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AN ANALYSIS OF THE CRIME RATE IN THE NETHERLANDS 1950–93

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This study describes an analysis of trends in crime in the Netherlands during the period 1950–93, using time-series analysis to estimate relationships between recorded crime and demographic, economic and policy developments in the community. We are especially interested in the relationship between crime and economic welfare.[1] *We use the crime rates recorded by the police, which, because of variations in the propensity to report by the victims and the recording policy of the police, may differ from actual crime rates. Therefore we include variables that measure the propensities to report and to record in our model. We estimate the relationship between several crime categories and the independent variables. The most important independent variables are: welfare measured by personal consumption of households per capita, number of unemployed people, male population in four age categories, police strength, and clear-up rate of offences. Three important hypotheses are tested: (1) a higher growth in consumption leads to lower growth in the number of thefts because it leads to less incentive with potential criminals (motivation effect); (2) a higher growth in consumption leads to higher growth in the number of thefts because more goods are available (opportunity effect); (3) a higher growth in consumption leads to higher growth in the number of violent offences because it leads to more outdoor activities (routine-activity effect). We find the following results. The motivation effect is significant with total theft, qualified theft, burglary, theft from shops and pickpocket theft. The opportunity effect is significant with car thefts. The routine-activity is significant with criminal damage. Interpretations for these findings and the problems that occur with the time-series analysis are fully discussed.*

This report describes a study of trends in recorded crime[2] in the Netherlands during the period 1950–93. The crime rates have increased enormously since 1970. We are therefore interested in how much of this growth is affected by changes in the community. We are especially interested in the relation between welfare and crime.

Previous studies of crime rates in the Netherlands have mainly used individual data. For example, for the city of Groningen during the sixties and seventies, Jongman (1982) has compared crime rates among unemployed persons with those among employed persons, and found the former to be higher. The problem with these simple comparisons is that the result could not only be the effect of a causal relation between unemployment and crime, but also of a reversed causal relation: someone who committed a crime may

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[1] We use welfare in the way it is used in economics, where it is more or less identical to the 'utility' of consumption; welfare in this sense should not be confused with well-being, which is more comprehensive.

[2] The recorded crime rates should not be identified with the actual crime rates, a problem we will discuss further below.

have a higher probability to be and stay unemployed and therefore to commit another crime (van Tulder 1985).

In other countries, in particular the Anglo-Saxon countries, a lot of economic and econometric research has been carried out on the relation between welfare and crime on a macro level. The idea that crime has economic causes has a long history. Criminologists writing about this subject at the turn of the century such as von Mayr, Poletti, Ferri and Bonger (see Field 1990) all discussed the issue and described relevant statistical evidence. More recently a large number of studies have given attention to unemployment, but have also examined other economic factors such as consumption, income and inequality.

Most empirical studies do not give a complete view of the relation between crime and unemployment. Cantor and Land (1985) suggest that the traditional theories about the relation between welfare and crime are incomplete, because they only deal with the effects of unemployment on the prevalence of motivated offenders in the population. Factors like the availability of goods to steal, the propensity to report by victims, other registration effects, police strength, demographic factors and criminal justice factors are mainly ignored.

In the early days researchers only looked at the so-called motivation effect. In recent empirical studies, such as Field (1990) the other effects were taken into account by specifying a model with a general lag structure.

The methodology of our paper is mainly based on the study performed by Field (1990). Field studied the relation between welfare and crime for Britain during the postwar period. Field found that temporary decreases in welfare had a positive effect on theft. These effects disappeared when he looked at the long-term relationship. In the long run an increase in welfare has a positive effect on crime. A methodological difference with Field is that he used a backward-elimination procedure for specifying the regression equations, whereas we have used a forward-elimination procedure, since in the case of collinear data, the backward procedure does not give consistent results (Maddala 1977: 124–7). Besides this methodological difference we feel that the main contribution of our paper to the debate is twofold. First, we give an analysis for the Netherlands, whereas most other papers focus on the UK. Secondly, some of the contributors to the recent debate have found that the relevant data are second-order stationary, i.e. they have to be differenced twice in order to make them stationary; we, however, find that after taking logarithms the data are first-order stationary (see 'Stationarity and estimation of the regression equations' below), i.e. the rates of growth are stationary and the data have to be differenced only once.

