Maastricht University

Police and thieves in the stadium: measuring the (multiple) effects of football matches on crime

Citation for published version (APA):

Marie, O. (2016). Police and thieves in the stadium: measuring the (multiple) effects of football matches on crime. *Journal of the Royal Statistical Society Series A-Statistics in Society*, *179*(1), 273-292. https://doi.org/10.1111/rssa.12113

Document status and date:
Published: 01/01/2016

DOI:
10.1111/rssa.12113

Document Version:
Accepted author manuscript (Peer reviewed / editorial board version)

Please check the document version of this publication:

• A submitted manuscript is the version of the article upon submission and before peer-review. There can be important differences between the submitted version and the official published version of record. People interested in the research are advised to contact the author for the final version of the publication, or visit the DOI to the publisher's website.
• The final author version and the galley proof are versions of the publication after peer review.
• The final published version features the final layout of the paper including the volume, issue and page numbers.

Link to publication

General rights
Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

• Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
• You may not further distribute the material or use it for any profit-making activity or commercial gain
• You may freely distribute the URL identifying the publication in the public portal.

If the publication is distributed under the terms of Article 25fa of the Dutch Copyright Act, indicated by the “Taverne” license above, please follow below link for the End User Agreement:

www.umlib.nl/taverne-license

Take down policy
If you believe that this document breaches copyright please contact us at:

repository@maastrichtuniversity.nl

providing details and we will investigate your claim.

Download date: 03 Aug. 2025

Police and Thieves in the Stadium:
Measuring the (Multiple) Effects of Football Matches on Crime

Olivier MARIE [a,b,c,d]

Abstract: Large sporting events affect criminal behaviour via three channels: fan concentration, self-incapacitation, and police displacement. I exploit information on football matches for London teams linked to detailed recorded crime data at the area level to empirically estimate these effects. I find that only property crime increases in the communities hosting matches but not violent offences. There is negative away game attendance effect on crime which is due to voluntary incapacitation of potential offenders attending a match. Police displacement during home games increases property crime by 7 percentage points for every extra 10,000 supporters in areas left under-protected.

Keywords: Crime; Police Displacement; Self-Incapacitation; Football Matches

a – Corresponding Address: Department of Economics, GSBE and ROA, Maastricht University, P.O. Box 616, 6200 MD Maastricht, The Netherlands. Tel: +31 43 388 84605 o.marie@maastrichtuniversity.nl ; *b* - Centre for Economic Performance (CEP), London School of Economics, United Kingdom; *c* - Institute for the Study of Labor (IZA), Bonn, Germany; *d* - CESifo Group, Munich, Germany

"If I were involved in criminality of a more sophisticated kind… would I not work on the assumption that the police will be fully occupied in a particular city - it will not be difficult to find out when these premiership games are being played - and I could go about my unlawful business?"

Question by Mr David Winnick MP to the House of Commons Home Affairs Committee "The Cost of Policing Football", 16 June 2009.

1. Introduction

The impact on local crime rates of hosting large sporting events is complex. It is not limited to the documented increases in violence resulting from (i) the concentration of hostile fans. One must also consider the impact on criminal behaviour of: (ii) the displacement of police personnel sent to monitor the event and (iii) the voluntary incapacitation of a substantial number of individuals who are attending it. Still, most research on this issue has focused on documenting and studying aggressive fan behaviour. This literature has attempted to explain the reasons for the recurring problem of crowd violence during sporting events (see review by Young 2002) with special attention to the phenomenon of hooliganism associated with European football (Dunning *et al*. 1988) which reached its peak in the 1980s. One of several aims of this research will be to investigate if a similar relationship can be observed during or after football matches because of the geographical concentration of rival fans. We are also interested in other possible indirect impacts that hosting sporting events could have on local crime and especially property and other nonviolent offences. This could stem from the possible displacement of law enforcement personnel sent to police a game which could leave other areas under-protected. Another effect is that of some potential offender being voluntarily incapacitated while attending a game.

In this paper we estimate the overall impact of hosting a sporting event on local crime taking into account all these possible impacts on offending behaviour. Because the relationship described is relatively complex, we first develop a conceptual framework to disentangle the different effects through which match attendance and police displacement affect crime. While it is difficult to exactly estimate the

respective impact of concentration, displacement, and self-incapacitation on crime, we can assess their relative influence by making some simple assumptions on their likely impact on various types of offences during either home or away matches. This strategy of differentiating between property and violent crimes is inspired by the work of Jacobs and Lefgren (2003) on the impact of school attendance on juvenile offending. They found that concentration of youths when school is in session increased violent crime but also led to drops in property crime that they attribute to a self-incapacitation effect. With sporting events we can assume that offending behaviour could be affected in a relatively similar manner. We can also consider the difference in impact of the local team playing at home and away since police displacement should only occur when the event is hosted in the area. Finally we can treat each match according to the size of the fan population they attract. When the game is being played away this should only have an impact on the potential numbers of offenders incapacitated during the game. As Dahl and DellaVigna (2009) point out in their study of the impact of violent movies on violent crime, the size of an audience should matter more for criminal behaviour if there is self-selection into attendance. We argue that football fans are a non-random sample of the population with demographic characteristics making them more prone to be potential offenders. Combining all these assumptions we can identify each of the three channels through which sporting events could impact on crime separately.

To empirically investigate this question, we gathered information on the home and away matches of the nine major London football teams with stadiums located in seven different boroughs of the city. We have matched this data to hourly recorded crime from the Metropolitan Crime Statistics System (MCSS) covering 31 London boroughs (one borough, Sutton, did not properly record crimes during this period and had to be dropped) which is available from October 1994 to March 1997. We divide each day into four six hour windows starting at 6 A.M. Almost all matches start either at 3 P.M. or 8 P.M. and consequently fall near the middle of the second and third six hour window of the day defined. To identify a match effect on local criminal activity one also can exploit the variation in location and timing of both home and away games. Since we have extensive information on each game, we will focus our attention on the impact of the large variations in attendance for our identification,

controlling for weather conditions and whether the game is played on a public holiday day. We also include a whole set of controls to net out the possible influence of other matches taking place at the same time as well as the distance of each borough to the stadium hosting a home game and the distance of each away match. We check how the results are affected by controlling for the type of game being played and the outcome of each match as these factors could influence the three effects we seek to identify differently. Finally we consider the issue of possible temporal displacement of criminal activity before and after games. This is important for two reason: first crime rates have been shown to be serially correlated (Jacobs *et al.* 2007) and second, post event criminal activity of an audience could change for psychological reasons (Dahl and DellaVigna 2009 and Card and Dahl 2011). In all the models we estimate we include borough, hour window, day of the week, month, and football season fixed effects to account for unobserved time- and location-specific factors that may be correlated with matches and crime.

We find that the level of property crime increases by roughly 4 percent and falls by about 3 percent for every extra 10,000 supporters attending respectively a home and an away game. Following our conceptual framework we conclude that displacement of police is the factor that contributes most to the rise in property crime, likely because opportunistic offenders in the under protected areas of the borough take advantage of the smaller detection probability. We also conclude that voluntary incapacitation can explain the drop in criminal activity observed when attendance to away matches increases. We find no measureable impact on violent crime in the local community except during a derby match (i.e. when London teams play each other). This suggests some effect of concentration during those matches which are reputedly the ones with the highest levels of animosity between rival fans. As for displacement of crime, there are some signs that violence increases in the period after home games with attendance. This is again consistent with some level of hooligan behaviour between opposing fans after games. We then consider the difference in coefficients between home and away attendance on crime for up to 8 time periods before and after a match. We see then that only differences in property crime with changes in attendance are statistically significant. This leads us to downplay the importance of temporal displacement resulting from sporting events.

These results lead us to conclude that, assuming that voluntary incapacitation has a relatively similar impact during home and away games, the displacement of police forces during football matches increases property crime in London by almost 7 percentage points for every extra 10,000 fans attending a game. This is in line with a growing body of evidence that police presence has an important effect on reducing crime. It also raises important issues of the negative impact of policing of private sporting events at the cost of the local communities wellbeing. It finally demonstrates the importance of considering all the direct and indirect channels which may influence crime when investigating such issues.

