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MATCHES ON CRIME

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**HOW TIME SHAPES CRIME: THE TEMPORAL
IMPACTS OF FOOTBALL MATCHES ON CRIME ***

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ABSTRACT: In this paper we analyze the temporal profile of crime in the urban context of Barcelona (Spain) for the period 2007-2011 using a unique micro dataset with police reported crime. Additionally, we assess the temporal effect that a leisure activity clearly bounded in time, namely the matches played by Football Club Barcelona (FCB), exert on criminal activities. We obtain a detailed time profile for the crime recorded in the city of Barcelona and the displacement effect attributable to the football matches. The latter was found to be notable in the case of thefts, criminal damage, robberies and gender violence. Instances of gender violence were more prevalent after a FCB defeat.

JEL Codes: K42, R1, L83

Keywords: Hourly data, reported crime, crime displacement, gender violence, football

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1. Introduction

Criminal behavior varies greatly according to the time of day but, while Felson and Poulsen (2003) note that monthly and seasonal cycles of crime are well-known periodicities among criminologists (see, for example, Harries, 1980), the hourly periodicity of crime is under-researched. This lack of research is surprising if we consider that several existing theoretical approaches to the understanding of illegal behavior, including routine activity theory (Cohen and Felson, 1979), stress the essential role of hourly activities and their association with crime opportunities (see Felson, 2002). A possible explanation for this absence of formal study of the temporal patterns of crime is because spatial patterns have tended to focus all the research attention. Indeed, the tools developed by geographers have been widely used in the spatial mapping of criminal activity and for the statistical description of spatial processes, leaving the temporal element in a secondary plane.

However, time would seem to play an important role in its own right in defining illegal activities. For instance, time defines when people stumble out of bars, when alcohol or other stupeficients are consumed (concentrating around bar closing times), when drink driving tests are performed by police patrols or when the working day begins and ends. All these events can affect the number of potential offenders, the number of suitable targets and the presence (or otherwise) of police forces and, therefore, in line with routine activity theory, they have a direct impact on criminal activities.

The impact of time on crime, however, can be *a priori* positive or negative. On the one hand, a positive impact can be expected, given that at certain times of day crime is more likely to occur because of the routines and activities that are being engaged in (work, leisure, etc.). On the other hand, activities that are clearly demarcated by time may have a displacement effect and, hence, a negative effect on crime. In this respect, crime displacement may be defined as the relocation of crime from a particular time, place, target, offense, or tactic to another as a result of some activity and/or crime prevention initiative. Spatial displacement is by far the most commonly recognized form, but the other forms are also frequently acknowledged by researchers as they examine the impact of crime prevention policies.

More specifically, the possible forms of displacement are temporal (offenders change the time of day when they commit a crime); spatial (offenders switch from targets in one location to those in another); target (offenders change from one type of

target to another); tactical (offenders change the methods used to carry out a crime); and offense (offenders switch from one form of crime to another). Clearly, it is crucial to have a good comprehensive understanding of all of them so that the police forces might define prevention initiatives to tackle criminal activities.

The aim of this paper therefore is twofold. On the one hand, and drawing on a unique dataset, we analyze the temporal profile of urban crime in Barcelona (Spain) in an attempt at obtaining further evidence of monthly, weekly and hourly patterns of crime. We undertake an in-depth examination of the temporal nature of crime by determining if there is a temporal displacement of crime attributable to major events in the city of Barcelona, more specifically in relation to the matches played by Football Club Barcelona (FCB, hereafter). The social importance of football in Spanish society makes it an ideal event for determining whether the sport is responsible for a temporal displacement of crime in the city. Football matches, major sporting events that attract a large proportion of the population, provide excellent scenarios for analyzing temporal displacement, given that for certain periods of time (before, during and after the match) the feelings and attitudes of individuals are subject to fluctuation. Such a differentiated time profile is, therefore, optimal for analyzing the potential temporal effects on crime. Moreover, given the media coverage dedicated to football, these effects are not necessarily spatially constrained and, so, football matches are ideal for analyzing temporal displacement effects in criminal activities, and should further our understanding of the relationship between crime and time. The results of this analysis should provide interesting insights into the impact of football on crime, a particularly relevant issue today for governments concerned with the security issues related to major sporting events, among others.¹

The rest of the paper is structured as follows. Section 2 briefly presents the various temporal patterns presented by crime data by reporting a descriptive analysis of crime on a monthly, weekly and hourly basis. Section 3 analyses the potential channels through which football matches may affect criminal activity. Section 4 describes the unique dataset on recorded crime for the city of Barcelona and outlines the methodology employed. Section 5 presents the main results regarding the temporal effect of football on crime while Section 6 presents the results for the case of defeats and violent crimes. Section 7 discusses the main results. Finally, section 8 concludes.

¹ See, for instance, Marie (2010) or the latest episodes of violence that have occurred in and around Spain's football grounds (http://deportes.elpais.com/tag/operacion_neptuno/a/)

2. Temporal crime patterns: a descriptive analysis for the city of Barcelona

This section analyzes monthly, weekly and hourly crime patterns for the following crime types: property crimes (*Robberies*, *Thefts* and *Criminal damage*), crimes against the person (*Violent crimes* and *Gender violence*) and other crimes (*Against police*, *Driving crimes* and *Drug related crimes*).²

Figure 1 (panels a to h) gives us a broad temporal picture of the evolution of the sum of offenses, by month, for each type of crime. Several features are worth highlighting. First, all types of crime, with the exception of *Robberies* (which presents an upward trend) and *Gender violence* (which presents a downward trend), are quite stable within the period of study (January 2007 – December 2011). Without seeking to be exhaustive, a priori, the reduction in the number of family related crimes (*Gender violence*) could be related, on the one hand, to the resources devoted by governments (national, regional and local) to tackling this problem in Spanish society³ and, on the other, to the impact that an economic crisis can have on report rates for this type of crime.

As expected, there seems to be a marked seasonal effect with an increase in *Violent crimes* and, especially, *Thefts* in the summer. This would appear to be associated with the massive arrival of tourists – attractive targets for pickpockets – to the city during these months.⁴

It should perhaps be pointed out that the sharp rise in *Driving crimes* recorded from the end of the year 2007 reflects the new traffic regulations (*Ley Orgánica 15/2007*) passed on the 30th of November,⁵ which increased the severity of such crimes and hence the number of offences (see BOE, 2007).

Figure 2 (panels a to h) presents the weekly trend for each type of crime. The daily number of crimes of each type has been calculated by taking the average of all daily crime counts for the period of study (2007-2011). For all types of crimes there is a weekend effect with crime rates increasing significantly during the weekend.⁶

² See Section 4 for more details on the data used and Table 1 for a precise definition of each type of crime used.

³ Counselling, social housing, rapid police responses to aggressions and faster trials of offenders are some of the policies that have been adopted in recent years in Spain to tackle this problem.

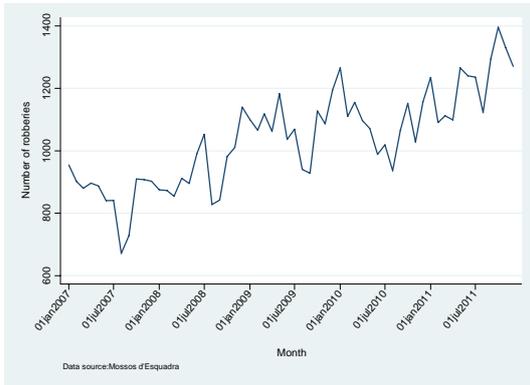
⁴ Tourists are known to carry valuable items on their person, including cameras and cell phones. This, together with a low level of surveillance, makes them attractive targets for offenders. See Montolio and Planells-Struse (2013) for an analysis of the impact of tourism on crime for the Spanish case.

⁵ The law actually came into effect on 2nd of December.

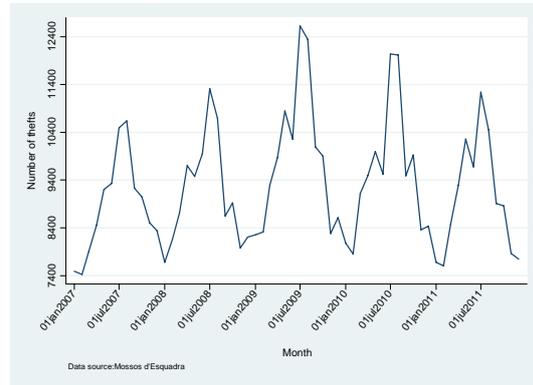
⁶ The marked weekend effect observed for *Gender violence* has also been reported in Vazquez *et al.* (2005) and Gantz *et al.* (2006).

Figure 1: Monthly crime evolution.