The further contents of this paper are as follows. In the second and third parts below the different crime categories, the theoretical backgrounds of the chosen independent variables and the available data on crime are discussed. The penultimate section discusses our analysis, the results and the interpretations. Finally we discuss the possible areas for further research.

The Dependent Variables

We analyse 13 kinds of crime categories with time-series data that are long enough for an adequate time-series analysis. We have two major categories: theft and violence. The

chosen theft categories for analysis are mainly based on the criminal code: total theft is the sum of the following two categories, simple theft and qualified theft. We also analyse some categories based on the type of theft: theft of car, theft of motor vehicle (including car theft and joy-riding), theft of bicycle, theft from shops, and pickpocketing.

The violence categories are based on the criminal code: violence against the person (including wounding, assault and homicide), sexual offences and criminal damage. In Beki (1996) all the crime categories are thoroughly described.

Our research is based on crime rates recorded by the police. These rates are not only affected by the actual crime rates, but also by the propensity to report by the victims and the recording policy of the police. Crimes may not be recorded by the police because for example, people do not report them, the police find these crimes not serious enough to record them, or the police do not have enough manpower to record them (Kester and Junger-Tas, 1994). Because there was a tendency to believe that one could not get a clear picture of the trend of the actual crime rates, Statistics Netherlands (CBS) has conducted victim surveys since the seventies.

Although the trends of the reported crime rates from the victim surveys and the recorded crime rates from police statistics correspond reasonably, there is sometimes a difference between the absolute numbers of about 30 per cent. The most important causes are the difference in definitions of the various sorts of crime and the measurement procedure. It appears that a comparison on absolute numbers between the different data sources is complicated (see Kester and Junger-Tas 1994 for more details). Therefore we focus on the coherence of the trends of these two different data sources on crime.

According to both data sources, crime increased between 1970 and 1984. However, since 1984 the victim survey shows constant crime rates, whereas the police statistics show a small increase every year. This increase can be explained by the increasing propensity to report by the victims during that period and also as the result of the recent modernization of the recording practices of the police by computers since 1985. These processes led to a greater part of the committed crimes at first belonging to the 'dark figure' now being recorded and therefore appearing in the police statistics. The dark figure comprises the number of committed crimes not recorded by the police because victims do not report them or the police do not record them—for any reason. Overall we can conclude that crime has not increased much since 1984; the only exception is crimes of violence, in particular theft by force, threat and extortion, which increase according to both victim surveys and police statistics.

A second important development is that since the eighties, in contrast to the constant crime rates, the awareness about crime of the Dutch population has changed. It is possible that this is the result of the fact that crime was a political hot issue during that period. This may have led to an increase in the propensity to report by the victims.

All this means that the findings of a relationship between the demographic, economic and policy factors and the crime rates cannot only be explained by the effect of these factors on the behaviour of criminals and victims, but also by the propensity to report by victims and the recording policy of the police. Because the time-series data from the victim surveys are too short, all we can do is to include factors which affect the propensity to record and report crime in our model (see below).

The Independent Variables

We divide the independent variables into six categories: (1) economic variables, (2) demographic variables, (3) criminal justice variables, variables affecting either the level of crime or its propensity to be recorded, (4) environmental variables, (5) other variables potentially affecting the propensity for crime to be recorded, (6) other variables like trend and dummy variables.

Economic variables

Real personal consumption per capita Following Field (1990) we can distinguish three effects of consumption expenditure on crime. First, consumption growth increases the number of goods that might be stolen, and so creates more opportunities for potential offenders. This is the so-called opportunity effect, where we expect a positive relationship between consumption and theft. Secondly, according to modern consumption theories (the permanent-income hypothesis and the life-cycle hypothesis; see Deaton and Muellbauer 1980), the present level of personal consumption is determined by the expected future lifetime stream of income and wealth. Changes in the level of consumption hence reflect changes in the expected future income. Since an increased expectation of future legal income will decrease the need for illegal profits, consumption and crime will be negatively related (motivation effect). Thirdly, an increase in consumption manifests itself partly in a shift from indoor to outdoor activities. This has two effects. As individuals spend less time at home, they can no longer serve as a proper guardian of the goods at their homes. Additionally, the chance of these individuals becoming a victim of a crime will increase, as they spend more time outside. This third effect is called the routine-activity effect.