The remainder of the paper is structured as follows. The next section presents a conceptual framework for understanding and identifying the match-crime relationship. Section 3 describes the data and the estimation strategy used for the analysis. Section 4 presents and discusses the results. Section 5 concludes.

2. Understanding and Identifying the Match-Crime Relationship

2.1 - Conceptual Framework

There are three channels through which we expect sporting events to influence crime in the local community: concentration, displacement, and incapacitation. We describe in detail each of their likely respective impact below.

2.1.1 Concentration

Concentration is the most obvious channel linking sporting events and crime: the geographical proximity of fans from teams with long standing rivalries is likely to increase the number of volatile interaction between them. In its most extreme form this can lead to the extreme levels of hooligan violence observed during European football matches in the 1980's. More generally we expect that concentration could, on average, increase the incidence of violent offences in the communities which are hosting a game as shown by Rees and Schepnel (2009) during American Football matches in college towns and by Campaniello (2013) in cities hosting games during

the 1990 FIFA World Cup in Italy. When games are played away, it is on the contrary very unlikely that concentration will affect crime in the areas where the teams originally come from.

In the context of large sporting events the potential numbers of violent interactions will increase with attendance levels. It could also depend on a game's outcome which may affect the emotional state of fans to a point of modifying their gain-loss utility perception of participation in violence. Card and Dahl (2011) for example showed that family violence increased after a local American Football team suffered an upset loss (i.e. team was largely odds on favourite to win but loses). Finally, the probability of volatile interactions may also increase with higher levels of rivalry between fans such as during derby games featuring teams from the same city. It is likely that these parameters will be taken into account when local authorities when planning the level of police personnel to deploy around stadiums during each home game. This leads us to consider the possible impact of police displacement during sporting events on local crime activity.

2.1.2 Displacement

There is a growing literature looking at the police-crime relationship using terrorism related events since they sometimes induce a surge in police presence in particular locations (Di Tella and Schargrodsky, 2004 and Draca *et al*. 2011). Exploiting the resulting unexpected displacement in law enforcement personnel is an interesting strategy to measure the impact the police may have on criminal activity. In the case of football matches in England there is also a large increase in police presence around a particular location: the stadiums. However this increase is not the result of unexpected consequences such as a terrorist attack. Consequently one could assume that with proper planning the effect of concentrating police at the stadium should be minimal, and displacement in the area could be avoided.

However, there is documented evidence of a substantial amount of displacement occurring during matches. A report commissioned by the Metropolitan Police Authority (MPA) on the impact of policing football games in London concluded that: "On an average Saturday, 500 officers are lost to their communities policing football

matches throughout the MPA…Football costs the MPA £7.4M in police staffing alone" (MPA, 2003). These estimated 500 officers represent about 7 percent of the police manpower working in London on an average Saturday being deployed to monitor football matches instead of their regular duties. This is a relatively high level of regular displacement, with potentially a lot of variation around this mean, considering that it compares to the exceptional 34 percent local surge in police after the terrorist attacks of July 7 2005 in London (Draca *et al*. 2011).

The MPA report also gives evidence on the large difference in the cost in terms of number of officers deployed at matches depending on the police risk classification of the game played (unfortunately not publically available). These costs almost double when the risk increases with the expected level of attendance at a game and the type of match which will be played. We exploit the variation in crowd attendance at football matches as a proxy for the level of police displacement. The type of game played, regular championship or knockout competition, is also of interest since policing strategy for the latter cannot be as accurately planned as those matches only occur in the event of a win from the local team at each stage of a competition. Note finally that displacement only occurs during home games and that it theoretically could equally affect violent and property crime in the under protected areas of the communities hosting matches.

2.1.3 Incapacitation

Incapacitation is the general term used to express that individuals who are incarcerated or otherwise monitored cannot commit crimes in the community. More recently this definition has expended to other activities in which potential offenders engage more or less voluntarily, keeping them from committing crimes. The impact of self-incapacitation on offending behaviour has been investigated in the context of school attendance and juvenile crime (Jacob and Lefgren, 2003) and violent movie frequentation and the incidence of violence (Dahl and DellaVigna, 2009). In both cases the authors point out that these activities are undertaken by sub-samples of the population which have relatively high propensities of committing crime: the young

and the potentially violent. Can we argue that the same selection is occurring for individuals choosing to attend football matches?

There is little information on who football fans who attend games are apart for some basic demographic characteristics. Still, one of the most widely documented factor explaining the probability of individuals' criminal behaviour is linked to their gender and age profile (Hirshi and Gottferdson 1983 and Hansen 2003). UK arrest data shows that 85 percent of arrested offenders are male and 80 percent are under 30 years old. Surveys of English football supporters (Williams 1997) show that over 50 percent of them are under 30 years of age and nine out of ten are male. This is evidence of the strong demographic similarities between the football fan and the crime committing population. This does not imply that supporters are systematically potential offenders. It suggests that as the attendance and importance of a game grows it is increasingly likely that it will incapacitate certain individuals which would have otherwise been involved in criminal activity.

We assume here that voluntary incapacitation will impact on property and violent crime in a similar way. More importantly we argue that incapacitation influences criminal behaviour during both home and away games. Note that away attendance may mostly vary because of the size of the fan base of the opposite team but it is also likely that more London supporters will try and see their team play bigger rivals. This is supported by the afore mentioned fan surveys which show that fans attempt to travel to as many away games as possible, especially larger teams, or will at least watch the television broadcast of the match (we have collected game viewing figures for this paper but as less than 1 percent of matches used here – 92 out of the 1,147 – were televised and using this information did not improve the analysis). One other important characteristic of football fans is that two thirds of them report that they are born locally (within 20 miles of where their team plays). This is important: if we want to attribute changes in borough crime rates to incapacitation of potential local criminals, matches must attract fans who also reside in the area. To assess the incapacitation impact of a match we exploit the variation in attendance levels to each game, which captures the variation in the degree of incapacitation.

2.2 – Identification Strategy

We summarise the impact of the three potential channels - concentration, displacement, and incapacitation - through which sporting events potentially affect crime in Figure 1. The direction in which sporting events may impact on area crime rates is represented (increase ↑, decrease ↓, no effect →) for the three potential effects by type of offences depending if local team is playing a home or an away game. This depiction of the conceptual framework makes it clear for example that a decrease in property or violent crime during an away game can be attributed to some level of incapacitation. Increases in property crime during home games would be interpreted as the effect of police displacement being stronger than the incapacitation effect. An estimate of the net displacement effect on property crime can be estimated by comparing the impact of home and away games on such offences. Finally, a measure of the impact of concentration can be obtained by comparing the change in property and violent crimes during home games.

[Figure 1 about here]

We return later to the interpretation of separate estimates for each of the effects we are interested in. First we present the simple model, equation (1), we will use to identify the match-crime relationship :

$$C_{at} = \alpha_a + \tau_t + \delta_1 Home_{at} + \beta_1 HomeAtt_{at} + \delta_2 Away_{at} + \beta_2 AwayAtt_{at} + Z_{at} + u_{at} \quad (1)$$

where C is a measure of criminal activity (number of property or violent offences recorded) at time t in area a. α is an area level fixed effect, and τ a set of time specific controls (football season, month, day of the week and six hour time window). *Home* and *Away* are binary variable which take the value one or zero if the team from area a is respectively playing a match at home or away. *HomeAtt* and *AwayAtt* represent the corresponding attendance levels to each of these matches. The δ coefficients will therefore capture the home and away match effects in the boroughs concerned. Our real interest lies in the identification of the β coefficients which will be estimates of

the direction of the variations in attendance on the direction of the effects summarised in Figure 1.

