Home Office

Seasonality in recorded crime: preliminary findings

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Background

Monthly recorded crime data, like many other time series, are affected by short-term variations associated with the time of year. This report identifies which crime types are seasonal and to what extent, which in turn will help crime reduction agencies to develop their policies and strategies for managing varying crime levels within the year.

The existing research on the seasonality of crime in England and Wales is restricted to quarterly data and to local areas. Of course, analysis of national crime data may mask varying seasonal patterns between local areas, so the analysis discussed here extends to a selection of Crime and Disorder Reduction Partnerships (CDRPs).

Summary

Twenty-five of the 29 crime types tested showed evidence of seasonal patterns (statistically significant at the p0.01 level). Each crime shows a different seasonal pattern but they can be grouped into three main themes:

- peaks in the summer months and troughs in the winter months;
- peaks in the winter months and troughs in the summer months; and
- regular peaks and troughs each year which are not led by the seasons.

Five of the 20 CDRPs that were tested showed evidence of seasonality in the crime type for which they were tested (statistically significant at the p0.01 level). Further detail is given in the findings section of this report.

The data and methodology

Recorded crime data from all 43 police forces in England and Wales are routinely collected by the Home Office. The following three types of data were analysed:

- quarterly national data spanning April 1995 to March 2000;
- monthly national data spanning April 2000 to March 2005; and
- monthly data for a selection of CDRPs spanning April 2000 to March 2005.

The results from this analysis are presented as preliminary as they are based on only five year's worth of monthly recorded crime data, whereas ten would have provided more robust results. All presented results are statistically significant at the p0.01 level.

The findings in this report focus mainly on the monthly time series for April 2000 to March 2005 and only comment on the quarterly analysis where the results appear to be contradictory.

X11ARIMA

X11ARIMA is the program used through most of the Government Statistical Service for seasonal adjustment. The program models the series using a multiplicative[1] model:

$$Y = C \times S \times I$$

Where; **C** is the trend-cycle – the medium- and long-term movements in the series.
S is the seasonal component – which reflects the effect of climate and institutional events which evolve more or less smoothly from year to year.
I is the irregular component – which contains those parts of the time series which cannot be predicted and have been left behind after the identification of the C and S components.

The program decomposes the time series into these three components using moving averages. The programme does this in three iterations to get successively better estimates of the three components. Outliers are identified and replaced during these iterations.

Prior adjustments

Changes to the recorded crime counting rules in 1998 and 2002, as well as the introduction of the National Crime Recording Standard in 2002, have caused trend breaks in the recorded crime series. This can cause distortion in the estimates of the components of the time series. This problem was solved by adjusting the series before the break to shift it to the level of the series after the break, before running the data through X11ARIMA. This will take into account the single-step impacts of these changes but not any additional variation in trend which occurred as a result of the changes in subsequent periods.

Limitations

Recorded crime is a count of crimes reported to and recorded by the police. Crime is counted in the month in which it is recorded, not necessarily when it occurred. Recorded crime is an imperfect measure of the extent of crime, as it does not include crimes that are not brought to the attention of the police, but it is the only source for analysing crime patterns by time and geography as survey data cannot be reliably disaggregated for these purposes.

Each of the series analysed through X11ARIMA is five years in length. The Home Office holds monthly recorded crime from April 2000, before which it was captured on a quarterly basis. Ideally ten years of data are required to conduct an adequate seasonal adjustment. However, five to ten years can still be used but it should be noted that results may be subject to revisions.

[1] The program asks the user to choose multiplicative or additive.

Findings

National seasonal patterns

Of the 29 crimes tested, 25 showed evidence of stable seasonality (statistically significant at the p0.01 level). Theft of a pedal cycle proved to be the crime type with the most identifiable seasonal pattern (indicated by the M7 statistic), followed by criminal damage to a building other than a dwelling and robbery of business property.

The M7 statistic indicates the amount of moving seasonality present in the series. A value close to zero indicates a strong seasonal pattern; a value greater than one indicates that there is no identifiable seasonality evident in the series. The M7 statistic for the crime types studied suggested that no seasonality was present for only four crimes: rape of a male, homicide, the fraud and forgery group and drug offences. Additionally, while seasonality was clearly indicated for the other crimes, it was weaker for robbery of personal property, dangerous driving, going equipped for stealing, threat or conspiracy to murder and rape of a female. The expectation may be that robbery of business property and robbery of personal property would share similar seasonal factors and patterns, but evidence of seasonality in robbery of personal property is much weaker, although still present (Annex Table 1).

