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The ex-ante impact of conflict over infrastructure settings on residential property values: The case of Paris's suburban zones

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Abstract

The presence of nearby public facilities has an impact on real-estate values; for this reason, the market may reasonably anticipate that public infrastructure projects will affect house prices. But undesirable and semi-desirable facility location choices may be contested by nearby residents, as they are a source of negative externalities or expectations. In Paris's suburban zones, opposition to these infrastructures is frequent, and the official announcement of a project does not automatically mean it will be implemented. Through three case studies, we explore the way in which the expectation mechanism is affected by legal conflicts driven by nearby residents. We suppose that expectations depend on the probability that a given project will be realised. The variation is captured by a hedonic model. As conflicts amplify or reduce the certainty of the new facility's arrival, market perceptions of the infrastructure vary.

Keywords

house prices, infrastructure setting conflicts, market expectations

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Introduction

This article investigates the impact of conflicts concerning public facilities on property values in suburban Paris. The creation and location of undesirable facilities is becoming a serious problem for decision-makers, especially when these facilities have to be built near a residential or protected

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ecological zone. They can generate negative externalities such as water or air pollution, unpleasant smells, noise pollution or environmental damage, and impose costs on the host community. However, the costs may be partially or completely offset by the range of benefits provided by the infrastructure project (Kiel and McClain, 1996). Because negative impacts reduce inhabitants' well-being, but are not yet considered a social cost (Gilchrist and Allouche, 2005), the project could face organised opposition as soon as it is announced. Urban economists talk about infrastructure setting conflicts (Cox and Johnston, 1982; Janelle and Millward, 1976), and we note that in the case of the Paris region, the phenomenon is linked to the scarcity of available land stock (Pham et al., 2013).

Property depreciation is used to justify the loss of value due to non-marketed environmental damage as a result of pollution (Boyle and Kiel, 2001; Farber, 1998). Many works have focused on the impact of noise pollution (Nelson, 2004), industrial pollution (Letombe and Zuindeau, 2005), air pollution (Smith and Huang, 1993), or undesirable land use (Farber, 1998). But they focus primarily on the *ex-post* measurement of the negative impacts. Hence, little is known about the period before a project's realisation. This period corresponds to the time interval between the announcement and the realisation of a project, and has an influence on the local housing market's expectations with regard to the project. The price signal corresponds to the public valuation of the facility's utility, but also includes the extent to which it is expected to cause inconvenience. This paper concentrates on this *ex-ante* phase (before the completion of the project) by studying the prices of property in three case studies.

What is specific in our context is that infrastructure projects can still face opposition even after the official announcement (Darly and Torre, 2013; Jeanneaux, 2006). The form of opposition varies considerably, from protests to legal action, which leads us to think that a project announcement does not automatically guarantee the project's realisation. Based on lawsuit information, we studied the period following the announcement of a project, which is *ex-ante* to the project's realisation. We supposed that lawsuits can change the perception of the market. They reduce or increase the certainty of the project's realisation, while the market expectation mechanism requires information to anticipate the future impacts of the project.

Inspired by the model of Yiu and Wong (2005), we developed a hedonic model in order to identify the market's expectations. In its original version (2005), the model detects variations in house prices during the period under examination and shows the changes *before, during* and *after* the construction of the public facility. In concentrating only on the *ex-ante* phase, we sought a more detailed observation by fragmenting this pre-construction period. We introduced the variable of legal conflict, and tested whether the sub-periods defined by legal action influenced the price.[1] The material is taken from a lawsuit survey conducted at French administrative tribunals where opponents challenged public infrastructure projects.

This paper is organised in four sections. The first provides the background of our study. It focuses on the hedonic model, and in particular the hedonic approach used to capture expectations. The second section presents our three case studies of undesirable and semi-desirable infrastructure setting conflicts, the data, and the econometric models. The third presents our main findings, and the final section closes the paper with a discussion of future research and conclusions.

Background

It is well known in the field of housing economics that public facilities have an impact on real-estate values (Beckerich, 2000). Capitalisation effects depend on the nature of the facility[2] (for more details, see Brueckner et al., 1998; Des Rosiers, 2002; Kiel and McClain, 1996; Maleyre, 2007). For an undesirable or semi-desirable facility – our target object – the literature is abundant; see, for example, Kohlhase (1991), Boyle and Kiel (1991) and Nelson (2004) for a summary. A special 2002 report commissioned by the Royal Institution of Chartered Surveyors (RICS; 2002) studied the impact of transport facilities – semi-desirable construction – on property prices. On the whole, there is a consensus in the literature that these kinds of public facilities have a depreciative effect.

But while the negative impacts of infrastructures are widely known to reduce property values, little is known about what the market expects of their future presence. Yiu and Wong (2005) remarked that of the 150 reference on the topic of land value and public transport surveyed in (RICS, 2002), very few have paid attention to this kind of observation. Their work follows that of Chau and Ng (1998) in exploring the effects of transport improvements on property values, and shows that impacts on prices can take effect before the arrival of the infrastructure in question. They concluded that more market expectation studies were needed, as they can be used to guide public policy, or at least reduce risky transactions in the options market. Farber (1998) and Gravel and Trannoy (2003) also underlined the importance of understanding market anticipation, but they did not explain how to detect this phenomenon and what its magnitude might be.

The use of conflict variables to study market expectations has, to date, never been reported in the literature. This may be because it is assumed that public facility projects will always be implemented without hindrance once they have been announced. Conflict over public infrastructure projects is, however, frequent, at least in France. Despite an important preparatory phase where the population is asked for its opinions, public decisions in favour of certain infrastructure projects can still raise opposition, and may be challenged in court for a number of reasons. The announcement of a project, then, does not automatically equate to its realisation. We are interested in understanding the reaction of the market in such a situation.

Measuring the conflict phenomenon is not an easy task. In our approach, a conflict is defined as any opposition to a public decision. It is a collective action, which may incorporate a warning message to the public decider (Mann and Jeanneaux, 2009): 'You, the decider, could be sanctioned by us, if you implement this polluting project here'. The credibility of the message is therefore crucial to the market, as it provides information as to whether the project will be implemented.

In practical terms, we had a choice between measuring conflict using litigation data and measuring conflict using press articles (Torre et al., 2014). In the first case, challenges are brought before a court of law, while in the second challenges are reported in the (local) press, by journalists following the conflict. Newspaper articles have been used before in housing economics literature to measure public awareness of an opportunity or a risk. For example, Gayer and colleagues (Gayer and Viscousi, 2002; Gayer et al., 2002) worked on press material and found that house prices vary in inverse proportion to the risk-related information reported in newspaper articles. We chose to use litigation data because it is a reliable and measurable indicator of conflict, and because litigation can also lead to legal enforcement, conferring a degree of certainty to the buyers' and sellers' positions regarding a given project. Moreover, newspapers cannot cancel a project, whereas a court judgement can.