To improve our estimation of the match-crime relationship we also consider a number of other factors which may influence both game attendance and offending simultaneously. The first obvious candidate is the weather which has been proven to change crime patterns (Jacobs, Lefgren, and Moretti [2007]) and is also likely to have an impact on match attendance. We therefore include weather controls in our model measuring daily temperatures and rain falls in London. The day and the hour at which a match is played could also be important. Crime is not evenly distributed during the day and across days of the week. The fans attending afternoon or evening games may also be different and this may change from one season to the next depending on the successes of each team. To attempt and capture all these concerns we include (borough*period of the day*day of the week*month*season) fixed effects in our models. Finally our first model should include a public holiday indicator since such days may also lead to changes in attendance and crime patterns simultaneously.

Other factors which could influence our estimation strategy include: i) the number of home and away game being played at the same time by the 9 London teams we consider which could have an impact on the levels of police displacement and voluntary incapacitation that go beyond just the match and attendances we measure for a single borough; ii) the distance of each London borough to the one where the local team is playing a home game to capture possible geographical displacement effects. Related to this we also may be concerned that the attendance to away games will differ depending on the distance of the host team. We therefore include distance in kilometres to the away game in the models we will estimate for various crime categories.

The type of match and the outcome of a game could also influence crime. We control for the game having been lost when it was expected to be won using pre-match betting odds to test this hypothesis in our context. We also include controls for the goal difference, number of yellow and red cards received during the game, and the match being a derby. We argue that these characteristics of a football match could incite changes in fan behaviour not captured by the size of the crowd attending a game. A last element of interest for our identification is to see if there is a differential

impact of matches on crime if the games were scheduled on short notice. This would be reflected by the impact on local crime of football matches changing as teams move further up a knockout competition. We test this assumption by including at which round of a competition the game being played belongs. All these factors which may influence the match-crime relationship described above are included as a set of control included in *Z* in equation (1).

2.3 - Temporal Displacement

The extensive modelling strategy we describe should enable us to reliably estimate the contemporaneous impact of football matches on local area crime. Still it will not account for possible temporal displacement of criminal activity. This is especially important in the context of analysing violent crime as rival supporters may prefer to engage in aggressive behaviour before or after matches. There are two reasons for this. First they may choose to focus on the sport during the match or in other words prefer voluntary incapacitation over engaging in violent interaction at that time. Second, the risks of detection are the highest in the vicinity of stadiums during the match because of the large number of police forces deployed there. We therefore re-estimate equation (1) but with lagged and forward crime as the dependent variable.

We also investigate how property crime is affected in the time periods surrounding matches. Let us make the assumption that individuals choose to make an optimal number of crime, for example one, each day for financial reasons. If this offender is voluntarily incapacitated during a match because he is following it, he will decide to commit the property crime at another moment during that day. On the contrary, if this criminal is an opportunistic one, he will choose to commit the property offence while police are displaced during a game. The first example would increase property crime before or after matches while the second one would reduce this type of criminal activity outside the game period. The main point here is that the aggregate number of property crimes in a borough would then not change during the entire day. The game effect would only distort the time at which they occur. Another concern is the possibility of offenders coordinating future crimes while they are

together at matches. In this case the quantity of offences would increase in the periods following games more than by the normal daily aggregated level of crime.

Finally, to investigate the possibility of time displacement further we also extend our period of investigation to plus and minus eight six hour periods before and after games. We chose to graphically present the difference between the home and away attendance coefficients ($\beta_1 - \beta_2$) on both property and violent crime for all 17 periods. This will, following our conceptual framework, give direct estimates of the net police displacement and net concentration effects of football matches on crime.

3. Data

3.1- Football Data

We have collected information for all matches for the nine London football teams present in the top two divisions of English football (the Premier League and the First Division) from October 1994 to March 1997 with the help of the Association of Football Statistician. The teams are Arsenal, Charlton Athletics, Chelsea, Crystal Palace, Millwall, Queens Park Rangers, Tottenham Hotspurs, West Ham United, and Wimbledon. As can be seen in Figure 2, these teams have their home stadiums located in seven of the 31 boroughs of London. The teams located in the same boroughs always alternate home and away matches when playing at the same time which therefore does not pose problems for our modelling strategy. We have a total of 1,147 games played by our nine London teams during this time period. We drop from the data days which fall out of the football season which runs from mid-August to mid-May.

[Figure 2 about here]

Figure 3 shows the levels of attendance for each of the nine London teams with the top panel for home games and the bottom panel for away matches. The average attendance level across team for this period is roughly 20,000 spectators for both

types of games. However the Figures show how this varies greatly between teams and also from one match to the next. This is an important feature for our identification strategy which relies on changes in attendance levels across time.

[Figure 3 about here]

For each match we have detailed information on its type and outcome. We have the final score and goal difference for each match. We use the predicted outcome of each game by bookmakers (based on the Elo ratings system) to classify if a game was an upset loss or not. For the matches which are competitions - i.e. not regular schedule games part of the national championship -, we have up to ten rounds to reach a final. We gathered information on the number of yellow and red cards handed out by the referee during each game. We know the location of away matches and use it to estimate the distance fans have to travel.

Table 1 reports the main summary statistics for these matches and shows an almost even distribution between home and away games in our sample. Although most games are played on Saturday afternoon the distribution is still relatively dispersed with for example 17 percent of matches on Wednesday evenings. The distribution is also quite evenly distributed across borrows where the major London football teams are located. Finally, a significant number of matches are derbies (7%), competitions (17%), and upset losses (5%) which will be useful for our identification of the various effects these games could have on crime.

[Table 1 about here]

3.2 – Crime Data

The football data was matched at the borough level to hourly recorded crime from the Metropolitan Criminal Statistics System (MCSS). The database includes all crimes recorded in London by the police and contains information on the borough where the offence took place and the estimated time at which it was committed. We can differentiate between property (burglaries, theft and handling of stolen goods, and

criminal damage) and violent (violence against the person, sexual offences, and robberies) crime categories. This is to our knowledge the most geographically detailed and high frequency crime data available in the UK for this period. We generate from the timing of crime information four equal six hours periods which run from 6 A.M. one day to the same hour on the following day. The six hours window was chosen because this is the time officers are assigned to a home match (House of Commons Home Affairs Committee, 2009) and would accounts for the appropriate time during which there is within borough police displacement. A football game lasts more or less two hours and the six hours window therefore also captures the two hours before and after a match when a potential offender could be incapacitated with pre- and post-match activities.

[Table 2 about here]

Table 2 reports the mean number of crimes recorded for different categories in the seven boroughs where football teams are located. It shows the statistic by period of the day and whether there was no game, a home game, or an away game in the borough. We can see that most crimes recorded are property crimes and that the levels are much higher for this category during the afternoon rather than the evening hours. The large standard deviations suggest large variations in the number of recorded offences across periods and areas. The over-dispersion of the number of crimes committed is a common feature of area level crime data at high frequency. It is thus important, from an econometric standpoint, to use an estimation strategy that takes into account the particular distribution of our data.

3.3 - Estimation Strategy

While the simplest methodology is to estimate ordinary least-squares (OLS) models using the number of recorded crime, this strategy has several problems. Because criminal incidents are positively skewed, it is common to transform the data using log or log rates. However, because we are using six-hourly data for individual boroughs there are a non-trivial number of zeros in the data complicating the use of log rates,

particularly when focusing on individual crime categories (there are 3.4 percent hour-window/borough cells when no property crimes were recorded but almost 37.5 percent with no violent crimes reported). In order to address this concern we use a negative binomial regression model first developed by Greenwood and Yule (1920). It is a generalisation of the Poisson regression model that allows for the variance of the outcome measure to differ from the mean, making it appropriate for count data with over-dispersion. In view of the panel structure of our data we want to allow for both the possibility of permanent unobserved area effects as well as the possibility that these area effects are correlated with matches and other explanatory variables. We therefore use the fixed effects negative binomial developed by Hausman *et al*. (1984) which assumes that Poisson parameter λ_{at} follows a gamma distribution with parameters (γ, δ) and specifies $\gamma = e^{X_{at}\beta}$ with δ common both across areas and across time. We will throughout estimate the following negative binomial distribution:

$$\mathrm{pr}(C_{at}) = \frac{\Gamma(\gamma_{at} + C_{at})}{\Gamma(\gamma_{at})\Gamma(C_{at} + 1)}\left(\frac{\delta}{1+\delta}\right)^{\gamma_{at}}(1+\delta)^{-C_{at}} \qquad (2)$$

The coefficients we will derive from equation (2) represent the effects of the independent variables on the log of the mean incidence and can therefore be interpreted as the percentage effect of the independent variables on crime.

