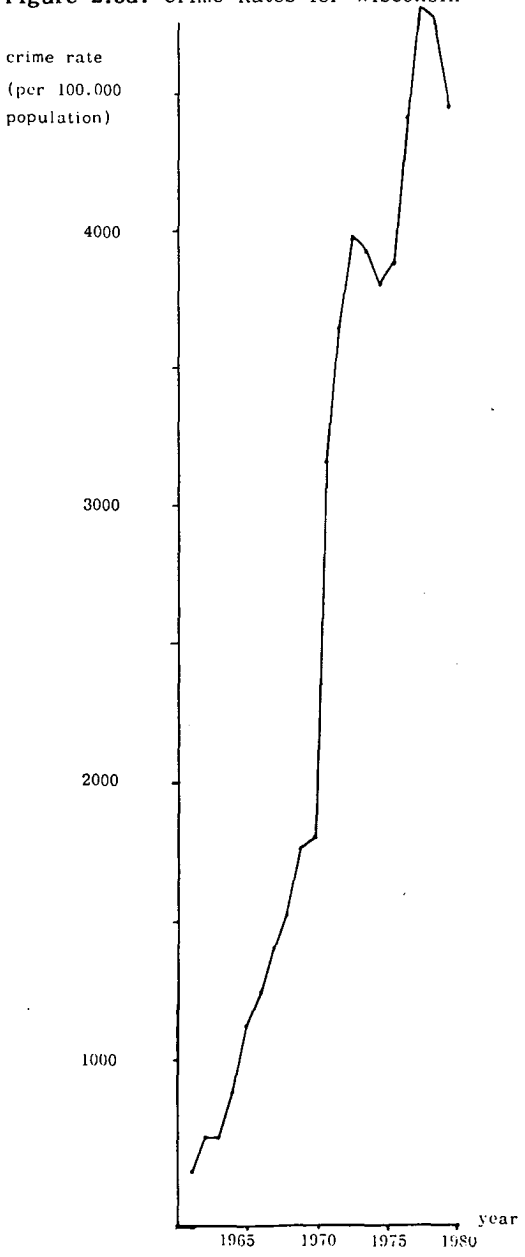


Figure 2.5d: Crime Rates for Wisconsin



Looking at the crime- and imprisonment-rates at the level of individual states, again shows the lack of correlation. For example, when we look at the crime-rates for the 4 states (WI, IA, Baden-Württemberg, Nordrhein-Westfalen) in figure 2.5, we see that the respective national trends are more or less reflected in the data from the states. We might note here that all the states of the Federal Republic of Germany had very similar time series, so the results regarding Baden-Württemberg and Nordrhein-Westfalen would be valid in general for the other states as well.

On further reflection, of course, this lack of any relationship between crime and imprisonment should not appear too surprising. We have discussed in Part 1 several reasons why no relationship might be seen between the aggregate crime and imprisonment-rates. As we have argued, aggregate data may conceal distinct relationships between crime- and imprisonment-rates for individual crime types. Clearly the criminal justice system would respond differently to increases in the rates of very different crime types, for example, public drunkenness versus homicide. Also, prison sentences could affect different offenders differently. Increasing the sentences for burglary may deter burglars, whereas increasing the sentences for aggrarated assault may have no impact on those who engage it in. Even though it may be true that offenders do not specialise in crime types (the empirical evidence is not at all conclusive at this point), sentences could (and probably do) have differential impacts on the commission rate of different crime types.

All of this, together with the reasons mentioned earlier, suggests that to properly understand the relationship between crime and punishment, we need to analyse disaggregated data and also data over a significant time period to disentangle all the different causal relationships. As noted above, because of the scarcity of such data, this study had to be limited to only a few countries. The most complete data available are for the FRG and in the U.S. for California. In the next section, we shall analyse and compare the data on crime and imprisonment rates for these two jurisdictions[49].

VII. Exploring the Relationship between Crime and Imprisonment Trends in the Federal Republic of Germany

VII.1. Description of the disaggregated data

In collecting the time series data for Germany, there were two initial concerns: to get data on as many crime types as possible, and at the most **appropriate** level of disaggregation. By the most appropriate level, we mean that distinct types of criminal acts should be classified separately, but at the same time, similar acts should be grouped within the same type. Of course, there is no ideal classification system, and to a large extent, it is dictated by official classification practices. The accompanying concern was of course that the crime types should be as comparable across countries as possible, and as mentioned earlier, this was attempted as far as possible. For this research, time series data at a disaggregated level was needed for crime rates, arrest rates, conviction rates and imprisonment rates at the very last. The last three rates reflect the response of criminal justice system at some stage or another. The basic problem, however, turned out to be the changes in the classification practices over the years, so that the rates for one period could not be compared with those given for other years, because some subsets had been excluded and/or others had been included. As it turned out, the police statistics on crime rates are given under consistent categories[50]. Time series data on arrest rates were also collected for the different crime types. Conviction data could not be collected because it was not reported at the required level of disaggregation for the earlier years, and also, for the few crime types for which convictions were reported, the classification system could not be reconciled with the police statistics nor with prison statistics. As will be seen later, it was not especially important in any case, except that it would have been interesting to have had the rates for burglary, larceny and fraud. The imprisonment data, however, often had its classification system changed[51]. The imprisonment data was as a rule disaggregated into finer categories than the police data on crimes and arrests. Therefore these categories had to be recombined to develop categories that corresponded to the police reports, and in general there were few problems in doing this. Problems arose for burglary, larceny, fraud and rape[52]. While it was possible to recover

a consistent classification scheme for burglary, larceny and fraud by regrouping the subdivisions[53)], this was not possible for the rape statistics, and therefore rape had to be excluded from the analysis. There were some inexplicable jumps in the imprisonment rates for fraud in 1970 and 1971. It jumped to a fairly high value in 1970, and then jumped down to a very low value in 1971. These data points are indicated by dots. However, when averaged out, the value matched the general pattern quite well, and so this average was used for both 1970 and 1971.

It should be noted that there was a major change in the sentencing laws in Germany in 1969 where short sentences (under 6 months) were largely replaced by fines. Another factor was an increase (temporary) in the use of pardons by judges. This explains the dip in the aggregate imprisonment rates and in the total prison population rates.

In analyzing the patterns of the imprisonment rates, the impact of the imprisonment rates of crime types not included here should also be kept in mind. In particular, the imprisonment rate for drug offences in the FRG has increased dramatically, and from being a negligible proportion of the total, has become quite significant. However, it has been reported as a separate category for only the last few years, and thus no time series analysis could be done.

Since our concern was to look at the relationship between crimes and imprisonment, only those crimes that accounted for a significant proportion of the prison population could be considered, and for this reason many of the minor crimes were excluded, for example, property damage, which although constituting a significant proportion of reported crimes (8% to 9%) accounted for less than half a percent of the prison population. Again, since the focus of this study was on serious crimes, traffic offences were also excluded.

Given these conditions, six crime types were ultimately selected for the analysis with data from the Federal Republic of Germany. They are: Mord und Totschlag (MT), Raub (RB), gefährliche und schwere Körperverletzung (GK), schwerer Diebstahl (SD), einfacher Diebstahl (ED) and Betrug (BT). We translate these types as Homicide, Robbery,

Aggravated Assault, Burglary, Larceny and Fraud respectively. Clearly these translations are approximate; on the other hand, they do characterize the different crimes as closely as it is possible. Mord und Totschlag, however, include both murder and attempted murder in the German statistics[54]. Raub corresponds almost exactly with what is understood (and classified) as robbery in other countries. Körperverletzung also corresponds to aggravated assault directly. Schwerer Diebstahl has been called burglary here, but it includes all breaking and entering, including for example the theft of a locked motorcycle. (Incidentally that could be one reason why it has increased so rapidly.) Einfacher Diebstahl refers to simple thefts and larcenies and is called larceny here. Betrug is called fraud in the most general sense, because it includes embezzlement and forgery as well. At this point it is interesting to see how the relative seriousnesses of different crimes are reflected in the rates of the crime rate to the imprisonment rate. This rate obviously varied greatly over the time period we are considering for some crime types, and so, only the orders of magnitude can be compared. Approximately they are as follows (the higher the number, the less seriously is the crime treated):

Homicide	1
Aggravated Assault	20-40
Robbery	50-60
Fraud	100
Burglary	150
Larceny	250

Thus the imprisonment rate of aggravated assault is higher relative to its rate of incidence than robbery, and this is in contrast to the U.S. One explanation for this might be that robbery was very rare in Germany until recently. (Of course, to understand the implications of these ratios fully, one needs to analyze the time series of these ratios and relate them to clearance rates, conviction rates and sentence lengths for each crime type.)

Before analyzing the time series, we present the table of simple correlations between the rates of the different crime types.

Table 2.2 Correlations among the Crime Rates:

	RB	GK	SD	ED	BT
MT	.94	.80	.94	.83	.08
RB		.94	1.00	.91	.39
GK			.94	.89	.60
SD				.91	.39
ED					.34

Most of the rates are highly correlated, but that is really an artifact of the general increasing trend in each case and the autocorrelation within each time series. It is the exceptions that are interesting. Fraud is clearly far less correlated with the other crime types in general. It is particularly distinct from homicide. However, it is most highly correlated with aggravated assault which is rather surprising. One could speculate that it might be due to a subset of offenders involved in organized crime, who generally would be involved in fraud-related offences, but who also resort to violence on occasions. But this might be rather far-fetched, and there may well be other reasons, or this might simply be a spurious correlation.

With this introduction to the time series of the crime rates, we turn now to the analysis of the crime and imprisonment rates[55]. For the Federal Republic of Germany (as in many other countries including the U.S.), the imprisonment rate has not increased in proportion to the crime rate as we have seen in Fig. 2.4.[56]. The explanations discussed above do not fully explain this difference in the trends for crime and imprisonment which is similar in both countries. For example, the demographic argument does not hold for West Germany where the arrests of adults have increased in approximately the same proportion as crimes, and serious crimes too, have increased dramatically over the last two decades, so the increase in the aggregate rate is not due only to minor crimes. One possible hypothesis that may explain the relative stability of imprisonment rates is that of adaptation which has been discussed previously. To explore this hypothesis, we need to examine the time-series of crime rates and imprisonment rates by individual crime type to see if such a differential relationship holds.

VII.2. Results of the analysis with data from the FRG

The time-series of the crime and imprisonment rates are shown together for each of the six crime-types in figures 2.6 to 2.11. Visual inspection reveals that there is indeed a correspondence between the crime and imprisonment rates for the serious crimes: homicide, aggravated assault and robbery, and also for fraud (which is considered as a much more serious crime in Germany than in the U.S.). For homicide, aggravated assault and robbery, there has been a general trend of a significant increase, while for fraud both rates show a striking similarity in following a U-shaped pattern. There is clearly little relationship between the rates for burglary and larcency: The crime rates have increased sharply, while the imprisonment rate has declined. The correlations between each pair of time-series were also obtained with lags, and they are plotted in figure 2.12. The lags are in both directions, because correlating imprisonment rates with crime rates for previous years (C_t, I_{t+k}) is equivalent to exploring a possible causal relationship where the crime rate is hypothesized to influence the imprisonment rate k years later. On the other hand, correlating crime rates with imprisonment rates for previous years (C_t, I_{t-k}) implies the reverse causality of imprisonment rates influencing the crime rate k years later, Bowker (1981). However, causality should be inferred with caution, as discussed earlier, since these are simple correlations, and there are no controls for other variables. Also, correlation is a measure of the **linear** relationship between two variables, and when the relationship is curvilinear, then the correlation can be very misleading. We now proceed to explore the relationships between crime and imprisonment for each of these crime types.

Homicide:

Comparing the rates of crime and imprisonment for homicide (figure 2.7), we can see that apart from the decline in the imprisonment rate between 1967 and 1972 (as a result of sentencing policy changes), the imprisonment rate has been following the crime rate. The correlation increases with the lag between crime and imprisonment (figure 2.12). This could be due in part perhaps to the length of their trials and longer sentence lengths, or it could be an artifact of the dip (i.e. nonlinearity) noted above which would tend to reduce the value of the

correlation at shorter lags. The reverse correlations (imprisonment driving crime) are insignificant and decrease rapidly to zero, thus ruling out both deterrence and criminogenic effects.

Robbery:

The rates for robbery are almost completely collinear, as can be seen from figure 2.7 and from the correlations which are around .9 (figure 2.12). The change in sentencing policy is reflected in the slight dip between 1969-1971, the only anomally in the collinearity. The reverse relations are also very high, due to this collinearity. It should be noted that in such cases it is impossible to infer causality since either variable could be influencing the other, or both may be driven by a third variable. The high correlations for negative lags (imprisonment driving crime) are only a result of this collinearity and should not be construed to mean the existence of a criminogenic effect.

Aggravated Assault:

The patterns for aggravated assault (figure 2.8) show an interesting variation. The crime rate was relatively stable until about 1968, and then almost exploded (with a slight decrease in the last two years). The imprisonment rate was also initially stable (1961-1967), but then declined sharply in 1967-1968 (like the imprisonment rate for homicide), and then again in 1969-1971, reflecting the change in sentencing policy. However, from 1972 on, it shows a strong correlation with the increasing crime rate. Thus there is a non-linear relationship between the rates: at first crime-rates were stable while imprisonment rates were decreasing, and later both were increasing in a similar manner. Given this divergence, their correlations (figure 2.12) should be interpreted with care, especially the negative correlations. They are almost certainly due to this non-linearity, and not to deterrence. We can see this because increases in the imprisonment rate followed increases in the crime rate and do not appear to have had a deterrent effect. Initial decreases in the imprisonment rates also had no effect on the crime rate (between 1965 and 1967), in that the crime rate continued to remain stable, and then began to increase. Moreover the increase continued even when imprisonment increased.

Figure 2.6

Crime and Imprisonment Rates for Homicide (per 100,000 population)

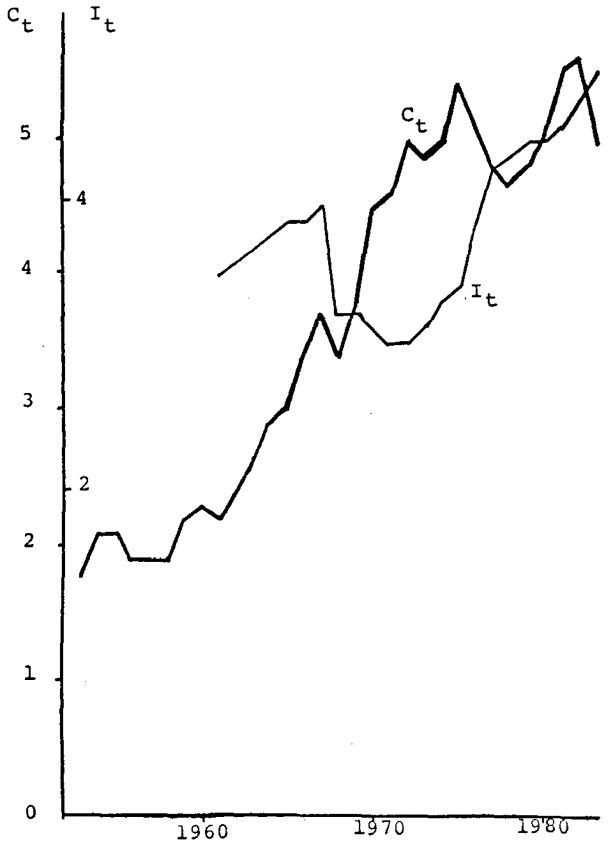


Figure 2.7

Crime and Imprisonment Rates for Robbery (per 100,000 population)

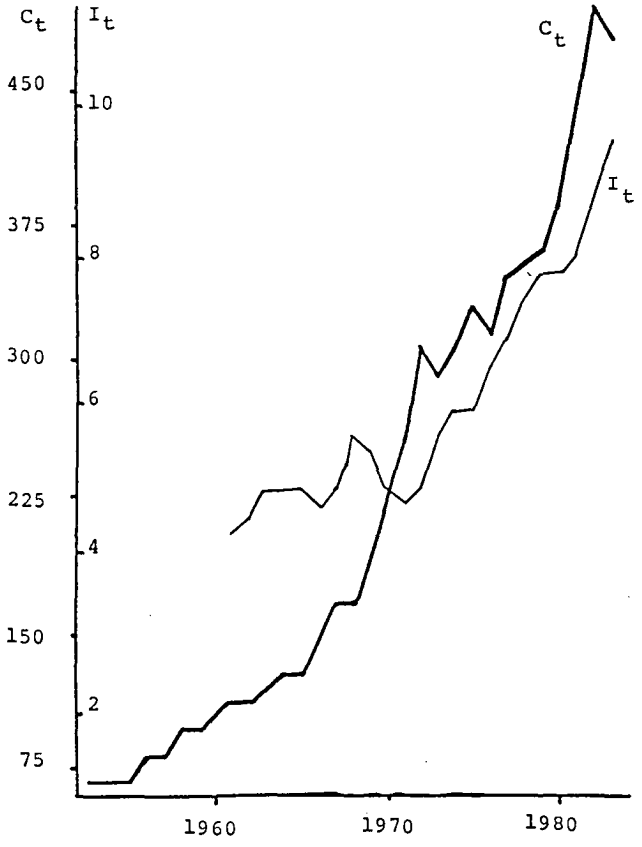
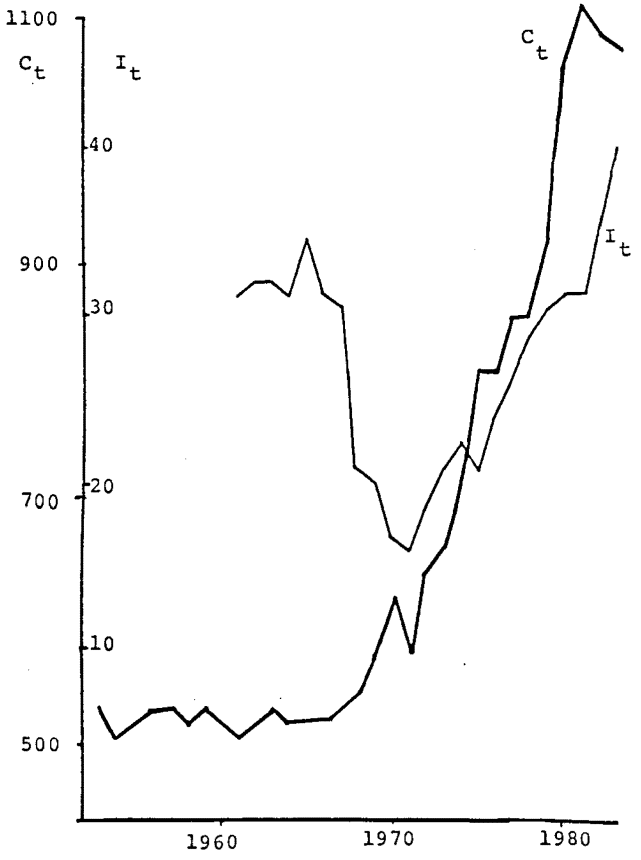


Figure 2.8

Crime and Imprisonment Rates for Aggravated Assault
(per 100,000 population)



Fraud:

The next crime, fraud, is considered to be relatively serious in Germany (for example, it is punished more often with imprisonment than in the USA). The crime rate reveals a distended U-shaped pattern with a gradual decrease followed by a sharp increase from 1974 (figure 2.9). The imprisonment rates follow approximately the same pattern, as reflected in the correlations as well (figure 2.12), following the crime rate with a lag of about 3 to 4 years. The correlations decrease after a lag of 5 years, and the reverse correlations also decrease rapidly to zero. Thus here again, we observe a close relationship (with a lag) between the crime rate and the imprisonment rate.

To sum up the findings so far, we see that for the more serious crimes, the imprisonment rate is indeed closely correlated to the crime rate, when the disaggregated rates are examined. We also note that there appears to be no evidence of criminogenic or deterrence effects. These findings are compatible with both the rational response hypothesis and the hypothesis of adaptation. What distinguishes these hypotheses are the correlations they predict for the relatively minor crimes. The rational response hypothesis predicts the same pattern while the adaptation hypothesis suggests that faced with increasing numbers of serious offenders and limited capacity (of prisons, among other criminal justice resources), the imprisonment rate for less serious offences will decrease. This would result in negative correlations between crime and subsequent imprisonment rates. Turning to these offences, we do indeed observe such a relationship (see figures 2.10, 2.11).

We see very clearly the lack of a direct relationship between the rate for both burglary and larcency from the plots of their crime and imprisonment rates. In both cases, there appears to be a negative relationship of an increasing trend in crime and a decreasing trend in imprisonment and this is reflected in the significantly negative values for the correlations at all lags (see figure 2.12). In the case of burglary, the crime rate experienced an accelerating rate of increase (almost parabolic), while the imprisonment rate seems to have been at a stable level till about 1968, then dropped precipitately between 1969

Figure 2.9

Crime and Imprisonment Rates for Fraud (per 100,000 population)

and 1970, and then remained stable at this lower level. The general trend was thus downward, but through a step change rather than a steady decrease. In other words the downward trend was nonlinear[57].

In the case of larcency, there was a steady decrease in the imprisonment rate upto 1970, and after that it remained stable. The crime rate displays a linear, increasing trend, with occasional fluctuations around the trend line[58].

Again, it should be noted that these patterns only reflect the negative collinearity and do not suggest the deterrence hypothesis. This is confirmed by noting that initial **increases** in the imprisonment rate for burglary were followed by sharp increases in the crime rate, while for larcency, a decrease in imprisonment coincided with a cyclic change in the crime rate and a stable imprisonment rate coincided with a sharply increasing trend. Thus the cause and effect pattern appears to rule out deterrence (see figure 2.12).

Figure 2.10

Crime and Imprisonment Rates for Burglary (per 100,000 population)

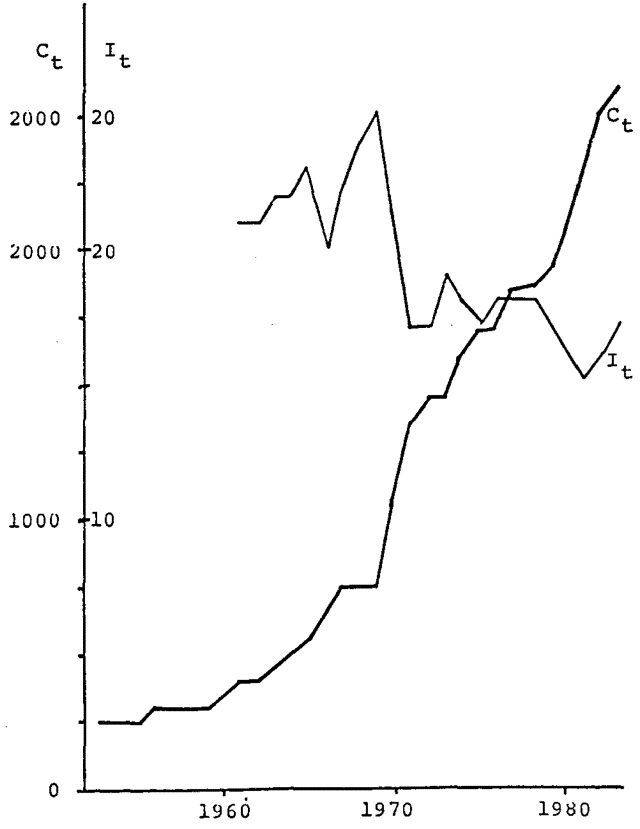
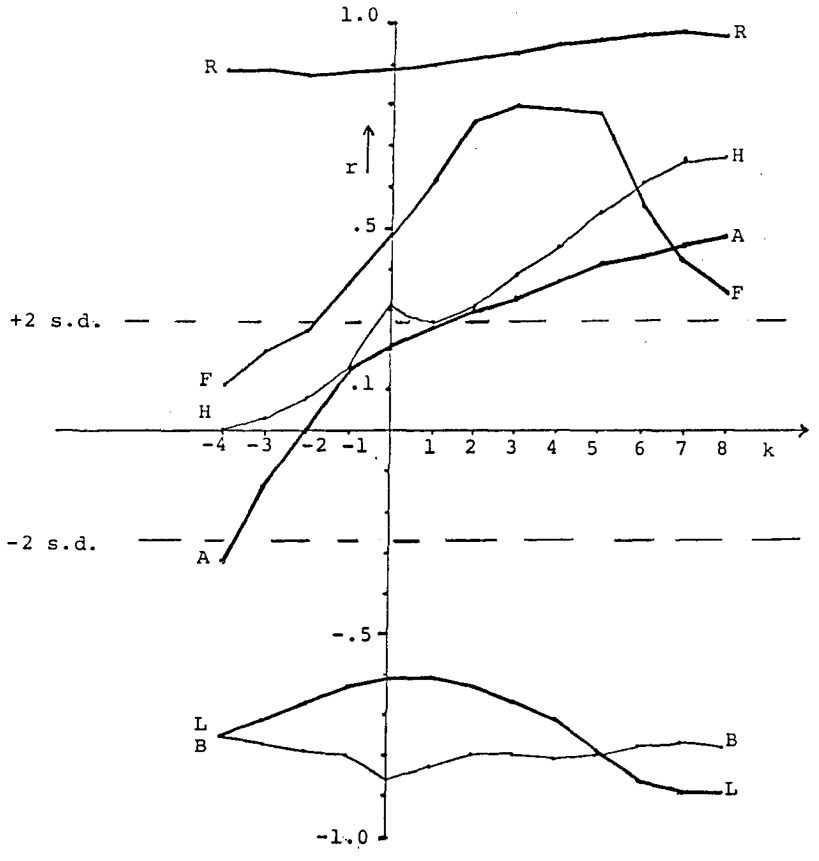


Figure 2.11

Crime and Imprisonment Rates for Larceny (per 100,000 population)

Figure 2.12



Cross-correlations of the Time Series of Crime and Imprisonment Rates for Positive and Negative Lags, r (C_t, I_{t+k}).

H=	Homicide	F=	Fraud
R=	Robbery	B=	Burglary
A=	Aggravated Assault	L=	Larceny
s.d.=	Standard Deviation		

Conclusions

In our analysis of the relationship between crime rates and imprisonment rates in the case of the FRG, we find that the rates are positively correlated for the more serious crime types, but negatively correlated for the less serious crimes, exactly as the hypothesis of adaptation would have suggested[59]. Given constraints on the capacity of the criminal justice system, including the prison capacity, and a concern for limiting the imprisonment rate, criminal justice policy would respond to increases in the crime rate (of both serious and minor crimes) by focussing on the more serious crimes. As more and more serious offenders are sentenced, there would have to be a decline in the number of minor offenders who are sentenced, even though the rate of minor crimes were increasing. It is of course possible that the imprisonment rate would increase somewhat, but in practice (due to various constraints) it has certainly not kept pace with the crime rate in most societies including, as we see, the FRG. In such a situation, some form of the adaptation mechanism suggested here must operate, and the data for the FRG conforms well to such a hypothesis.

To conclude this part of the analysis, we present the ARIMA models for each of the time series (see table 2.3).
All reveal an AR (I) process. This should not be too surprising, since many phenomena can be modelled as an AR (I) process, having as it does, a simple, intuitive interpretation. Also, these are rather short time series, and the identification of more complicated time series generally requires longer series. Before dismissing them, we should note that while these time series clearly appear non-stationary, they can be modelled nevertheless as a **stationary**, AR (I) process. The paradox lies in the fact that because these are all relatively short series, the trend can be interpreted as a temporary drift, and that in the future, the series may **drift back** to a stable level. At this point, no conclusion can be drawn. We have to wait till we can observe a longer time series before we can decide the issue of stationarity.

Table 2.3

ARIMA models of the time series of crime and imprisonment rates for individual crime types.

Crime Type	Model for	
	Crime Rate	Imprisonment Rate
Homicide	$C_t = .93\ C_{t-1} + a_t$	$I_t = .82\ I_{t-1} + a_t$
Robbery	$C_t = .90\ C_{t-1} + a_t$	$I_t = .83\ I_{t-1} + a_t$
Agg. Assault	$C_t = .90\ C_{t-1} + a_t$	$I_t = .81\ I_{t-1} + a_t$
Burglary	$C_t = .90\ C_{t-1} + a_t$	$I_t = .77\ I_{t-1} + a_t$
Larceny	$C_t = .89\ C_{t-1} + a_t$	$I_t = .84\ I_{t-1} + a_t$
Fraud	$C_t = .79\ C_{t-1} + a_t$	$I_t = .68\ I_{t-1} + a_t$

VIII. Trends in crime and prison admissions in California

We now turn to a similar analysis of the crime and sentencing rates for California. In this case, the time series for prison populations for the different crime types were not available, so prison admissions were used instead. This means that we are only looking at one component of imprisonment, the other being the length of sentence. If sentence length (and specifically time incarcerated) were stable, then temporal patterns in prison admissions can be compared to those in imprisonment rates, but if sentencing policies have changed, the comparisons would not be accurate. However, before discussing the issue of comparability, we first examine the time series for California.

Three crime types were selected on the basis of their being the major crime types and for which the police and prison statistics were comparable: homicide, robbery, and burglary. The years for which the data were available to the author were 1958 to 1981.

Homicide:

Figure 2.13 reveals a remarkably close correlation between reported crimes and prison admission rates for homicide. Both rates increased slightly from 1958 to 1969, and then both increased rapidly. This close correlation is reflected in Figure 2.16, where the correlation is seen to be around .9 for all lags. Such collinearity suggests that prison adimissions are very closely related indeed to crimes, and supports the hypothesis of a rational response on the part of the criminal justice system in the case of homicide. Increases in the crime rate appear to lead directly to increases in the admissions rate in that year or the next year, a pattern that contrasts with previous findings with aggregate data. Given this high collinearity, it would be expected that the correlations would be large for negative lags as well. This is found to be the case, and therefore these high correlations should not be interpreted as evidence for a criminogenic effect. Rather, they reflect the inherent collinearity between the two time series and the fact that there is autocorrelation in each[60].

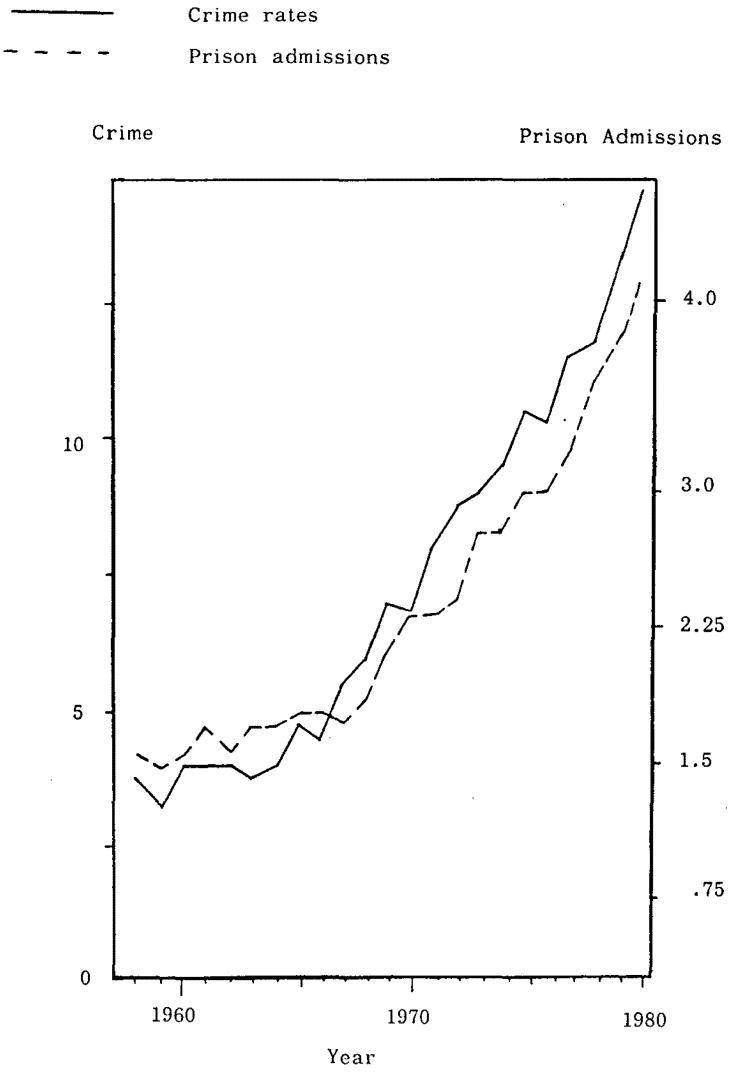
Robbery:

Turning to robbery (figure 2.14), we notice that in the early years,

Figure 2.13

Time Series of Crime and Prison Admission Rates for Homicide

(Rates are per 100,000 population)



1958 to 1972, there is little correlation between the rates with the admissions rate being relatively stable even as the crime rate was rising[61]. From 1973, however, the rates show a similar pattern of increase, and this is confirmed in Figure 2.16 where the correlations are seen to be around .8 for positive lags, and decrease rapidly for negative lags. The falling values of the correlations for negative lags suggest that there is no criminogenic effect for robbery, since a criminogenic effect would have produced the opposite effect. These correlations simply reflect the residual effect of the autocorrelation in the two time series.

Burglary:

For the third crime, burglary, we find a rather different relationship (figure 2.15). The crime rate has been increasing steadily, but the admissions rate actually had a decreasing trend till 1976, and then began to increase sharply. There could be at least three interpretations for this[62]. One interpretation would suggest that this a result of adaptation at some point within the criminal justice system such that because of the rise in the crime, arrest, conviction and imprisonment rates for the more serious crimes like homicide, rape, and robbery, the criminal justice system finds that it cannot pay as much attention to less serious crimes like burglary with the ultimate result that a smaller proportion of burglars are sentenced to prison. In particular, it may be that, faced with ever greated number of convicted offenders, judges (in the period 1960 to 1975) sent fewer convicted burglars to prison in order to reserve prison space for the more serious offenders. This would be the most plausible explanation of the decreasing trend in admissions in this time period.

The second (and not mutually exclusive) interpretation could be that the decreasing probability of a prison encouraged burglary, and the burglary rate shot up as a result of that. However, it should be observed that the reverse (deterrence) effect did not take place. When the rate of prison admissions went up, the crime rate did not come down, but continued to increase.