The seminal text on hedonic theory was written by Rosen (1974). The central idea is that the value of a complex good is not intrinsic to that good. Rather, it comes from the satisfaction that the owner will obtain by benefiting from each of its characteristics. Even if a given characteristic is not traded on a specific and separated market – because it is embedded in the good – we can work with its *implicit* market price. For a housing hedonic model, the characteristics selected are usually physical (e.g. number of rooms, surface area, storey, date of construction), local (e.g. district, quality of the neighbourhood, etc.), and more generally linked to amenities (e.g. public goods, transport). Hedonic theory usually allows for three kinds of works. The first is the calculation of a global market index, such as the *Notaires-INSEE* index for France (Chambre des Notaires, 2010), which is produced using the same database that we have used in this article. Secondly, it allows the development of valuation models to appraise non-transactional public goods. Lastly, the hedonic approach can be applied to define control variables in a more general study (see Engberg and Greenbaum, 1999). This article corresponds to the third kind of use.

Expectation-capture hedonic models fall into two main categories.[3] The first, and also the more frequently used model, is a distance-capture design (Kiel and McClain, 1996; Kohlhase, 1991; Smolen et al., 1992). This model is intended to measure changes in price with regard to distance from the future facility. Changes in the coefficients of distance variables over time correspond to different market estimates of the impact of the infrastructure. For example, Kiel and McClain (1996) ran a distance-capture model in a study of a project to set up a waste disposal site, in five stages: pre-rumour, rumour, construction, online, and operation. They found that the distance variable is positively significant before construction, and that the coefficient of this variable evolves between the pre-rumour and rumour stages – proof of the negative effect on the market's expectations. The same result was obtained by Smolen et al. (1992), who studied a proposed radioactive contamination site.

The second family of expectation-capture models is the price-gradient model (Chau and Ng, 1998; Yiu and Wong, 2005). In this model, the area under study is divided into sub-zones and the period under study into sub-periods. These sub-zones and sub-periods enable the interaction of dummy variables that trace the temporal and spatial price gradient. The model then measures the reaction in each sub-zone and in each sub-period in comparison to a chosen reference sub-zone and sub-period. Our article adopts this modelling design, as it can be applied to any kind of spatial organisation using a precise definition of zones and time-interval dummies. This criterion is crucial, as we will be dealing with more than one facility project. These projects present heterogeneous spatial organisations. In one case, we have a central-peripheral configuration, while in the two others we have linear configurations. Assuming they will not have the same spatial diffusion, the price-gradient model is our best option.

Case studies – Data – Model

Presentation of case studies

Our three case studies correspond to three legal conflicts regarding infrastructure locations in suburban areas of Paris. Our objective is to observe the variations in house prices relating to a controversial project before the beginning of the building phase, in order to understand how the market price adjusts to the conflict event. Three zones were identified by extracting information from the various projects' public announcements. Each zone covers the host community, which is to receive the controversial infrastructure, and the nearby neighbourhoods highlighted in the project documents.[4] The host communities are *Vaux-le-Pénil* (in the Seine-et-Marne *département*, in the south-eastern suburbs), *Maisse* (in the Essonne *département*, in the far southern suburbs), and *Saint-Nom-la-Bretèche* (in the Yvelines *département*, in the western suburbs).

In *Vaux-le-Pénil*, the project in question was the creation of a regional incinerator. Opposition to the project did not come from the host community, but from a neighbouring municipality that would be directly impacted: *Maincy*. An older, smaller incinerator was previously in service in *Vaux-le-Pénil* for over 30 years without being contested by *Maincy*. This project is supposed to replace it with a new incinerator 10 times the size, which raised the question of how the population of *Maincy* would be affected. *Maincy*'s population is directly exposed to the prevailing wind from *Vaux-le-Pénil*. As carcinogenic elements were found in *Maincy*, as well as a number of cancer cases, the mayor of *Maincy* challenged the project's promoter in court in order to block construction. The cases of *Maisse* and *Saint-Nom-la-Bretèche*, on the other hand, concern local opposition to two road projects. The proposed routes would require the use of some non-urbanised space to accommodate new roads. Roads facilitate transport, but they are also known to be a source of noise and air pollution for those who live nearby. The two projects are opposed by inhabitants who are afraid they will lead to environmental damage and a worsening of their living conditions.

We should highlight that our case studies are all different in terms of both the nature and the impact of the projects in question. But what they all have in common is that conflicts in general, and litigation processes in particular, arise in reaction to each project after an official announcement. As mentioned above, a court judgement is an official decision that has the power of enforcement with regard to the project's realisation. An act of conflict is materialised by a legal claim made before a court. Of course, conflicts are not limited to lawsuits. They also include activities such as information campaigns or other kinds of media dissemination. To a greater or lesser extent, there may be rumours about whether the project will be realised (or not) in each case and how dangerous it would be for the surrounding population. However, in our econometric model, we use litigation variables, mainly because of their suitability for measuring conflictuality.

The choice of our three cases is based on a survey of infrastructure setting litigation (see Table 1). We used a court litigation database[5] to select the most recent and representative conflicts in the Île-de-France (Paris) region (Pham and Kirat, 2008). Roads and incinerators are the most frequently opposed public facilities in the region. This choice was also based on our firm understanding of the history of the projects, thanks to discussions with those involved locally.

We registered the start and end dates of these claims, which helped to determine the duration of each conflict (see below). We also registered the result of the claim, i.e., whether it was accepted or rejected by the judge. In two of the three cases (*Vaux-le-Pénil* and *Saint-Nom-la-Bretèche*), the judge rejected the inhabitants' claims. In the case of *Maisse*, however, the litigation was at the appeal stage, following a first hearing where the court accepted the claim and cancelled the road diversion project, and a second hearing where the appeal court overturned

Table 1. Main characteristics of properties in the three case studies.

	Mean	*SD*
Vaux-le-Pénil case (800 transactions)		
Price	€187,338	€62,092
Number of rooms	5.10	1.38
Number of car parking spaces	0.86	0.55
Net surface	112.18 m^2	34.98 m^2
Land ground surface	620. 40 m^2	395.03 m^2
Maisse case (435 transactions)		
Price	€234,102	€83,308
Number of rooms	4.83	1.43
Number of car parking spaces	0.74	0.61
Net surface	115.82 m^2	42.48 m^2
Land ground surface	907.76 m^2	718.42 m^2
Saint-Nom-la-Bretèche case (665 transactions)		
Price	€416,882	€194,696
Number of rooms	5.26	1.36
Number of car parking spaces	1.04	0.59
Net surface	123.18 m^2	48.37 m^2
Land ground surface	458.80 m^2	431.49 m^2

Table 2. Summary of case-study specificities.

	Desirability	Sequence	Judge's decision	Informational specificities
Vaux-le-Pénil	Undesirable infrastructure (incinerator)	Yes	Project continues	Strong rumour about the pollution, as carcinogenic substance was found
Maisse	Semi-desirable infrastructure (road)	Yes	Firstly: project cancelation Secondly: project continues	Strong opposition at the beginning of conflict
Saint-Nom-la-Bretèche	Semi-desirable infrastructure (road)	No	Project continues	No rumour, weak opposition

the previous judgement. When we conducted our study (in early 2009), the case was still under way at the French supreme administrative court (the *Conseil d'État* or State council).