The motivation effect dominates theft crimes in the short run. Why does only one of the motivation and opportunity effects dominate in the short run? Potential victims are very widely spread in society, but potential offenders are usually found in groups having a retarded economic position in society. Often their position in the labour market is weak or marginal. Growth of consumption has a larger improving effect on the weak position of potential offenders on the labour market than the effect it has on the position of potential victims. Because the motivation effect is caused by the improving economic position of the offenders, we can justify the statement that 'the motivation effect dominates in the short run'.

Unemployment: number of unemployed people Unemployment can have two kinds of effects on crime:

- A higher unemployment rate decreases the number and value of goods to be stolen. This indicates a negative relationship between unemployment and theft crimes (opportunity effect).
- A higher unemployment rate implies that more people have income problems. This indicates a positive relationship between unemployment and theft crimes (motivation effect).

Basic social security benefit If the basic social security benefit increases, people with such income will have fewer income problems. We therefore expect a negative relationship between the social minimum wage and theft crimes.

Numbers of cars and motorized vehicles and number of new cars and new motorized vehicles For the categories theft of car and theft of vehicle we will include the number of goods available for theft in our model. As the number of available goods increases, we expect the theft of these goods to increase as well. The relationship between these independent variables and the other already mentioned theft crimes is expected to be positive.

Number of births Couples with newborn children face a worsening economic situation. As this occurs only after about one or two years, we use this exogenous variable lagged in our model (also see Field 1990). We expect a positive relationship between the number of births and certain crimes, e.g. theft from shops.

Demographic variables

Young people are more likely to become involved in crime than older people, and men are more likely than women to take part in crime. The age and sex composition of those found guilty and convicted bears this out. A theoretical background is as follows: the larger the population of young men, the harder it will be for these men to acquire a good position in society (see Easterlin 1968). This causes the desire to break the law to increase. We therefore expect the relationship between the number of young men and crime to be positive. We divide the population of men into five age categories: 10–14, 15–19, 20–24, 25–29 and the remainder. Demographic developments usually come gradually: a change in the number of men in the different age categories tends to go in one direction for several years before reversing itself. Changes in the categories will therefore be highly correlated. This collinearity may make it hard to find the exact relationship between the number of men in the first four age categories and crime.

Criminal justice variables

Police strength An increase in police strength can result in a higher number of recorded crimes, because more policemen are available to register these crimes (registration effect). This will result in a positive relationship between the number of policemen and crime. An increase in police strength may also lead to less crime (deterrence effect), which will result in a negative relationship between the number of policemen and crime. The relationship between police strength and crime will therefore not be quite clear.

Clear-up rates The clear-up rate shows a negative relationship with recorded crime because of the deterrence effect. The clear-up rate is also positively correlated with recorded crime because of the registration effect. A higher growth for the clear-up rate can lead to a higher propensity to report, which can lead to a higher growth in registered crime. Ideally the model should contain propensity to report, but not enough data on this are available. The consequence is that the deterrence effect could be underestimated in our model. Combining these theories, we do not expect to find a clearly determined relationship between the crime clear-up rate and crime.

Number of convicted persons for each type of crime Because of the deterrence effect we expect the relationship between the number of persons declared guilty and crime to be negative.

Average number of imprisoned persons per day If the average number of imprisoned persons per day increases, fewer criminals will be free and able to commit a crime (lock-up effect). Thus we expect a negative relationship between the average number of imprisoned persons and crime.

The variables: clear-up rates, number of offenders found guilty or cautioned and average number of imprisoned persons per day, have to be modelled lagged. These lags partly have a theoretical justification: the individual's perception of risk (clear-up rate) and punishment will adapt only gradually to reality. The practical justification is that many clear-ups and convictions happen some time after the crime was committed. An additional advantage is that we can get round the estimation of a simultaneous model, since these variables depend on the number of recorded crimes.

Environmental variables

Weather When the weather is good, more people will go out where the chance of becoming a victim of a crime is higher. Certain categories of crime will therefore show a positive relationship with the weather variable. For burglary, we expect a negative relationship with the weather, because criminals do not like to go out in bad weather. The weather is measured as the ratio of annual hours of sunshine to the annual amount of rain in millimetres.

Beer consumption There is probably a positive relationship between beer consumption and certain kinds of crime. Beer is mostly consumed in bars etc. where violent crimes are often committed.

Other variables potentially affecting the propensity for crimes to be recorded

Percentage of house owners House owners are more strongly motivated than renters to report crimes (burglary) to the police. This implies a positive correlation between the percentage of house owners and certain categories of crime.