A third possibility might be that the increasing burglary rate in

Figure 2.14

Time Series of Crime and Prison Admission Rates for Robbery
(Rates are per 100,000 population)

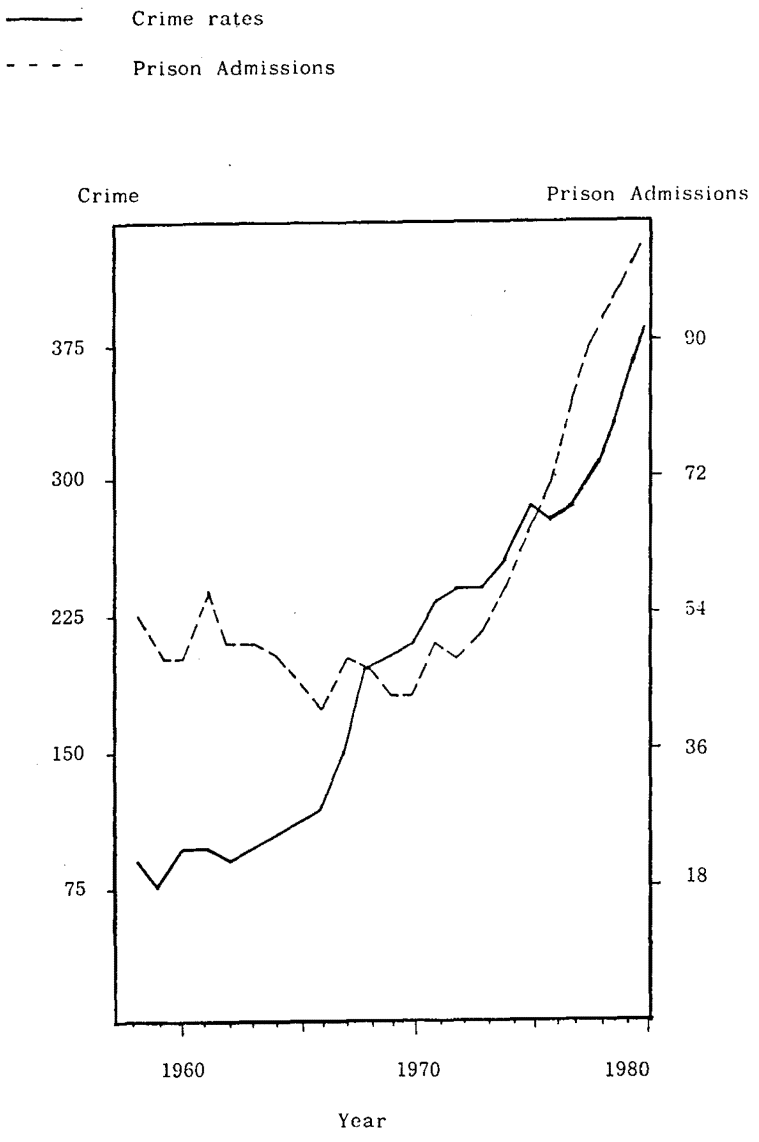
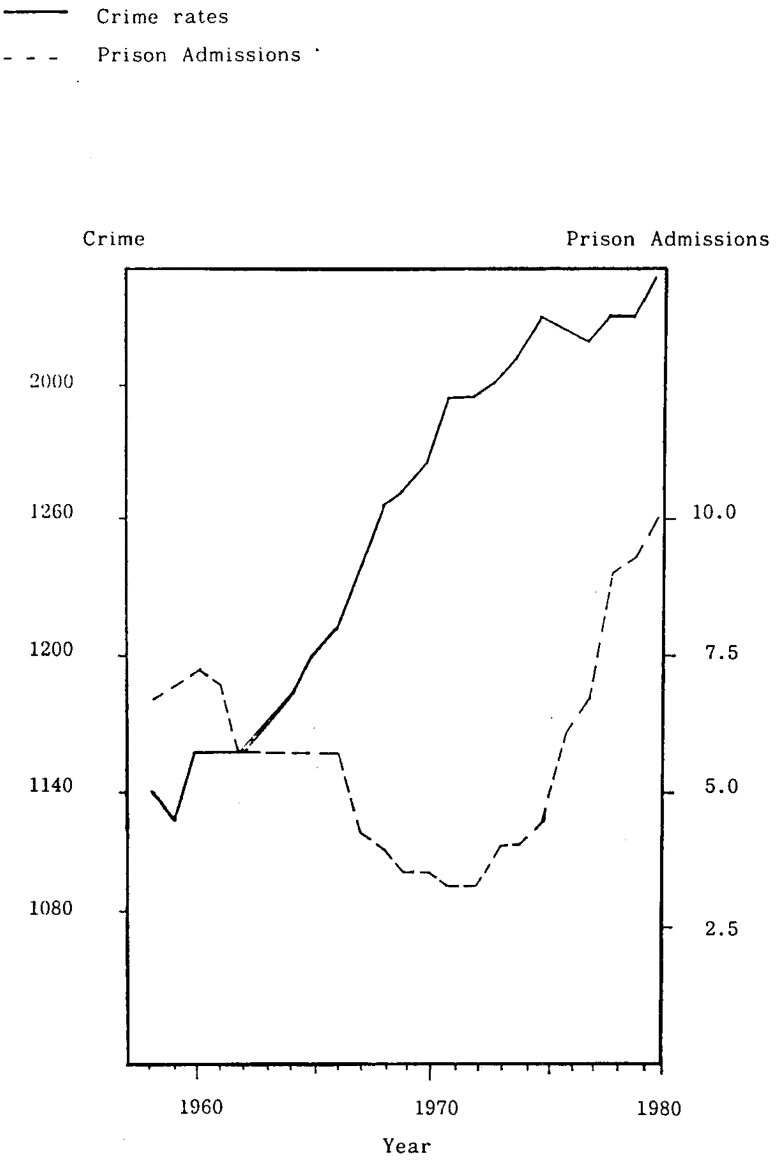


Figure 2.15

Time Series of Crime and Prison Admission Rates for Burglary
(Rates are per 100,000 population)



California was driven by relatively minor burglaries, or an increase in the efficiency of recording them. In this case it could be that the police (concerned with increases in the more serious crimes) paid less attention to solving them, or that they were difficult to trace, or that even if a conviction was obtained, it was not a prisonable offence. Any of these would result in the observed pattern of increasing crime rate and decreasing imprisonment, and the later increase in prison admissions could also reflect a changing mix in the types of burglary, with the proportion of serious burglaries increasing.

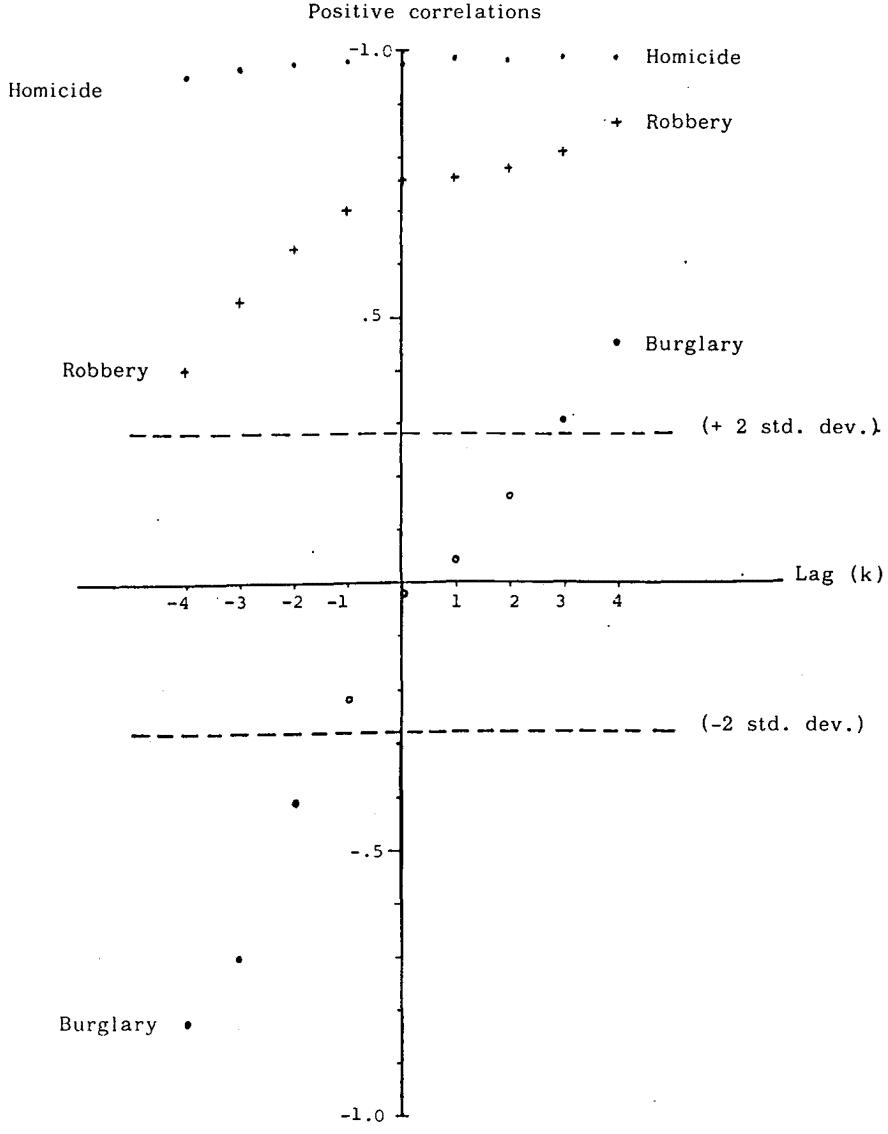
Turning to Figure 2.16, we see that the correlations increase with the positive lag and finally becomes significant at a lag of four years. This probably reflects the later increase of prison admissions along with crimes. The correlations also increase with negative lags and are significant (greater than two standard deviations from zero) for lags greater than two years. This would suggest a deterrence effect. And indeed, it would not be too surprising to see a deterrence effect (in this case, decreasing prison sentences causing increases in crime), since burglary may often require planning, and being an economic crime, potential burglars[63] may well base their decisions on the costs and benefits involved. However, we must be cautious in drawing such a conclusion for at least two reasons. Firstly, we should remember that correlations refer to **linear** relationships. This is not true for the crime and prison admission rates for burglary, and so the values of the correlation coefficient may not reflect the true relationship. Secondly, the fact that the correlations achieve significance for negative lags may be an artifact of when the criminal justice system adapted (if it did) by decreasing admissions for burglary to make room for the more serious criminals. That is, it may be that crime rates were going up in any case (driven by other factors, and independent of prison admissions), and we simply happen to observe significant correlations for negative lags, because admissions happened to decrease at that particular time. To clarify the issue we certainly need to examine the rates over a longer period of time.

Summary

We have examined four hypotheses pertaining to the relationship bet-

Figure 2.16

Plot of the correlations between the Time Series of Crime and Prison Admission Rates for Different Lags for Homicide, Robbery and Burglary



ween crime and sentencing rates over time. These hypotheses were related systematically to each other in terms of the correlations between the crime and sentencing rates they would be expected to produce for different lags between the rates. To recapitulate, if the rational response hypothesis were correct, the criminal justice system would respond to increases in the crime rate with corresponding increases in the sentencing rate. In that case we would expect significant positive correlations between the crime rate and **subsequent** admissions rate. The criminogenic hypothesis suggests that it is the sentencing rate drives the crime rate, and thus would predict significant positive correlations between crime rates and **previous** admissions rates. On the other hand, both the deterrence hypothesis and the adaptation hypothesis predict significant negative correlations. The deterrence hypothesis posits an inverse relationship between sentencing rates and **subsequent** crime rates. The adaptation hypothesis suggests that for **minor** crimes only, sentencing rates will be inversely related to **previous** crime rates.

When we explore these alternative hypotheses for individual crime types, we find not surprisingly, that for different crime types, different but meaningful relationships exist between the crime and sentencing rates. This analysis therefore clearly demonstrates that in order to understand the relationship between crime rates and imprisonment, we must examine the rates disaggregated by crime types. Thus we find a close and direct relationship between crime rates and prison admissions for homicide and robbery. That is, the hypothesis of rational response does seem to be supported for these, the more serious crimes, something that could not be inferred from aggregate data. This suggests both that the criminal justice system has not been adapting to increasing crime by reducing prison sentencing for these crimes, and also that there are no discernible criminogenic nor deterrence effects. Not only is the rational response hypothesis supported, but it is also what we would expect from the adaptation hypothesis, since the adaptation hypothesis presumes the rational response for serious crimes and adaptation for minor crimes only.

In the case of the less serious crime of burglary on the other hand, there was some evidence of adaptation and/or deterrence. However,

caution should be exercised in drawing any conclusions at this stage since the observed correlations could be spurious or due to other causal factors. Also, it is the adaptation hypothesis, and not deterrence based policies that can explain the decrease in the admissions rate in the sixties. In fact, one should be careful about Bowker's conclusions of criminogenic and deterrence effects on the basis of simple correlations only. As pointed out, in the presence of non-linear relationships, correlations can be misleading. Also, correlations are sensitive to outliers, and hence a few large deviations can produce an apparently significant correlation. One should always refer back to the original time series before making any inferences, and the correlations should be followed over several lags.

IX. Summary

The research undertaken here aims to further our understanding of temporal patterns in criminal justice data. In particular, we have undertaken time series analysis to explore the issue of stability of imprisonment, and to explore the relationship between crime rates and imprisonment rates. We have attempted to do this on a comparative basis and to this end have started with the Federal Republic of Germany and the United States.

As discussed earlier, there are always problems with comparative analysis, and this is no exception. Even though we might have reliable data from each jurisdiction, that is not enough. In this case for example, there are significant differences in the two societies that make comparisons often quite difficult. As a starting point, the incidence of crime is very different, with the crime level in the U.S. far higher than that in the Federal Republic of Germany. The behavior and practices of the criminal justice system are quite different. For example, the police in Germany have much greater powers in deciding whether to take an arrest case to court or not. The levels of imprisonment are also quite different, and this may be due to a variety of social, economic ar organizational factors. There is less use of parole in Germany than in the U.S. and a greater use of fines. Also, to explore sentencing rates, we have had to use different measures: prison population in the case of Germany (the correct variable to explore stability of imprisonment), and prison admissions for California.

To understand trends more accurately and to explore the relationship between crime and imprisonment more thoroughly, we have taken disaggregated data, which allows us to distinguish different relationships for different crime types. We have also been able to explore the issue of causal relations through lagged correlations which reveal the direction of the influence of one variable on another. In each case, we have limited ourselves to one jurisdiction in order to reduce the variabilities in the definitions of crimes, police behavior, prosecutorial or court practices, and sentencing policies. Although Germany is a federal republic, it can nevertheless be considered to be one

jurisdiction, since the variabilities between its states are not that great (as they are in the U.S.), and also all the states follow the same legal system (again, unlike the states of the U.S.).

In contrast to previous research in this area with aggregate data (Biles, 1981, 1982; Bowker, 1981; Berk et al., 1982), we do find distinct and understandable relationships between the crime rates and imprisonment rates for individual crime types. For serious crimes, the system does appear to behave rationally, and there is evidence that it does adapt to increases in crime with respect to the relatively minor crimes: The imprisonment rate remains stable or goes down even when the crime rate is going up. The evidence for adaptation appears especially strong in the case of the Federal Republic of Germany.

In any case, we see no sign of deterrence nor of criminogenic effects. This once again casts doubts on the efficacy of policies that presume either effect. In general, we can say that the analysis here does not appear to support any specific theory on which we might base criminal justice policy. However, we shall return to these policy issues in the last section, so here we shall only point out that since the criminal justice system does respond rationally to serious crimes there is no obvious corrective measures to take, aside from changing sentencing practices to achieve some other goals altogether. For the purposes of trying to change sentencing policy, it would be worthwhile to point out that this analysis suggests that the imprisonment rate comprises two components: offenders sentenced for serious crimes and less serious offenders. Policy changes with regard to the sentencing of the serious offenders are probably less likely to occur, than changes aimed at sentencing for minor offences.

In discussing policy issues, we should also remember that the data we analyse are really policy outcomes themselves, since different criminal justice policies and practices will produce different data. For example, the way data on crime rates are collected and reported influence the nature of the numbers and trends that we can observe. In the U.S. for instance, the crime data reported is only for the "index" crimes, and we have no reliable measure of the total crime rate in all the states. This is especially important to remember in comparisons, since the

aggregate crime rate for Germany reflects all crimes known to the police, and not just the "index" crimes.

Similar discrepancies exist in imprisonment data as well. In West Germany, there are two imprisonment rates reported, as we have seen: the total prison population, and the sentenced population. In the U.S., prison population implies the population in state prisons. This leaves out the populations in federal prisons (a relatively small number) and in jails (a very large number). Thus the prison statistics for the U.S. is not a complete measure of the incarceration rate at all, since it is estimated that the jail population is close to the prison population in most states. Also, the prison populations are not comparable across states, because the decision to send a convicted offender to jail or to prison is made in different ways. In some states for example, an offender goes to prison if sentenced to more than one year; in other states it may be when the sentence is more than two years; in still other states it may be six months. Obviously all these variations should be kept in mind when making comparisons.

We now proceed with the analysis of data from other countries. Most notably, we have been able to collect data for the U.K. and data for Australia was already available. These are over longer periods of time and thus gives us more confidence in our time series analysis.

Part 3:

TRENDS IN CRIMINAL JUSTICE DATA: AN INTERNATIONAL COMPARISON

X. Comparative Analysis of Criminal Justice Data from Europe, Australia and Canada: Introduction

We continue our exploration of trends in the imprisonment rate in other countries and jurisdictions. As before, we wish to investigate the prevalence of stability in imprisonment, and if stability is absent, the trends and temporal patterns in the imprisonment rates. We also wish to continue to study the relationship between crime and imprisonment rates over time, and especially their relationships for different types of crime, since we can now appreciate the importance of disaggregation by crime type.

Again, limitations on the availability of appropriate data is a major constraint. There are several types of limitations, ranging from insufficient disaggregation by crime type for some countries, through incomparable classification schemes in the reported data (for example, the categories in reported crime data being quite different from prison data or the categories for one type of data changing over time) to simple absence of relevant data over a sufficient number of years that is necessary to carry out time series analysis. Further, the more countries that are considered, the greater the problems of comparability[64]. Different countries report different kinds of data and in different ways. An outstanding example is that some countries only report prison admissions or committals by different crime types, not the numbers in prison, while some countries report both.

In the following sections we present analysis of criminal justice data from England and Wales, Australia, the Scandinavian countries (Sweden, Finland, Norway) and (very briefly) some time series data from Austria and Canada. The data for England and Wales is over a relatively large number of years, and this allows us to analyze it somewhat deeper. In particular, although we have mentioned the problem of autocorrelation in time series data, and although we have tried to

develop ARIMA models, there really was not much we could do, given the short time series and thus for example, we could not put much faith in the ARIMA models. In the case of England and Wales, however, the length of the time series allows us to correct for the autocorrelation properly, and analyze the relationships between crime and sentencing rates more accurately. The data for Australia is even better for time series analysis, since we have it for 72 years. This has enabled us to develop more elaborate models for the relationship between crime, conviction and prison admissions.

The relationship between aggregate crime and imprisonment rates has been examined by Biles (1982). He found that while the trends for the two rates were similar in the case of England and Wales (suggesting a rational response of the criminal justice system to increases in the crime rate), the trends for the two rates were quite different in Australia. In both countries, crimes increased significantly, but while the imprisonment rate remained fairly stable (and actually decreased slightly) in Australia, it increased for England and Wales.

The data from the Scandinavian countries covered only a short time span (although their aggregate imprisonment figures are the longest available). However, the data is presented here nevertheless for tentative comparisons. The author could find very little relevant data on other countries. There is in fact a large amount of miscellaneous time series (not always precisely annual, which is a necessity) for Austria, Holland and Canada. Thus we end this part with a brief review of this data and some overall comparisons.

Figure 3.1

Time Series of the Incidence of Crime (C_t) and Prison Admissions (A_t) for Violent Crimes

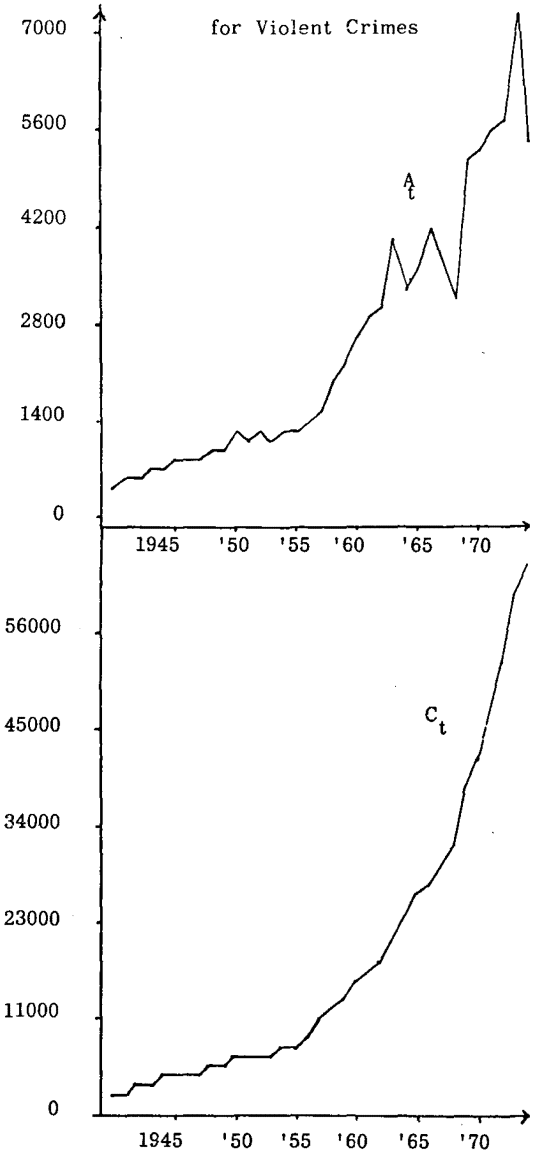


Figure 3.2

Time Series of the Incidence of Crime (C_t) and Prison Admissions (A_t) for Sex Offences

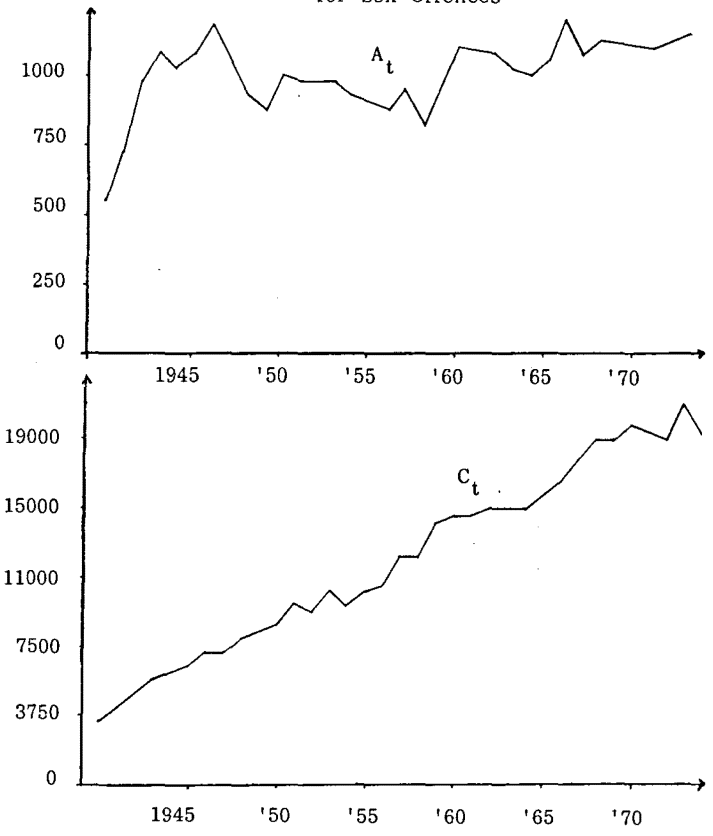


Figure 3.3

Time Series of the Incidence of Crime (C_t) and Prison Admissions (A_t) for Burglary

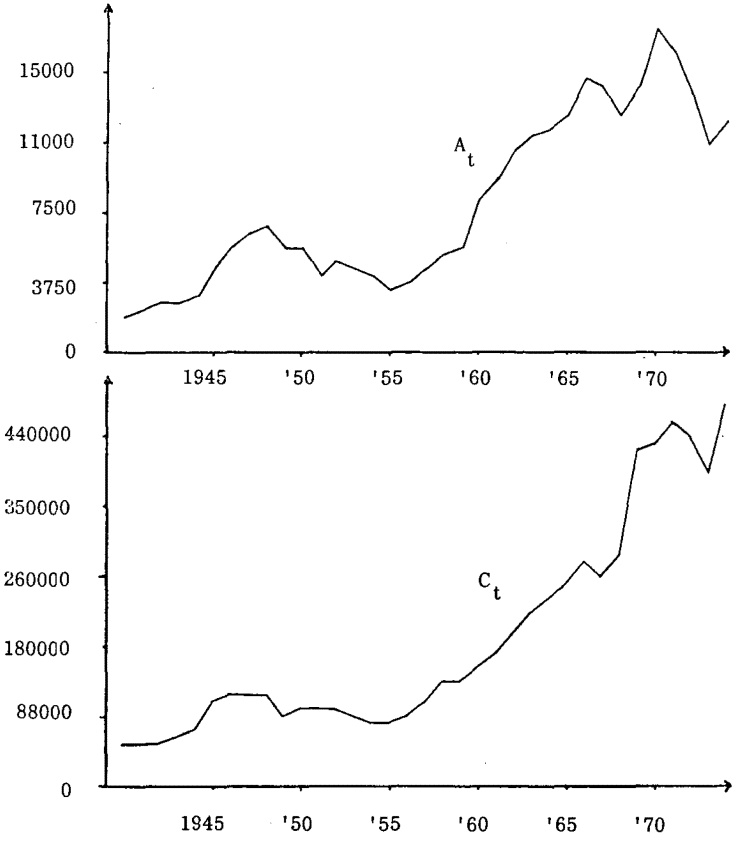
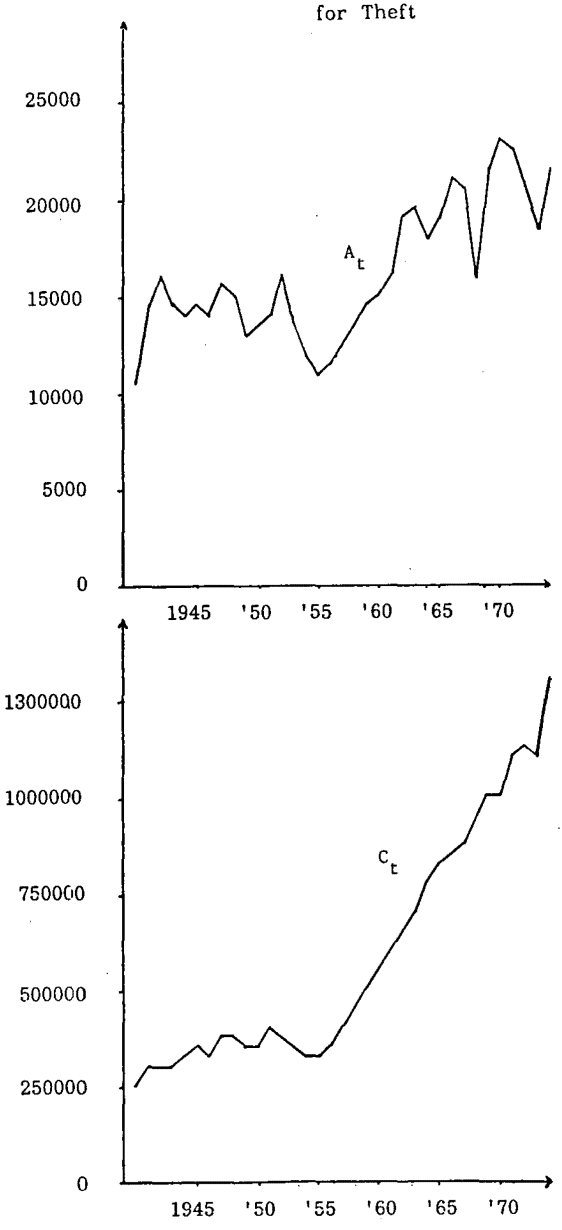


Figure 3.4

Time Series of the Incidence of Crime (C_t) and Prison Admissions (A_t) for Theft



XI. Exploration of crime and imprisonment trends in England and Wales

The data analysed here are the annual incidence of crime and prison admissions of sentenced offenders from 1940 to 1974, for four major crime types: violent offences, sex offences, burglary, and theft, where theft was taken to include larceny, fraud and forgery. The data were collected from the reports published by the Home Office (HMSO, 1940-1962; 1964-1974; 1940-1974). The reported data before and after were not comparable at such a disaggregated level so the analysis was limited to this time period and to these crime types for the same reason.

The data are plotted in Figures 3.1 to 3.4 for each crime type. It should be noted that the scale for prison admissions is greatly magnified to display changes in its level. Relative to the incidence of crime it is in fact far lower and far more stable for all the crime types. (The rates of incidence are taken instead of the usual rate per 100,000 population, since the correlations at zero would be identical, and the pattern of cross-correlations would be the same.)

Previous analyses had considered correlations among the disaggregated rates for West Germany. While this can be informative for getting an overview of the relationships, they would still fail to reveal various details of the relationships between the time series when there is significant collinearity as Biles (1983) found in the case of England and Wales, and when there is high autocorrelation within each (as is true for most time series). In such cases, it is necessary to go beyond the correlations between the series themselves and examine the cross-correlations between the prewhitened series, McCleary and Hay (1980). Prewhitening a series is equivalent to removing the autocorrelation component from the time series and looking at the resulting residuals. The cross-correlations of these prewhitened time series can provide important insights into the temporal relationships of time series that would be otherwise masked by the autocorrelations and collinearity.

For the time series we are considering here, there was not only a high

autocorrelation in every case, but also a high cross-correlation, between .7 and .9 (highest at zero lag, and gradually decreasing with lag in both directions) for each of the crime types, exactly as Biles had found for the aggregate rates. To examine the relationship between the incidence of crime and imprisonment, it is thus more appropriate to study the corss-correlations of the prewhitened time series for each of the crime types. This was not possible with the time series analyzed previously because they were too short (a chronic problem with ARIMA-type analyses), but for England and Wales it was possible to get data over a period of 35 years, and thus this more refined analysis was feasible. The cross-correlations are given in Figures 3.6 to 3.9. Since the orientation of the graphs is different here, we present the new orientation in terms of the corresponding hypotheses in Figure 3.5.

Violent Crimes:

Examining violent crimes first, we note that while the rate of increase in imprisonment rates has not been as great as in crime rates (the scales in Figure 3.1 are very different), both exhibit similar patterns of approximately exponential growth. From Figure 3.6 we see that the prewhitened series have a high cross-correlation at zero lag indicating that prison admissions for violent crime are indeed closely related to their incidence that year.

There are also relatively high negative cross-correlations at lags +1 and -1. The forward lag suggests some adaptation where high crime rates tend to produce low sentencing rates the next year. However, it is just significant being two standard deviations away. The backward lag (also barely significant) could indicate either a deterrence effect, that is, higher sentencing rates producing lower crime rates and vice versa or a feedback effect from courts to police behaviour, if perhaps police respond to any tendency towards leniency on the part of the courts by recording more crimes.