There are only seven boroughs in our data which will be identifying game attendance 'treatment' as their local teams are playing home or away which raises the question of the validity of using the other 24 London areas which for our analysis. There are two reasons why it seems appropriate to keep all the available boroughs in our analysis. First is simply that although the areas with no teams will not contribute to the identification of our estimates of the game attendance coefficients, they do help us to estimate the other covariates with greater precision. The fixed effect nature of our models also guarantees that we are estimating match attendance impacts on crime within borough that are not be affected by using the areas with no local football teams. The second reason is our concern with potential spatial displacement issues: the possibility that areas without a local team may be affected by match attendance in other boroughs. Fan concentration, police displacement, and voluntary incapacitation

may impact on the criminal activity of these areas although in a way which is difficult to conceptually describe. We can however assume that if there such an indirect impact should be stronger for boroughs closer rather than further away from treated areas. This is why we have included controls for measures distances to boroughs with home and away games in our models.

4. Results

4.1 – Changes in Crime During Matches

The first results in column (1) of Table 3 present negative binomial regression estimates with fixed effects, holiday and weather controls in which the dependent variable is the total number of recorded crimes. We build up from this model and add sequentially dummies for number of other games in column (2), total attendance level at those games in column (3), and finally distance measures for each borough to areas hosting a match and distance to away games played by a local team in column (4). The main finding is that we observe throughout a positive and significant home attendance effects. The coefficient on the home game dummy is significant once we control for information about other London team's matches and captures the raw impact of hosting a match on the crime rate in a borough. Our identification stems from the variations in attendance and we see in column (4) that an extra 10,000 fans at a home game lead to a 4 percent increase in crime. We find so far no impact of away attendance levels on criminal activity. The importance of considering different offence categories is highlighted in columns (5) and (6) which report results for property and violent crimes. We find that all the match effect on crime we observe comes from changes in the recorded property offences. There is also now a significant decrease in the numbers of property crimes committed when a local team is playing away suggesting some level of incapacitation as attendance to those games grows.

[Table 3 about here]

We consider more detailed crime categories in the results reported in Table 4. The results show that all the home and away game effects on property offences stems from the number of thefts committed during matches. There is no sign of changes in burglaries and importantly, criminal damage, which could be argued to be an atypical property crime that may increase as a result of the concentration effect. Also we still find no evidence of changes in violent crimes apart from the home game 'intercept' is now marginally significant. The increase in the number of recorded thefts almost entirely comes from changes in thefts from and of motor vehicles and thefts from shops but not from thefts from the person (which would be recorded as a robbery if any threat or violence was used). This evidence is very useful for us to reject a potential fourth channel in which football matches could impact on local crime by increasing the number of potential victims. This supply side mechanism does not hold as shops and motor vehicles (all stadiums have adjoined car parks and most fans use public transport) are in relative constant supply in comparison to the massive change in number of individuals who could be targeted during a game, the kind of crime for which we see no effect. We therefore interpret the strong coefficients associated with the theft category during home and away match attendance as a sign that a combination of displacement and voluntary incapacitation is at play in the match-crime relationship.

[Table 4 about here]

Results from models which include a large number of information on matches outcome and type are reported in Table 5. We still observe our main finding of increases (decreases) of property crimes as attendance to home (away) games grows. However all the other game controls we include do not appear to change the levels of property offences committed during matches. This is also what we find for almost all the match outcome and type variables we add to the model for violent crime. We are more surprised by this result since we assumed many of these match outcome controls could have psychological influence over fan violent behaviour. The most interesting result in Table 5 is the large and significant increase in violence when an area is hosting a derby game. This suggests that concentration could play a role in increasing

the number of violent interactions but only when the level of rivalry between opposing fans is high.

[Table 5 about here]

4.2 – Changes in Crime Before/After Matches

We now turn to considerations of possible temporal displacement of criminal activity in Table 6. These tables report results from the same model as Table 5 but for the six-hour periods just before and just after each game. The first four columns of Table 6 show that during these time windows there does not appear to be any game attendance impact on property crimes. This confirms that there is no time displacement in property offences over a match day and that the changes estimated previously during a match are absolute increases (during home games) and decreases (during away games). The picture for violent crime is different and the results are reported in the last four columns of Table 6. The number of recorded violent offences increase by 10 percent for every 10,000 extra fans after home matches. This is again a net increase over the day as we did not observe a matching decrease in crime over the other time periods. This is evidence that the voluntary incapacitation of potential offenders ends after a game and leaves way for the violent encounters predicted by the concentration effect.

[Table 6 about here]

Limiting possible temporal displacement to only the short time window around a game may not capture all the distortionary it may have on crime. Jacobs *et al.* (2007) showed that extreme weather shocks inversely displace crime in the following week. We therefore consider the possibility of a match effect up to 8 periods before and after games. The conceptual framework we designed to identify the various channels of the match-crime relationship (Figure 1) indicates that we can obtain estimates of the net displacement and net concentration effects by comparing the home (β_1) and away (β_2) game attendance effects for respectively property and violence offences. We therefore

compute estimates of the difference in attendance coefficients ($\beta_1 - \beta_2$) from the for the 17 six-hour periods of interest. The generated estimates are reported with +/- two standard errors in Figures 4 for property (top graph) and violent (bottom graph) crimes. The difference in game attendance effect *during* a match is at 0 on the axis with preceding and following six hour time windows going from -8 to +8. We find that the estimated effect is only statistically significant for property offences at the time when a match is taking place. The lack of any other effect identified for the difference of the home and game attendance coefficients leads us to several conclusions. First there appears not to be any noticeable temporal displacement of property or violent offence as a result of football matches. Second the observed increase in violence just after home matches is not precisely estimated enough to be significant. Finally the main finding from this research remains the important estimated contemporaneous increases in local property crime resulting from hosting large sporting events.

[Figures 4 about here]

4.3 Changes in Crime: Which of the Three Channels?

Following our conceptual framework we are able to distinguish between three channels (concentration, incapacitation, and displacement) by which football matches may impact on local crime rate. There are some signs of a concentration effect but only just after a home match was played where we observed increases in violent crime. The voluntary incapacitation effect on property crime during matches is estimated from the negative coefficient of away attendance at -.003.

Assuming a relatively similar level of incapacitation effect per supporter during home games, we are able to identify the net police displacement effect. This is equivalent to taking the ($\beta_1 - \beta_2$) coefficients at period zero in Table 5 gives us -.007 with an associated standard error of .002. It translate into property crime increases of 7 percent in a borough hosting a home game for every 10,000 extra fans attending and this is mainly of result of the displacement of law enforcement personnel policing the

event. In absolute term this represents an extra 1.5 property crimes committed in a borough hosting a match during the six-hour period around the game.

5. Conclusion

We show in this paper that the impact large sporting events may have on criminal activity is more complex than the simple effect they could have on the violent behaviour of fans. We develop a conceptual framework to understand the match-crime relationship which considers all the direct and indirect effects sporting events may have on offending behaviour. We describe three possible channels which are the geographical concentration of rival fans, the displacement of police personnel, and the voluntary incapacitation of potential offenders. Making simple assumptions we are able to determine the likely impact of each of these effects on local area crime during home and away games on property and violent crime. We the attempt to identify them separately by exploiting the variation in attendance to games from nine London teams located in seven different boroughs of the city.

