.SIAK REPUBLIC OF AUSTRIA
FEDERAL MINISTRY OF THE INTERIOR
SICHERHEITSAKADEMIE

.SIAK-Journal – Journal for Police Science and Practice

Hess, Julius/Jarchow, Esther

Rise and Fall in Crime Rates. Panel analysis as a method of data-driven crime research

SIAK-Journal − Journal for Police Science and Practice (International Edition/2016), 52-63.

doi: 10.7396/IE_2016_E

Please cite this articel as follows:

Hess, Julius/Jarchow, Esther (2016). Rise and Fall in Crime Rates. Panel analysis as a method of data-driven crime research, SIAK-Journal − Journal for Police Science and Practice (International Edition Vol. 6), 52-63, Online: http://dx.doi.org/10.7396/IE_2016_E.

published online: 9/2016

Rise and Fall in Crime Rates

Panel analysis as a method of data-driven crime research

What are the causes of the spatial distribution of crime and its temporal variation? How does the crime rate change depending on the alteration of economic, political, judicial and police frameworks? Criminal geographical panel analyses are particularly suited to answer questions of this kind. This article explains the fundamentals of panel analysis, its potential, limitations and requirements for databases as well as its links to criminal theory. This method is then exemplarily clarified by analysing the distribution of police-registered suspect rates in 91 districts of the German state of Hamburg between 1995 and 2009.

JULIUS HESS,
Research associate at the Potsdam Centre for Military History and Social Sciences of the German Armed Forces.

ESTHER JARCHOW,
Research associate at the Hamburg State Office for Criminal Investigation, Police Science Analysis.

WHAT ARE CRIMINAL GEOGRAPHICAL PANEL ANALYSES?

Quantitative panel analyses of geographical crime data typically deal with the explanation of why certain criminal indicators, such as frequency ratios of offenses (FR) or suspect rate values (SRV), vary greatly in different geographical areas and at different times. Other indicators are used in order to explain this, such as from the fields of social and demographic structure, labor market, land management and recreational habits, as well as from the work of the police, judiciary and other authorities. These indicators also apply to the different geographical areas and times and are set in relation to the crime indicators. Therefore, these are statistical analyses of the causes of the spatial and temporal distribution of crime.

What is peculiar to panel analyses as opposed to simpler analysis methods is the combination of the spatial and temporal distribution of crime: the spatial differences between the different geographical areas and the temporal changes of the crime are examined uniformly. The results do not only apply to the different spatial areas at one point in time nor only to a single area at different points in time, but can be generalised to all examined geographical areas and the entire time period. This strengthens the validity of the results and reduces the risk of arriving at false conclusions. The results can also be used for crime prediction (Hanslmaier et al. 2014).

The typical research questions of criminal geographical panel analyses are:

To what extent does the crime rate increase if unemployment rises? How do structural, police or social measures have an impact on the degree of deviant behaviour? What are the consequences of social or demographic transformation or migration processes on the number of suspects in a geographical area? What happens when the leisure time activities of a certain city district change greatly? In other words: What are the causes of spatially and temporally varying crime rates?

Referring to the panel analysis discussed further below, the example of a panel analysis of the Hamburg city districts between 1995 and 2009 will be continuously used for illustration. The phenomenon to be explained here is the suspect rate or the real perpetrator rate of the city districts during the investigation period, i.e. the number of suspects residing in the city district relative to the number of inhabitants.[1] The explanatory variables are the economic, demographic and social-structural characteristics of the district.

WHAT ARE THE STATISTICAL FUNDAMENTALS AND POTENTIALS OF PANEL ANALYSIS?

Panel analysis is based on regression analysis, one of the most widely used quantitative analysis methods in social sciences (Giesselmann/Windzio 2012). The basis of a regression analysis is a data matrix, which assigns different measurable characteristics to the various units being analysed. Thus, on the one hand, these explanatory factors (independent variables) and on the other, the explanatory dimensions (dependent variables) are distinguished. Should, for example, the suspect rate of districts be explained, the economic resources, age structure and ethnic heterogeneity of the residents of a district come into question as explanatory factors. These factors can thus be converted into measurable characteristics via the unemployment rate, the proportions of certain age groups and the proportion of non-German residents. Each district manifests a certain value for each of these variables for every year investigated. The statistical method of regression analysis seeks to identify relationships in the distribution of the characteristic occurrence. A statistical relationship between the unemployment rate and the suspect rate exists, e.g. when in most of those districts with a relatively high occurrence of the characteristic unemployment rate, a relatively high occurrence of the characteristic SRV also prevails.

Simple regression analyses are mostly cross-section analyses. Only the characteristic occurrences in the district in a given year are, for example, taken into account. For the more complex panel analysis, however, a further dimension is included in the data matrix: the investigation is extended to many years. Thus, not only the differences between the districts, but also the temporal changes of the characteristics in the individual districts are incorporated in the calculation as well.[2]

The consequences for the logic of the explanation are far-reaching. The changes of the dependent variable can be analysed and used to explain the changes in the explanatory factors. It is then asked how the suspect rate reacts if measurements, such as the unemployment rate, increase or decrease. If changes in unemployment systematically lead to changes in the suspect rate, this is an indication of a causal relationship.