Each crime shows a different seasonal pattern but they can be grouped into three main themes. Figures 1.1 to 3.11 show the seasonal variation in the data averaged over five years.

1) Peaks in the summer months and troughs in the winter months (figures 1.1 to 1.10)

This group contains the violent assault offences and sexual offences, theft of a pedal cycle and arson, all of which appear to show regular increases in the summer months.

The two sex offences follow very similar seasonal patterns to each other with a large peak in July, when indecent assault on a female is 21 per cent above trend and rape of a female is 14 per cent above trend.

Theft of a pedal cycle has a very clear seasonal pattern; peaks start in May and continue to reach 29 per cent above trend in September. This peak in September could be related to the beginning of university terms and new students learning the hard way that they need to keep their belongings secure. The number of offences drops in November through to April with the lowest point in December: 31 per cent below trend. This pattern is likely to be due to an increased number of people using their bikes in the summer months and therefore increasing their availability for theft.

Arson, unlike other criminal damage offences, shows rises in summer months, with August the highest month above trend (14%).

Figure 1.1: Serious wounding

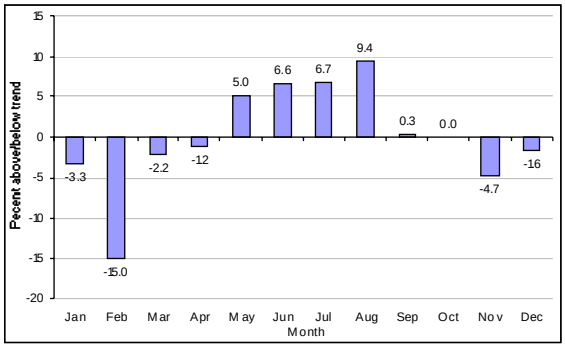


Figure 1.2: Threat or conspiracy to murder

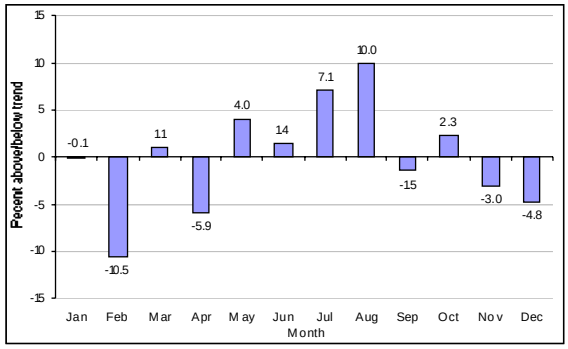


Figure 1.3: Less serious wounding

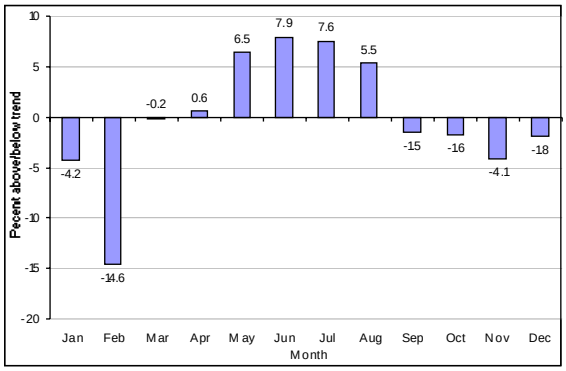


Figure 1.4: Common assault

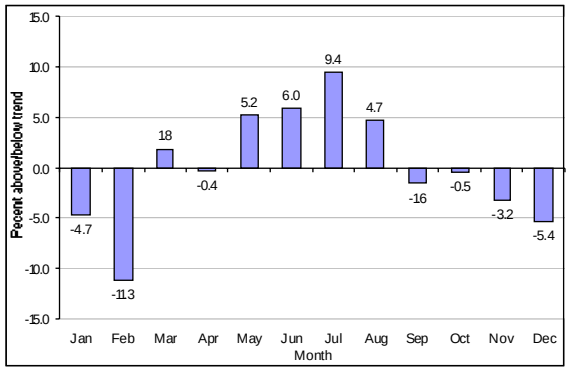


Figure 1.5: Harassment

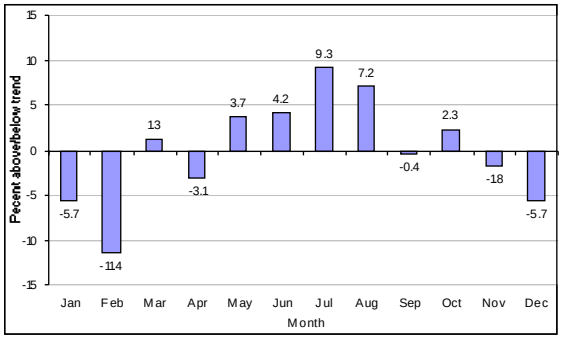


Figure 1.6: Indecent assault on a female

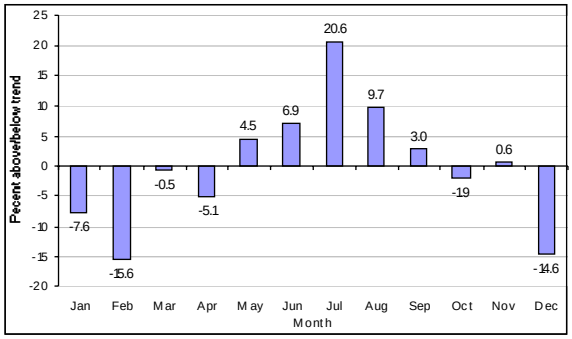


Figure 1.7: Rape of female

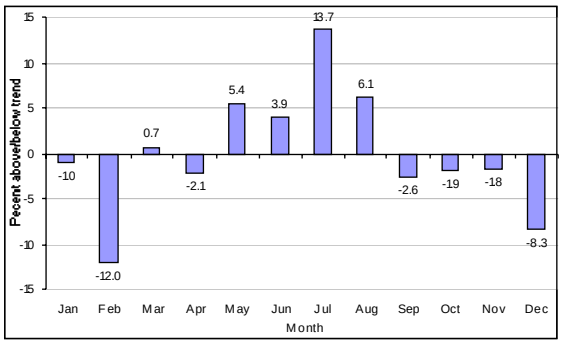


Figure 1.8: Theft of pedal cycle

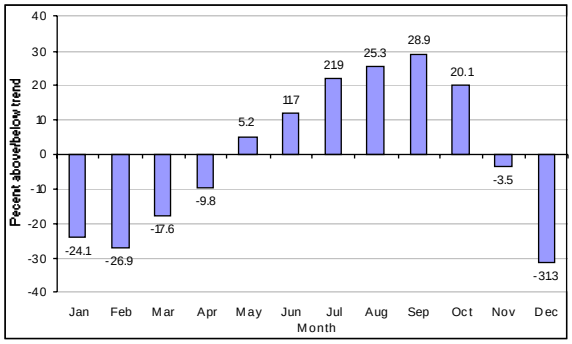


Figure 1.9: Non-domestic burglary

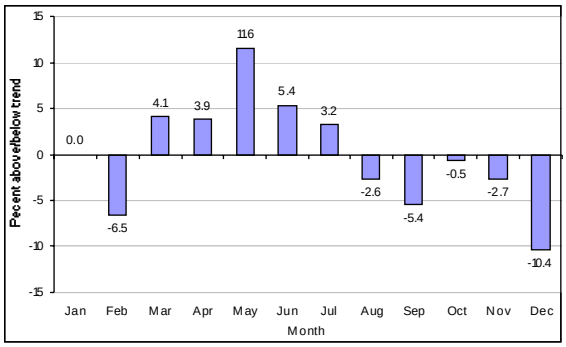
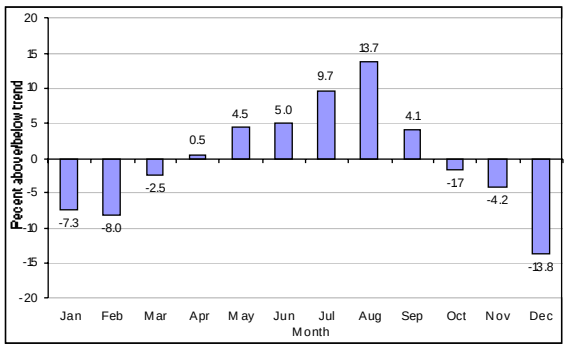


Figure 1.10: Arson



2) Peaks in the winter and troughs in the summer months (figures 2.1 to 2.4)

Just four crime types display seasonal peaks in the winter and falls in the summer. These are all property crimes.

