Home Office Research Study 195

Trends in Crime Revisited

by
Simon Field

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Home Office Research Studies

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Foreword

Simon Field did much to pioneer econometric analysis of the links between macroeconomic performance, demographics, and property crime during his time as the Home Office's head of economics. This report was originally published in 1998 as an Occasional Paper. We are now reissuing it in the Home Office Research Studies series so that it can be exposed to a wider audience. In doing so we hope to encourage debate about the use and possible extension of Simon's analysis. In this spirit we would welcome comments on this report, and on our subsequent development work (shortly to be published in Home Office Research Study 198).

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October 1999

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Summary

This report is a reappraisal, and further development, of research first published by the Home Office in 1990 (Field, 1990). This earlier study explored a range of factors which might be linked to recorded crime trends, and presented a number of findings. The main result was that rates of property crime growth are closely tied to growth, when consumption is growing quickly, property crime growth tends to slow down or reverse. The opposite is true during economic recessions. The explanation advanced was one of motivation – as people feel better off, as indicated by their spending, they are less likely to be attracted to criminal methods of obtaining goods. The potential for a reverse opportunity effect – whereby increased spending might create more opportunities for property crime was also noted.

A number of developments have made these findings ripe for reappraisal. Other researchers have entered the field, and built on the results. The recorded crime total has been declining for some years, and to an extent unexpected on the basis of the earlier findings. Theoretical limitations in the earlier approach have come to light. In the light of these developments, the present report offers a reassessment of the linkage between economic factors and property crime.

The new research shows that *in the long run*:

- thefts and burglaries are linked to the stock of crime opportunities, represented by the sum of real consumers' expenditure in each of the last four years. For every 1 per cent increase in the is stock, burglary and theft increase by about 2 per cent;

- thefts and burglaries are associated with the numbers of young males. For every 1 per cent increase in the number of males aged 15 and 20, burglary and theft increase by about 1 per cent;

The long term link between crime and economic growth confirms the findings of other researchers. The relationship determines what might be called the 'equilibrium' level of crime – recognising that this equilibrium level itself changes over time. The 'gaps' between actual equilibrium levels are explicable in terms of *short term* influences:

- when the actual crime level falls below the equilibrium, crime growth increases, drawing the crime level back towards the equilibrium. The reverse occurs when actual crime rises above the equilibrium;

- rapid consumption growth tends to depress property crime growth, and vice versa.

The model appears to explain the downturn in recorded property crime in the period since 1992, although not the sharp fall in crime in 1997. The downturn is attributable to a combination of a correction to rapid growth in the earlier 1990s, combined with demographic factors, and, more recently, more rapid growth in consumers' expenditure.

Although the explanation advanced provides a powerful historical explanation of property crime trends, applicable over half a century, and in broad terms replicable in relation to property crime trends in the United States, it should not be seen as involving an unchanging mechanical linkage between economic growth, criminal opportunities and acquisitive crime.

Forecasts are always perilous. Practical forecasts of the recorded crime count in the next few years must be somewhat hypothetical. From 1998, the counting rules for recorded crime will change. This means that there will be a somewhat unpredictable one-off change in the crime count, the trends might be affected as well, and the counting rules may take a little while to bed down in routine practice. All this makes the actual crime count in the next few years very uncertain.

Extrapolation of the model developed in this study implies strong upward pressure on property crime in the coming years. Set against this, the 1997 figures were much better than expected, and there is some evidence of crime growth slackening or reversing worldwide. On balance therefore, we may expect some renewed upward pressure on the recorded crime figures in the coming years, but not to the extent which might be predicted from a mechanical extrapolation of trends over the last half century.

Introduction

In 1990, the Home Office published *Trends in Crime* (Field, 1990), a statistical analysis of trends in recorded crime in England and Wales in the period since the second World War. The report explored the factors which might be linked to recorded crime trends, and presented a number of findings, including that of a strong connection between the business cycle and both recorded property and personal crime.

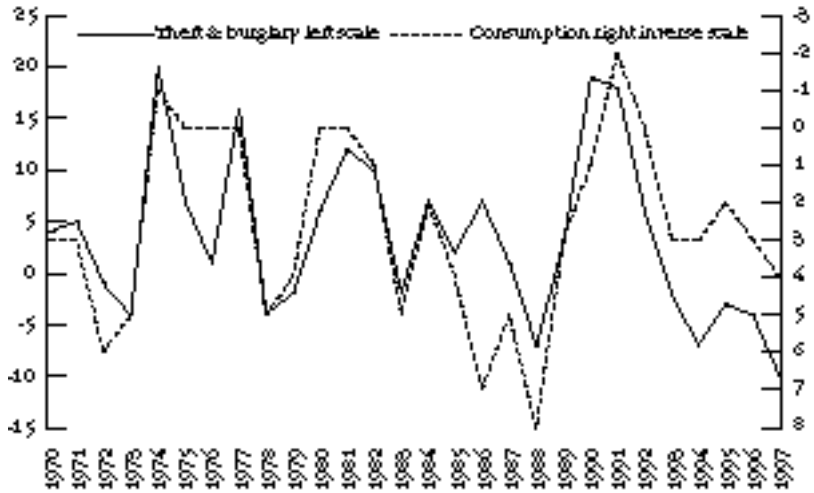
A number of developments have made these findings ripe for reappraisal. Other researchers have entered the field, and built on the results. The recorded crime total has been declining for some years, and to an extent unexpected on the basis of the earlier findings. Theoretical limitations in the earlier approach have come to light. In the light of these developments, this report offers a reassessment of the linkage between economic factors and property crime. It is more specific and limited in its concerns than the earlier paper, in that it concentrates on the impact of economic factors on the two main varieties of acquisitive property crime – theft and burglary – and does not address the full range of potential causal factors considered in the earlier report.