Furthermore, the influence of such volatile influence factors is first separated analytically from constant differences between districts. Thus, in Hamburg, for example, Blankenese is a very rich district with a low suspect rate and Billstedt is a socially weak district with a high suspect rate. Short-term changes in the volatile factors such as umemployment will not completely change these differences between districts. Secondly, so-called period effects can be isolated, i.e. temporal variations in the suspect rate, which apply uniformly to all districts. Therefore, in the panel analysis, the influence of volatile influence factors can be investigated independent of the constant average values of an individual district and the temporal variations which affect all districts uniformly. The focus is on the effect of the volatile influence factors on the parameter to be explained.[3]

A substantially more rigid examination of the relationships between independent and dependent variables takes place in a panel analysis than in conventional cross-sectional analyses. The panel analysis makes a large contribution to the control of statistically ostensible relationships and the disclosure of causalities (cf. Oberwittler/Gerstner 2011, VII, 3). In addition, by integrating the temporal dimension, it can be calculated whether the supposed causes of a phenomenon also exist prior to the supposed effect. For this, lagged variables are used. In addition, a greater weight is accorded to statistical statements which are based on the panel analysis than in the case in cross-sectional analyses.

Moreover, the inclusion of the temporal dimension enables the modeling of the extent to which the value of dependent variables for one unit of investigation in one year depends on the value of the previous year. The inertia or path dependencies of the suspect rate of a district can be analytically isolated and compared to the influence of the change in volatile influence factors, such as the unemployment rate. If there is high inertia, the suspect rate assumes a course which is relatively unaffected by the volatile influences. If, however, there is low inertia, the suspect rate reacts significantly to the changes to the volatile explanatory factors.

Finally, the crime-statistical panel analysis provides the opportunity to considerably curb the impact of the gap between reported and unreported crime. "All crimes which are known of by the police are officially considered reported crimes" (Lüdemann/Ohlemacher 2002, 13). Longitudinal studies to explain offense frequencies are particularly affected by this interpretation problem. It is plausible to assume that temporally variable factors, such as reporting behaviour, intensity of police control, modalities of statistical collection as well as changes to criminal law, also affect police registration and the detection of crime (BKA 2008, 7; cf. Schwind 2011, 21–61). However, those of the above factors which apply equally to all units of investigation (here: the whole of Hamburg) may be isolated statistically as period effects. Their influence on the suspect rate values can therefore be controlled. Decreasing police control intensities differing constantly between districts rise again in the temporarily constant differences between districts. Panel analyses offer empirical crime research the opportunity to react appropriately to the problem presented by the gap between reported and unreported crime.

Panel analyses are preferable to simpler analytic methods. This applies not only to the causal explanation of past crime phenomena, but also to crime forecasts based on quantitative and empirical data (Hanslmaier et al. 2014). However, the panel analysis also requires large amounts of data and thus strains method-specific limitations.

WHAT ARE THE REQUIREMENTS AND LIMITATIONS OF CRIMINAL GEOGRAPHICAL PANEL ANALYSES?

Conducting empirical analyses depends on the availability of appropriate data series of sufficient quality, which in the case of criminal geographical panel analyses, can generally only be provided by authorities, statistical offices or organizations. The quality and scope of the available data series, however, are impressive. This pool of appropriate data, in the case of statistical offices, is even mostly available free online. The following discussion places an emphasis on the data series for a crime analysis of the city of Hamburg (for the whole of Germany, see Hanslmaier et al. 2014).

The requirements for data quality are high for panel analyses in comparison with more simple analytical methods. First of all, data series have to map a theoretical construct adequately. This is easy to fulfill in some cases (income or unemployment as indicators of economic status) and not so in others (strength of informal social control). Secondly, corresponding data series must, if possible, be available for all units of investigation (district) and all time periods of the investigation period (years). Thirdly, the data series must be accurate and reliable. Fourthly, the level of aggregation should correspond to the research question.

Crime-statistical data form the backbone of many crime geographical analyses. Police Crime Statistics (PCS) provides an important source, including, among others, the indices for frequency ratios and suspect rate values. Under certain circumstances, however, these must be converted in order to be usable for a panel analysis. This requires IT skills for the preparation of output data.

The aggregation level should initially be as low as possible. A subsequent aggregation to a higher level – counties, districts, federal states and countries – is possible, but an additional disaggregation of data is hardly so. It can also be difficult to match aggregation levels between different data series. Finer resolution than that by district was not possible for Hamburg. In other federal states it would, for example, be necessary to check the usability of data at the municipality level.