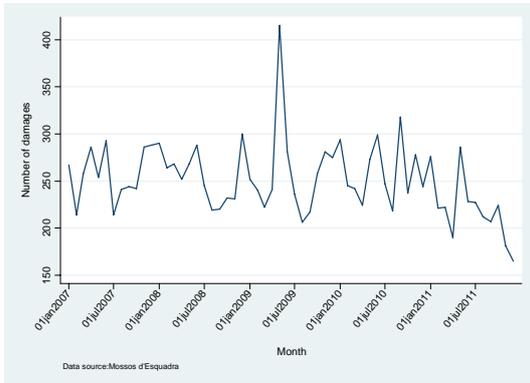
Panel 1a: *Robberies*



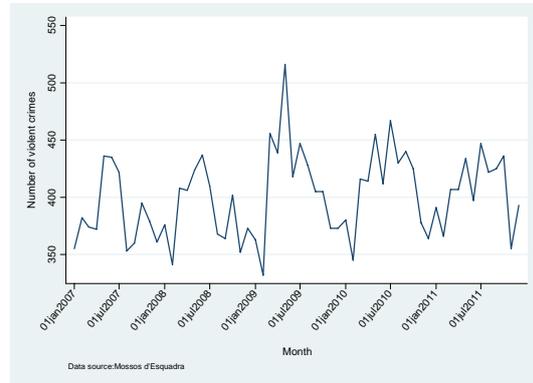
Panel 1b: *Thefts*



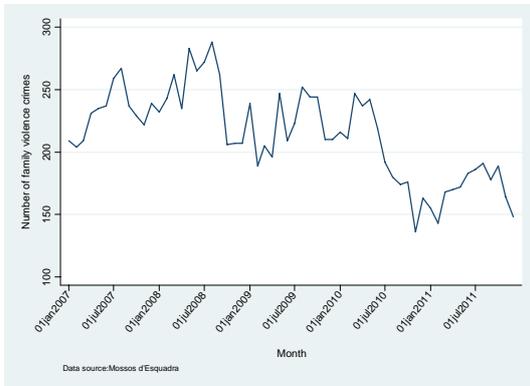
Panel 1c: *Criminal damage*



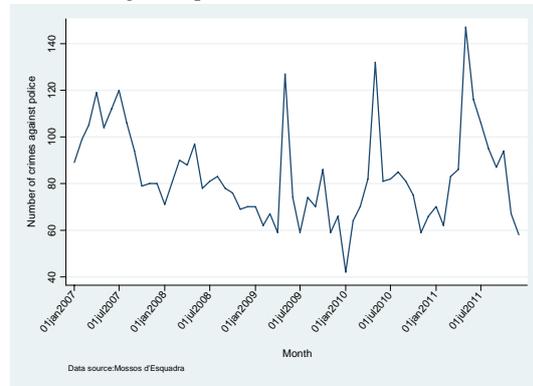
Panel 1d: *Violent crimes*



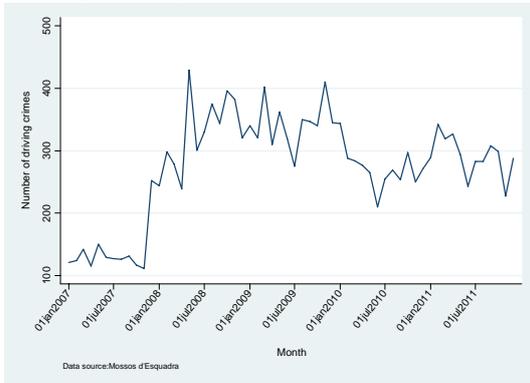
Panel 1e: *Gender violence*



Panel 1f: *Against police*



Panel 1g: *Driving crimes*



Panel 1h: *Drug related crimes*

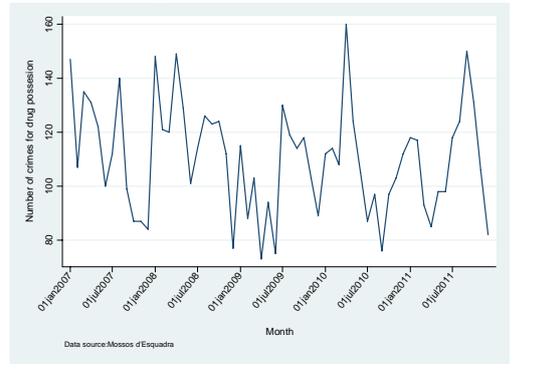
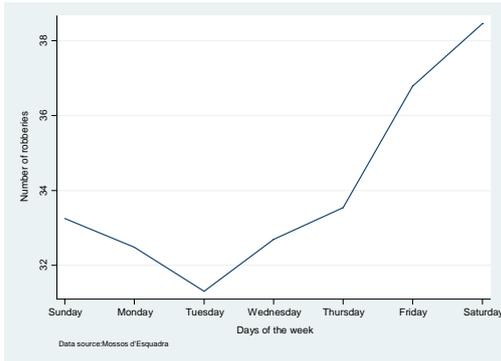
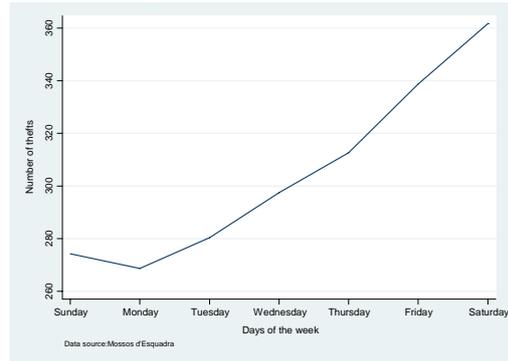


Figure 2: Weekly crime evolution.

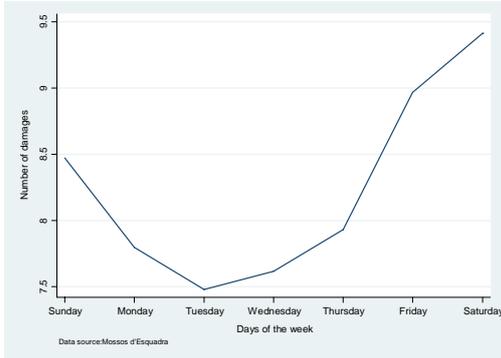
Panel 2a: *Robberies*



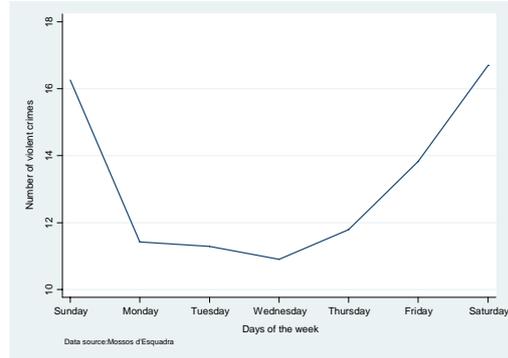
Panel 2b: *Thefts*



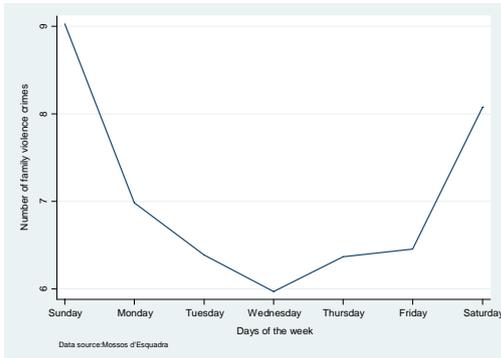
Panel 2c: *Criminal damage*



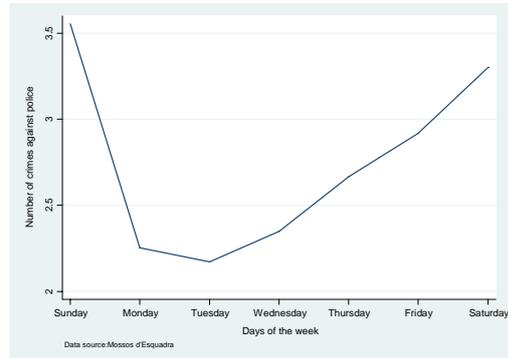
Panel 2d: *Violent crimes*



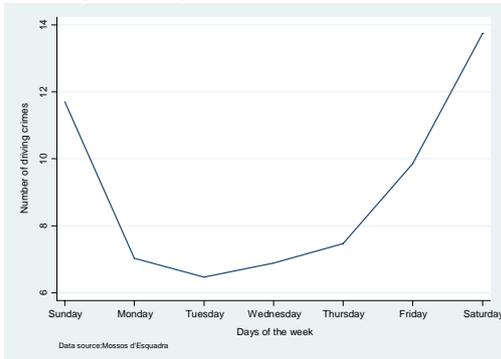
Panel 2e: *Gender violence*



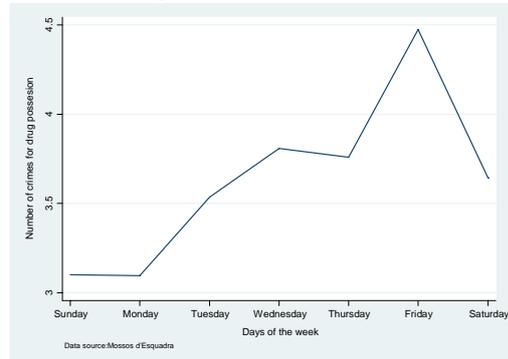
Panel 2f: *Against police*



Panel 2g: *Driving crimes*



Panel 2h: *Drug related crimes*



In general, rates fall from Sunday to Tuesday/Wednesday; thereafter, they begin to rise again reaching a peak on Saturday/Sunday. Note the low level of reports made for drug consumption and trafficking on Sundays (a crime that peaks on Fridays), a pattern that might reflect the incapacitation of drug users by Sunday (i.e., drug consumption is highest on Fridays and Saturdays, with users resting on Sundays before the start of the week).