The other negative, forward cross-correlation that is just significant also suggests adaptation, where the criminal justice system responds after three years. Given that court proceedings for violent crimes may

Figure 3.5

Interpretation of the Different Types of Cross-correlations between the Time Series of Crimes (C_t) and Prison Admissions (A_t)

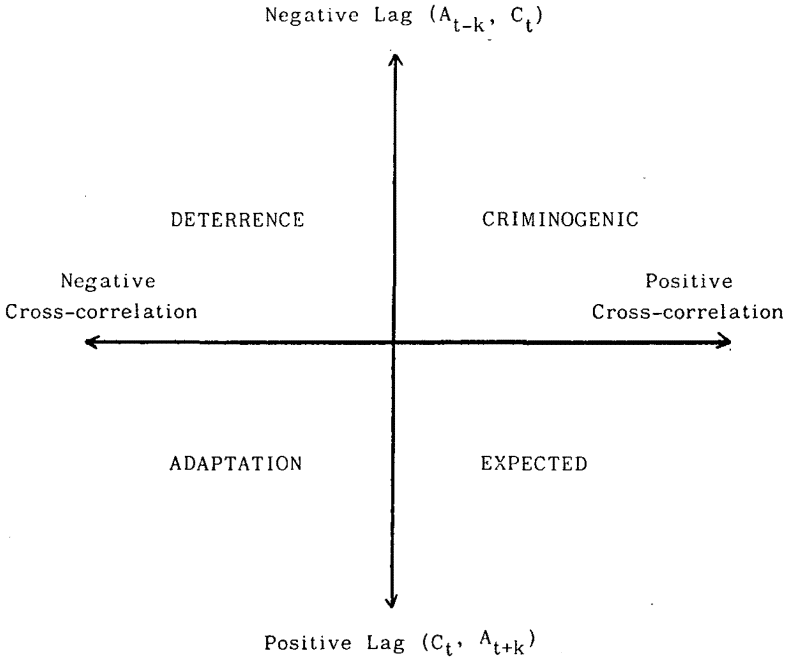


Figure 3.6

Plot of Cross-correlations between the Prewhitened Time Series of Crimes and Prison Admissions for Violent Crimes with the significance level (2x standard deviation) marked

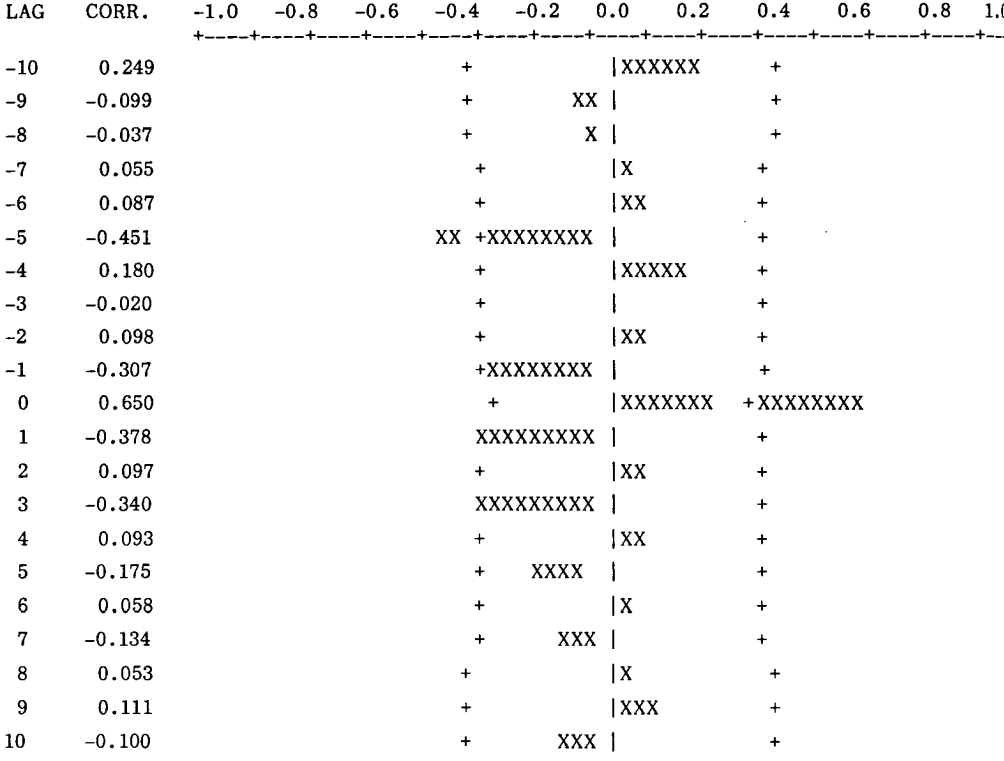


Figure 3.7

Plot of Cross-correlations between the Prewhitened Time Series of Crime and Prison Admissions for Sex Offences with the significance level (2x standard deviation) marked

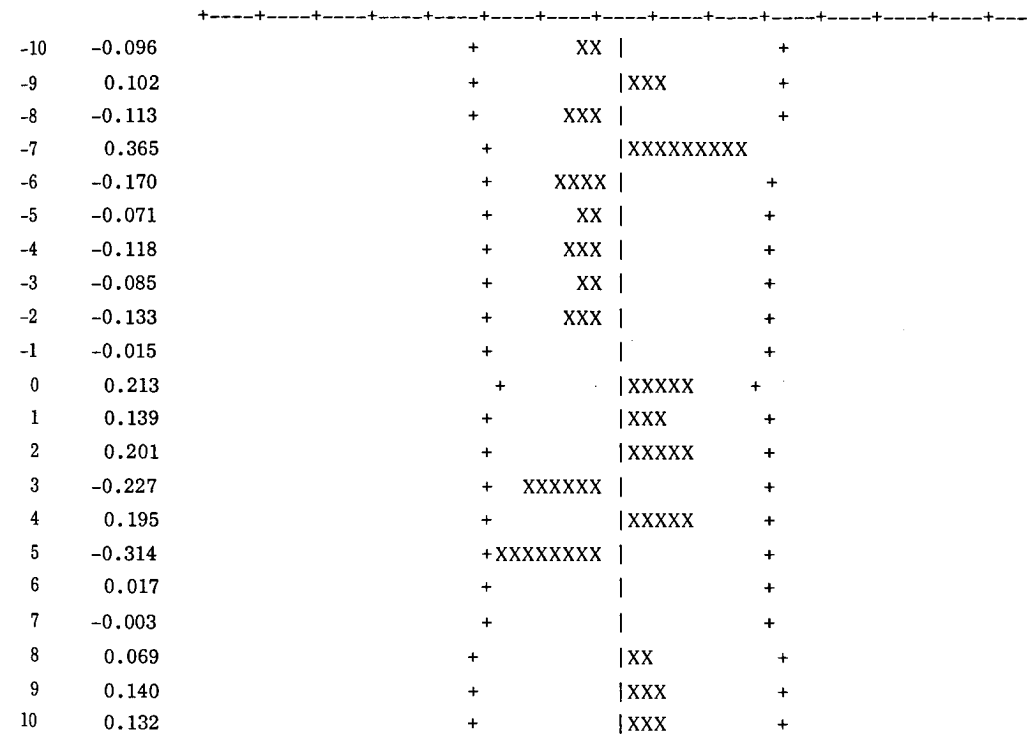


Figure 3.8

Plot of Cross-correlations between the Prewhitened Time Series of Crimes and Prison Admissions for Burglary with the significance level (2x standard deviation) marked

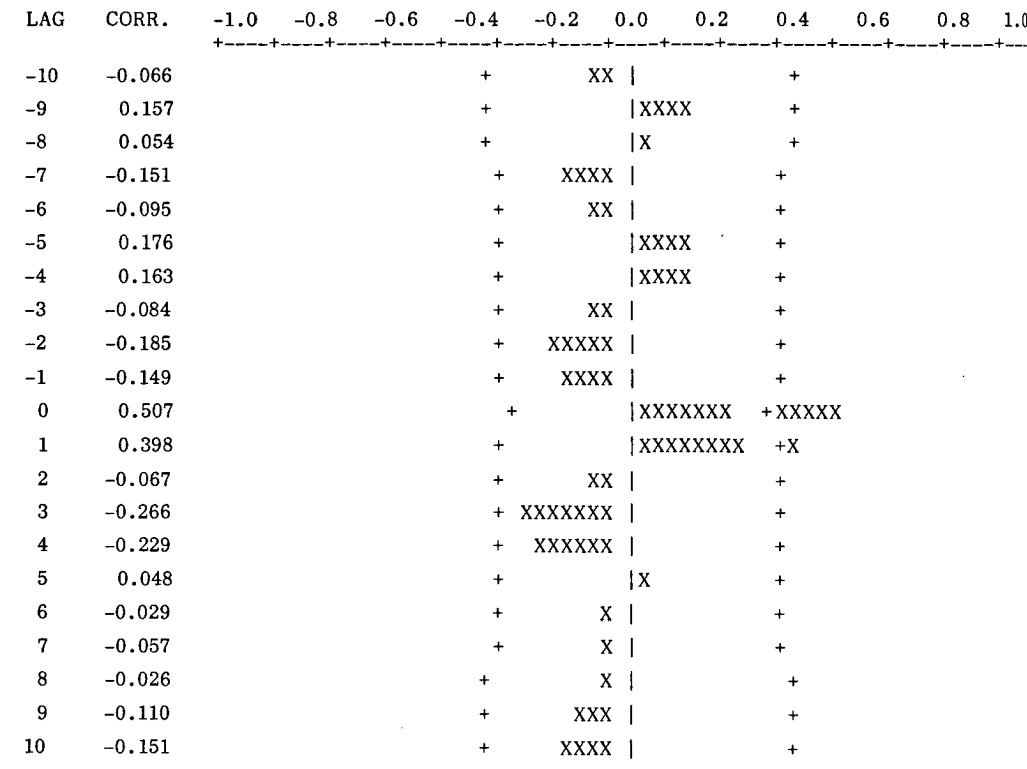


Figure 3.9

Plot of Cross-correlations between the Prewhitened Time Series of Crimes and Prison Admissions for Theft with the significance level (2x standard deviation) marked

LAG	CORR.	-1.0 -0.8 -0.6 -0.4 -0.2 0.0 0.2 0.4 0.6 0.8 1.0
-10	-0.078	XX | +
-9	0.055	|X +
-8	-0.142	XXXX | +
-7	-0.186	XXXXX | +
-6	-0.125	XXX | +
-5	0.367	|XXXXXXXXX
-4	-0.004	| +
-3	-0.202	XXXXX | +
-2	0.072	|XX +
-1	-0.141	XXXX | +
0	0.436	|XXXXXXX +XXX
1	0.202	|XXXXX +
2	-0.127	XXX | +
3	0.056	|X +
4	-0.060	X | +
5	0.066	|XX +
6	0.040	|X +
7	-0.034	X | +
8	-0.128	XXX | +
9	-0.123	XXX | +
10	-0.060	X | +

take a relatively long time and that it takes time for the system to respond in any case, a lag of three years is not unreasonable. The adaptation may take the form of courts reducing the rate of prison sentencing for the less serious offences in this category, in the face of large increases in the crime rate.

Finally we should note a significant negative cross-correlation at lag -5. This suggests a deterrence effect where increases in sentencing produce a decrease in crime (or decreasing sentencing increases crime) after five years. If indeed the prison sentences are relatively long (3 or 4 years) and if some time is required for information on expected punishment to be disseminated among potential criminals, then it may be a reasonable supposition. But it could of course be reflecting some other effect.

Sex Offences:

Next we consider sex offences. The time series of their incidence and of prison admissions for them are shown in Figure 3.2, and the cross-correlations of the prewhitened series are given in Figure 3.7. From Figure 3.2 we see that crimes increased with a linear trend, while admissions were relatively stable from 1942 onwards. This difference could well reflect a changing mix of the different offences reported in this group of crimes. But in any case, the direct relationship is not as strong as Biles found for the aggregate data, and thus this confirms the need to examine disaggregated data.

This lack of a direct relationship is reflected in the absence of any significant cross-correlations between the prewhitened time series. There is one relatively large cross-correlation at lag +5. It is negative and thus might indicate a delayed adaptive response, but the lag of 5 years makes it somewhat unlikely. The other large correlation at lag -7 is positive and could indicate a criminogenic effect, but again 7 years appear to be too long a gap for it to be plausible.

Burglary:

Turning now to the third crime, burglary, we see a similar pattern for crimes and admissions. Both were fairly stable till 1956 (with

temporary increases around 1944-45), and then both increased sharply. The plot of the cross-correlations (Figure 3.8) of the prewhitened series reveal only two significant values, both positive and at lags 0 and +1. That is, prison admissions for burglary are closely correlated to burglaries recorded that year and to a lesser extent to those for the previous year. The lag may well represent delays in catching burglars and/or court delays. In general for burglary as for violent crimes, there appears to be a close relationship between crime and imprisonment, similar to Biles' finding for aggregate data.

Theft:

The time series for the last crime we consider, theft, can be divided into two segments. Before 1960, the incidence of crime was fairly stable, while prison admissions were stable, but with many fluctuations. After 1960, the number of crimes rose steadily, while admissions also rose but much less steadily. While this might be some indication of some adaptation within the criminal justice system, it is not confirmed by the cross-correlations of the pre-whitened data (Figure 3.9). There is one significant value at lag zero, suggesting that admissions are related to the incidence of crimes that year, and there is another positive correlation at lag -5. While this could be an indication of a criminogenic effect, the large lag makes it somewhat unlikely.

Conclusions

In this section the relationship between crime and imprisonment were examined for individual crime types in the case of England and Wales, and some new aspects of the relationships were found for each of the crime types. The approach used here was to analyse the cross-correlations between the prewhitened time series of crime rates and prison admissions for each crime. One of the significant features of these cross-correlations is that their values change sharply as a function of lag, whereas cross-correlations of the original series vary very gradually with lag because of autocorrelation. It is this persistence of the effect of autocorrelation that is removed by prewhitening.

Another new aspect that we notice is that the cyclic pattern that can

be observed in the time series of the aggregate prison population (Biles, 1982) is absent in the data for prison admissions for the crime types considered here. In general, as Biles had found, prison admissions have tended to vary in approximately the same way as the crime rate (with the exception of sex offences). Thus, there is fairly consistent evidence that the system responds rationally to changes in the crime rate, particularly for violent offences, burglary and theft. However, in all cases the rate of increase of admissions has been far less than the rate of increase of crimes. To account for this, the hypothesis of adaptation has been suggested, and some evidence was indeed found. For example, from the plots of the time series and from the cross-correlations there appeared to be some adaptation in the case of violent crimes, sex offences; a rather weak evidence in the case of burglary and only from graphical analysis for theft. Similarly, there was some suggestion of a deterrence effect for violent crimes and a possible criminogenic effect for theft. But the evidence is not very strong nor conclusive and certainly does not provide any basis for policy making. In later sections we will compare these findings with those for other countries, and in the final section we shall consider the policy implications in more depth.

XII. Analysis of criminal justice data for Australia: An Application of ARIMA Transfer Function Models

So far we have analyzed crime and imprisonment rates for disaggregated crime types, we have examined lagged correlations to explore possible relationships between crime and imprisonment, and finally, for England and Wales, we were able to study the cross-correlations of the time series after filtering out the effects of autocorrelation. It is possible, however, to apply ARIMA models to investigate the temporal relationships more thoroughly. However, in order to develop these models, one needs relatively long time series, at least for fifty time periods (in our case years). Such data is of course extremely difficult to come by, but we do have such data, available for Australia (Mukherjee, et. al., 1981). There are of course a number of difficulties in using these data. For example, Biles (1982) discusses various changes that took place that might invalidate the data, and some of the data points are estimates. However, it still represents a useful data set to explore the different relationships between crime and punishment, and therefore we now turn to the analysis of this data.

Data on four crime groups are available, and for this analysis three of them were selected[65]. They were "offences against the person" (henceforth refered to as violent offences), "property offences" and "petty offences" (henceforth refered to as minor offences). For each of the three types, there are data for arrests (charges), convictions and prison admissions (committals) from 1900 to 1971. These long time series allow us to explore long term trends, to use models that provide more details about temporal relationships, and to distinguish specific relationships that correspond to the four hypotheses discussed above. Australia is a particularly interesting case because while the total crime rate has gone up considerably, the imprisonment rate has remained quite stable, leading Biles (1982) to suggest that the criminal justice system does not appear to have responded rationally and has probably adapted to increases in crime. However, before we reject the rational hypothesis and also in order to understand the mechanism of adaptation, we should look at the disaggregated figures.

We wish to analyse the issues along several dimensions: first of all we

wish to see if indeed there are different relationships between arrests and convictions or between convictions and admissions for different crime types: secondly, we wish to investigate what kind of relationship exists for each crime type (for example deterrence or adaptation, etc.). Thirdly, we wish to see how the relationships vary at different stages in the criminal justice system (between arrest to conviction and conviction to sentence). In order to do this, we need to be able to model the temporal relationship between two variables. One method is of course through regression, but as discussed earlier, there are a number of problems in using regression with time series, since time series data tend to be highly autocorrelated. Also, regression assumes a linear relationship (in the absence of any transformations), and very often the temporal relationships can be nonlinear. Thus, the results from regression can be very misleading.

However, we can use ARIMA models to identify a "transfer function" which shows the nature of the relationship between two time series. We can conceptualize the transfer function as follows:

Figure 3.10

Model of one time series being influenced by another series plus a series of random shocks

Where Y(t) is being influenced by X(t) through the transfer function and is also subject to random shocks in the form of a random (white-noise) time series e(t). The advantage of this model is that the transfer function gives us a structure for the relationship between Y and X, that provides a great deal of information about that relationship. For example, it can suggest the direction of a possible causal relationship, that is, whether X is influencing Y or whether Y is influencing X (or both); it will also indicate the time lag between the "causing" variable and the "caused" variable; and it will give the strength of the relationship between X and Y for different time lags. For example, from the transfer function we might be able to deduce that X appears

to have a strong influence on Y after 3 years and a weaker influence after 5 years and that Y appears to have no influence on X at all. The method of identifying the transfer function and the details of interpreting a givent transfer function are given in the appendix. The transfer function indicates the nature of long term relationships between two time series. Thus, it assumes that the relationship is a stable one rather than a dynamic one, and this is reflected in the fact that the transfer function itself is invariant over time. Therefore this methodology is not suitable for analyzing short term changes in relationship, because short term trends are subsumed under the overall, long term pattern.

Analysis and results

The analysis proceeds through three steps. First of all, we identify the ARIMA model that fits each of the time series. Since there are three crime types and three types of data (arrests, convictions, admissions) for each, we have nine time series. The time series are shown in Figures 3.11 to 3.13 and the ARIMA models for each are given in Table 3.1.

The identification of the transfer function is based on the "cross-correlation function" or CCF. This is the correlation between two time series as a function of different lags between them. In the second step, the cross-correlation function between the time series for arrests and conviction, and conviction and admissions are obtained for each of the three crime types and these CCFs are plotted in the appendix.

From the CCFs, we proceed to the third step of identifying the transfer function. The details of the procedure can be found in the appendix, but basically we identify all the significant correlations and try to incorporate a term in the transfer function that would correspond to each of them. As an example, a simple transfer function might look like this:

$Y(t) = | (aB^2)/(1+cB^3) | X(t) + e(t)$.

The B's are the backward operators, so B^k refers to a lag of k years. Therefore this transfer function indicates that Y is being influenced by X after a lag of two years, since (--→ to page 120)