There is future potential for quantitative and empirical crime research in the use of geographic information systems (GIS), which enable the precise localisation of events and information. Here, for example, offenses can be assigned to any spatial unit. Nevertheless, finer spatial resolution has two limits. Data protection laws prevent the use of some data, such as recipients of social security benefits in districts where there are very few inhabitants. A second reason is more important: the lower the number of inhabitants, the greater the fluctuation in the data, in particular in the FR of the PCS. Here, it is quite possible that the number of registered offenses greatly exceeds the number of inhabitants and that small absolute variations in one of the parameters hugely affect the FR. Therefore, districts with fewer than 1,000 inhabitants were excluded from the analysis for the following exemplary application. The aforementioned problems are solvable, but require IT creativity and relevant skills.

In addition, data on population are significantly easier to obtain than data on business, use of public spaces, recreational habits, environment, value orientations, informal and formal social control as well as police resources and police action. Relevant data are certainly available, but are however – in the case of Hamburg – either incomplete, costly to collect or not freely accessible. Data from the Statistical Office on the use of public spaces, restaurants and hotels or on employees and workplaces of other industrial sectors are only available for a small number of years. Other data sets are sold commercially and are not accessible free of charge for research.

Some of this missing data can, however, be very important in explaining the geographical distribution of the occurrence of crimes, especially the data on the use and commercial structure of space. Thus, studies on the suspect rate are much easier to carry out than studies on criminal activities. The fact that the spatial and temporal distribution of criminal offenses should also, however, be analysed with the provision of adequate resources is demonstrated by its use in American cities, known as “Predictive Policing” (Gluba 2014) or the underlying “Crime Mapping” (Perry et

al. 2013). This perspective presents itself mainly for researchers and practitioners within the police.

WHAT KIND OF THEORETICAL ISSUES IS PANEL ANALYSIS USEFUL FOR?

The methodology of panel analysis is particularly well suited in the application of research questions in criminal geography. Criminal geographical theories include, on the one hand, explanations of the spatial distribution of crime and apply, on the other hand, to the question "[…] to what extent the space itself can be a condition for the emergence of crime occurring within it" (Herrmann/Sessar 2007, 190). Representatives of the Chicago School, in particular Shaw et al. (Shaw et al. 1929) have paid considerable attention to the question of spatial conditions of crime; their socio-ecological approach provided the framework for a series of follow-up studies, which dealt with so-called "delinquency areas", i.e. urban areas which had a particularly high suspect rate in addition to an unfavorable social structure. These are referred to as "breeding areas", i.e. breeding grounds for crime. The realization that crime rates are associated with social deprivation in an area was the cornerstone of the "theory of social disorganisation".

Based on the Burgess zone model (Park/Burgess 1925), Shaw and his associates identified certain urban areas, which, due to social disorganisation or upheaval processes (so-called "zones in transition"), were exposed to a higher suspect rate than other urban areas. The degree of social disorganisation was thereby measured above all by the low economic status, high ethnic heterogeneity as well as the increased mobility of the inhabitants of a district. This is accompanied by a weakness or absence of both formal and informal institutions of social control. Sampson und Groves (Sampson/Groves 1989) argue that urbanisation and the disintegration of family relationships contribute to social disorganisation.

A further social mechanism, which can explain an effect on an area that encourages crime, is the cultural dissemination of delinquent orientations, values and behavioural norms. According to this thesis of "cultural transmission" from Shaw and McKay (Shaw/McKay 1969), "criminal behaviour arises – similarly to as it was conceptualised in learning theoretical approaches – due to contact with criminal behaviour patterns in the social environment" (Eifler 2009, 44). In other words: delinquent traditions are passed down through generations of young people and thus produce a constant and hence inert crime rate in urban areas over a longer period of time. Statistically speaking, there is inertia or path dependence in the fact that the suspect rate does not change immediately, but only with a longer delay, even when the socio-spatial framework conditions are altered.

In addition to this research strand focused on "breeding areas", the question soon arose as to which socio-spatial, geographical and physical characteristics of a district correlate with a high rate of criminal activity. In the regressing "routine activity" approach of Cohen and Felson (Cohen/Felson 1979), it concerns opportunities for crime and districts as "attracting areas", i.e. as areas attracting crime. More recent research endeavours attempt to integrate both perspectives. In Oberwittler (Oberwittler 2001; idem 2004 and Oberwittler/Gerstner 2011), the question brings the relationships between, on the one hand, the local crime rate and, on the other, the mobility of potential offenders to the fore.

The transferability of the disorganisation approach to national European behaviours

requires a modification to the model. Nevertheless, an empirical verification of the theoretical assumptions by means of complex mathematical methods, such as the panel analysis, has rarely been applied before in German-speaking countries. The main exceptions are the publications of Horst Entorf and Hannes Spengler (Entorf/Spengler 2000; idem 2002; idem 2005; Entorf 1996; Spengler 2004). They move in the tradition of the economic theory of crime by Becker (Becker 1968), basing this broadly on, among other things, a statistical relationship between crime and unemployment (Spengler 2004, 71 ff; Entorf 1996, 430 ff; Entorf/Spengler 2000, 97 ff). The Criminological Research Institute of Lower Saxony uses the method of panel analysis on regional and federal state level for the explanation and forecasting of registered crime in times of demographic change (Hanslmaier et al. 2014) in its recently completed project "Crime in the year 2020".