Part one of this report – the introduction – will summarise the earlier research findings, describe some recent developments, and suggest some limitations in the earlier theoretical model. Part two will describe the development of a new model of property crime and present some results. Part three will discuss the implications of the new model.

The background

The main finding of *Trends in Crime* (updated to 1997) is illustrated in figure 1.

Figure 1 Annual percentage change in property crime (theft and burglary) and in consumers' expenditure



The solid line in figure 1 is the annual percentage growth in property crime – theft and burglary – in England and Wales. The broken line displays annual percentage growth in consumer expenditure (after inflation), and is associated with the right scale. As this scale is inverse, high rates of consumption growth correspond to low points in the line. The close parallelism between the lines shows that during economic recessions, such as in the early 1990's, property crime tends to grow rapidly, while during more economically favourable periods, when consumption is growing rapidly, as in 1988 (and again at present) property crime may fall.

The pattern extends back to the early years of the twentieth centre and is too strong for coincidence. There are three possible explanations:

i crime has a powerful effect on national economic trends;

ii a hidden factor determines both crime and the behaviour of the national economy;

iii economic trends have a powerful effect on crime.

Only the last explanation is plausible.

A further result was obtained, but it is not directly visible in this graph. Although, as shown in the graph, the immediate effect of consumption growth is to hold down property crime, after a few years the effect seems to reverse, pushing crime levels up.

Three explanations of the observed relationships between crime and the economy – in the shape of consumers' expenditure – were advanced:

- a *negative* motivation effect – when people feel richer, as manifested by their spending, they are less likely to be attracted to criminal methods of obtaining goods;

- a *positive* routine activity effect – when people have money, they tend to spend more time away from their homes earning and spending, increasing the vulnerability of persons and their property to crime;

- a positive opportunity effect – as people buy more goods, more goods are available to steal, creating more opportunities for property crime;

Trends in crime noted that the negative motivation effect appeared to be dominant in the short term – in other words the immediate impact of a boom in consumer spending is the suppression of property crime growth – as is evident in figure 1.

Limitations of the earlier model

The model set out in *Trends in Crime* had a number of limitations.

First, statistical techniques for analysing time trends have developed somewhat since the earlier publication. No claim was made in the earlier report to explain the *level* of crime, only rates of *change*. This followed a procedure which had become standard, of exploring relationships between growth rates, rather than between levels, because of the risk of spurious correlations between factors which are all subject to a time trend – a common and dangerous fallacy. The drawback of this procedure is that information about the long run is lost. Partly in response, recent work has given increasing emphasis to the mechanism of 'cointegration', a device for detecting long run relationships which go deeper than the (spurious) correlation between factors subject to a time trend.

Following out this approach Pyle and Deadman (1994) suggested that property crime has a *long-run* (cointegrating) relationship with key economic variables. Pyle and Deadman suggested that the rate at which recorded property crime grows is related to an economic variable – either the level of consumers' expenditure, or Gross Domestic Product, or unemployment. They report this result on the basis of annual data for the 1949-1991 period and quarterly data for 1975 –1991.

Osborn (1995) and Hale (1998a, 1998b) have criticised these findings, arguing instead for a more straightforward long run relationship between the level of crime and the level of consumption (but not with unemployment). Pyle and Deadman's linkage of the growth rate of crime with the level of an economic variable is not easy to interpret. However Hale's main argument against the Pyle and Deadman model is that it is statistically incorrect. Hale finds, instead, that the levels of burglary and theft were both co-integrated with the level of consumer's expenditure over the 1946-1991 period, but not with GDP or unemployment. This implies that the gradual increase in recorded crime during that period may be attributed, in a significant part, to economic growth. (For a full discussion of this issue, and the associated technical issues surrounding cointegration, see Hale, 1998a, 1998b).

Hale offered an inter-related explanation of the short run factors affecting *growth rates* in burglary and theft. He estimated that the growth of theft and burglary is positively influenced by current growth in unemployment, and negatively by current growth in consumption. He also reports a negative impact of current growth in the number of convictions – possibly a deterrent effect.

Second, there has been a downturn in recorded property crime during the last five years. Between 1992 and 1996, recorded theft fell by 16 per cent and burglary by 14 per cent. The explanatory model developed in the early study cannot explain this downturn. This could be because the downturn is a new departure in crime trends, but it might also be because of weaknesses in the initial analysis.

One possible explanation of the pattern is the existence of a long run 'cointegrating' relationship between property crime and some other factor. A feature of such relationships is that they imply a gradually changing 'equilibrium' level of crime underlying more volatile actual crime numbers. If such an equilibrium level exists, then the sustained decline in property crime since 1992 can be explained partly by reference to the very rapid increases in property crime in 1990-92, when the combined total of theft and burglary rose by nearly half. Thus the recession of the early 1990s could have driven property crime significantly above its equilibrium level. The decline since 1992 would then be explained by a gradual return to equilibrium.