Domestic burglary peaks to 11 per cent above trend in January. This may be a reporting/recording effect. Victims that have left their homes vacant over the Christmas period may not discover that they have been burgled until January, when they then report the crime to the police.

Alternatively, the January peak in domestic burglary may be due to burglars resting over Christmas, then having to over-compensate in January (when there are also more new goods in homes to steal). Another theory is that there is more need to burgle in January following the excesses of Christmas.

It is important to note that domestic burglary has an opposite seasonal pattern to non-domestic burglary.

Figure 2.1: Robbery of business property

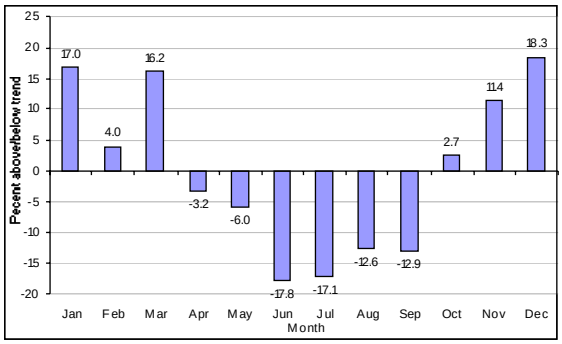


Figure 2.2: Domestic burglary

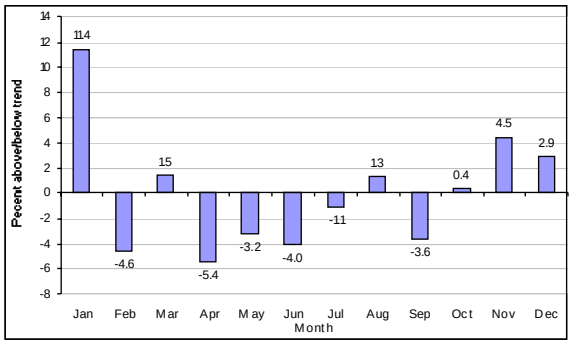


Figure 2.3: Theft of a motor vehicle

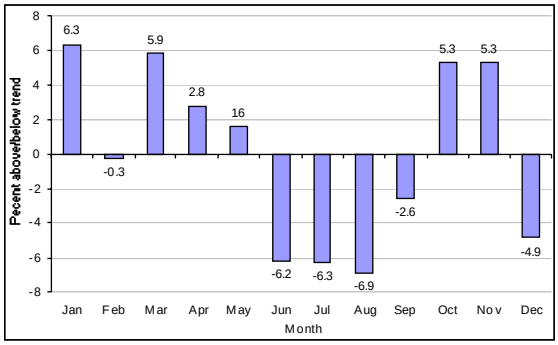
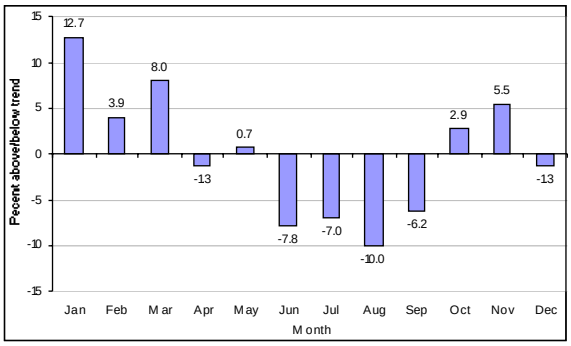


Figure 2.4: Vehicle interference and tampering



3) Regular peaks and troughs each year but not led by the seasons (figures 3.1 to 3.11)

Several crime types show evidence of seasonality but do not show clear patterns by summer and winter. Some of these crime types, such as dangerous driving and possession of weapons, may be displaying seasonal patterns in police activity. Alternatively, the seasonal peaks and troughs could simply be due to the varying number of days in months (for example, see figure 3.2 where all troughs are in months with less than 31 days except December).

More surprising are the contrasting patterns between robbery of personal property, robbery of business property and theft from the person. Robbery of business property clearly peaks in the winter yet robbery of personal property shows no distinct pattern. The only difference between these two crimes is the ownership of the item stolen, although some robberies of business property will take place inside businesses, such as shops and banks, so may be less (or differently) affected by the seasons than street robberies from the person. However, as has been shown, the seasonality for non-domestic burglary is of an opposite nature, rising in the summer. This contrast is also apparent between thefts from the person and shop thefts (see below). Theft from the person (where there is no use or threat of force) is different again, although this shares a peak in December with robbery of business property.