The aforementioned studies use data on a high macro-aggregation level (federal states or counties). Research designs of this type are therefore not immune to the accusation of ecological fallacies, i.e. the direct conclusion of aggregate data on individual behaviour. Micro and macro models which attempt to satisfy the individual and collective level are again only possible to implement with great effort (Oberwittler 2012, 827). This applies especially to panel designs which make regular repetitions of the respective surveys necessary.[4]

The following panel analysis is set on an average level: a macro analysis based on a relatively fine geographic resolution (district) mitigates the problem of ecological fallacies, even if it does not eliminate it completely. The theory of social disorganisation in particular is well-suited for this: it links statements on a small-scale macro level about the social and resident structure of urban areas with statements on the frequency of delinquent behaviour on the part of the residents. The matching between theoretical analysis level and research design is therefore high.

EXEMPLARY APPLICATION OF THE PANEL ANALYSIS

For the following exemplary panel analysis of the suspect rate in Hamburg districts between 1995 and 2009, an attempt was made to operationalise the central theoretical constructs of the theory of social disorganisation. Table 1 lists the respective independent variables; all respectively operationalised constructs are given in

Source: Heß/Jarchow

Data series	Mean	Standard deviation	Minimum and maximum
SRV (suspect rate)[1]	3,222	2,188	837–22,498
Unemployment rate in % (economic status)[2]	6.18	2.73	1.24–21.71
Living space per resident in m² (urbanity)[3]	36.9	6.45	14.8–58.0
Mobility ratio (fluctuation)[4]	121.8	49.50	35.9–445.3
Proportion of non-German residents in % (ethnic heterogeneity)[5]	15.7	11.72	0.7–78.3
Proportion of 15- to 24-year-olds in % (age structure)[6]	10.7	2.21	6.2–21.8
Proportion of 55- to 64-year-olds in % (age structure)	12.6	2.33	6.3–21.3

[1] Since the SRV is distributed heavily skewed to the right, the natural logarithm of the variable is used below.
[2] Unemployment benefit pursuant to Section 16 of the Social Code (SGB III). The reference value for the calculation of the unemployment rate is the population between 15 and 65 years of age.
[3] For the use of the variable, see Entorf and Spengler (Entorf/Spengler 2002, 33–37); Sampson and Groves (Sampson/Groves 1989); Miethe et al. (Miethe et al. 1991); Oberwittler and Gerstner (Oberwittler/Gerstner 2011, 27 ff).
[4] "The mobility ratio is calculated from the halved sum of immigration and emigration per 1,000 residents of the Civil Register" (Northern Statistical Office 2011). For the use of the variable, see Lüdemann und Peter (Lüdemann/Peter 2007, 28); Entorf and Spengler (Entorf/Spengler 2002, 37).
[5] For the use of the variables, see Sampson and Groves (Sampson/Groves 1989, 781), Entorf and Spengler (Entorf/Spengler 2002, 32–37) and Schwind et al. (Schwind et al. 1978, 376). Since the proportion of foreigners is distributed heavily skewed to the right, the natural logarithm of the variable is used below. Data on the proportion of residents with an immigration background are only available for a few years and thus are unsuitable for the present panel analysis. The data series relating to foreigners and immigrants, however, correlate very highly with each other.
[6] For the use of the variables relating to age structure, see Oberwittler (Oberwittler 2004, 13 f) and Shaw and McKay (Shaw/McKay 1969).

Table 1: Variables used for a panel analysis of Hamburg districts between 1995 and 2009[5]

Source: Heß/Jarchow

Variable	Beta coefficient	Significance
Unemployment rate	.143	***
Mobility ratio	.045	**
Proportion of non-German residents (log)	.261	***
Living space per resident	-.031	
Proportion of 15- to 24-year-olds	.007	
Proportion of 55- to 64-year-olds	-.053	**
SRV in the previous year (log)	.546	***
Corrected R^2	0.95	
N	1,365	

Dependent variable: SRV (log)
* = significance at the 5% level;
** = significance at the 1% level;
*** = significance at the 0.1% level
Constants and fixed effects of the units and periods are not shown

Table 2: Panel model of the logarithmic suspect rate in Hamburg districts between 1995 and 2009; FE (two-way)

parentheses. All data with few exceptions are available for the districts for every year from 1995 to 2009. The units of investigation are 91 Hamburg districts with an average number of residents of over 1,000. The basic population consists of 1,365 observations.