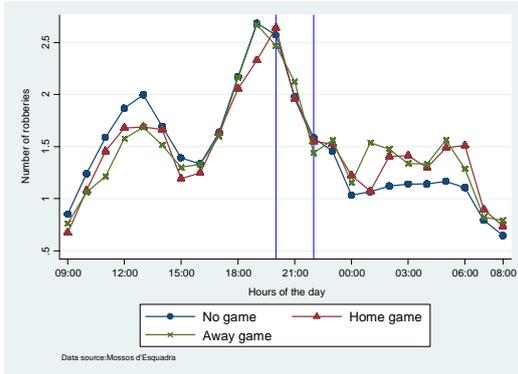
Finally, Figure 3 (panels a to h) shows the hourly patterns of crime. We compute the average number of crimes (by type) for every hour of the day.⁷ Various patterns emerge. *Robberies* (panel 3a) and *Thefts* (panel 3b) present similar profiles: both peak at 19:00 (when people leave work on working days) following an upturn after 15:00. In both cases, rates are lowest around 9:00, increasing up to 13:00 and falling during lunch time (13:00-15:00). *Criminal damage* committed against the property of others (panel 3c) also peaks at 19:00 and is concentrated in the evening hours while during the rest of the day there is little fluctuation in the rate.

Panel 3e shows the evolution of *Gender violence*, with rates peaking in the late evening (having gradually increased throughout the day) and dropping off at night. *Violent crimes* (panel 3d) follows a similar pattern with an increasing rate from the early morning to a peak at around 19.00, but a second peak emerges at around 04:00 in the early morning. This is presumably associated with activities in leisure areas that end up in brawls and fights which, if reported to police, are likely to be catalogued as violent crimes.

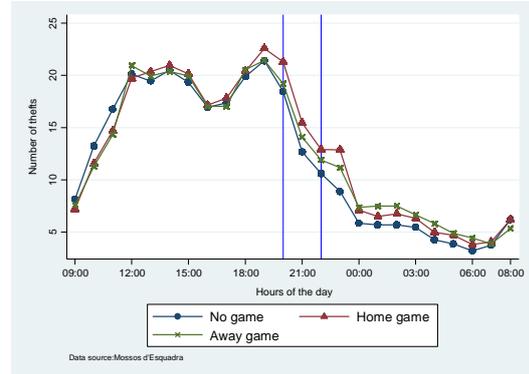
In the case of the other types of illegal activity, crimes *Against police* (panel 3f) peaks at night (00.00 - 03.00), again presumably related with the attempts of police forces to actively control leisure activities, which are likely to result in illegal behavior. This seems to be confirmed by *Driving crimes* (panel 3g) and *Drug related crimes* (panel 3h), which present very similar time profiles, although the latter presents a second peak between 19:00 and 20:00 (after working hours).

⁷ The vertical lines plotted in all the panels of Figure 3 denote the typical kick off and final whistle times for FCB football matches (20:00 and 22:00); see footnote 11 for more details. Additionally, and given its utility for the subsequent analysis, Figure 3 plots the hourly evolution of crime for days when no matches were played (No game) and for days when FCB played at home (Home game) and when the club played away (Away game).

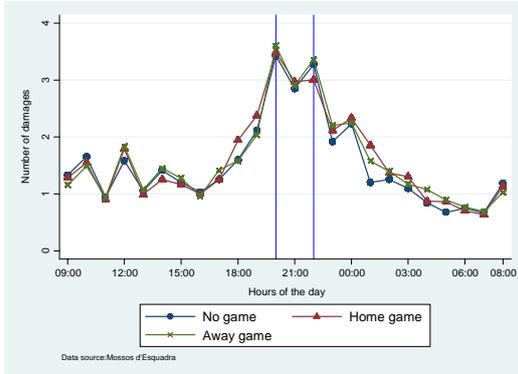
Figure 3: Hourly crime evolution.
 Panel 3a: *Robberies*



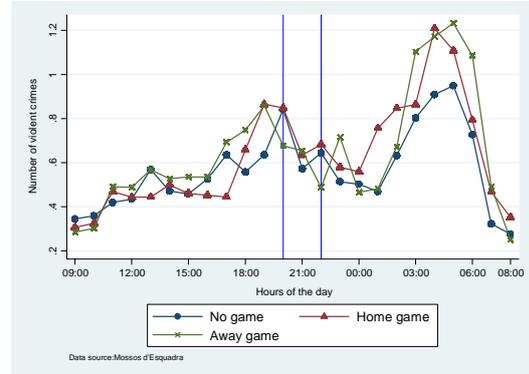
Panel 3b: *Thefts*



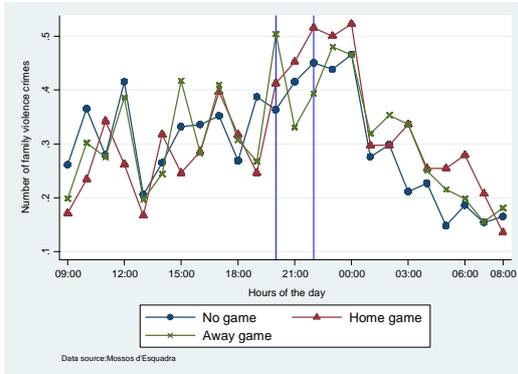
Panel 3c: *Criminal damage*



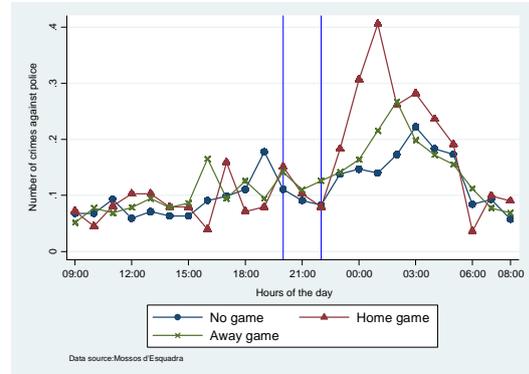
Panel 3d: *Violent crimes*



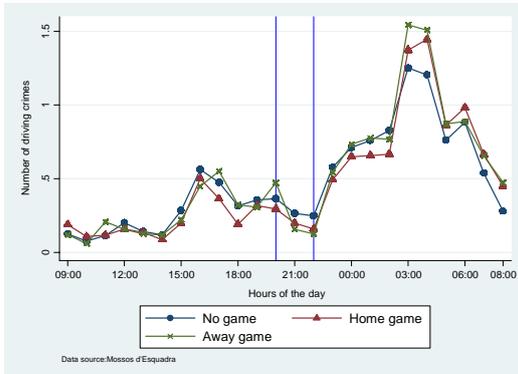
Panel 3e: *Gender violence*



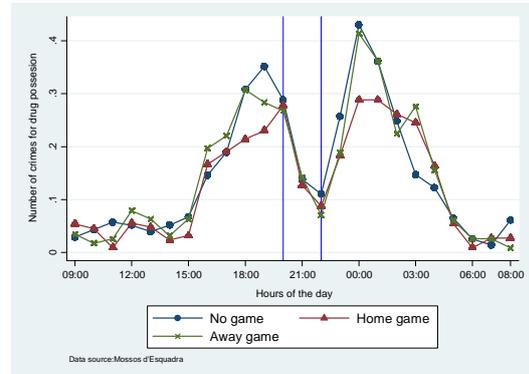
Panel 3f: *Against police*



Panel 3g: *Driving crimes*



Panel 3h: *Drug related crimes*



Interestingly, the hourly evolution of the eight typologies of crime analyzed above can be broadly summarized in three time patterns: first, crimes related to leisure activities (crimes *Against police*, *Driving crimes* and *Drug related crimes*), with peaks late at night, low rates during the day-time and rates that increase as the evening progresses; second, crimes against property (*Robberies*, *Thefts* and *Criminal damage*), with low rates at night and a clear peak around 18:00 (related to the time when people are leaving work on weekdays); and, third, crimes involving violence (*Violent crimes* and *Gender violence*), with rates that increase throughout the day, peaking in the evenings. The crime types that might benefit from the hours of darkness (drug related crimes, violent crimes and criminal damage) occur more frequently during the evening, as corroborated by Calandrillo and Buehler (2008).

