THE EFFECT OF FLOODS AND FLOODPLAIN DESIGNATION ON VALUE OF PROPERTY; AN ANALYSIS OF PAST STUDIES

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Abstract: The frequency of severe flood incidents in the UK and worldwide is increasing resulting in heightened interest in the implications of flooding on floodplain residents and the wider community. Short-term impacts include severe disruption to normal business, damage to buildings and increasing flood insurance claims. For property owners, the long-term cost of a flood can include loss of property value because potential purchasers are deterred by the risk of repeat flooding. Property can also suffer reduction in equity, without having a history of flood damage, due to location in a designated high-risk area. This paper examines the evidence from previous studies in the UK, US, Canada, Australia and New Zealand to determine the range of measured flood effects and detect any broad patterns. The magnitude of estimated impacts varies widely across studies, partly because both flood events and floodplain designation have been considered, partly due to the quantity and quality of data available but also due to the highly local nature of floods and the risk awareness of house purchasers under different disclosure regimes. Lessons are drawn from the methodologies, including data collection and analysis problems to inform a proposed study of flood impacts in the UK.

Keywords: Flood, price, property, review.

1. INTRODUCTION

Flooding is an increasing phenomenon, not just in the UK but worldwide, see for example Munich Re (2004), Halligan (2004). The increase has been blamed on climate change, global warming and the melting of the polar ice caps although experts disagree on the extent and speed of this change (Office of Science and Technology, 2004). Additional factors in the UK are the natural erosion of the coastline and the slow tilt of the country towards the South East. The increasing urbanisation of the world means that the activities of mankind have increased the amount of properties at risk of flooding whether or not the climate is in a permanent shift (Clark, 2002). Properties continue to be built on the floodplain and there is some evidence that the actions of governments in building flood defences has increased the tendency for floodplain development (Boase, 2005). In addition to this, in the UK, the value of property at risk has increased as homeowners have increased investment in their homes in carpets, fitted kitchens and other fixtures which cannot be easily removed in anticipation of flooding.

Recent events in the UK, particularly the floods of Autumn 2000, Boscastle in 2004 and Carlisle in 2005, have focused the media and public mind on the impact of flooding on homeowners and businesses in the centre of vulnerable conurbations. There have been many newspaper articles covering the immediate aftermath of storms and floods

and much speculation about the impact on insurance and house prices, for example Hughes (2000), Halligan (2004) and Thompson (2005). In a first attempt to assess the real effect of flood disasters and flood awareness on property value the existing evidence in the literature is analysed. It emerges that there is a body of literature that examines the effect of living on a floodplain, concentrated largely in the United States where flood insurance is compulsory for floodplain residents. There is some work in Canada, Australia and New Zealand and two lone studies in the UK. This paper summarises that literature and attempts to draw from it some insights into the possibilities and difficulties in generating models of flood effects on house prices. This will feed into an ongoing study into the impacts of flooding on residential house prices in the UK.

2. LITERATURE REVIEW

The findings from studies from the UK, US, Canada Australia and New Zealand are grouped below by country. When interpreting the results from the research to date, and particularly its relevance to the UK it must be borne in mind that different disclosure regimes exist across the world and this seems to be partially reflected in different observed impacts. Potential purchasers may become aware of flood risk status at various stages of the buying process. At one extreme personal experience, or high media coverage, may ensure that all buyers are aware of local flood issues. At the other extreme sits the normal situation in the UK where there will be ad-hoc discovery of flood risk.

2.1 UK Findings

The UK studies (Building Flood Research Group (BFRG), 2004; Eves 2004) are both based upon surveys of valuation professionals, thus the prices examined are assessed prices and depend heavily on the experience of surveyors. Both authors are reluctant to fix upon an absolute figure for discount of flooded or floodplain property because of the wide variation in responses. For example BFRG (2004) found the median discount to be 12-15% but the responses indicated a wide range of opinions among valuers even when working in the same market. It is also concluded that there is no consensus on the length of recovery, the median value is 3-4 years. There is consensus in that flooded properties may stay on the market longer than other similar properties, and that a slight discount for floodplain properties not previously flooded may be expected. This study illustrates both the difficulty of the problem and the need for some guidance for valuers on the matter. High insurance premiums on previously flooded properties are identified as a possible driver for price discounting. Another aspect stressed by Eves (2004) in particular is the positive value placed on riverside location, which acts in direct opposition to the risk of flood.