Also in this group are the four criminal damage offences. Criminal damage to a vehicle and criminal damage to a dwelling have almost identical seasonal patterns: peaks in the spring months, then falls in the summer months, followed by peaks in autumn. Criminal damage to non-dwellings and other criminal damage are also similar.

Figure 3.1: Dangerous driving

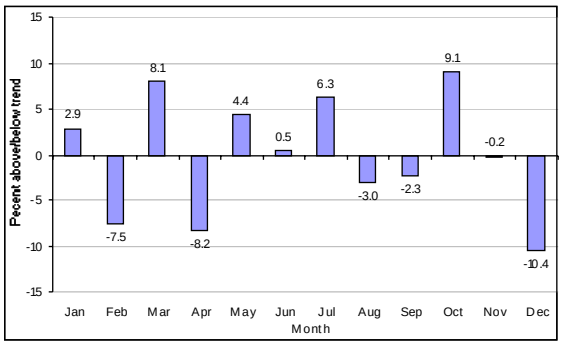


Figure 3.2: Possession of weapons

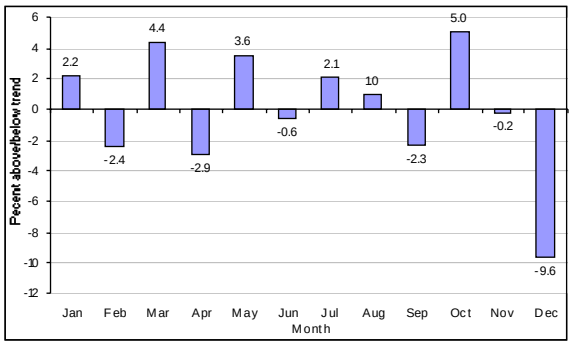


Figure 3.3: Robbery of personal property

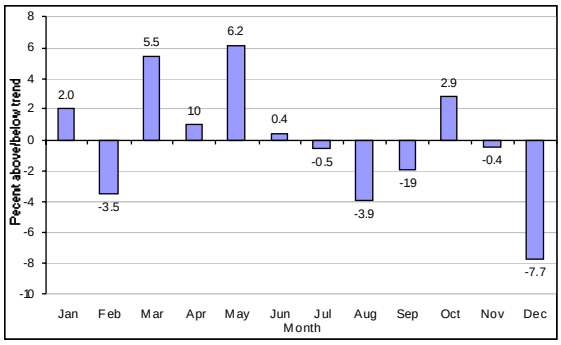


Figure 3.4: Theft from motor vehicle

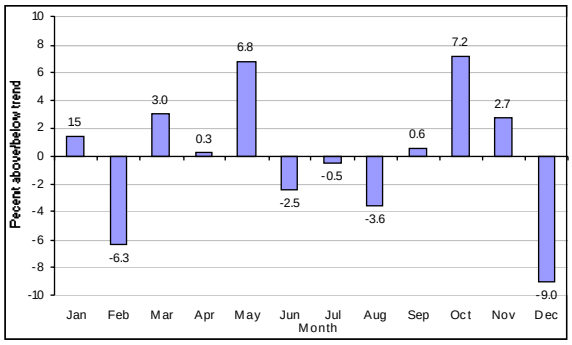


Figure 3.5: Theft from shops

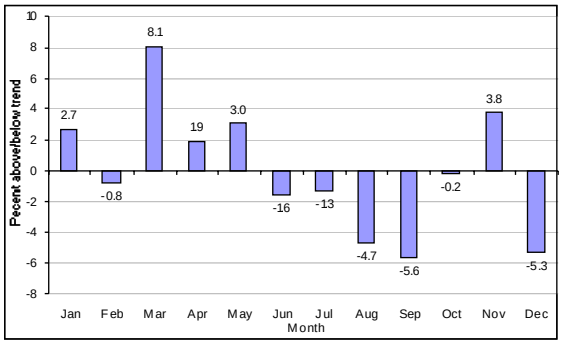


Figure 3.6: Theft from the person

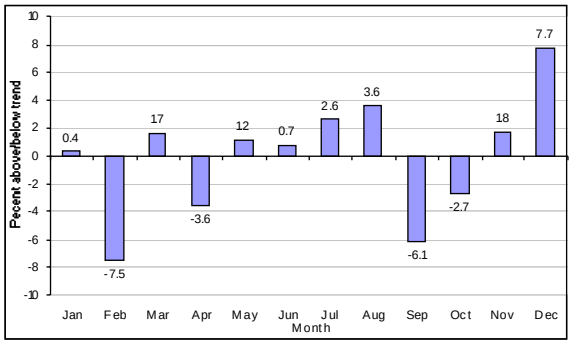


Figure 3.7: Criminal damage to a dwelling