Figure 3.11a

Time series of arrest rates for violent offences

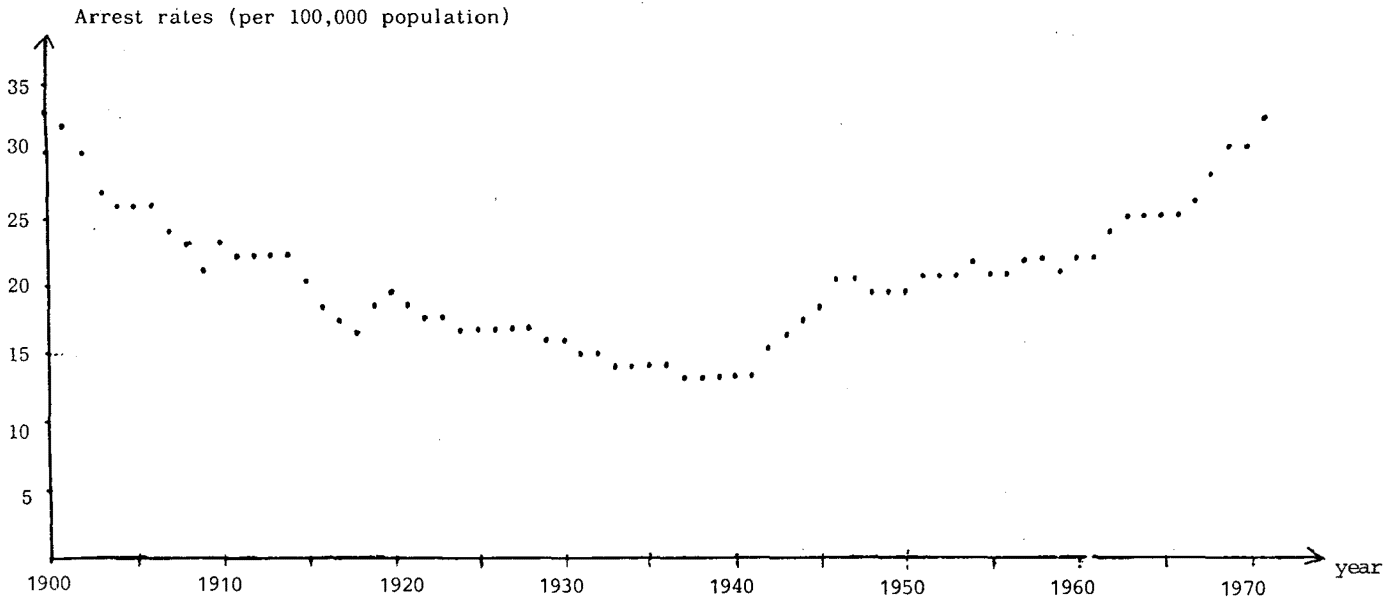


Figure 3.11b

Time series of conviction rates for violent crimes

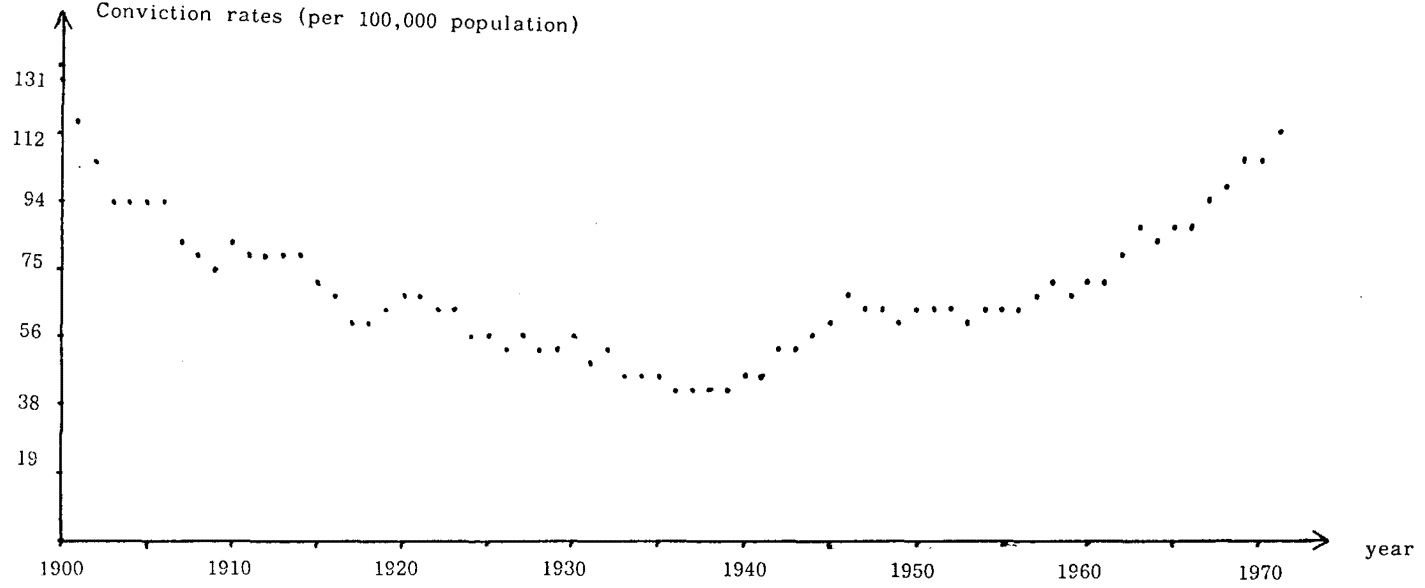


Figure 3.11c

Time series of prison admissions for violent crimes

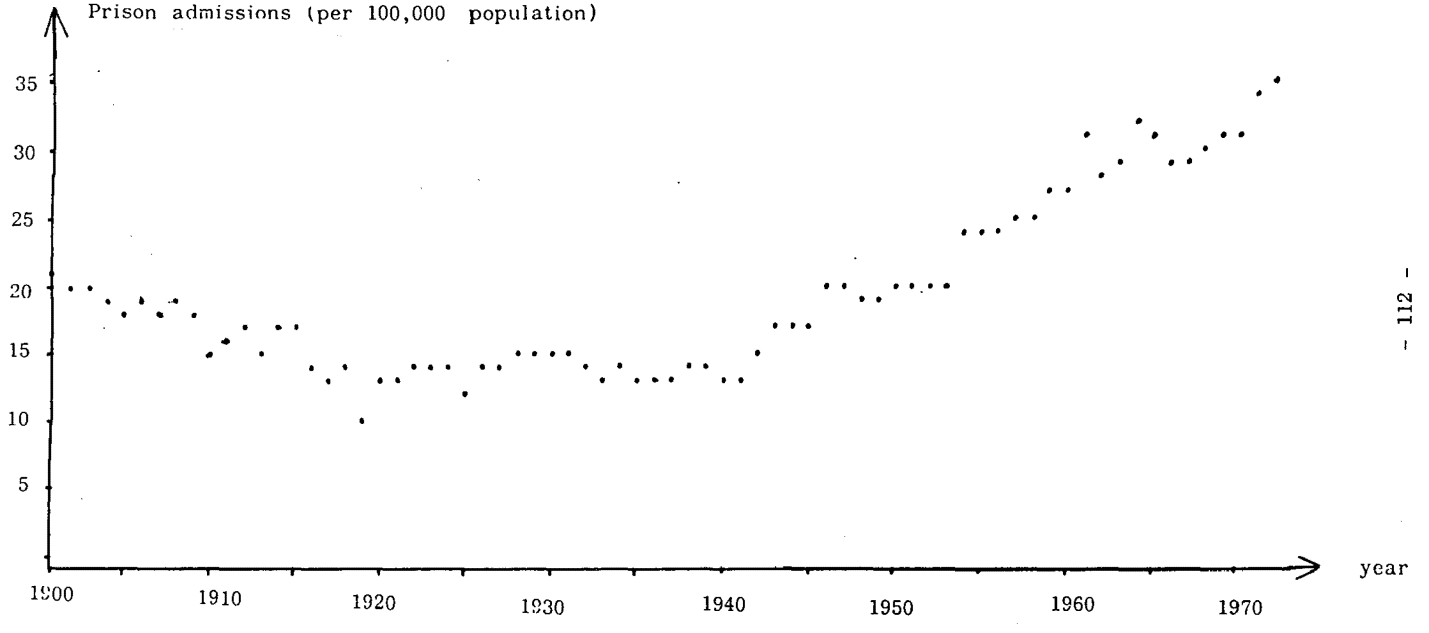


Figure 3.12a

Time Series of arrest rates for property crimes

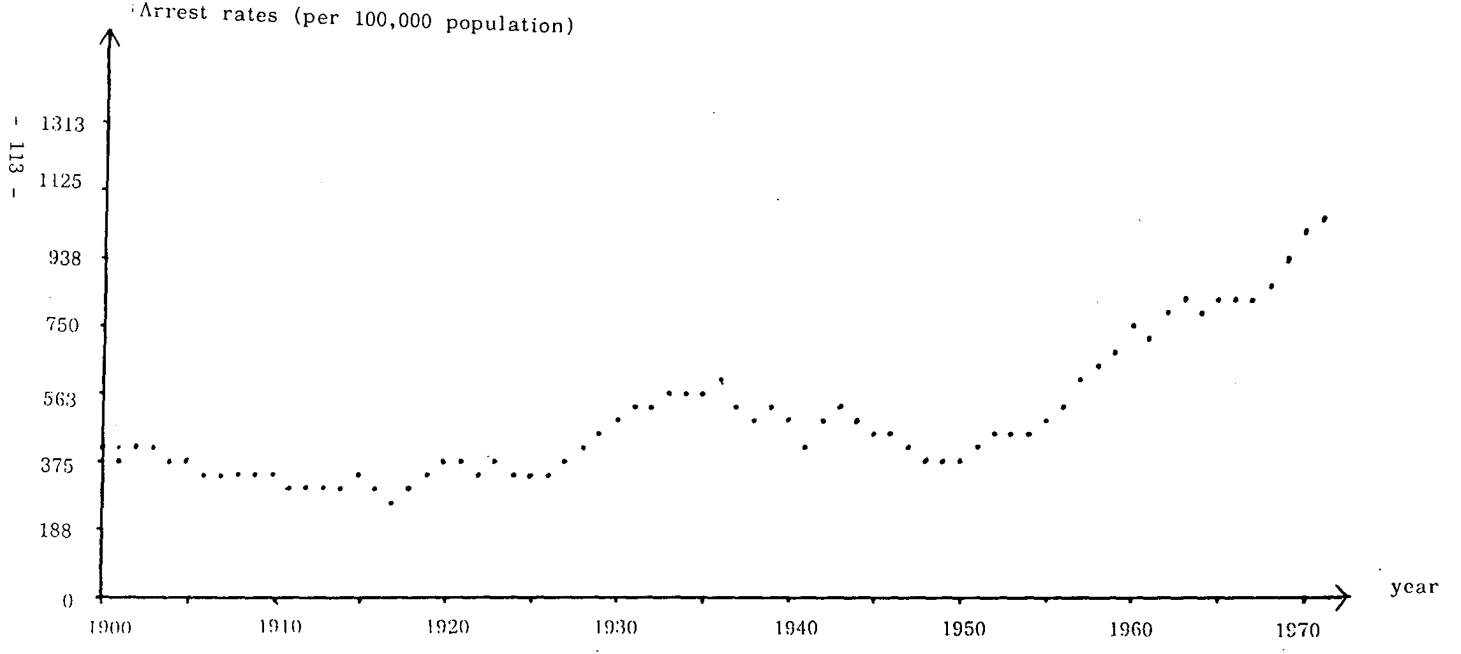


Figure 3.12b

Time series of conviction rates for property crimes

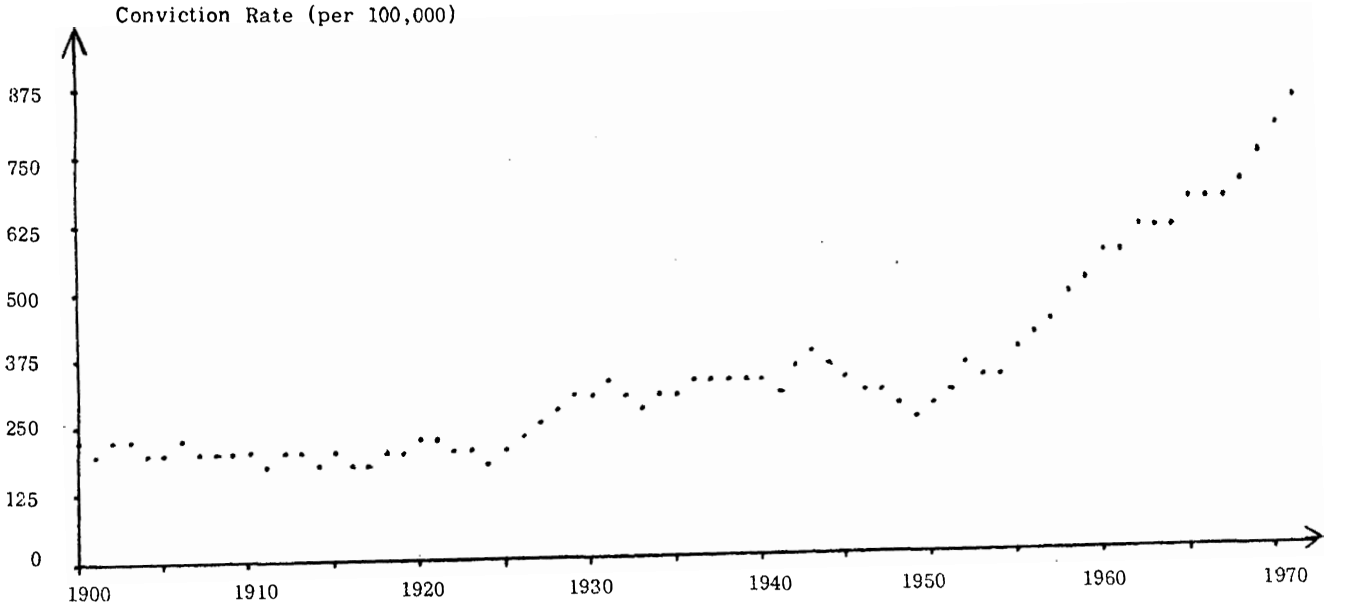


Figure 3.12c

Time series of prison admissions for property crimes

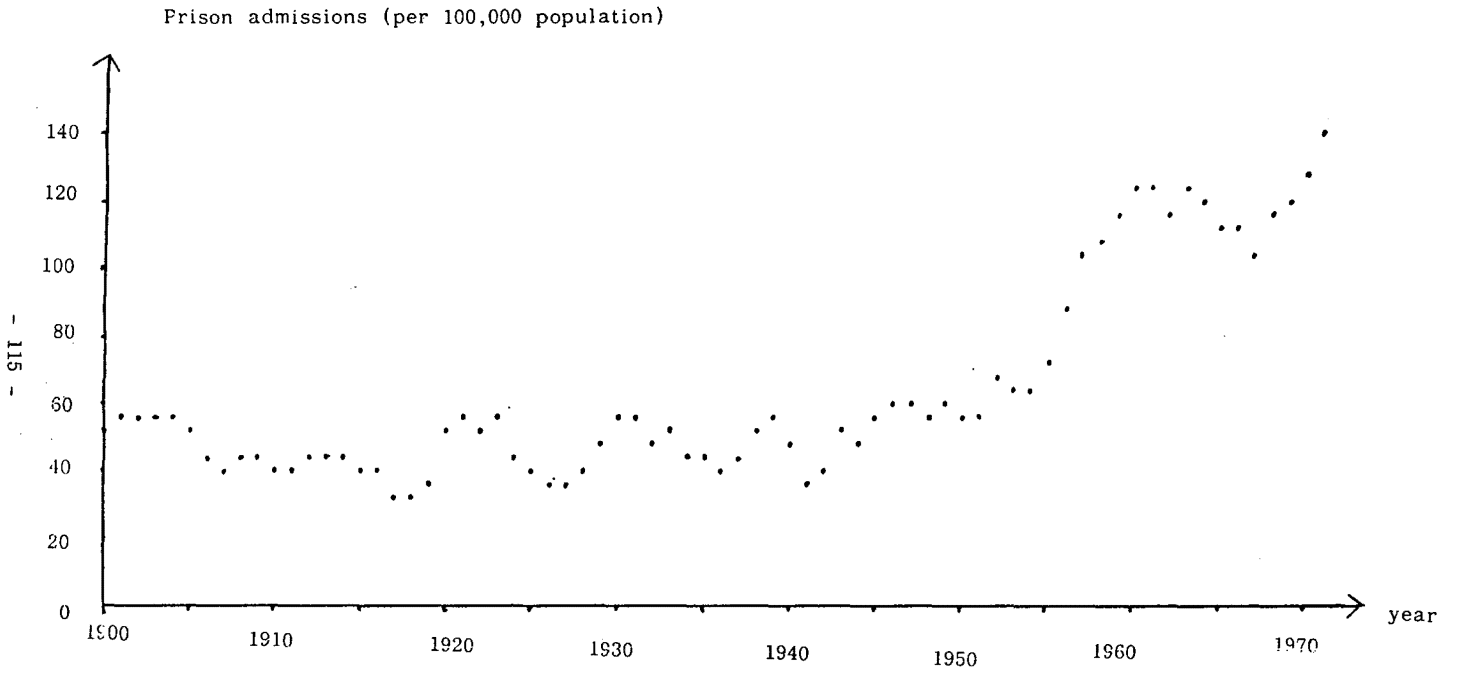


Figure 3.13a

Time series of arrest rates for minor crimes

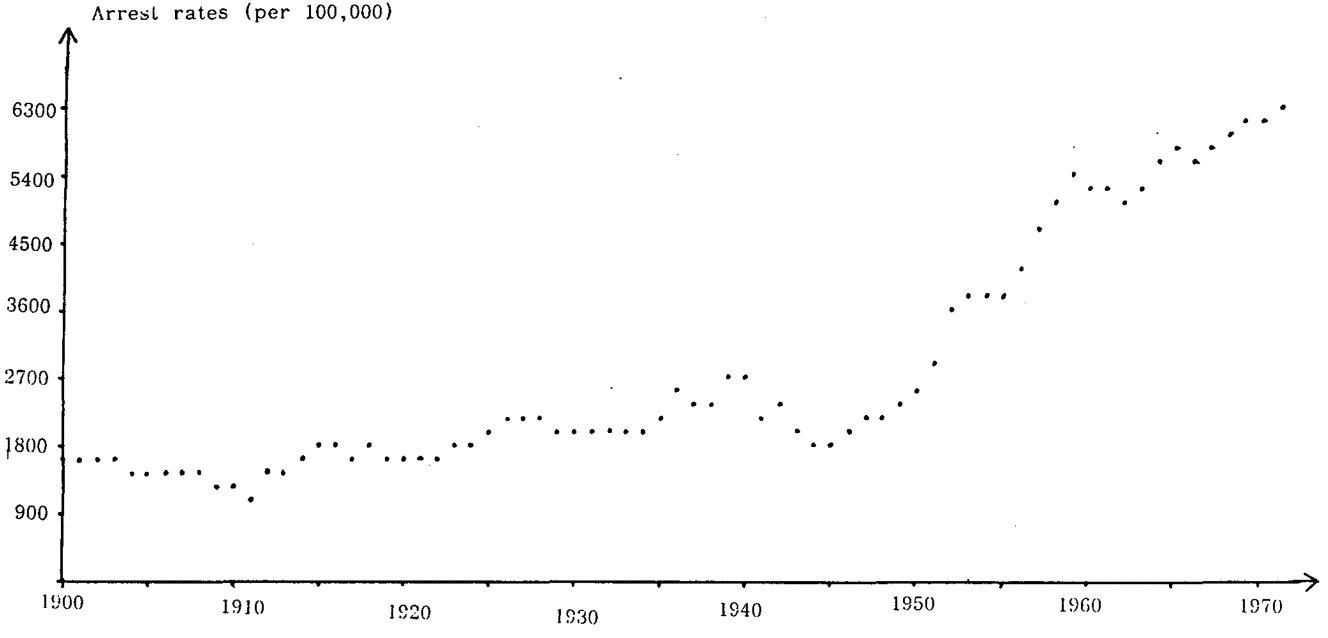


Figure 3.13b

Time series of conviction rates for minor crimes

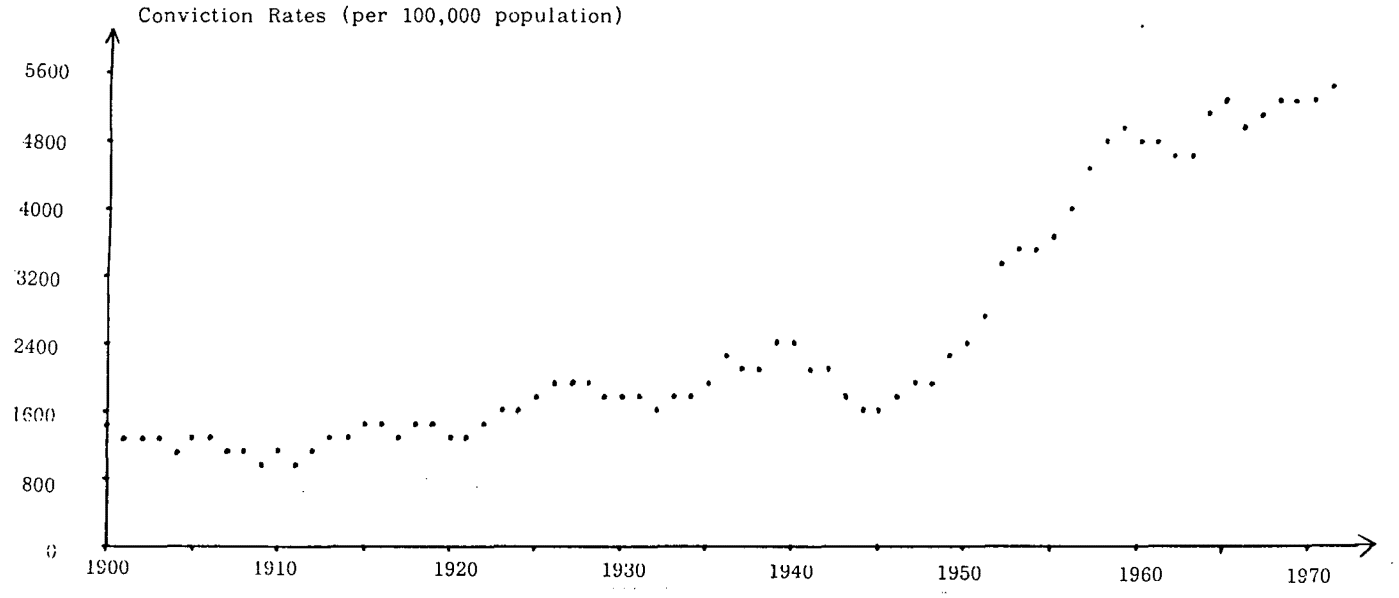


Figure 3.13c

Time Series of prison admissions for minor crimes

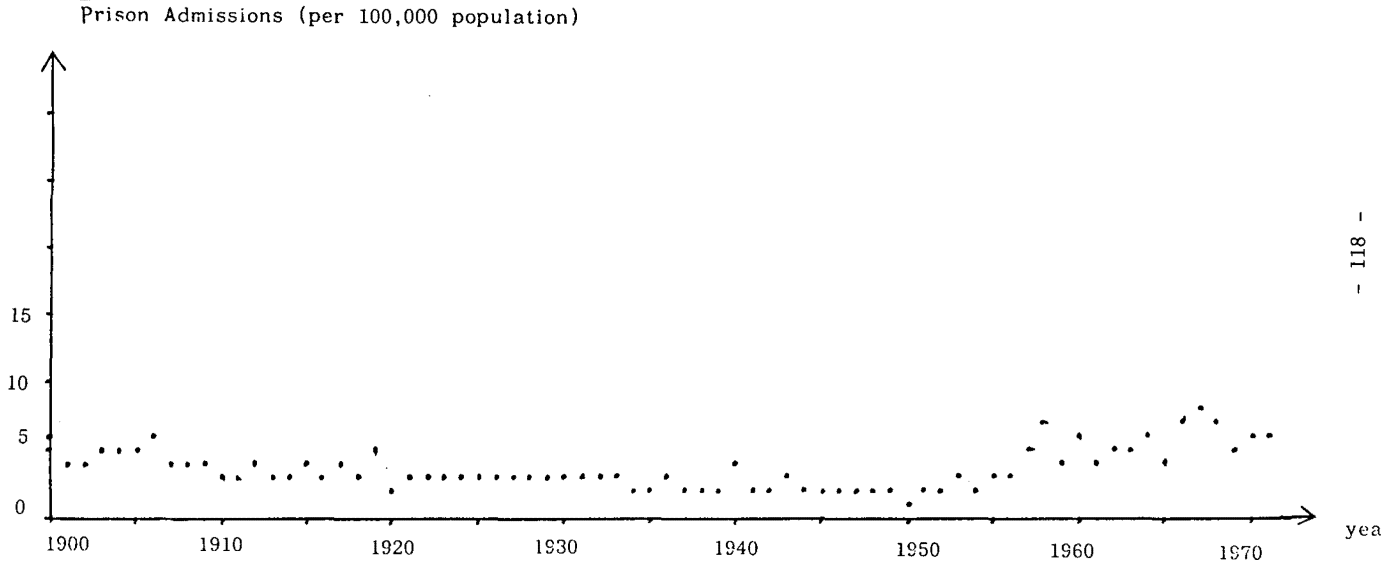


Table 3.1

ARIMA models of the time series of arrest, conviction and prison admission rates for all three crime types

Rate of	crime type: Violent	Property	Minor
Arrest	$A_t = .90\ a_{t-1} + a_t$	$A_t = .92\ A_{t-1} + a_t$	$A_t = .95\ A_{t-1} + a_t$
Conviction	$V_t = .88\ V_{t-1} + a_t$	$V_t = .92\ V_{t-1} + a_t$	$V_t = .96\ V_{t-1} + a_t$
Admissions	$E_t = .94\ E_{t-1} + a_t$	$E_t = .93\ E_{t-1} + a_t$	$E_t = .73\ E_{t-1} + .33\ E_{t-2} + a_t$

Y_t ------> X_{t-2}

where, very much like a regression equation, a unit increase in X will increase Y by a unit after two years. Also, the denominator indicates that X is also being influenced by Y after a lag of one year, since it implies

X_{t-2} ------> Y_{t-3} or

X_{t+1} ------> Y_t [66].

While these interpretations are clearly from a causal perspective, it should be obvious that we cannot infer causality right away. Rather these findings should be interpreted in the following way: If there were indeed such an underlying causal mechanism, then these findings conform to that theory (but cannot be said to prove the theory). As is well known, it is notoriously difficult to conclude that there is a causal relationship.

The transfer functions identified for each pair of time series and for each crime type are displayed in Table 3.2. We now discuss them for each crime.

Violent crimes:

Here we see that arrests have an effect on convictions. The numerator indicates an effect A_t --> V_{t+2},
and the denominator indicates an effect A_t --> V_{t+1}.
This seems to be a fairly reasonable relation with the arrest rate influencing the conviction rate for the following year, and to a lesser degree the conviction rate two years later. These delays could presumably be due to court procedures. Convictions in turn have an effect on prison admissions, and with a delay of one year V_t --> E_{t+1}. This again seems to be a reasonable finding, in that there might well be a year's delay due to appeals and before a sentencing decision could be made.

Property crimes:

Here we find very similar relationships in both cases. The transfer functions are quite simple and indicate that arrests do influence the

Table 3.2

Transfer functions identified for "arrest-to-conviction" and "conviction-to-prison admission" time series pairs

Time series pair	Crime type		
	Violent	Property	Minor
arrest --> conviction (A) (V)	$V_t = \frac{.18B^2}{1+.39B} A_t + \frac{1}{1+.99B} a_t$	$V_t = .25A_t + \frac{1}{1+.99B} a_t$	$V_t = (.65 - .4B^9) A_t + \frac{1}{1+.99} a_t$
conviction --> admission (V) (E)	$E_t = .11B\ V_t + \frac{1}{1+.99B} a_t$	$E_t = .11\ V_t + \frac{1}{1\ .99B} a_t$	$E_t = \frac{1}{1 + .47B + 37B^2} a_t$

conviction rates the same year, and convictions have an influence (but a rather weak one) on admissions. It appears, there are no time lags in either case, perhaps reflecting a quicker rate of disposal of property crime cases.

Petty offences:

The transfer functions for petty offences are on the other hand quite different. The arrest rate does appear to influence the conviction rate, but the pattern is rather interesting. The arrests have a fairly strong effect on the convictions for that year (as reflected by the large coefficient), but it also appears to have a negative influence on the conviction rate nine years later, which would appear to indicate a cyclic relationship. However, this is probably a spurious cross-correlation, but we should note in passing that the hypothesis of adaptation often involves a cyclic pattern because of the time needed for the system to adjust to changes. In examining the effect of convictions on prison admissions, we see in fact that convictions do not affect admissions at all. Refering back to the time series, we see that prison admissions for petty offences is a stable time series, independent of the convictions which have increased over the years. Indeed, the time series for admissions for petty offences can be modelled as an AR(2) process, which is a process that simply depends on its own past values and is not influenced by external factors.

Summary:

For the serious crimes (violent and property), there is a clear and reasonable relationship between arrests, convictions and prison admissions. It would appear both from a visual inspection of the time series and from the transfer functions that the criminal justice system responds rationally to changes in the crime rate. Thus analysing disaggregated data is once again clearly advantageous, in that this could not be observed with aggregate data (Biles, 1982). The reason for the discrepancy is also clear in that the crime rates are being driven by minor crimes: petty offences and good order offences, while prison admissions are related mainly to the serious crimes: violent and property crimes. Clearly, much remains to be done, and the disaggregation has by no means gone far enough, but at least this analysis

helps to clarify some of the issues. The lack of relationship between crime and imprisonment can be explained in part by the far greater increases in minor crimes, but the imprisonment rate for which has not gone up[67]. This does, however, give some support to the hypothesis of adaptation in that minor offences are being punished at a relatively lower rate, since their rates of incidence has gone up, but the rates of sentencing for those crimes have not. Thus the criminal justice system appears to be adapting in part to the aggregate rise in crimes by not punishing minor offences as severely as it did before.

Conclusions:

These findings compare well with similar results found with disaggregated data from the other jurisdictions. Thus the data from the Federal Republic of Germany, California and the United Kingdom all suggested that the rational response hypothesis appears to be generally true for serious crimes in all countries. For Germany, there appears to be significant evidence of adaptation, in that the imprisonment rate for minor crimes have actually decreased, even as their rates of incidence have increased; presumably to make prison space available for the more serious offenders (whose numbers had also increased). We shall make a fuller comparison later after reviewing the trends for other countries.

XIII. A Multi-country Comparison of Temporal Trends in Criminal Justice Data

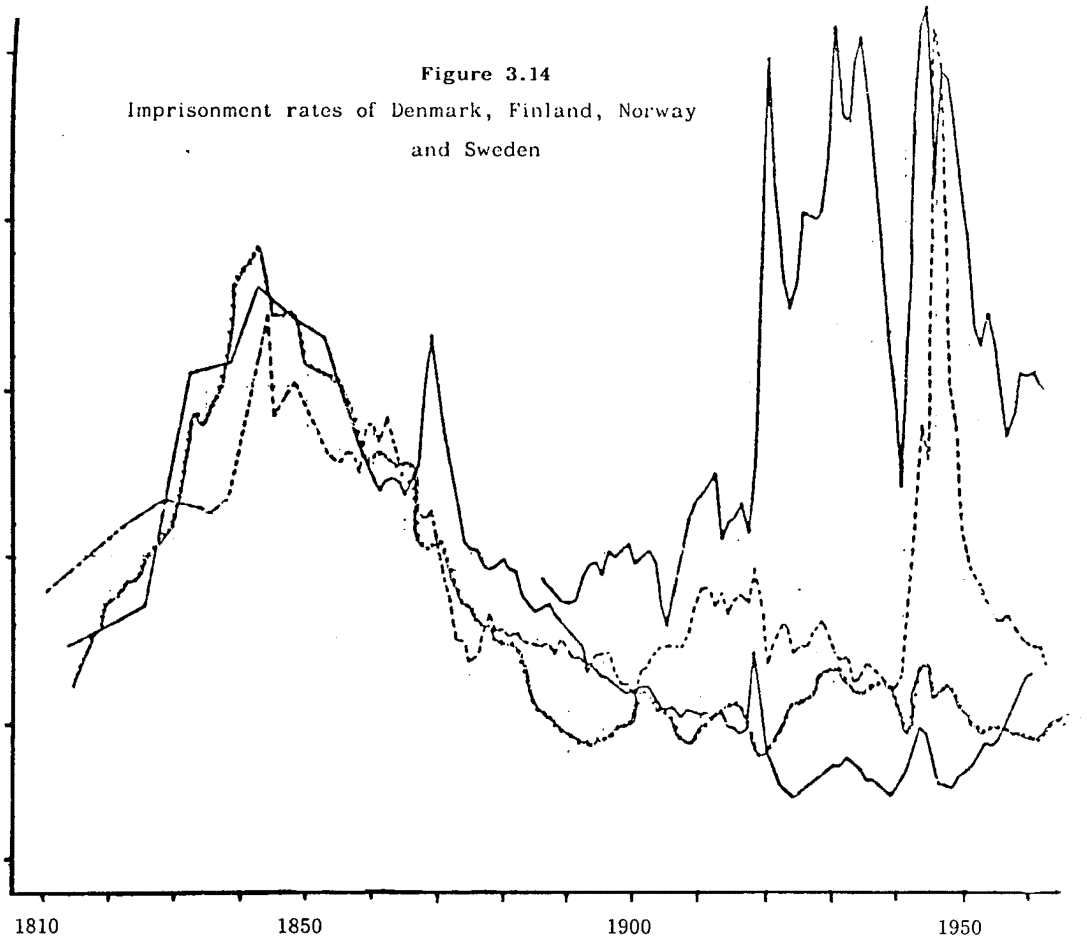
In this section we wish to review data from other European countries and Canada. Unfortunately it was either infeasible or impossible to obtain data at the desired level of detail or for a sufficiently long period of time, and therefore no extensive analysis could be undertaken. However, it might still be worthwhile to survey whatever time series data could be obtained and see what trends are displayed. First we discuss data from the Scandinavian countries, and then (even more briefly) we discuss some data from Holland, Austria and Canada.

The Scandinavian Countries

For the Scandinavian countries, Christie (1963) had examined the time series of the imprisonment rates for Denmark, Finland, Norway and Sweden from about 1810 to 1960. Although he did not address the issue of stability directly, one can explore that issue with his data (figure 3.14). Although it might appear rather surprising at first sight, but all the time series data fit the model of stability. This (perhaps unexpected) conclusion can, however, be explained through a closer look at the time series and with the understanding that a stochastic process may exhibit considerable variations or drifts and still be stable or stationary, as discussed in Part 1. From this point of view, the apparent instability in the Scandinavian imprisonment rates would be due to the increase between 1820 to 1840, resulting from an increasing use of imprisonment as a substitute for corporal punishment. However, what is striking and what gives support to the finding of stability is that after this increase, an apparent reaction set in, and the rates (for Denmark, Norway and Sweden) went back down to a level very close to that which prevailed in 1810! Thus (although perhaps hard to accept immediately), on reflection, the rates even from visual inspection appear to be stable. The case of Finland is perhaps the most difficult to accept, since the series appears to be unstable. This, however, is because the fluctuations in the imprisonment rate for Finland are indeed very large, and because of this, there is not strong enough evidence to reject the hypothesis of stability or stationarity. Stability or stationarity can encompass quite large fluctuations. To reject that hypothesis, we need definite evidence that

Figure 3.14

Imprisonment rates of Denmark, Finland, Norway and Sweden



Source: "Changes in Penal values" by Nils Christie in Scandinavian Studies in Criminology, vol. 2.

the **level** of the series has shifted. One cannot say that even for Finland, and for the present we should accept the hypothesis of stability for all the imprisonment rates, with the rate for Finland having a distinctly higher level[68] than Denmark, Norway and Sweden.

We now turn to the exploration of the relationships between crime and imprisonment for disaggregated crime types for the individual countries: Sweden, Finland and Norway. In all cases, the time series were very short, so we can only make very tentative suggestions with regard to the trends. The Swedish data is given in Table 3.3[69]. Sweden seems to display a somewhat different pattern in that its prison admission rates have gone up **faster** for some crime types than the crime rate. For example, for both homicide and rape admissions increased much more than did the crime rate between 1974 and 1981. The same is true for theft, where the rate of increase was greater than the rate of increase in total admissions. For robbery and fraud, the increase in admissions was slightly greater than for their respective crime rate, while for aggravated assault, crime and prison admissions increased at approximately the same proportion. This is also the case for all crime types together. The number of crimes increased by a factor of 1.33, while the prison admissions increased by a factor of 1.47. Thus, while no firm conclusions can be drawn and no further time series analysis can be meaningfully done, we might say that, overall, Sweden seems to have responded rationally to the increase in crime rate with harsher sentencing (in terms of sending offenders to prison) for homicide, rape and theft. It may be that because the increase in crimes was not very large, the capacity of the criminal justice system had not reached its limits, and hence there is no evidence of adaptation. It should be remembered that adaptation takes place only at the limits of capacity constraint, and until that constraint is reached, the criminal justice system may well respond to increases in the crime rates with increased harshness, as appears to be the case for homicide and rape, and even for the relatively minor crime of theft.

In the case of Finland, the interpretation of the data is somewhat problematic, since there are some ambiguities over the classification of the different crime types[70]. For example, we have the annual prison

Table 3.3

Number of crimes (Cr.) and prison admissions (Pr. Ad.) in Sweden: 1974-1982

Year	Crime Type															
	Homicide		Aggr. Assault		Rape		Robbery		Thefts		Fraud		All crimes	
	Pr.Ad.	Cr.	Pr.Ad.	Cr.	Pr.Ad.	Cr.	Pr.Ad.	Cr.	Pr.Ad.	Cr.	Pr.Ad.	Cr.	Pr.Ad.	Cr.
1974		93	628	19,899	59	684	160	2296	1091	403139	270	45,005	9,025	570610
1975		122	618	21,509	73	769	153	2336	1467	465396	251	47,539	9,839	643405
1976	21	128	572	21,378	85	773	164	2697	1647	501467	385	49,752	9,901	683279
1977	19	131	629	23,596	98	800	152	3374	1751	520583	386	54,392	9,742	716367
1978	22	124	670	22,868	93	851	189	3461	1871	493367	362	48,846	10,547	683646
1979	37	170	716	23,171	115	922	151	3075	1851	487033	369	67,332	10,822	698171
1980	42	135	795	24,668	113	885	170	3427	2146	514130	455	16,701	12,054	760911
1981	47	146	888	24,314	105	865	204	3228	2485	511898	557	92,539	13,234	760614
1982	52	-	885	-	128	-	184	-	2710	-	597	-	13,798	-

population for crimes of violence, but we cannot be sure whether they include crimes other than homicide and assault (the two for which crime rates are available). The data for rape, theft and robbery are given in Table 3.4. In the case of rape, both the number of crimes and the number imprisoned (for sex offences) remained fairly stable. For theft, the crime rate increased steadily, while the imprisonment rate first increased and then decreased, perhaps an indication of adaptation. For robbery, both the crimes and prison population increased at first from 1974, but then decreased, and by 1984 were back to almost the same level as in 1974. Overall, the number of crimes increased by a factor of 1.22, while the prison population remained stable, but since the increase in the crime rate was not particularly dramatic, the issue of adaptation is not very salient.

For Norway, while we do have quite detailed data, the time series are rather short. This is because there was a major change in the reporting system for the imprisonment rates between 1965 and 1966, thus rendering the data before that incompatible with subsequent data[71]. However, looking at the data from 1966-1977, we see that for homicide the imprisonment did not go up as much as the crime rate, but the numbers in both cases are too small to make any inferences about trends. The increases in the two rates for assault and rape were approximately the same, suggesting a rational response in these cases. For robbery, the imprisonment rate did not go up as much as the crime rate, but the trends are similar, so it does not appear to indicate adaptation. For theft on the other hand, there was a fairly steady increase in the crime rate while the imprisonment remained stable, and this does appear to indicate some adaptation. For fraud, the imprisonment rate increased somewhat more than the crime rate, but the trends are basically similar: The higher imprisonment rates in the later years probably reflect the higher crime rates that prevailed in between. As far as aggregate trends are concerned, the crime rates experienced a steady increase and increased proportionately much more than imprisonment rates which first increased and then decreased somewhat. (In fact, the imprisonment rates for most of the individual crimes showed a similar pattern of an initial increase and then a slight decrease, with a maximum around the years 1973 to 1975.)

Table 3.4

Number of Crimes (C_t) and Imprisoned Population (I_t) for Finland 1974-1981

Year	Rape		Theft		Robbery		All	
	C_t	I_t	C_t	I_t	C_t	I_t	C_t	I_t
1974		59		1752		337		5104
1975		50		1736		333		5452
1976		54		1785		411		5596
1977		45		1950		453		5555
1978		53		2110		438		5399
1979		40		2020		461		5216
1980		56		2031		478		5088
1981		60		1734		465		4883

Table 3.5

Number of Crimes (C_t) and Imprisoned Population (I_t) for Norway, disaggregated by crime type: 1966-1977

Year	Crime Type															
	Homicide		Assault		Rape		Robbery		Theft		Fraud		All Crimes	
	C_t	I_t	C_t	I_t	C_t	I_t	C_t	I_t	C_t	I_t	C_t	I_t	C_t	I_t
1966	9	14	2166	283	70	39	156	83	34,865	2829	3531	250	48,509	4201
1967	24	9	2161	233	92	50	135	70	37,107	2842	3254	221	51,258	4274
1968	5	15	2233	278	95	42	165	111	38,158	3062	3197	252	51,747	4654
1969	9	16	2751	286	93	52	209	164	44,386	3152	3869	277	60,060	4961
1970	6	18	3092	361	109	67	262	236	47,331	3298	4376	297	64,868	5568
1971	8	23	3115	381	123	61	244	166	54,310	3524	4593	310	73,482	5750
1972	17	18	3212	449	95	50	323	199	59,471	3400	4031	294	79,727	5980
1973	23	46*	3304	467	105	51	290	239	65,928	3377	4287	302	86,725	6276
1974	20	45	3563	546	127	85	316	185	69,005	3508	4586	364	91,208	6507
1975	21	28	3495	560	119	65	306	280	76,148	3399	4478	379	96,754	6180
1976	32	42	3524	476	108	85	331	230	68,710	3012	4763	373	90,262	5710
1977	29	36	3599	476	147	74	281	200	69,460	2984	4210	371	90,101	5720

* There are no explanations given for this jump. Presumably it is a response to the increase in the crime rate between 1971 and 1972.

Holland:

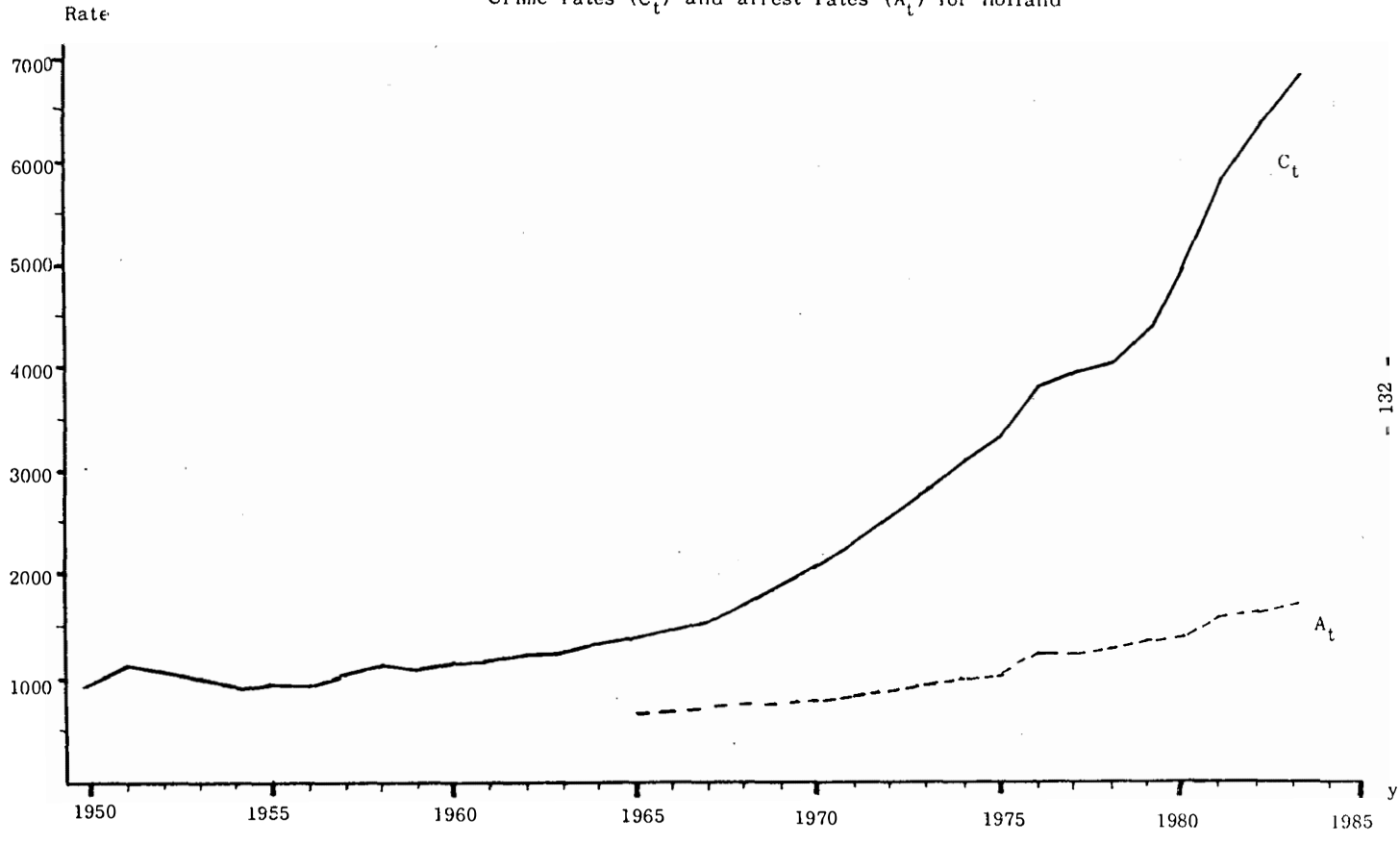
We turn now to a review of some time series data from Holland[72]) Figure **3.14** shows the aggregate crime rate and the arrest rate, and Figure **3.15** shows the numbers of known crimes, arrests, court charges and convictions. We note a striking divergence between the large increase in the crime rate and the much more stable (albeit slightly increasing) arrest rate. This suggests some form of adaptation, along with the possibility that the increase in the crime rate was driven by minor crimes, and the police had neither the wish nor the possibility of arresting the offenders. In the absence of disaggregated data, not much more can be said. Figure 3.16 indicates that a very high proportion of arrests lead to court charges, and also that the number of court charges has increased at about the same rate as arrests. This suggests that there is probably little or no adaptation at this stage in the criminal justice system in Holland. However, the numbers convicted have remained remarkably stable. Again, lacking data disaggregated by crime type, we cannot explore the existence of any adaptation process.

Austria:

The next country whose criminal justice data we review is Austria[73]). Data on the aggregate crime rate, arrest rate, conviction rate, imprisonment rate and proportions of convicted offenders who are sentenced to prison or fined are available from 1953 to 1977 and are given in Table **3.6.** There is a slightly increasing trend for the crime rate, but the surprising observation is that the arrest rate is amazingly close to the crime rate until 1966. In the absence of disaggregated data it is difficult to interpret this relationship, but it could be that more crimes are committed in groups in Austria, and thus a higher number of arrests occur for every crime that is cleared. Or, it could be that during this time period, the police "over-arrested", that is arrested whoever they suspected. If this was their practice, then their arrest rates would be high, although presumably the number of arrests cases that are dismissed would also be high. However, this close relationship seems to have changed, and since 1970 the arrest rate has been decreasing even though crime rates have continued to increase.

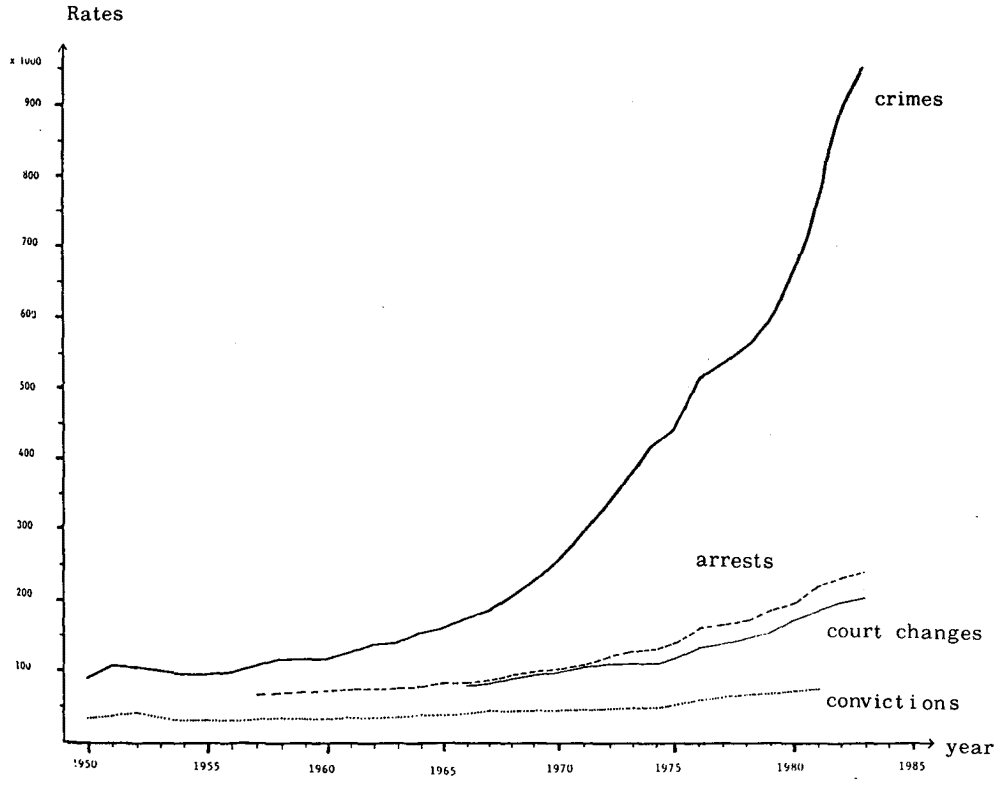
Figure 3.15

Crime rates (C_t) and arrest rates (A_t) for Holland



Source: CBS, criminele-politiële statistiek, maandstatistiek 1970-1984.

Figure 3.16
Crime rates, arrest rates, rates of court charges
and conviction rates for Holland



Source: CBS, statistical yearbook of the Netherlands 1956-1984

Table 3.6

Time Series of criminal justice variables for Austria: 1953-1977

Year	C_t+	A_t+	V_t*	I_t*	Q_t	F_t
1953	2812	2805	1854	167	49,7	44,8
1954	2906	2874	1885	154	46,3	48,0
1955	3087	3053	1991	138	42,4	51,1
1956	3097	3020	2109	145	41,8	50,7
1957	3240	3075	2109	147	42,4	49,7
1958	3315	3151	2082	150	42,4	50,2
1959	3407	3229	2208	157	41,4	51,6
1960	3431	3237	2140	163	41,6	52,0
1961	3218	2947	1955	166	42,9	50,5
1962	3225	2897	1854	167	42,8	50,6
1963	3280	2896	1819	157	42,7	50,4
1964	3297	2893	1830	147	41,4	51,7
1965	3370	2890	1779	139	40,8	52,2
1966	3470	2927	1860	143	39,9	53,3
1967	3644	3013	1915	154	41,2	52,2
1968	3774	3054	1957	159	41,8	52,5
1969	3827	3086	1979	162	40,4	53,2
1970	3844	3081	1931	153	38,8	54,4
1971	3708	2855	1887	155	40,0	52,9
1972	3925	2790	1760	149	37,5	55,6
1973	3876	2734	1574	149	35,6	58,5
1974	4065	2785	1550	147	34,6	59,2
1975	3933	2380	1405	130	22,9	71,4
1976	4053	2367	1411	129	22,9	71,5
1977	4038	2375	1422	133	23,1	70,8

C_t= crime rate

A_t= arrest rate

V_t= conviction rate

I_t= imprisonment rate

Q_t= proportion of convictees sentenced to prison

F_t= proportion of convictees fined

\+ per 100,000 population excluding the 0-6 year age group

* per 100,000 population excluding the 0-14 year age group.