Third, the link between opportunity and consumption expenditure was inadequately represented in the earlier study. That study pointed out that rising consumption could increasing the number of goods available as targets for theft-for example the number of cars on the roads. However the earlier report failed to point out that the annual total of consumer's expenditure-employed in the original model – is not the correct proxy for the number of

stealable goods, since the number depends on expenditure over a period of some years, a history of purchases responsible for the current stock. It is not an indefinite history, since after some years goods are discarded or replace. Thus, for example, the number of cars on the road represent purchases accumulated over several years. The correct proxy for the 'stock' of stealable goods-representing opportunities for theft-is therefore not consumer's expenditure in a single year, but cumulative expenditure over several years.

As the stock of goods will be strongly influenced by past patterns of consumption, the opportunity effect of consumption will be subject to a time lag. This may well explain why in the earlier study rising consumption was found to be associated with rising property crime after a time lag. It also explains why the immediate negative effect on the motivation of potential offenders overwhelms any immediate positive impact through the opportunity effect (or through a routine activity effect). A revised theoretical model needs to reflect these considerations.

A new model of theft and burlgary

This part of the report will explain the basis for the new model of theft and burglary, describe the model and give some results.

The model was developed (a) by estimating long run 'cointegrating' relationships between recorded property crime and other factors, and (b) by estimating short run relationships. This is a standard approach, and was used both by Pyle and Deadman and by Hale. Separate models were estimated for theft and burglary. Further technical details are given in the statistical appendix. The main results are quoted here.

Long term determinants of the level of crime

As argued above, opportunities for theft and burglary may be related to the stock of goods, which can in turn be represented by consumers' expenditure over a period of years. A period of four years was chosen.

Given the compelling evidence that in almost every context, young males are responsible for a large proportion of recorded crime, demographic factors should effect crime trends. *Trends in Crime*, unsurprisingly, reported a link between the changes in the level of many types of crime and changes in the number of young men. The number of young males was represented by the sum of males in the two single year age groups of 15 and 20. (This rather unusual formulation was selected for technical reasons, as described in the statistical appendix).

The estimation procedures and results are set out in the statistical appendix. It was shown that:

- thefts and burglaries are both linked to the stock of crime opportunities, represented by the sum of real consumer expenditure in each of the last four years. For every 1 per cent increase in this stock, burglary and theft have increased by about 2 per cent;

- thefts and burglaries are both associated with the numbers of young males. For every 1 per cent increase in the number of males aged 15 and 20, burglary and theft increase by about 1 per cent.

- no equivalent relationships could be found for robbery. (This does not show that they do not exist – since they could readily be masked by other factors affecting robbery trends and recorded robbery data).

The relationships are not simply correlation, but rather the special relationship of cointegration. These findings broadly confirm those reported by Hale, although Hale adoped a somewhat different modelling strategy[1]. Hale also found that consumption was associated with theft and burglary, but not with robbery.

Hale linked the level of property crime to consumption in that same year – rather than to the four year running total of consumption reported here. Although tests show that annual consumption and the four year running total of consumption are both linked with (cointegrated with) theft and burglary, the four year total appears to provide a better fit to the data. Clearly different measures of economic growth are all closely related so clear distinctions may be difficult to achieve.

Short term determinants of crime trends

The long term relationship between crime, demography and the economy, as described above, determines what might be called the 'equilibrium' level of crime. There is nothing permanent or final about this equilibrium, which changes over time in response to demographic and economic changes. It may, and almost certainly does, also respond to a range of other socio – economic factors, and specific criminal justice and crime prevention initiatives. Data limitations, so limited effects during the period under examination, mean that such effects are not readily visible.

The 'gap' between actual levels of recorded crime and these equilibrium levels are illustrated in figures 4 and 5 later in the report. These gaps are partly explicable in terms of short term influences on the growth rate (or decline) in crime. Most prominent among such influences is the immediate effect of consumption growth on property crime, as illustrated in figure 1.

Under this model the main factors determining the *growth* rate of theft and burglary in each year are the following:

1 Hale modelled the relationships in terms of simple levels of the different variables. This study uses logarithms of the different variables. This approach receives some justification from a comparative test of the two approaches (reported in the technical report).

- when the actual crime level falls below the equilibrium, crime growth increases, drawing the crime level back towards the equilibrium. The reverse occurs when actual crime rises above the equilibrium;

- rapid consumption growth tends to depress property crime growth, and vice versa. This is the relationship identified in *Trends in Crime*;

- crime growth in the previous year has an influence, other things being equal. Thus, for example, if burglary growth in any one year is high, it is more likely to be high in the following year, after taking into account other factors.

The findings again are somewhat similar to, and therefore tend to confirm, those reported by Hale (1998a, 1998b).

The first factor – representing a pressure on property crime to return to its equilibrium level – is critical. It means that the effect of all the other factors listed above on the *level* of crime will be temporary only, since shifts away from the equilibrium level of crime will eventually be corrected. As the equilibrium may itself shift while this correction takes place the correction is towards a moving target.

