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Sports Stadia in a Real Estate Context: The case of the Emirates Stadium in London

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Abstract:

The present research aimed at making two parallel contributions. First, assessing the inherent characteristics of a football stadium and then appraising its impact on housing prices. The stadium of interest was the Emirates Stadium, the home of Arsenal Football Club in Islington, a London's Borough.

The first part comprised the development of a grading model that intended to capture the potential of attraction of the stadium, according to the sport performance. It resulted in poorer performance for the Emirates Stadium (74.86%) than its counterpart the Stamford Bridge Stadium (90.69%). An investigation on the key features of the Emirates Stadium development was also undertaken in this part. It was found that the stadium development had positive effects on the Islington Borough, with new residential stock, transport enhancement but also in terms of image. However, one of the inherent characteristic of such an amenity is its NIMBY status at a local scale.

The second part of the search was focused on the use of a difference-in-difference (DiD) regression to assess if there was an effect of the Emirates Stadium on housing prices in the Islington borough. Three different regressions were done in order to refine the data being modelled. The three regressions resulted in a negative impact in the housing prices for the Islington borough. As a consequence, the two research were complementary and enabled to have a global image of the impact of the Emirates Stadium on the Islington borough: in terms of exposure, Urban Development, and housing prices. But such methods can be improved by the addition of other factors in the grading model, or taking into account distance to the stadium to make several DiD regression.

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I Introduction:

The scale of major sport events has experienced a boom in the last decades with a fierce competition between countries and cities (JLL, 2001). Cities and countries often see those events as an occasion to build stadia and use them as a development tool (Baade, 1990).

As a consequence, there was skyrocketing number of stadium and arena development in the last decades. For instance, 64 major league stadia were built in the USA between 1991 and 2006 (Feng and Humpheys, 2008).

Stadia and sport events are seen as a catalyst for local development that bring an increasing demand for services (Alakshendra, 2016). Sports is even perceived as an industry able to address social issues such as inequality, deprivation or crime in urban areas (Davies, 2005).

This is why it is of paramount importance to assess the potential impact of sport infrastructures on Economy, including Real Estate. The supporters of stadium development often argue that stadia generate benefits for local economy: increase in income, job creation (Feng and Humphreys, 2008). The global literature has globally found no (or even negative) impact of sport facilities on local economy. This literature comes into conflict with the continuing support to subsidize sport facilities. It can be explained by intangible elements such as civic pride that may appear when a sport team or a sport facility moves to a certain area. Cities have embraced the idea that stadia are enhancing their image and provide an international exposition (Baade and Dye, 1990).

Mega sport events (Olympics, Commonwealth Games, FIFA World Cup …) are expected to bring economic benefits: employment growth, increased investment and increase in retail sales. However, these effects are short-term (Coates and Matheson, 2011).

Other repercussions on local economy are visible on the longer term. Indeed, the development of sport facilities can be included in a wider regeneration project and comprise the enhancement of local infrastructures and the upgrading of residential stocks (JLL,2011) This brings a shift in house price levels thanks to the capitalisation of those new amenities and new employment opportunities (Kontokosta, 2010). This is particularly the case since 1992 Olympics in Barcelona which was used as a lever to undertake major urban regeneration projects (Yamawaki and Duarte, 2014).

Then, sports stadia, and the Olympics have seen a growing recognition amongst city authorities as an urban regeneration tool (JLL, 2002). Iconic sport facilities are the occasion to improve its image and become the momentary centre of the World with mega-events (Wang and Bao, 2018). However, stadia are also considered as disruptors at a local scale as they are often characterized as NIMBY (Not in My Backyard) amenities and are thought to be the stage of vandalism or noise pollution (Davies, 2005).

Housing prices are often seen as the interaction of several attributes, including neighbourhood attributes. Means of transportation, schools, parks, industrial warehouses, regional crime, noise and pollution levels are known to have a significant impact on residential prices for instance (Kavetsos, 2012).

Generally, the economic benefits of new amenities are reflected in housing prices since the increasing appeal of a neighbourhood after being subject to urban regeneration. Indeed, people tend to settle in places with a favorable endowment in specific amenities because they are located closer to them (Ahlfeldt and Kavetsos, 2014).

Therefore, when undertaking a stadium development, there is a need of understanding the key features that can make it a successful amenity to forecast the future evolution of housing prices (KPMG, 2013)

The purpose of the present dissertation was to make two contributions using first the characteristics of a stadium development and then its impact on housing prices.

The example taken was the Emirates Stadium development in Islington, a London's borough in 2006. Since 2006, The Emirates Stadium is the home stadium of the Arsenal Football Club which plays in the English Premier League (PL). The Premier League involves 20 teams every "season", from September to May.

The layout of this dissertation is as follows:

Firstly, the literature review gives an overview of what was already written on stadia and sport events in a real estate or urban development context.

Then, the research was split into two parts: the assessment of the success of the Emirates Stadium development, and the evaluation of the impact of the Emirates Stadium on housing prices in the Islington Borough.

At first, a grading model has been constructed to assess the potential sport appeal of the Emirates Stadium. It was inspired by Multiple Criteria Decision Analysis. In the same part, an investigation has been undertaken to evaluate the key features of the Emirates Stadium in accordance to what was found in the literature. The aim was to answer the following question: given the characteristics of the Emirates Stadium development, is it possible to make any forecast on the evolution of housing prices?

The second part was focused on the use of a Difference-In-Difference (DiD) regression, using the Kensington and Chelsea borough as a comparable group. The data used was the average house price between 1995 and 2010 in the Islington borough. The variables used was time on a monthly-basis, the location (using a dummy variable), and the intervention variable (using a dummy variable as well). Three different models were constructed in order to improve the fit with the data being modelled. The two parallel contributions aimed at complementing themselves, to give a global overview of the impact of the Emirates Stadium in the Islington borough.

II Literature review:

II.1 What are the factors that make stadia development successful?

A wide literature which deals with factors that can make a stadium development successful has been found. According to JLL (2002) some of those factors are:

- The creation a vibrant neighbourhood around the stadium: A mix between leisure, and retail to create an "experience".
- The enhancement of community pride.
- The ability to become a landmark and gain exposure.
- An increase in Real Estate values that can attract higher value uses, new employment opportunities by capitalizing the sport tourism.

Some stadia are built to move in line with a club or a nation economic and sportive growth, others are initiated for the purpose of hosting a major event: Olympics, World Cup, or Champion's League in football. For example, a qualification for the latter has a significantly positive effect on attendance demand since it takes places all-year long. (Martins and Cro, 2016). So, sport performance is essential in making a successful stadium development and gain exposure.

The type of ownership also matters. The vast majority is publicly owned in Europe, but in the UK 18 clubs among 20 own their football stadium (KPMG, 2013). It brings a financial strength to the English Premier League compared with other leagues. Indeed, owning its stadium enable clubs to boost their revenues and gain flexibility while enabling them to grow (EY, 2013).

Architecture also help to gain exposure for a stadium development. Some of the most renown architects were chosen to work on sport infrastructures like the Allianz-Arena in Munich (Herzog and de Meuron, 2018). By using state-of-the-art techniques and original architecture, those developments became a landmark and created a visiting-card for their home town (Ahlfeldt and Manning, 2009). Thus, the built environment plays a key role in the appeal of a neighbourhood.

However, according to some researchers, it is quite difficult to assess what is a “good” design and what is not since it is mainly subjective. However, some features of iconic architecture can lead to a high recognition value (Ahlfeldt and Mastro, 2012). Besides, an iconic stadium architecture and urban design can boost successful municipal policies for urban development (Ahlfeldt and Maenning, 2010).

Spatial configuration is also at the heart of a stadium success because a good design enables a maximisation of customer flows and increase revenues. Food and beverage is indeed one of the main source of revenues for stadium owners along with tickets sales and depends on customer flows (KPMG, 2013). Therefore, it is paramount to appoint a stadium management company to operate the stadium so that spatial configuration can meet the company’s requirements (UEFA, 2011).

However, even a standard stadium can have positive effects the project goes along other development and contribute to the attractiveness of the surrounding area (Ahlfedt and Maenning, 2010).

Therefore, it is necessary to include its development in a wider development scheme (JLL ,2002).

Indeed, stadia have become places of entertainment to keep visitors for longer periods of time before or after an event (KPMG, 2013). This is why there is a need of including the stadium in a mixed-use area.

For example, Beijing has seen a shift in its urban development around the main stadium of the 2008 Olympics (Horne, 2011). This was also the case for 1992 Olympics in Barcelona where the urban rehabilitation was one the main focus of the public investment (Ahlfeldt and Maenning, 2010). 1992 Olympics left a legacy made of new districts and buildings in Barcelona waterfront and important leisure facilities along with the enhancement of the road networks. It demonstrates how the construction of new sport infrastructures along with mega-events can shape a city (Chen, 2012).

Other cities like Seoul, Sydney, Atlanta also used the Olympics and the development of sport infrastructures as a catalyst to revitalise declining neighbourhoods. Atlanta for instance had serious traffic issues and the 1996 Olympics enabled to tackle them (Friedman, 2001).

Athens 2004 Olympics was also ambitious with numerous urban regeneration projects: the establishment of park, recreation, education and leisure areas covering more than 250 ha (JLL, 2001). Olympic villages development consists in large residential areas, retail, hotels to host visitors and national teams. Therefore, the Olympics and mega-events in general can be the theatre of the creation of new urban centres around sport facilities (Munoz, 2006).
It demonstrates how important is the creation of vibrant places around sport facilities by enhancing transportation, housing stock and by providing facilities such as Hotels and retail area.

However, the impact of Olympics and other events real estate markets is mainly focused on Hotels and residential markets with little consequences on office and retail markets (JLL, 2011). But if those bring new residential supply and hotels, it could mean that the demand for offices and retail spaces will be more important if the facilities are located far from the business districts (JLL, 2015).

The location of the stadium is also decisive in stadium success. The accessibility by public transport and the presence of a potential fan base is decisive in the final decision. For example, the Velodrom location was chosen in a specific area in Berlin because of the proximity of the tram and suburban railway network (Ahlfeldt and Manning, 2009). Iconic structures in general reveal certain common characteristics, among which its location which is within walking distance of the city centre (Ahlfeldt and Maenning, 2012). However, one of the main flaw of some of the new stadia development is their distance with the city cores. Allianz Arena in Munich for example is located on the urban periphery and is surrounded by roads and infrastructures of waste disposal which tend to limit its appeal (Ahlfeldt and Maenning, 2010).

Feng and Humphreys (2008) claimed that cities continue to provide subsidies to build sport infrastructures even if there is no evidence that these facilities provide important economic benefits. This led them to suggest that sport facilities may generate other intangible benefits such as exposure, public image enhancement.