3. Football, time and crime

Having described the temporal profile of crime in the city of Barcelona and having shown that crime varies markedly with time, we now explore whether some activities might displace illegal activities in time. Barcelona is a busy city offering a wide range of cultural and tourist activities (not to mention those organized by the city's neighborhood associations), which can be examined in order to detect the existence of any kind of relationship between the timing of these activities and criminal activity. Barcelona, moreover, has a long tradition in hosting leading sporting events, commencing in 1992 with the Olympic Games and more recently with the organization of numerous World and European Championships, including swimming (2003 and 2013), athletics (2010), basketball (2014) and handball (2013).⁸ And, of course, Barcelona, as home to FCB and RCD Espanyol, plays host to football matches on a regular basis.⁹

Despite the positive economic effects that hosting a world-wide famous football club undoubtedly has for the city of Barcelona (for a cross-country comparison, see, Sterken, 2006, and Allmers and Maening, 2009), a number of negative externalities arise from its being home to such a major team and its hosting of such large events on a

⁸ Barcelona is also the frequent host of many Spanish Championships in a variety of disciplines.

⁹ RCD Espanyol attracts less support than FCB. By way of illustration, RCD Espanyol has 27,000 members (paying an annual fee) and around 70,000 followers on Facebook, while FCB has 169,000 members and more than 45 million followers on Facebook. Moreover, although originally with its home ground in Barcelona, RCD Espanyol moved to the neighbouring city of Cornellà-El Prat in September 2009. Therefore, for the purposes of this study we focus only on the temporal impact FCB matches have on criminal behaviour in the city of Barcelona.

regular basis.¹⁰ The literature dealing with the impact of sport on crime has mainly focused on the spatial patterns of this relationship (see, for instance, Kurland *et al.*, 2013; Rees and Schnepel, 2009; Russell, 2004; Marie, 2010; Breetzke and Cohn, 2013; Breetzke and Carl, 2009), while only a few studies have focused on the possible temporal displacement effects of such events (Card and Dahl, 2011; Doleac and Sanders, 2012; Kirk, 2008; Sachs and Chu, 2000). As such, this paper, rather than addressing the so-called crime pattern theory (Eck *et al.*, 2007), which states that certain specific places (such as football stadiums) are rich in suitable targets and attract potential offenders, focuses on the temporal displacement effects of football matches.

In order to provide an initial, visual evaluation of the potential temporal displacement effect of FCB matches on crime, in Figure 3 we depict the hourly crime evolution in Barcelona on days when FCB played at home and away as well as on days when FCB were not involved in a game.¹¹ In general, the hourly patterns of crime on the three types of day are fairly similar; however, closer inspection reveals some interesting features.

In general, home match days and away match days do not differ considerably from other non football days except in the time band following the final whistle. In the case of *Robberies*, *Thefts*, *Violent crimes*, *Gender violence*, and crimes *Against police officers* there is an increase in the number of illegal activities in the hours after the football (both for home and away games). The same is true for *Driving crimes*, but in this case five to six hours after the match has finished. For *Criminal damage*, there are no apparent differences across the different types of day analyzed, while there is a lower level of *Drug related crimes* in the hours following home matches.

Certain characteristics of the days under analysis provide us with plausible explanations for the crime patterns observed. For instance, police deployment when FCB are playing at home to guarantee the protection of those going to the stadium or congregating in recreational areas to watch the match may be responsible for the marked increase observed in crimes *Against police officers* on home match days (given the greater interaction between fans and police officers), a decrease in *Drug related*

¹⁰ Given that FCB typically gets to the final rounds of most of the competitions that it enters means that in some periods of the season, the club is playing almost every three days (taking into account both home and away matches).

¹¹ Note that FCB matches kick off at different times, depending on the match and on the competition. For instance Champions League matches always kick-off at 20:45 (CET), however, Domestic League matches may vary, the average starting time being 20:20 (and the mode 20:35). In Figure 3, therefore, the additional vertical lines correspond to a 20:00 starting time and 22:00 final whistle.

crimes as the police are concerned with other security issues, and also the time profile of *Driving crimes* with traffic checkpoints being set up after matches.

Fluctuations in supporters' emotions following a defeat or victory may account in part for the sharp increase in *Violent crimes*, the rate of which also increases in the hours prior to a match. The same post-match pattern is observed for *Robberies* and, albeit to a lesser extent, for *Thefts*, which in the case of the city of Barcelona are limited mainly to pick pocketing. Incidents of *Gender violence* also seem to rise on match days, but the graphical evidence here is less conclusive.

Clearly the preceding has been an attempt at providing a descriptive approximation of the evolution of crime over time, and the possible effects that a major sporting event can have on illegal behavior. In the next section, we address the issue by means of formal estimations taking into account other possible determinants of the differences observed (day of the week, type of match, weather conditions, etc.) in crime patterns across football and non-football days.

4. Data and empirical methodology

4.1. Crime data

In this section we formally describe our unique data (used in the previous sections to describe the time patterns of crime). We use a non-public dataset for the city of Barcelona containing all registered crimes obtained from the autonomous police agency in Catalonia (Spanish region in which Barcelona is located), the *Mossos d'Esquadra*, which is responsible for crime prevention, crime solving and specialized crime investigation in the Catalan region.¹² The dataset contains reports made both by citizens and police officers. Additionally, the dataset contains information on all the crimes registered by Barcelona's local police (the *Guardia Urbana*), responsible primarily for urban traffic and upholding municipal laws and ordinances.

The crime dataset records the time of the crime (when known) and the exact location. The dataset spans from 2007 to 2011 and is classified according to the more than 190 articles making up the Spanish penal code.¹³ In order to reduce the number of categories without creating an aggregation bias (Cherry and List, 2002) that could

¹² The *Mossos d'Esquadra* are responsible for virtually all police duties. The Spanish National Police (*Cuerpo Nacional de Policía*) and the military police (*Guardia Civil*) retain a number of administrative responsibilities (e.g., issuing of identity cards and passports) and undertake counter-terrorist and anti-mafia activities.

¹³ The *Mossos d'Esquadra* were fully deployed in the city of Barcelona in 2006.

reduce the effectiveness of our estimations, we combined some of these articles according to the type of crime, paying particular attention not to aggregate crimes with different offender motivations (for example, crimes against the person and crimes against property). Table 1 specifies the type of crime included in each category.

Table 1: Crime classification.

Type	Description
Property Crimes	
<i>Robberies</i>	Misappropriation of the belongings of others against their will with the use of violence.
<i>Thefts</i>	Misappropriation of the belongings of others against their will without the use of any violence.
<i>Criminal damage</i>	Minor/serious damage to the belongings/property of others.
Crimes against the Person	
<i>Violent crimes</i>	Physical injuries to other individuals. Mass fights and brawls.
<i>Gender violence</i>	Abuse in the home. Physical and psychological violence in the home.
Other Crimes	
<i>Against police</i>	Misconduct, intimidation, resistance, use of force and aggressions against police officers.
<i>Driving crimes</i>	Dangerous driving. Driving with no license. Driving under the influence of alcohol or drugs (considered a serious crime when alcohol tests are above a certain threshold). Endanger lives of other drivers.
<i>Drug related crimes</i>	Drug consumption in public areas and drug trafficking. The amount of drugs determines the classification.

For the main property crimes, we include *Robberies*, i.e., the use of violence in the misappropriation of the belongings of others, as opposed to *Thefts*, which do not involve any violence. Among property crimes, we also include *Criminal damage* which accounts for any type of damage caused to the belongings of others. Aggregated categories of property crime often include this type of crime but the motivation that may lead an offender to commit a theft or criminal damage are clearly different.

Among violent, interpersonal crimes we include the category *Gender violence*, which refers to crimes committed against a family member, and *Violent crimes*, which includes the inflicting of injuries of any type against another person or persons. This category also includes fights that break out among crowds in places of leisure (such as night clubs or discos) or at major events (such as football matches).

Finally, we create a separate category (Other crimes) to account for special types of crime normally reported by police officers and not by citizens. Broadly speaking, this means that if the police are not concerned with these crimes, they tend to go unreported and so are not accounted for in the registered crime data. In this category we include crimes *Against police*, i.e., misconduct (normally reported by the police themselves), such as, disobeying police orders or injuring a police officer; *Driving crimes*, i.e., driving under the influence of drugs or alcohol or traffic violations that endanger the lives of others; and, finally, *Drug related crimes*, i.e., crimes related to drug trafficking and/or consumption.

Table 2 shows the main descriptive statistics of the crime types used in this study. It is evident that property crimes are much more common than other types of crime. The most common offence committed in the city of Barcelona is that of *Thefts*, primarily pick pocketing, with a daily average of 306.79 recorded instances (nearly ten times greater than *Robberies* and *Criminal damage*). Fewer crimes against the person are recorded, although the figures for *Gender violence* are worrying given their implications. Finally, *Driving crimes* are the most common crime type among those directly recorded by police officers.

Table 2: Average number of crimes by different time dimensions.