The full impact of economic trends on crime can now be described. Suppose that in one year only there is a sudden surge in the economy, causing a sharp increase in consumption. The immediate effect – through the short run impact – will be to reduce or reverse growth in property crime. The longer term effect of such a change will be to increase the underlying equilibrium level of property crime. Over time property crime will rise back to its equilibrium level, more than negating the immediate impact.

The power of the full models to explain fluctuating property crime trends over the last half century is illustrated in figures 2 and 3.

Figure 2. Explaining theft trends. Actual annual change in theft and change 'expected' on the basis of the model.

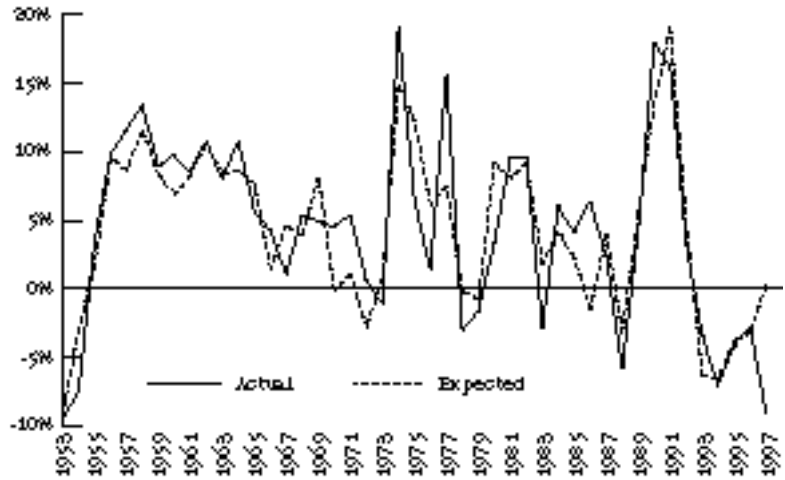
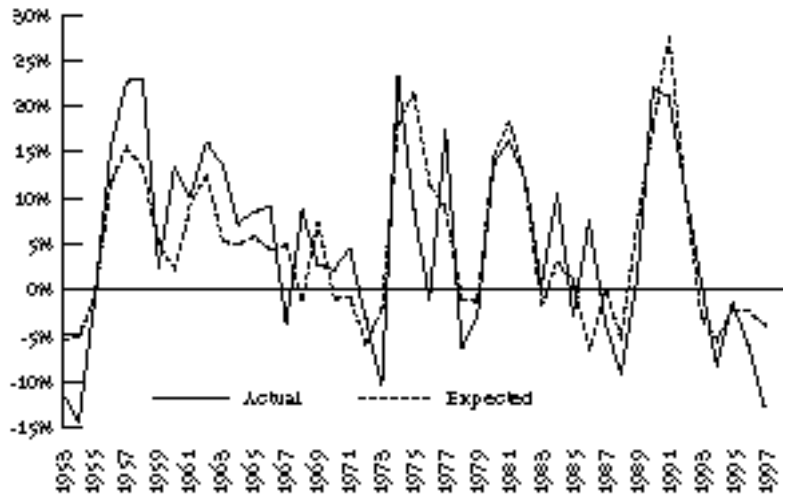


Figure 3. Explaining burglary trends. Actual annual change in burglary and change 'expected' on the basis of the model.



Implications of these findings

The main finding reported here, confirming the results of Hale, is a long term positive link between general economic growth-reflected in the 'stock of consumer goods-and growth in property crime. The linkage is nether simple, nor inevitable, nor mechanical. The influence of the economy on crime opportunities for crime and the numbers of crimes. Cash, as well as goods is a target of theft and burglary, and only a proportion of consumers expenditure is devoted to goods which represent potent opportunities for theft – particularly cars, portable electronic goods, jewellery and other valuable items.

Household surveys, such as the British Crime Survey and the General Household Survey before it, have provided convincing evidence that some of the increase in the recorded theft and burglary figures is attributable to increases in the reporting of crime. Increased wealth may explain this in part, by providing the telephones and cars which make crime reporting easier, and the insurance policies which commonly involve a requirement to report losses to the police.

Economic growth may also have a very wide range of direct and indirect effects on social structure – changing working and housing patterns, means of transport and the rhythm of everyday life. Many of these changes could affect the level of crime.

While all these considerations indicate that the causal linkage between economic growth and recorded crime has a number of separate strands, the empirical evidence suggests that the dominant strand may be a close relationship, during the period under examination, between the availability of consumption goods and opportunities for acquisitive crime.

The recent downturn in crime

As indicated in figures 2 and 3, the model appears to explain the downturn in recorded property crime in the period since 1992, although not the sharp fall in crime in 1997. The downturn can be explained as the result of three separate factors working together – two of them associated with the recession of the early 1990s.

Firstly, the immediate impact of the recession was to drive property crime well above its equilibrium level in the early 1990s. This is illustrated in figures 4 and 5. Since the long term determinant of recorded crime levels is this equilibrium level of crime, growth in burglary and theft was held down in subsequent years as the level of recorded property crime gradually returned to its long term equilibrium.