In the same spirit, Carlino and Coulson (2004) affirmed that the large amount of money dedicated to new stadia appeared to be a good investment for cities and their residents regarding the increasing quality of life of local resident.

Public reception is then of a paramount importance. Some activists may protest against a stadium development since they expect disturbances: traffic congestion, vandalism. This may lead to decrease in property values (Ahlfeldt and Manning, 2009). Stadia are often categorized as NIMBY (Not in My Backyard facilities) because even if the developments are supported by a majority within society, it is not the case for people living in their vicinity (Davies, 2005). Strong opposition emerged in the case of the Allianz Arena, the stadium which host the Bayern Munich, a football club with worldwide reputation (Ahlfeldt and Maenning, 2012).

So, despite the fame of the club and the state-of-the-art architecture of its stadium, the development remained controversial at a local scale. The positive attitude towards the Allianz-Arena stadium at a bigger scale underlines the fact the people located far from the stadium only sees its benefits: transportation enhancement, improvement of the residential stock (Ahlfeldt and Maenning, 2009).

More recently, terrorism has raised some questions about stadium security (The Guardian, 2017). Summer Olympics in 1972 was the first stage of terrorist's attack which led to a reinforcement of security in most arenas (Coates and Matheson, 2009). More recently, Greece has spent $1.5 billion on security in 2004 for the Olympics (Meeks B., 2004), and severe doubts have been raised about the weak status of stadium construction and potential terrorist attacks in France before 2016 Euro Cup. (Süssmuth et.al, 2010). Therefore, the literature highlights the reluctance that can have people towards the stadia development and their negative impact on the neighbourhood. This is why security is a matter of importance in the success of a stadium development.

Despite these negative external effects, some found that sport can provide a unifying element to civic pride (Johnson et.al, 2001). This notion would be embedded in real estate prices, but one may wonder if that would be the case in cities that do not have a strong appeal in sport.

However, stadia benefits are generally thought to be not large enough to justify the outstanding amount of money spent on such facilities (Jones, 2001).
That is why market analysis is one of the most important aspect that must drive stadium development which has to meet the expected demand and supply trends. Fan Surveys, interviews, focus groups can be used before a stadium development to assess how much they are willing to spend to see a football game (KPMG, 2013).

The economic benefits which are generated by stadiums are mainly derived from: rent, seating and premium seating (Deloitte, 2018). In some cities, the rent paid by a team is related to the attendance. For example, the Chicago White Sox rent its stadium for a 22-year lease (Baade and Dye, 1990). The team had to reach a certain number of attendance over a decade, otherwise the team had to pay the difference to the owner. This highlights the relevance of including a stadium in a wider development context. It allows to capitalize the stream of pedestrian around the arena. This is also why a stadium must suit to people's need and expectation in order to maximize the attendance (Jones, 2001).

Making a stadium development successful also requires it to be a multi-use arena. Veltins Arena in Gelsenkirchen Germany is maybe one of the most meaningful example of a state-of-the art stadium development for multi-purpose use (KPMG, 2013).

Figure 1: Veltins Arena during a Football Match

Its technology enables it to host a range of different sports: football, ice hockey, American football, handball, biathlon, concerts, trade shows, corporate conferences and private events. The stadium hosts between 25 to 30 major international events and attracts more than 1.5 million people per year (Paramio et.al, 2008).

Figure 2: Veltins Arena During a concert

A careful analysis of funding opportunities is also crucial in the success of a stadium development. Achieving to raise finance is easier when clubs or nations have a large and loyal fan base which can ensure a steady cash-flow in the years following the development. Several options are available for clubs: equity financing, debt financing, public funds (Alakshendra, 2016).

Naming is also one of the main mean to ensure revenues from a stadium. This is why the biggest clubs try to find sponsorship to build a new stadium or renovate one such as Real Madrid (Ginesta, 2017).

Finally, in order to undertake such a development, there is a need of skilled project managers to avoid the main risks associated with the construction sector: delay, costs, defect in design (KPMG, 2013). However, this factor is quite unquantifiable.

The impact of stadia on the economy of the stadium surrounding is also a major concern to give subsidies to finance these amenities. This impact is always a subject of controversy or scepticism for researcher (Baade, 1996; Noll and Zimbalist, 1997).

II.2 What is the impact of stadia and sport events on housing prices?

Tiebout's theory asserted that consumer-voters' preferences are displayed by exit and not by voice (Tiebout, 1956). In other words, if people have to choose between different communities, they will tend to move in area which exhibit their most preferred local public goods and services (Boadway and Tremblay, 2012). When it comes to Real Estate, this theory reveals that owners and renters pay higher rents and higher housing values when they move to neighbors with higher amenity value (Ahlfeldt and Kavestos, 2014). Cebula and Clark (2013) added that Tullock's work in 1971 completed the Tiebout's Model, by affirming that consumer-voter choice also evaluates the tax burden preferences. Thus, communities have means to enhance its home values, among which the production of a nice environment and an effective fiscal zoning (Fischel, 1992). This theory is at the basis of the numerous studies that tried to found the impact of local amenities on housing prices: Hedonic Modelling, difference-in-differences approach… These methods were used in some of the following literature:

For a long time, literature tried to link housing prices with the surrounding amenities. Fack and Grenet (2010) found for instance that school performance in Paris has a significant impact on housing prices. Black (1999) also studied their impact on residential prices from 1993 to 1995 in Boston suburbs. She asserted that research have been complicated by the fact that better schools tend to be located in better neighbourhood, which led to overestimate the role of school in house prices. She concluded that parents are willing to pay 2.1% more for houses associated with better test scores at school. Clapp et. All (2007), found similar results.

Transports have also been the subject of numerous research; Debresion et.al (2007) depicted for instance the repercussion of transport facilities on both commercial and residential properties prices in terms of distance. The results showed that the effect of railway stations is observable only on short distances. The effect was greater for commercial properties than for residential properties within a ¼ mile zone compared with other parts of the city (12% larger).

Until recently, most of the literature related with sport facilities was focused on the impact of golf courses. For instance, Do and Grudnitski 1995 used a standard hedonic pricing model on sales transactions in the urban area of a large city. Their findings shown that golf course location added 7.6 % to property's sales price. This premium appeared to be highly significant for the area of the research.

Katvestos (2012) asserted that this "trend" to focus research on the impact of sport facilities on property values is due to the fierce competition of countries and cities to host major events or franchise. For instance, Carlino and Coulson (2004) appraised the impact of National Football League Franchise (NFL) on property rents. They identified an 8% increase in rents for central cities that comprised an NFL Franchise and 4% in the wider metropolitan area. However, Ahlfeldt and Kavestos (2014) raised an interesting issue: are these effects attributed to the presence of new amenities like the stadia or the sport franchise?

Others like Charles C.Tu (2005) focused their research on the impact of a stadium (FedEx Field in Washington D.C) on housing prices depending on their proximity to the stadium using a hedonic approach. The researcher also undertook a difference-in-differences analysis, using housing values before and after the date of opening was revealed.

The models shown that properties at the vicinity of the stadium were sold at a lower price than those more distant to the FedEx Field. However, difference-in-differences analysis revealed that the price discount was effective before the stadium development which could be a reason why the FedEx Field was developed in this area. Then, the price difference was reduced after the development completion.

Some delivered a strategy to assess external effects of stadia in property prices, taking the example of New Wembley and the Emirates Stadium in London (Ahlfeldt and Kavetsos, 2014).

They found that there was an immediate positive effect on property prices just after the stadium development announcement at the vicinity of the stadium. They also asserted that architecture plays a paramount role in determining prices since a stadium can become a landmark in its surrounding.

They noticed a 15% increase in property prices very close to Wembley Stadium, and a 1.7% increase in property prices for a 10% decrease in distance to the Emirates Stadium.

An interview-based analysis by Davies (2006) provided similar results for the City of Manchester Stadium and the Millennium Stadium in Cardiff. Positive impacts were observed in the surrounding areas of the stadia. However, the repercussions were mixed for commercial properties. This could be explained by the fact that people preferred not to go shopping on stadium-event days to avoid traffic jam. This assertion is quite striking because one may think that stadium-event days bring a massive pedestrian flow in the stadium surroundings.

Announcement effects are also sometimes appraised. For example, Dehring et.al (2007) focused on the National Football League's Dallas Cowboys which was searching for a city to host its new stadium in the Dallas-Fort-Worth area. The announcement of their will to build a stadium led to a rise in residential property values. However, this pattern of prices was inverted when the stadium project was rejected.

G. Kavetsos (2012) focused on 2012 Olympics announcement in London. The area of the research was defined as Greater London. His findings showed that properties in host boroughs were sold between 2.1% and 3.3% higher. He found that properties comprised in a three-km ring around the Olympic Stadium were sold 5% higher than those outside of the ring.

All of this can lead to the following assumption: people might wish to move their housing in proximity to a stadium, because it may embody a certain pride. This drives the price up because of an increasing demand.

Kontokosta (2011) also appraised the impact of the Olympics on residential prices for 6 host cities between 1984 and 2000. Only two of the six cities have seen positive impact on property prices and the other four had negative or no significant impact. JLL (2001) asserted that the "true" Olympic-effect on residential sector is not in the evolution of prices, but in the development of new districts within the Olympic area. It is also suggested in this report that the Olympics impact can be a short-term boost in rentals, and the upgrading of the existing housing stock is a long-lasting effect.

Zentelis and Labropoulos (2004), evaluated the impact of the Olympics development on the Athens Real Estate values. Market values increased by 30% to 50% near metro stations. The road network was improved which drove the demand up for residential and commercial properties. However, even if the Olympic Village hosted 2,292 residences, it did not affect the surrounding neighbourhoods in term of gain in value. Here contrary to most of the papers, it dealt with the Market Values of residential properties which differ from housing prices.

Market value is "The estimated amount for which an asset or liability should exchange on the valuation date between a willing buyer and a willing seller in an arm's length transaction, after proper marketing and where the parties had each acted knowledgeably, prudently and without compulsion" (RICS, 2017). This can differ from the price that is finally achieved during transactions because there can be a lag time depending on the maturity of the real estate market.

Thus, some papers have found that the Olympics can boost residential prices around sport facilities through the development of Olympic Villages for instance.

Allmers and Maenning (2009) found that France which hosted the 1998 Football World Cup did not register an increasing number of foreign visitors, so the real estate hotel sector was not impacted. According to the paper this was due to the reluctance of some tourists who might have postponed their trip because such events can bring disturbances for tourism, such as noise or traffic congestion. The two researchers also asserted that South Africa will surely have to cope with the underuse of the World Cup stadia. It underlines the difficulty to find the correct balance between investing large amount of money to host sport events and being able to capitalize on those investments afterwards.