Number of telephone connections A telephone makes it easier to warn the police. This would lead to a positive relationship between the number of telephone connections and certain kinds of crime (especially burglary).

Annual real expenditure on burglary insurance per household If people spend more money on insurance, they will be more willing to report a crime for which they have taken out insurance. For this reason we expect a positive relationship between expenditure on burglary insurance and crime. It is possible that the simultaneity problem occurs: more crime with victims compensated by insurance will lead to higher insurance premiums to be paid in the following year.

Other variables

Logarithmic trend variable This variable should capture any independent time trends in the data.

Automation dummy variable since 1992 Since 1985 computers have been gradually introduced by Dutch police forces, which has led to better registration. Certain larger municipalities have been automated since 1992. Because of the better registration we expect a positive relationship between the dummy variable and crime.

Dummy variable for introduction of moped-helmet legislation We expect a negative relationship between the obligation to wear a helmet when riding a motorcycle and theft of these vehicles. Stealing a motorcycle has become too troublesome and risky for many potential offenders.

Analysis, Results and Interpretations

The results of a time-series analysis are shown below, relating the developments of recorded crime data to developments in certain demographic, economic and policy factors. We will discuss the main results; detailed results can be found in Beki (1996).

Stationarity and estimation of the regression equations

Since OLS-estimates of relationships between non-stationary variables are inefficient and biased, we have first tested whether the logarithms of the variables are stationary, using the augmented Dickey-Fuller (ADF) test (Banerjee and Hendry 1992). The results show most variables to be non-stationary, except for the following: theft of motorized vehicles, number of offenders found guilty of theft, number of policemen, weather, and number of newborn babies; these are stationary around a trend (for more details see Beki 1996). Pyle and Deadman (1994) and Deadman and Pyle (1997) show that crime in England and Wales is non-stationary for first differences. Furthermore they argue that recorded crime data are integrated to the order of 2 and hence would need to be differenced twice for stationarity. However, after having transformed our data to logarithmic differences, the ADF-test showed that stationarity of them can be accepted at the 5 per cent level or at the 10 per cent level (see Appendix A).

As a second preliminary step we have tested whether the logarithms of the variables are co-integrated. This is important, since if they are co-integrated, a long-run relationship between the variables would exist even if they are individually non-stationary and we could then estimate an error-correction model (Engle and Granger 1987; Banerjee *et al.* 1993: ch. 7). Testing for co-integration proceeds as follows. First we estimate the long-term relationship between each of the variables mentioned above as independent variables (x_t) and the 13 crime categories as dependent variables (y_t):

$$\log y_t = \alpha \log x_t + \varepsilon_t \qquad (1)$$

Next we test whether the residuals in equation (1) are stationary or not. We do this also by means of the ADF-test. The results with independent variable real personal consumption per capita are presented in Appendix B, while the results with the other independent variables are available upon request. The ADF-test statistics show that the logarithms of the 13 crimes and the independent variables are not co-integrated. Therefore we cannot draw any conclusions about the long-term relationship in levels (equation (1)). Nor is it possible to estimate an error-correction model.

Therefore we can only estimate the logarithmic regression equation in first differences

$$\Delta \log y_t = c + \sum_{i=1}^{k} \alpha_i \Delta \log y_{t-1} + \sum_{i=0}^{k} \beta_i' \Delta \log x_{t-i} + \varepsilon_t \qquad (2)$$

In this equation, the variable y_t can be any of the 13 crimes (theft, simple theft, qualified theft, etc.) The x_t contains the variables mentioned above in an earlier section. Note that the transformation to logarithmic differences is almost equivalent to a transformation to relative changes, since $\Delta \log x_t \approx (x_t - x_{t-1}) / x_{t-1}$, so that equation (2) relates the growth rate of crime to the growth rates in consumption and the other independent variables.