Figure 4. Theft

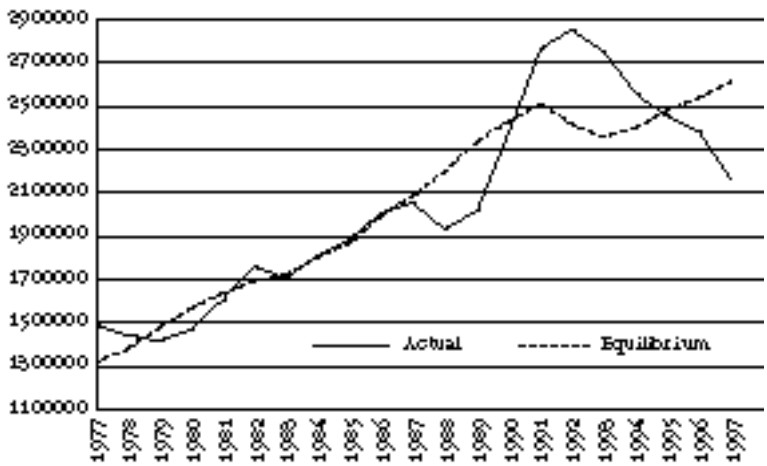
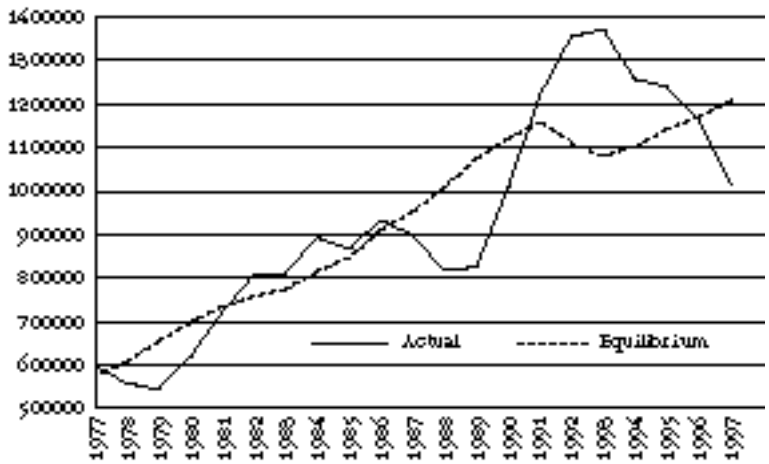


Figure 5. Burglary

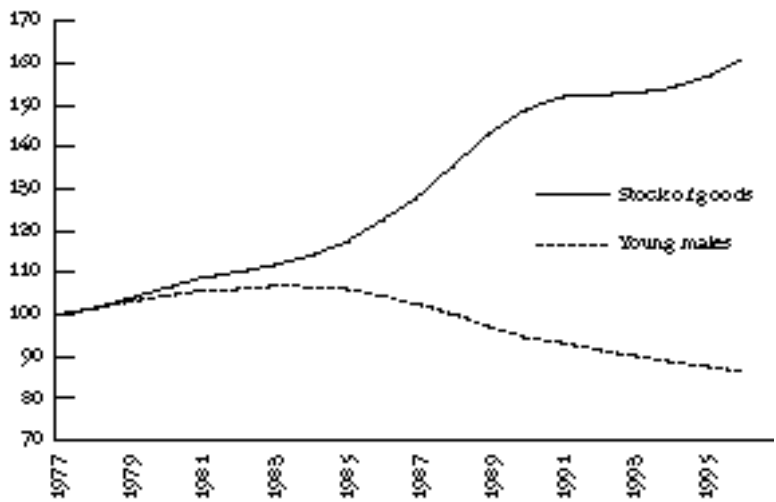


Secondly, the recession involved a reduction in consumer expenditure. This means that the stock of consumer goods – as measured by our proxy of consumers' expenditure over four years – stablished rather than growing as

it normally does (see figure 6). The result was that the equilibrium level of crime failed to grow at its usual pace during this period.

Thirdly, demographic factors have been playing a part. Since the mid – 1980s the number of young men in the crime prone age groups has been falling (see figure 6).

Figure 6 Factors underlying equilibrium level of crime. Stock of goods (real consumption over four years) and numbers of young males. 1977 = 100



Corroborative evidence from the United States

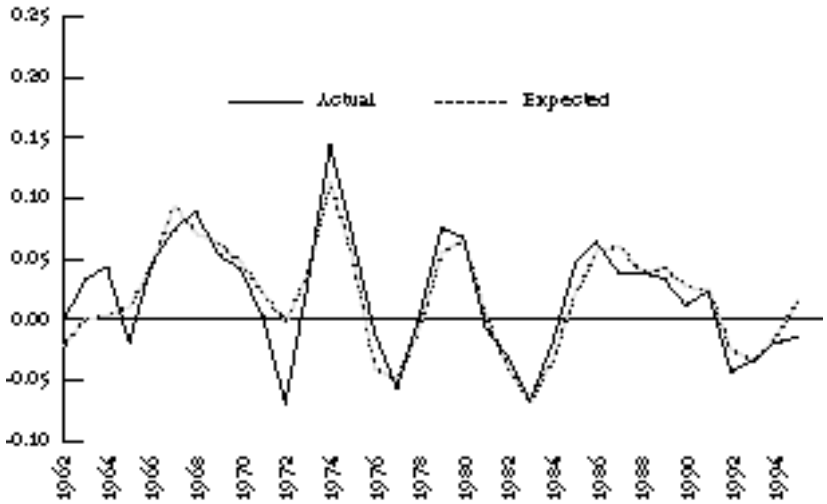
Trends in Crime reported that some of the links between crime and the economy identified in England and Wales were also visible in the United States, although a later study of European countries found that few of the same relationships were recognisable there (Field, 1995). One test of the revised theoretical model is its applicability to other countries. A test of its applicability to the US – although not to European countries – was undertaken.