Type	Hour	Day	Month	Year
Property Crimes				
<i>Robberies</i>	1.46 (1.43)	34.96 (8.73)	1,064.39 (144.44)	11,069.6 (4,430.41)
<i>Thefts</i>	12.80 (8.58)	306.79 (61.57)	9,339.25 (1,273.94)	97,128.2 (34,918.44)
<i>Criminal damage</i>	1.50 (1.55)	35.96 (9.84)	1,094.69 (128.42)	11,384.8 (4,329.19)
Crimes against the Person				
<i>Violent crimes</i>	0.55 (0.81)	13.21 (4.80)	402.25 (36.90)	4,183.4 (1,507.29)
<i>Gender violence</i>	0.29 (0.56)	6.95 (3.16)	211.48 (37.31)	2,199.4 (787.54)
Other Crimes				
<i>Against police</i>	0.11 (0.41)	2.63 (2.63)	79.96 (19.18)	831.6 (288.21)
<i>Driving crimes</i>	0.41 (0.75)	9.75 (5.23)	296.85 (65.55)	3,087.2 (1,425.48)
<i>Drug related crimes</i>	0.15 (0.41)	3.56 (2.09)	108.40 (20.18)	1,127.4 (438.09)

In order to control the size of our analysis, and given that our focus is on the temporality of crime, we have opted not to include crimes such as *Burglary* (illegal entry into a building for the purposes of committing an offence) and *Car theft*. Note that all the crime types included in Table 1 are characterized by the fact that the timing of the offence can be quite accurately determined, either because they directly involve victims and offenders or because they are reported by police officers. In contrast, just when exactly a *Burglary* or a *Car theft* occurred is usually unknown, and has to be approximated by police officers (or victims) when filing the complaint. Moreover, police officers usually state a time window for when the crime is likely to have occurred. Therefore, so as not to distort the main aim of the study – namely, the time analysis of crime and the possible (hourly) displacement effect of football matches, we do not include these crimes.

4.2. Football data

We merge the above hourly crime dataset with the dataset containing all the football matches played by FCB between the 25th of September 2007 and the 31st of December 2011. The latter contains information regarding the day, the exact time of the match, the rival, the match result, the number of spectators and whether it was played at home or away match. Table 3 summarizes the number of matches by level of attendance and by type of match. It shows that the level of attendance was high for home matches, with 70% attracting more than 60,000 spectators to the stadium and just seven presenting an attendance of less than 40,000 spectators.

Table 3: FCB football matches 2007-2011.

Attendance	# of matches in the sample
> 80,000 spectators	36
> 60,000 and < 80,000 spectators	58
> 40,000 and < 60,000 spectators	24
< 40,000 spectators	7
Home matches	125
Away matches	130
Type of match	
Spanish Domestic League	169
Spanish King's Cup	32
European Champions League	50
Spanish and International Super Cups	4

Note: In this period FCB played Real Madrid CF, its main rival, ten times (home and away).

Our dataset contains a total of 125 home and 130 away matches. Most of the matches were played in the Spanish domestic league (169). The Spanish King's Cup is the second most important domestic competition (32 matches played); however, the European Champions League is the competition that attracts by far the most spectators (50 matches played). Table 4 completes the description of the datasets used in this paper presenting the main types of crimes by match day type (no match, home match and away match).

Table 4: Daily average number of reported crimes by typology and by type of match played.

Crime type	No Match	Home Match	Away Match
Property Crimes			
<i>Robberies</i>	34.95	36.29	35.68
<i>Thefts</i>	288.02	310.96	303.68
<i>Criminal damage</i>	8.15	8.27	9.19
Crimes Against the Person			
<i>Violent crimes</i>	12.71	14.03	14.55
<i>Gender violence</i>	6.78	7.30	7.32
Other Crimes			
<i>Against police</i>	2.53	2.64	2.98
<i>Driving crimes</i>	9.43	10.61	11.95
<i>Drug related crimes</i>	3.62	3.15	3.58

4.3. Empirical methodology

The evidence presented above seems to indicate a clear crime time profile and that a major event, such as a football match, can influence criminal behavior, especially after the event. In order to study the temporal behavior of crime and potentially distinct patterns on match days, we use a panel approach comprising two time dimensions: time of day and days. Thus, we compare the same times on different days while controlling for any potential source of heterogeneity across days, weeks, months and years. The empirical model used is the following:

$$Crime_{d,h}^k = Match_{d,h}^t \sum_{l=-7}^7 \delta_{d,h+l} + \beta X_d + \gamma_y + \gamma_m + \gamma_w + \sum_{c=1}^3 \gamma_d^c + \gamma_h + \varepsilon_{d,h} \quad (1)$$

where k denotes the type of crime, d denotes the day in our time span running from the 25th September 2007 to 31st December 2011 and h is the time of day from 00:00 to

23:00. t denotes the type of match played (home or away);¹⁴ thus, the variable $Match_{d,h}^t$ can be transformed into $Home_{d,h}$ and $Away_{d,h}$, which are dummy variables taking a value of 1 if it is a time when there is a home or an away match being played, respectively, and 0 otherwise.¹⁵ The subscript l denotes the lag and lead effects of home and away matches. We analyze a period of up to seven hours before and after the match, assuming this to be a reasonable time period to observe the displacement effect of football on crime rates.

In Eq. (1) X_d represents a vector of control variables that can affect (recorded) crime, such as weather variables (average rainfall, average number of sun hours, average temperature, average pressure, average wind speed).¹⁶ The weather has long been recognized to be an important factor influencing crime dynamics. For instance, higher temperatures can explain, through a psychological effect, higher levels of violent crimes (Anderson, 2001; Harries *et al.*, 1980; Jacob *et al.*, 2004). Rain has also been shown to be a determinant in explaining lower levels of violent crime, perhaps due to the lack of social interactions among individuals (people are more likely to stay at home and not go out) or due to the lack of potential targets. We also include a dummy variable accounting for the lunar phase (indicating the presence of the full moon) since some police agencies have reported experiencing higher levels of violent crime when there is a full moon.¹⁷ This set of control variables is completed by a dummy variable that indicates if a particular day is a bank holiday; summer and winter seasonal dummies, dummies for days (home and away) with special matches such as the big derby between historic rivals FCB and Real Madrid CF which is considered, by the police, as a potentially dangerous match, and dummies to control for the type of competition (Spanish Domestic League, European Champions League, Spanish King's Cup, Spanish Super Cup and International Super Cup) since this may determine the typology of person interested in (and following) the match.

In order to account for unobserved heterogeneity across time, days, weeks and years in our data span, we include a full set of time fixed effects. First, we include an hour of the day fixed effect (γ_h) since, as shown in Figure 3, those hours with the greatest

¹⁴ We retain only those months corresponding to the football season in the sample; that is, we discard the summer months from the beginning of June to the end of August. Recall, the summer months are characterized by high seasonal crime records.

¹⁵ We assume a match has a two-hour duration (90 minutes plus stoppage time).

¹⁶ Weather variables present daily variation.

¹⁷ See "Crackdown on lunar-fuelled crime". BBC News. 5 June 2007 at http://news.bbc.co.uk/2/hi/uk_news/england/kent/6723911.stm (last accessed 14 March 2014).

movement of workers (early morning or after work) are more likely to coincide with the peak times for pick pocketing.¹⁸ By including hour of the day fixed effects, we capture this unobservable time characteristic and ensure our estimations of the effect of football matches on crime are unbiased. Second, we include three types of dummies related to different days (γ_d^c); (i) day of the week fixed effects to account for the heterogeneity of crime across days. As shown in Figure 2, there is a clear weekend effect (maybe due to higher outdoor/leisure mobility of individuals or to higher alcohol and drug consumption). By including these specific day of the week fixed effects we can capture these weekend effects as well as other specific day effects, such as, (ii) day of the month fixed effects, which account for days with specific monthly characteristics (for instance, pay day in the lasts days of a month); and (iii) day of the year fixed effects, which control for special days such as Christmas Day, New Year's Eve, local holidays (*fiestas*) or any other special day.

Third, we also include week of the year (γ_w), month of the year (γ_m) and annual fixed effects (γ_y). Finally, we draw on monthly and yearly trends to account for potential trends (e.g., thefts increase from the beginning of the year to the end of August) or for different levels of popularity expressed for FCB (e.g., the club may be more popular one year because it won a major title the previous season or because it bought a world-class player).

As we employ hourly data, the crime count in our dataset is positively skewed with a large presence of zeros. Taking logs would result in a considerable increase in the number of missing values, which could bias our estimations. In order to deal with data of this type, we follow Marie (2010) and Dahl and DellaVigna (2009) and use a negative binomial approach. Such estimations constitute a generalization of the Poisson model but allow for the over dispersion of data, in other words, they allow for the variance of the outcome to differ from the mean.

5. Main results

In this section we present the results of estimating Eq. (1), that is, the temporal effect of football on crime. The columns of each table of results present the different crime types considered. All the regressions include the full set of controls previously presented. Note that given that we estimate a negative binomial model, the coefficients

¹⁸ All the temporal fixed effects and trends included in the regressions have been based on the descriptive temporal crime analysis carried out in the previous section.

reported are the incidence rate ratios that represent the increase or decrease in percentage of the number of counts of each crime type.