The conviction rate has been quite stable and in fact has had a decreasing trend since 1959. Again, there could be several explanations for this, including adaptation, but is is impossible to explore them without more information. The imprisonment rate has also been quite stable and has been generally decreasing since 1969. The explanation for that probably lies in part with the policy trend of sentencing fewer people to prison and imposing fines more often. Thus, we see a very significant decrease in the proportion of convicted offenders who are sent to prison, from 49.1% in 1953 to 23.1% in 1977. Again the role of policy changes and the possible cahnge in the crime mix (that is the proportion of minor crimes that are normally punished with a fine) cannot be clarified at this stage. We see that the proportion of convicted offenders who are fined has gone up at approximately the same rate of the proportion sentenced to prison has gone down.

Canada:

Finally we present in Figure 3.17 the imprisonment rates for Canada from 1920 to 1972[74]. This is also a stable time series, even though there are significant fluctuations. The point about stability from the point of view of stochastic processes is that as long as there is no conclusive evidence that the **level** of the series has changed, it must be considered stationary or stable. Again, we refer the reader to McCleary and Hay (1981) for a more detailed exposition. A stationary ARIMA model did in fact fit the data:

$I_t = .84I_{t-1} + a_t$

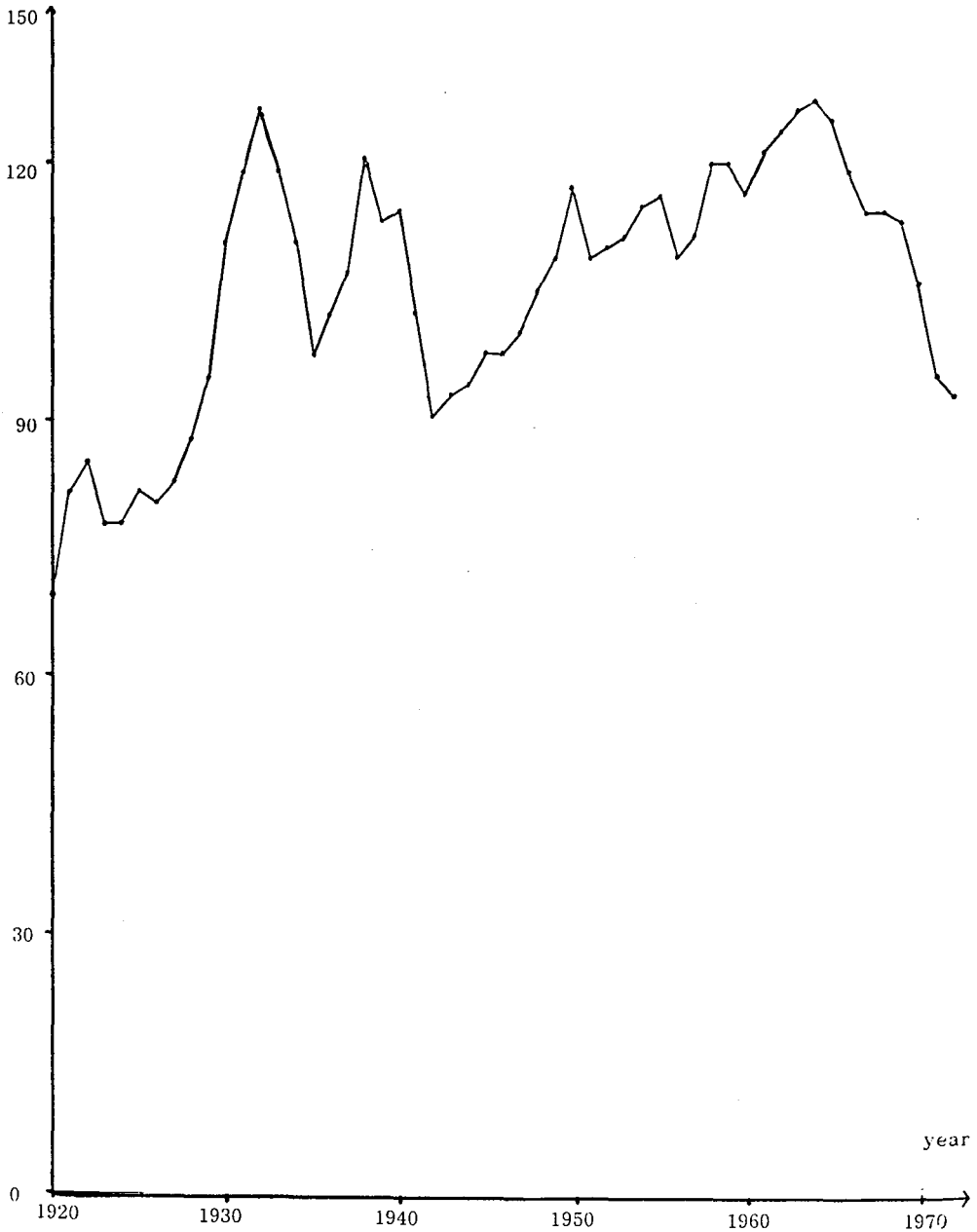
This time series has been discussed several times in the literature (Blumstein and Cohen, 1973; Greenberg 1977; Waller and Chan, 1979). In particular Greenberg found that the time series was correlated with the unemployment rate[75]. We should note that the imprisonment rate in Canada has gone up somewhat since then, but whether that has made the series unstable cannot yet be determined. It could be a temporary fluctuation or perhaps the series will stabilize at a higher level.

Summary

We may conclude this survey of trends in criminal justice data by commenting on the fact that even though we often see substantial

Figure 3.17

Imprisonment Rates for Canada: 1920-1972



fluctuations, the imprisonment rate in many countries appear surprisingly stable. The one clear exception to that is the United Kingdom which has had a steady and significant increase in its imprisonment rate. In other countries, most notably the U.S., there have been significant increases in the imprisonment rate in recent years, but it is too early to infer instability.

What is also clearly evident is that the imprisonment rate is much more stable than the (total) crime rate. That is, for those countries that have experienced significant increases in crime, the imprisonment rate has not increased to the same extent. While this of course could have been expected, given the many constraints on increasing the imprisonment rate (most obviously prison capacity), the exact mechanism of this adjustment or adaptation had not been clarified before. Using disaggregated data from a number of countries, we can now clearly identify some aspects of this adaptation process. For serious crimes, the criminal justice system has responded rationally, and the imprisonment rate has gone up in about the same proportion as the crime rate. It is with respect to the relatively minor crimes that the criminal justice system had adapted, and we can observe this from the finding that the imprisonment rate for these crimes have not increased as much as the crime rates (or even at all, in some cases and decreased in others). Of course, there are exceptions to this overall pattern, most notably Sweden. Here we might speculate that since the crime rate had not increased that dramatically, the capacity of the criminal justice system had probably not reached its limit and hence such an adaptation was not necessary. This highlights another aspect of adaptation: that it operates only at the limits, especially at the upper limit.

Part 4:

INVESTIGATION OF THE RELATIONSHIPS BETWEEN CRIMINAL JUSTICE VARIABLES AND OTHER SOCIOECONOMIC VARIABLES: THE CASE OF THE FEDERAL REPUBLIC OF GERMANY

XIV. DEVELOPING EXPLANATORY MODELS

The key issue we wish to investigate in this final part is the pattern of relationships that exist over time between criminal justice variables like the crime rate or the imprisonment rate, and socioeconomic variables like the unemployment rate or economic growth. In fact, many theories have been propounded on this issue, and various authors have suggested that crime or imprisonment rates are related to demographic, economic or sociological variables or some combination of them. As we have already discussed in the review of the literature, the demographic variables cited include population growth, regional and/or age distribution of the population, migration patterns, etc. A great deal of emphasis has been placed on economic variables, particularly unemployment, but also economic conditions like economic growth, inflation, cost-of-living, lack of economic opportunities for the underclasses and also the economic resources allocated to and within the criminal justice system. Criminologists and sociologists have also sought to explain crime and punishment trends in terms of sociological variables, for example in social-conflict/social control theories, or variables related to inequality, change, social unrest or upheavals, industrialization and urbanization with its accompanying alienation and anomie, among others.

There is a large literature on this, as discussed earlier, and Gurr (1982) and Brantingham and Brantingham (1984) in particular refer to many of the sources. However, the empirical verification of these theories has been rather rare. Among the significant efforts to relate criminal justice data to other variables is the analysis by Greenberg (1979) of imprisonment rates and employment rates in the U.S. and Canada. Berk et al. (1983) investigated a number of demographic and policy variables to explain the imprisonment rate of California. The

most thorough analysis of this kind has been done by Mukherjee (1981) with Australian data. He considered a variety of socioeconomic variables and examined their relationships to several criminal justice variables, using correlations, partial correlations and lagged relationships. His findings (see the review of the literature for a summary) show in addition, the importance of looking at different time periods separately, since, as he finds, the relationships vary from one time period to another[76].

Another study in this area is a report recently published by the Council of Europe (1985). The study attempts to relate some socioeconomic indicators to crime trends in the United Kingdom, France and the Federal Republic of Germany. The relationships are examined through simple correlations and regression equations. Before discussing the results, it might be worthwhile to review the methodology used, since such methodologies have been widely used previously, and in general, there are some problems with the interpretation of the results. For example, very often the correlations between two time series are taken at their face value, when in fact it could be very misleading due to the autocorrelation present in each time series. It is necessary to remove this effect of autocorrelation before any accurate indications of the relationships between two variables can be discovered. As another example, single regression equations should not be used in general with time series data without first correcting for autocorrelation. Even then there could be a number of problems. If there are two or more independent variables, then there could well be interaction effects among them, or there could be a simultaneous relationship between one of them and the dependent variable, and in either case, the regression results will be incorrect. If there are interactive effects, then they should be modelled as well through structural (that is, two or more) equations. If there are simultaneous effects, for example, if the crime rate influences the size of the police force **and** the size of the police force influences the crime rate (a very likely simultaneous effect), then that simultaneity should be modelled too, since otherwise not only could the regression coefficients be biased, but even their signs could be wrong. In addition, lagged effects should always be examined in time series, but often, as is the case in this Council of Europe study, they are not included.

In drawing conclusions, it is very important to pay attention to the R^2 value. If it is low, it is usually better not take the model too seriously. If in addition, the regression coefficients are not significant, then it is probably best not to interpret them at all. This study, for example, discusses in detail insignificant coefficients, and even interprets a coefficient whose value is zero (pg. 62). It is our view that insignificant coefficients should as a rule be treated as such. Even their signs are suspect, given the likelihood of simultaneous effects. The above study does indeed qualify its findings with regard to the above methodological problems, and does in general suggest that there is little evidence of systematic and consistent relationships, and the few hypotheses that this and other studies have suggested should still be regarded with caution.

The fundamental problem is that the relationships are extremely complex, and models that incorporate even part of this complexity become too unwieldy to estimate and interpret. In addition of course, the different measures and indicators that are used are at best approximate, and sometimes even misleading. For example, measures of anomie or social control are very difficult to come by. The study by the Council of Europe (1985) suggests using unemployment as a measure of anomie, but this identification seems problematic. Here it is suggested that perhaps the suicide rate or the divorce rate might be a better measure of anomie. Social control is also extremely difficult to quantify, although some authors have used various measures like the imprisonment rate (Berk et al., 1982) or the size of the police force (Council of Europe, 1985), but neither appear to be satisfactory. Social control in modern societies is obviously very complex and is probably achieved through a variety of institutions and groups, including perhaps social workers, psychiatrists and community services. Then there is the problem associated with possible intervening variables that are not included or are unobservable. Finally, using aggregate crime rates tell us very little, and we really need to examine the issue of the relationship between crime statistics and socioeconomic indicators with the crime statistics disaggregated by crime type.

In this study we consider disaggregated data and limit our attention to bivariate relationships, as a way of exploring the basic relationships

that might exist between two variables. To recapitulate, we use ARIMA models and examine the cross-correlations of the pre-whitened time series for lags in both directions. Thus, the effect of autocorrelation is removed, and we get a more accurate picture of the relationship between two time series. In addition, by examining the lags in both directions, we can see the direction of different influences and the time lag after which the influence is felt. As a hypothetical example, we could find that the crime rate is positively correlated with the size of the police force one year later, and is negatively correlated with the size of the police force three years ago. This would suggest (but certainly not prove) that crime influences the size of the police force a year later, and that the size of the police force has a deterrent effect on crime three years later. Thus this methodology allows us to explore some of the complexities of the relationships among time series. However, here again the results should be regarded with caution, especially because the time series considered here are relatively short.

In addition to elucidating temporal relationships, time series has the advantage that it "tracks" the gradual changes over time in the same entity in this case, the same society, so that we are observing social variables within the same cultural framework. In cross-sectional studies, however, there would be invariably many extraneous cultural factors that should also be controlled for, but usually cannot be. For example, if very different countries are included in the same cross-sectional analysis, we would not get very meaningful results, if only because of all the possible influential social variables left out. In time series analysis, we see the relationships between social variables **within** one country. Then we can compare that with what we find within another country.

We continue our exploration of the time series of criminal justice data with an investigation of their relationships to other socioeconomic variables. Our aim is to understand these relationships a little better, to see how, if at all, any are correlated and tentatively investigate the possibility of causal relationship, although it should be clear that we could not possibly infer causality at this stage. Rather, we hope that further studies would help to clarify these relationships better and that more complete theories could be developed on the basis of

these analyses. What we need are specific theories that would relate a set of socioeconomic indicators to specific crime types. While many **postulates** have been put forward, they have often gone untested. Rigorous theories and empirical investigation have to go hand in hand, and here we attempt to develop some empirical understanding of relevant data which might then lead to further theories in criminology.

Having observed different trends for different crimes and distinctly different relationships between crime and imprisonment rates for different crimes, it is now abundantly clear that crimes are very different from each other. We should therefore expect that the social factors that would influence them would also vary from crime to crime. So, in order to understand the relationships between crime statistics and other socioeconomic variables, we must again take the crime statistics disaggregated by crime type. To better understand these relationships, we should ideally consider a variety of different societies to observe the effects of changes in the social and cultural variables, but unfortunately that is far beyond the scope of this study. Here we consider mainly data from the Federal Republic of Germany and make some comparisons with the findings of Mukherjee for Australia.

The first step is naturally to select the hypotheses we would like to investigate, and then the appropriate variables. However, there are a vast number of potential theories and numerous variables that could be examined. Since there are no easy ways to decide on specific hypotheses at this stage of theoretical development, our approach here will have to be in the spirit of exploratory analysis, as mentioned earlier, and we shall attempt to think through plausible relationships and then consider the various variables that would be relevant. For example, we might consider how the rates for different types of crime could be related to demographic variables, and for example, population growth and particularly the proportion of males in the 16 to 24 age group might be related to the crime rates. The list of socioeconomic indicators that were considered was naturally strongly influenced by the survey of the literature[77)]. In particular, attempts were made to explore those indicators that have been considered as related to crime and imprisonment rates. For example Heiland (1983) discusses a variety of models

where economic and demographic variables like median family income, GNP, the price index, unemployment rate, urbanization, age distributions, etc. have been utilized to predict crime rates. For the purposes of this study, a number of theoretical concepts were developed that might be considered to have either direct or indirect influence in crime rates, arrest rates, conviction rates, imprisonment rates or any other criminal justice variable. These concepts led to the consideration of specific, measurable variables. The concepts and the associated variables are shown in the form of a chart given in Table 4.1.

The economic climate has often been considered to have an influence of crime and imprisonment statistics. It shapes the overall mood of society, and through that, the mood of individuals. It may be that during a time of economic growth, crimes of violence (due to anger and frustration) decrease, while property crimes increase due to increased opportunities. For example, Georg von Mayr found that for Germany during 1835 to 1861, the price of grain (an important price index) was positively correlated with the theft rate, but was negatively correlated with the rate of violent crimes (see Council of Europe, 1985). The concept of economic need refers to pressures only on certain individuals that might increase the probability of their committing crimes. In this case, one might hypothesize (quite naturally) that the greater the economic need, the greater the likelihood of committing property crime. We might further hypothesize, that violence might also increase due to frustration.

There are of course a very large number of sociological indicators that might be considered, and here we list a selection of them, according to what has been considered in the literature. The relationships between these and crime rates are what would be intuitive, with of course different indicators influencing different crime types differently. Demographic indicators would also influence crime, although the effects of urbanization is rather complex (Shelley, 1981). Finally, the criminal justice system itself would have an effect on the crime statistics, and some likely indicators are listed by way of examples, although there could clearly be others. As it turned out, apart from prison capacity, it was not possible to collect data on any of the criminal justice variables.

Table 4.1
Theoretical Concepts that would impact on Criminal Justice Variables, and Socioeconomic Indicators derived from them

Theoretical Concept (That might have a bearing on crime)	Relevant, measurable indicators
ECONOMIC CLIMATE: ("macro" influences on the general mood of society: often affecting criminal justice variables through intervening variables)	economic growth/GNP per capita/ expendible income/expenditure on luxury goods industrial capacity being used price index opportunity for crime (density of cars, homes empty during the day)
ECONOMIC NEED: ("micro influences on individual decision making)	unemployment rate (by age) chronically unemployment (by age) poverty rate extent of welfare services number of guest workers (as the complement of unemployment in the FRG)
SOCIAL SYSTEM/STRUCTURE: (reaction of minorities/poorer groups to social control or economic deprivation; extent of anomie; climate of violence: perhaps mediating through psychological variables)	degree of inequality (e.g. Gini index) socioeconomic mobility size of military availability of social workers/ lawyers divorces suicides population in mental institutions school dropont rates single-parent households alcoholism disruptive actions (demonstrations/ strikes)
DEMOGRAPHIC STRUCTURE:	population growth internal migration urbanization/regional redistributions of population males in the age group 15-25
CRIMINAL JUSTICE SYSTEM:	size of police force police expenditures prison capacity changes in sentencing laws or policy

From this chart, we have identified several major variables that would be of interest to us[78]. Next, the Statistisches Jahrbuch for the FRG was consulted to see what data was actually available. Data on many of our indicators of interest were either simply not available, or too difficult to construct from the data reported, or were given for only the recent years (that is, not long enough for any time series analysis to be done), or for which the reporting system had been changed and earlier data could not be compared with later data. As a result of these problems, data on only the following indicators could be collected[79]: divorces, internal migration, number of foreign workers, unemployment rate, productivity index, GNP, urban population, the price index, males in the age group 15-25, suicides, density of cars, single-parent households and expendible income.

However, it became apparent that some variables from this list had to be excluded, because they were highly collinear with some of the other variables, or that some of these exhibited virtually no variation all over the years, or that they appeared to have no relationship at all to the time series of the crime rates[80]. Thus, in the end five socioeconomic variables were used in this analysis. They are: the gross national product per capita (GNPC), expendible income (EXP), number of cars per capita (CARC), unemployment rate (UR) and the suicide rate (SR). It should be pointed out that while few in number, they do in fact represent the spectrum of variables that have been discussed in the literature reasonably well.

XV. DISCUSSION OF THE RESULTS

The time series for each of the variables are presented in figures 4.1 to 4.5. Given that we are seeking to relate these to the time series of the six crime types, we have considered for the Federal Republic of Germany, we can inspect the time series visually, and as a preliminary exercise, try to discern which socioeconomic indicators might be related to which crime tpyes. Clearly this can only be very tentative at this stage, and no actual relationships are implied at this stage. However, as a starting point, it would appear that some possible relationships would be worth exploring. For example, even though many of them seem highly correlated to the crime rates, expendible income in particular, appears to be highly correlated to both robbery and burglary[81]. The gross national product per capita appears closely correlated with larceny, and the number of cars per capita is also very similar to larceny. Then we find that the unemployment rate has a U-shaped form which is strikingly similar to the time series for fraud. Finally, there appear to be similar variations in both the homicide rates and suicide rates. For ease of inspection, the time series are presented in pairs suggested above in figures 4.6 to 4.12.

The above postulated relationships all appear eminently reasonable. Robbery and burglary as economic crimes could well be related to how much is available to steal, which in turn would be strongly determined by expendible income (EXP).

There has been considerable discussion about the recent phenomenon in several industrialized countries of increasing affluence being accompanied by increasing crime. One interpretation is that increasing affluence is accompanied by greater inequality because the wealthy get wealthier faster than the poor (whose lot is nevertheless improving). This inequality results in a greater sense of **relative** deprivation, which motivates people to crime. Some evidence to support this has been found by Heiland (1983). A second interpretation is that of opportunity theory which suggests that as affluence increases, the opportunities to rob, burglarize or steal also increase because there are more goods around, and criminals simply avail themselves of this

Figure 4.1

Time series of the Gross National Product per capita (GNPC) in the Federal Republic of Germany

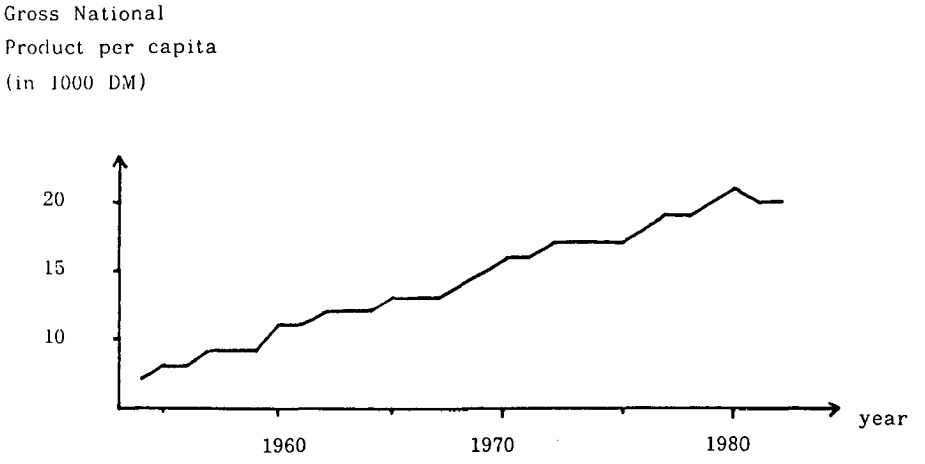


Figure 4.2

Time series of expendible income (EXP)
of the Federal Republic of Germany

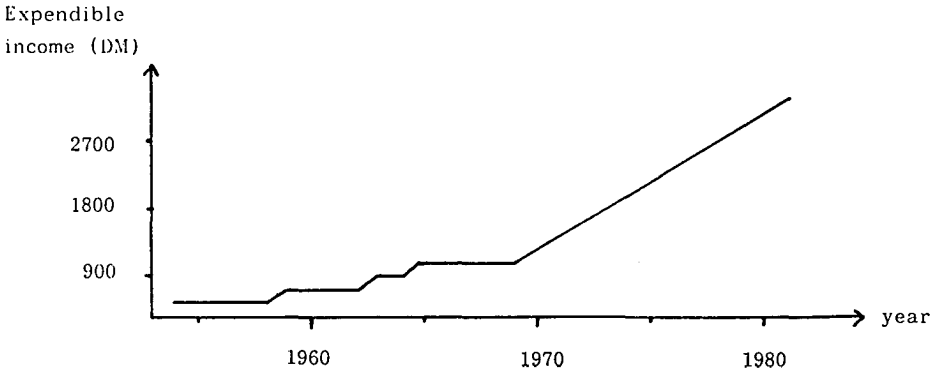


Figure 4.3

Time series of the number of cars per capita (CARC)
in the Federal Republic of Germany

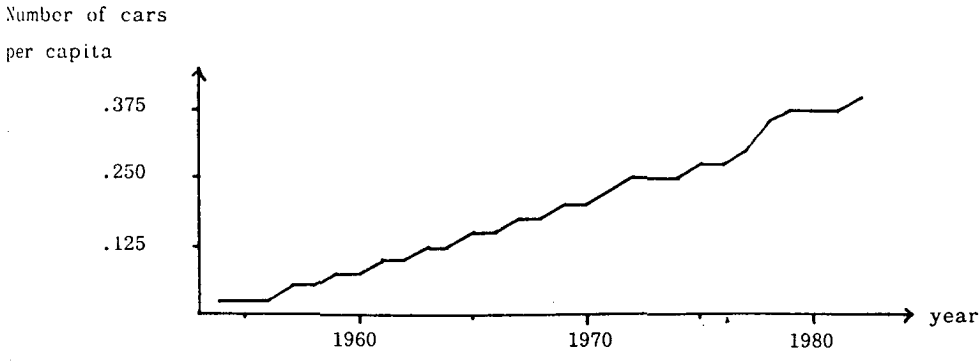


Figure 4.4

Time series of the unemployment rates (UR) of the Federal Republic of Germany

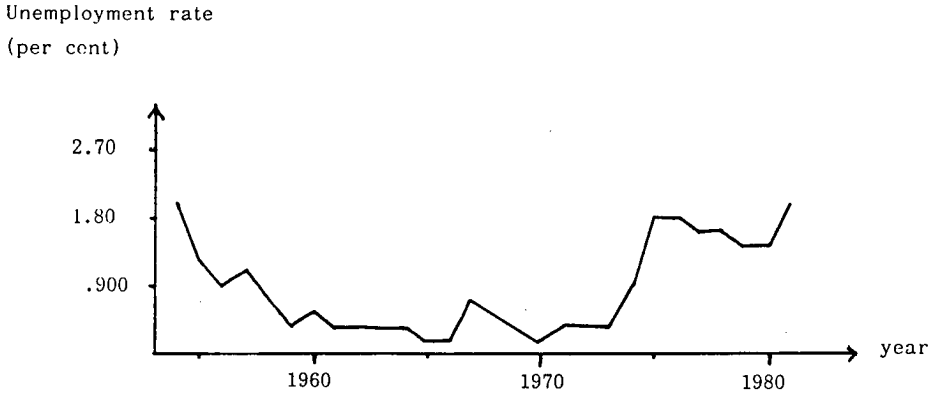
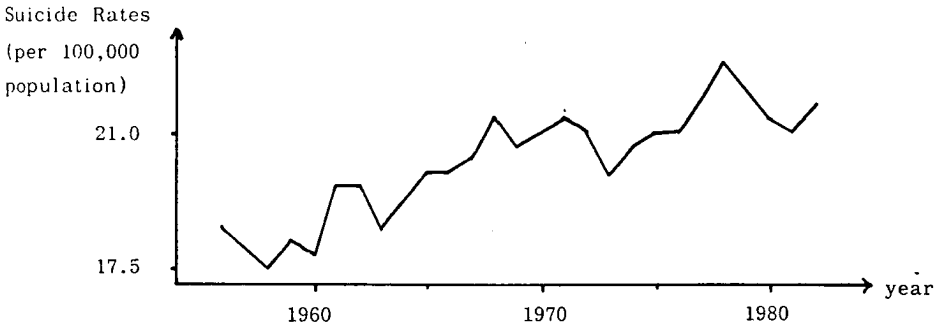
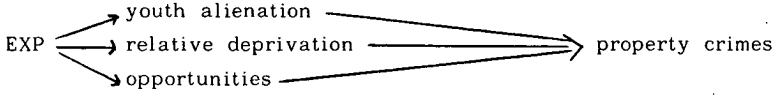


Figure 4.5

Time series of the suicide rates (SR)
of the Federal Republic of Germany



opportunity. A third interpretation focusses on the social status of juveniles and youth in modern, materialistic societies and suggests that they are more prone to crime because of a greater sense of alienation and lack of identity. If we consider a measure of affluence, and expendible income (EXP) is probably the best, we can express the above hypotheses as follows:



It should be clear, however, that it is almost impossible to separate out the different effects. It is very difficult to construct a psychological indicator for either youth alienation or relative deprivation in the first place, and even if we could, any collinearity among the three intervening variables (which is very likely) would render any measure of individual effects dubious. The best that we can say at this stage is that it is probably some combination of the above.

Larceny is also related closely to EXP, GNPC and the density of cars, CARC. Again this is quite reasonable in light of any of the above explanations for increasing crime, but its apparently closer relationship with CARC than with GNPC or EXP might suggest that less well-off people are victimized more through larceny, and the better-off people are victimized more through robbery or burglary, since the ownership of a car has become relatively widespread, while it is still the wealthier people who have significant expendible incomes. However, this can only be a speculation, since the correlations are too close to make any significant distinctions, and in any case, burglary is even more closely related to CARC. The relationship between unemployment rate and fraud is quite intriguing, since both have the same unique U-shaped pattern. Again it appears quite reasonable that those out of work might resort to fraud, but more research is needed before such a relationship can be established. Finally the possibility of a connection between homicide and suicide should not be too surprising either. Both could be thought of as classic manifestations of anomie, where frustration, anger, helplessness and violent impulses have to find an outlet. Both have been thought of as symptoms of a breaking down of social cohesion by sociologists, perhaps most emminently by Durkheim.

Figure 4.6

Time series of expendible income and robbery rates: 1954-1982

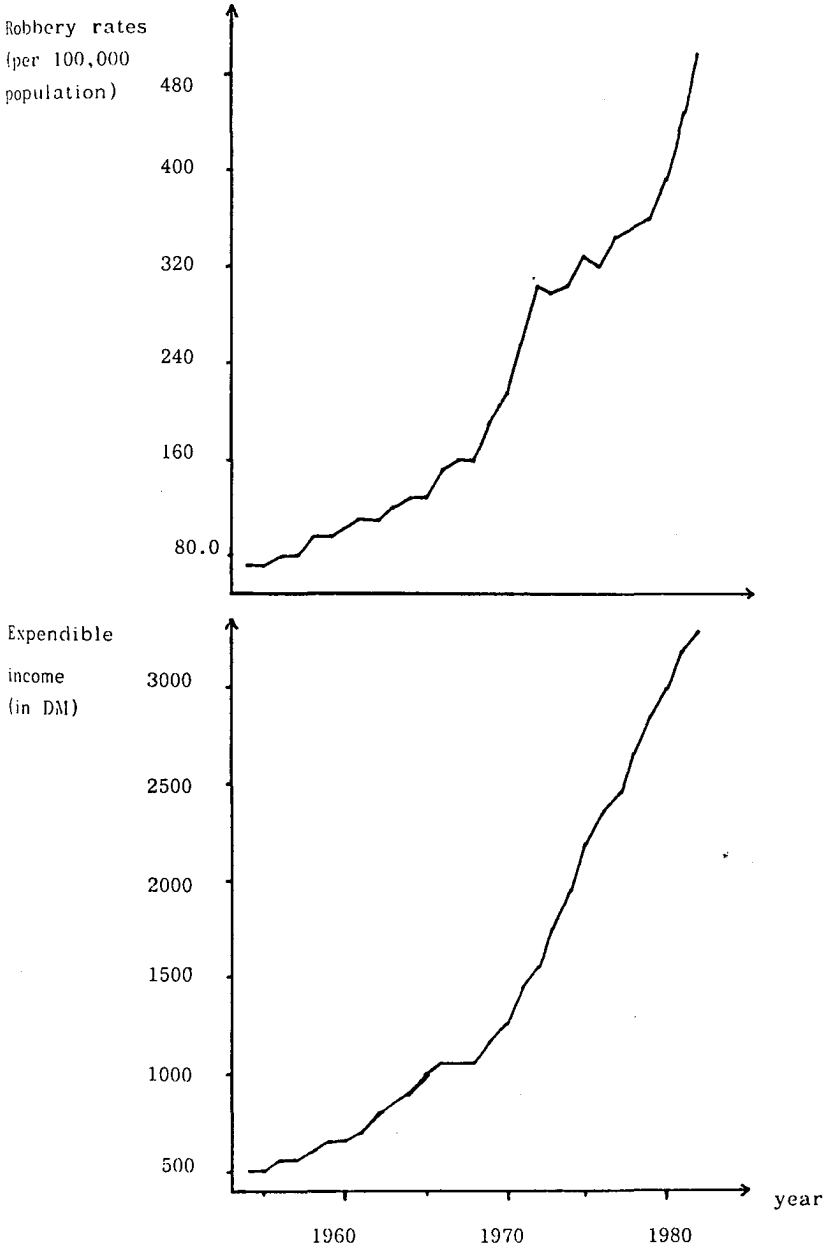


Figure 4.7

Time series of expendible income and burglary: 1954-1982

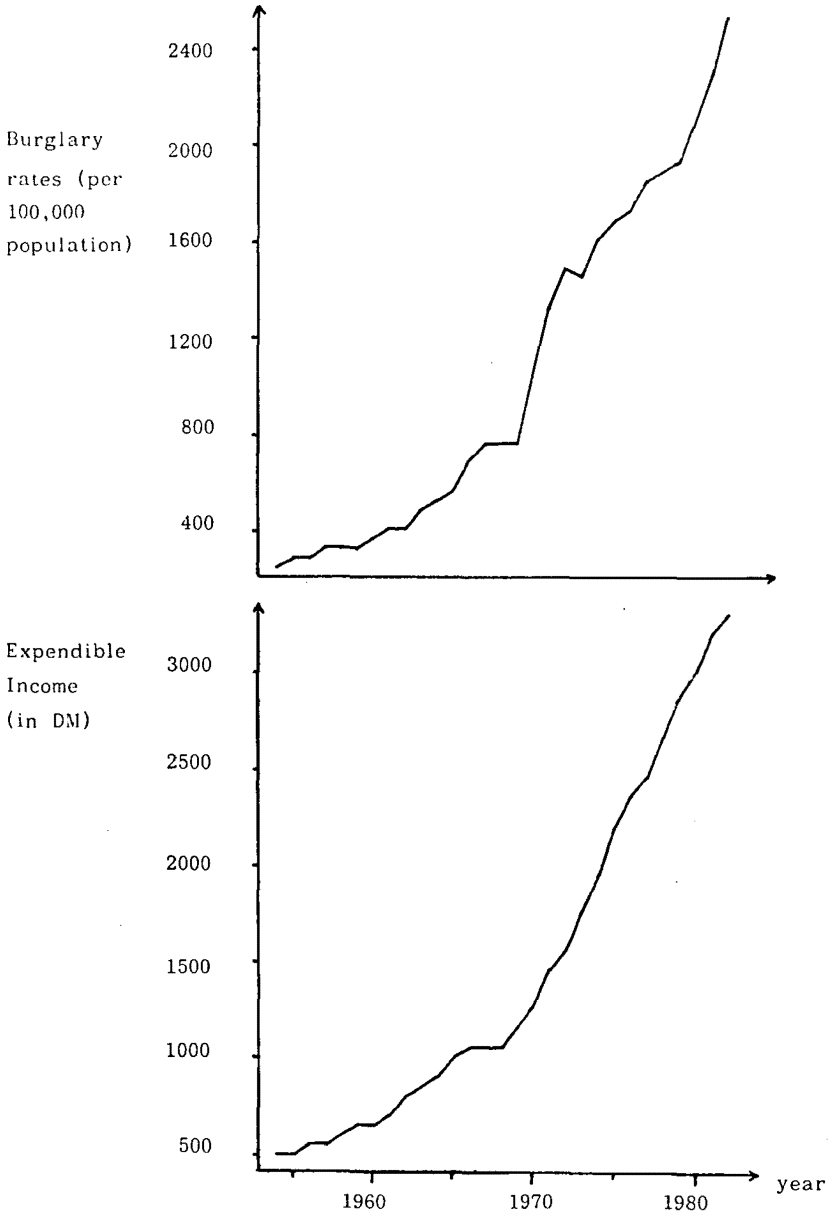


Figure 4.8

Time series of the gross national product per capita and larceny rates: 1954-1982