In the US, as in this country, it can be shown that levels of theft and burglary are, in the long run, closely linked to the 'stock' of opportunities for property crime. However the United States also displays one large difference, for in that country a trend decline in record crime can be identified during the period in question, over and above any trends which can be linked to the economic factors.

The short run factors causing divergence from equilibrium are also similar in the US. Again, growth in personal consumption is the key factor. The full

model, integrating the long run and short run effects (as in the model for England and Wales), and combining these with the trend decline in recorded crime, is illustrated below. It explains most of the volatility in US recorded property crime trends.

Figure 7. Recorded theft and burglary in the United States: actual annual change and change expected on the basis of the explanatory model.



Other factors

Many factors affect crime. They may include, for example, criminal justice policy and practices, the features of parenting and childhood deprivation which precipitate delinquency, and crime prevention measures and programmes. Such factors are not amenable to this type of analysis, since they can be difficult to reflect in quantified time series. Although this report has not attempted to trawl through the range of possibilities investigated in *Trends in Crime*, some of the key possibilities – including unemployment, the prison population and the numbers of offenders found guilty and cautioned – were investigated. The statistical tests applied here examined whether certain other factors might provide additional explanations of either long run trends, or short term effects. No further positive findings emerged from this work.

Among economic factors, there has been a long debate about the impact of unemployment and crime, and it has been demonstrated that young men are more likely to commit crimes during periods when they are unemployed (Farrington, 1986). In tests on this model, no evidence emerged of any relevance for unemployment, once the other economic factors, indicated

above were taken into account. There is a simple correlation between unemployment and property crime trends – the link between crime trends and the business cycle makes this inevitable – but consumption growth is linked much more strongly with crime trends than is unemployment growth. This confirms the findings of *Trends in Crime*.

These findings leave the casual role of unemployment on crime undecided. It could be that unemployment has a relatively small impact on property crime, and the link between crime and the business cycle is mediated instead through factors like wage rates, the availabity of overtime and short-time working, and the buoyancy of the black economy on which some habitual criminals may rely. Alternatively, it could be that these aggregate data obscure a strong link. A large proportion crime is committed by a small group of people – mainly young males, and unemployment trends among this group may be significantly different from those observed in the aggregate data.[2]

These findings apply to recorded crime. We cannot be certain how they apply to the underlying actual crime trends since no comparable annual time series for the entire period exists. Our evidence of actual crime levels comes mainly from the British Crime Survey, which is now conducted every two years. However even this series only covers the very end of the period.

Conclusion: crime trends in the past and future.

It has been demonstrated here that the growth of recorded property crime – theft and burglary – over the period since the second world war is intimately linked with growth in the economy, a finding consistent with that of Hale. This paper has sought to explain the finding in terms of the growth in criminal opportunities associated with the stock of consumer goods. Many other explanations have been advanced for the post-war rise in crime. These findings do not remove such explanations from the picture, but they do suggest that their proportionate contribution may be very much less than has often been suggested.

Although the explanation advanced provides a powerful historical explanation of property crime trends, applicable over half a century, and in broad terms replicable in relation to property crime trends in the United States, it should not be seen as involving an unchanging mechanical linkage between economic growth, criminal opportunities and acquisitive crime. At different time in this country and others economic growth has coincided with periods of decline in crime, for example in late Victoria Britain. Such changes are not surprising. Prior to the second World War, increases in

2 Hale (1998b) reports that some of the long run changes in property crime could be related to shifts in the structure of employment.

national income were heavily invested in improvements in the basic necessities of life, such as good quality food and housing, heating lighting and public transport. Increased expenditure in these areas did little to affect the opportunities for crime. It is only in the last half century that increasing wealth has been devoted to more stealable commodities – cars and electronic good prominent among them. This feature of the half century may explain why economic growth during this historical period can be linked so clearly to rising property crime.

The gradual increase in the proportion of household thefts and burglaries reported to the police may already have run out of steam. There is limited scope for further growth in the household insurance and telephone ownership which have increased reporting levels in the past. The burglaries and thefts which remain unreported to the police may reflect victims' assessment of the value of bringing in the police rather than the difficulty of reporting, or the insurance requirement to do so. Some of the traditional targets of theft and burglary such as electronic goods and cars have undergone a degree of price deflation making them less attractive as targets and cash is less widely used. The shift in expenditure towards information goods will have increased the opportunities for other types of crime, such as computer fraud and copyright piracy, but these crimes are unquestionably less well reported and recorded in the standard recorded crime counts. Rapid progress in information technology is also making many sorts of security devices – such as CCTV – both more effective and cheaper.