Table 5: FCB home matches attendance and crime in the city at time of the match.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	<i>Robberies</i>	<i>Thefts</i>	<i>Criminal damage</i>	<i>Violent crimes</i>	<i>Gender Violence</i>	<i>Against Police</i>	<i>Driving crimes</i>	<i>Drugs</i>
Stadium attendance	0.974** (0.0102)	1.013 (0.00955)	1.007 (0.00995)	0.999 (0.0219)	0.981 (0.0207)	0.963 (0.0494)	0.959 (0.0258)	1.017 (0.659)
>80,000	0.802** (0.0827)	1.023 (0.0406)	1.023 (0.0688)	0.743* (0.117)	0.959 (0.189)	0.496* (0.208)	0.624* (0.176)	0.727 (0.236)
>60,000	0.930 (0.0691)	0.986 (0.0356)	1.009 (0.0658)	0.929 (0.115)	0.780 (0.124)	0.878 (0.260)	0.783 (0.159)	0.707 (0.159)
>40,000	0.781* (0.112)	0.908* (0.0475)	0.961 (0.0970)	1.137 (0.187)	0.999 (0.257)	0.443 (0.307)	0.745 (0.222)	0.462 (0.227)
>20,000	1.014 (0.241)	0.964 (0.0955)	1.045 (0.172)	1.045 (0.382)	1.004 (0.258)	1.689 (1.225)	0.999 (0.645)	0.602 (0.391)
Observations	29,123	29,123	29,123	29,123	29,123	29,123	29,123	29,123
Climate controls	YES	YES	YES	YES	YES	YES	YES	YES
Time controls	YES	YES	YES	YES	YES	YES	YES	YES
Seasonal controls	YES	YES	YES	YES	YES	YES	YES	YES
Monthly trends	YES	YES	YES	YES	YES	YES	YES	YES
Yearly trends	YES	YES	YES	YES	YES	YES	YES	YES
Lunar phase	YES	YES	YES	YES	YES	YES	YES	YES
Holiday dummy	YES	YES	YES	YES	YES	YES	YES	YES
Derby dummy	YES	YES	YES	YES	YES	YES	YES	YES
Type of competition	YES	YES	YES	YES	YES	YES	YES	YES

Note: Attendance is expressed in 10,000. >80,000, for instance, is a dummy that takes the value of 1 for matches with an attendance above the specified threshold. The estimations for each level of attendance are performed separately. Climate controls include: average rainfall, average number of sun hours, average temperature, average pressure and average wind speed. Time controls include: hour of the day, day of the week, day of the month, day of the year, week of the year, month and year. Seasonal controls include dummies for summer (mainly September) and winter. Type of competition includes dummies for: Spanish Domestic League, European Champions League, Spanish King's Cup and Super Cups (both Spanish and International). Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 5 shows the results of the impact of FCB playing at home on crime, focusing on the time when the games are played (recall, we consider a game to have a duration of two hours (20:00 – 22:00)). The first row represents the impact of an increase of 10,000 spectators on the different types of crime. For the case of *Robberies*, the coefficient presents a decrease in the expected number of *Robberies* of 2.6% (1-0.974) during the football match for each 10,000 additional spectators in the stadium. Similarly, the following rows analyze the effect of different matches depending on attendance. In general, it seems that football matches only have a significant impact on crime (for the duration of the game), in the case of those attended by over 80,000 spectators. These matches are typically important games for FCB. During such matches, there is a decrease in the number of *Robberies* in the city, and there is some weak evidence of a reduction in crimes *Against police*, the number of *Driving crimes* and *Violent crimes*

during the two hours of the game. This lack of significant results for crime during the time of the match (or even the reductions in some crime types) might point to an incapacitation effect on offenders, as found by Dahl and DellaVigna (2009) in relation to violent movies.¹⁹ The detailed results for the vector of control variables (X_d) for the above estimation are reported in Table 6.

Table 6: Control variables.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	<i>Robberies</i>	<i>Thefts</i>	<i>Criminal damage</i>	<i>Violent crimes</i>	<i>Gender Violence</i>	<i>Against Police</i>	<i>Driving crimes</i>	<i>Drugs</i>
Rainfall	0.998** (0.00093)	0.998*** (0.0004)	1.002** (0.00094)	0.996** (0.0015)	0.999 (0.0020)	0.999 (0.0034)	0.996** (0.0019)	0.996 (0.0029)
Sun hours	1.004** (0.00195)	1.006*** (0.0009)	1.006*** (0.00190)	1.006** (0.0031)	0.993 (0.0040)	1.009 (0.0072)	1.000 (0.0036)	0.997 (0.0056)
Temperature	1.009*** (0.00236)	1.008*** (0.0012)	0.999 (0.00226)	1.012*** (0.0038)	1.015*** (0.0052)	1.001 (0.0083)	1.023*** (0.0045)	1.021*** (0.0072)
Pressure	1.000** (0.0000)	1.000** (0.0000)	1.000 (0.00005)	1.000 (0.00008)	1.000 (0.0001)	1.000 (0.0001)	1.000 (0.0001)	1.000 (0.0001)
Wind speed	0.998** (0.001)	0.999* (0.0005)	0.998* (0.0010)	1.000 (0.0017)	1.000 (0.0023)	0.996 (0.0038)	0.997* (0.0020)	0.993** (0.0031)
Summer dummy	0.524** (0.142)	0.863 (0.112)	1.061 (0.241)	1.480 (0.679)	1.914 (0.874)	1.111 (1.256)	0.720 (0.361)	2.108 (1.387)
Winter dummy	1.357 (0.383)	0.996 (0.123)	0.903 (0.256)	3.206*** (1.306)	0.450 (0.298)	0.680 (0.622)	0.634 (0.393)	0.539 (0.437)
Lunar phase	0.996 (0.0335)	1.020 (0.0168)	1.038 (0.0342)	1.021 (0.0543)	1.087 (0.0746)	0.927 (0.111)	1.045 (0.0656)	0.985 (0.0974)
Holiday dummy	0.993 (0.0289)	0.981 (0.0147)	0.953* (0.0267)	1.038 (0.0470)	0.952 (0.0573)	1.183 (0.127)	0.962 (0.0497)	1.136 (0.0986)
Derby dummy	0.868 (0.243)	1.045 (0.114)	1.063 (0.133)	1.910** (0.540)	1.447 (0.423)	2.356 (1.603)	0.704 (0.436)	0.753 (0.701)
King's Cup	0.815 (0.116)	1.103 (0.0825)	1.023 (0.142)	0.709 (0.210)	0.890 (0.302)	0.420 (0.440)	1.048 (0.381)	0.178* (0.181)
Champions League	1.070 (0.127)	1.015 (0.0405)	1.215** (0.104)	0.893 (0.196)	0.827 (0.231)	1.162 (0.458)	0.950 (0.320)	0.743 (0.248)
Domestic League	0.845*** (0.0517)	0.907*** (0.0269)	0.937 (0.0498)	0.819** (0.0800)	0.763* (0.108)	1.032 (0.259)	0.680** (0.124)	0.750 (0.136)
Super Cups	1.044 (0.360)	0.927 (0.215)	0.822 (0.226)	1.082 (0.332)	1.6e-08*** (8.37e-09)	2.977 (3.099)	1.6e-08*** (9.52e-09)	1.889 (1.308)
Observations	29,123	29,123	29,123	29,123	29,123	29,123	29,123	29,123
Hour of the day	YES	YES	YES	YES	YES	YES	YES	YES
Day of the week	YES	YES	YES	YES	YES	YES	YES	YES
Day of the month	YES	YES	YES	YES	YES	YES	YES	YES
Day of the year	YES	YES	YES	YES	YES	YES	YES	YES
Week of the year	YES	YES	YES	YES	YES	YES	YES	YES
Month of the year	YES	YES	YES	YES	YES	YES	YES	YES
Year	YES	YES	YES	YES	YES	YES	YES	YES

Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

In general, some climate variables are related to crime behavior. For instance, longer days in terms of sun hours, warmer days in terms of temperature, calm days in terms of

¹⁹ Note that in our case, *a priori*, there is a similar profile of football supporters and that of (potential) offenders: basically young males.

wind speed, and non-rainy days, are related to higher crime rates (especially property crimes).