The results presented below are those for 'final regression equations' obtained by a stepwise regression procedure of variables with a t-value larger than 1, selected from all independent variables (see Beki 1996, for more details). Afterwards we have tested for mis-specification. The final estimated regression equation appears to be well specified and passes several tests on mis-specification (Spanos 1986 and Charemza and Deadman 1992):

- Durbin-Watson test and Godfrey test (serial correlation in the residuals)
- Ramsey's reset test (functional form of the final regression equation)
- Lagrange multiplier test (normality of the residuals)
- Breusch-Pagan test (heteroskedasticity in the residuals)
- Chow test for stability of the coefficients
- Recursive Chow test for significant structural break in the sample period

Exceptions to this occur for the equations regarding:

- Total theft (coefficients are not stable in time)
- Simple theft (heteroskedasticity in the residuals and the coefficients are not stable)
- Bicycle theft and car theft (functional form of the regression equation is non-linear)
- Theft of vehicles and fraud (residuals are not normally distributed) (see Beki 1996)

Economic variables and crime

Table 1 gives the estimated coefficients of current consumption and lagged consumption.

We can draw three conclusions from this table:

- Theft crimes show a negative relationship with consumption growth (the motivation effect), except for car theft, where the opportunity effect occurs significantly. Total theft and qualified theft show a positive relationship with lagged consumption growth (opportunity effect), although for qualified theft it is not significant.
- Criminal damage shows a significant positive relationship with consumption growth (the routine-activity effect). Sexual violence however, is negatively related to consumption growth, which contradicts the routine-activity effect.
- Crimes of fraud and theft of vehicles do not have a significant relationship with consumption growth.

These results correspond to those of Field (1990). The motivation effect occurs for theft crimes and the routine-activity effect for crimes of violence. Both are short-term effects.

TABLE 1 *Estimated coefficients of consumption*

Crime categories	$Consumption_t$	$Consumption_{t-1}$
Total theft	–1.214 (2.9)	0.694 (2.2)
Simple theft	–0.074 (1.3)	*
Qualified theft	–1.406 (3.6)	0.885 (1.6)
Burglary	–1.454 (3.4)	0.584 (1.1)
Pickpocket theft	–3.075 (3.7)	*
Theft from shops	*	–1.511 (2.9)
Car theft	2.688 (2.9)	2.074 (3.4)
Vehicle theft	*	*
Bicycle theft	–0.609 (1.5)	*
Fraud	*	*
Violence against a person	0.510 (1.8)	*
Sexual offences	–0.831 (2.5)	*
Criminal damage	0.702 (3.2)	*

t-values between brackets.
* Somewhere in the specification procedure consumption had a *t*-value below 1 and is therefore not used in the final regression equation.

Besides the motivation effect with theft crimes, Field found a lagged opportunity effect (see also Cantor and Land 1985). To test for this, further lags of the consumption variable have been included. By including the two, three and four-year lagged value of consumption in the final regression equation, we can test whether the opportunity effect occurs lagged. From the regression results we conclude that the lagged opportunity effect is only significant for car theft (see Beki 1996).

Consumption and other economic variables Until now we have used real consumption expenditures of households per capita in the Netherlands to indicate welfare. Other empirical studies use different economic variables, like real income per capita, real gross domestic product per capita and real expenditures on consumer durables. These economic variables are quite closely correlated. A significant relationship between consumption and crime could be caused by a significant relation between one of the other economic variables and crime. For example, it is often discussed whether unemployment is an important factor. We will return to unemployment later in this section. The above-mentioned problem is treated by replacing the consumption variables in all 13 regression equations by one of the other economic variables. These

alternative equations are estimated by means of OLS. We compare the R^2s with the R^2 score from the original equations. The regression equations with consumption as an independent variable have the highest R^2s for nearly all crimes. This justifies our choice of consumption growth to indicate an increase in welfare in our model. A remark to be made is that the explained variance (R^2) is not a completely reliable indicator for the quality of the models, and should only be used as an indication.

Unemployment and crime The theory stating that unemployment causes crime has often been mentioned in the history of criminology. Some micro-economic studies suggest that unemployed persons are more easily inclined to commit a crime than individuals with a job (see Farrington *et al.* 1986).

Research at the macro level does not give clear results on the relationship between unemployment and crime. Cantor and Land (1985) claim that the traditional theories on this issue are incomplete. In most cases the scope was the effect of welfare change on potential criminals in the population. However, unemployment does not only affect the behaviour of potential offenders, it also changes the behaviour of potential victims. Cantor and Land performed a time-series analysis of the relationship between unemployment and crime for the period 1946 to 1982. They tested a structural model, which assumed the changes in unemployment to cause a direct negative effect on crime behaviour because of the opportunity effect, and a lagged positive effect because of changes in the motivation of the offenders. So in this model, an increase in the unemployment first decreases crime, and increases it some time afterwards. Their results confirm the existence of the opportunity effect for robbery, theft, burglary, homicide, and vehicle theft. The lagged motivation effect was only found for theft, burglary and raid. The net effect was found to be negative.