Perhaps surprisingly, considering the amount of anecdotal evidence on the aggressive behaviour, we do not uncover any effect of football matches on area violent crime. There is however some evidence that the number of violent interactions is more frequent when the rivalry between opposite supporters is higher. The results also suggest that if the concentration effect is responsible for increases in violent crime, it is only in the hours after the game is over. This could be explained by the displacement and incapacitation effects only impacting on criminal behaviour during matches. However this evidence is relatively weak and we do not believe that football matches in London contribute to substantial changes in violent behaviour.

The main finding of this research is that home game attendance significantly increases property crime in the borough hosting the event. On the contrary when teams are playing away, an inverse relationship is observed with property crime dropping as away attendance increases. We find no evidence of inter-temporal substitution of property crime even after extending the sample period of analysis to up to two days before and after the event. We calculate that voluntary incapacitation is responsible of a drop of 3 percent in the incidence of property crimes in a team home

borough for every extra 10,000 fans attending an away match. Using this estimate we are able to evaluate a net police displacement effect of 7 percentage point increase in property crimes in the host community.

These findings show how crucial it is to distinguish between the different channels though which certain events may impact on criminal behaviour. In our case, how important is the effect on crime of the incapacitation of the potential thieves attending a match relative to the displacement of police to the stadium. These results will also fuel the ongoing public policy debate about who should 'pay for police' during football matches in the UK. They do not however clearly answer this question since reduced property crime levels during away games could be seen as socially beneficial although one could argue that it is only displacing the cost to other communities.

More importantly, the surprising result of no changes in violent behaviour during matches – except during derbies where the emotional state of fans is arguably the 'the most volatile – suggests that the high levels of police deployed is successful in containing group violence behaviour. Indeed, recent research by Poutvaara and Priks (2009) and Priks (2014) has shown that good policing practices in stadium have a strong impact on hooligan violence. One could therefore conclude to some social benefits of the police being displaced to stadiums although this should of course not be at the cost to the rest of the community. This is especially true in large metropolitan areas where resources are so stretched that it may be difficult to control both crowds at stadiums and guarantee law and order in other parts of the city.

Acknowledgment: I would like to thank Arnaud Chevalier, Thomas Dohmen, Stephen Machin, Christian Traxler, Jonathan Wadsworth and audiences at seminars at the London School of Economics, the University of Surrey, Maastricht University, the RES, ESPE, and EALE/SOLE Conference for useful discussion and comments. I am extremely grateful to Mark Baber from the Association of Football Statisticians (AFS) for his help in gathering the football match data and Bill Hunter from Mables-Tables.com for providing me with the Elo ratings data for each game. This research was made possible thanks to funding from the Netherlands Organization for Scientific Research (NWO Veni Grant 451.12.005).

References

Campaniello, N. (2013) Mega Events in Sports and Crime: Evidence from the 1990 Football World Cup. *Journal of Sports Economics*, **14**, 148-170.

Card, D. and Dahl G. (2011) Family Violence and Football: The Effect of Unexpected Emotional Cues on Violent Behavior. *Quarterly Journal of Economics*, **126**, 103-143.

Dahl, G. and DellaVigna S. (2009) Does Movie Violence Increase Violent Crime? *Quarterly Journal of Economics*, **124**, 677-734.

Di Tella, R. and Schargrodsky E. (2004) Do Police Reduce Crime? Estimate Using the Allocation of Police Forces after a Terrorist Attack. *American Economic Review*, **94**, 115-133.

Draca, M., Machin, S. and Witt, R. (2011) Panic on the Streets of London: Police, Crime and the July 2005 Terror Attack," *American Economic Review*, **101**, 2157–2181.

Dunning, E., Murphy, P. and Williams, J., (1988) *The Roots of Football Hooliganism. A Historical and Sociological Study*, London: Routledge and Kegan Paul.

Greenwood, M. and Yule, G. U. (1920) An Enquiry Into the Nature of Frequency Distribution of Multiple Happenings. *Journal of the Royal Statistical Society, Series A*, **83**, 255-279.

Hansen, K. (2003) Education and the Crime-Age Profile, *The British Journal of Criminology*, **43**, 141-168.

Hausman, J., Bronwyn H. and Griliches, Z. (1984) Econometric Models for Count Data with an Application to the Patents-R&D Relationship. *Econometrica*, **52**, 909-938.

Hirschi, T. and Gottfredson, M. (1983) Age and the Explanation of Crime. *American Journal of Sociology*, **89**, 552-584.

House of Commons Home Affairs Committee (2009) The Cost of Policing Football Matches. *HC 676*, London: The Stationary Office Ltd

Jacob, B. A. and Lefgren L. (2003) Are Idle Hands the Devil's Workshop? Incapacitation, Concentration and Juvenile Crime. *American Economic Review*, **93**, 1560-1577.

Jacob, B. A., Lefgren, L. and Moretti, E. (2007) The Dynamics of Criminal Behaviour: Evidence from Weather Shocks. *Journal of Human Resources*, **42**, 489-527.

Metropolitan Police Authority (2003) Football Club Recharges. *MPA Report N. 08*. (Available from http://www.mpa.gov.uk/committees/x-f/2003/030116/08/)

Poutvaara, P. and Priks, M. (2006) The Effect of Police Intelligence on Group Violence: Evidence from Reassignments in Sweden. *Journal of Public Economics*, **93**, 403-411.

Priks, M. (2014) Do Surveillance Cameras Affect Unruly Behavior? A Close Look at Grandstands. *The Scandinavian Journal of Economics*, **116**, 1160–1179.

Rees, D. I. and Schnepel, K. T. (2009) College Football Games and Crime. *Journal of Sports Economics*, **10**, 68-97.

Williams, J. (1997) FA Premier League Fan Survey: National Surveys of FA Premier League Club Fans 1994-1997, General Sample Report. Sir Norman Chester Centre for Football Research.

Young, K. (2002) Sport and Violence. In *Handbook of Sports Studies*. (J. Coakley and E. Dunning), pp. 382-408. London: Sage Publications.

Table 1: Summary Statistics of Football Matches

	Number of Games	Fraction of Games
All Games	1147	1
Home Games	571	.502
Away Games	576	.499
London Derbies	81	.071
Competitions	98	.172
Upset Losses	53	.046
Saturdays (12-18h)	616	.537
Sunday (12-18h)	107	.093
Other Days (12-18h)	60	.052
Wednesday (18-00h)	193	.168
Tuesday (18-00h)	114	.099
Other Days (18-00h)	57	.050
Croydon	263	.229
Greenwich	131	.114
Hammersmith	247	.215
Haringey	121	.106
Islington	134	117
Lewisham	134	.117
Newham	117	.102

Note: Summary statistics for the 1147 games played by the 9 London teams between October 1994 and March 1997. Upset losses are defined as the home team losing at a home or away game although the advantage in terms of Elo ratings was > 100.

Table 2: Mean Number of Crimes per Hour Window

	Mean Number of Crimes (Standard Deviations)					
	12 to 18 Hours			18 to 00 Hours		
	No Game	Home Game	Away Game	No Game	Home Game	Away Game
All Crimes	29.48 (11.81)	30.99 (13.85)	29.13 (13.24)	20.37 (8.76)	21.83 (8.93)	20.13 (9.68)
Property Crimes	20.94 (8.85)	23.70 (11.04)	21.60 (10.61)	12.06 (5.55)	14.36 (5.76)	12.45 (5.63)
Burglaries	6.48 (4.07)	6.65 (4.41)	6.52 (4.08)	4.16 (3.06)	3.85 (2.59)	3.82 (2.89)
Thefts	14.25 (6.69)	16.79 (8.61)	14.89 (8.33)	7.65 (3.98)	10.27 (4.58)	8.41 (3.93)
Criminal Damage	0.20 (0.57)	0.26 (0.74)	0.18 (0.48)	0.24 (0.61)	0.25 (0.51)	0.23 (0.54)
Violent Crimes	7.40 (5.56)	6.28 (5.22)	6.63 (5.64)	7.15 (5.37)	6.35 (5.10)	6.86 (5.90)
Violence	3.86 (3.97)	3.72 (3.77)	3.82 (4.17)	4.26 (4.32)	3.90 (4.00)	4.18 (4.21)
Sexual offences	0.34 (1.09)	0.24 (0.84)	0.22 (0.81)	0.30 (0.97)	0.19 (0.74)	0.27 (0.97)
Robberies	3.20 (1.17)	2.32 (3.04)	2.59 (3.34)	2.59 (2.96)	2.26 (3.13)	2.41 (3.27)
Sample	**5,007**	**391**	**392**	**5,315**	**180**	**184**

Note: The reported means are generated from the 7 boroughs which are home to one of the 9 teams since there are no equivalent for the home and away columns for the other boroughs.