The following panel analysis tested to what extent the developments of the independent variables related statistically to the development of the SRV over the investigation period. Since it is a multivariate analysis, the explanatory factors are tested together with their effects on the parameter to be explained. Thus, the influence of the independent variable is calculated under the control of other variables. Spurious correlations can be monitored in these circumstances.[6] The beta coefficients of the seven independent variables as well as the significance values are displayed and interpreted below.[7]

The theoretical assumptions of the theory of social disorganisation can be largely confirmed (see Table 2). The unemployment rate and the proportion of non-German residents have a highly significant and quite high positive beta coefficient (0.14 and 0.26). That means that if the unemployment rate rises, the suspect rate also rises. If the employment situation improves, the suspect rate falls. The same applies to the proportion of non-German residents. If the value rises, the suspect rate also rises. The development of these two independent variables is therefore connected to the development of the dependent variable. In addition, the mobility ratio and the proportion of older residents exhibits the expected signs and highly significant, albeit very low coefficients.

The factor of the proportion of young people in the total population considered as theoretically significant is not significant, here, it was operationalised to the proportion of 15- to 24-year-olds. The change of this value within a district is (under the control of the other independent variables) not pivotal for the change in the suspect rate in the district. The suspect rate of districts that "become younger" does not change if the other factors remain the same.[8]

The change in recorded crime can therefore be explained to a certain extent by volatile changes in the social structure. In addition, however, a further value substantially determines the development of the suspect rate: their inertia, theoretically composed under "cultural transmission" and operationalised by the SRV lagged by one year. This variable also results in a high, highly significant coefficient (0.55). The respective status of the suspect rate of a district in a year therefore depends to a fairly large extent on the suspect rate of the previous year. The coefficient is significantly higher than the coefficients of the volatile influence factors. These findings support the following theoretical assumption: the attitudes, value orientations and the socio-cultural milieu, which are accompanied by an increased readiness for deviant behaviour, change more slowly than the indicators of the social structure.

A further interpretation of this inertia effect refers to police control strategies: there may be particular police attention in certain urban areas, even if – temporarily, under certain circumstances – the local crime rate falls.

However, the analysis also shows that the volatile influence factors can certainly give a clear direction to the development of the suspect rate. Inertia is therefore the resistance which is opposed to this influence.

The whole model indicates a confirmation of most of the assumptions of the disorganisation theory. Tests on the correct model specification point to the high validity of the results.[9]

However, the causal direction of the connection between the variables under consideration is still unclear. Does, for example, a rising unemployment rate cause a higher suspect rate value, or does an inverse relationship exist at the same time, i.e. a retroactive effect of the suspect rate on the unemployment rate? With the help of panel analysis, much greater insight can be gained into causal structures, which will be shown below. The following causal analysis only draws on the explanatory relationships with the highest coefficients.

In order to investigate the causal structures, a panel analysis was calculated for the three respective indicators (unemployment rate, proportion of non-German residents and SRV) as dependent variables and with the remaining indicators as independent variables. Therefore, in addition to the examination of how unemployment and the proportion of non-German residents statistically influences the suspect rate, the other way around is investigated as well, i.e. how the SRV influences the unemployment rate and the proportion of non-German residents. This is operated with independent variables. It is thus considered whether, for example, the suspect rate depends on the unemployment of the previous year and the unemployment on the SRV of the previous year, and so on. This corresponds to the causality criteria of empirical studies. The fact that an event x temporally precedes an event y is a necessary condition for a causal effect of x on y (Kappelhoff 2000, 36; ibid. 60 f).

Source: Heß/Jarchow

	Dependent variable: suspect rate (log)
Unemployment rate Proportion of non-German residents (log)	.072*** .349***
Corrected R^2 N	0.95 1,274
	Dependent variable: proportion of non-German residents (log)
Unemployment rate Suspect rate (log)	.010 -.006
Corrected R^2 N	0.99 1,274
	Dependent variable: unemployment rate
Suspect rate (log) Proportion of non-German residents (log)	.035 .019
Corrected R^2 N	0.94 1,274

* = significance at the 5% level;
** = significance at the 1% level;
*** = significance at the 0.1% level

Time-delayed dependent variables, constants and fixed effects of the units and periods are not shown

Table 3: Three FE (two-way) panel model of Hamburg districts between 1996 and 2009[10]

The results of all three panel regressions are summarised in Table 3. The regression in which the SRV is investigated as a dependent variable is shown above. The proportion of non-German residents and the unemployment rate of the respective previous year constitute the explanatory factors in the time-delayed regression. The coefficient of the proportion of non-German residents is even higher in this model than before. The coefficient of the unemployment rate is on the hand more moderate, but still highly significant. Thus, it can be shown that temporally lagged effects of the explanatory factors on the dependent variable exist.

Causality should only be highlighted here if it can be shown that the same effects do not work the other way around, i.e. from the independent variable back onto the independent variable.

Therefore, a regression is shown in the middle of the table in which the proportion of non-German residents constitutes the dependent variable and the unemployment rate of the previous year and the SRV of the previous year the explanatory factors. No significant coefficients show here. The same applies to the unemployment rate: no significant differences can be observed in the lowest regression.

