Quantifying the deterrent effect of police patrol via GPS analysis

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Summary

The efficacy of police patrolling as a means of crime deterrence remains a significant area of uncertainty within crime prevention study. It is, however, an issue of substantial practical importance, since the design of policing strategies depends crucially on knowledge of the form and intensity of intervention required to achieve a given effect. Here, we examine GPS traces of police vehicle movement in a major UK city in order to quantify precisely the patrol activity applied to each street segment. This is then compared against crime data to test, and estimate the magnitude of, the deterrent effect of patrolling.

KEYWORDS: police patrol, street networks, crime prevention, survival analysis.

1. Background

Patrol is one of the primary tactics employed by the police in the course of their efforts to prevent crime. In accordance with the principles developed by Sir Robert Peel, which remain influential in current models of policing, one of the functions of the police is to demonstrate the presence of a legal force that has the authority to punish transgressions of law. Patrol fulfils this remit by increasing the awareness among potential offenders of the risks associated with committing offences. That this should prevent crime can be rationalised by appealing to rational choice theory: if a prospective offender is considered to act with (bounded) rationality, any increase in risk will reduce the anticipated utility of an offence and thus reduce the likelihood that the individual will choose to offend. Patrolling therefore represents a well-grounded and efficient crime prevention activity, and has been adopted widely for this reason.

While it is common to the majority of policing models, however, the concept of patrolling is a broad one, and considerable variation can be observed in its use. To take one basic aspect, the volume of resource allocated can differ substantially: the relative emphasis placed on proactive patrolling and reactive response varies considerably across policing models. There are also differences, however, in the form of patrolling. For example, the role of vehicular patrol, as opposed to that carried out on foot, has increased over time, and the balance between the two continues to vary between settings. The nature of patrol activity is also dependent on overall strategy. The approach of 'neighbourhood policing', for example, suggests that officers should be integrated with the local community, fostering a familiar and co-operative relationship. This contrasts with a 'zero tolerance' approach, in which many resources are committed to individual areas and high-impact tactics are employed.

Given that such variation exists within police patrolling, the question naturally arises of which forms are most effective in deterring crime. This is an issue of clear practical importance: if patrolling is to be applied in an evidence-based manner, then it is essential to have some understanding of the level and type of patrolling necessary to achieve a given effect. This need is made even more urgent by

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recent developments in the field, such as predictive policing. A crucial underlying assumption for systems of this type is that crimes occurring in predicted locations can be prevented by focussed police activity (of which patrolling is typically the principal form). The success of such strategies is therefore contingent on the deterrent effect of patrolling: if predicted crimes cannot be prevented, the accuracy of a predictive algorithm is immaterial. We argue that these issues are addressed only partially by existing research.

2. Previous Research

A number of studies have been concerned with the evaluation of patrol-based interventions as a means of reducing crime. Many of these are focussed on the particular tactic of 'hot spot policing', in which small geographic areas with acute crime problems are patrolled intensively, and these are summarised in a systematic review by Braga *et al.* (2014). The meta-analysis presented demonstrated that focussed patrolling had been modestly but significantly successful at controlling crime problems. While this is a useful finding, however, it refers only to patrolling in one particular context: hot-spot policing is a specific intervention, applied over and above existing activities. The effect of routine day-to-day patrolling – which, we argue, is of greater overall significance for policing – must be considered independently of this.

Some indication of the effectiveness of day-to-day police activity can also be found by considering the relationship between overall police resource levels and crime. A number of studies examine this (and, indeed, it is the subject of a systematic review by Lee *et al.*, 2013); however, since the analysis is only carried out at macro level, there are a number of reasons why positive results in these studies cannot be taken as a reliable indication of the effect of patrolling. Officers working in better-resourced departments may have the freedom to undertake enhanced policing on a number of fronts: they might improve victim support, for example, or have faster response to real-time incidents. To presume that an increased capacity to patrol is the mechanism by which the increased crime reduction is found in such places is difficult to justify.

Inferential reliability is not the only reason to analyse patrol effects at the micro level; it is also necessary in order to understand properly the mechanism by which policing patrol might reduce crime. A number of possibilities exist for how the deterrent effect is manifested, some more viable than others. In hotspot policing studies, many authors assert that it is the visible presence of officers which is the fundamental driver of deterrence. This would stop offenders undertaking offences at the time of the police patrol only; however, it is also hypothesised that patrol activity also has a residual deterrence effect. In other words, it alters the behaviour of would-be offenders for a period after the patrol has gone. Koper (1995), for example, suggests that foot patrol has a positive deterrent effect on crime within an 11-15 minute timeframe, compared with a drive-by patrol approach. Again, this is only partial evidence, as the study in question is primarily observational.