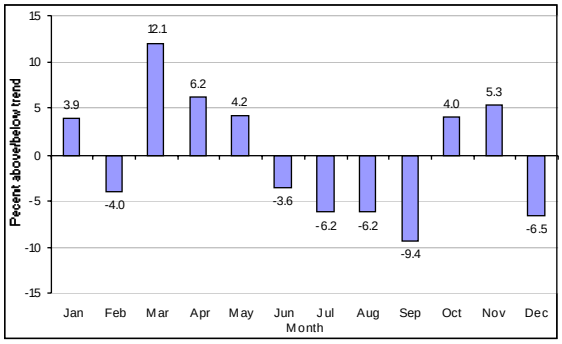


Figure 3.8: Criminal damage to non-dwelling

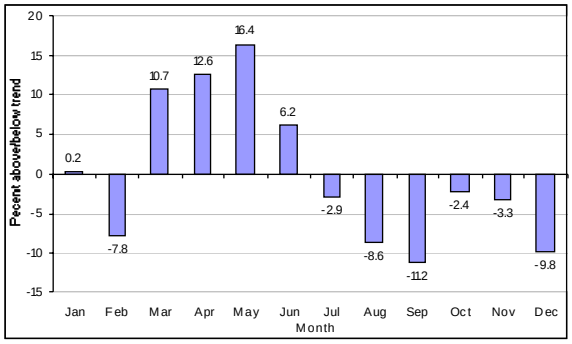


Figure 3.9: Criminal damage to a vehicle

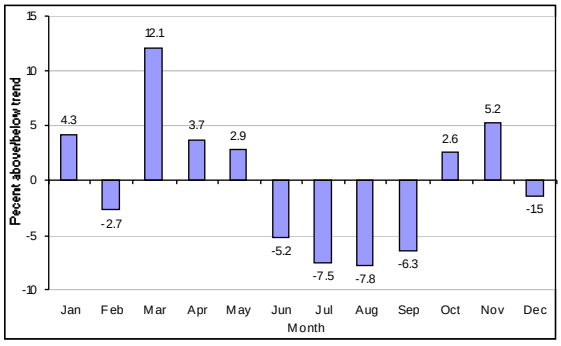


Figure 3.10: Other criminal damage

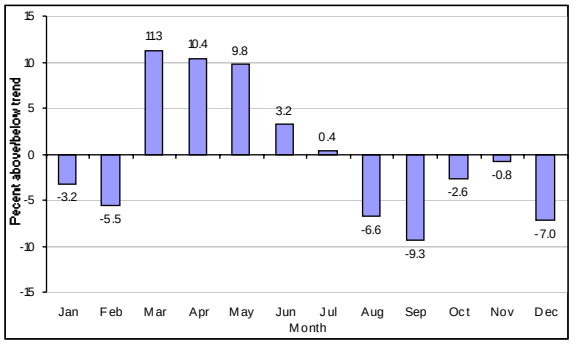
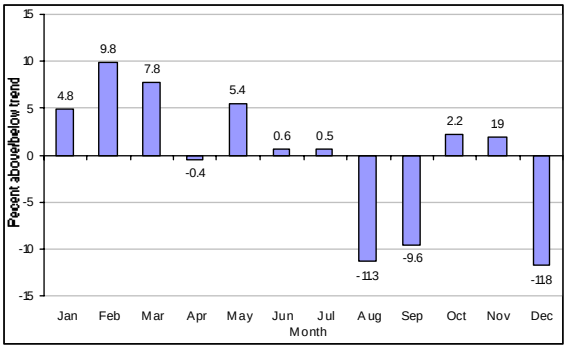


Figure 3.11: Going equipped for stealing



Seasonal patterns in CDRPs

A selection of CDRPs were analysed to see if local areas display markedly different seasonal patterns to England and Wales as a whole and to demonstrate how this analysis might be useful at a local level. Areas that have large annual events or seasonal changes in population (university towns and seaside resorts, for example) are likely to show seasonal patterns that differ from the national average.