Table 7: Hours prior to and after FCB home matches.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	<i>Robberies</i>	<i>Thefts</i>	<i>Criminal damage</i>	<i>Violent crimes</i>	<i>Gender violence</i>	<i>Against police</i>	<i>Driving crimes</i>	<i>Drugs</i>
T - 7	0.916 (0.0811)	0.966 (0.0288)	1.045 (0.0729)	0.763* (0.120)	0.936 (0.164)	1.020 (0.306)	0.933 (0.197)	0.655 (0.289)
T - 6	0.826** (0.0702)	0.944** (0.0247)	0.977 (0.0835)	0.827 (0.112)	0.901 (0.167)	0.941 (0.271)	0.810 (0.168)	0.634 (0.207)
T - 5	0.892 (0.0759)	0.919*** (0.0264)	0.908 (0.0801)	0.770* (0.115)	0.787 (0.155)	0.824 (0.238)	0.844 (0.124)	0.679 (0.175)
T - 4	0.929 (0.0732)	0.983 (0.0272)	0.922 (0.0830)	0.668*** (0.0814)	0.808 (0.154)	0.954 (0.271)	0.737* (0.115)	0.692* (0.151)
T - 3	0.896 (0.0655)	0.966 (0.0257)	0.963 (0.0656)	0.898 (0.112)	1.090 (0.167)	0.607 (0.186)	0.587*** (0.112)	0.678** (0.134)
T - 2	0.948 (0.0626)	1.014 (0.0308)	1.101 (0.0696)	0.954 (0.0988)	0.945 (0.151)	0.561* (0.190)	0.618*** (0.113)	0.728* (0.132)
T - 1	0.928 (0.0602)	1.154*** (0.0328)	1.107* (0.0670)	0.989 (0.101)	0.917 (0.155)	0.865 (0.216)	0.715* (0.137)	0.533** (0.136)
T + 1	1.052 (0.0797)	1.429*** (0.0619)	0.963 (0.0585)	0.789* (0.103)	0.959 (0.189)	1.062 (0.309)	0.880 (0.124)	0.673* (0.153)
T + 2	1.086 (0.0955)	1.325*** (0.0760)	1.148** (0.0760)	0.964 (0.117)	0.780 (0.124)	1.245 (0.366)	0.920 (0.118)	1.047 (0.182)
T + 3	1.102 (0.106)	1.252*** (0.0778)	1.311*** (0.113)	1.262* (0.155)	0.999 (0.257)	2.002** (0.575)	0.928 (0.117)	0.745 (0.205)
T + 4	1.149 (0.100)	1.203*** (0.0849)	1.238** (0.131)	1.251* (0.166)	1.004 (0.138)	1.892** (0.523)	1.051 (0.116)	1.059 (0.205)
T + 5	1.347*** (0.121)	1.235*** (0.0937)	1.091 (0.139)	1.175 (0.149)	1.016 (0.136)	1.368 (0.322)	0.911 (0.0941)	0.933 (0.213)
T + 6	1.429*** (0.133)	1.331*** (0.105)	1.113 (0.119)	1.018 (0.114)	1.088 (0.169)	1.347 (0.288)	1.082 (0.0956)	0.696 (0.238)
T + 7	1.332*** (0.128)	1.261*** (0.102)	0.893 (0.107)	1.150 (0.120)	1.039 (0.166)	0.770 (0.214)	0.946 (0.102)	0.882 (0.328)
Observations	29,123	29,123	29,123	29,123	29,123	29,123	29,123	29,123
Climate controls	YES	YES	YES	YES	YES	YES	YES	YES
Time controls	YES	YES	YES	YES	YES	YES	YES	YES
Seasonal controls	YES	YES	YES	YES	YES	YES	YES	YES
Monthly trends	YES	YES	YES	YES	YES	YES	YES	YES
Yearly trends	YES	YES	YES	YES	YES	YES	YES	YES
Lunar phase	YES	YES	YES	YES	YES	YES	YES	YES
Holiday dummy	YES	YES	YES	YES	YES	YES	YES	YES
Derby dummy	YES	YES	YES	YES	YES	YES	YES	YES
Type of competition	YES	YES	YES	YES	YES	YES	YES	YES

Note: Climate controls include: average rainfall, average number of sun hours, average temperature, average pressure and average wind speed. Time controls include: hour of the day, day of the week, day of the month, day of the year, week of the year, month and year. Seasonal controls include dummies for summer (mainly September) and winter. Type of competition includes dummies for: Spanish Domestic League, European Champions League, Spanish King's Cup and Super Cups (both Spanish and International). Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

We examine in greater depth the temporal profile of crime and the way in which football can shape it in Table 7 by presenting the detailed results of crime in the hours leading up to and following FCB home matches. On the one hand, in the pre-match

hours there seems to be fewer *Driving crimes* and *Drug related crimes*. In the case of interpersonal *Violent crimes* there also seems to be a reduction in the crime rate, but at a much earlier point in the day (between four and five hours before the match). In the case of *Thefts* (primarily pick pocketing), in the hour immediately prior to the match, the number of thefts increases by around 15%. Less robust is the increase (10%) found for *Criminal damage* one hour prior to kick-off.

In the hours following the match there seems to be a marked increase in crime. This result is, as expected, very strong and robust for *Thefts*. Victory celebrations bring supporters out on to the streets making them targets for thieves. The number of *Thefts* peaks just one hour after the match, but the impact of the event remains significant throughout the night (up to seven hours after the match). Likewise, an increase in the number of *Robberies* (thefts involve some sort of violence) is recorded, especially five hours after the final whistle, along with more instances of *Criminal damage*, *Violent crimes* and crimes *Against police* between three and four hours after the match. These results are related to post-match activities that include victory celebrations and/or going out after the match.

Tables 8 and 9 show the results for away matches, given that a city with a major team will have a large number of supporters that are liable to modify criminal patterns, even when the team plays away.

Table 8: FCB away matches and crime in the city during the game.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	<i>Robberies</i>	<i>Thefts</i>	<i>Criminal damage</i>	<i>Violent crimes</i>	<i>Gender violence</i>	<i>Against police</i>	<i>Driving crimes</i>	<i>Drugs</i>
Away match	0.934 (0.0727)	0.951** (0.0241)	0.991 (0.0451)	0.989 (0.0891)	0.784* (0.106)	1.507* (0.321)	0.797* (0.109)	0.533*** (0.0956)
Observations	29,123	29,123	29,123	29,123	29,123	29,123	29,123	29,123
Climate controls	YES	YES	YES	YES	YES	YES	YES	YES
Time controls	YES	YES	YES	YES	YES	YES	YES	YES
Seasonal controls	YES	YES	YES	YES	YES	YES	YES	YES
Monthly trends	YES	YES	YES	YES	YES	YES	YES	YES
Yearly trends	YES	YES	YES	YES	YES	YES	YES	YES
Lunar phase	YES	YES	YES	YES	YES	YES	YES	YES
Holiday dummy	YES	YES	YES	YES	YES	YES	YES	YES
Derby dummy	YES	YES	YES	YES	YES	YES	YES	YES
Type of competition	YES	YES	YES	YES	YES	YES	YES	YES

Note: see notes to Table 7.

Table 8 shows a significant reduction in *Drug related crimes* and *Thefts* and a reduction (albeit less strong in terms of statistical significance) of *Gender Violence* and *Driving crimes*. Again, these results could be driven by an incapacitation effect during

the match.²⁰ Table 8 also shows a slightly significant increase in the number of recorded crimes *Against police*: the coefficient seems to be positive and significant at the 10% level indicating an increase in the number of crimes of 50.7%. This result might be attributed to the celebrations of the football fans who meet in bars or at specific locations in the city.²¹

Table 9. Hours prior to and after FCB away matches.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	<i>Robberies</i>	<i>Thefts</i>	<i>Criminal damage</i>	<i>Violent crimes</i>	<i>Gender Violence</i>	<i>Against Police</i>	<i>Driving crimes</i>	<i>Drugs</i>
T - 7	0.899 (0.0664)	0.912*** (0.0232)	1.040 (0.0826)	0.916 (0.118)	1.264 (0.195)	1.145 (0.335)	0.835 (0.185)	0.874 (0.372)
T - 6	0.765*** (0.0635)	0.898*** (0.0249)	0.964 (0.0831)	0.922 (0.112)	0.670** (0.132)	1.134 (0.306)	0.686 (0.204)	0.858 (0.274)
T - 5	0.925 (0.0684)	0.922*** (0.0262)	0.956 (0.0842)	0.886 (0.110)	0.988 (0.180)	1.387 (0.349)	0.946 (0.132)	0.922 (0.180)
T - 4	0.903 (0.0675)	0.936*** (0.0240)	1.024 (0.0875)	0.789* (0.0969)	1.228 (0.190)	0.892 (0.287)	0.640 (0.223)	0.799 (0.164)
T - 3	0.936 (0.0608)	0.924*** (0.0276)	0.866** (0.0614)	0.953 (0.100)	0.955 (0.158)	0.683 (0.200)	0.973 (0.137)	0.910 (0.161)
T - 2	0.999 (0.0646)	0.909*** (0.0228)	0.932 (0.0645)	1.023 (0.120)	1.049 (0.146)	1.303 (0.374)	0.818 (0.129)	0.777 (0.145)
T - 1	0.873** (0.0592)	0.917*** (0.0289)	1.034 (0.0644)	0.794* (0.0949)	0.965 (0.157)	0.662 (0.199)	0.719* (0.141)	0.759 (0.135)
T + 1	0.934 (0.0727)	0.951 (0.0433)	1.062 (0.0706)	1.008 (0.121)	1.092 (0.144)	0.784 (0.230)	0.900 (0.134)	0.890 (0.168)
T + 2	1.164* (0.0937)	1.152*** (0.0591)	1.173** (0.0826)	0.970 (0.118)	0.866 (0.114)	0.831 (0.202)	0.972 (0.128)	0.905 (0.167)
T + 3	1.220** (0.103)	1.165** (0.0753)	1.183** (0.0861)	0.870 (0.111)	1.145 (0.165)	1.451 (0.358)	0.983 (0.105)	1.250 (0.195)
T + 4	1.110 (0.101)	1.232*** (0.0755)	0.974 (0.0864)	1.143 (0.140)	1.274 (0.199)	1.447 (0.347)	1.191* (0.110)	1.299 (0.240)
T + 5	1.099 (0.123)	1.218*** (0.0841)	1.246*** (0.100)	1.022 (0.124)	1.025 (0.187)	1.261 (0.290)	1.022 (0.106)	0.710 (0.194)
T + 6	1.165 (0.116)	1.340*** (0.0949)	1.193* (0.120)	1.264** (0.144)	1.285 (0.246)	0.866 (0.199)	1.013 (0.106)	1.683** (0.359)
T + 7	1.165 (0.116)	1.339*** (0.0948)	1.192* (0.120)	1.264** (0.144)	1.284 (0.245)	0.866 (0.199)	1.013 (0.106)	1.682** (0.358)
Observations	29,123	29,123	29,123	29,123	29,123	29,123	29,123	29,123
Climate controls	YES	YES	YES	YES	YES	YES	YES	YES
Time controls	YES	YES	YES	YES	YES	YES	YES	YES
Seasonal controls	YES	YES	YES	YES	YES	YES	YES	YES
Monthly trends	YES	YES	YES	YES	YES	YES	YES	YES
Yearly trends	YES	YES	YES	YES	YES	YES	YES	YES
Lunar phase	YES	YES	YES	YES	YES	YES	YES	YES
Holiday dummy	YES	YES	YES	YES	YES	YES	YES	YES
Derby dummy	YES	YES	YES	YES	YES	YES	YES	YES
Type of competition	YES	YES	YES	YES	YES	YES	YES	YES

Note: see notes to Table 7.