The litigation 'procedures' are not necessarily identical in all three cases. They may be sequential, meaning that the legal action results from several successive claims brought before the court, or non-sequential if there is only one claim. Table 2 summarises the various situations of our studies. The column *Sequence* indicates whether the conflict has a sequential development in court. The column *Judge's decision* indicates the decision's impact on the project – i.e., whether or not it was cancelled.

Data

House prices come from the Paris Notaires Services (PNS) database. Data were extracted for transactions according to their geographical and temporal proximity to the conflict in question. The zones concerned were determined by the decisions made by the public authorities when the projects were launched.[6] Conflict duration is determined by our survey of court decisions. We consider that a legal conflict begins with an administrative decision (project announcement) and ends when there is no longer any litigation. In operational terms, we took the year of the project's official announcement as the starting point of the study period, and the year that litigation comes to a close as its end point.

We then built three samples for each study zone (*Vaux-le-Pénil, Maisse* and *Saint-Nom-la-Bretèche*). The case studies are named after the host towns, but they also contain house sales from neighbouring districts. In order to avoid bias and to obtain homogeneous data, irregular transactions (e.g. especially low or especially high prices, too many rooms, parking included) were eliminated. The three samples are given in Table 3.

Model and explanation of variables

Our model adopts the price-gradient approach, and takes a log-linear form, which means that we explain price by an exponential function of the house characteristics:

$$LnDP = \beta_0 + F(K_H) + \sum \gamma_i C_i + \alpha Z_{OP} + \sum \omega_i C_i Z_{OP} + \varepsilon$$

in which:

DP is the deflated sale price of the observed house. We use the house-price index by *département* for the Île-de-France region (Chambre des Notaires, 2010), published by the Paris Notaries' Chamber to correct the overall market trend. This index, calculated by the Chamber each quarter, allows us to eliminate the departmental market trend from the price and isolate the local impact of the project. *LnDP* is the deflated price in the logarithm.

K_H is the vector of hedonic characteristic variables of the observed property. We build K from nine variables: two continuous variables (i.e., the number of rooms (Ln_NbRoom) and the surface area of the land lot (Ln_LotSize), and seven dummy variables that control the presence of basement spaces (Cellar), the number of parking spaces (NbPark), the type of property (HouseTYPE), the number of storeys (Level), the period of construction (PERIOD), the reason for sale (Motif_ SPC_Sale), and the presence of a leasehold at the time of sale (RENT_HOUSE).[7]

As local opponents anticipate the potential nuisance, we argue that house prices in some conflict zones fall after the announcement of the project. We use dummy variables to capture this. There are three kinds of dummies:

- The dummies C*j* control the period of conflicts.

For each case study, we project the conflict events on to the study period, and then define conflict dummies as intervals between the dates of two events. Conflict events are legal complaints made before an administrative tribunal (coded as AT) and, in the case of *Maisse*, subsequent appeals at the appeal court (coded as AC) and the Supreme Court (coded as SC). See Table 3 for details of litigation periods, which help to determine these dummies.

As mentioned above, a conflict may be sequential or not. The conflict's progress can then be broken down into a series of *j* successive events brought to court. The case of *Vaux-le-Pénil* is marked by three claims, all made before the administrative tribunal (AT). We gave each of them a dummy value, as they were successively reported to the tribunal at different points in the litigation (due to the progressive discovery of information by *Maincy*'s residents about the future project). In this case, $j = 3$. In the case of *Maisse*, the conflict begins at the administrative

Table 3. Litigation periods.

Case 1: Vaux-le-Pénil, project announcement: 6 April 2001 (3 claims at TA, the reference situation is non-conflict)				
Av conflict (Non-conflict)	AT Claim1 (Conflict)	AT Claim2 (Conflict)	AT Claim3 (Conflict)	Service date (Non-conflict)
January 2001–August 2001 108	August 2001– January 2002 77	February 2002– January 2003 169	February 2003– August 2003 88	September 2003–December 2005 358
Case 2: Maisse, project announcement: 2004 (3 claims due to appeal procedure, reference = non-conflict)				
Av conflict (Non-conflict)		AT (Conflict)	CAA (Conflict)	SC (Conflict)
January 2004–August 2004 114		September 2004–June 2006 178	June 2006– June 2007 78	July 2007– December 2008 65
Case 3: Saint-Nom-la-Bretèche, project announcement: 2005 (1 claim at TA, reference = non-conflict)				
Av Conflict (Non-conflict)		AT (Conflict)		Af AT (Non-conflict)
January 2004–January 2005 221		February 2005–September 2006 428		October 2006– December 2006 6

tribunal, continues at the appeal court, and is subsequently taken to the Supreme Court; j is also equal to 3. Lastly, for the case of *Saint-Nom-la-Bretèche*, only one claim is made, before the administrative tribunal, so $j = 1$. In each case, the non-conflict period is taken to be the reference period. This whole period covers all of the time before the conflict and, except in the case of *Maisse*, after the conflict.

Because the litigation period dummies also had an embedded time impact, reflecting market trends at the global and local levels, we used the deflated price, as mentioned above, to eliminate global market trends. As a result, the coefficient γ_j of the dummy C_j will provide indications only about the local market trend of the reference zone during the different periods of conflict C_j. Through interviewing residents and surveying local press, we also made sure that there was no major renovation project in the three cities during the period under consideration. Moreover, as the periods are quite long, retention effects are unlikely to happen.

- Z_i ($I = 2$) is the dummy to control geographical location. For each case, we identify the zone of opposition to the setting project, whose inhabitants do not agree with the project, and name it Z_{Op}. The rest of the study zone will act as a reference zone,[8] Z_R (see Figure 1).
- We use cadastral divisions to identify zone Z_{Op}. Here, we used only the first division level, which splits a community into homogeneous residential zones based on natural borders or main roads.

The coefficients α_i will then measure the reaction of the opposition zone Z_{Op} with regard to the reference zone Z_R during the reference period of no conflict. The coding is as follows: C_j takes the value 1 if the transaction is observed during the conflict period j, 0 if not. Z_i takes the value 1 if the transaction is in the zone i, and 0 if not.

- The final term, ω_{ij}, also called the interaction term, controls the cross effect between zone and conflict factors (Chau and Ng, 1998; Yiu and Wong, 2005). We code this dummy using the same rule: if the transaction is made in zone i at period j, the conflict–location interaction dummy takes the value 1; otherwise it will be 0. This control tells us how each observed zone reacts to a specific period of conflict, with regard to the general situation at Z_R, which helps to build the price gradient. Practically, we have the following interactive terms: Z_{OP}_*Claim.1*, Z_{OP}_*Claim.1*, Z_{OP}_*Claim.1* for Vaux le Penil, Z_{OP}_*AT*, Z_{OP}_*AC*, Z_{OP}_*SC* for Maisse, and Z_{OP}_*AT* for *Saint-Nom-La-Bretèche*.