Finally, there is the following, surprisingly clear picture: it has been shown that a rising suspect rate follows a rising unemployment rate and in particular a rising proportion of non-German residents. A falling suspect rate follows a falling unemployment rate and a falling proportion of non-German residents. This, however, is not true the other way around. Unemployment and proportion of non-German residents are independent of the suspect rate and are not influenced by this.

Even though a high proportion of non-German residents, low economic status and high suspect rate often concur empirically, the causal effect paths only exist in one direction. It should be noted that the indicators of the unemployment rate and the proportion of non-German residents are linked to the suspect rate independently of each other. Figure 1 illustrates these relationships.

Source: Heß/Jarchow

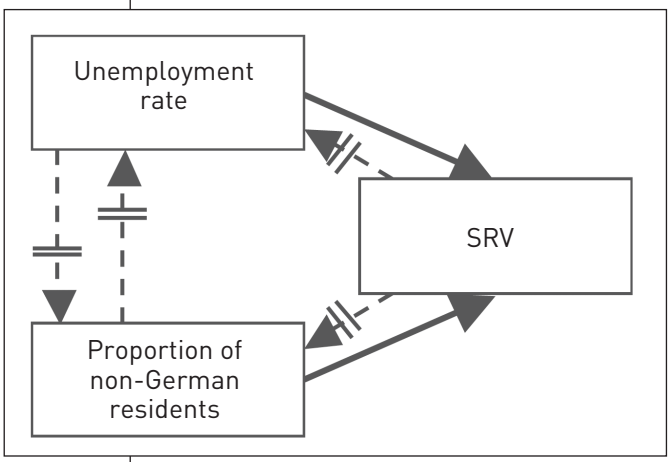

Figure 1: Causal relationships between suspect rate, proportion of non-German residents and unemployment rate[11]

Using complex methods of analysis, such as the panel analysis, it was possible to establish an empirical causal model to explain the variation of the suspect rate of Hamburg's districts, which permits the formulation of robust and instructive conclusions.[12] There is significant empirical evidence for the causal effect of the unemployment rate and the proportion of non-German residents on the suspect rate.

It should be noted, however, that statistical relationships are not deterministic and regression equations always include error terms which can be understood as deviations from these relationships. Relationships exist between rough statistical parameters. The suspect rate does not always increase, and not in every district, if the unemployment rate or the proportion of non-German residents rises. Social reality is complex. Operationalisations can only ever be approximations to a theoretical construct.

The strong relationship between the proportion of non-German residents of districts and the suspect rate can also not be interpreted as meaning that the non-German residents are responsible for higher crime rates in one way or another. The proportion of foreigners is only an indicator of ethnic heterogeneity. In socially disorganised areas, characterised by poverty and ethnic heterogeneity among other things, social control is more difficult according to the theory of social disorganisation. The instability of the residential environment is therefore accompanied by an increased frequency of delinquent behaviour.[13]

PRECISION AND FORECAST – THE BENEFITS OF PANEL ANALYSIS

The calculated model of the suspect rate in Hamburg districts between 1995 and 2009 is robust from a statistical perspective. The development over time of the SRV estimated by the model is consistent to a great extent with the actual values registered by the police. But how are the results of the panel analyses applicable for police practice? Can they be used to forecast crime trends, as some researchers have already tried to do (Hanslmaier et al. 2014)? The article is concluded with some comments on the scope and usability of panel analysis.

1) The future is always unknown. National and international migration, as well as the ups and downs of economic conjectures are hard to predict. Panel models can, however, be used to mathematically predict precisely what kind of crime rate is to be expected under certain economic and social conditions. The method is well suited to support and quantify forecasts on the basis of the scenario technique.
2) Usually, statements about the future development of the number of offenses are to be understood by crime forecasts. The calculation of model-estimated figures for a rise in crime is, however, much more difficult due to insufficient data and therefore more uncertain than the analysis about suspect rate values carried out here.
3) Panel analysis has proved to be an excellent method for testing hypotheses from the field of the theory of social disorganisation. Its applicability, however, goes beyond this. It is suitable for revealing causal structures, rigidly testing hypotheses and considerably reducing the impact of the gap between reported and unreported crime. Thereby, the analytical separation of volatile influence factors and period effects that act uniformly on the entire study area, as well as the temporally constant characteristics of the individual units of investigation have been found to be crucial.
4) However, the high requirements for data mean that it is not always possible to adequately model all theoretically interesting influence values. In addition, the application of the panel analysis requires a certain amount of IT and statistical expertise.
5) The mathematical-statistical reconstruction of human behaviour is useless, a mere finger exercise, without a great deal of knowledge gained by experiencing the living environments, intentions and attitudes of those involved. On the one hand, generating hypotheses to be deductively tested is not possible without practical knowledge, on the other, "an empirical scientific system […]" must "be able to fail compared to experience" (Popper 1976, 15). Empirical science is not about ultimate proof, but about reasonable, comprehensible information which supports or casts doubt upon the plausibility of assumptions.