²⁰ Note that in Table 5 we include attendance at home games. If we perform a similar regression as that presented in Table 8 but with a dummy variable indicating home match we also find a reduction in the crime committed in the city during the hours of the game.

²¹ Barcelona football fans traditionally meet at the *Canaletes* fountain in the city center to celebrate their victories.

Table 9 presents the time profile of crime in the hours leading up to and following FCB away matches. In this case the results seem quite clear: *Thefts* fall prior to the game and increase after it (at an increasing rate whereas after home games the rate appears to decrease with time). Some weak evidence of a lower level of crime prior to the game can also be observed for *Robberies*, *Violent crimes*, and *Driving crimes*. In common with home games, in the hours following the match, people typically go to bars and meet with friends to celebrate or to console themselves in defeat. This can create large crowds that attract pick pockets, increase *Criminal damage* (including urban furniture) or, by increasing the level of social interaction, lead to higher levels of interpersonal violence.

In sum, the results obtained for the temporal impact of away matches on crime broadly confirm the patterns observed for home matches. The differences observed can be attributed to the spatial dimension, which has purposefully been omitted from the present analysis. Clearly, the high spatial concentration of individuals when FCB play at home is likely to be the driver for some of the results obtained during home matches and not during away matches, such as the increase in crimes *Against police* observed during home games.

6. Further results: gender violence

Note that all the results obtained up to this point seem to indicate that football matches do not have any effect on *Gender violence*. However, and as reported by Card and Dahl (2011), what seems to spark family violence (and violence in general) are defeats. Indeed, in such instances the authors find a direct relationship between these emotional cues and crime²² which suggests this type of crime may occur after a football match. Here, our results (see Table 10) point to the presence of this temporal displacement effect, indicating that it is a relevant crime type to analyze from a temporal perspective. Indeed our results show a positive and significant effect of defeats on *Gender violence*.

Thus, from between two and four hours after a defeat, there appears to be an effect on violent behavior in a family related environment, with such crimes rising by up to 150%. A similar result was reported by Card and Dahl (2011) for the case of the NFL in North America. In the case of non-family *Violent crimes*, there does not appear to be a

²² Our sample includes 25 defeats and 56 draws in total. Of these, 15 defeats and 38 draws occurred in away matches.

consistent increase, though five hours after a defeat an increase in the number of violent crimes is noted.

Table 10: Psychological effects of an FCB defeat.

	Violent crimes	Gender violence
T + 1	0.658 (0.296)	0.932 (0.464)
T + 2	0.813 (0.416)	1.565* (0.411)
T + 3	0.827 (0.380)	1.045 (0.405)
T + 4	1.104 (0.565)	1.673** (0.439)
T + 5	1.353 (0.552)	0.826 (0.369)
T + 6	3.050*** (1.004)	1.057 (0.297)
T + 7	1.418 (0.711)	1.069 0.932
Observations	29,123	29,123
Climate controls	YES	YES
Time controls	YES	YES
Seasonal controls	YES	YES
Monthly trends	YES	YES
Yearly trends	YES	YES
Lunar phase	YES	YES
Holiday dummy	YES	YES
Derby dummy	YES	YES
Type of competition	YES	YES

Note: see notes to Table 7.

7. Discussion

The results reported above regarding the temporal displacement effect of football matches on crime rates require a fuller discussion. As already mentioned, the results associated with home matches can be explained if we take into account the spatial dimension. For instance, the fact that the number of *Thefts* increases an hour before the match would seem to indicate that offenders take advantage of the agglomeration of supporters entering (or congregating near) the stadium. Although a proper spatial analysis needs to be conducted to confirm that this increase in *Thefts* is due to the agglomeration of football fans, the fact that a similar increase does not occur before away matches provides partial confirmation.

The results obtained in the hours leading up to a home match can be accounted for in terms of a substitution effect. That is, since large numbers of police officers are deployed in order to safeguard citizen security around the stadium, less attention is given to other criminal activities (for instance, drug consumption, dangerous driving or

alcohol consumption) and so crime reports fall (especially since these crimes are reported by the authorities themselves). In the case of *Drug related crimes* this effect also appears to last for an hour after the game. These results again are confirmed by the apparent effect of away matches, which as expected present no impact on these types of crime, given the absence of any substitution effect.

Importantly, therefore, our estimates, after controlling for a wide range of possible temporal determinants, indicate that certain crime types increase after FCB football matches. Some of these increases can be attributed to victory celebrations or the commencement of weekend leisure activities after watching the game, accompanied by consumption of alcohol. This is the case of *Robberies*, *Criminal damage*, and *Violent crimes*, regardless of whether FCB have played at home or away (albeit in different time spans), indicating that this impact can be attributed, in general, to the euphoria occasioned by football. Logically, crimes *Against the police* only increase after home matches, attributable to agglomerations and problems of euphoric crowds clashing with police officers in the vicinity of the stadium.

8. Conclusions

This paper has presented the first detailed temporal analysis of crime in an urban context, with a particular focus on the hourly displacement of crime patterns attributable to the scheduling of a major sporting event (i.e., FC Barcelona's football matches). In short, we have analyzed the principal effects of these games on crime before, during and after the match.

First, as expected, the results reveal a clear time pattern for criminal activities. Although different patterns are found according to the specific type of crime under analysis, we can report a number of stylized facts. Crimes most closely associated with leisure activities (e.g., crimes *Against police*, *Driving crimes* and *Drug related crimes*) peak late at night, presenting low rates during the day-time which increase as the evening progresses. Crimes against property (*Robberies*, *Thefts* and *Criminal damage*) peak after 18:00 (associated with people coming out of work on weekdays), but fall again as the night progresses. Crimes involving violence (*Violent crimes* and *Gender violence*) gradually increase throughout the day and peak in the evenings. Additionally, we find evidence of a week-end effect for all crimes, while some types of crime present a marked seasonal pattern, especially those most closely associated with tourism (*Violent crimes* and *Thefts*).

Second, our results point to the temporal impact of football matches on crime rates. Thus, we find a fall in some types of crime in the hours before an FCB football match is played and an increase in some types of crime afterwards. The reduction in crime prior to a match would appear to be capturing the incapacitation effect of potential offenders, whereas the post-match increase appears to depend on the type of crime. Thus, increases in *Thefts*, *Robberies* and *Criminal damage* occur regardless of whether FCB have played at home or away, indicating that offenders are taking advantage of victory celebrations or the initiation of post-match leisure activities. Other significant increases appear to be related to the spatial distribution of individuals in association with the match that has just been played; thus, for instance, the increase in crimes *Against police* reported after home games but not after away matches appears to point to the impact of spatial concentration on crime.

Our study identifies an interesting impact that is likely to be related to the possible substitution effect experienced by some types of crime and which reflects the specific deployment of police resources during a football match. In general, during major events, such as FCB matches, police officers inevitably switch their attention away from fighting certain types of crime in favor of safeguarding citizen security in and around the event. For example, police check points or random checkpoints are not manned with the subsequent fall in the number of reports of drunk driving, drug consumption or drug smuggling.

In general, football matches do not appear to have any impact on rates of *Gender violence*; however, an increase is noted when the sample is restricted to those games in which FCB were defeated, and so we obtain some evidence of a link between sports results and violence in the family.

The results reported herein provide new, broader evidence on the crime patterns produced on football match days, pointing to the temporal displacement effects that football matches may have on crime. As such, it is our belief that these results can be useful in determining the temporal deployment of police officers on match days as well as in understanding the way in which offenders behave according to the characteristics of a match day. Further research needs to be focused on spatial analyses, which should illustrate how the crimes are spatially distributed across the city and how football matches can alter these crime patterns. Similarly, closer collaboration with police agencies should improve the data available for researchers, since knowledge of the

actual allocation of police officers and their deployment during a match is essential for identifying crime displacement and concentration effects.

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