2.2 Australian Findings

Eves (2002) studied the effects of flooding on the housing market in Sydney. It was concluded that in periods of flooding there is a discounting effect for flood-prone property, peaking at about 16%. As the gap between floods increases this discounting ebbs away and flood-prone property catches up with its flood-free equivalent. Lambert and Cordery (1997) studied floods in Sydney and in Nyngan. In Sydney they

observed some small and temporary impacts. In Nyngan, where the whole town was deluged, and where again the main effects were temporary, prices were depressed for about 6 months following the flood. There was some suggestion that a slight divergence in long-term growth between Nyngan and the control community could have been caused by memories of the flood. An examination of repeat sales of houses sold immediately following the flood at a depressed price and then resold shortly afterwards shows the action of opportunist entrepreneurs making gains well above expected returns, presumably after some investment in reinstatement. Faith in the long-term recovery in prices seems to be widespread and borne out in reality.

2.3 New Zealand Findings

Montz (1992) studied the effect of events in three New Zealand communities. No precise estimates of impacts are presented, however, the conclusions are that all flood effects are temporary. In Pearoa a temporary dip was observed, in Te Aroha the whole community, not just those properties flooded, experienced decline and in Thames while there was no effect for a first flood, a second flood affected the whole market. Four years after the flood in Te Aroha the flooded properties had recovered more than the non-flooded and in Thames the non-flooded properties seemed to suffer more discount from the second flood than the flooded properties. In a further study of two of these communities Montz (1993) demonstrated that subsequent disclosure of flood risk via planning constraints had no effect on the value of properties.

2.4 US Studies

In the US as mentioned above, there is great interest in the designation of floodplains because in some areas of the country, where credit is required, flood insurance is compulsory and is subsidized by government. A summary of results from studies undertaken in the US is presented in table 1. The studies vary between testing properties actually flooded and properties designated at risk of flooding. This can be a very important distinction. Actual inundation might be expected to heighten the concern of potential buyers, if they are made aware of it. Designation on the other hand may carry with it obligations on the future resident and may not correlate well with actual flood risk. In many cases the accuracy of categorisation is poor. For example in Houston, Texas (Skantz and Strickland, 1987) a flood occurred in 1979 and of the 33 studied properties that were actually flooded only 10 were in the 100-year floodplain. The research also differs in whether it tests for the temporary effect of specific events or looks at the long-term static effect of floodplain.

Results worth highlighting include a study by Tobin and Montz (1994) in Wilkes Barre, Pennsylvania that found a positive effect of flood in that the prices of flooded properties were higher after the flood, relative to non-flooded properties. This is similar to the effects that Montz (1992) discovered in New Zealand. The authors propose that this may be due to investment in the damaged houses resulting in improved quality in the flooded sub market. In Wilkes Barre it could also be attributed to the lack of alternative property. The Skantz and Strickland (1987) study observed no direct impact following a flood but saw, albeit weak evidence, that later insurance increases triggered a depression in house prices.

Table 1: Summary of findings from US flooding studies

YR	AUTHORS	PLACE	FLOODPLAIN EFFECT
2004	Troy and Romm	California	-4.2%
2003	Bin and Polasky	Pitt County North Carolina	-8.3% post flood -3.7% pre flood
2001	Harrison et al	Alachua County, Florida	-2.9%
2001	Shultz and Fridgen	Fargo/Moorhead NorthDakota/Minnesota	-9%
1994	Tobin and Montz	Des Plaines, Illinois	No effect
1994	Tobin and Montz	Linda and Olivehurst California	-30% >10ft flood -10% 18" flood
1994	Tobin and Montz	Wilkes Barre, Pennsylvania	Positive effect.
1991	Speyrer and Ragas	New Orleans, Urban Suburban	-6.3% -4.2%
1990	Bialaszewski and Newsome	Homeworld Alabama	no effect floodplain location
1989	Shilling et al	Baton Rouge, Louisiana	-8% floodplain location
1989	Donnelly	La Crosse, Wisconsin	-12% floodplain
1987	Skantz and Strickland	Houston, Texas	No effect. Effect of insurance rate increase
1987	Macdonald et al	Monroe Louisiana	-8.5%
1979	Zimmerman	New Jersey	No effect
1976	Shabman and Damianos	Alexandria, Virginia	-22%

2.5 Canadian Findings

The Canadian experience is somewhat different; floodplain regulation is weaker than in the US and is aimed at controlling development on the floodplain. Disclosure is not widespread and so perhaps it is not surprising that of seven studies quoted by Schaeffer (1990) only one found any significant discount. The Schaeffer (1990) study itself, based on a very small sample, produces confusing and inconsistent results. Three different methodologies are applied and the outcomes are dependent on the methodology. One approach yields no significant effects while the others show marginal price depression due to floodplain. The effect of subsequent designation is seen, against expectation, to raise the prices of designated property. A survey of homeowners by Babcock and Mitchell (1980) seems to show that even in high-risk areas, and with homeowners, who had suffered flooding in the past, perception of risk is low and very few had purchased flood insurance. This was reflected in the house price data where no significant impacts were detected.