It could be that some of these factors are already having a significant impact. There is striking recent evidence of declines in recorded crime in may Western countries as well as Britain and the United States. Between 1992 and 1996 (when recorded crime fell by 10 per cent in England and Wales), the recorded crime total fell in 10 other developed countries out of a sample of a sample of 22 for which recorded crime data were available. In the United States, France and Greece recorded crime fell by 7 per cent, in Canada by 8 per cent, in Denmark by 6 per cent. Where it did not fall it stabilised. In none of the 22 countries did the crime total grow by more than 6 per cent over the entire four year period.

The contrast with the previous four year period – from 1988 to 1992 – (when the recorded crime total grew by 50 per cent in England and Wales) could not be more vivid. In only one country in the sample – Spain – did crime actually fall during that period, and in 16 of the 22 countries crime grew by more than 10 per cent. (Source: Home Office Criminal Statistics, 1996).

Despite these caveats, it remains worth examining what an extrapolation from the patterns observed here would imply for future crime trends. In

1997, recorded theft and burglary were respectively 17 to 16 per cent below their equilibrium levels (as illustrated in figures 2 and 3 above). This 'gap' reflects the degree of upward potential in future crime trends, on the basis that crime has been observed to correct such disequilibrium over a period. The equilibrium level of recorded theft and burglary will itself grow in the next few years as a result of current increases in consumption expenditure and some increases in the number of young males. This will add to the upward pressure on recorded property crime.

Practical forecasts of the recorded crime count in the next few years must be somewhat hypothetical. From 1998, the counting rules for recorded crime will change. This means that there will be a somewhat unpredictable one-off change in the crime count, the trends might be affected as well, and the counting rules may take a little while to bed down in routine practice. All this makes the actual crime count in the next few years very uncertain.

Forecasts are always perilous. Frequently, the future differs from the past. We do have a model which has accurately tracked recorded property crime trends for most of the last half century. Extrapolation of this model implies substantial upward pressure on property crime in the coming years. Set against this, there are a number of reasons for believing that the underlying determinants of recorded crime may be becoming more benign. Supporting this view is some international evidence, and the very latest evidence of recorded crime in 1997 shows some significant further falls which would not be predicted on the basis of previous patterns. On balance therefore, we may expect some renewed upward pressure on the recorded crime figures in the coming years, but not to the extent which might be predicted from a mechanical extrapolation of trends over the last half century.

Statistical appendix

This appendix describes the main features of the analysis. Further details are available from the author on request.

The Data	Source
The annual number of recorded crimes in England and Wales (including sub-categories)	Criminal Statistics
UK Real personal consumption	Economic Trends
UK Real gross domestic product	Economic Trends
UK unemployment	Economic Trends
The numbers of persons in single year age groups (male)	Office for National Statistics

The Theft Act 1968 introduced some discontinuity into the property crime data series as a result of the redefinition of these crimes. The burglary and theft data series were adjusted to remove this discontinuity by setting the rate of change between 1968 and 1969 equal to the average change of the two periods 1967-68, and 1969-70. The adjusted data series were then used throughout the analysis.

A 'stock' variable was created as an indicator of the quantity of goods available as targets for theft and burglary. This was represented by personal consumption over a four year period including the current year.

Initial test regressions on the different crime categories demonstrated that a long-linear formulation for the co-integration regressions would be preferable to the linear formulation. All the data were therefore modelled in logarithms.

Establishment of the cointegrating relationship

Tests for stationarity

Informally a stationery variable is one which has constant means and variance. Clearly variables which are trending over time – like crime rates – are non-stationary as their mean is not constant.

Stationarity is important because when regressions are estimated using non-stationary variables either as the dependent or independent variable, the regression coefficients may be biased.

There is some discussion in the literature over whether theft and burglary are I(1)(stationary in first differences) or 1(2) (stationary in second differences) variables, Pyle and Deadman (1994) have argued that they are I(2), while Osborn (1995) and Hale (1998a) have argued that the tests conducted by Pyle and Deadman are incorrect, and that the crime variables are I(1). All the variables (transformed into logs) were subject to augmented Dickey-Fuller tests for stationarity. The balance of evidence suggests that the crime variables were I(1).

The demographic variable, when initially constructed as the log of the number of males aged 12 to 24 is I(2). Further testing revealed that most demographic variables of this type are I(2). A statistically valid approach would be difference the demographic variable for comparison with a level of crime variable in a potentially cointegrating regression (both variables then being I(1)). The disadvantage of this approach is that it makes no theoretical sense. The theoretical assumption must be that the level of crime depends on the number of young men not on their growth rate.

To resolve this difficulty, a somewhat artificial demographic variable was constructed, designed to be stationary in first differences. The variable is the sum of the number of young men aged 15 and the number of young men aged 20 (excluding the intervening years). Exclusion of the intervening years renders the variable I(1).

The cointegration models

Models TI and B1 were first estimated.

T1 $\quad \text{Log (theft)}t = ß_0 + ß_1 \text{ Log (stock of goods)}t + ß_2 \text{ Log(males 15 and 20)}_t + U_t$

B1 $\quad \text{Log (burglary)}t = ß_0 + b_1 \text{Log (stock of goods)}t + b_2 \text{Log (young males)}_t + U_t$

Table 1 Estimation period 1951 – 1997
Estimated coefficients and (in brackets) standard errors.