Coates and Humphreys (2006) had a different approach and tried to know what were the preferences of local residents on subsidies for professional sport facilities in several cities of the U.S. Their research resulted in finding that the net benefits of stadiums and arenas were perceived by resident in areas in the close vicinity of sport facilities. The voting preference was indeed in favour of subsidies in these areas. This can be explained by the fact that people see the benefits in their living area.

People in the proximity of a stadium are more likely seeing the benefits of the sporting facilities, but the drawbacks as well.

There a few papers on the impact of those sport facilities on community's "quality of life": civic pride, city image, community exposure since it is very hard to quantify and change quickly progressively (Noll and Zimbalist, 1997).

Feng and Humphreys (2008) focused their research on the intangible benefits of professional sport facilities and their impact on residential property values, using a spatial hedonic approach. Those intangible benefits, such a civic price, were said to be capitalized into housing values.

Their conclusion drawn different patterns of stadia development. A state-of-the-art stadium included in an urban redevelopment program will provide a great increase in residential property values in the vicinity of the sport facilities. A stadium located outside the downtown core of a city, which is not connected to the city economic development will still see its residential prices increase, but at a lower level.

Globally, the papers that were analysed found a positive impact at the vicinity of sport facilities. Most of the studies identified that the effects of major sports venues on property values in surrounding areas indicated a maximum affect area of some 3-km (Fedderson et. Al, 2009).

However, some empirical research found that professional sports facilities have little or no impacts, or even sometimes negative impacts on the local economy as a whole, including real estate. Baade (1994) research resulted in no impact on personal income growth from 1958 to 1987 in U.S metropolitan areas that hosted a professional sport team compared with other cities that did not.

Coates and Humphreys (1999) even found that the presence of stadia cut down incomes per capita in host cities. They affirmed that if people average consumption is the same inside or outside a stadium, the economic impact of sport facilities is unlikely to be important at the scale of a metropolitan area. However, it can be noticed that it is not be the case for teams that can attract money from outside their area, which is the case with international renowned teams (Siegfried and Zimbalist, 2000).

Similarly, Coates and Matheson (2009) looked for the impact of three mega-events (Surperbowl, Olympics and World Cup) on rental prices in host cities in the U.SA between 1993 to 2005. The research resulted in a failure to find a significant impact of those events on rentals, and are more likely decreasing them rather than increasing them. However, it should be criticized that the Football World Cup took place in 1994. Therefore, looking at the data only 1 year before could have distorted the results. Indeed, stadia development, transport enhancement and urban development projects took place before 1994, and as a consequence it could have had an impact on rental prices. Moreover, the vote to designate the World Cup organizer took place on 1988 and it triggered fluctuations in rentals.

Baade (1996) also found no positive correlation between sport facilities and job creation. He even asserted that stadia have been oversold by the teams as a catalyst for economic development.

As a consequence, the literature has tried the assess the impact of stadia development, sport events such as the Olympics or the Football World Cup. The results are quite diverse depending on the geographical area. Most of the literature noticed a positive effect on residential prices in a 3-km ring around stadia. But the global impact on host-cities economy seem to be insignificant. However, the organization of mega-events, especially the Olympics seem to have a more disruptive effect on real estate prices since it often includes the urban regeneration of certain areas, in the surrounding of the Olympic Village.

III Methodology:

The Emirates and the Stamford Bridge stadia were the matter of interest in the present research. Firstly, an appraisal of the Emirates Stadium development success was undertaken. Then, the impact of the Emirates Stadium development on housing prices in the Islington borough was assessed, using Kensington and Chelsea borough as a comparable group.

III.1 Assessing a Stadium development: The case of the Emirates Stadium:

The first part of the research assesses the success or not of a stadium development: The Emirates Stadium in London (Islington Borough). The literature raised several key points that must be taken into account in a stadium development:

- The stadium must be exposed: host major sport events and being linked with a successful club or team that have a solid fan base.
- an appealing architecture to become a landmark and embody civil pride while enhancing the neighborhood image.
- Maximize revenue: a multi-use arena that can host other sports, even museums, concerts, shops in the stadium.
- Include the stadium in a wider development context to enhance the neighborhood and capitalize the stream of pedestrian: Hotels, retail area and to create a new urban center.
- A good accessibility.
- Ensure a good cash-flow revenue to repay the club's debt with a use of naming rights for instance

Therefore, two analyses were done. The first one aimed at grading the Emirates Stadium between the seasons 2006/2007 and 2010/2010 in order to estimate its appeal for football fans.

The data estimated to be important to capture the potential of attraction of the Emirates Stadium at that period of time is as follows:

- Number of games at home
- Number of Champion's league games
- Number of wins at Home
- Win rate at home
- Number of goal scored at Home
- Average ranking in the league
- Number of trophies
- Average attendance
- Average occupancy rate

The data were graded on a scale from 0 to 100% according to the ranking in Premier League concerning those data. For example, an increase by 1 position in the ranking was converted by a 1/20 premium in the grade which means 5% (because 20 clubs play in Premier League). Then, each grade was weighted according to what was considered to be important to assess a stadium appeal. The aim was to capture the potential of attraction of a stadium for people. This "attraction" is embedded in the final grade.

Then, a comparison was made between the Emirates Stadium and the Stanford Bridge, another stadium located in the Kensington and Chelsea borough. The latter is hosting the Chelsea F.C which plays in PL too. The aim of the research was to grade each parameter previously stated in order to make a comparison between the two stadia.

The chosen grading model was inspired by Multiple Criteria Decision Analysis:

III.1.1 Multiple criteria decision analysis (MCDA):

Grading criteria is an inevitable step in a variety of fields. The preference modeling is used to establish an order between "objects".

Building a model based on reality always need to abstract from it, and is necessarily subject to uncertainty. The latter can be due to hesitation or to incomplete information (Greco et.al, 2016).

After that, weights can be attributed to characterize their importance relative to each other. It remains a critical step in the multiple criteria decision analysis. One of the most common way of weighting is to try to reflect the importance through expert interviews, surveys. Some are collecting it before weighting the criteria (*a posteriori* weights). Others prefer to weight criteria before collecting the information (a priori weights) The former is more convincing because the weights are a reflection of the date (Kao, 2010). The latter was used in the present research.

Secondly, an investigation was conducted using a variety of sources to reveal the key characteristics of the Emirates Stadium. The aim of those two-parallel research was to give a global overview of the Emirates Stadium impact on its surrounding. Both are complementary and helpful.

III.1.2 Limits of the methodology:

The grading was based on factors that were thought to be important to estimate a stadium appeal. Even if this data was quantifiable, it is quite tricky to grade and weight them. Survey and interviews could have been undertaken to ask to football fans what are the most important factors that drive them to go into a stadium. Also, the available data could have captured more stadium aspects such as the security of the stadium or the architectural shaping of the stadium inside. However, those data were either impossible to quantify or not available.

III.1.3 Data:

The sport performance data comes from the official Premier League website. It comprises statistics about Premier League teams since the 1992/1993 season. The data was picked from the 2006/2007 season to the 2010/2011 season for the purpose of the research. Those dates were chosen because they cover the date of interest of the second part when assessing the impact of the development on housing prices.

2006/2007 was the first season where Arsenal F.C played in its new stadium. The investigation was undertaken by using a variety of secondary data sources: newspapers, official club statement, professional reports.

III.2 Difference-in-Differences method:

The aim of the second and parallel research was to use the DiD model and apply multiple regression to this model to assess the effect of the Emirates stadium on residential prices in Islington, the London Borough which hosts the Emirates Stadium. The comparable group was chosen as being the Kensington and Chelsea Borough in London as well. Indeed, Islington and Kensington and Chelsea have approximately the same area: respectively 14.86 km^2 and 12.13 km^2. Moreover, Kensington and Chelsea borough is located more than 10-km away from the Emirates Stadium. It means that the impact of the Emirates Stadium development will be imperceptible. Indeed, most of the studies and papers that tried to assess the impact of sport facilities on residential have found that the impact will be more visible on a radius between 3 and 5 km (Ahlfeldt and Maenning, 2010)

"Difference-in-differences" (DiD) is used to study a treatment group (experimental group) which is treated at some point in time while a control group (comparable group) is never treated. A before-after (BA) analysis calculates the difference of the experimental group outcome before and after a treatment (intervention). But DiD calculates the two BA differences for the experimental and control group (Lee and Matching, 2016).

The DiD method is a widely used method in Economy or in Biology. It is a simple but effective way to assess the effect of an "intervention" using a statistical analysis. It needs however to have data of a control group and of a group who was treated, before and after the intervention.

The BA analysis compares the same group before and after an intervention to find the effect of it. But if the intervention effect is long lasting, some variables may change over time.

So, the changes in the outcome Y may be due to changes in changing variables and not the treatment (Lee and Matching, 2016). This leads to the use of the DiD model.

The DiD model has the particularity to remove all the effect of disruptive elements that would affect the treatment, as long as the control group is also affected by those disruptions; It is because DiD deducts the outcome change in the control group from those observed in the treatment group. As the two groups were chosen so that they have the same "trend", the DID results remove the treatment confounders.

It is conventional to estimate the DiD using multiple regression analysis (Cataife et.al, 2017). This regression-based DiD has the advantage to both increase the accuracy of the estimate and report standard errors and p-values to assess statistical performance.

In the following research, the DiD regression was used in its simplest version, with two periods: before and after the Emirates Stadium development and two groups: Islington (The Emirates Stadium borough in London) and the Kensington and Chelsea Borough in London.

The DiD estimate is used using a multiple regression as follows:

$$Y= \beta_0 + \beta_1 * A + \beta_{2*} I + \beta_3 * A * I$$

Where:

- Y: Outcome of interest
- A: dummy variable equal to 0 or 1, captures differences between the experimental and control group before the treatment
- I: dummy variable for the second-time period, equal to 1 or 0
- A*I: a dummy variable, equals to 1 for observations in the experimental group in the second-time period, after the treatment (Imbens and Woolbridge, 2007).

The regression results in finding $\beta_{0,}\, \beta_{1,}\, \beta_{2,}\, \beta_3$ coefficients:

- β_0 is the intercept for the control group
- β_1 represents the slope for the pre-intervention period, for the experimental group

- β_2 represents the adjustment compared with β_0 to calculate the intercept for the experimental group. So, the intercept for the experimental group would be: $\beta_0 + \beta_2$.
- β_3 represents the adjustment that takes place after the intervention period compared with before. This is the coefficient of interest in the DID regression.

In its general form, the DiD equation comprises an interaction term μ as follows:

$$Y = \beta_0 + \beta_1 * A + \beta_{2*} I + \beta_3 * A * I + \mu$$

III.2.1 Limit of the DiD analysis:

The important assumption is: if there was no intervention, the outcome (Y) of the intervention group would have followed the same trend as the outcome of the comparable group.

Thus, changes in Y in the control group must be similar to changes in Y for the experimental group if there was no intervention, which is a strong assumption. It implies that the control and experimental groups are influenced by the same factors, so that they behave similarly.