[1] *The suspect rate value by place of residence used in the following is the number of suspects residing in a district per 100,000 residents. It differs from the PCS standard tables, which include only residents from the age of eight years.*

[2] *For regression analysis, see Backhaus (Backhaus et al. 2006, 45–118) and Urban and Mayerl (Urban/Mayerl 2008), among others; for the panel analysis, see Baltagi (Baltagi 1995) and Hsiao (Hsiao 1986).*

[3] *These remarks apply for the variant of the panel analysis used here (two-way fixed effects).*

[4] *For general information and details about geographical crime analysis units, see Weisburd among others (Weisburd et al. 2008).*

[5] *Data sets and definitions of terms can be referenced via the Northern Statistical Office (2011) (now: Statistical Office for Hamburg and Schleswig-Holstein). Some variables were modified for the present analysis.*

[6] *An example of spurious correlation: data for the two variables "weather conditions" and "number of umbrellas sold" shows a high relationship with the dependent variable "number of soft drinks sold". There is spurious correlation between umbrella and soft drinks sales as the number of umbrellas sold is only conveyed with the relation between weather conditions and the soft drinks. In a multivariate analysis of the effect of the two independent variables on the soft drinks sales, the relationship between umbrellas and soft drinks will disappear completely, as it is calculated under the control of the intervening variable "weather conditions".*

[7] *The beta coefficients indicate relationship strengths. Values near 0 indicate the absence of relationships and values near 1 or -1 indicate strong positive or negative relationships. However, the significance expresses the probability that the calculated relationships do not occur by chance. A high significance for the variable unemployment means, for example, a low probability that the spatio-temporal distribution of the suspect rate has just happened to result, in our example, in a district with high unemployment also having a higher suspect rate. The significance levels shown in Table 3 (see page 59) reflect this so-called error probability. In this case, the following applies: the lower the percentage value of the error probability, the higher the significance of the relationship.*

[8] *This may be due to the fact that the age structure in a district changes too slowly to exert a significant, demonstrable influence on the volatile suspect rate.*

[9] *The statistical tests and models were calculated with the software packages SPSS, R and Gretl (Croissant/Millo 2011; Cottrell/Lucchetti 2011). The very high variance explanation results from the FE two-way specification of the regression model.*

[10] *Lagged dependent variables were considered as independent variables.*

[11] *Based on three panel models on Hamburg districts between 1995 and 2009 with lagged variables (see Table 3, page 59).*

[12] *In addition to the temporal sequence of cause and effect and the determination of the direction of action of the statistical relationship, other important conditions for causal relationships apply here: "x and y are linked with each other within the framework of a theory, x and y are empirically correlated […], the relationship between x and y disappears under the control of other influences […], the influence of measurement errors was controlled" (Kappelhoff 2000, 36).*

[13] *This interpretation is supported by the fact that, as shown by other analyses, the suspect rate among Germans also increases with a growing proportion of non-German residents.*

Sources of information

Backhaus, Klaus et al. (2006). Multivariate Analysemethoden. Eine anwendungsorientierte Einführung, Berlin u.a.

Baltagi, Badi H. (1995). Econometric Analysis of Panel Data, Chichester.

Becker, Gary S. (1968). Crime and Punishment. An Economic Approach, Journal of Political Economy (76/2), 169–217. Bundeskriminalamt – BKA (Ed.) (2008). Polizeiliche Kriminalstatistik Bundesrepublik Deutschland, Berichtsjahr 2007, Wiesbaden.

Cohen, Lawrence E./Felson, Marcus (1979). Social Change and Crime Rate Trends. A Routine Activity Approach, American Sociological Review (4), 588–608.

Cottrell, Allin/Lucchetti, Riccardo (2011). Gretl User's Guide. Gnu Regression, Econometrics and Time-Series Library, Online: http://ricardo.ecn.wfu.edu/pub/gretl/manual/en/gretl-guide.pdf (24.03.2015).

Croissant, Yves/Millo, Giovanni (2011). Panel Data Econometrics in R. The plm Package, Online: http://cran.r-project.org/web/packages/plm/vignettes/plm.pdf (24.03.2015).

Eifler, Stefanie (2009). Kriminalität im Alltag. Eine handlungstheoretische Analyse von Gelegenheiten, Wiesbaden. Entorf, Horst (1996). Kriminalität und Ökonomie. Übersicht und neue Evidenz, Zeitschrift für Wirtschafts- und Sozialwissenschaften (116), 417–450.

Entorf, Horst/Spengler, Hannes (2000). Socioeconomic and demographic factors of crime in Germany. Evidence from panel data of the German states, International Review of Law and Economics (1), 75–106.

Entorf, Horst/Spengler, Hannes (2002). Crime in Europe. Causes and Consequences, Berlin.

Entorf, Horst/Spengler, Hannes (2005). Die Abschreckungswirkung der deutschen Strafverfolgung – neue Evidenz durch Verknüpfung amtlicher Statistiken, Research Notes 5, DIWBerlin, Online: http://www.diw.de/documents/publikationen/73/43510/rn5.pdf (24.03.2015).