In summary, our model is based on the estimated value of a reference house determined by regression using continuous and discrete variables and spatio-temporal dummies. One of the modalities is removed from the dummy variables and the discrete variables to avoid multicollinearity misspecification, while the continuous variables are regressed directly. The reference house value is based on the number of rooms, the land-lot area, and the number of cellar rooms; it is by default a 'pavilion' (smaller detached home), built between 1947 and 1980, sold under normal conditions (i.e., not following a major life event, and with no existing leasehold), with one car-parking space and one storey. It should be located in a zone of no opposition and sold outside any conflict period.

Empirical results

Estimation using the ordinary least square (OLS) model

Here, we present the results of our model using OLS estimation. We shall first review the bloc of internal character variables

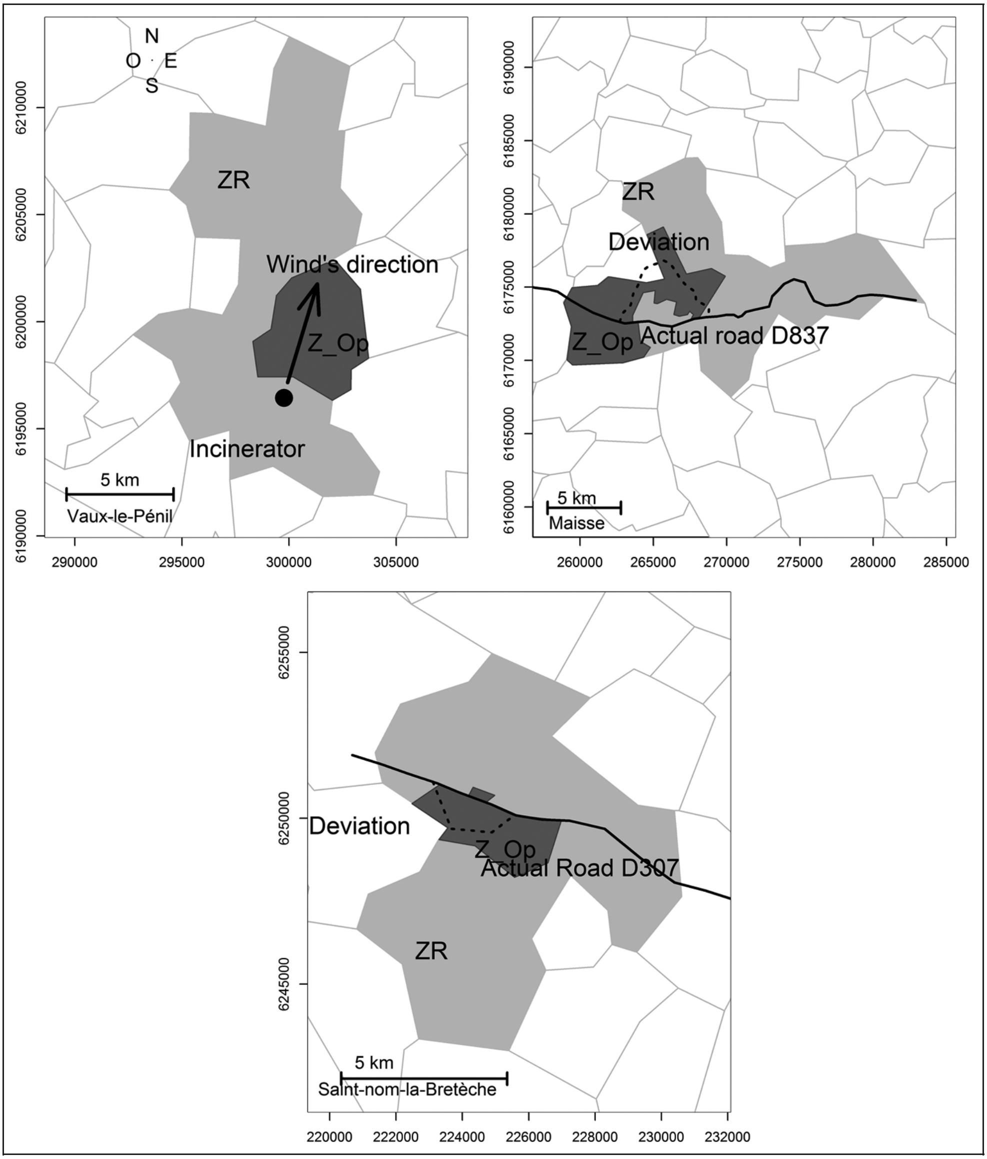

Figure 1. Study zones and opposition zones.

(vector K_H). In general, this bloc is highly significant, particularly with regard to the number of rooms, the land-lot area, the number of car-parking spaces, the number of storeys, and sales following a major life event. An additional room increases the value of the reference house (a change of 20% for this five-room property) by a proportion ranging from 7.6% for *Saint-Nom-la-Bretèche* to 10.8% for *Vaux-le-Pénil*.[9] The relative value for an additional room in *Maisse* is calculated to be 9.5%.

The land-lot area variable and the dummy variable for the number of storeys also impact positively on house prices. In *Vaux-le-Pénil*, the coefficient of dummy LEVEL.2 is 7% and that of LEVEL.3 is 13%, meaning that the price of a two-storey house and a three-storey house are respectively about 7% and 13.8 % more expensive than the reference house (see Note 9). The same values in the case of *Maisse* are 11.6% and 13.8%, respectively, which is logical as houses with more storeys are also bigger, explaining the difference in price. A sale due to a major life event (such as a marriage, an inheritance or a divorce) generally reduces the value of a house by 8% to 14.8 %. This loss could be considered to be the cost of making a transaction under exceptional conditions. Similarly, selling a house with an existing tenant reduces the price by 8% on average, as the coefficients of the RENT_HOUSE dummy suggest a price discount of 7%, 8% and 9%, respectively, for our three case studies (non-significant for *Saint-Nom-La-Bretèche*). These results are not surprising, as these variables are well known in the literature (the RENT_HOUSE dummy becomes significant only after the spatial correction; see below).

Some internal character variables are, however, not significant, or only partly significant over the three study cases. The variables concerned are the dummies for the period of construction (PERIOD.BF.47 and 80.2000 are significant in only 1 out of 3 cases; PERIOD.AF.2000 in 2 out of 3 cases; PERIOD.NA is not to be commented as it is only used to control missing values), NB.PARKING.2 for houses with more than 2 car-parking spaces (significant in 1 out of 3 cases), and HOU_TC, which represents 'town cottages'. We consider that the specificities of the local periurban markets are at play here. Our zones are composed of communities with a dominant semi-rural configuration. Hence, the variables are not discriminating enough for their contribution to be econometrically detected. Take the HOU_TC dummy, for example: if there is no price difference between a 'town cottage' and a 'pavilion' (the reference house type), it is because a 'town cottage' is quite similar to a 'pavilion' in a periurban context. Both are of more or less the same size and both have similar characteristics (e.g. relatively close to natural spaces). Nevertheless, the local market's specificities do not affect all our dummies, as the price of a luxury house ('villa') is considerably higher than that of the reference house in all three cases: coefficients of *HOU_VI* are 17% in *Vaux-le-Pénil*, 16% in *Maisse* and 10% in *Saint-Nom-la-Bretèche*.