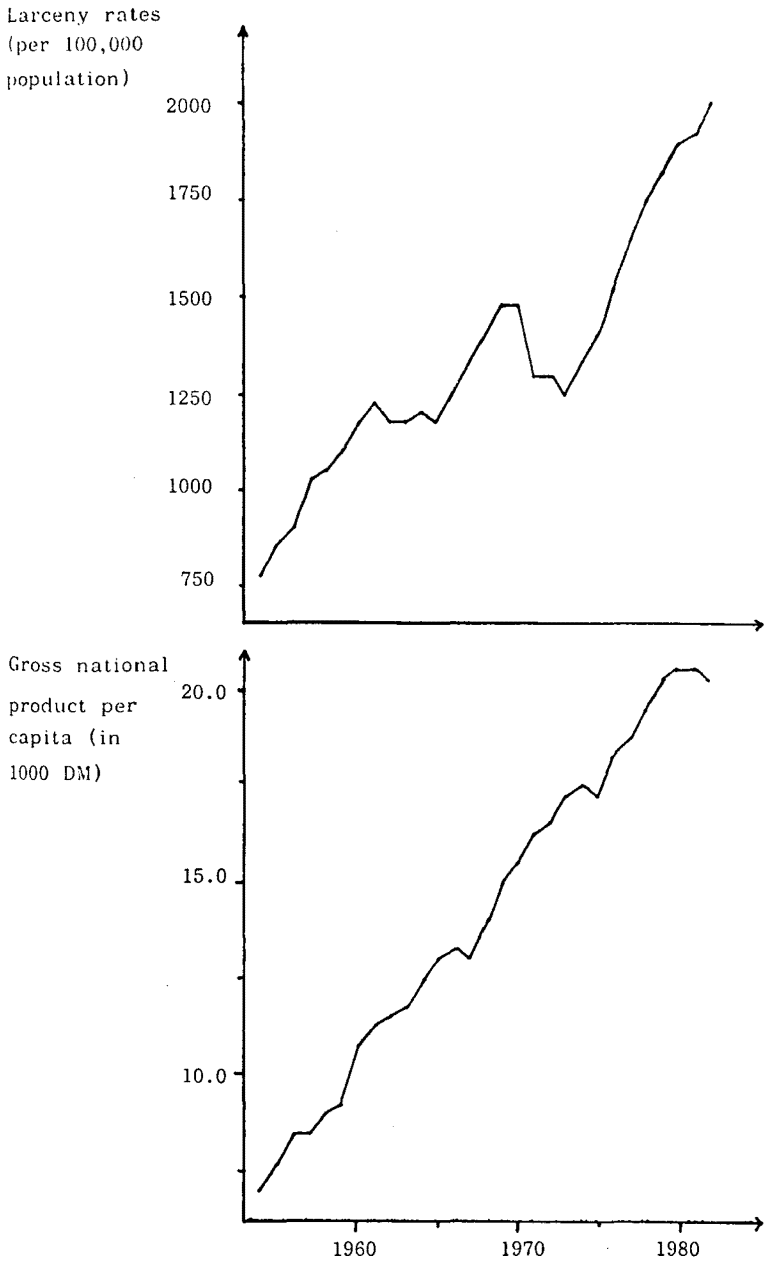


Figure 4.9

Time series of the number of cars per capita and larceny rates: 1954-1982

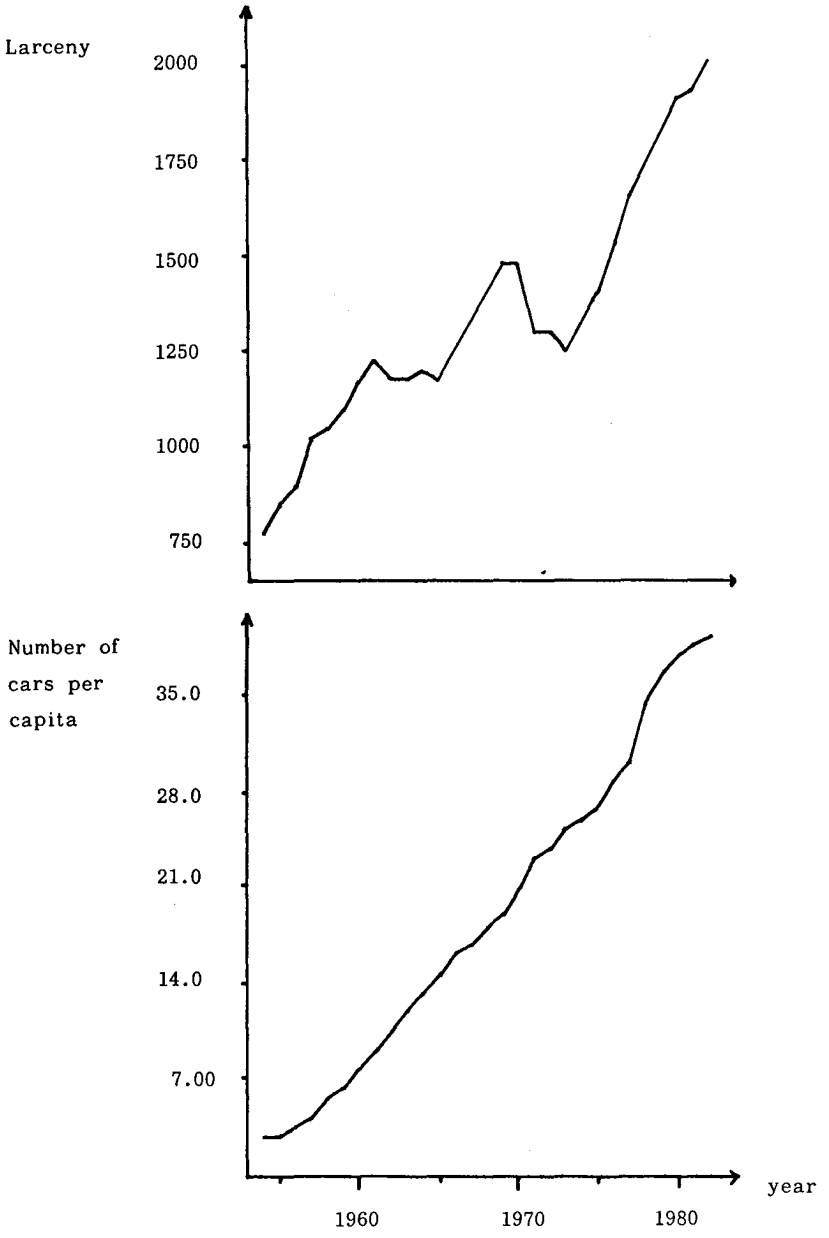


Figure 4.10

Time series of unemployment rates and fraud rates: 1954-1982

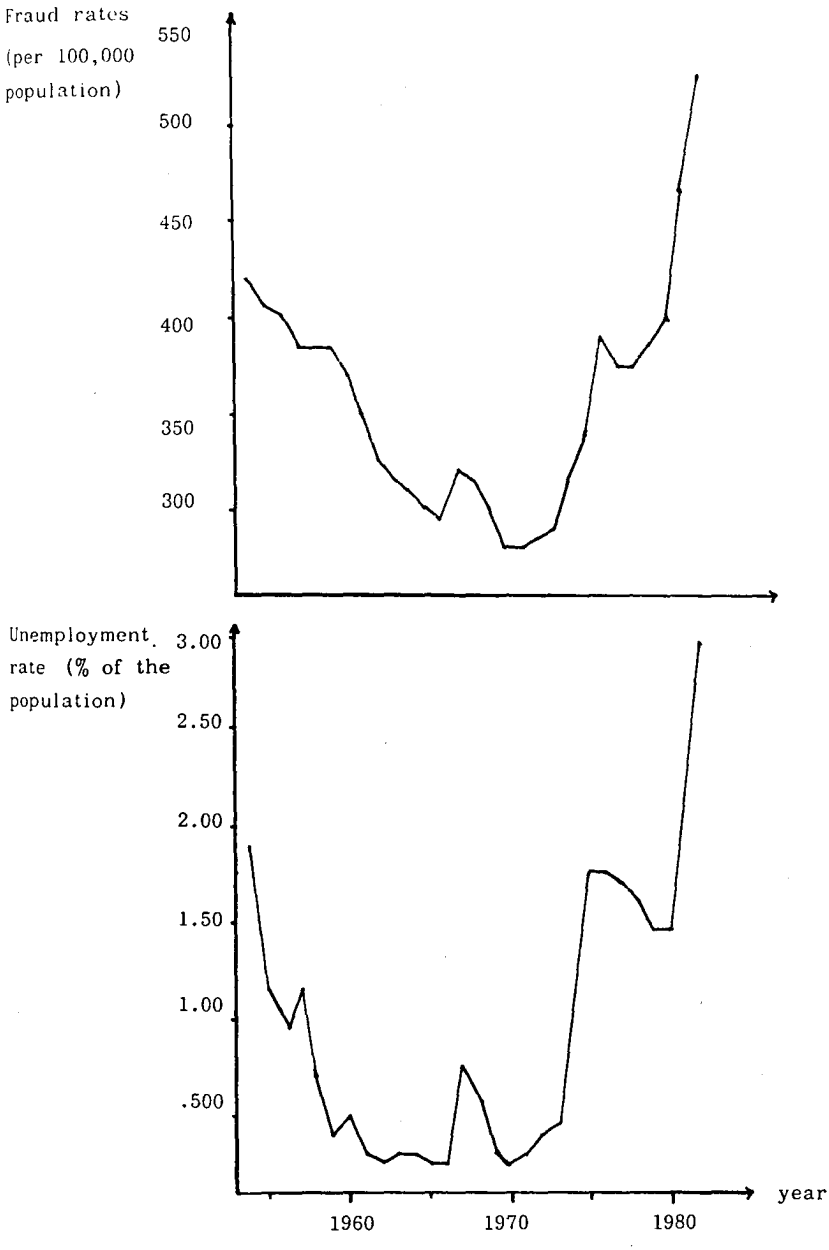
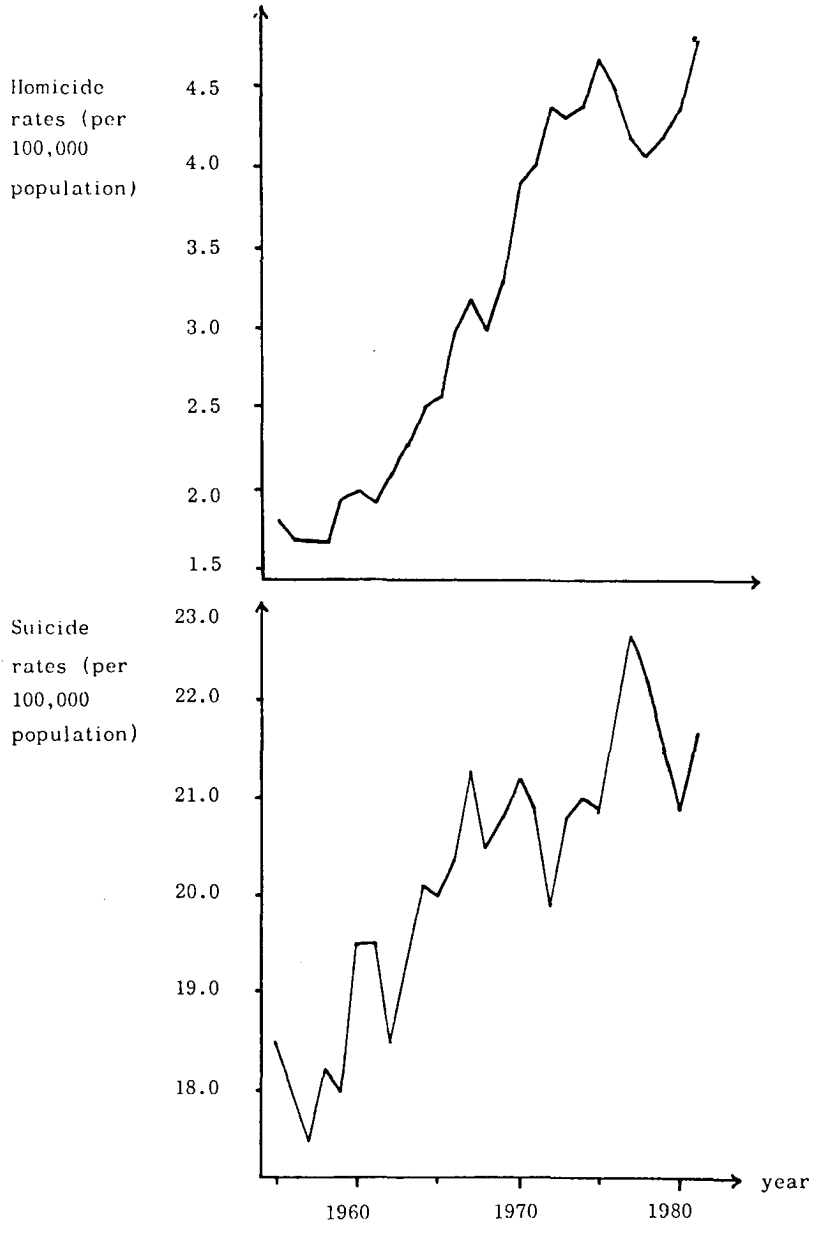


Figure 4.11

Time series of suicide rates and homicide rates: 1955-1981



The correlations are given in table 4.2, and what they indicate most strongly is that many of the socioeconomic indicators are highly correlated to many of the crime rates, and the particular relationships postulated above cannot be separated from several other possible relationships. In particular, we find that GNPC, EXP, CARC and SR are all highly correlated with homicide, robbery, aggravated assault, burglary and larceny. It is the exceptions that are the most interesting: the unemployment rate is significantly related only to aggravated assault and fraud, perhaps representing two outlets for that difficult (especially in Germany) state of being.

As we have seen in the survey of the literature, the relationship between unemployment and crime has often been explored, but no clear evidence has yet been found for it, including in the Federal Republic of Germany (Council of Europe, 1985). One problem with several previous analyses has been that aggregate data for crime (or imprisonment) has been used, or when it has been somewhat more disaggregated, only violent crimes as a group have been considered. Also, there may well be lagged effects, and these have not been thoroughly analyzed. It may be that unemployment has an influence only of specific crime types and perhaps with lagged effects, and this is indeed what is suggested by these results.

Fraud is exceptional in that unemployment and the only socioeconomic variable to which it is related, and aggravated assault is the only crime type in the remaining five (which have high correlations with the socioeconomic variables) that is not strongly related to suicide rates.

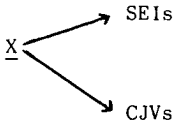
In summary we may say that there is clearly a high degree of collinearity in the time series, reflecting the fact that most of them experienced steady increases during the years we are observing them. There almost certainly are other factors driving both sets of time series. This issue require further analysis, but is beyond the scope of this book. For example, path analysis or some other form of structural models might have been employed to explore these relationships between the socioeconomic indicators (SEIs) and the criminal justice variables (CJVs). Indeed, one can postulate two classes of relationships, one

Table 4.2

Correlations between the time series of socioeconomic indicators and rates of the different crime types

Socioeconomic Indicator	Crime Type					
	Homicide	Robbery	Aggr. Assault	Burglary	Larceny	Fraud
Expendible Income	.90	.98	.97	.98	.92	.39
CNP per capita	.96	.96	.85	.96	.92	.09
Cars per capita	.95	.97	.90	.98	.94	.19
Unemployment Rate	.45	.63	.77	.64	.50	.83
Suicide Rate	.86	.81	.66	.81	.82	-.11

where other variables (X) simultaneously influence them



or another where X is an intervening variable:

SEIs --> X --> CJVs.

Such models have been explored by Mukherjee (1981), and among his findings is that the crime rate is strongly influenced by the size of the police force and cars per capita. We have not been able to explore the influence of the size of the police force, but we have indeed noted a similar relationship between indicators of economic affluence and crime. (We might remind ourselves that in the Federal Republic of Germany burglary and larceny account for about 70% of all reported crimes.) Otherwise, it is rather difficult to compare the findings between the two countries. For one thing data on similar variables were either unavailable or it was infeasible to collect them. For another, the FRG has a very short history, and any time series analysis must be considered as tentative at this stage.

XVI. EXPLORATION OF SOME SPECIFIC RELATIONSHIPS

However, even for these series it is possible to investigate the relationships between the SEIs and the CJVs more thoroughly through ARIMA analysis provided, we remember that this is only an exploratory analysis. That is, we can proceed by first prewhitening the relevant time series and then computing the cross-correlation function for the prewhitened series. Since it was impractical to do this for all possible combinations, we selected the pairs discussed above (and which indeed have high first order product-moment correlations) to investigate the relationships in more detail and to explore the possibility of causal relationships. The cross-correlation functions are plotted in figures 4.12 to 4.17. For the first pair (EXP, RB), the cross-correlation function is rather a surprise, since the original series seemed highly correlated, even to the extent of having identical trends in two identical time periods (1954-1968 and 1969-1982). But we find significant cross-correlations only at lags of -3 and -4, which must be regarded as spurious and a negative one at lag 4. This negative value is not only surprising given the nature of the time series, but apparently inexplicable (although we shall discuss one possible explanation later). For the second pair (EXP, BG), we again see the surprising absence of significant cross-correlations at or around zero lag and a similar (clearly spurious) cross-correlation at lag -4. The significant values at lags 3 and 4 are also puzzling, and we shall return to them later. The third pair (GNPC, LC) was also selected because the time series appeared quite similar, but the cross-correlations that are significant are both negative, one at lag -6 (spurious) and another at lag 2.

Turning now to the next pair (CARC, LC), we find that there is no relationship, except for a spurious correlation at lag -7. These correlations at negative lags are clearly artifacts of the data and must be considered spurious, since it is difficult to imagine the larceny rate influencing the GNPC or CARC. However, the negative correlations at **positive** lags may have an explanation. They might be interpreted in the following way: after accounting for the increasing trends and the autocorrelation in each series (by prewhitening them), we find that as economic affluence goes up, the rate of property crimes goes down

Figure 4.12

Plot of Cross-correlations of the prewhitened Time Series of Expendible Income and Robbery

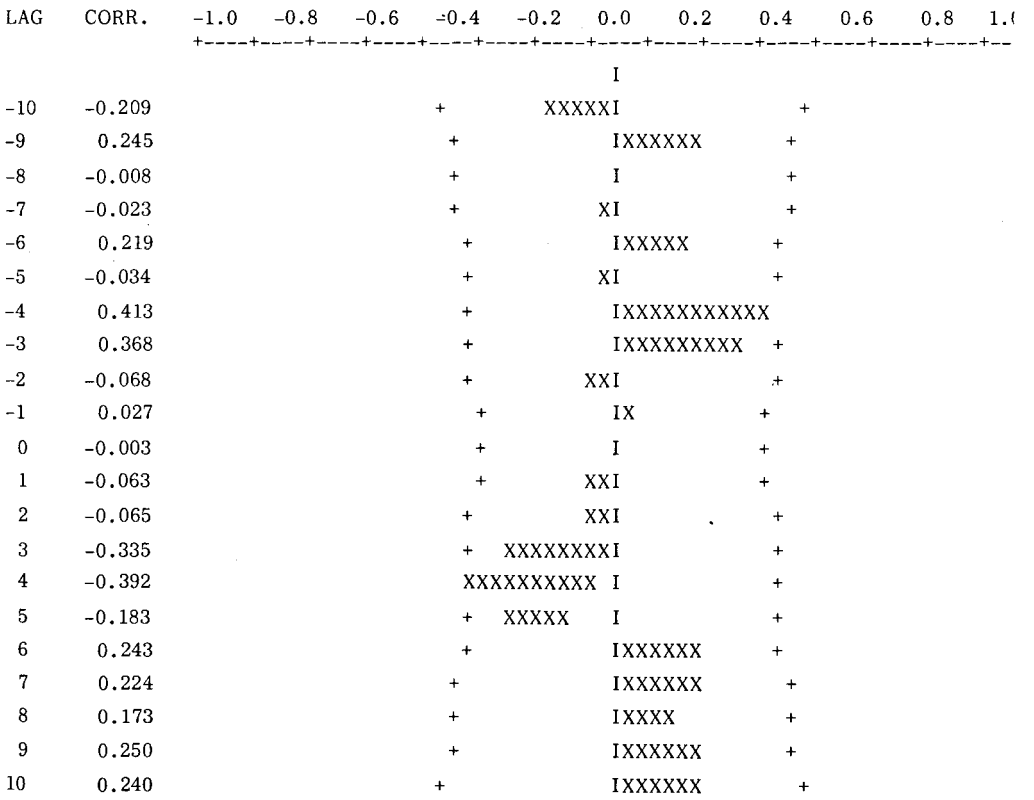
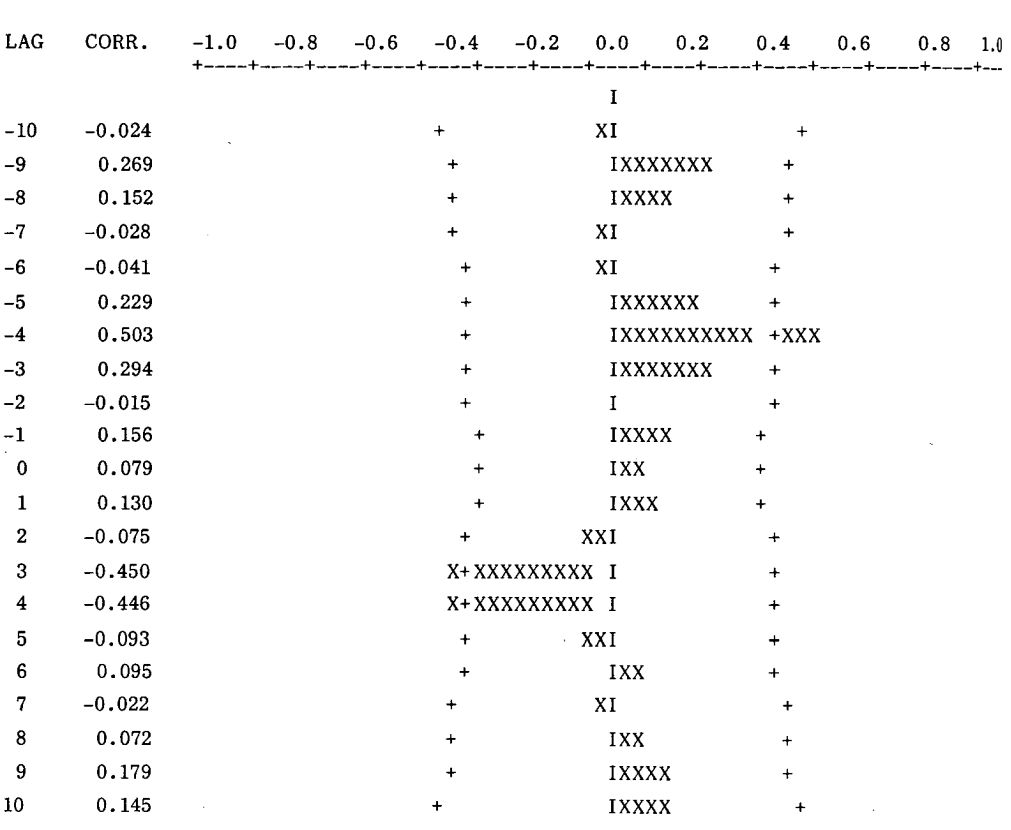


Figure 4.13

Plot of Cross-correlations of the Prewhitened Time Series of Expendible Income and Burglary



(above and beyond the first order increasing trend). Perhaps this could be the result of various security measures that have been taken as a response to the observed trend in increasing crime rate and in awareness of the fact that one has more valuable property that should be better protected. This better security arrangements (taking a few years to come into effect) could produce the observed negative correlation between economic affluence and property crimes a few years later.

Turning now to the next pair (UR, FR), we do find some interesting correlations that confirm the relationship that was suggested by their similar shapes. There is one significant negative correlation at lag 1, and another significant positive correlation at lag 3. (The fact that both lags are positive implies that it is unemployment that is influencing fraud.) The negative correlation at lag 1 could have two explanations. One might be due to the existence of economic cycles and the lag between becoming unemployed and taking up fraud. The decrease in frauds one year after unemployment has gone up may simply be reflecting the better times in earlier years, rather than last year. The people just thrown out of work still think they will find employment and are not desperate enough to resort to illegal sources of income. Another explanation might be that this reflects fraud **in the workplace**. This would follow from an alternative interpretation that as unemployment decreases, frauds increase the following year. Having found a job (as a result of decreasing unemployment), some individuals now find the opportunity to commit frauds in the establishment where they are working. This is particularly plausible, since the opportunity to commit a fraud often comes only through one's work (for example, access to papers, checks, documents, etc.). The other correlation, at lag 3, also makes sense and was almost expected. It implies that a subset of the chronically unemployed eventually becomes desperate, and after about three years seeks alternative sources of money through fraud. These fraud cases could also involve people declaring themselves as unemployed while engaging in some side (and otherwise legal) employment, or of unemployed individuals guilty of hiding some other (quite legal) source of income. Again, in all these cases it would take time for such cases of fraud to increase, after unemployment has increased. In Germany, unemployment insurance lasts for almost one

Figure 4.14

Plot of Cross-correlations of the Prewhitened Time Series of the Gross National Product per capita and Larceny

```
LAG    CORR.   -1.0   -0.8   -0.6   -0.4   -0.2    0.0    0.2    0.4    0.6    0.8    1.0
                +----+----+----+----+----+----+----+----+----+----+----+----+----+----+
                                                  I
-10     0.192                          +          IXXXXX          +
-9      0.123                           +         IXXX            +
-8     -0.190                           +      XXXXXI             +
-7     -0.336                           +   XXXXXXXXI            +
-6     -0.419                              XXXXXXXXXXI           +
-5     -0.322                              + XXXXXXXXI           +
-4      0.110                              +         IXXX        +
-3      0.185                              +         IXXXXX      +
-2      0.071                              +         IXX         +
-1      0.204                               +        IXXXXX     +
 0      0.048                               +        IX         +
 1     -0.061                               +      XXI          +
 2     -0.360                              +XXXXXXXXXI           +
 3     -0.146                              +      XXXXI          +
 4      0.193                              +         IXXXXX      +
 5      0.106                              +         IXXX        +
 6      0.281                              +         IXXXXXXX    +
 7      0.181                               +        IXXXXX       +
 8      0.271                               +        IXXXXXXX     +
 9      0.147                               +        IXXXX        +
10     -0.051                               +          XI              +
```

Figure 4.15

Plot of Cross-correlations of the Prewhitened Time Series of the Number of cars per capita and Larceny

```
LAG    CORR.   -1.0   -0.8   -0.6   -0.4   -0.2    0.0    0.2    0.4    0.6    0.8    1.0
                +------+------+------+------+------+------+------+------+------+------+------+
                                                      I
-10     0.345                        +               IXXXXXXXXX     +
-9      0.216                         +              IXXXXX         +
-8     -0.245                         +       XXXXXXI               +
-7     -0.624                  XXXXX+ XXXXXXXXXXI                   +
-6     -0.320                        +   XXXXXXXXI                  +
-5     -0.319                        +   XXXXXXXXI                  +
-4      0.075                        +           IXX                +
-3      0.259                        +           IXXXXXX            +
-2      0.263                        +           IXXXXXXX           +
-1      0.262                         +          IXXXXXXX          +
 0     -0.081                         +        XXI                  +
 1     -0.102                         +       XXXI                  +
 2     -0.140                        +        XXXI                   +
 3     -0.055                        +          XI                   +
 4      0.072                        +           IXX                 +
 5      0.034                        +           IX                  +
 6      0.125                        +           IXXX                +
 7      0.081                         +          IXX                  +
 8     -0.033                         +          XI                   +
 9     -0.079                         +         XXI                   +
10     -0.079                        +          XXI                     +
```

Figure 4.16

Plot of Cross-correlations of the Prewhitened Time Series of the Unemployment Rates and Fraud

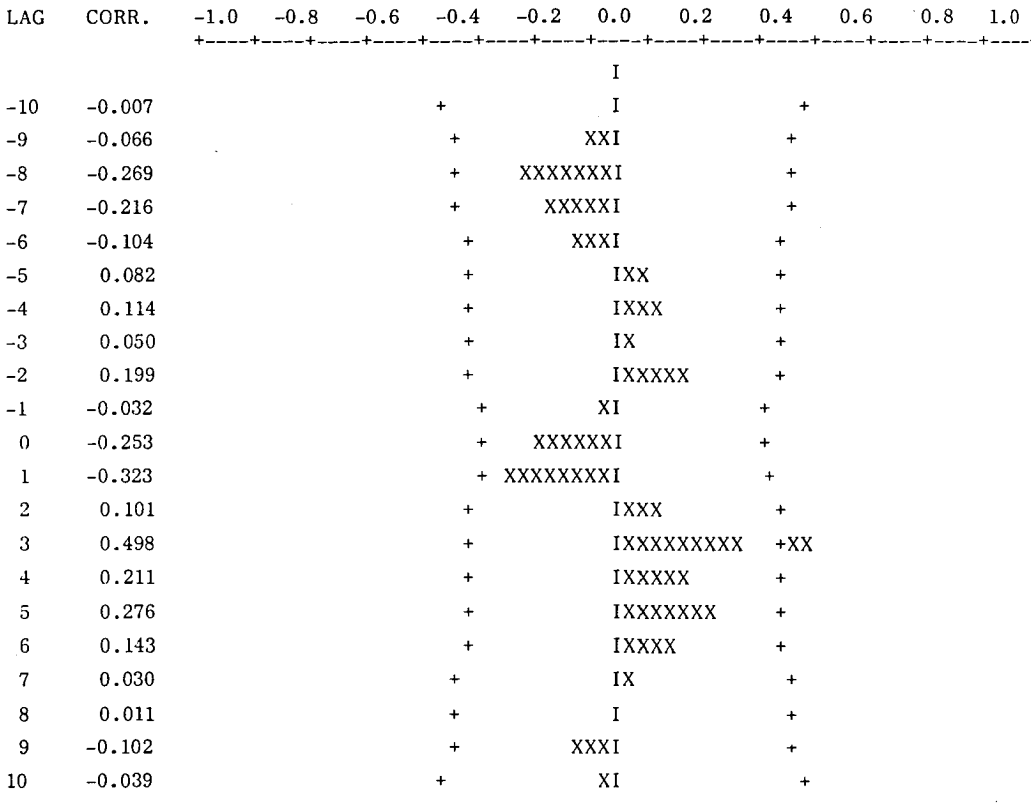


Figure 4.17

Plot of Cross-correlations of the Prewhitened Time Series of Suicide Rates and Homicide Rates

LAG	CORR.	-1.0 -0.8 -0.6 -0.4 -0.2 0.0 0.2 0.4 0.6 0.8 1.0
		+----+----+----+----+----+----+----+----+----+----+----+
		I
-10	-0.014	+ I +
-9	-0.152	+ XXXXI +
-8	-0.181	+ XXXXXI +
-7	0.150	+ IXXXX +
-6	0.065	+ IXX +
-5	-0.025	+ XI +
-4	0.090	+ IXX +
-3	0.077	+ IXX +
-2	-0.039	+ XI +
-1	0.289	+ IXXXXXXX +
0	0.130	+ IXXX +
1	-0.104	+ XXXI +
2	0.060	+ IX +
3	0.168	+ IXXXX +
4	0.126	+ IXXX +
5	0.248	+ IXXXXXX +
6	0.307	+ IXXXXXXXX +
7	-0.007	+ I +
8	-0.054	+ XI +
9	-0.018	+ I +
10	-0.125	+ XXXI +

year, and then the benefits decrease sharply, and that is when an unemployed individual's motivation to commit fraud would increase. Yet another possibility is that the police become even more diligent in uncovering and recording fraud cases if they see an increase. That is, the observed increase could be a multiplicative effect of some real increase and an increase in the proportion recorded. Finally the police may be more easily convinced that fraud has taken place when the alleged offender is unemployed (and for example, clearly incapable of meeting some financial commitment he has made). And such cases would again be more common when unemployment has been high[81].

The last pair (SR, HM) show no relationship whatsoever in their cross-correlation function. Thus, what appeared to be similar deviations around their respective trend lines do not appear to have any relation at all. We might note here that the suicide rates appear to have a cyclic pattern of around 19 or 20 years. This identification can only be speculative, since we have only 29 data points, but to the extent that suicidal tendencies are sometimes thought to be related to inherited (or family induced) traits, this might be reflecting some generational effect coupled with the extreme situations experienced by Germany (total ruin to great affluence).

In conclusion it has to be emphasized that all suggestions here are extremely tentative, and these findings should be treated as exploratory analysis only, that is, as a necessary first step to more in-depth analysis. The last part of the analysis using ARIMA models and cross-correlation functions has not been undertaken before in such a context, and hence we cannot compare them with other results. However, it can be hoped that this analysis will provide evidence and ideas for further research. We need much more research to even begin to clarify the complex relationships between SEIs and CJVs[82]. At this stage, we do not have the data at the required level of detail nor do we have sufficiently specific theories that can be empirically explored. Clearly there is a full agenda for future research in this area.