Moreover, there is an assumption that there are no disruptive factors, which is no directly testable. But, it is possible to assess the accuracy of this assumption by looking at the trends before the intervention period. The Y trend of the control group must be parallel to the Y trend of the experimental group before the intervention period.

So, finding that the outcome trends are parallel before the intervention period can imply that in the absence of treatment, trends would have continued to follow parallel trends. Finding non-parallel trends would mean that the DiD analysis is not reliable (Imbens and Woolbridge, 2007).

IV Research part:

IV.1 Assessing the Emirates Stadium development:

IV.1.1 Grading Model: Potential of attraction appraisal

The grading model aimed at assessing the potential exposure of the stadium due the sport performance between the 2006/2007 and the 2010/2011 season. Different weights were attributed to the nine factors that were included in the grading.
The weights were chosen according to one assumption: winning (trophies and games) is more important than playing well (scoring goals). That is why the greatest weight has been attributed to the number of trophies won: 3 over 9. Then the second greatest weight has been attributed to the average ranking in Premier League over this period of time: 2 over 9.

IV.1.2 Results and analysis:

From 2006/2007 to 2010/2010 season	Emirates Stadium	Rank (over 20)	Grade	Weight	Stamford Bridge	Rank (over 20)	Grade	Weight
Number of games at home	138	3	90%	0,5	145	2	95,00%	0,5
Number of Champion's league games	24	4	85%	0,5	28	2	95,00%	0,5
Number of wins at Home	94	3	90%	0,25	102	2	95,00%	0,25
Win rate at home	68,12%	3	90%	0,5	70,34%	2	95,00%	0,5
Number of goal scored at Home	296	2	95%	0,25	326	1	100,00%	0,25
Average ranking in the league	3,6	3	85%	2	2	2	95,00%	2
Number of trophies	0	11	50%	3	4	2	95,00%	3
Average attendance	60021,4	2	95%	1	41477	10	55,00%	1
Average occupancy rate	99,05%	5	80%	1	99,63%	2	95,00%	1
Total Grade				**74,86%**				**90,69%**

Table 1: Grading model, example of the Emirates Stadium and Stamford Bridge

The data from season 2006/2007 to season 2010/2011 are presented in **Appendix I**.

According to the grading model, the Emirates Stadium score is lower than the Stamford Bridge Stadium: **74.86%** against **90.69%**.

This can be explained because the Stamford Bridge is performing better in most of the key areas, expect for the average attendance. During the chosen period Chelsea performed way more than the Arsenal football club in their home stadium: 4 trophies against 0, more wins, more champion's league games (the most important

competition for football clubs in terms of recognition), and more games played in the stadium.

Therefore, according to this grading model, one could assert that Chelsea is more appealing than Arsenal in terms of sport results in this particular period of time which corresponded to the Emirates stadium opening. With an average ranking of 3.6 over 20, Arsenal is doing better than most of the Londoner clubs, except Chelsea. Arsenal was ranked 5th over 20 teams in term of occupancy rate which is quite good and testifies the popularity of the club and the potential exposure of the Emirates Stadium.

Several of those factors are related between each other but are not redundant:

1. Average attendance and Average occupancy rates at home,
2. Number of games and Champion's league games at home,
3. Number of wins and win rate at home.

For the first relation, it was assumed that the average attendance was more meaningful to assess the potential of attraction of the stadium. Indeed, it was thought that the occupancy rate would have been more meaningful if the attendance was lower, unequal and highly variable.

For the second point, the number of games reflects the fact that the club is going further in the competition it is engaged in. Even if Champion's league is the most important competition for clubs, a higher number of games indicates a higher probability to win trophies and therefore it was considered to be more important.

For the third point, the win rate was considered to be more important than the number of wins. Indeed, the win rate indicates the proportion of win over the total number of games when the team plays in its stadium. Thus, it expresses the probability for a spectator to see a win when he comes to the stadium.

IV.2 Investigation:

As it is said in the literature, the stadium location is of paramount importance to assess if the development is successful. In particular, the accessibility by public transport is necessary to ensure the transport of the crowd on match-day or for other events. The following means of railway transports are located around the Emirates Stadium and Stamford Bridge:

Means of transport (15-min walk)	Emirates Stadium	Stamford Bridge
Underground	• Holloway Road (10 min) • Arsenal (2 min) • Highbury & Islington (13 min)	• Fulham Broadway (2 min) • Parsons Green Station (13 min)
Train	• Drayton park (2 min) • Highbury & Islington (13 min)	• Imperial wharf (15 min)

Table 2: Means of transport accessible by a 15-min walk

Therefore, it appears that the Emirates Stadium is better served than its counterpart: the Stamford Bridge. This underlines a better accessibility and can also be explained by a higher attendance in average due to the higher capacity of the Emirates Stadium. The two stadia are located approximated at the same distance from the London city Centre.

The journey duration using the Underground to go from Central London to the Arsenal station is 25 mins using the Piccadilly line (tfl.gov.uk, 2018a).

The journey is more complicated at the departure of Central London to go to Fulham Broadway station. People have to take 3 different lines: Bakerloo, Picadilly and District line for a 30-min journey (tfl.gov.uk, 2018b). Besides, the Highbury & Islington station is only one stop further from King's Cross, one of the busiest railway station in the UK. So, it can be concluded that the Emirates Stadium is more accessible by public transport from the city center than the Stamford Bridge Center. This raises a good point in order to attract people into the stadium.

An analysis of the season ticket is also a good mean of appraising the consumer appeal potential. Arsenal season ticket was the most expensive one of the Premier League with £891 a year during the 2016/2017 season and is still reputed to be the most expensive. On the contrary, Chelsea season ticket price was £750 for this season which accounted for the eighth one in the Premier League. Those season tickets were even the two most expensive in Europe for 2017/2018 season (Evening Standard, 2017).
One could think that the price could be a factor that drives customer not to buy it. However, the figures suggest a different reality. With 45 000 season tickets, Arsenal is the third club in PL in terms of season ticket holders and is doing better than Chelsea which accounted for 25 000 season ticket holders (Talksport, 2017). Arsenal is even the second London football club behind West Ham in terms of season ticket sale. It shows the popularity of Arsenal, as an historical London football. It means that there is a solid fan base which can ensure a steady stream of spectators in stadium, assuming that the sport performance stays correct.

The other uses are certainly one of the main force of the Emirates Stadium which can host conferences, audition for reality shows and be an important music venue. Its flexibility allows it to become a landmark place and an important event hub in London (Populous, 2006). For instance, the Emirates Stadium hosted an important meeting between the former Prime Minister Gordon Brown and the French President Sarkozy in 2008 (BBC, 2008). The Emirates is also a major musical scene and hosted several important concerts featuring Bruce Springsteen, Coldplay or Greenday with a record of attendance (60,000) for the latter (nme,2013).

Figure 3: From left to right: N.Sarkozy, A.Wenger, G.Brown

Also, the architecture of the stadium makes it a landmark in the Islington borough. The scale of the stadium never dominates or threatens the local area (Williams, 2005). At the time of the construction, the Emirates stadium was highly innovative. The global structure in steel construction sparkles in sunlight and flows at night which enable to stadium to be highly recognizable (Design Build Network, 2018). The pitch was equipped with a state-of-the-art heating and drainage system along with an innovative roof (Arsenal Holding plc, 2006).

Figure 4: Emirates Stadium at night

The Stadium even won several awards during the 2007 building awards including:

- Major project of the year
- Best Built Project Contributing to London's Future
- Mayor's Award for Planning Excellence
- Best Mixed-Use Regeneration Project

Figure 5: The Emirates Stadium during a match-day

Source: Sir Robert MacAlpine constructor website (2018)

As a result, the Emirates Stadium is known to be a state-of-the-art development which helps it to gain exposure to public.

In addition, the Emirates Stadium development was included in a wider development project. It was undertaken accordingly to the Islington borough council local regeneration strategy. As a consequence, Arsenal F.C contributed to a £100 million regeneration scheme of the Islington Borough (Walters, 2011). It comprised the development of new residential supply: 2,500 new homes including 1,000 affordable homes. The financial contribution was also focused on buildings and highways maintenance, construction of children nurseries, health centers and a water and recycling center. The scheme also comprised the development of 40,000 sq.m new commercial floor space.

As a whole, it was the largest agreement for planning contribution relative to the size of the development in the UK (Islington Council, 2006).

Besides, the Emirates development provided 1,800 new long-term jobs in the area. Train and underground stations in the surrounding were even upgraded to be able to host 60,000 people on match day with additional lifts and staircase (Williams, 2005).

Therefore, it shows the role of the Emirates Stadium in the regeneration "package" to benefit the Islington borough. This is a key point to demonstrate the success of the stadium development which aimed at enhancing the neighborhood and contribute to its growth. The development of the all borough are helps to capitalize on the pedestrian flow and allows for more spending in the surrounding of the stadium.

This new leisure economy is often very effective in cities that are football-friendly. For instance, the Nou camp stadium in Barcelona and its surrounding has become one of the city's top tourist attraction and the Emirates Stadium can expect to become the same (Thornley, 2002).

The funding of the stadium also seemed to have been carefully thought. The finance came from a variety of sources: two great sponsorships, the sale of land for housing development on their former Highbury stadium close to the new construction site, and a bank loan. The naming rights sponsorship of the stadium will bring £100 million over 22 years thanks to Emirates, an airline company (BBC,2004).

Besides, their former stadium: the Highbury stadium was converted into 711 apartments (Arsenal Holdings plc, 2006). The sale of the stadium land also allowed to pay the loan back (Islington Council, 2006).

On top of that, the stadium development has driven a 111% increase in match day revenue for Arsenal Football club for 2006/2007 season to reach €70.8 million (Deloitte, 2008). The financial success of the stadium development stresses that it is appealing for people.

Besides, the club has taken into account people's opinion on the subject. In June 2001, the club sent 24,000 newsletters to residents in the Islington borough. The club received 513 out of 690 (74%) replies in favor of the Emirates Stadium development. Also, a club representative was present at every of the 21 public consultations meeting organized by the Islington Council (Walters, 2011). It shows that the club wanted a project that fits people's needs and desire.

Concerning the management, the football club appointed its subsidiary: Arsenal Stadium management. It is often thought that an effective way of management strategy is to involve stakeholders in the decision-making process (Low and Cowton, 2004). The aim of the company is to address potential public issues brought by the stadium. It includes litter collection, street cleaning, analyzing spectator flows in order to close temporary roads and put pedestrian signs (Arsenal and Islington City Council, 2006). However, people were still worried about the potential disruptions that can provide such amenity (The Guardian, 2006a). This is mainly due to the fact that during match day, 40 coaches are authorized to park in residential streets at the vicinity of the Emirates stadium (The Guardian, 2006b). Therefore, the stadium management aims at reducing stadium nuisance at its maximum (Walters, 2011). This along with the consultation underlines that the club was concerned about the potential issues that could generate the Emirates Stadium development.