3. ANALYSIS OF METHODOLOGIES

Many of the studies summarised above are based on a hedonic model of house prices. Where sufficient data is available this appears to be the preferred method (MacDonald, 1987; Shilling et al, 1989; Donnelly, 1989; Harrison, 2001; Bin, 2003; Troy and

Romm, 2004; and others). Hedonic models are based on a utility function, breaking price down into a function of a set of preferences for various aspects of the heterogeneous commodity of housing. Aspects considered might be physical properties of the house, such as the number of bedrooms, or locational variables such as proximity to local amenities or transportation. The result is a regression model of some form where the influence of each factor is estimated with least squares.

Variations on the hedonic or regression model include alternative methods of dealing with locational variation for example Speyrer and Ragas (1991) who used spline variables in the regression to model location and by Troy and Romm (2004) who used layering, that is taking information on locational attributes at a more aggregate level than the pricing information. An extension of the regression method was used by Skantz and Smersh (1987), adapting events analysis from the financial sector. Predictions are made from the estimated model and the residuals examined over time. This method shows where deviations from the equilibrium model occur in time and then this can be linked to events in the market, in their case a huge increase in insurance cost. An interesting adjustment to the hedonic methodology was employed by Shabman and Damianos (1976). In attempting to model the flooded sub-division, the explanatory power of the model was low. Using the model developed on the non-flooded control area, predicted values were compared to actual transaction prices in the affected zone. This same method was subsequently employed by Schaeffer (1990).

Other studies (Tobin and Montz, 1994; Eves, 2002) look at raw sales figures over time. Means are compared before and after events. The variability of house sales, mix effects, seasonality and other market events may confuse the picture when looking at raw sales data but this may be a useful methodology either as a first step or where specific flood events are examined on well understood sub-markets or where good information on location and mix variables is not available.

Repeat sales was used by Montz (1992) and others. In this method the problems of differences between properties is removed by considering the differences between serial sales of the same property. This method is most useful in analysing prices before and after a flooding event or where growth rates are different between flooded and non-flooded sub groups. In those markets where frequent flooding or floodplain regulation has resulted in permanent capitalisation into property price, repeat sales would not capture the effect. Finally the UK examples are based on surveys of expert opinion and Babcock and Mitchell (1980) also use surveys to test perceptions of homeowners and real estate valuers.

4. LESSONS DRAWN FROM THE LITERATURE

The above examples of work examining the influence of flooding on property value illustrate some of the issues that will face the proposed research in the UK. Below is a summary of the lessons that can be utilised in any future work

4.1 Data Requirements

Firstly, and most obviously is the availability of data. It is clear that to build models such as those quoted above, highly detailed data on individual properties is necessary.

Data is needed on house prices, property details and locational variables. Information on the flooding incident is also desirable, including which houses were flooded and to what depth. As mentioned above, relying on floodplain designation as a proxy for properties flooded may be risky and result in underestimating the effects of flooding. In using designation to look at capitalisation of flood risk in the absence of flood it is important to establish the profile of the designation and whether the official designation correlates with the populations perception of that risk. The burden of collecting such data and the necessity that houses have to change hands during the study period has resulted in small sample sizes for many analyses. Availability of data has in many cases determined the methodology used and so data collection is of primary importance in such housing research.

4.2 Explanatory Variables

In the US models the variables commonly included are: Size of heated accommodation, size of unheated accommodation, size of plot, presence of air conditioning, fireplace, garage, number of bathrooms, number of bedrooms, age and date of sale. Some studies (Bin and Polasky, 2003; Troy and Romm, 2004 and others) also include locational variables, distance to airport, rivers, major roads or specific estate variables. Troy and Romm (2004) also include socio-economic variables by census tract. In general, size, age and number of bathrooms are strong explanatory variables. In the UK one would anticipate that some of these would be less relevant such as air conditioning and other additional locational variables may be needed. A review of UK housing studies, not related to flooding will help to identify the most important variables for the UK.

4.3 Time Period

This will very much depend on the sort of research intended. If a particular event is to be analysed, sufficient observations before and after the flood must be taken, and time must be allowed for the market to return to equilibrium. Lambley and Cordery (1997) reported recovery in under a year. Tobin and Montz (1995) however, in revisiting Linda and Olivehurst eleven years after their first study, suggest that for the homes flooded to the greatest depth recovery may take longer than ten years. The long-term impact of the flood was exacerbated by the presence of properties that were not renovated quickly after the 1986 flood. It would seem that the maximum possible time period must be examined. If, on the other hand, a static hedonic model is constructed, then, ideally, the shortest time period should be used which provides sufficient data points. The choice of a period of relative stability is desirable, not too close to any disruptive events. In most markets a fairly long time period will be necessary in order to obtain sufficient observations, the researcher must then deal with the effects of inflation during that time.