3. The present study

The scarcity of fine-grained quantitative research concerning patrolling is, in fact, unsurprising, when the practical requirements of such research are considered. The problem is primarily one of data: until recently, systematic recording of police locations at micro level simply did not take place, so that there was no means of systematically measuring the presence of police officers at particular locations. This is the information required to measure patrol 'dosage' – the key concept in assessing policing intensity in space and time – and its absence has traditionally precluded such analysis. Recent years, however, have seen the widespread proliferation among police officers of GPS-enabled devices, via which the required location data can be systematically recorded. The present research seeks to address a number of the questions raised in the previous section by analysing one such dataset.

3.1. Data and pre-processing

The data in question relate to police vehicle movement for one area of a major UK city. In the

recording system used, vehicles are tracked at regular intervals, providing a log of movement as they are used by officers. In addition to locational information, a number of attributes are also recorded, including the speed of travel and 'blue light' status; these are both variables with which the effect of patrolling might be expected to vary. The objective of the research is to examine patrol intensity at the street segment level in terms of both its distribution and its effect on crime.

The first aspect of the research to be discussed will concern a number of technical issues which arise in the study of such data. GPS records of this type are, by nature, subject to significant uncertainty, both in their location and other attributes. Since the research is dependent on reliable association of patrol activity with specific street segments, however, this must be eliminated in order to ensure the validity of results. We will discuss the methods used for data cleaning and the process of associating records with the street network, both of which involve the use of bespoke geo-processing and routing algorithms.

3.2. Patrol distribution analysis

Having discussed the data processing, we will present analysis of the overall spatio-temporal distribution of police patrol activity. The comprehensive nature of the data means that each street segment can be profiled in terms of all visits by police vehicles: the time at which the segment was visited, the travel speed, and whether the vehicle stopped can all be examined. We will demonstrate that the overall distribution of activity displays particular interesting features: certain areas receive disproportionate levels of coverage, and the usage level of some streets conflicts with what would be expected on the basis of their network centrality (such as the network metric 'betweenness'; see Figure 1). We will discuss what can be inferred about both individual officer behaviour and the influence of central command on the basis of these findings.

Figure 1 Street segments coloured according to network betweenness, which provides a first-order estimate of the likely usage levels of each segment during travel through the network.

3.3. Testing and measurement of deterrence

Finally, we will present analysis of the relationship between patrolling and the occurrence of crime. Using data concerning crime events for the same area and time period as the vehicle movement data, each street segment can also be profiled in terms of the exact times at which incidents took place. The relationship between these two event types can therefore be analysed, with the street segment as the

unit of analysis. Figure 2 shows an example of one day's activity for a particular street segment: this exemplifies the non-uniformity typically observed in the temporal distributions. We will present analysis of the dependence between these two distributions, examining in particular the extent to which patrol visits tend to be followed by periods of no criminal activity. The findings of this analysis provide important evidence concerning the residual effect of patrolling. Finally, we will show how the situation can be framed in terms of survival analysis, with patrol activity playing the role of treatment and criminal events representing failures. Preliminary analysis of this type will be presented, and implications for practice subsequently discussed.

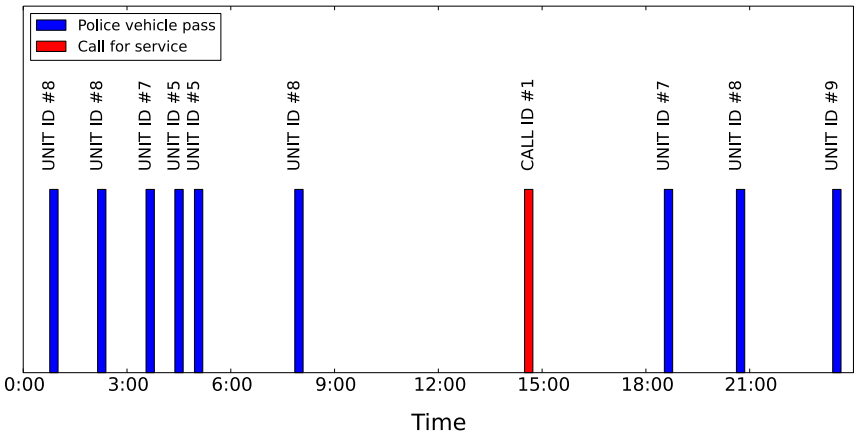

Figure 2 Daily log of both patrol visits and calls for police service on an individual segment: examining the intervals between events allows the deterrent effect of patrol activity to be examined.

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Biography

Toby Davies is a Research Associate working on the Crime, Policing and Citizenship (CPC) project at UCL. His background is in mathematics, and his work concerns the application of mathematical techniques in the analysis and modelling of crime. His research interest include networks and the analysis of spatio-temporal patterns.

Kate Bowers is a Professor in Crime Science at the UCL Department of Security and Crime Science. Kate has worked in the field of crime science for almost 20 years, with research interests focusing on the use of quantitative methods in crime analysis and crime prevention.