Dependent variable / Independent variables	Model T1 Log (Theft)		Model B1 Log (Burglary)	
Intercept	-28.7	(1.27)	-33.61	(2.01)
Log (consumption over 4 years)	1.8	(0.04)	1.9	(0.06)
Log (males aged 15 plus males aged 20)	1.0	(0.11)	1.2	(0.17)
R-squared	0.99		0.97	

Conintegration tests were conducted by taking residuals from these regressions and differencing them, then regressing the dependent variable against the first lag of the residual and sufficient additional lags on the differenced residual to remove serial correlation from the regression residuals. No constant was included. The t-statistic on the estimated coefficient on the first lag on the residual was then examined. The (Mackinnon) test statistics were as follows.

- For T1 the null of no cointegration is rejected at the 1 per cent level. (Test statistic = -5.09, critical value-4.64). T1 was therefore accepted as the cointegrating equation for theft.

- For B1 the null of no cointegration is rejected at the 5 per cent level. (Test statistic = - 4,06, critical value – 3.94). Model B1 was therefore accepted as the cointegrating regression for burglary.

The dynamic (error correction) models

The standard error correction regressions, based on these two cointegrating regressions, can be written as follows:

T2 $\Delta\text{Log(theft)}_1=ß_0+ß_1\Delta\text{Log(stock of goods)}_1+ß_2\Delta\text{Log(young males)}_1+ß_3\text{EC(T1)}_{t-1}+U_t$

B2 $\Delta\text{Log(burglary)}_1=ß_0+ß_1\Delta\text{Log(stock of goods)}_1+ß_2\Delta\text{Log(young males)}_1+ß_3\text{EC(B1)}_{t-1}+U_t$

(Where EC(T1) and EC(B1) are the error correction mechanisms – the residuals from estimated modes T1 and B2.)

In practice more unrestricted regressions were estimated at the outset. These less restricted regressions included consumption growth, which in previous work had been found to have the dominant short term influence on crime growth, and additional lags on all the variables. These models were as follows.

T3 $\Delta\text{Log(theft)}_t=ß_0+ß_1\Delta\text{Log(stock of goods)}_1+ß_2\Delta\text{Log (consumption)}_t+ß_3\Delta\text{Log(young males)}_t+ß_4\text{EC(T1))}_{t-1}+ß_5\Delta\text{Log(theft)}_{t-1}ß_6\Delta\text{Log(stock of goods)}_{t-1}+ß_7\Delta\text{Log(consumption)}_{t-1}+ß_8\Delta\text{Log(young males)}_{t-1}+U_t$

B3 $\Delta\text{Log(burglary)}_t=ß_0+ß_1\Delta\text{Log(stock of goods)}_1+ß_2\Delta\text{Log(young males)}_t+ß_3\text{EC(B2)}_{t-1}+ß_4\Delta\text{Log(burglary)}_{t-1}+ß_5\Delta\text{Log(stock of goods)}_{t-1}+ß_6\Delta\text{Log(young males)}_{t-1}+ß_7\Delta\text{Log(consumption)}_t+ß_9\Delta\text{Log(consumption)}_{t-1}+U_t$

Elimination of variables with estimated coefficients not significantly different from zero resulted int he final dynamic models T4 and B4.

T4 $\Delta\text{Log(theft)}_t=ß_0+ß_1\Delta\text{Log(stock of goods)}_t+ß_2\Delta\text{Log(consumption)}_t+ß_3\Delta\text{Log(young males)}_t+ß_4\text{EC(T1)}_{t-1}+ß_5\Delta\text{Log(theft)}_{t-1}+ß_6\Delta\text{Log(consumption)}_{t-1}+U_t$

B4 $\Delta\text{Log(burglary)}_t=ß_0+ß_1\Delta\text{Log(stock of goods)}_1+ß_2\Delta\text{Log(consumption)}_t+ß_3\Delta\text{Log(young males)}_t+ß_4\text{EC(B1)}_{t-1}=ß_5\Delta\text{Log(burglary)}_{t-1}+U_t$

Table2 Full dynamic (error correction) models
Estimation period 1952 – 1997
Estimated coefficients and (in brackets) standard errors

Dependent variable	Model T4 ΔLog (Theft)		Model B4 ΔLog(burglary)	
Independent variables	**Estimated coefficients**			
Intercept	-0.03	(0.02)	0.05	(0.02)
Error correction mechanism (lagged residuals from cointegrating regressions)	-0.52	(0.12)	-0.24	(0.11)
ΔLog(consumption over 4 years)	-0.61	(0.93)	1.88	(1.04)
ΔLog(males aged 15 plus males aged 20)	0.43	(0.14)	0.37	(0.24)
ΔLog(consumption)	-1.25	(0.38)	-2.67	(0.62)
ΔLog(consumption) lagged one year	1.10	(0.51)	not included	
Dependent variable lagged one year	0.58	(0.12)	0.36	(0.11)
	Diagnostic statistics			
R-squared	.72		.62	
F-statistic	F(6.39) 16.58		F(5.40) 13.00	
SE of regression	0.04		0.06	
DW-statistic	1.87		2.15	
Serial Correlation	p=0.40		p=0.22	
Functional form	p=0.27		p=0.21	
Normality	p=0.41		p=0.69	
Heteroscedasticity	p=0.17		p=0.94	

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