Table 3: Impact of Home and Away Games and Attendance Levels on Total Number, Property, and Violent Crimes Reported to the Police

	Dependent Variables = Number of Crimes Reported					
	All Crimes				Property	Violent
	(1)	(2)	(3)	(4)	(5)	(6)
Home Game Dummy	.009	.054*	.086**	.084**	.136***	.104
	(.033)	(.033)	(.040)	(.040)	(.041)	(.095)
Home Game Attendance (in Thousands)	.003*	.003*	.004**	.004**	.004**	.002
	(.002)	(.002)	(.002)	(.002)	(.002)	(.004)
Away Game Dummy	-.023	.019	-.008	-.020	-.011	.055
	(.031)	(.032)	(.038)	(.042)	(.040)	(.092)
Away Game Attendance (in Thousands)	-.000	-.001	-.001	-.002	-.004**	.002
	(.001)	(.001)	(.001)	(.002)	(.002)	(.004)
Dummy Number of Other Home and Away Games	No	Yes	Yes	Yes	Yes	Yes
Attendance to Other Home and Away Games	No	No	Yes	Yes	Yes	Yes
Distance from Borough of Home and to Away Games	No	No	No	Yes	Yes	Yes
Holiday Indicator	Yes	Yes	Yes	Yes	Yes	Yes
Rain and Temperature	Yes	Yes	Yes	Yes	Yes	Yes
Borough * Hour * Day of the Week * Month * Season Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	43,896	43,896	43,896	43,896	43,896	43,896

Notes: An observation is a six hour period 12 to 18 H or 18 to 00 H for the 31 London boroughs during the football season (mid –August to mid-May) between September 1994 and October 1997. The estimates come from negative binomial regressions, standard errors are in parenthesis. *, **, and *** respectively denote significance at the 10, 5, and 1 percent level.

Table 4: Impact of Home and Away Games

and Attendance Levels on Various Types of Crimes Reported to the Police

	Dependent Variables = Number of Crimes Reported for the Following Categories					
	Property Crime			Violent		
	Theft	Burglary	Criminal Damage	Violence	Sexual	Robbery
Home Game Dummy	.192***	.026	.124	.203*	-.517	.183
	(.046)	(.073)	(.263)	(.121)	(.428)	(.145)
Home Game Attendance (in Thousands)	.006***	-.001	.002	.001	.006	-.008
	(.002)	(.003)	(.011)	(.005)	(.017)	(.006)
Away Game Dummy	.040	-.102	.168	.133	-.263	.005
	(.050)	(.074)	(.290)	(.119)	(.418)	(.139)
Away Game Attendance (in Thousands)	-.006***	.002	-.015	.005	-.020	.003
	(.002)	(.003)	(.012)	(.005)	(.015)	(.005)
Other Games and Distance Controls	Yes	Yes	Yes	Yes	Yes	Yes
Holiday and Weather Indicators	Yes	Yes	Yes	Yes	Yes	Yes
Borough * Hour * Day of the Week * Month * Season Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	43,896	43,896	43,896	43,896	43,896	43,896

Notes: An observation is a six hour period 12 to 18 H or 18 to 00 H for the 31 London boroughs during the football season (mid –August to mid-May) between September 1994 and October 1997. Other games and distance controls are: dummy for number of home and away games played by London teams at the same time; attendance level to other home and away games played by London teams at the same time; distance (in Km) of home game played to all London boroughs; and distance (in Km) from a team's borough to away game played. The estimates come from negative binomial regressions, standard errors in parenthesis. *, **, and *** respectively denote significance at the 10, 5, and 1 percent level.

Table 5: Impact on Property and Violent Crime of Home and Away Games and Attendance Levels Controlling for Match Characteristics

	Dependent Variables = Number of Crimes Reported			
	Property Crime		Violent	
	Home	Away	Home	Away
Game Dummy	.139***	.014	.126	.013
	(.042)	(.047)	(.097)	(.097)
Game Attendance	.004**	-.003*	.001	.002
	(.002)	(.002)	(.005)	(.004)
Lose Game Upset	-.019	-.087	.127	-.050
	(.079)	(.091)	(.211)	(.231)
Goal Difference	.015	-.000	-.052	-.023
	(.019)	(.021)	(.051)	(.052)
Number of Cards	-.002	-.008	.005	-.026
	(.008)	(.012)	(.018)	(.031)
London Derby	-.005	-.069	.184*	.168
	(.042)	(.052)	(.100)	(.114)
Competition Round	-.001	-.016	-.035	-.015
	(.012)	(.012)	(.030)	(.025)
Other Games and Distance Controls	Yes		Yes	
Holiday Indicator	Yes		Yes	
Rain and Temperature	Yes		Yes	
Borough * Hour * Day of the Week * Month * Season Fixed Effects	Yes		Yes	
Observations	43,896		43,896	

Notes: The Home and Away coefficients by crime type are estimated from the same model but reported next to each other for convenience. An observation is a six hour period between 12 to 18 H or 18 to 00 H for the 31 London boroughs during the football season (mid – August to mid-May) between September 1994 and October 1997. Other games and distance controls are: dummy for number of home and away games played by London teams at the same time; attendance level to other home and away games played by London teams at the same time; distance (in Km) of home game played to all London boroughs; and distance (in Km) from a team's borough to away game played. The estimates come from negative binomial regressions, standard errors in parenthesis. *, **, and *** respectively denote significance at the 10, 5, and 1 percent level.

Table 6: Time Displacement of Crime – Impact of Home and Away Attendance Levels Controlling for Match Characteristics

	Dependent Variables = Number of Property Crimes Reported							
	Property Crimes				Violent Crimes			
	Before		After		Before		After	
	Home	Away	Home	Away	Home	Away	Home	Away
Game Dummy	-.021 (.081)	.011 (.086)	-.007 (.081)	.006 (.084)	.108 (.123)	-.065 (.126)	-.008 (.121)	.107 (.131)
Game Attendance	.002 (.004)	-.003 (.003)	.003 (.004)	-.001 (.003)	.009 (.006)	.004 (.005)	.010* (.006)	-.002 (.005)
Lose Game Upset	.074 (.180)	-.054 (.183)	.077 (.187)	.081 (.172)	-.334 (.296)	-.365 (.329)	.030 (.267)	-.291 (.278)
Goal Difference	-.031 (.040)	.019 (.043)	.054 (.042)	-.012 (.045)	-.073 (.070)	-.014 (.069)	.072 (.056)	-.046 (.066)
Number of Cards	.009 (.015)	-.009 (.023)	.018 (.014)	-.028 (.021)	-.034 (.024)	-.023 (.040)	-.026 (.023)	-.018 (.034)
London Derby	-.061 (.088)	.038 (.095)	-.040 (.086)	.033 (.097)	-.199 (.143)	.017 (.145)	-.158 (.132)	.029 (.141)
Competition Round	.012 (.003)	-.015 (.021)	.033 (.022)	-.004 (.021)	-.021 (.034)	-.015 (.031)	-.021 (.034)	-.012 (.032)
Other Games and Distance Controls	Yes		Yes		Yes		Yes	
Holiday and Weather Indicators	Yes		Yes		Yes		Yes	
Borough * Hour * Day of the Week * Month * Season Fixed Effects	Yes		Yes		Yes		Yes	
Observations	43,880		43,880		43,880		43,880	

Notes: The Home and Away coefficients by crime type are estimated from the same model but reported next to each other for convenience. An observation is a six hour period between 12 to 18 H or 18 to 00 H for the 31 London boroughs during the football season (mid –August to mid-May) between September 1994 and October 1997. Other games and distance controls are: dummy for number of home and away games played by London teams at the same time; attendance level to other home and away games played by London teams at the same time; distance (in Km) of home game played to all London boroughs; and distance (in Km) from a team's borough to away game played. The estimates come from negative binomial regressions, standard errors in parenthesis. *, **, and *** respectively denote significance at the 10, 5, and 1 percent level.