For our model we wished to test whether unemployment had a significant effect on crime. We therefore add actual unemployment and unemployment lagged one year, to all 13 regression equations. Using a t-test we test both variables on significance. It turns out that unemployment has a significant negative effect on most theft crimes (simple and qualified theft, burglary, theft of vehicles and theft from shops (the opportunity effect)). For fraud, the effect of unemployment on crime is significant and positive. This is not surprising, because the motivation effect is directly present.

Other economic variables The regression results show that the basic social security benefit has a significant negative relationship with car theft and with violence against a person. Car theft shows a positive relationship with the change in the number of cars and a lagged negative relationship with the change in the number of new cars. A change in the number of births, affecting the economic position of a family, does not have a significant effect on crime.

Demographic changes and crime

As discussed above, crime does not only depend on the size of the population, it also depends on the age structure. Young men get involved in crime more easily than women or older men. We divide the male population into five age categories: 10–14, 15–19, 20–24, 25–29 and the remainder; in this way, we can take changes in the age structure into account as well.

Almost all crimes (except car theft, fraud, violence against a person and sexual offences) show a positive significant relationship with the changes in the number of men in the five age categories. The more serious theft crimes show a significant positive relationship with the change in the number of men in both age groups 20–24 and 25–29. Less serious crimes, theft of bicycle and criminal damage are affected positively by changes in the number of men in age groups 10–14 and 15–19. It is remarkable that these results correspond with the age pattern of the offenders.

To avoid possible multicollinearity (see above), we have re-estimated the equations with the significant demographic variables replaced by the change in the number of men in age category 15–29. Now for the same crimes the estimated coefficient is positive, except for vehicle theft and criminal damage. The positive coefficients are to be interpreted as follows: for instance for total theft, as the male population in age group 15–29 increases by 1 per cent, the theft crimes increase by more than 1 per cent. This evidence suggests that demographic change may have effects on rates of certain recorded crime over and above the purely arithmetical effects.

Criminal justice and other variables and crime

The criminal justice variables are included with a time lag in our model (except for police strength), because these variables depend on registered crime in the same year. These lags partly have a theoretical justification: the individual's perception of risk (clear-up rates) and punishment will adapt only gradually to reality. The practical justification is that many crime clear-ups and convictions happen some time after the crime was committed. An additional advantage is that we prevent the estimation of a simultaneous model, since these variables depend on the recorded crime in the same year. Police strength is not modelled with a time lag. Police strength does depend on the level of crime, but higher crime will result in more police personnel only after some time has elapsed. Police personnel have to be acquired and trained, so adjustments in the police force will occur later.

Bicycle theft, violence against a person and criminal damage show the following relation: more police leads to more recorded crime, because there are more policemen to record crimes (registration effect). Theft of vehicles has a negative relationship with police strength, so more police lower the number of crimes (deterrence effect). We see that the registration effect dominates the relationship between police strength and crime. It is remarkable that there is no significant effect of police strength on total theft.

The clear-up rate has a significant negative effect on simple theft (deterrence effect). Only pickpocketing is positively related to changes in the clear-up rate (registration effect). A higher growth in the clear-up rate can lead to a higher propensity to report. The consequence is a higher growth in recorded crime. We already mentioned that pickpocket theft depends strongly on the propensity of the victims to report a crime. On balance the deterrence effect dominates.

The numbers of people found guilty for car theft, fraud, violence against a person and theft from shops have a negative effect on these crimes. The deterrence effect clearly dominates here. The change in the average daily number of imprisoned persons has a significant positive effect on crime for violence against a person and fraud. These results contradict the lock-up effect discussed above.

The change in the weather, the change in the real expenditure on burglary insurance per year and the change in the percentage of house-owners do not have a significant effect on burglary. The change in the number of telephone connections does not have a significant effect on the individual crime categories. The effect of automating police registration is significant only for car thefts. The introduction of motorcycle helmets significantly decreases motorized vehicle theft.

A significant trend is found for bicycle theft and criminal damage (see Beki 1996).