Once area-related specificities had been taken into account, we then concentrated on market expectation dummies, which are central to our study, by analysing litigation period controls, location controls, and their interaction terms.

The results show that the dummy Z_{Op} and all litigation period dummies, including Claim1, Claim2 and Claim3 for *Vaux-le-Pénil*; AT, AC and SC for *Maisse*; and AT for *Saint-Nom-la-Bretèche*, are insignificant. These results indicate that: (a) no difference exists between houses prices in the reference zone <u>during the periods of conflict</u>; and (b) there is no difference in houses prices *in the conflict zones as opposed to the reference zone* <u>during the period of no conflict</u>.

Regarding the interaction terms, some of them are significant during the periods of conflict. Such a result indicates that the market adjusts prices in the zone of conflict and during the period of conflict. This is proof of market expectations. In *Vaux-le-Pénil*, the coefficient of the cross-effect terms showed that, after the second claim, prices fall by 15% (dummy Z_{Op}.Claim.2) with a p value of 0.03. In *Maisse*, the interaction term Z_{Op}.SC also shows a negative impact of 15.6 %.[10] However, we found no impact in *Saint-Nom-la-Bretèche*.

Table 4. Results of spatial autocorrelation statistics based on Lagrange Multiplier tests.

	Vaux-le-Pénil			Maisse			St-Nom-La-Bretèche		
	Statistic	*df*	*p* value	Statistic	*df*	*p* value	Statistic	*df*	*p* value
SARMA	5.37	2	0.068	27.257	2	$1.205e^{-06}$	396.01	2	$<2.2e^{-16}$
LMerr	3.43	1	0.064	27.096	1	$0.936e^{-07}$	242.8	1	$<2.2e^{-16}$
LMlag	5.36	1	0.021	17.456	1	$2.940e^{-05}$	305.01	1	$<2.2e^{-16}$
RLMerr	0.02	1	0.899	9.801	1	0.019	90.1	1	$<2.2e^{-16}$
RLMlag	1.94	1	0.163	0.161	1	0.166	153.2	1	$<2.2e^{-16}$

Because our R^2 values are not very high, we conducted a series of spatial autocorrelation tests, including the Moran's *I* test, the SARMA test, the LM_{ERR} test and the RLM_{ERR} test (Anselin and Bera, 1998; Le Gallo, 2002) to control for the error term. As is well documented in Cliff and Ord (1973) and Anselin (1980), spatial autocorrelation may result from the presence of a hidden spatial variable, but may also be the result of the fact that a house's price is determined with regard to the price of neighbouring' houses.

Our test results show that spatial autocorrelation is not important, but does exist. The Moran's *I* is approximately 1% for *Vaux-le-Pénil*, 7% for *Maisse* and 18% for *Saint-Nom-la-Bretèche*. Consequently, our OLS estimators face the risk of being biased or inefficient (Le Gallo, 2002). With regard to the SARMA tests, we then decided to apply a spatial autoregressive model (SAR) for *Vaux-le-Pénil*, and a spatial error model (SEM) for *Maisse* and *Saint-Nom-la-Bretèche*.[11] See Table 4 for the RLM Err and RLM Lag tests.

Because the aim of SAR/SEM correction is not to change the object of our estimates, but merely to obtain a better estimation, we shall present here only the technique used to improve these models, and then discuss the results obtained (see Table 5). Readers interested in a more detailed presentation are advised to review (Anselin, 1988; Anselin and Bera, 1998).

Robustness and correction of spatial autocorrelation

Mathematically, the SAR presents a spatially lagged dependent variable ρ in addition to initial OLS variables. The lag variable stands for the contribution of the neighbourhood factor to a house price. By contrast, the SEM supposes that the autocorrelation factor could be controlled using a variable λ, which represents the degree of autocorrelation among the error terms of the initial OLS estimation.

$$y = \rho W y + \beta X + \varepsilon \qquad \text{(SAR)}$$

$$\varepsilon = \lambda W \varepsilon + u \qquad \text{(SEM)}$$

For both models (SAR and SEM), we used the inverse distance matrix as the weight matrix *W*. These distances are calculated within a neighbourhood of radius 600 m. Table 4 shows the results of our regression and indicates that the use of SEM and SAR models helps control the spatial autocorrelation phenomenon without invaliding our initial OLS model. In fact, both ρ and λ are significant, indicating that their presence in the model is relevant. Although they modify some estimators, they only slightly alter most initial OLS estimators.

The case of Vaux-le-Pénil. For *Vaux-le-Pénil*, the dummy Z_Op.Claim2 is always significant with a coefficient of −0.15 now, instead

Table 5. Summary of model regressions.