Giesselmann, Marco/Windzio, Michael (2012). Regressionsmodelle zur Analyse von Paneldaten, Wiesbaden.

Gluba, Alexander (2014). Predictive Policing – eine Bestandsaufnahme. Historie, theoretische Grundlagen, Anwendungsgebiete und Wirkung, Hannover.

Hanslmaier, Michael et al. (2014). Kriminalität im Jahr 2020. Erklärung und Prognose registrierter Kriminalität in Zeiten demografischen Wandels, Wiesbaden.

Herrmann, Heike/Sessar, Klaus (2007). Zur Kontextualisierung von Unsicherheit und Furcht im urbanen Raum. Der Fall Wilhelmsburg/Hamburg, in: Sessar, Klaus et al. (Eds.) Großstadtängste/ Anxious Cities. Untersuchungen zu Unsicherheitsgefühlen und Sicherheitspolitiken in europäischen Kommunen, Wien/ Berlin, 189–228.

Hsiao, Cheng (1986). Analysis of panel data, New York.

Kappelhoff, Peter (2000). Methoden der empirischen Wirtschafts- und Sozialforschung, Online: http://kappelhoff.wiwi.uni-wuppertal.de/fileadmin/kappelhoff/Downloads/Vorlesung/skriptkomplett.pdf (24.03.2015).

Lüdemann, Christian/Ohlemacher, Thomas (2002). Soziologie der Kriminalität. Theoretische und empirische Perspektiven, Weinheim/München.

Lüdemann, Christian/Peter, Sascha (2007). Kriminalität und Sozialkapital im Stadtteil. Eine Mehrebenenanalyse zu individuellen und sozialräumlichen Determinanten von Viktimisierungen, Zeitschrift für Soziologie (1), 25–42.

Miethe, Terance D. et al. (1991). Social Change and Crime Rates. An Evaluation of Alternative Theoretical Approaches, Social Forces (70/1), 165–185, cited in: Entorf, Horst/Spengler, Hannes (2002) Crime in Europe. Causes and Consequences, Berlin, 35.

Oberwittler, Dietrich (2001). Zu den innerstädtischen Verteilungsmustern der registrierten Gewaltkriminalität und ihren sozialen Korrelaten am Beispiel Kölns, in: Jehle, Jorg-Martin (Ed.) Raum und Kriminalität. Sicherheit der Stadt. Migrationsprobleme, Mönchengladbach, 121–146.

Oberwittler, Dietrich (2004). Re-Balancing Routine Activity and Social Disorganisation Theories in the Explanation of Urban Violence – A New Approach to the Analysis of Spatial Crime Patterns Based on Population at Risk, Arbeitsberichte aus dem Max-Planck-Institut für ausländisches und internationales Strafrecht Freiburg im Breisgau, (10), Freiburg im Breisgau.

Oberwittler, Dietrich (2012). Kriminalität und Delinquenz als soziales Problem, in: Albrecht, Günter/Groenemeyer, Axel (Eds.) Handbuch soziale Probleme (1), 772–860.

Oberwittler, Dietrich/Gerstner, Dominik (2011). Kriminalgeographie Baden-Württembergs (2003–2007). Sozioökonomische und räumliche Determinanten der registrierten Kriminalität, Freiburg im Breisgau.

Park, Robert/Burgess, Ernest (1925). The City. Suggestion for Investigation of Human Behavior in the Urban Environment, Chicago.

Perry, Walter L. et al. (2013). Predictive Policing. The Role of Crime Forecasting in Law Enforcement Operations, Santa Monica, CA.

Popper, Karl R. (1976). Logik der Forschung, Tübingen.

Sampson, Robert J./Groves, Byron W. (1989). Community Structure and Crime. Testing Social-Disorganization Theory, American Journal of Sociology (4), 774–802.

Schwind, Hans-Dieter (2011). Kriminologie. Eine praxisorientierte Einführung mit Beispielen, Heidelberg u.a.

Schwind, Hans-Dieter et al. (1978). Empirische Kriminalgeographie. Kriminalitätsatlas Bochum, Wiesbaden.

Shaw, Clifford/McKay, Henry (1969). Juvenile Delinquency and Urban Areas, Chicago.

Shaw, Clifford et al. (1929). Delinquency Areas, Chicago.

Spengler, Hannes (2004). Ursachen und Kosten der Kriminalität in Deutschland. Drei empirische Untersuchungen. Dissertation, Darmstadt.

Statistikamt Nord (2011). Stadtteil-Datenbank Hamburg, Online: http://www.statistik-nord.de/fileadmin/regional/regional.php (24.03.2015).

Urban, Dieter/Mayerl, Jochen (2008). Regressionsanalyse. Theorie, Technik und Anwendung, Wiesbaden.

Weisburd, David et al. (Eds.) (2008). Putting Crime in its Place. Units of Analysis in Geographic Criminology, New York.