The results found are sum up in **Appendix II.**

IV.3 The impact of the Emirates Stadium on housing prices in the Islington Borough:

IV.3.1 Data:

The data was taken from the United Kingdom government website. The data of interest was the UK House Price Index or HPI (gov.uk, 2018a).

The UK HPI is the aggregate of sales data of residential housing transaction, with cash or with a mortgage. The data which have been included were the English one, and date from January 1995. The source of those transactions data is HM Land Registry in England. The average sale price was used in the research and was used on a monthly-basis.

IV.3.2 Two-sided Test:

Given what was found in the investigation part, one can assert that the Emirates Stadium development ticked many boxes of what it is considered to be a successful sport amenity. The stadium development brought residential stock, transport enhancement and a landmark stadium. However, given the small scale of the study, it cannot be asserted that those positive effects were not be countered by other negative aspects such as noise or civic disorders.

Therefore, no opinion has been expressed on the direction of the stadium development effect on housing prices (up or down).

Thus, a two-sided test was undertaken for each model: The alternative hypothesis being:

- H_A(2) : "The stadium development had an impact on log(price)".

The null hypothesis is therefore:

- H_0(2) "The stadium development had no impact on the log(price)".

IV.3.3 Time period:

The average sale price data was used from January 1995 (time X1=0) to December 2010 (X1=191). Given that the stadium was built from February 2004 (X1= 109) and was opened in October 2006 (X1=146), the time period seemed to be sufficient to analyze the impact of the stadium development on residential prices.

As it was said in the previous part, an important assumption of the DID regression is that the control group or comparable group (Kensington and Chelsea borough) and the experimental group (Islington borough) must have the same trend before the intervention (the Emirates Stadium development). At first, when looking at the graph that shows the log(price) evolution depending on time, it can be asserted that taking this hypothesis was reasonable:

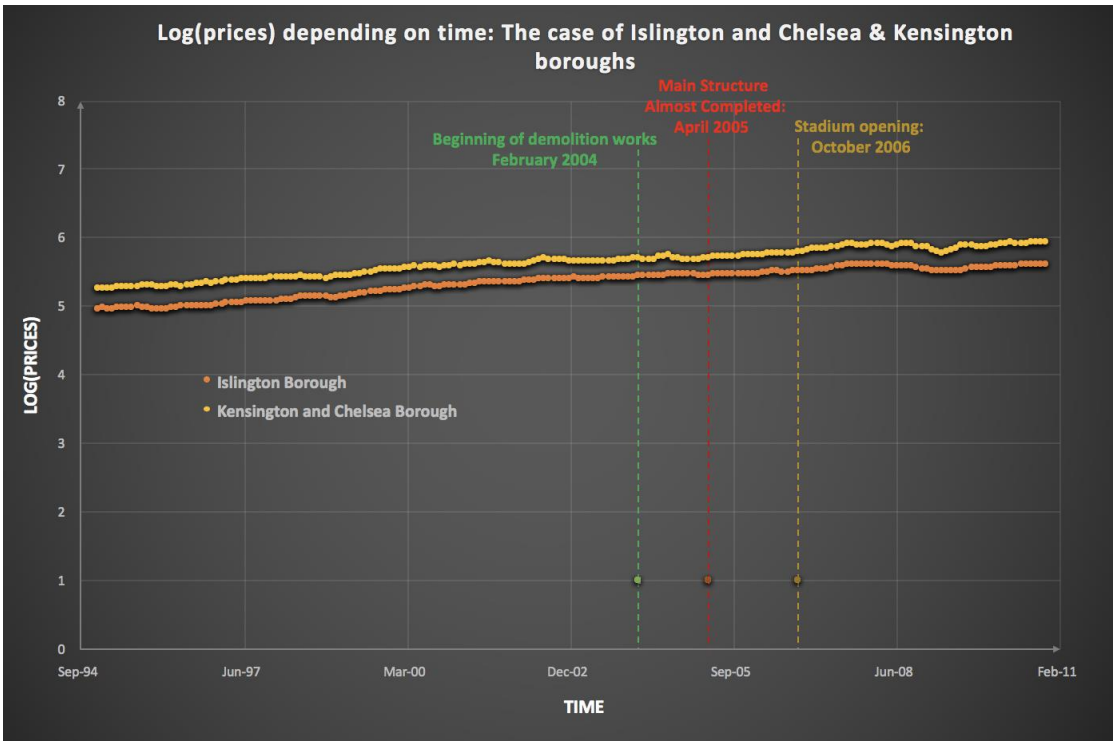

Figure 6: Log(prices) depending on time: the case of Islington and Kensington and Chelsea boroughs

It can be verified when looking at the difference in their slopes. A comparison has been made between the two slopes before the intervention date (t=109) which corresponds to the start of the Emirates Stadium construction.

So, two single regressions were calculated between the log(price) of Islington Borough and Chelsea and Kensington Borough with the following formula:

$$(1)\ \text{Log (Price)} = \beta_0 + \beta_1 * X1$$

With X1 being the time in months

The results are given in the following tables:

Islington prices regression	Coefficients	Standard Error	t Stat	P-value
Intercept	4,925E+00	4,574E-03	1,077E+03	1,040E-217
X Variable 1	5,104E-03	7,318E-05	6,974E+01	5,060E-91

Kensington and Chelsea prices regression	Coefficients	Standard Error	t Stat	P-value
Intercept	5,2580E+00	4,8300E-03	1,0886E+03	3,2374E-218
X Variable 1	4,3930E-03	7,7282E-05	5,6844E+01	9,0580E-82

Table 4: Regression results for (1)

The values of the two slopes are **0.51%** for Islington borough and **0.44%** for Kensington and Chelsea borough. Regarding this, it was reasonable to pick Kensington and Chelsea as a comparable group since they have the same trend over time.

IV.3.4 First model:

In the first model, the average sale price for residential properties was taken for Islington and Kensington and Chelsea Borough between January 1995 and December 2010. The log of the housing prices was then calculated for each borough so that the values can be "contained" in a smaller interval. The DID model that was used for the regression is given by the following formula:

$$(2)\ \text{Log (Price)}_1 = \beta_0 + \beta_1 * X1 + \beta_2 * X2 + \beta_3 * X3$$

Where:

- X1: Time variable that goes from X1=0 (January 1995) to X1=191 (December 2010)
- X2: Experimental variable. It is a dummy variable that is equal to 1 for the Islington borough and 0 for the Kensington and Chelsea borough.
- X3: Intervention variable. It is a dummy variable equal to 0 before the intervention date and 1 from the intervention date to the end of the study.

In that case, it is equal to 1 from t=109 (February 2004) to t=191 (December 2010) for the Emirates stadium development.

IV.3.4.1 Result and Analysis:

After this, a multiple regression was undertaken using Excel software. The results are shown in the following table:

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	5,28539	0,0061	862,2849	0
X Variable 1	0,00368	0,0001	68,5077	6,0562E-216
X Variable 2	-0,28378	0,0060	-47,3275	2,1417E-161
X Variable 3	**-0,01863**	0,0085	-2,1903	**0,02911**

-0,01863 Negative effect on price 0,02911 < 5%

Table 5: Regression results for (2)

The coefficient of interest is here β_3, the multiplying coefficient X3 variable. Given the results β_3 = **-0,0186** is negative. So, contrary to the general conclusion that were drawn in numerous papers, results found a negative impact of the stadium development on property prices in the Islington borough for that period of time.

IV.3.4.2 P-Value:

P-value is the area under the curve of a probability distribution defined by a mathematical model, in the present case: the DID regression model. The P-value value is related with the null hypothesis.

Generally, P-value <5% is an indicator to reject the null hypothesis. And the littler is the P-value, the less there is probability to make an error by rejecting the null hypothesis (Stockburger D.W. 2007). It is important to mention that P-value is a measure of whether or not the mathematical model describes a distribution of sample means, and is not a measurement of the truth of a model (O'Donnell and John.L, 2018). In the case of the present research, the DID results display the P-value of variable X1, X2 and X3. The P-value of interest is here X3's.

In this model, the P-value for the variable of interest X3 is **2.9% < 5%.** The null hypothesis can therefore be rejected and it can be asserted that the Emirates Stadium development had an impact on property prices. However, no direction can be found only with the analysis of the P-value. There is a need for β_3 coefficient sign, and the counter-factual situation to portray the negative impact on housing prices.

IV.3.4.3 Coefficient of determination R^2 and the adjusted R^2

In a multiple linear regression, the coefficient of determination R^2 and the adjusted-R^2 are tools to measure the quality of the fit of a model (Ohtani, 1994). Comparing the two values in several models of multiple regression can provide indication of the suitability of the variables in fitting the model. (Renaud and Victoria-Feser, 2010).

R^2 is a measurement of how close the data are to the regression model. The higher is the R^2 and the better is the fit. In the first model, those variables are: time, the location (Islington or Kensington and Chelsea), and the Emirates stadium development. One of the drawback of R^2 is that it supposes that every independent variable X1, X2 or X3 explain the variation in the log(Price) (Investopedia, 2018).

On the contrary, the adjusted-R^2 is influenced only by the variables that really affect the log(price). In other words, the adjusted-R^2 only increases if the added variable really improves the model while the value of R^2 increases the fit each time a new variable is added by assuming that all variables enhance the data modelling. The two values will be compared between the different models.

Regression Statistics	
Multiple R	0,9831
R square	**0,9664**
Adjusted R Square	**0,9662**
Standard Error	0,0464
Observations	384

Table 6: Regression statistics for (2)

In this first model **R^2 = 0,966** and **adjusted-R^2** = **0,966**

IV.3.4.4 Counter-factual appraisal:

The impact of the Emirates Stadium development was assessed at t=156 (January 2008), after the stadium development was complete. The formula (2) was used by replacing the different coefficients with the value found in the regression results in Table 5.

Using X1 = 156, X2=1 and X3 =1, the formula results in Log(Price) = 5,56 which can be converted in an average price of **£360,965**.

The impact of the stadium development was then appraised by using the same formula, but this using X3 = 0. It aims at establishing the average housing price in Islington if the stadium did not exist and if the prices where following the same trend as the Kensington and Chelsea Borough at that particular date.

It resulted in Log(Price) = 5,58 which was converted in an average price of **£376,785.** It implies that according to this model, if the stadium was not built, the price difference would have been **£15,820** upward which would have been a **4.38%** increase at that date. In the other sense, the first model signifies that the Emirates stadium brought **4.20%** decrease in prices in the Islington Borough for that specific date.