	Vaux le Pénil				Maisse					St-Nom-La-Bretèche				
	Estimators	(Initial OLS Estimators)	Std. Error	Pr(>|z|)		Estimators	(Initial OLS Estimators)	*SE*	Pr(>|z|)		Estimators	(Initial OLS Estimators)	*SE*	Pr(>|z|)
(Intercept)	6.43***	(9.92***)	1.20	0.000		10.25***	(10.33***)	0.12	0.000		11.07***	(9.67***)	0.32	0.000
Ln_Nb.Room	0.52***	(0.54***)	0.03	0.000		0.45***	(0.47***)	0.04	0.000		0.42***	(0.38***)	0.04	0.000
Ln_Lotsize	0.14***	(0.16***)	0.01	0.000		0.13***	(0.11***)	0.02	0.000		0.24***	(0.34***)	0.01	0.000
CELLAR	0.02	(0.03)	0.02	0.189		0.02	(0.03***)	0.03	0.341		0.03	(0.03***)	0.02	0.147
NB.PARK.0	−0.05***	(−0.07**)	0.02	0.009		−0.08***	(−0.07)	0.03	0.003		0.00	(0.04)	0.02	0.975
NB.PARK.2	−0.01	(−0.02)	0.03	0.784		0.00	(0.01)	0.04	0.925		0.08***	(0.11***)	0.02	0.000
HOU.TC	0.04	(0.12)	0.06	0.554		0.00	(0.02)	0.07	0.978		−0.06	(−0.09)	0.11	0.597
HOU.VI	0.16	(0.17**)	0.13	0.221		0.09	(0.16**)	0.07	0.161		0.09**	(0.10**)	0.04	0.030
HOU.NA	−0.02	(−0.04***)	0.02	0.181		0.01	(0.01)	0.03	0.566		0.05***	(0.07***)	0.02	0.001
LEVEL.2	0.08***	(0.07***)	0.02	0.000		0.09***	(0.11***)	0.03	0.007		0.03	(0.04)	0.03	0.295
LEVEL.3	0.14***	(0.15***)	0.04	0.000		0.10*	(0.13)	0.06	0.084		−0.02	(−0.03)	0.03	0.596
LEVEL.4	0.10	(0.49)	0.24	0.685		n/a	n/a	n/a	n/a		0.10	(0.18)	0.19	0.598
PERIOD.BF.47	0.03	(0.03)	0.03	0.226		0.00	(0.00)	0.04	0.929		0.25***	(0.39***)	0.06	0.000
80.2000	0.01	(0.01)	0.03	0.654		0.02	(0.01)	0.04	0.541		0.07***	(0.12***)	0.03	0.006
PERIOD.AF.2000	0.09	(0.09)	0.06	0.121		0.13*	(0.12)	0.08	0.095		0.18***	(0.32***)	0.04	0.000
PERIOD.NA	0.00	(0.00)	0.02	0.872		0.01	(−0.03*)	0.03	0.866		0.03	(0.07***)	0.02	0.110
MOT_SPC_SALE	−0.08***	(−0.07***)	0.03	0.005		−0.14***	(−0.12***)	0.04	0.000		−0.09***	(−0.14***)	0.03	0.006
RENT_HOUSE	−0.08***	(−0.07*)	0.05	0.072		−0.15**	(−0.08)	0.07	0.029		−0.07	(−0.09)	0.05	0.171
Claim.1	0.05	(0.04)	0.03	0.112	AT	−0.02	(−0.01)	0.03	0.563	AT	0.01	(0.02)	0.02	0.715
Claim.2	0.02	(0.03)	0.02	0.431	AC	−0.02	(−0.01)	0.04	0.547					
Claim.3	−0.03	(−0.02)	0.03	0.265	SC	0.00	(0.02)	0.04	0.913					
Z_Op	0.05	(0.01)	0.04	0.170	Z_Op	0.01	(−0.09)	0.08	0.926	Z_Op	−0.03	(0.07)	0.08	0.712
Z.Op.Claim.1	−0.09	(−0.01)	0.11	0.454	Z.Op.AT	−0.03	(−0.01)	0.09	0.699	Z.Op.AT	0.13	(0.11)	0.09	0.146
Z.Op.Claim.2	−0.15***	(−0.16**)	0.07	0.014	Z.Op.SC	−0.02	(−0.01)	0.10	0.857					
Z.Op.Claim.3	−0.12	(−0.09)	0.10	0.262	Z.Op.SC	−0.14*	(−0.17*)	0.11	0.096					
	Rho: 0.30474 Pseudo-R^2: 0.51499				Lambda: 0.72477 Pseudo-R^2 = 0.56014					Lambda: 0.97578 Pseudo-R^2: 0.83631				
	Log likelihood: 48.29742 for lag model				Log likelihood: 7.538894 for error model					Log likelihood: 148.3205 for error model				
	AIC: −42.595 (AIC for lm: −36.736)				AIC: 36.922 (AIC for lm: 67.849)					AIC: −250.64 (AIC for lm: −56.681)				
	LM test value for residual autocorrelation: 0.12189, p = 0.72699													

Note: *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$.

of −0.16 in the OLS model. Therefore, the second claim has a negative impact on prices in *Maincy*. This claim made by *Maincy* called for an urgent public intervention to stop the incinerator project, as carcinogens had been found and some cases of cancer had been detected in this community. *Maincy* is directly exposed to wind from the direction of the incinerator in *Vaux-le-Pénil*, and the cancers may have been a direct consequence of the incinerator's discharge. *Maincy*'s mayor had warned the population about the danger, and initiated a petition to block the project. The price fall should correspond to a strong rumour of dangerous pollution; moreover, it is backed by a legal claim in court.

This second claim caused only brief panic, as the prefecture announced that the pollution was not scientifically confirmed, and officially guaranteed the safety of the new incinerator. With this change of informational content, the danger was no longer confirmed and houses stopped losing value. Both of our models, SAR and OLS, show that the discount was not maintained during the subsequent period either. Thus, except for the second claim, there was no price change during the conflict periods in comparison to the period of no conflict. The driver of the fall in prices during the second claim is likely to be a market adjustment to a subjective perception of risk. It seems clear that the litigation procedure had an influence on house prices, in particular because prices stopped falling when the claim was rejected by the court.

The case of Maisse. *Maisse* is the only case of ongoing legal action with an appeal procedure. The results are convergent in the SEM and OLS models and show that the claims during phases 1 and 2 at the administrative tribunal (dummy *Z.Op.*AT) and the appeal court (dummy *Z.Op.*AC) had no effect on prices in the conflict zone. This result is adequate for our survey on conflict situations. In fact, the first claim at the tribunal (AT) corresponds to fierce local opposition, backed by a long history.

Fifteen years ago, another project was to be realised in the south of *Maisse*, but was ultimately cancelled in 2004. The north of the village was subsequently transformed into a semi-urbanised area with the construction of private housing estates.[12] Consequently, when the announcement of a new project in the north was made, it came as something of a surprise to the population, and explains why very strong opposition emerged. After investing confidently in a major lifetime purchase, it seems only normal that inhabitants would not accept the future road easily.

In this situation, the market first of all experienced disbelief concerning the project prior to the judgement: this could explain why house prices did not drop during this period. Then, the opponents won a first victory at the administrative tribunal (AT). During the next phase, the prefecture lodged an appeal with the appeal court (AC) following the cancellation of the project. We may assume that, given this cancellation, the inhabitants remained confident that the project would not be realised. This would explain why the market did not react to the same extent during this period, despite the appeal.

However, the situation dramatically changed when the appeal court overruled the administrative tribunal's decision, and ordered that the project continue. This judgement had a marked impact on property prices in the post-appeal period: according to our equation, prices fell sharply in the opposition zone (−15,6 % using the OLS estimation, −13,1 % using the correcting SEM model[13]). The conflict continued, with an appeal from inhabitants at the Supreme Court (SC), but prices kept on falling, reflecting residents' dwindling hopes of winning the lawsuit. Litigation procedures clearly seem to impact house prices.

The case of Saint-Nom-la-Bretèche. In *Saint-Nom-la-Bretèche*, our model tests the impact of only one conflictual event (the claim brought to the administrative tribunal). The time–location interaction term *Z.Op.*AT is insignificant in both the OLS and SEM models. It seems that the market's expectations are null with regard to the project in this case.

At first sight, this result is surprising, as the new road would modify the landscape in the area. But, in observing the conflict, we noticed that the main argument presented by the project's opponents was that the future road would depreciate the value of their homes. They asked for more protection measures, such as noise barrier walls or the planting of trees to compensate for the degradation of the landscape, most of which were granted by the local authorities. The absence of price changes or other impacts in the case of *Saint-Nom-la-Bretèche* could therefore be explained by the fact that the local population was mostly satisfied with the public decision taken. The road is likely a welcome infrastructure in *Saint-Nom-la-Bretèche* and local inhabitants merely wanted greater protection, not the project's cancellation. The conflict was ultimately of low intensity, and left the housing market indifferent. We should point out that, in *Saint-Nom-la-Bretèche*, local associations did not appeal, and the conflict ended after the first judgement.