To select CDRPs for analysis, a one-way analysis of variance between and within months was used to identify CDRPs (those with a significant F test) for each crime type. From this list CDRPs were picked for each geographical region and for each main crime type for further analysis using X11ARIMA.

Of the 20 CDRPs that were examined, the majority showed no evidence of seasonality in the crime types for which they were tested. This was possibly due to the small number of crimes recorded in CDRPs leading to a strong irregular component that dominated the seasonal component, making the seasonal component difficult to identify at this level of geography. The expected seasonal pattern in seaside resorts did not emerge although many more areas and crime types could be tested than was possible for this report.

The figures 4.1 to 4.5 show the average seasonal factors for those CDRPs and crime types that did show evidence of seasonality (significant at the p0.01 level). The seasonal factors tend to be greater in CDRP areas than nationally as only large factors are statistically significant, because of the smaller number of crimes at CDRP level.

Domestic burglary in Harrow displays a similar seasonal pattern to domestic burglary nationally, but the factors are much stronger. In Harrow domestic burglary typically peaks in November at 38 per cent above trend compared to a peak of 11 per cent in January nationally. The pattern in Harrow is also much more obvious than the national pattern, with clear peaks in the summer months and dips in winter. It should be noted here that it is unlikely that Harrow is unique with this pattern. If our analysis had extended to all CDRPs it is likely that we would have found areas with a similar pattern (Figure 4.1).

Pedal cycle theft in Cambridge also shows increases in the summer months but also a very large peak in October (typically 50 per cent above trend). This peak coincides with the start of term for the University of Cambridge (Figure 4.2).

The seasonal pattern in theft from the person in Cheltenham is dominated by a very large peak in March that makes the month typically 153 per cent above trend. This peak coincides

with the Cheltenham National Hunt Festival which takes place each March and attracts around 120,000 people to the area (Figure 4.3).

Cardiff and Salford show similar seasonal patterns to each other in criminal damage to a vehicle and are both similar to the national pattern. Both areas typically experience a strong peak in March and drops throughout the summer months (Figures 4.4 and 4.5).

This analysis could be replicated by other CDRPs or police forces to enable them to get a comprehensive view of the seasonal nature of different crime types in their areas.