Areas for Further Research

With time-series analysis we have related changes in recorded crime in the Netherlands to demographic, economic and policy developments in society. The estimated relationships are based on historical relationships. With regard to future scenarios of economic and demographic development, our model enables us to predict future development of individual crimes for these scenarios, with reasonable reliability. The development in crime is an important factor in the demands which are placed on the police and the criminal justice system. Our results can be helpful in forecasting future demands.

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APPENDIX A

ADF-test statistics for stationarity of the differences of the logarithms of the dependent and independent variables

Variable	No constant and no trend		Constant and no trend		Constant and trend	
	p-value	degrees of augmentation	p-value	degrees of augmentation	p-value	degrees of augmentation
Total theft	0.06	3	0.03	3	0.04	3
Simple theft	0.06	3	0.05	3	0.06	3
Qualified theft	0.06	3	0.06	3	0.06	3
Burglary	0.05	4	0.05	4	0.05	5
Pickpocket theft	0.07	2	0.07	2	0.05	2
Theft from shops	0.06	2	0.02	2	0.06	2
Car theft	0.04	3	0.03	3	0.07	3
Vehicle theft	0.02	3	0.02	3	0.00	8
Bicycle theft	0.06	3	0.04	3	0.06	3
Fraud	0.07	2	0.06	2	0.05	2
Violence against a person	0.06	4	0.06	4	0.02	4
Sexual offences	0.07	2	0.02	2	0.02	2
Criminal damage	0.06	4	0.05	4	0.05	6
Real personal consumption per capita	0.04	3	0.03	3	0.04	3
Number of unemployed people	0.05	4	0.04	8	0.04	8
Basic social security	0.02	3	0.01	3	0.02	3
Number of cars and motorized vehicles	0.01	4	0.00	7	0.01	7
Number of new cars and new motorized vehicles	0.03	2	0.01	2	0.02	2
Number of births	0.01	2	0.01	2	0.00	3
Men 10–14 years	0.02	8	0.07	8	0.08	10
Men 15–19 years	0.06	3	0.01	8	0.09	10
Men 20–24 years	0.06	3	0.03	3	0.03	3
Men 25–29 years	0.06	8	0.03	8	0.03	8
Police strength	0.01	2	0.01	2	0.01	2
Clear-up rates	0.01	5	0.01	5	0.01	5
Number of convicted persons	0.01	2	0.01	2	0.01	2
Average number of imprisoned persons per day	0.01	4	0.01	4	0.01	4
Weather	0.01	2	0.01	2	0.01	2
Beer consumption	0.02	5	0.02	5	0.04	5
Percentage of house-owners	0.02	2	0.02	2	0.00	2
Number of telephone connections	0.02	3	0.01	3	0.02	3
Annual real expenditure on burglary insurance per household	0.01	2	0.01	2	0.01	2

Appendix B

This appendix gives ADF-test statistics for stationarity of the residuals of the regression equations with the 13 kinds of crime categories as dependent variables and consumption as independent variable.

ADF-test statistics for co-integration

Variable	No constant and no trend			Constant and no trend			Constant and trend		
	t-value	p-value	k[a]	*t*-value	p-value	k[a]	*t*-value	p-value	k[a]
Car theft	0.606	0.977	20	–2.706	0.197	3	0.761	1.000	19
Violence against a person	–1.838	0.303	18	–2.087	0.483	19	–2.007	0.769	2
Simple theft	–0.661	0.819	20	–1.791	0.634	4	–2.021	0.763	19
Qualified theft	–1.852	0.297	10	–1.474	0.771	3	–2.243	0.658	19
Total theft	–0.662	0.819	3	–1.524	0.752	3	–1.878	0.819	3
Theft from shops	–0.925	0.731	3	–2.024	0.516	3	–1.721	0.869	2
Criminal damage	–2.639	0.067	20	–2.090	0.482	19	–1.284	0.953	17
Burglary	–0.878	0.748	3	–1.553	0.740	3	–1.997	0.773	4
Pickpocket theft	–0.942	0.724	6	–1.118	0.878	3	–1.531	0.915	2
Bicycle theft	–1.314	0.559	2	–1.256	0.843	16	–1.254	0.957	3
Sexual offences	–1.152	0.636	2	–2.535	0.264	2	–2.574	0.479	2
Fraud	–1.326	0.554	2	–4.249	0.003	2	–3.067	0.236	2
Vehicle theft	–1.354	0.540	14	–2.351	0.349	3	–2.224	0.668	12

[a]k = degrees of augmentation.