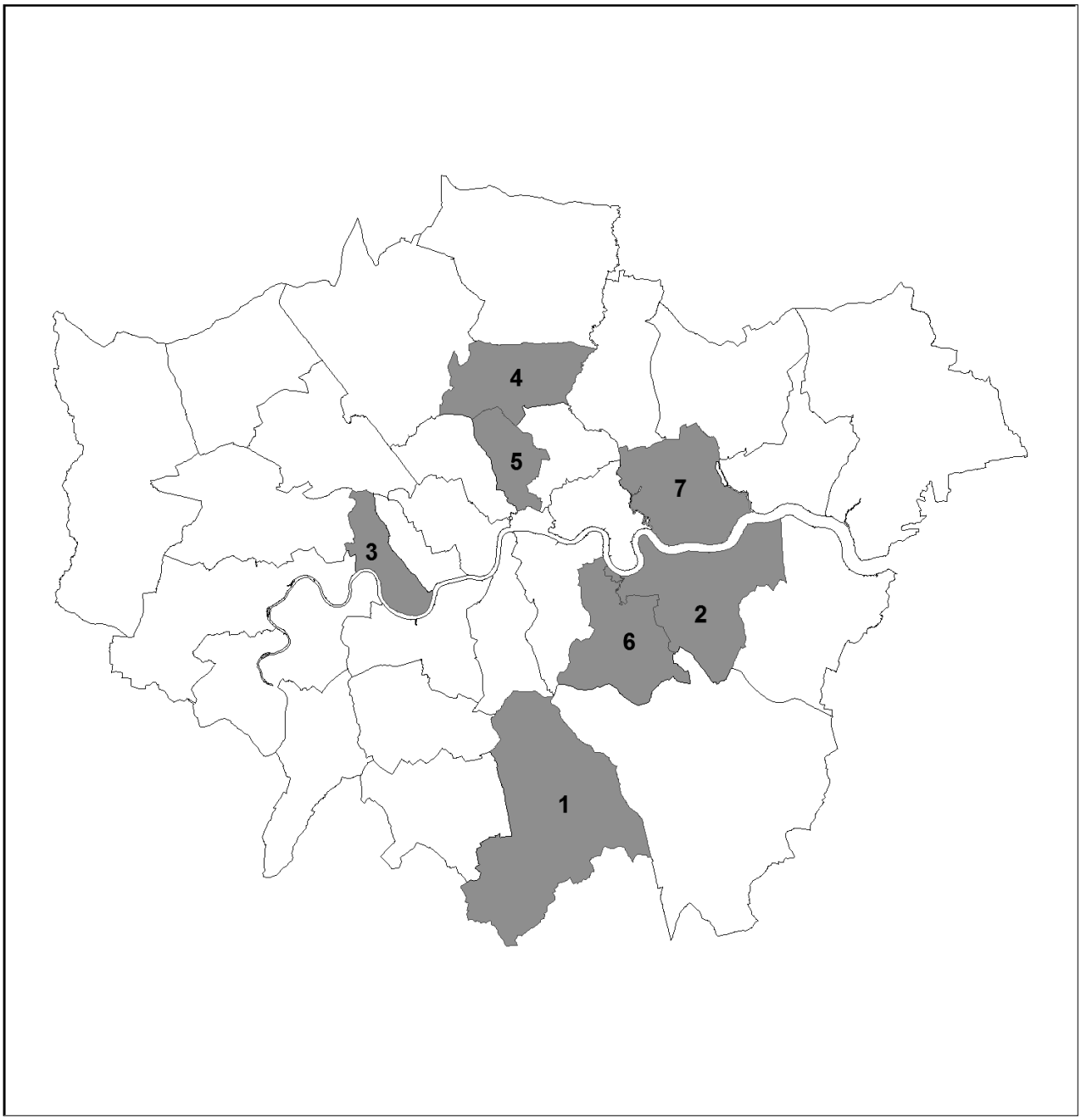
Figure 1: Potential Direction of Displacement, Incapacitation, and Concentration Effects on Property and Violent Crimes during Home and Away Games

	Property		Violent	
	Home	**Away**	**Home**	**Away**
Displacement	↑	→	↑	→
Incapacitation	↓	↓	↓	↓
Concentration	→	→	↑	→

Note: Upward and downward pointing arrows represent respectively positive and negative impact from each of the three channels - concentration, incapacitation, displacement- through which home or away sporting events may impact one local property or violent crime. The flat arrows suggest that we do not expect any effect during home or away games for the corresponding crime category.