IV.3.5 Second model:

The first model applied a "step" function for X3, going from 0 to 1 instantly after the beginning of the stadium development. The second model was adjusted with an increasing slope for variable X3 depending on the construction stage. In the first model, passing directly from 0 to 1 meant that the Emirates stadium development had a direct impact on prices at the beginning of the construction works.

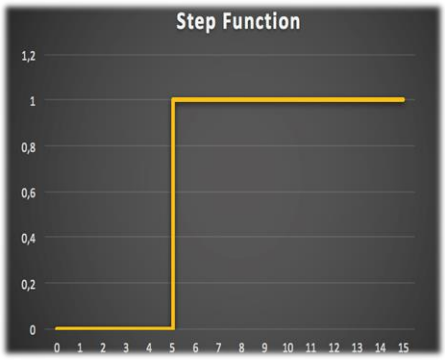

Figure 7: Example of step function, equivalent to X3 evolution in the first model

In the second model, the assumption is that the stadium development had a progressive impact on housing prices. The Emirates development planning was as follows:

- February 2004 (t=109): Demolition phase began
- April 2005 (t=123): The main levels where completed and the roof installation began. At that stage, the stadium development looked like a real stadium and could start to become a landmark in the surroundings.
- May 2006 (t=136): The stadium was finished once the pitch construction was completed.
- July 2006 t=138): Test matches and events to obtain certifications and the right to host football games.
- October 2006 (t=141): The Stadium officially opened (Arsenal.com, 2012)

The model was then refined according to the different stages of the Emirates stadium development.

So, from February 2004 to April 2005, the slope was designed as slow with X3 going from 0 to 0.2 between those two dates. From April 2005 to May 2006, the slope is more important with X3 going from 0.2 to 0.8 because the stadium was at an advanced stage of development. From May 2006 to October 2006, X3 goes from 0.8 to 1.

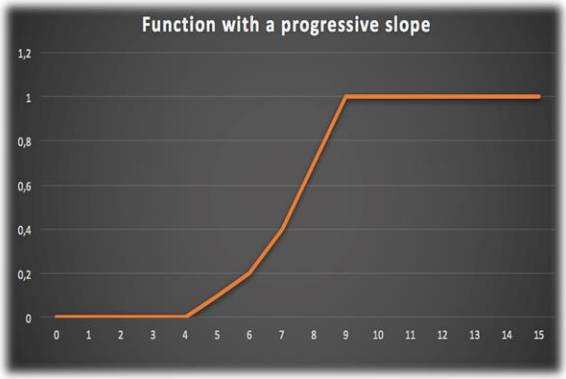

Figure 7: Example of a function with a progressive slope, equivalent to X3 evolution in model 2 & 3

The second model can be express using the same formula as for model 1 but with a different definition of X3 as explained above:

$$(3)\ \text{Log (Price)}_2 = \beta_0 + \beta_1 * X1 + \beta 2 * X2 + \beta_3 * X3$$

IV.3.5.1 Results and Analysis:

Then, the same regression as for the first model was done. The results are shown in the following table:

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	5,27636	0,00594	888,32549	0
X Variable 1	0,00378	0,00005	72,58186	8,3917E-225
X Variable 2	-0,27588	0,00550	-50,13915	1,3128E-169
X Variable 3	**-0,04847**	0,00917	-5,28516	**2,12189E-07**

-0,04847 Negative effect on price 2,12189E-07 << 5%

Table 7: Regression results for (3)

The regression resulted in β_3**= -0,0485** which is negative. Like the previous model, the regression indicates a negative impact of the Emirates Stadium on housing prices.

IV.3.5.2 P-value:

In this refined model **P-Value = 2,12E-07** which is way lower than with the first model for variable X3. It is still less than 5%, so it is reasonable with this model to reject the null hypothesis. The variable X3 has therefore on impact on the model, and it can be asserted that the Emirates Stadium had an impact on property prices.

IV.3.5.3 Coefficient of determination R^2:

Regression Statistics	
Multiple R	0,9840
R Square	**0,9683**
Adjusted R Square	**0,9681**
Standard Error	0,0451
Observations	384

Table 8: Regression statistics for (3)

In this second model, **R^2 = 0,968** and **adjusted-R^2 = 0,968**. Both are slightly higher than those of the previous model. It means that this model fits better the data than the previous one, which justifies the choice to assess the stadium development impact with an increasing slope.

IV.3.5.4 Counter-factual appraisal:

As for the first model, the impact of the Emirates Stadium was appraised at t=156.
Using X1 = 156, X2=1 and X3 =1, the formula results in Log(Price) = 5,54 which can be converted in an average price of **£347,731**.
In the same way, using X3 =0, the formula results in Log(Price) = 5,59 which means an average price of **£388,787£.**
It implies that according to this second model, if the stadium was not built, the price difference would have been **£41,056** upward which would be a **11.81%** increase at that date. In the other sense, the first model signifies that the Emirates stadium brought a **10.56%** decrease in prices in the Islington Borough at that specific date.

Therefore, by refining it, the model resulted in a bigger price difference for the Islington borough. As the result is surprising compared with what was found in the previous papers, it could have meant that there was another effect that impacted the prices. This is why a third model was done, by taking into account the effect of the 2008 recession on property prices.

IV.3.6 Third model:

Another intervention variable was added: the 2008 recession which lasted from 2008 Q2 and ended after 2009 Q2. This means from April 2008 (t=159) to June 2009 (t=173). The recession effect was applied to both the experimental and the control group since it was a global crisis. Therefore, the formula becomes:

$$(4)\ \text{Log (Price)}_3 = \beta_0 + \beta_1 * X1 + \beta_2 * X2 + \beta_3 * X3 + \beta_4 * X4$$

With:

•X4: Intervention variable. It is a dummy variable equal to 0 before the intervention date and 1 from the intervention date to the end of the intervention. In that case, it is equal to 1 from t=159 (April 2008) to t=173 (June 2009) which corresponds to the recession dates.

IV.3.6.1 Result and Analysis:

A new regression was undertaken like for the previous models, but this time X4 variable was added. The results are shown in the following table:

	Coefficients	Standard Error	t Stat	P-value
Intercept	5,27394	0,00579	910,97831	0
X Variable 1	0,00384	0,00005	73,71251	8,546E-227
X Variable 2	-0,27758	0,00535	-51,83936	3,7927E-174
X Variable 3	-0,04331	0,00897	-4,82967	1,98824E-06
X Variable 4	-0,04415	0,00902	-4,89353	1,46754E-06
	Both negative effect on price			Both << 5%

Table 9: Regression results for (4)

The coefficient of interests are β_3 and β_4, with the latter being related to the intervention of 2008 recession. The regression resulted in β_3**= -0,0431** and β_4**=-0,0441,** two negative figures. Like the previous model, the regression indicates a negative impact of the Emirates Stadium on housing prices. Unsurprisingly, the 2008 regression also had a negative effect on housing pricing in the Islington borough.

IV.3.6.2 P-value:

This time, the P-value of both X3 and X4 where examined. It appears that they are both significantly less than 5%, so for each variable, the null hypothesis can be rejected and it can be asserted that both the Emirates stadium development and the recession had an impact on property prices with this model.

IV.3.6.3 Coefficient of determination R^2:

Regression Statistics	
Multiple R	0,9850
R Square	0,9702
Adjusted R Square	0,9699
Standard Error	0,0438
Observations	384

Table 10: Regression Statistics for (4)

In this third model, **R^2 = 0,970** and **adjusted-R^2 = 0,970** which is higher than the previous models. It means that this model fits better the data than the previous ones and it the choice to add the recession intervention as a variable that drives the housing prices in the Islington Borough.

IV.3.6.4 ANOVA:

The third model can be expressed with the second one as it follows: $Log(Price)_3 = Log(Price)_2 + \beta_4 * X4$. As the two models are related to each other, a comparison between their Analysis of Variance (ANOVA) can be done.

ANOVA seeks to find variation among the mean value of a statistical model (Galwey, 2014). In that specific case, the Sum of Squares (SS) will be the data of interest. This number represents the sum of the squares of the differences from the mean. The SS measures the variation of the different points relative to the model found in the DID regression. The sum of squares can be expressed as:

The total sum of squares = regression sum of squares (SSR) + sum of squares of the residual error (SSE).

The SSR is the variation between the variables X1, X2,X3, X4 and the log(price) while the SSE is the variation attributed to the error (minitlab, 2018). In order words, this quantity indicates how well they DID regression represents the data modelled (between the prediction and the observation) since it pictures the dispersion around the mean.

In the first model the variable X3 does not behave the same way as it goes from 0 to 1 instantly, that is why the sum of square cannot be compared between with other models:

ANOVA for model 2	df	SS	MS
Regression	3	23,6156	7,8719
Residual	380	0,7720	0,0020
Total	383	24,3876	

ANOVA for model 3	df	SS	MS
Regression	4	23,6614	5,9154
Residual	379	0,7261	0,0019
Total	383	24,3876	

Table 11: ANOVA for model 2 & 3

In the second model, the SS is **23,62,** while the SS is **23,66** in the third one. It indicates that the third model differs more from the data modelled than the second one. So, the third model is more spread around the data it is supposed to model.

IV.3.6.5 Counter-factual appraisal:

The impact of the recession and the stadium construction was assessed at a specific point in time. Unlike the previous models, the date was chosen so that both the stadium development and the recession have an effect on log(price): X1 = 165 (October 2008).

Using X1 = 165, X2=1 and X3 =1 and X4=1, the formula results in Log(Price) = 5,5855 which can be converted in an average price of **£348,553**

Then, X3 and X4 were "switched off" in order to compare two situations: no stadium or no recession when X1= 165.

Using, X3 = 0, the formula results in Log(Price) = 5,5856 which can be converted in an average price of **£385,106**.

Using X4 = 0, the formula results in log(price) = 5,5864 which can be converted in an average price of **£385,853**

Using X3 = 0 and X4=0, the formula results in Log(Price)= 5,6297 which can be converted in an average price of **£426,318.**

It means that according to the model, at X1=165 the Emirates Stadium alone brought a **9,49%** decrease in housing prices, the recession alone brought a **9,67%** housing prices, and both events brought a **18,24%** in residential prices. It implies that at this specific date and according to this model both events had almost the same impact on residential prices.

When applying the second model at the same date (X1=165), we found the same decrease in percentage as before: **11,81%** when X3=0

Therefore, it can be asserted that the addition of variable X4 has decreased the role of the Emirates Stadium development in the decrease of property prices compared with the same situation in the second model.