A brief summary of our results, in order to obtain an overview of our three regressions, follows: first, our model captures the impact of conflicts in the opposition zones. Outside these zones, and in periods of non-conflict, it does not reveal any signs of price change. Value loss was only detected in opposition zones during certain litigation periods, providing proof of market expectations. Losses in value coincide to a great extent with the intensity of the conflict and the expected impact of the new infrastructure. Even in the case of *Saint-Nom-la-Bretèche*, it could be asserted that the absence of market expectation was due to the lack of dynamism of the opposition, all other things being equal.

Discussion

The regressions described above show that:

(1) the price effect (decrease) is a function of the perceived *ex-ante* level of undesirability;
(2) conflict behaviours, particularly litigation procedures, did influence property values;
(3) the market expectation depends on the degree of certainty of the project.

Such conclusions have, to date, never been borne out by empirical verifications in the literature. Messer et al. (2006) found, for example, that house prices in a pollution site did not recover if clean-up operations were delayed for too long. In particular, despite a public announcement that the polluted site would be cleaned up at some point in the future, the market did not adjust prices in anticipation prior to the actual clean-up operation; however, in this case, it had already been confirmed that the pollution was a real problem. Similarly, Gayer et al. (2002) found that house prices fell after the release of a government report on polluted waste sites, and Gayer and Viscusi (2002) showed that property prices also fell in reaction to newspaper articles mentioning the waste site. But these studies deal with known pollution situations and not with market expectations regarding an unpredictable future, as in the case of our research. They fail to reveal how risk perception is estimated by the market *ex-ante*. Our model enables the integration of *ex-ante* information on risk perception, using an expectation study approach. It isolates local market trends with respect to infrastructure setting conflicts during the pre-construction period, and matches price changes with signals indicating the level of certainty of the projects (provided by cases of legal action) and the level of undesirability of these projects.

In our results, we consider the following points as being especially important:

In the case of the incinerator project at *Vaux-le-Pénil*, the mayor's legal claim caused panic among the population. But when the prefecture announced that the pollution had not been scientifically confirmed and officially guaranteed the security of the new incinerator,[14] the panic waned and changes in market expectations were not detected in the latter periods, even when the new incinerator came into operation. Here, it is the perceived level of undesirability (i.e., the perceived risk) that seems to be the main driver.

In *Maisse*, the judgement of the administrative tribunal and the local history surrounding the conflict was in the local inhabitants' favour. At this point, the market did not see fit to reduce property prices: as long as the project was blocked and there were good reasons to assume it would stay that way, with non-urbanised space protected, there was no need to sell houses at a discount. But as soon as the appeals court ordered that the project should go ahead, prices fell as the level of certainty regarding the new facility's construction rose significantly; expectations were reversed. In this case, the expectation was not only that the project would have a negative impact, but also that its chances of being realised had increased significantly following the litigation process.

In *Saint-Nom-la-Bretèche*, we did not detect any price variation. Given what we know about the history of the conflict, this result is not surprising. There was a broad consensus regarding the infrastructure among local residents, and the legal claim made was not a sign of a strong conflict, but concerned certain details only. The population was not calling for cancellation, but simply for protection against the noise that would be generated by the road. Here, the chances of it being realised were high, but the expected undesirability level remained very low.

Since legal claims can result in an administrative decision being overturned, the definitive realisation of a project remains uncertain until a judgement is issued. By following the legal process, we detected price changes via signals indicating the level of certainty of each project, resulting from court judgements. Based on these interesting conflict situations, and on our results, we would suggest the hypothesis that, strictly speaking, the expectation mechanism concerning the impact of conflictual activity on house prices is primarily based on:

the estimation by the population of the negative impacts; and

the degree of certainty of the impacts – i.e., the chances that the project will come to fruition – which can, in turn, depend on the level of intensity of the conflict.

This means, for instance, that a project may simultaneously have a potentially high impact and not be considered by the market until there is some certainty as to its implementation. This mechanism explains why prices changed during different periods of conflict, according to changes in the estimations of the projects' impact and certainty during these periods. We have sought to interpret our results in relation to these two aspects.

Regarding the robustness check, we controlled for the usual hedonic variables, we deflated the house prices in accordance with the index for the *départements* in question, and we also controlled for spatial autocorrelation. We estimate that our database registered 80% of all transactions in these districts. Based on these elements, we found that the market clearly reacts to litigation. When a court's decision over a given period is associated with a sharp modification of property prices, we consider this judgement to be the main explanatory factor. The loss value was 13.9% in *Vaux-le-Pénil*, and 13% in *Maisse* (loss calculated using the correcting model described above). Price decreases of this magnitude can surely not be the result of chance alone, as this is highly infrequent in classical hedonic modelling. Furthermore, the price fall in *Vaux-le-Pénil* was not maintained during the next phase of litigation, when the court refused the second claim. The price fall in *Maisse* was also detected *only after* the judgement issued by the appeal court. The market seems to react in a consistent fashion when it decides to adjust house prices; it is difficult to consider these results as being a consequence of biased samples. Even though our model did not perfectly isolate the litigation effect, this finding is interesting because it reveals expectations in terms of quantified values, and not hypothetical values.

From this standpoint, one of the limits of our model acts as a reminder that the probability of a project's realisation reflects a collective perception of a situation where conflict exists. It depends on the litigation process, but still remains largely the product of human psychology. We do not behave in the same way when faced with risk and opportunity, hence the difficulty of quantifying an expectation. An economic approach helps to determine, step by step, this unknown quantity, but cannot be expected to explain it fully. Our results suggest that we need to build a more advanced model (or even method) to enable a more detailed investigation, rather than continuing to observe the phenomenon from a certain distance. In any case, the imperfection of the model used does not invalidate our findings. We believe that our results represent a useful step for further research in the field of housing economics.

Furthermore, the use of litigation data is not free from imperfections either. As mentioned earlier, conflicts are not limited to lawsuits. They also take other forms, such as information campaigns or media exposure, which could also impact on seller and buyer behaviours. Our results reveal that the impact of litigation is partly associated with rumour. In the case of the *Vaux-le-Pénil* incinerator, the legal claim caused panic among the population, which decreased property transaction prices. In the case of *Maisse*, prices did not drop while awaiting the administrative tribunal's judgement, meaning that another source of information was having an effect on transaction values. The lack of price impact in the case of *Saint-Nom-la-Bretèche* is not quite as easy to analyse. Nonetheless, it also shows that the mechanism of expectation was in operation, and that there was another factor that attenuated price decreases, namely the population's lack of mobilisation, as concern was focused on one very specific detail of the project. In all three cases, litigation seems to be amplified to a greater or lesser extent by an additional factor that contributes partly to the market's reaction. Our work did not aim to capture this phenomenon econometrically; in other words, if conflict is a combination of effects (of legal action and of implicit information dissemination), we did not seek to capture the impact of litigation alone.