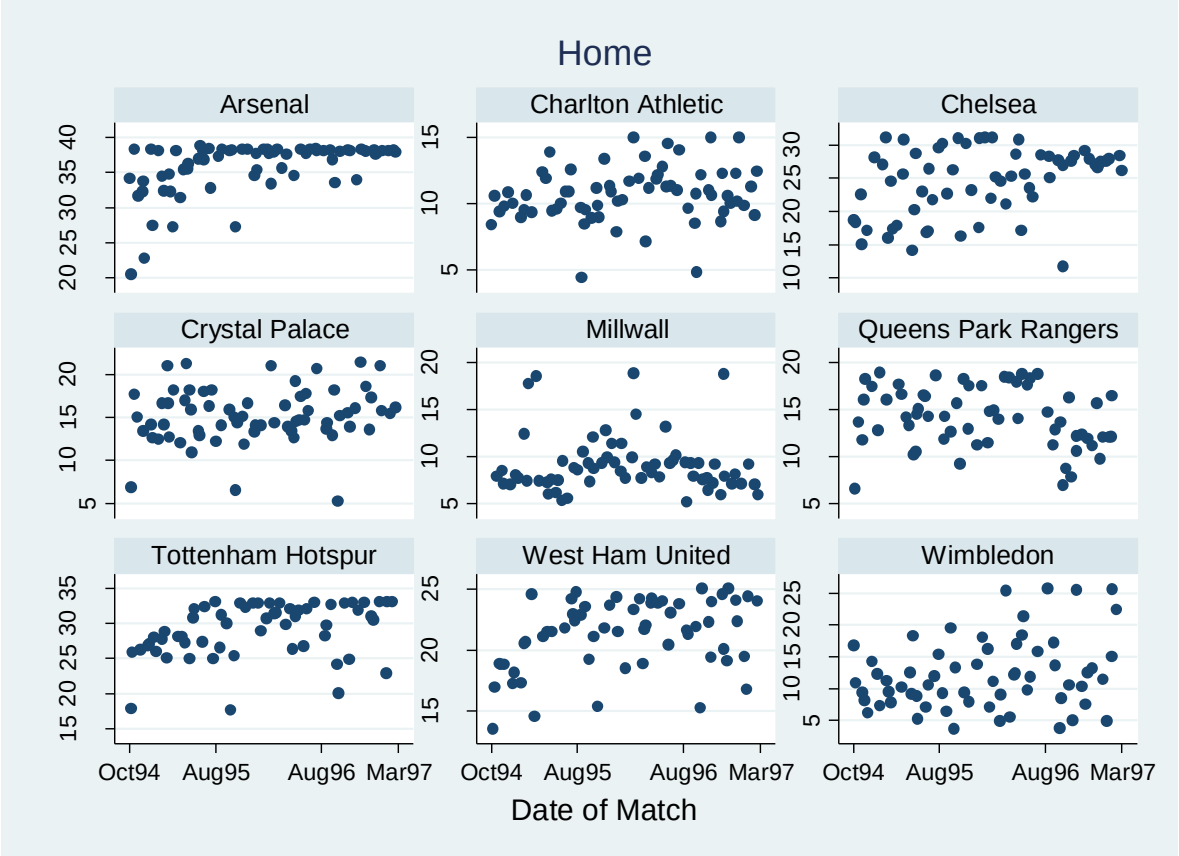
Figure 2: Map of London Boroughs

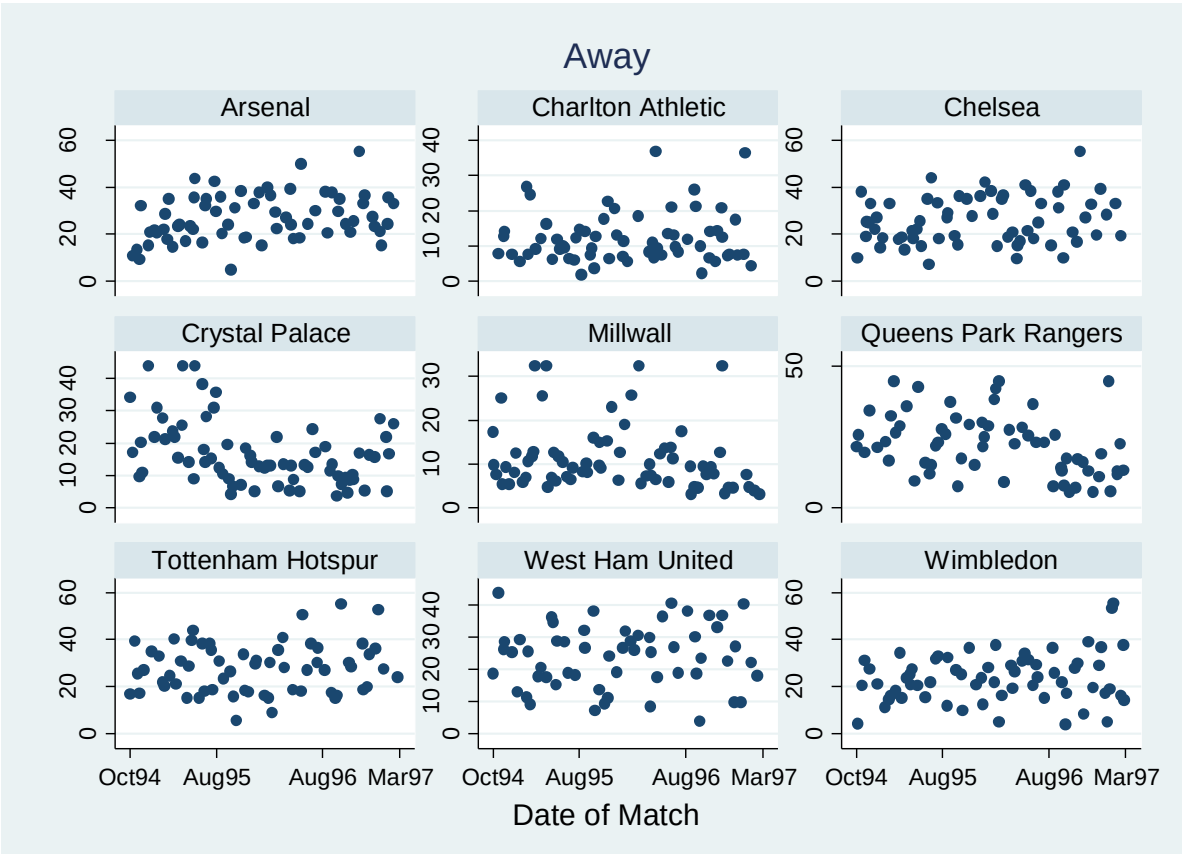
with Football Grounds and Associated Football Teams



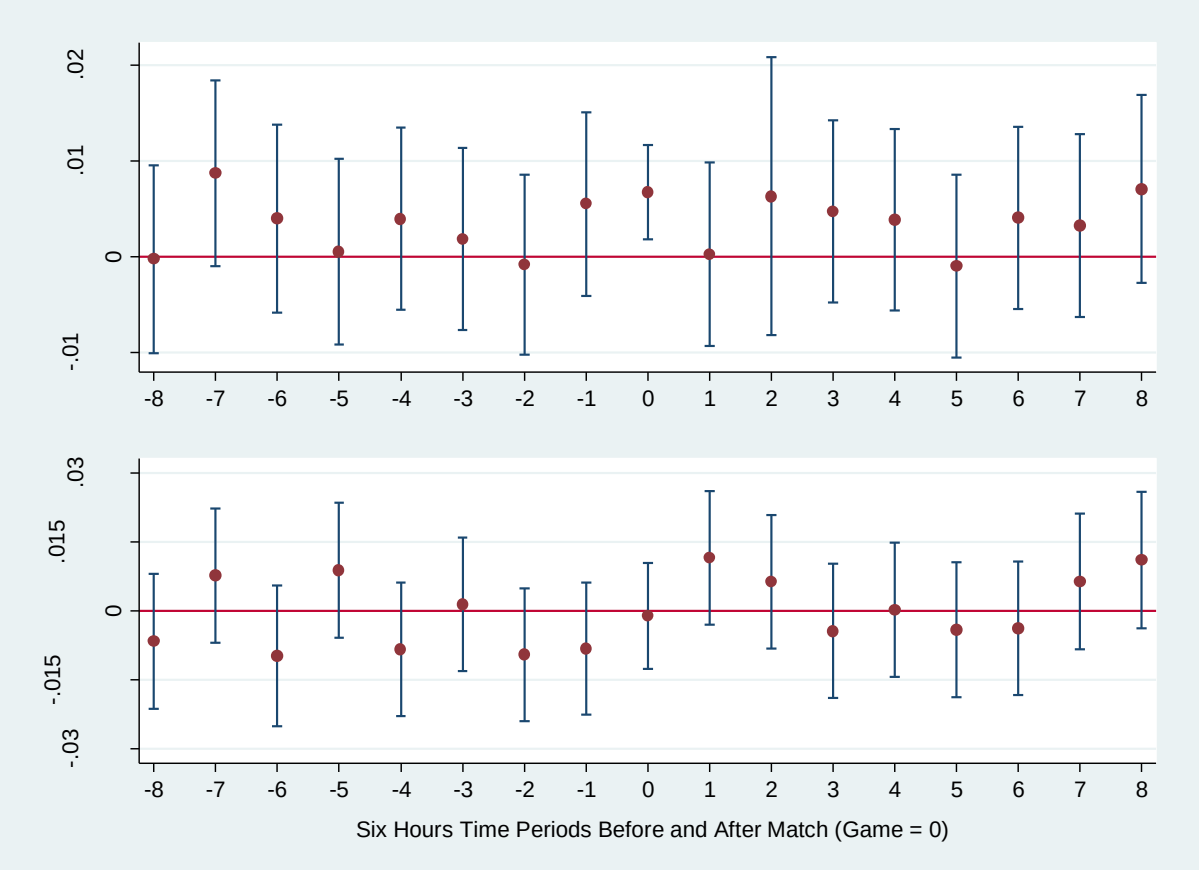
	Borough	Team(s)
1	Croydon	Crystal Palace & Wimbledon
2	Greenwich	Charlton Athletics
3	Hammersmith & Fulham	QPR & Chelsea United
4	Haringey	Tottenham Hotspur
5	Islington	Arsenal
6	Lewisham	Millwall
7	Newham	West Ham United

Figure 3: Home and Away Match Attendance Levels by Football Team





Figures 4: Estimated Displacement (Property Crime – Top Graph) and Concentration (Violent Crime – Bottom Graph) Effects of Football Matches for 8 Periods Before and After A Game



Note: Each point represents the difference between the home and away attendance coefficients ($\beta_1 - \beta_2$) for regression on property crime in the top graph and violent crime in the bottom graph. These are shown with +/- two standard errors for the 8 six hour windows surrounding a match and for the game time itself at 0. Following our conceptual model presented in Figure 1, the property crime results are estimates of the net displacement effect of matches on property crime and the violent crime results are estimates of the net concentration effect.