SUMMARY AND RESEARCH IMPLICATIONS

This study was undertaken in order to arrive at a better understanding of temporal trends in criminal justice data. Such a study helps us to see what kinds of changes took place in crime rates or arrest rates or imprisonment rates and when they took place. This in turn allows us to explore possible reasons for the observed changes. These reasons could be changes in criminal justice policies or changes in other socioeconomic indicators. Thus, analysing patterns of change in criminal justice variables could lead to a better understanding of their relationships to other social factors. This helps us to both appreciate the significance of the changes we observe, as well as in developing more effective policies in criminal justice. Such an analysis is useful at least in suggesting what kinds of policies might work and what probably would not.

One issue in temporal analysis that has significant policy implications is whether the imprisonment level remains stable or not, and we have explored this issue in some detail. A related concern is the relationship between crime rates and imprisonment rates, and this again we have examined in some depth. Understanding these issues gives us a better insight into the nature of criminal justice systems, how they operate, how they respond to external (or internal) changes and the mechanism through which the relative stability of imprisonment (that is, imprisonment rates going up far less than crime rates) in maintained. Such an analysis also provides us with a better understanding of the impact of criminal justice policies on the incidence of crime. Perhaps on the other hand, it is the impact of social factors that are more decisive, and we explore the relationships between criminal justice variables and socioeconomic indicators with data from the Federal Republic of Germany. This allows us to see how changes in crime rates or sentencing rates are related to the social system. It also provides insights into the crime commission process by suggesting what conditions seem to be related to changes in the rates of any given crime type. This in turn makes it possible to explore the validity of previous explanations and theories of crime and provides a basis for the further development of criminological theories.

An important aspect of this research is the use of criminal justice data **disaggregated** by crime type. We have used such data extensively and as often as possible because it was not only initially clear, but also amply confirmed during the course of the study that there are very significant differences among crime types. Not only are the acts very different in nature, but the criminal justice system treats them in quite different ways, and further, sentencing will have a differential impact on the incidence of different crimes. This results in their having different trends, in the relationships between crime rates and imprisonment rates being very different and in the fact that the relationship between the crime rate and socioeconomic variables will be very different for different crime types. Since these issues could not be addressed with aggregate data, the importance of using disaggregated data is obvious. Disaggregate data can also be more accurate. For example, data on specific crime types may have fewer errors associated with them (for example, what is included or not included or changes in classification schemes), and by focusing on the important crimes, we avoid the errors (reporting and recording variations) associated with the minor crimes, which are generally far more frequent and can dominate trends in the aggregate rates.

Of course, disaggregation could go further, and in some analyses it might be useful to have data disaggregated by regions or jurisdictions so that there is reasonable homogeneity within that unit. In some cases that has been possible, for example in examining rates for the individual states in Germany or for California (rather than the whole of the U.S.), but often the required data was not available. In the case of the Federal Republic of Germany, it can however be argued that the differences between the individual states are not that great, and the country as a whole can be usefully considered to be one unit. In general we have considered countries as units, and this **comparative approach** is another important aspect of this study. The comparative approach is extremely important in developing theories about crime, since their validity depends to a large extent on their generalizability to different societies, and the only way to verify this is to observe patterns of criminality under different social conditions. We need to see for instance, if similar societies have similar patterns and dissimilar ones dissimilar patterns. We would like to check if similar social

changes have a similar impact on crime trends. A thorough analysis of this kind was far beyond the scope of this research, but we have attempted a beginning by examining the relationships between crime rates and imprisonment rates (for individual crime types) in different societies. The comparative perspective helps not only in understanding differences in crime and other social trends or differences in criminal justice systems, but it can also illuminate the situation within a given country. Finally, observing the responses of other criminal justice systems offers the possibility at least of learning from the experiences of other societies.

The third important aspect of this research is the application of a variety of **time series methodologies.** Since we wish to observe trends in variables like the crime rate and the relationships between two or more variables, we have to analyse the variables over time, and we have availed ourselves of the appropriate methodologies. For example, in analysing the disaggregated data, we examine the correlations between two time series at different lags to see what relationships exist between the two variables and the time lag for the influence of one to be felt by the other. We do this in both directions without making any priory assumptions about the direction of possible influences because, as we know, crime rates could influence sentencing levels and sentencing levels could influence crime rates. A persistent problem with time series data is the presence of autocorrelation, that is, the dependence of the current value on previous values. When possible, we have tried to correct for this by using prewhitened time series. Prewhitened time series are the series with their autocorrelation components removed or filtered out. The correlations between the prewhitened series gives a more accurate and reliable picture of the relationships between variables. We have also used ARIMA models to characterize the time series. This provides a structure for the temporal patterns and allows for useful comparisons of time series from different countries, since it is no longer the raw data that is being compared, but rather the pattern of changes. Unfortunately however, we could not get sufficiently long time series in many cases. ARIMA modelling also provides a way of analyzing the relationship of two variables over time through the identification of a transfer function. This transfer function reflects many details of the relationships and the mutual

influence between two variables. For instance, we were able to find out after what time lags one variable influences another, as well as the magnitude of those influences.

To summarize the findings, we have observed in general that the imprisonment rate is fairly (and sometimes surprisingly) stable in many countries, that is, it tends to vary considerably, but around a stable value. Moreover, in all cases it has been much more stable in aggregate than the crime rate, which has increased enormously in most of the societies that we have examined. This finding clearly leads to the question of how this relative stability is maintained, and we have explored this question with disaggregated data. We find evidence in many countries of some form of adaptation where serious crimes are punished to the same extent even when they increase (that is, imprisonment rates increase with crime rates), but that the punishment level for relatively minor crimes often decreases, even as their rates of incidence increase. Since the relatively minor crimes are far more numerous than the serious crimes, they dominate the aggregate crime rates, and this explains the absence of clear relationships between aggregate crime and imprisonment rates that has been found in the past. We find rather complicated relationships in many individual cases, but relatively little evidence of deterrence or criminogenic effects in general. Detailed analyses were made for four countries: the Federal Republic of Germany, the United States (with California data), the United Kingdom and Australia, since detailed data for a sufficient number of years were available for these countries. In the case of Germany, there was a strong suggestion of adaptation with a high positive correlation between crime and imprisonment for the serious crimes (in this case, homicide, robbery, aggravated assault and fraud) and a high negative correlation for the minor crimes (burglary and larceny). In the case of the U.S. it again appeared that the criminal justice system responded rationally to the serious crimes of homicide and robbery, while for burglary, there seemed to be some deterrent effect, although that could also be a product of the artifacts of the data. For the United Kingdom, more complicated relationships could be uncovered since longer time series were available, but overall, the hypothesis of rational response appeared to hold. In the case of Australia, we again see clearly a rational response with respect to the

serious crimes (violence and property) and adaptation in the case of the minor crimes.

The relationships between individual crime rates and socioeconomic indicators were explored with data from West Germany. It is difficult to arrive at any firm conclusions because of a variety of methodological problems (short time series, approximate measures, high collinearity) etc., but overall, we might say that there is clearly a similar, increasing trend in inidicators of affluence and property crimes. However, as noted, a number of different hypotheses could explain this. There also appeared to be a relationship between unemployment and fraud, with fraud going up one year after unemployment went down (suggesting fraud in the workplace) and fraud going up three years after unemployment went up (a more expected relationship as the chronically unemployed, for example, resorted to fraud). This again shows the advantages of examining disaggregated data, since such a clear relationship has not been found in the past even though a relationship between crime and unemployment has often been hypothesized and explored previously. Indeed, while broad groups of crime types have been considered (for instance property crimes) to the best of the author's knowledge, fraud has not been specifically examined in this context before, although in retrospect, the relationship between fraud and unemployment does appear quite reasonable.

The policy implications of these findings are by no means straight-forward. What we have found are a variety of relationships between crime and sentencing for different crime types. Even when these relationships appear fairly simple, there are almost certainly further complexities involved, and any policy implications that we draw must be strongly qualified. But there are rather few policy implications to be drawn in the first place. Our findings actually provide very little guidance for further policy development. Thus, the finding that sentencing and imprisonment rates are closely related to crime rates in the case of serious crimes does not in itself suggest any new policy directions. The criminal justice system appears to have responded rationally in such cases, and if any changes are to be recommended, they would have to be based on normative grounds.

There appears to be very little evidence for either deterrence or criminogenic effects (apart from a few possible, but doubtful exceptions). What this suggests is that the empirical evidence provides no support for the assumptions of any significant deterrence or criminogenic effects, and to the extent that policies and policy proposals in the past have been based on such assumptions (particularly on deterrence in recent years), the empirical evidence found here does not support such policies. Again, we seem to be left with normative considerations for the development of policy. This is particularly true in the case of the other significant finding in this study, that is, the evidence of adaptation by the criminal justice system with respect to the minor crimes. Whether this is a good thing (because it keeps the lid on the imprisonment rate, or that it corrects on excessively harsh policy of the past) or a bad thing (because these minor crimes are being treated more leniently, and offenders responsible for them are getting away with less punishment than their predecessors) really depends on social preferences and on the normative arguments that are invoked. The empirical analysis alone cannot be directly applied to making policy. All we can say is that there is some evidence of the adaptation process, and that this evidence should be taken into account in policy making.

The findings of relative stability of imprisonment and of adaptation together have an interesting implication for strategies for those who wish to change sentencing policy. The findings suggest first of all, that imprisonment is probably constrained by social and economic factors, and not just in the short run (because of prison space). Secondly, it suggests that the imprisonment rate has two components: one consisting of offenders convicted of serious offences and another consisting of offenders convicted for relatively minor offences. Realistically speaking, there is probably little chance of effecting major changes in the first component. There would be too many constraints and inhibiting forces including the statutes, sentencing practices and public opinion. On the other hand, sentencing policies with regard to the relatively less serious offences might well be modified significantly, as in fact it has been in the past. There is a different but related issue of how punishment is measured: by the rate of prison admissions or by the imprisonment rate. The imprisonment

rate reflects both the admissions rates in the past and time served, while the admissions rate reflects an immediate response to convicted offenders and does not reflect changes in sentence lengths nor changes in parole policies. Ideally of course both time series should be analyzed, but in practice the data are often unavailable.

As pointed out earlier, the findings (and any policy recommendation based on them) have to be qualified in a number of ways. First of all, there are all those problems with the insufficiencies of the data available. For example, a thorough analysis would require complete time series data on all crime rates, arrest rates, conviction rates, prison admission rates and imprisonment rates. Moreover, the data should be completely unambiguous about the crime types included, method of recording and should be consistent over time. As we have mentioned repeatedly, that is obviously never the case. Beyond the limitations of the data, there is the basic question of whether the complexities of the criminal justice system and particularly of social trends can be represented accurately through the statistics used here. Again, the answer is obviously no, and the purpose of the study, as explained previously, is to explore some hypotheses with the data available to at least further our understanding of temporal patterns.

More specifically, there are some difficulties with the interpretation of time series analyses. The results could be due to artifacts of the data (for example, the assumptions of correlation analysis not being satisfied), or due to interactions among variables that are not accounted for, or as a result of influences from unobserved (perhaps unobservable) variables. Thus, simple correlations between time series must always be interpreted with caution. Some trends could be caused by a self-fulfilling prophecy, for instance, if a slight increase in crime triggers a public concern, then that in itself may cause more people to report, and the police to record, more crimes and thus create an artificial trend.

Because of all these problems with such analyses, it would be better for the present not to base policies on theories that are claimed to be supported by such analyses. Rather, the proper use of such analyses lies in what they suggest is not empirically true. In other words,

their value lies in what they suggest should **not** be the basis of policy making. For example, the deterrence theory has often been adduced to support harsher sentences of various kinds. The empirical evidence here, along with many previous studies, throws doubt on the notion of deterrence, and to that extent suggests that the assumption of deterrence should not be a basis for policy making. This point is also relevant in the debate over prison moratoriums and to the extent that it suggests that imprisonment does not have a significant impact on crime, the results would on the whole support the arguments of those who call for such a moratorium[1]. Similarly, given the evidence of adaptation, the research suggests that policies that do not take adaptation into account may not be effective and should be modified to take adaptation (and other relevant factors) into account.

In discussing the role of empirical findings in shaping criminal justice policy, it should be remembered that the role is probably minimal, and that policy is based far more on social preferences and political considerations than on empirical analysis. Public policy in general is shaped largely by cultural values and norms, moral beliefs and economic resources. A further point to remember is that it may well be that criminal justice policy may not have a very significant effect on the incidence of crime in any case, and that much larger social trends drive the crime rate. However, it is our hope that more effective criminal justice policies would effect improvements (and in any case, they clearly have an impact on arrest, conviction and imprisonment rates, even if they did not affect crime rates), and therefore we hope that further research will help in developing policies that will benefit society.

Appendix 1
Identifying ARIMA Models.

It is beyond the scope of this book to give a thorough introduction to ARIMA models, and the reader is referred to the texts on time series analysis in the text. Here we provide a simple outline of the preliminary identification procedure for such models. In ARIMA time series, the series is modelled such that its current values are a function of a finite number of its own past values, the autoregressive component, and a finite number of previous shocks (random influences) that it has received, the moving average component. However, before this model can be developed, the time series must be stationary, or if not, must be differenced to make it stationary, and this is the integrated component. The full model (excluding periodicity) can be written as follows:

$$(1-\phi_1 B-\phi_2 B^2 \ \ldots \ -\phi_p B^p) \quad {}^{d}Z_t = (1-\Theta_1 B-\Theta_2 B^2 \ \ldots \ \Theta_r B^r)a_t$$

or

$$\phi\ (B)\ \nabla^{d} Z_t = \Theta\ (B)\ a_t$$

Where the autoregressive component (ϕ) is of order p, the average component (Θ) is of order r, and d is the degree of differencing that is required to make the series stationary. The identification procedure consists of determing d, p, and r, and then the coefficients, ϕs and Θ's. To do this, the first step is to compute the autocorrelation and partial autocorrelation functions. The autocorrelation function is computed as a function of the lag k as follows:

$$p_k = \frac{\sum_{t=1}^{N-k} (Z_t - \ ) \ (Z_{t+k} - \ )}{\sum_{t=1}^{N} (Z_t - \ )^2}$$

where N= number of time periods we have for this series

and $= \sum_{t-1}^{N} \frac{Z_t}{N}$, or the mean of the series.

The partial autocorrelation function gives the correlations as a function of the lag k, after controlling for the autocorrelations above. The individual partial autocorrelations (k) can be obtained by solving a set of simultaneous equations (the Yale-Walker equations:

Yale-Walker Equation:

$$\begin{array}{lllll} po & p1 & p_{k-1} & & 1 \\ . & . & . & & . \\ . & . & . & & . \\ . & . & . & & . \\ p_{i-1} & pi & p_{k-i} & X & i \\ . & . & . & & . \\ . & . & . & & . \\ . & . & . & & . \\ p_{k-1} & p_{k-2} & po & & k \end{array} \quad = \quad \begin{array}{l} p1 \\ \\ \\ \\ pi \\ \\ \\ \\ pk \end{array}$$

The solution consists of a set of recursive equations (given by Durbin):

$$1 = p1$$

$$2 = \frac{p_2 - p_1^2}{1 - p_1^2}$$

$$3 = \frac{-2p_1p_2 - p_1^2p_3}{1 + 2p_1^2p_2 - p_2^2p_1^2}$$

etc.

After these functions are computed, we can proceed with the identification.

Determing d: A series is said non-stationary, if neither its autocorrelation function, nor its partial autocorrelation function dies out to

insignificant values after a few (4 or 5) lags. The number of times the series needs to be differenced until at least one of these functions dies out is denoted by d. When no differencing is required d=0.

Determining p: If the process is purely autoregressive, then the autocorrelations slowly die out while the partial autocorrelation function has a sharp cut off point after p lags. That is, it has significant values for the first p lags and then becomes insignificant. An example of an AR (2) process is illustrated in Figure A 1.1. Determining p for a mixed process is more involved and is not discussed here since we do not encounter it at all.

Determining r: If the process is purely moving average, then the partial autocorrelation function dies out gradually while the autocorrelation function has a sharp cut off point after r lags. That is, it has significant values for the first r lags, and then becomes insignificant. This is illustrated for an MA (1) process in Figure A 1.2. (Again the determination of r in the case of mixed processes is omitted here.)

Determining Periodicity: Even though we found no periodic effects in the time series analyzed here (perhaps because most were relatively short), it is important to identify periodicity in time series. The importance is illustrated in the case of the imprisonment rates for Ohio, U.S. Periodicity is recognized by a regular, periodic pattern of high values of the autocorrelation function. For example, if there is a periodicity of D in the time series, the D^{th} autocorrelation will be relatively large. This is illustrated for two cases (D= 6 and 10) in Figure A 1.3. Apart from this, the autocorrelation function can have any pattern.

Periodicity was identified for the imprisonment rates for Ohio, and the data, the regression line, and the time series (ARIMA) fit are shown in Figure A 1.4. The series is clearly cyclic and stable, but because the series happens to begin on the upward part of a cycle, and ends on a downward part, a simple regression analysis would have indicated a decreasing linear trend, which is clearly inappropriate in this case. This can be very clearly seen in terms of forecasts. If we forecasted

on the basis of the regression line, we would have predicted decreasing imprisonment rates, but based on the periodicities detected in the time series analysis, we would have predicted increased rates. The actual rates for the next three years (denoted by the dots) are clearly much closer to the forecasts from the time series analysis.

Figure A 1.1

The autocorrelation and partial autocorrelation functions for an AR(2) process

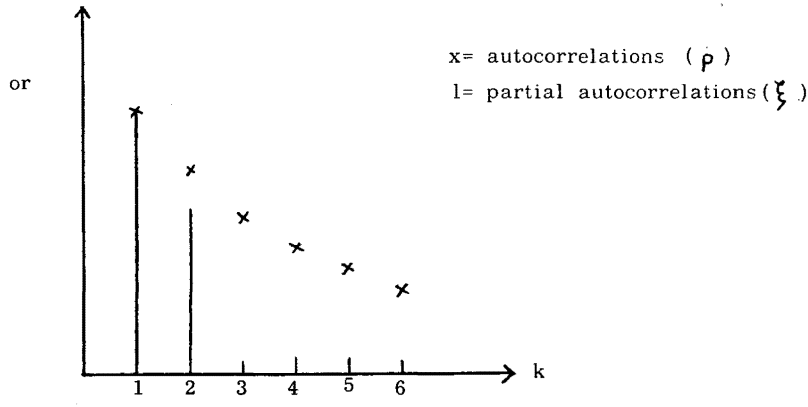


Figure A 1.2

The autocorrelation and partial autocorrelation functions for an AR(2) process

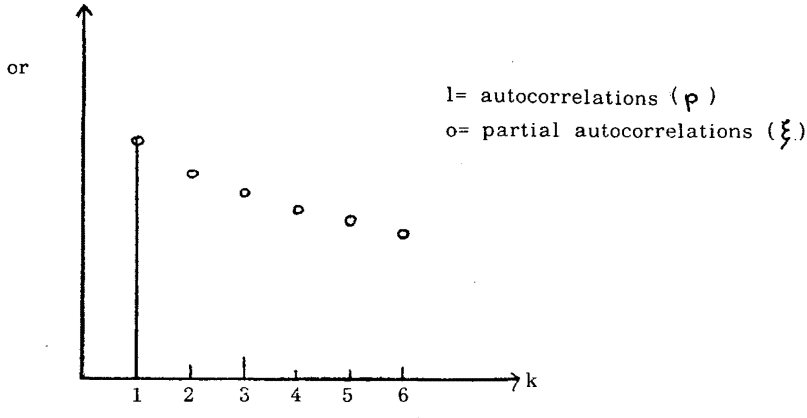


Figure A 1.3

Autocorrelation functions for time series with periodicities (D)

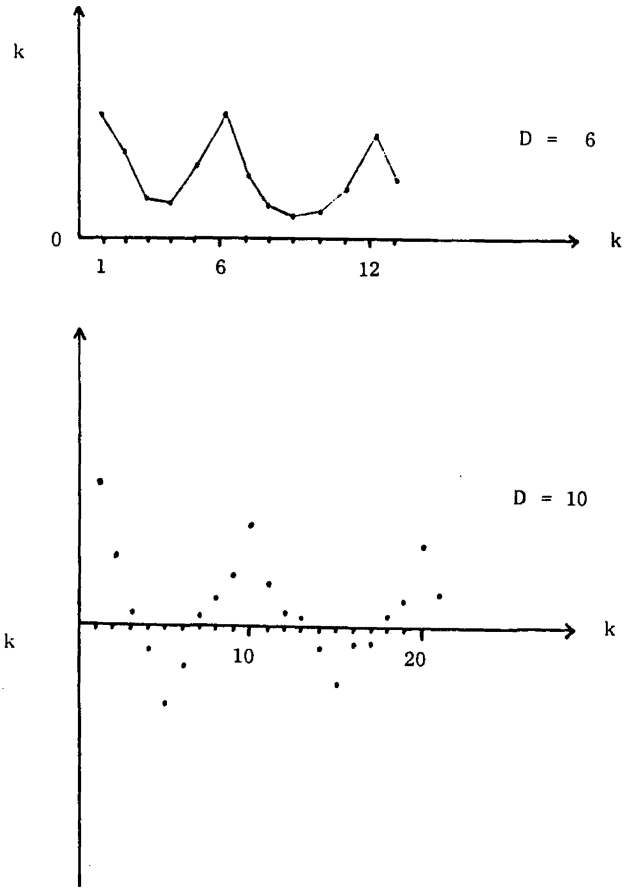
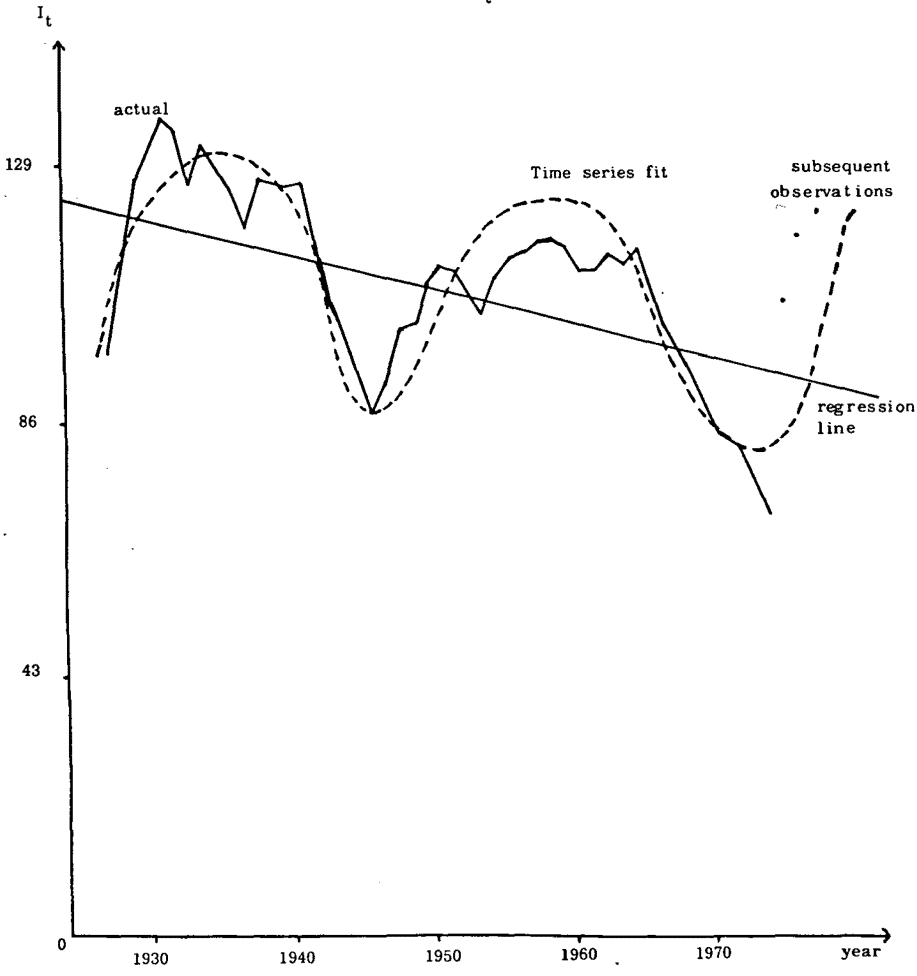


Figure A 1.4

Imprisonment Rates (I_t) for Ohio, U.S.



Appendix 2

Identifying and Interpreting Transfer Functions for Bivariate (ARIMA) Time Series Analysis.

The transfer function represents the relationship between two time series. In developing the transfer function, one series is considered to be the input series and the other to be the output series, and even though there is an implied causal relationship, the transfer function allows the possibility of feedback (and feedforward) from the output series to the input series.

For details on the identification and diagnostic checking of transfer models, see Vandaele (1983) or McCleary and Hay (1981). The BMDP handbook also provides a useful guide to the application of transfer functions, and BMDP was used for this analysis. Here we provide a very brief outline for the reader to follow the analysis presented here, and to show how the transfer functions were actually derived. There are a number of steps in the identification process. First, the ARIMA model for both the input and output series are determined. Second, both the time series are prewhitened, that is, filtered so that their ARIMA component is removed. (We note here that for all the transfer functions involved, the ARIMA models for the input and output series were all AR (1)). Third, the cross-correlation function for these two prewhitened time series is obtained. Fourth, based on the cross-correlations, a tentative transfer function is identified.
The transfer function is of the following form:

$$\frac{V_0 + U_1B + U_2B^2 + \ldots\ldots}{1-S_1B - S_2B^2 - \ldots\ldots}$$

In the numerator we consider only those U_k's where the k^{th} positive lag has a significant correlation (or very nearly significant). In the denominator, we consider those S_k's for which the k^{th} negative lag has a significant (or nearly significant) correlation. Fifth, we test this model to see if it fits the time series. A good fit is indicated when the residuals are white noise. However, it may be necessary to go through

a number of iterations at this stage. For one thing, it may turn out that some of the U's and S's in the tentative model are not significant. In that case the model has to be tried again without them. Also, the residuals may not appear as a white noise process, but rather as an autoregressive process. In that case, it must also be modelled as such before the final transfer can be estimated. (It can also happen that after the residuals are modelled as an AR process, the transfer function might have to be modified once again). In the end we shall arrive at a model like this:

$$Y_t = \frac{U(B)}{S(B)} X_t + \frac{1}{\phi(B)} a_t$$

Applying this process to identify the transfer function for arrests-to-convictions and convictions-to-admissions for each crime type, we have already seen that each of the time series is an AR(1) process with the exception of admissions for minor offences. After prewhitening the series, cross-correlation functions were obtained for each of the pairs, and these are given in figure A 2.1 below.

These give all the information to tentatively identify the transfer functions. In some cases, initial coefficients were non-significant and the transfer function had to be modified. The conditional least squares estimates are given here. The estimates by the backcasting method were also obtained (see BMDP handbook), but while the estimates were somewhat different, the transfer function models derived from those estimates were similar in form.

Figure A 2.1a

Plot of cross correlations

Violent Crimes (V_t <-- A_t)

LAG	CORR.	-1.0 -0.8 -0.6 -0.4 -0.2 0.0 0.2 0.4 0.6 0.8 1.0
		I
-10	0.046	IX +
-9	0.146	IXXXX +
-8	0.191	IXXXXX +
-7	0.197	IXXXXX +
-6	0.298	IXXXXX +X
-5	0.111	IXXX +
-4	0.265	IXXXXX +X
-3	-0.005	I +
-2	0.383	IXXXXX +XXXX
-1	0.335	IXXXXX +XX
0	0.900	IXXXXX +XXXXXXXXXXXXXXXXX
1	0.271	IXXXXX +X
2	0.271	IXXXXX +X
3	0.062	IXX +
4	0.173	IXXXX +
5	0.137	IXXX +
6	0.148	IXXXX +
7	0.140	IXXXX +
8	0.109	IXXX +
9	0.177	IXXXX +
10	0.070	IXX +

Figure A 2.1b

Plot of cross correlations

Property Crimes (V_t <-- A_t)

LAG	CORR.	-1.0 -0.8 -0.6 -0.4 -0.2 0.0 0.2 0.4 0.6 0.8 1.0
		I
-10	-0.136	+ XXX I +
-9	-0.046	+ X I +
-8	-0.014	+ I +
-7	0.022	+ I +
-6	-0.027	+ X I +
-5	0.014	+ I +
-4	0.054	+ IX +
-3	0.078	+ IXX +
-2	0.040	+ IX +
-1	0.141	+ IXXXX +
0	0.844	+ IXXXXX +XXXXXXXXXXXXXXX
1	-0.029	+ X I +
2	0.038	+ IX +
3	0.129	+ IXXX +
4	-0.013	+ I +
5	-0.150	+XXXX I +
6	0.136	+ IXXX +
7	0.119	+ IXXX +
8	0.079	+ IXX +
9	0.050	+ IX +
10	-0.065	+ XX I +

Figure A 2.1c

Plot of cross correlations

Minor Crimes (V_t <-- A_t)

LAG	CORR.	-1.0 -0.8 -0.6 -0.4 -0.2 0.0 0.2 0.4 0.6 0.8 1.0
		I
-10	-0.050	+ XI +
-9	-0.255	XXXXXXI +
-8	-0.130	+ XXXI +
-7	0.035	+ IX +
-6	0.148	+ IXXXX +
-5	-0.039	+ XI +
-4	0.008	+ I +
-3	0.041	+ I +
-2	0.010	+ I +
-1	0.208	+ IXXXXX +
0	0.990	+ IXXXXX +XXXXXXXXXXXXXXXXXXX
1	0.189	+ IXXXXX +
2	0.006	+ I +
3	0.062	+ IXX +
4	-0.023	+ XI +
5	-0.042	+ XI +
6	0.155	+ IXXXX +
7	0.047	+ IX +
8	-0.173	+ XXXXI +
9	-0.269	X+XXXXXI +
10	-0.070	+ XXI +

Figure A 2.1d

Plot of cross correlations

Violent Crimes (E_t <-- V_t)

LAG	CORR.	-1.0 -0.8 -0.6 -0.4 -0.2 0.0 0.2 0.4 0.6 0.8 1.0
		I
-10	0.021	IX +
-9	0.364	IXXXXX +XXX
-8	0.110	IXXX +
-7	0.187	IXXXXX +
-6	0.114	IXXX +
-5	0.224	IXXXXXX
-4	0.075	IXX +
-3	0.172	IXXXX +
-2	0.210	IXXXXX +
-1	0.191	IXXXXX +
0	0.354	IXXXXX +XXX
1	0.382	IXXXXX +XXXX
2	0.207	IXXXXX +
3	0.201	IXXXXX +
4	0.025	IX +
5	0.063	IXX +
6	0.190	IXXXXX +
7	0.204	IXXXXX +
8	0.193	IXXXXX +
9	0.150	IXXXX +
10	0.028	IX +

Figure A 2.1e

Plot of cross correlations

Property Crimes (E_t <-- V_t)

LAG	CORR.	-1.0 -0.8 -0.6 -0.4 -0.2 0.0 0.2 0.4 0.6 0.8 1.0
		I
-10	-0.103	+ XXXI +
-9	-0.014	+ I +
-8	0.044	+ IX +
-7	-0.011	+ I +
-6	0.120	+ IXXX +
-5	0.064	+ IXX +
-4	-0.050	+ XI +
-3	-0.067	+ XXI +
-2	-0.104	+ XXXI +
-1	-0.009	+ I +
0	0.353	+ IXXXXX +XXX
1	0.295	+ IXXXXX +X
2	0.010	+ I +
3	0.095	+ IXX +
4	-0.052	+ XI +
5	-0.148	+ XXXXI +
6	-0.064	+ XXI +
7	-0.162	+ XXXXI +
8	-0.068	+ XXI +
9	-0.093	+ XXI +
10	-0.098	+ XXI +

Figure A 2.1f

Plot of cross correlations

Minor Crimes (E_t <-- V_t)

LAG	CORR.	-1.0 -0.8 -0.6 -0.4 -0.2 0.0 0.2 0.4 0.6 0.8 1.0
-10	0.033	+ IX +
-9	0.078	+ IXX +
-8	-0.069	+ XXI +
-7	0.124	+ IXXX +
-6	0.076	+ IXX +
-5	-0.235	XXXXXXI +
-4	-0.004	+ I +
-3	-0.019	+ I +
-2	-0.020	+ I +
-1	0.132	+ IXXX +
0	0.108	+ IXXX +
1	0.202	+ IXXXXX +
2	-0.204	+XXXXXI +
3	0.113	+ IXXX +
4	0.026	+ IX +
5	0.090	+ IXX +
6	-0.022	+ XI +
7	0.190	+ IXXXXX +
8	-0.074	+ XXI +
9	0.141	+ IXXXX +
10	-0.042	+ XI +

Appendix 3

1. Trends in the distribution of crimes committed across crime types and regions

In this appendix we examine whether the proportion of crimes of a given type in a given region in West Germany has remained stable or whether this proportion has been unstable for particular types of crime or alternatively, for particular regions. We further investigate whether these proportions conform to a model of independence[84], or whether there are interactions among specific regions with specific crime types. For example, a particular region may have an exceptionally high (or low) rate for a given type of crime; a rate that does not conform to the general prevalence of that crime, nor to the general crime rate for that region. Finally we seek to identify groups of states having similar patterns.

The data analyzed here are the known crimes for the 11 states of the Federal Republic of Germany for 6 selected crime types, and for the years 1971, 1977 and 1983, obtained from the police reports. They are: murder (MT), robbery (RB), aggravated assault (GK), burglary (SD), larceny (ED) and fraud (BT). The 6 crime types were selected because they were either serious or very prevalent, and also because offenders for these crimes account for a significant proportion of the prison population in Germany.

We use log-linear models to test first for stability in the distribution of crimes over time, and next to test for independence with respect to type and region[85]. We are also interested in analyzing the residuals from fitting such models to the data, since they may reveal important patterns in terms of exceptional trends or groupings among crime-types or regions. In every case, the residuals are displayed in terms of standardized deviates, that is, (obs.-exp.)/ (obs.).

2. Investigating Stability

To investigate this issue, that is, whether the distribution of crimes across types or regions is constant over time, we fit the following log-linear model to the data:

$$l_{c,e,y} = u + u_{c(i)} + u_{e(j)} + u_{y(k)} + u_{ce(ij)} \qquad (1)$$

where

$l_{c,e,y} = \log p_{c,e,y}$

$p_{c,e,y} = \frac{n_{c,e,y}}{n...}$ = cell probability

$n_{c,e,y}$ = no. of crimes of type c committed in region l in year y.