The result found for the three regressions are sum up in **Appendix III.**

IV.4 Discussion:

IV.4.1 Grading model and investigation:

The grading model has shown that the Emirates Stadium was less attractive than its counterpart Chelsea from 2006/2007 to 2010/2011 in terms of sport performance. Sport performance is important in the long-term since the qualification for major competition is always a factor to drive people to go to the stadium (Martin and Cro, 2016). The win of trophies was weighted more importantly because it was thought to be able to create a link between the club and the fans and were thought to ensure a steady stream of historical fans into the stadium. However, the model limitations remain the fact that some factors are intangible, and difficult to assess such as the impact of a stadium on local civic pride. Those intangible factors were found in the investigation part:

The stadium became a landmark in the Islington Borough which was not an easy task given that it replaced a popular stadium in England (Walters, 2011).

However, one should wonder if this is due to the presence of the Arsenal football club or for its architecture. Indeed, the Emirates Stadium does not exhibit any attribute visible at a large-scale contrary to the Wembley Stadium (Ahlfeldt and Kavetsos, 2014).

Nonetheless, the project earned a number of prizes that have boosted its fame. Despite its classic design, the stadium was included in a wider development project like it was the case for several Olympics (Friedman, 2011). The Emirates Stadium location is also one its main strength, with numerous train and railway stations that enables the stadium to be accessible from the city center. The neighbor's opinion was also paramount in the process of the stadium development with surveys, newsletter and involvement in the development process. It enabled it to meet people's requirements (Jones, 2011). But even with a careful preparation, the stadium will likely bring disruptions during match day with the arrival of 60,000 people every week end.
The stadium potential is maximized because it is also used as a concert venue, and a meeting place such as the Veltins Arena, often considered as a reference in terms of multi-use arena (KPMG, 2013).
Considering that, one could expect to see positive effects on property prices in the surrounding. It may have brought a certain civic pride along with transportation enhancement, new residential and retail supply that should have upgrade the neighborhood.
However, fans want to see good football and players lifting trophies and do not really care about finance (Forbes, 2006). Without good sport performance, the Emirates attendance could drop quickly and weaken its appeal.

This is why the grading model could be the subject of further research. Conventions could be held with stakeholders and sport experts: sport economist, investors, club managers, fan representatives, and sportsmen. This would help to refine this grading model by adding other factors. This would be the occasion to discuss about the addition of intangible features such as security or well-being inside a sport amenity. Debates could be held on how to "grade" the other attributes found in the investigation part.
The way to scale the items is also paramount since it influences directly the attributed grades. In the present research, the different items had different range of values (number of goals, attendance rate for instance). This is why a standardization has been done, using the Premier League ranking of the club over the period of time of interest.

However, it should be noted that this ranking should be extended to other English leagues if the stadium of interest was owned by a club with irregular sport performance and subjected to relegation.

The weighting of the different sport performance features could also be discussed to assess what is the most important to measure a stadium appeal using standard methods.

One of those methods could be related to MCDA, where it is stated that weights are the decision maker "space of freedom" (Greco et.al, 2016). There are mainly two ways of weighting the criteria: a direct and an indirect explication. The former refers to attributing weights according to stakeholder's interviews, questionnaire, surveys. Those weights are attributed before data collection. The indirect explication involves the weighting of criteria after data collection, using the same tools involving the stakeholders (Kao, 2010). The latter was used in the grading model, but was up to personal thoughts and lacked professional opinion. Since it is difficult not to be subjective when applying weights, some have developed tools like CRITIC method to create objective weights. This enabled to construct weights that reflect the information transmitted by all criteria while taking into account dilemmas brought by conflicting criteria. (Diakoulaki et.al, 1994).

This would lead to examine how the changes in weighting could shape the decisions on future stadia development. Moreover, some criteria might interact between themselves: increasing, weakening or antagonistic effects. Some common methodologies to tackle those interactions are for instance non-additive integrals such as Choquet and Sugeno (Corrente et al., 2017).

IV.4.2 DiD regression:

As discussed in the literature review, papers tried to link the presence of amenities on housing prices in their surroundings. The general conclusion drawn by papers is that amenities have a positive impact on housing prices. Ahlfeldt and Kavestos (2014) for instance found a 1.7% increase in property prices for a 10% decrease in distance for the Emirates Stadium.

Their result differ from what was found in the DiD approach, where a negative impact was found with the three models according to the value of β_3.

However, the two methodologies and chosen area were not the same: Ahlfeldt and Kavestos observed the effect of distance in prices in a 5-km radius around the Emirates Stadium (area of 78.5 km^2) with data from 1995 to 2008.
On the contrary, in the present paper, the three models tried to reproduce the general trend from 1995 to 2010 at a smaller scale (14,86 km^2 for the Islington Borough). In their paper, they also observed very tiny or even negative effects at a small level but the scale was not specified. The present research and the one of Ahlfeldt and Kavestos were also singularly different since the latter omitted the financial crisis that just happened in 2008 where ends their data. Kavetsos also (2012) found positive impact on housing prices after the 2012 Olympics announcement in London in a 3-km ring around the Olympic Stadium. The chosen scale (28.26 km^2) was again higher than the Islington Borough.

A way to explain the decrease of property prices after the Emirates Stadium could be the Marginal Utility. In Economics, it refers to the additional satisfaction or benefit that a consumer derives from buying an additional unit of a commodity or service (Britannia Academic, 2018). The concept asserts that the utility perceived by the consumer is inversely proportional to the number he/she already owns (Hartmann, 2006).

In the case of the Emirates Stadium development, this could be illustrated by the fact the Islington borough already had a stadium: the Highbury Stadium.

Figure 8: The Emirates Stadium (Left) and the Highbury Stadium (Right)

This stadium was located ½ mile from the actual Emirates Stadium and already hosted the Arsenal Football Club. The new stadium did not bring a new mean of watching football games in the Islington Borough since the transition was direct between the old and the new stadium.

Therefore, the potential benefits embedded in property prices in the Islington Borough were unchanged and even lowered by the stadium development even if it was a brand new one, because the Arsenal team decided to stay in the same borough.
This could also mean that the new stadium was perceived as an amenity that would bring disruptions in the borough which was reflected in property prices in Islington because the borough is a small area. At a larger scale, Ahlfeldt and Kavestos (2014) found a significant positive effect that can be explained by the fact that the demand for property was driven by the positive impact of the Emirates Development: civic pride, enhancement of the neighborhood, new amenities, transport improvement. People at a large scale are not necessarily concerned about the potential disruptions that can bring a stadium, which refer to Coates and Humphreys research (2006).

The main limitation of this DiD approach remains the strong assumption that disruptive factors will have the same impact on the comparable and experimental group. However, given the trend of the two boroughs before the intervention date, it could be assumed that they react similarly to external factors. The other limitations are the chosen intervention dates for the Emirates Stadium development or the recession. Indeed, the start date for the Emirates Stadium effects was chosen as being the start of demolition works, but could have started before when the development was approved on December 2001.
Besides, the choice of X3 variable evolution for model 2&3 during the stadium development was up to personal thoughts and could be the subject of further research to assess in which proportion the different development stages impacted housing prices. Moreover, the recession period was chosen according to the official definition, with a fall a GDP in two consecutive quarters.

Further research can be done in order to assess how to recession effect decreased over time which will help to enhance the DiD approach.

IV.4.3 Conclusion:

The two-parallel research undertaken are both helpful and complementary. The grading approach can assess the potential appeal of football fan to go into a football stadium using nine key data. This model could be enhanced by further research, through surveys with sport industry stakeholders. This would help to refine the grading model, by including some key features that have been raised during the investigation. The inherent characteristics of its development, along with the sport performance of the team and the attendance would give a global overview of the attractiveness of its development on the surrounding. The way to scale the attributes could also be discussed, if this model was applied to other clubs that could be subjected to relegation.

Such a model can be used to compare a stadium attractiveness with other stadia. The investigation also helped to draw hypothesis for the two-sided test in the analysis.

The DiD approach is of paramount importance. This method is the result of a long process of research which finds its source in the Tiebout model back in 1956. The DiD approach helps to figure out this theory because the benefits derived from the surrounding amenities are embedded intro property prices. Thus, the DiD method is complementary to the grading model since it enables to represent indirectly the effect of intangible factors at a local scale through housing prices evolution. The DiD approach was also able to portray the attractiveness of a stadium through the evolution of housing prices in the Islington Borough.

V Conclusion:

To sum up this work, an attempt to link the characteristics of the Emirates Stadium development with its effect on housing prices in the Islington borough was undertaken.

The grading model was based on multiple-criteria decision analysis and gave a lower grade for the Emirates Stadium than its counterpart: the Stamford Bridge in the Kensington and Chelsea borough between 2006/2007 and 2010/2011. This can be explained by poorer performance in many factors, except for the average attendance which is skewed by the fact that the Emirates Stadium has a better capacity. The grading model has therefore shown a lower sport performance for this particular period. One could think that it will have negative impact on the attendance or on the fans loyalty. But the investigation revealed that the club is ranked third in terms of season tickets holders with 45,000 for 2016/2017 season. However, it seems that there is a disconnection between the sport performance and the price of the season ticket which is the most expensive in Europe.

It shows that the demand is high and this is also proved by a good attendance rate of more than 99% in the seasons observed. The other characteristics of the Emirates stadium development depicted an image of a modern stadium which is very well served by public transports from the city center. Such as the Veltins Arena in Germany, the Emirates Stadium is a multi-use arena that can host concerts, conferences and a museum. Therefore, its potential of attraction is exceptional and it could keep a regular stream of visitors all year long. The stadium was included in the biggest urban redevelopment scheme relative to the small size of the Emirates Stadium. Arsenal F.C contributed to the urban regeneration of its surroundings with an upgrading of residential supply, new commercial spaces and maintenance of highways, and train stations. Its role was also social-oriented with the development of children nurseries and health center. This, along with the numerous prizes won make it a landmark building in the Islington Borough, and it contributed to revitalize the area.

Even though there was an involvement of local residents in the development process, stadia are considered as a NIMBY (Not In My Backyard) amenities, because they disruptions in the neighborhood.

Given this part of the research, the only two flaws of the Emirates Stadium development are the sport performance of Arsenal F.C and its inherent NIMY status. Therefore, it could have been thought than the Emirates Stadium development enhanced the neighborhood image, which would have stimulated the demand for housing up, and therefore driving the price up.

In the second part of the research, a difference-in-differences regression was undertaken in order to assess the impact of the Emirates Stadium development on property prices. Three different models were constructed in order to refine the fit to the data being modelled. The first model assumed a direct effect just at the beginning of the construction works which was unlikely the case. This direct effect was embedded in the step from 0 to 1 for the dummy variable X3 which represents the intervention period. The second model implied a progressive impact of the Emirates Stadium development with an increasing slope for X3 variable. The third model included the 2008 recession with variable X4.

The three different regression results gave a negative sign for β_3, meaning a negative impact of the Emirates Stadium development on the average housing price for the Islington Borough. Unsurprisingly, the same result was found for β_4 in the third model, concerning the influence of the 2008 recession. For each model, the P-value of the variable of interests X3 and X4 are lower than 5%, which means that the null hypothesis could be rejected. It means that for each model, X3 and X4 variable had an impact on the evolution of log(prices) during the period of interests.