Figure 4.1: Harrow domestic burglary

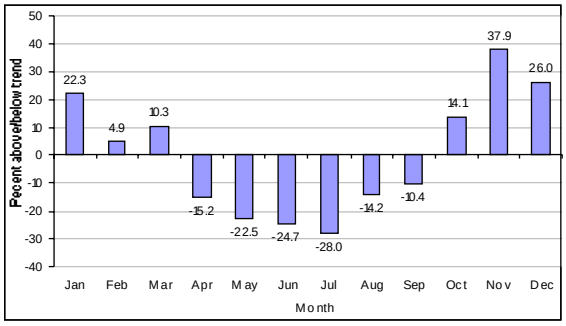


Figure 4.2: Cambridge theft of a pedal cycle

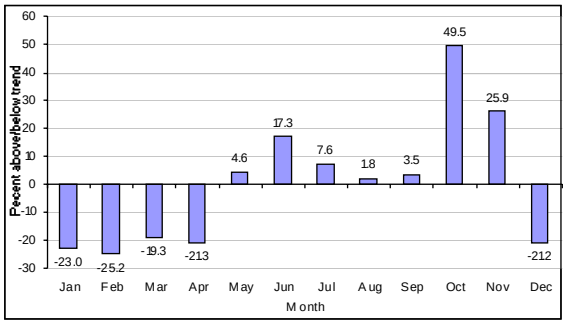


Figure 4.3: Cheltenham theft from the person

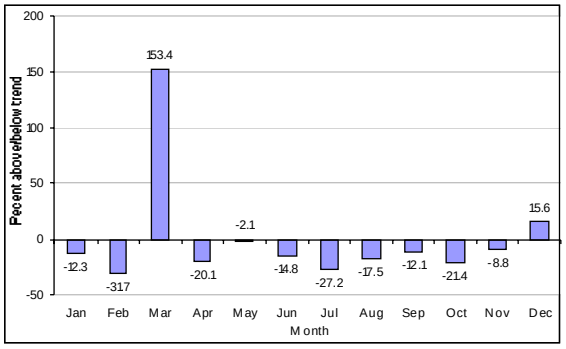


Figure 4.4: Cardiff criminal damage to a vehicle

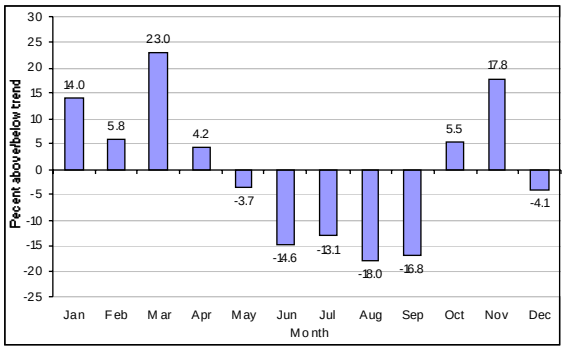
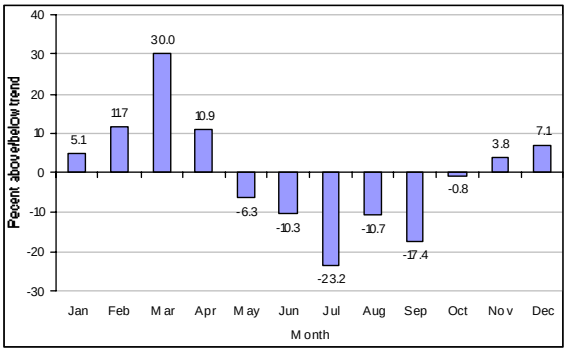


Figure 4.5: Salford criminal damage to a vehicle



Implications

Information such as this, on which crimes take place disproportionately in different months of the year, is useful for a number of reasons:

- it can help inform the use of crime prevention resources;
- it can inform the timing of crime prevention advice;
- it gives us a better understanding of crime trends;
- it can help those involved in crime reduction performance management as it provides a guide of when to expect changes in crime levels throughout the year; and
- it can give us an insight into the drivers of crime.

Acknowledgements

Many thanks are due to all the Home Office and Office for National Statistics staff that commented on earlier drafts of this report and gave statistical advice. Particular thanks go to John Dobby, Matthew Scribbins, Debbie Moon, Rose Hinks and Mark Dancox. We would also like to thank the external reviewer for some very helpful comments.

ANNEX

Table 1: X11ARIMA results for national monthly data 2000 to 2005

Crimes showing evidence of seasonality	HO offence code(s)	M7 statistic[1]
Theft of pedal cycle	44	0.228
Criminal damage to other building	58B, 58F	0.341
Robbery of business property	34A	0.36
Common assault	105A, 105B	0.374
Non-domestic burglary	30, 31	0.406
Harassment	8C, 8E	0.416
Vehicle interference and tampering	126	0.418
Less serious wounding	8A, 8D	0.432
Criminal damage to a dwelling	58A, 58E	0.448
Indecent assault on a female	20	0.465
Theft from a vehicle	45	0.477
Criminal damage to a vehicle	58C, 58G	0.481
Arson	59	0.518
Theft of a vehicle	37.2, 48	0.526
Other criminal damage	58D, 58H	0.528
Theft from the person	39	0.536
More serious wounding	5	0.553
Domestic burglary	28, 29	0.575
Theft from shops	46	0.62
Possession of weapons	8B	0.679
Rape of a female	19A	0.716
Threat or conspiracy to murder	3	0.769
Going equipped for stealing	33	0.802
Dangerous driving	802, 4.4, 4.6, 37.1	0.929
Robbery of personal property	34B	0.932

Crimes not showing evidence of seasonality	HO offence code(s)	M7 statistic[1]
Drug offences [2]	92A, 92B, 92C	1.145
Fraud and forgery [2]	51, 52, 53A, 53B, 55, 60, 61, 814	1.048
Homicide	1, 4.1, 4.2	1.946
Rape of a male	19B	2.311

1. The M7 statistic indicates the amount of moving seasonality present relative to the amount of stable seasonality. A value close to zero indicates a strong seasonal pattern; a value greater than one indicates that there is no identifiable seasonality evident in the series.
2. These series are marginally seasonal; they may be affected by limited time series data. A more accurate picture may emerge if more data were available.

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