$n... = $ all known crimes $= \sum_c \sum_e \sum_y n_{c,e,y}$

and the u-terms represent the various effects as follows:

u	= grand mean of the logarithms of the cell probilities
$u_{c(i)}$	= the effect (deviation) due to being in level i of variable c
$u_{e(j)}$	= the effect (deviation) due to being in level j of variable l
$u_{y(k)}$	= the effect (deviation) due to being in level k of variable y
$u_{ce(ij)}$	= the interaction effect due to being in level i of variable c **and** in level j of variable l.

We note that the effects that represent interactions with year ($u_{cy(ik)}$ and $u_{ey(jk)}$) are omitted. This implies that the variables crime type and region are independent of year, that is, the prevalences are independent of time and stable.

The results of fitting this model are shown in Table 1. Clearly the model of stability does not fit the data at all (chi^2= 65,197.55 for 130 degrees of freedom), but the residuals reveal an interesting pattern. Focussing on the largest deviates, we see that larceny (ED) accounts for a very large number of them. For all states except for BW, SA and SH, its values are much larger than expected for 1971 and much smaller than expected for 1983. Given the significant increases in larceny (ED) in all states, it may appear surprising, but in fact the deviations refer to relative changes. It simply means that relative to the total changes in the crimes committed over the years, and given the changes in each region as well, larceny (ED) has not increased as much as would have been expected. The aggregate changes in these

years seem to be driven by burglary (SD) and fraud (BT), both of which have increased dramatically. burglary (SD) also accounts for a number of the larger deviations, but the trends are different for different states. In 1971, its prevalence was higher than expected for BY, BE and lower than expected for BR, HH, NS, NW and SH. In 1977 it is higher than expected for HS, NS, NW and RF. Finally, in 1983, it is higher than expected for BR, HH, NS, NW and SH (the exact reverse of 1971) and lower than expected for BY, BE (again the reverse of 1971) and also SA.

Fraud (BT) is the third crime type to have many deviates. It displays a general trend of being less than expected (in 5 states) in 1971 and being more than expected (in 6 states) in 1983.

The deviations for the violent crimes are generally very small, suggesting that the prevalence of violent crimes has remained relatively stable across the states. The deviations also reveal some similarities among the states. For example, BR and HH are seen to have very similar patterns, and NS, NW and SH also appear to have a similar pattern, especially for the property crimes burglary (SD), larceny (ED) and fraud (BT). In order to explore the similarities among the states further, we fit the log-linear model that includes all 2-way interactions, that is,

$$l_{c,e,y} = u + u_{e(i)} + u_{e(j)} + u_{y(k)} + u_{ce(ij)} + u_{ey(ik)} + u_{ey(jk)} \qquad (2)$$

In this model, all possible first order (2-way) interactions are included (among the 3 variables: crime-type, state and year), but as can be seen from the large deviates in Table 2, even this model does not fit the data ($chi^2 = 25{,}413.08$ with 100 degrees of freedom).

Looking at the largest deviates, we again see that they are all due to the property crimes - (SD, ED, BT)[86]. We find once again a similar pattern for BR and HH and also a new group, BW and BY. However, the other group of northern states (NS, NW and SH) does not show up here.

Since there appears to be a major difference in the temporal patterns in the distribution of crime, we disaggregate the crimes into 2

groups; the violent crimes (MT, RB, GK) and the property crimes (SD, ED, BT). The results of fitting the model for stability (1) are shown in Tables 3 and 4 respectively. For the violent crimes, the fit is actually quite good. The high value of x^2 (1,650.95 for 64 degrees of freedom) is basically a reflection for the very large numbers involved. There do not appear to be any distinct patterns involved, except for the fact that BY has relatively large positive residuals for all 3 crimes for 1971.

Turning to the property crimes (Table 4), we find a very high number of large deviates (x^2= 63.421,74 for 64 degrees of freedom). In particular, ED and SD exhibit a great deal of instability. Among the states, NS and NW show a similar pattern once again, and as in both previous cases BR and HH are very similar (this time along with HS).

3. Investigating Independence

In addition to the issue of stability, it would be of interest to examine the issue of independence as discussed earlier. So far we have always included the interaction effect between crime-type and state ($u_{ce(ij)}$). We would now like to remove this restriction and see how well the data fits the model of independence, given by

$$l_{c,e} = u + u_{c(i)} + u_{e(j)} \qquad (3)$$

and we do this for each of the years separately.

The results are shown in Tables 5,6 and 7 for the years 1971, 1977 and 1983 respectively. In no case do the data fit the model of independence[87], indicating there are very strong interactions between crime-type and state. Simply knowing the marginal values for crime types and for the states will not help us in predicting how much of a given crime type occurred in a given state.

Examining the deviations for 1971, we find there is no pattern of grouping by state. The violent crimes have relatively smaller deviations with only aggravated assault (GK) having a somewhat high positive value in the case of BY and a large negative value in the

case of NS. A positive residual means that more crimes occur in that state for that crime category than would be expected simply from the prevalence of that crime type in general and from the total crime rate in that region. A negative residual obviously means the opposite.

The economic crimes again exhibit the largest deviations. Burglary (SD) has large positive residuals for BE and NW and large residuals for BY and HH. Larceny (ED) has large positive residuals for BY and NS and a large negative one for BE. Fraud (BT) has large positive residuals for BW, BY, HH and large negative ones for BE, NS and NW.

For 1977, the patterns are rather similar. In addition to similar residuals for aggravated assault (GK) (positive for BY; negative for NS), robbery (RB) has a high positive residual for BE. Once again, it is the property crimes that have the largest residuals. Burglary (SD) has large positive residuals for BE, NS and NW, exactly as in 1971, but has large negative residuals for BW, BY and RF, a new pattern. Larceny (ED) also exhibits a new pattern among its larger residuals: positive for BY, RF and SH; negative for HH, NW. Fraud (BT) on the other hand has a very similar pattern: positive for BW, BY, HH and HS; negative for BE, NS and NW; exactly as in 1971, except for the case of HS.

The deviations for 1983 are significantly larger, and this time we also notice some groupings by state. Thus, BW, BY, RF have a similar pattern of deviations (reminding us that BW and BY were in a group before), and BR and HS are also similar. BR and HS also have similarities with NS and NW (also an earlier group), and finally HH and BR (another earlier group) have similar residual patterns for burglary (SD) and larceny (ED), the two most prevalent crimes. HH here is different from BR in that it has 4 large deviations, 3 of them positive and all for monetary crimes. This may perhaps be a reflection of greater economic activity and population growth in the largest city in W.G. outside Berlin.

Looking at the larger deviations by crime-type, we see only two (positive) for the violent offenses: robbery (RB) in HH and aggravated assault (GK) in BE. Among the economic crimes, burglary (SD) has a

new pattern: positive in BR, HH, HS, NS and NW; negative in BW, BY, RF and SA. Larceny (ED) also displays a new pattern: positive for BW, BY, RF and SA; negative for BR, HH, HS, NW. Fraud (BT) has large positive deviates in BW, BY, HH and RF and large negative deviates in NS, NW and SH, exactly as in 1971 and 1977, except for RF and SH. Thus, it is only the residuals associated with fraud (BT) that appear stable over these years.

4. Conclusions

We have investigated two hypotheses (stability and independence) for the distribution of crimes across crime-types and states. The analysis shows that the data deviates widely from both stability and independence. Analysis of the residuals in both cases, however, reveals some stable groupings among the states.

Table 1: Standardised Residuals from the model for stability

year	crime	Land (state)										
		BW	BY	BE	BR	HH	HS	NS	NW	RF	SA	SH
1971	MT	4.6	6.5	3.9	1.7	3.2	4.6	1.5	7.8	0.5	0.1	3.6
	RB	-1.9	6.4	-2.7	0.2	-6.1	2.5	-6.7	-4.9	1.1	-1.5	-0.8
	GK	-7.6	2.5	-1.6	1.4	-2.3	1.5	**-15.3**	-10.3	6.1	-4.9	-4.8
	SD	-1.1	**46.1**	**55.8**	**-19.8**	**-39.9**	-4.2	**-15.8**	**-84.1**	5.8	7.2	**-11.9**
	ED	-2.9	**40.8**	**35.6**	**37.0**	**47.4**	**26.5**	**29.6**	**25.9**	**11.1**	-1.0	-8.4
	BT	2.9	**12.2**	**-15.7**	-4.1	**-13.5**	0.3	**-19.7**	**-17.0**	**-15.1**	2.5	-1.7
1977	MT	0.2	-2.5	1.0	-1.1	-0.6	1.3	1.5	1.6	0.5	1.3	-0.4
	RB	0.1	-3.0	7.3	-1.4	-4.5	-3.5	-0.2	-1.8	-1.9	1.6	-2.2
	GK	0.9	8.2	-2.0	5.3	-1.0	5.7	2.3	7.9	0.0	0.3	1.3
	SD	-1.8	-7.4	-5.2	-5.7	**-22.6**	**-41.6**	3.2	4.4	1.3	8.2	**-23.0**
	ED	-1.4	-9.1	9.1	2.9	-1.1	**16.9**	**25.9**	**31.1**	**16.8**	5.6	**13.1**
	BT	**-21.4**	0.4	**-32.4**	**15.5**	**19.4**	1.3	**-15.9**	**-13.0**	-9.1	0.3	**-24.5**
1983	MT	-3.7	-2.8	-3.8	-0.3	-1.9	-4.6	-2.4	-7.3	-0.9	-1.2	-2.3
	RB	1.4	-2.2	-4.3	1.1	8.5	1.2	5.2	5.3	0.9	-0.3	2.5
	GK	5.0	-9.1	2.9	-5.7	2.6	-6.1	9.5	0.9	-4.6	3.5	2.5
	SD	2.4	**-28.3**	**-37.6**	**19.9**	**49.8**	39.4	**36.3**	**59.6**	-5.5	**-12.6**	**29.0**
	ED	3.4	**-22.9**	**-34.8**	**-30.4**	**-34.8**	**-34.7**	**-44.9**	**-46.7**	**-23.0**	-4.1	-5.1
	BT	**16.5**	-9.5	**40.2**	-10.5	-6.8	-1.4	**28.8**	**24.1**	**19.3**	-2.1	**22.7**

Table 2: Standardised Residuals from the Model of Stability with 2-way Interactions Included

year	crime	Land (state)										
		BW	BY	BE	BR	HH	HS	NS	NW	RF	SA	SH
1971	MT	-0.2	-0.8	-0.6	-0.2	1.0	-0.2	-1.4	3.2	-2.5	-1.6	1.4
	RB	0.5	3.2	-7.0	0.3	-4.2	3.0	-2.7	2.7	1.9	-1.0	1.9
	GK	-2.2	-0.8	-6.3	2.6	1.2	3.8	-8.4	4.5	8.8	-3.4	0.3
	SD	**17.9**	**26.1**	**27.2**	**-17.8**	**-26.4**	1.3	-17.3	-23.7	12.5	11.4	11.1
	ED	**-23.8**	**-22.6**	**-15.7**	**20.5**	**32.4**	-4.0	**22.4**	**20.9**	-7.8	-10.9	-14.2
	BT	**14.0**	1.0	-25.2	-3.2	-6.1	3.1	-6.3	8.3	-12.1	4.3	7.7
1977	MT	0.1	-2.3	1.1	-1.3	-0.6	1.6	0.6	0.3	-0.1	0.7	-0.3
	RB	2.0	-1.3	8.9	-1.4	-2.8	-1.1	-0.5	-2.1	-2.1	1.1	-0.3
	GK	-1.2	5.6	-4.1	3.0	-2.0	5.0	-2.6	-0.7	-3.4	-2.4	1.1
	SD	12.9	6.0	5.0	-4.3	-10.7	**-23.0**	2.6	5.0	1.0	5.4	-6.9
	ED	-8.0	-13.2	5.7	-4.4	-4.5	**16.5**	2.7	-2.4	3.1	-4.8	13.4
	BT	-8.3	13.5	-26.4	**18.4**	**30.3**	**15.0**	-12.4	-6.4	-6.4	0.5	**-16.3**
1983	MT	0.1	3.0	-0.5	1.5	-0.4	-1.3	0.7	-3.2	2.4	0.8	-1.0
	RB	-2.0	-1.4	-2.1	0.9	5.3	-1.3	2.3	-0.1	0.5	-0.2	-1.0
	GK	2.7	-4.5	8.9	-4.7	0.9	-7.1	8.1	-2.5	-3.4	4.8	-1.2
	SD	**-23.3**	**-25.6**	**-26.4**	**16.9**	**27.4**	**18.1**	9.8	12.1	-10.1	-13.2	-1.9
	ED	**26.4**	**32.6**	9.1	**-13.2**	**-21.9**	-11.6	**-20.2**	-14.1	3.6	**13.8**	-0.8
	BT	-3.1	-12.1	**42.8**	**-13.1**	**-20.1**	-14.3	14.6	-0.4	**14.2**	-3.5	7.6

Table 3: Standardised Residuals from the Model of Stability (for Violent Offences)

year	crime	Land (state)										
		BW	BY	BE	BR	HH	HS	NS	NW	RF	SA	SH
1971	MT	**5.6**	**7.5**	4.4	2.0	3.7	**5.4**	2.2	**9.0**	1.1	0.4	4.1
	RB	0.1	**8.5**	-1.0	1.1	-4.6	4.4	-4.9	-1.9	2.4	-0.8	0.4
	GK	-4.7	**6.1**	1.1	2.8	-0.5	4.0	**-12.9**	**-5.7**	**8.2**	-3.9	-3.0
1977	MT	-0.3	-3.0	0.7	-1.3	-0.8	0.9	1.0	1.0	0.2	1.0	-0.6
	RB	-1.3	-4.2	**6.1**	-2.0	**-5.5**	-4.6	-1.4	-3.8	-2.7	1.1	-2.9
	GK	-1.1	**5.8**	-3.7	4.3	-2.2	4.0	0.5	4.6	-1.3	-0.5	0.1
1983	MT	-3.8	-2.9	-3.8	-0.3	-2.0	-4.7	-2.5	**-7.5**	-0.9	-1.2	-2.4
	RB	1.1	-2.5	-4.6	1.0	**8.2**	0.9	4.8	4.7	0.7	-0.4	2.3
	GK	4.5	**-9.6**	2.5	**-5.9**	2.3	**-6.5**	**9.0**	0.1	-4.9	3.3	2.1

Table 4: Standardised Residuals from the Model of Stability (for Property Offences)

year	crime	Land (state) BW	BY	BE	BR	HH	HS	NS	NW	RF	SA	SH
1971	SD	-1.5	**45.6**	**55.5**	**-20.0**	**-40.2**	-4.6	**-52.2**	**-84.8**	5.5	7.0	-12.2
	ED	-3.3	**40.3**	**35.3**	**36.8**	**47.1**	**26.1**	**29.1**	**25.2**	10.8	-1.1	-8.7
	BT	2.6	11.9	-15.8	-4.2	-13.7	0.1	-19.9	-17.3	-15.3	2.4	-1.8
1977	SD	-1.5	-7.2	-4.9	-5.6	**-22.3**	**-41.3**	3.5	4.9	1.5	8.3	**-22.8**
	ED	-1.1	-8.8	9.3	3.0	-1.0	17.1	**26.2**	**31.6**	17.0	5.7	13.3
	BT	**-21.2**	0.6	**-32.4**	15.6	19.5	1.4	-15.8	-12.8	-9.0	0.3	**-24.5**
1983	SD	2.5	**-28.2**	**-37.6**	**20.0**	**49.8**	**39.5**	**36.4**	**59.7**	-5.5	-12.5	**29.1**
	ED	3.5	**-22.8**	**-34.8**	**-30.4**	**-34.7**	**-34.7**	**-44.9**	**-46.6**	**-23.0**	-4.1	-5.1
	BT	16.6	-9.5	**40.2**	-10.4	-6.7	-1.3	**28.8**	**24.2**	19.4	-2.1	**22.7**

Table 5: Standardised Residuals from the Model for Independence: 1971

crime	Land (state)										
	BW	BY	BE	BR	HH	HS	NS	NW	RF	SA	SH
MT	6.3	5.7	-3.5	-2.0	-4.7	2.9	-4.0	-2.6	1.0	1.1	-1.5
RB	1.1	-1.8	7.2	-0.8	5.2	4.7	-8.1	-0.7	-0.8	0.9	-4.5
GK	-3.2	**23.4**	12.7	2.6	-10.7	-7.1	**-23.7**	2.6	8.3	0.4	-6.6
SO	-19.1	**-46.0**	**48.0**	-5.6	**-20.0**	9.8	0.2	**22.1**	-7.2	-0.2	11.5
ED	-12.5	**20.9**	**-32.3**	8.5	11.0	-15.7	**25.9**	-8.6	8.5	4.3	-1.4
BT	**68.6**	**44.4**	**-42.6**	-6.8	**23.9**	14.0	**-42.4**	**-30.2**	-6.2	-9.4	-17.5

Table 6: Standardised Residuals from the Model of Independence: 1977

crime	Land (state)										
	BW	BY	BE	BR	HH	HS	NS	NW	RF	SA	SH
MT	7.2	4.0	-1.7	-2.9	-5.9	5.0	-2.2	-5.3	4.2	4.3	-3.0
RB	3.2	-6.0	**27.8**	-2.5	8.7	1.1	-7.0	-5.8	-4.8	3.7	-7.3
GK	-1.3	**36.2**	18.4	3.4	-15.6	-7.2	**-22.5**	-1.7	-3.3	3.0	-6.8
SD	**-30.9**	**-70.8**	**24.0**	9.1	-4.8	-15.7	**22.7**	**58.2**	**-22.0**	-8.3	-7.4
ED	6.8	**36.1**	-12.4	-16.7	**-26.5**	3.9	7.8	**-36.4**	**23.4**	14.0	**30.0**
BT	**53.1**	**65.2**	**-44.1**	14.3	**71.8**	**29.4**	**-53.7**	**-49.5**	2.2	-14.1	**-41.0**

Table 7: Standardised Residuals from the Model of Independence: 1983

crime	Land (state)										
	BW	BY	BE	BR	HH	HS	NS	NW	RF	SA	SH
MT	7.6	10.5	-3.1	-0.5	-6.1	1.9	-2.1	-8.6	7.2	4.4	-3.7
RB	-0.5	-6.3	16.6	-0.6	**20.2**	1.2	-5.4	-4.8	-2.4	2.9	-9.3
GK	3.2	28.9	**36.1**	-4.3	-15.4	-19.8	-15.0	-3.5	-2.6	12.0	-9.7
SD	**-73.4**	**-107.6**	-7.0	**32.2**	**32.0**	**25.9**	**34.2**	**72.4**	**-34.4**	**-25.8**	-0.7
ED	**44.4**	**92.9**	-10.8	**-26.7**	**-47.6**	**-26.1**	-14.2	**-52.5**	**26.7**	**36.7**	19.3
BT	**74.1**	**47.5**	14.8	-17.7	**21.0**	1.0	**-39.2**	**-54.9**	**25.9**	-19.3	**-27.2**

Notes PART 1

1) There is now a growing literature in quantitative historical analysis, and in particular in historical criminology. See for example Brantingham and Brantingham (1984) for a discussion of the literature.

2) The inference of causality is always very difficult and the methodological problems are not yet fully resolved. For further details see McDowall and Loftin (1982), Greenberg and Kessler (1982) and Kenny (1979).

3) There is an enormous literature on economic forecasting, for example, see Granger and Newbold (1977), and recently there have been some applications in criminology, Fox (1978), and Phillips, Ray and Votey (1984).

4) See Gurr (1981) for a review of this literature.

5) In the last four years, some of these countries have experienced a small decline in the crime rates, probably due to demographic factors. However, the rate is still very high compared to say 1950 or 1960. On the other hand, Japan has recently experienced an increase in the crime rate.

6) In addition to a number of time-series studies examining the issue of deterrence (to be discussed later), there is a large body of literature on the application of econometric models to investigate deterrence. See for example Cook (1980) for an overview.

7) Models can be developed to describe the structure of the time-series data and the relationship between different time-series, and thus they help to classify the nature of temporal variations in criminal justice data.

8) This issue is discussed in greater detail later when the various time-series models are described.

9) It is obviously beyond the scope of this report to review in detail every single study. This section attempts to provide an overview of some of the research done in this area and it is indicated where further details and references may be found.

10) All three, Gurr (1981), Mukherjee (1981) and Brantingham & Brantingham (1984) provide extensive reviews of the literature.

11) Time-series data on Canada has been analyzed by Irvin Waller, at the University of Toronto (unpublished report).

12) For a further discussion of the issues see Blumstein, et. al. (1981) and Rauma's response. The paper by Berk, et. al. is discussed further below.

13) The data in Berk, et. al. on the imprisonment rates for California can also perhaps be interpreted along similar lines, with one stable level up to 1900 and a lower one after that.

14) As an example of this difficulty, see Blumstein, Cohen, Moitra and Nagin (1981) where it is shown that a stationary and a non-stationary model can be in fact very similar, and the same time series can fit either.

15) Since the imprisonment rate is the product of two variables: the admission rate and the average sentence length, and each may be unstable for a variety of reasons (e.g. changes in the number of offenders sentenced, changes in sentencing policies, etc.) while the imprisonment rate remains stable all along, the hypothesis of the stability of imprisonment cannot be tested with data on admission rate only, as Rauma (1981) has attempted to do.

16) These include normative grounds for punishment of breaches against the social order, and utilitarian grounds like deterrence, rehabilitation or incapacitation.

17) This is discussed in detail below.

18) This was first pointed out by Fox (1976).

19) These data were needed at the very least. Other time series data, e.g. prison capacity and sentencing rates that were needed for the analysis were also collected (mainly in the case of the Federal Republic of Germany). Still further detailed data could have been helpful, but their collection was beyond the scope of the project.

20) The Scandinavian countries appeared as another possible group of countries that could be usefully included in this comparative analysis and their official agencies were contacted. However, it was not feasible to obtain data for disaggregated crime types or for long enough time periods. For other European countries, the data were either unavailable or were not easily comparable, or the linguistic barriers could not be overcome by the author.

21) I would like to express again here my appreciation for having the opportunity to work there. Thanks are also due to the library staff who were always most helpful, especially to Frau Biele and Frau Schreiber.

22) All crime rates for the Federal Republic of Germany as a whole were collected from Polizeiliche Kriminalstatistik 1953-1983. Bundeskriminalamt Wiesbaden. These reports also had data on individual states starting from 1961. For earlier data on individual states, the Polizeiliche Kriminalstatistik for each state was consulted to get data as far back as possible.

23) Thus Sachbeschädigung (property damage) was excluded because it is not only one of the least serious crimes, but also because hardly anyone was imprisoned for it. Drug offences were ommitted for another reason, namely, that the time series for the reported offences were too short. Among the serious crimes, only rape was ommitted, because, as explained later, comparable rates of imprisonment for offenders convicted of rape could not be obtained.

24) Polizeiliche Kriminalstatistik 1953-1983.

25) Conviction data can be found in Rechtspflege, Reihe (4).

26) Rechtspflege Reihe 4: Strafvollzug. 1961-1983. Bundeskriminalamt, Wiesbaden.

27) I am indebted to H.-J. Albrecht for showing me how to recognize the corresponding categories. The problem was essentially in matching to subcategories in the prison data to the broader categories in the police data.

28) For both burglary (schwerer Diebstahl) and fraud (Betrug), the classification system had changed in the course of the time period studied. For the later years (after the change), fractions from the new categories were combined so as to reconstitute totals corresponding to those for previous years.

29) The imprisonment rates for the U.S. and its states can be obtained from the U.S. Statistical Abstracts. The data here were taken from Blumstein and Moitra (1980) and updated with the help of the Abstracts. To keep the comparisons within feasible limits, two states of the U.S. (Iowa and Wisconsin) were chosen since they appeared reasonably similar to the states of Germany in their crime rates. Two states of Germany were chosen (Baden-Württemberg and Nordrhein-Westfalen) because they reported the longest time series data. All the states of the Federal Republic of Germany had very similar time series for their imprisonment rates.

30) California Department of Corrections, Sacramento. California Prisoners: Summary Statistics of Prisoners and Paroles. 1958-1981.

31) For the U.K. the data was collected from the Prison Reports and the Criminal Statistics for England and Wales, HMSO 1940-1980. For Australia, the data is provided in Mukherjee et al. (1981). For Sweden the imprisonment data was obtained from Rättsstatistisk åssbok 1975-1982,. For Austria, the data was taken from Pilgram (1980).

32) For a comparison of the definitions of different crime types as reflected in the criminal statistics of the U.S. and West Germany see Teske and Arnold (1982).

33) See Teske and Arnold (1982) for examples of such differences between the U.S. and the Federal Republic of Germany.

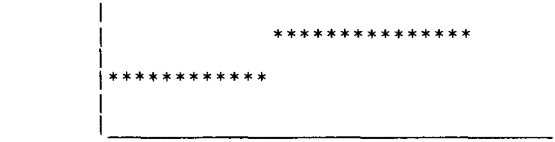
34) See Mukherjee (1981) and Mukherjee et al. (1981).

35) Thus the simple regression equation would be
$y(t) = a + bt$
where y is the criminal justice variable of interest, b is the slope of the regression line, that is, the rate at which y increases with t. Thus b represents the trend and can be positive or negative, and a is the intercept, but which is not significant for our analysis. The multiple repression equation would be
$y(t) = a + bt + \underline{z}(t)$
where $\underline{z}$ represents the vector of other independent variables that are presumed to influence y.

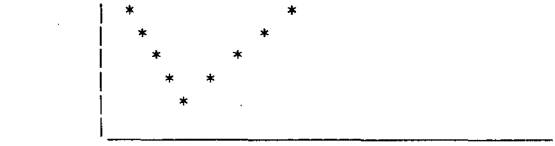
36) Sometimes the quadratic form can be used, for example, if we think that one variable is increasing in proportion to the square of time. In some cases this may be plausible because this represents an accelerating change, that is, a change where the rate of increase (or decrease) becomes greater and greater.

37) See Block and Miller (1983).

38) A step change is said to occur when the level of the time series changes as for example:



and a turning point is that point when the trend changes sharply and abruptly as for example:

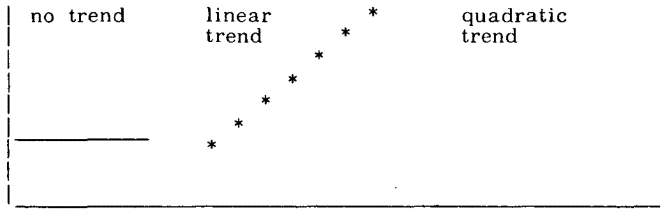


39) For more detailed explanations of correlation, see Blalock and Blalock (1981) or McCleary and Hay (1980).

40) We shall return to this method later, and its application will be discussed in more detail, along with examples.

41) See for example Vandaele (1981) or McCleary and Hay (1980) for a rigourously demonstrated justification.

42) A quadratic trend is when the series varies with the square of t, and the three types of trends, no trend, linear trend and quadratic trend can be illustrated as follows:



43) Here we are considering only models without periodicity.

44) See the illustration in the appendix.

45) A more detailed explanation is provided in the appendix.

46) Ehrlich (1975) for example has used such models to investigate the relationship between the death penalty and homicide rates. For a more detailed explanation of structural models, see Hanushek and Jackson (1977).

47) The reduced form equation is one where endogenous variables have been successively substituted, and only the last one remains on the left hand side of a single equation. This also assumes a hierarchy among the endogenous variables and that no two variables mutually influence each other.

48) See Kessler and Greenberg (1981) for details.

Notes PART 2

49) By a jurisdiction we mean a region that has a common legal system, and has a reasonably homogeneous criminal justice system. Of course, it is often difficult to justify regarding a given region as a jurisdiction, and indeed also, it may be worthwhile disaggregating a legal jurisdiction, for example into urban/rural areas.

50) The "Polizeiliche Kriminalstatistik", for example has the complete time series (1955-1982) in its recent issues. The data are also disaggregated into convenient crime types.

51) This refers to the prison reports in Rechtspflege, Band 4, 1961-1983.

52) We shall discuss the English translations of the German names later.

53) I am indebted to Dr. H.-J. Albrecht for helping me with this regrouping.

54) For a more detailed discussion on the comparability of sta-

tistics, see Teske and Arnold (1982).

55) The time series for the arrest rates were also analysed. However, they corresponded almost exactly with the crime rates, so they do not explain imprisonment rates any further. The implication is of course that the police has responded to increasing crime with increasing arrests, and this is reflected in the stable clearance rates for most of the crime types. For burglary and larceny, the clearance rates have decreased somewhat.

56) The divergence is in fact sharper, since the scale for the crime rates has been reduced by a factor of 10. The imprisonment rate (per 100,000 of the population) for the United States includes the state prison population of all 50 states but includes local jails and federal institutions. The imprisonment rate for Germany is the number of sentenced prisoners per 100,000 of the population.

57) We should remember here that what we have translated as burglary is "schwerer Diebstahl", literally serious theft, that is, everything that involves breaking and entering, including locked vehicles.

58) Here we have translated as larceny what is "einfacher Diebstahl" or simple theft, but it includes acts that would be classified as larceny as well.

59) Part of this trend may be due to a change in the mix of the kinds of theft and larceny that were committed. If the increases were due mainly to very minor offences which could not have led to imprisonment, then that would explain the absence of a proportional increase in the imprisonment rate without invoking the adaptation hypothesis. To investigate this, we need of course even more disaggregated data. However, it appeared that all kinds of theft and larceny had increased.

60) These conclusions are supported by the relatively high arrest-to-crime ratio for homicide, and the relatively low recidivism rate for homicide.

61) It should be remembered that some of the increase in the crime rate for robbery between 1963 and 1971 (when there was a slight decline in admissions) could be due to changes in reporting habits or in police recording practices, for example, recording a higher proportion of minor or doubtful robberies than before, or classifying as robbery acts which had been classified as larcenies before. Even a relatively minor shift in classifications could produce a significant change in recorded robberies.

62) An additional possibility is that the increase in the crime rate was influenced by changes in reporting behavior or in recording practices by the police such that more and more minor burglaries were included in the statistics over the

years. The decrease in prison admissions could reflect such a change in the mix of crimes reported under burglary, or a policy change, for example, a shift to more jail sentences.

63) While there may well be some burglaries that are committed on the spur of the moment and without thought to the consequences, there is presumably a subset of burglars who react to changes in expected punishment and their behavior would have an effect on the burglary rate.

Notes PART 3

64) As discussed in detail in the Introduction in Part 1.

65) The fourth group, offences against "good order" comprise such a mixed set of crime types that it could not be used for this analysis, whose whole point is to examine disaggregate crime types.

66) There is an additional error term e(t). Very often in such bivariate time series analysis, they are not normally distributed, that is, they are not white-noise. In such cases, the time series of the error terms should also be modelled as an autoregressive process, and this was done for all the series here. Generally this does not have great significance for the relationship between the variables being studied, and in our case especially they were of no significance whatsover, since in all cases but one they could be modelled as an AR(1) process, as shown in the appendix. The exception was for the time series for conviction and admissions for petty offences, and that will be discussed later.

67) This has not been tested directly, however. Our conclusions are based on prison admission rates and not on actual prison populations. If the lengths of time served for different crime types had changed significantly relative to each other, then this conclusion may not be true.

68) As a matter of fact, it was found that a stationary ARIMA model fitted the data for Finland, although we are not suggesting that this makes it conclusive.

69) It should be remembered that there had been occasional changes in the law or reporting practices or statistical procedures. For all further details see the Annual Statistical Reports for Sweden and the Summary of Scandinavian Data.

70) The data was obtained from the Central Statistics Bureau of the Finnish Government.

71) The data was obtained from the Central Bureau of Statistics, Oslo.

72) The data discussed here is from "Kriminalität in den Niederlanden in den Jahren nach 1950" by O. Grosch, Max-Planck-Institute für Law, Freiburg.

73) The data discussed here is from Pilgram (1980).

74) This data was supplied by J. Chan at the Center for Criminology, University of Toronto.

75) For a discussion of the role of unemployment rate in influencing the imprisonment rate, see the review of the literature in Part 1.

Notes PART 4

76) Unfortunately in this study of German data, we cannot follow such a strategy because the time periods for which we have data are too short. (See the discussion of this point in the methodology section.)

77) See the review of literature in Part 1, especially Gurr (1981), Mukherjee (1981) and Heiland (1983).

78) Of course one can always add other variables to this list or argue that one or another should be excluded, but this list does include almost all the significant variables that have been considered in the literature. Also, as we shall see, the main limitation was the availability of data over a sufficiently long time series.

79) In most cases, the earliest available data were for 1954. Therefore this was taken as our starting year for all the time series. The latest year is 1982.

80) Thus the price index was so highly collinear with both GNPC and CARC that it would have been totally redundant, and therefore was dropped. The number of single parent families, number in the military service, rate of internal migration were all almost constant over these years. Finally, the number of foreign workers per capita and the divorce rate were two variables that displayed changes that were totally unrelated to any of the crime rates.

81) Although at first sight these seem to be very different crimes, with robbery involving violence and burglary not, there is evidence that robbery should be considered more as a property crime than a violent crime. In a study of crime switching patterns, Moitra (1980) found that switching between robbery and burglary was much more frequent than switching between robbery and other violent crimes.

82) Here we have only examined crime rates among all the

possible criminal justice variables. The rationale for this is that given the close and direct relationship found for the serious crimes between imprisonment and crime, the same relationships would be expected to hold between the socioeconomic indicators and imprisonment rates. For the minor crimes (burglary and larceny), there is even less of a relationship between imprisonment rates and socioeconomic indicators.

83) See for example Bowker (1981). He cites further references on this issue.

Notes Appendix

84) Independence implies that knowing the national prevalence of that crime type (p_c) and the relative prevalence of all crimes in a "Land" (p_e), one can predict the proportion of crimes of that type in that region (p_{ce}), from $p_{ce} = p_c \cdot p_e$

85) Log-linear models are particularly suitable for such analysis, and each model is introduced as it is used. For a detailed development of the theory see Bishop, Feinberg and Holland (1975).

86) There are no striking patterns by crime-type other than what we have already discussed with regard to Table A.1.

87) The x^2 values are 23,247.01; 43,202.61; and 67,331.63 respectively with 50 degrees of freedom in each case.

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