The increasing value of the coefficient of determination R^2 and adjusted-R^2 have shown an improvement of the models to fit the log(prices) evolution. Especially the adjusted-R^2 significantly increased, which demonstrates the significant impact X3 and X4 in the variations.

For each model, a counter-factual situation was imagined by switching off the dummy variable X3 or/and X4 for the third model. It means that a situation was imagined where the stadium did not exist at a specific point in time (X1= 156: January 2008, and X1=165: October 2008).

For each model, results found a higher average housing price when considering an absence of the Emirates stadium development, or the absence of the 2008 recession. The counter-factual situation with an absence of the Emirates Stadium Development resulted successively in a 4.20%, 10.56%, and 9.49% decrease in housing prices for the date of interest (X1=156 for Model 1 & 2, X2= 165 for Model 3). Model 3 results have shown that including the 2008 recession has lowered the decreasing effect on prices provoked by the stadium, compared with model 2 at X1=165.

This negative impact on housing prices can seem striking. Indeed, it goes on the opposite direction to what was found in the literature, where stadia development has generally been found to provoke a rise in housing prices with a decreasing effect with distance to the amenity.

However, the methods used in the literature can be discussed. Their areas of interest were between a 3 and a 5-km radius, which means an area between 28.26 and 78.5 km^2, higher than the Islington Borough (14.86 km^2). The area of interest in the present study covered the Islington Borough as a whole, at a very local scale.

The results can be explained by the fact that at a very local, people are more likely seeing the potential disruptions of the stadium, rather than the enhancement of the borough as a whole. Those flaws were directly embedded in property prices, which brought a decrease in that period of time.

Non-linear effects could not be controlled here due to data limitations. The available data only enabled to assess the impact of the Emirates Stadium at the scale of the Islington Borough. Non-linear effects could have been the effect of distance to the Emirates Stadium on housing prices, or unobservable location characteristics. The non-linear effects can be controlled using data transactions with full postcode reference. This would help to make several DiD regression depending on the distance to the stadium.

For instance, 3 zones could be defined:

- In a 500-m radius from the stadium. The one-sided test could be used, with the following alternative hypothesis: “The stadium will decrease housing prices”.
- In a transition zone, say between 500 to 1000 m radial distance to the stadium. A two-sided test, with the alternative hypothesis: “The stadium will impact housing prices”: the scale of study implies that positive effects on the borough can be countered by negative effects.
- Above 1000-m radial distance to the stadium. A one-sided test would be appropriate, with the alternative hypothesis: “The Stadium will increase housing prices”.

However, it would raise an issue of distance measurement: which kind of distance should be used in such a study? A simple linear distance in a two dimensions map, walking distance, or radial distance? This improved DiD approach would enable to see the non-linear effects of distance on housing prices, and characterize what was suggested in the present research with very local negative effects that reflect the potential disruptions of the stadium.

In addition, the Emirates Stadium development replaced a former stadium in the same borough: the Highbury Stadium which hosted the same team. The transition between the use of the two stadia was direct, so the Emirates stadium did not bring a new mean of watching football in Islington borough. As the Highbury Stadium was located at half a mile of the Emirates Stadium, it was equivalent to a total refurbishment of the old stadium. Nonetheless, this new stadium development included 22,000 more seats to reach a 60,000 seats capacity. This increase in frequentation in the Islington borough could have been considered as a flaw, and was reflected in housing prices. Considering the Marginal Utility Theory, this means that an area with many amenities will gain less from a stadium development than another area with fewer amenities. It was suggested by McFadden and Train (2017), who asserted that residents are willing to trade money for the first increment of an environmental amenity such as a park, but not additional increments.

Further research could compare the difference in prices evolution between an area that already has a sport amenity and another one which has little or none.

To conclude, the 2 models are both useful and complementary. The grading model measures the Emirates Stadium potential of attraction for fans according to sport performance. It could be enhanced with the addition of other factors that were found in the investigation. This would give a global overview of the attractiveness of the Emirates Stadium development due to multiple factors: sport performance, impact on the Urban environment. Thus, it will give a measurement of the potential demand for this area, related with the stadium development.

The DiD regression exhibits the evolution in housing prices which reflects changes: The Emirates Stadium development and the 2008 recession. Intangible factors such as civic pride, or stadium architecture and design are quite difficult to measure and this led to exclude them from the grading model. However, those factors are capitalized in property prices and this is why the DiD regression is complementary to the grading model. The use of counter-factual situation by switching off/on the experimental variables is also of paramount importance. It allows to see the potential effect on housing prices of not having the Emirates Stadium in this area.

As a whole, the two models complement themselves and give a global overview of the Emirates Stadium impact one the Islington borough: in terms of housing prices evolution, of Urban Development and exposure.

VI Appendix:

VI.1 Appendix I: Data for the grading model

Emirates Stadium	2006/2007	2007/2008	2008/2009	2009/2010	2010/2011
Number of games	26	27	31	26	28
Number of Champion's league matches	4	5	6	5	4
Number of wins at Home	15	19	21	21	18
Number of goal scored at Home	52	56	60	67	61
Rank in the league	4	3	4	3	4
Average attendance	60045	60070	60040	59927	60025
Number of seats	60600	60600	60600	60600	60600
Average occupancy rate	99,08%	99,13%	99,08%	98,89%	99,05%

Stamford Bridge	2006/2007	2007/2008	2008/2009	2009/2010	2010/2011
Number of games at Home	31	31	28	29	26
Number of Champion's league matches at	6	7	6	4	5
Number of wins at Home	22	21	17	24	18
Number of goal scored at Home	70	59	51	92	54
Rank in the league	2	2	3	1	2
Average attendance	41542	41397	41588	41423	41435
Number of seats	41631	41631	41631	41631	41631
Average occupancy rate	99,79%	99,44%	99,90%	99,50%	99,53%

VI.2 Appendix II: Investigation and grading model results:

Emirates Stadium	Results	Details
Grading	**74.86%** against **90.69%** for Stamford bridge	0 trophy One good point: 5th over 20 for occupancy rate
Transport	**5 stations** accessible by a 15-min walk **25 mins** from Central London with Picadilly Line Located one stop further from King's cross train station	In comparision, Stamford Bridge is accessible with 3 stations Complicatred to get there from Central London
Season Ticket	The most expensive in Europe with **£891** a year in 2016/2017 Third club in PL in terms of season ticket holders: **45,000** in 2016/2017	In comparison, Chelsea had 25,000 season ticket holders (8th over 20) in 2016/2017
Other Uses	Host conferences, audition, concerts and the Arsenal F.C museum	Hosted a meeting between former French President and UK Prime Minister Music Venue: record of attendance (60,000) for Greenday band
Architecture	2007 building awards: -Major Project of the year -Best Built Project Contributing to London's future -Mayor's Award for Planning Excellence -Best Mixed-Use Regeneration Project	Steel construction, do not dominate the surrounding area
Urban redevelopment	Arsenal contributed to a **£100 million** scheme according to Islington Borough Strategy	New Residential supply: **-2,500** new homes including **1,000** affordable homes -New commercial space: **40,000 sq.m** -Maintenance of highways, buildings -Upgrading of underground/train stations -Development of Children nurseries, health center and Water recycling center
Finance	Came from: -Two sponsorships: catering company and stadium naming with Emirates -Sale of their former Highbury area for housing development -Bank Loan	The stadium development has driven a 111% increase in match day revenue in 2006/2007 season
People involvment	Arsenal F.C sent **24,000 newsletters** to Islington residents A club representative was present at 21 public consultations meeting	The club received 513 out of 690 **(74%)** replies in favor of the stadium development
Management	Creation of a subsidiary to reduce the stadium disturbance	Litter collection, street cleaning, road traffic management, security on match-day However **40 coaches** park in the residential streets around the stadium at avery game

VI.3 Appendix III: Difference-in-difference results for model 1, 2 & 3:

	First Model	Second Model	Third Model
Intervention dates	The Emirates Stadium development for: X1 = [109; 141]	The Emirates Stadium development for: X1 = [109; 141]	The Emirates Stadium development for: X1 = [109;141] The 2008 recession for X1 = [159;173]
Variables	X1: time variable [0;191] X2: Islington: 1 or Kensington and Chelsea Burough: 0 X3: Intervention variable: 0 before the intervention, 1 during and after the intervention	X1: time variable [0;191] X2: Islington: 1 or Kensington and Chelsea Burough: 0 X3: Intervention variable: variable slope depending on the development stage	X1: time variable [0;191] X2: Islington: 1 or Kensington and Chelsea Burough: 0 X3: Intervention variable for the Emirates Stadium development: variable slope depending on the development stage X4: Intervention variable for the recession: 1 during the intervention and 0 otherwise
β_3 , β_4	β_3 = **-0,0186** => Negative impact of the Emirates Stadium on housing prices	β_3 = **-0,0485** => Negative impact of the Emirates Stadium on housing prices	β_3 = **-0,0433** β_4 = **-0,0441** => Negative impact of the Emirates Stadium and recession on housing prices
P-value	For X3: **2.91%** < 5%: Null hypothesis rejected	For X3: **2.12E-07** << 5%: Null hypothesis rejected	For X3: **1.99E-06** << 5%: Null hypothesis rejected For X4: **1.47E-06** << 5%: Null hypothesis rejected
R^2 and adjusted-R^2	R^2 = **96,64%** ; Adjusted-R^2=**96,61%**	R^2 = **96,83%** ; Adjusted-R^2=**96,81%** => Improvement of data modelling	R^2 = **97,02%** ; Adjusted-R^2=**96,99%** => Improvement of data modelling
Counter-factual situation	At X1= 156, with X2=1 and X3=1 : Average price of **£360,965.** With X3=0: Average price of **£376,785** => The Emirates Stadium brought a **4.20%** decrease in housing prices at X1=156 compared with if it was not developed	At X1= 156, with X2=1 and X3=1 : Average price of **£347,731** With X3=0: Average price of **£388,787** => The Emirates Stadium brought a **10.56%** decrease in housing prices at X1=156 compared with if it was not developed	At X1= 165, with X2=1 and X3=1 : Average price of **£348,553** With X3=0: Average price of **£385,106** => The Emirates Stadium brought a **9.49%** decrease in housing prices at X1=165 compared with if it was not developed => The addition of X4 variable has decreased the negative impact of the Emirates Stadium on property With X4=0: Average price of **£385,853** => The 2008 recession brough a **9.67%** decrease in housing prices at X1=165 compared with if it did not happened With X3=0 and X4=0: Average price of **£426,318** => The 2008 recession and the Emirates Stadium brought a **18.24%** decrease in housing prices compared with if they did not happened

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