Another point that could be also viewed as a limitation of our work is the small data-sample size, even though we worked with a good database. Choosing to study small-scale projects helped us obtain a solid understanding of local market price trends, but we were somewhat 'penalized' by the small number of transactions. As our dataset gives significant results, this potential limitation should not be a problem; however, more qualitative methods could also be of valuable interest for future research. Capturing local sensibilities is not an easy task. Some colleagues advised us to use contextual variables as a proxy to predict whether people are likely to react against certain information. For example, we could use socio-economic indicators to control the sub-zone in a quantitative approach, or refer to the historical or cultural conditions of the zone in a qualitative approach. Incorporating new variables could, however, expose our model to multicollinearity problems, as the variables may be highly correlated with litigation dummies.

In any event, the fact remains that conflicts are complex phenomena, which are not limited to lawsuits or rumours only, or indeed any or other single kind of information disseminated.

Conclusion

In this article, we have studied changes in property values during conflicts relating to public facilities. We worked with three case studies where inhabitants expressed opposition to announcements of public projects. In all three cases, the conflict was brought before a tribunal and/or court of appeal. A semi-logarithmic hedonic regression model was used with deflated prices as the dependent variable in order to isolate the impact of the conflict from other determinants of property value. The results show that the conflicts had an impact on house prices, which can be read as proof of the market expectations of the projects. They also show that the expectation mechanism depends on the signals of certainty being confirmed by conflictual action. Future research is needed to better understand market behaviours in conflict situations, but we argue that expectation can be seen as a product of estimated negative impact and the chances of realisation of a public infrastructure project.

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Notes

1. The authors thank Lionel Vedrine, UMR Cesaer, Dijon, for his valuable assistance with regard to spatial analysis.
2. The desirability of a public facility can be considered in regard to the willingness to locate close to it. Hence, an infrastructure is desirable if people are keen or happy to be in its neighbourhood, while an undesirable one is kept as far away as possible. A semi-desirable facility is one that people wish to be located at a moderate distance – neither too far away nor too close, in other words. It is generally admitted that desirable infrastructures increase neighbourhood house prices, while undesirable facilities reduce them.
3. Note that a third possibility is the spline model, a hybrid of the two others, which is not considered in this article.
4. French legislation demands that an Impact Study (*Étude d'impact*) be carried out by the developer before a project can be officially announced. The Impact Study document, produced by engineers, reveals the project's geographical perimeters and its impacts on the local area's economic and environmental situation. We used these documents to define our study areas.
5. *Lamyline*, the French Council of State's database for all jurisprudential decisions.
6. See Note 4.
7. *NbRoom* (number of rooms), measured as a continuous value.

   SurfT (surface area of land lot), measured as a continuous value (in m^2). The land lot normally has no buildings on it, and is attached to house as a purely supplementary space (which may or may not allow for future construction).

Cellar (number of cellars), measured as a continuous value. A house can have 0, 1, or 2 underground rooms called cellars, which are principally basement areas.

The two variables *NbRoom* and *SurfT* are transformed in the logarithm so as to be in a linear relation with the logarithmic sale price.

NbPark (number of car-parking spaces), measured by three dummies: *NbPark0, NbPark1*, and *NbPark2*, respectively, for houses with 0, 1, or 2 car-parking spaces. *NbPark1* was removed.

HouseTYPE, measured by four dummies: *HOU_PV* ('pavilion', i.e., a smaller, generally newer detached house), *HOU_TC* ('town cottage', i.e., an older, cottage-style house in an area of relatively high density), *HOU_VI* ('villa', i.e., a larger, generally older detached house), and *HOU_NA* (for unrecognised house type). *HOU_PV* was removed.

Level, measured by four dummies: *Level_1, Level_2, Level_3*, and *Level_4plus* for, respectively, a house with 1, 2, 3, or 4 and more levels. *Level_1* was removed.

PERIOD (period of construction) measured by four dummies: *Period_bf.47* (before 1947), *Period.47.80* (between 1947 and 1980), *Period.80.2000* (between 1980 and 2000), *and Period.af.2000* (after 2000). *Period.47.80* was removed.

Motif_SPC_Sale (sale due to a major life event). This dummy controls specific events that lead to a house sale, such as a divorce or a marriage. By default, *Motif_SPC_Sale* is set to 0.

Finally, *RENT_HOUSE* is a dummy to control whether the house is freehold or subject to a leasehold at the time of the sale.

8. The term 'reference zone' has to be understood in a relative way, because even the retained reference zone could be slightly affected by the infrastructure. In that sense, what is captured in the model is the differentiated effect between this much less affected zone and others zones where the effect is maximum
9. Regarding the continuous variables for the rooms and the surface, as they are log-transformed, the estimators has to be interpreted as elasticity coefficients. Based on the value of Ln_NbRoom's coefficient of 0.38 in *Saint-Nom-la-Bretèche* and 0.54 in *Vaux-le-Pénil*, we calculated the price change for the additional room with regard to the reference house (5 rooms): 0.38 × 20% = 7.6% and 20% × 0.54 = 10.8%, respectively. For the dummy variables, a given result α in the estimation will correspond to a price impact of exp(α) −1.
10. They are given by the coefficient 16% of the dummy Z_{Op}.Claim.2 (price change = $e^{-0.16}-1 = 0.15$, and the coefficient 17% of the dummy Z_{Op}.SC (price change = $e^{-0.17}-1 = 0.159$). See Note 9.
11. The choice of SEM or SAR depends on the nature of the autocorrelation. SEM corrects the effect of an omitted spatial variable that presents the error terms, whereas SAR takes into account the fact that spatial autocorrelation is linked more to a general autoregressive interdependence of house prices than to the presence of a potentially hidden spatial variable.

    The results of the SARMA tests (based on Lagrange multiplier tests) show that spatial autocorrelation could result from (a) an autoregressive process in price formation, (b) an autoregressive process in error terms, or (c) both. In the case of (a), the solution is to apply the SAR model, whereas in the case of (b) a SEM is needed. The RLM Err and RLM Lag tests were realised and reported in Table 4. They suggest that we should apply a SEM model for *Maisse* and *Saint-Nom-la-Bretèche* and a SAR for *Vaux-le-Pénil*. This choice was based on the experience of Anselin and Florax (1995) and Vedrine (2012). Theoretically, the possibility exists to use a combined model that deals with both types of autocorrelations (see, for example, Huang, 1984; Jayet, 1993) for the SARMA and SARAR process; however, as Finglteton and Le Gallo (2008) highlighted, such a combined model has only limited applied value.
12. *Lotissements* in French.
13. The same mode of calculus is applied. Price change equal to $e^{-0.15}-1 = 0.131$. See Note 9.

14. In this situation, there are contradictory results in terms of the pollution risk reported by the community of *Maincy* (where cancer cases were detected) and the risk reported by the prefecture's study. The risk is not clearly determined, and the property market is likely to lack certainty regarding the project's impact.

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