4.4 Dealing with market Inflation

In most of the models above either discounting (Bin and Polasky, 2003), or a time trend variable were added (Skantz and Strickland, 1987). Time trend variables in linear models have the defect that they can only generate a steadily increasing (or decreasing) market; in real examples this is not very likely. Speyrer and Ragas (1991) used dummy variables for each year because they identified a non-monotonic trend in house prices. Use of discounting raises the problem of which discounting factor to use. Regional

house price indices are not always available and constructing a local index specifically for the study increases the data demand or leads to bias if too small a sample is used. Comparison against a control group was used by Montz (1993) and Shabman (1976) however careful choice of this control group is necessary.

4.5 Number of Properties

Given the difficulty in obtaining data, it is unlikely that any study of a flooding incident would collect too much data. In the UK where most flooding incidents affect relatively small numbers of properties, lack of data could be a real issue. Previous research has been carried out on samples ranging from just under one hundred (Bialaszewski and Newsome, 1990) to many thousands (Troy and Romm, 2004). Typically if designation is studied then more observations are available than if an actual flood is examined. Given the high variability of house price data and the large number of variables necessary to account for all influencing factors, the larger the dataset the better. The smaller the sample the more likely it is that omitted influential variables will bias the estimate of the impact of flooding. Of course the collection of data is expensive in terms of time and money and this should be balanced against the increased reliability of the results. If a predictive model is required then an even larger set is needed in order to allow for testing of the model on a held back sample.

4.6 Functional Form

Where a regression model is utilised, many authors discuss the use of different functional forms. The theory does not predict a particular relationship and so the choice is an empirical one, often based on best fit. Linear and Log/linear are the most common selection. Where more than one form has been tried, the overall conclusions have not differed between models (Shilling et al, 1989). It is probable that other considerations such as collinearity have a greater bearing on the outcome of the model. Bin and Polasky (1993) use a log transform for distance related variables based on the experience of other housing studies. Unless there are theoretical reasons to choose alternative forms or unless data exploration clearly demonstrates a specific non-linear relationship, a linear model should be preferred with testing of residuals to determine if it is adequate. Troy and Romm (2004) used a semi logarithmic model after examination of residuals from a linear estimation.

4.7 Partitioning the Data

Datasets may need to be divided in the time dimension or into sub markets as building one model of the whole market may not be an effective strategy resulting in poor estimation and reducing explanatory power. Firstly consider the case where a flood or new legislation imparts new information on risk to the market. The house buyers' perception of the relative desirability of properties in and out of the floodplain will change after the event. Harrison et al (2001) built three models, one before and one after the implementation of the National Flood Insurance Reform act in 1994 and one over the whole time period. They found that the price discount due to floodplain location doubled after the implementation, while estimates of other factors remained fairly robust across the time periods. The third model, utilising the whole time period and including a dummy for post implementation discount gave an even higher estimate post reform discount, however, this is no longer significant. Their results demonstrate

the danger of using a global model, in this case detecting no significant effect from the legislation. Research should begin, if possible, by estimating pre and post flood and testing whether the models are significantly different. An alternative to using different models would be to use a model that allows for time varying effects.

Secondly consider the case where there are different markets for floodplain and non-floodplain property. This could be due to differences in type of property. In New Zealand Montz (1993) found that houses in the flood plain differed, in terms of average physical attributes, from those outside it and therefore compared trends within sub markets. Differences could also occur in the type of buyer, they might be poorly informed individuals, cash buyers or buyers who are in the market for "development" or "investment" property. Troy and Romm (2004) for example found that hazard disclosure had a significantly greater impact on Hispanic neighbourhoods of California than non-Hispanic communities. Research should consider likely sub markets to ensure that smoothing across sub markets does not affect significance testing but also to generate a deeper understanding of the underlying process. MacDonald et al (1987) split their dataset to check the homogeneity of their test neighbourhood. They observed higher impacts in one neighbourhood that consisted of higher priced properties.

4.8 Collinearity

If the independent variables used in a predictive model are correlated to one another then they are described as collinear. This is a common problem in housing studies where, for example, lot size will be strongly related to house size. Collinearity results in biased estimates of the partial regression coefficients; they cannot then be used for robust prediction. Most authors in this literature search have ignored or sidestepped the problem, simply selecting the variables with the most explanatory power. Presumably the assumption is that there will not be much correlation between flood variables and the rest. Troy and Romm (2004) touch on the issue. Their model included a Hispanic/disclosure interaction term that demonstrated that the strength of the effect of disclosure varied with the percent of Hispanic residents. Hispanic concentration was highly correlated with floodplain location, they posit due to financing arrangements. Bialaszewki and Newsome (1990) tested whether multicollinearity had affected their results using stepwise regression and by examining the correlation between other independent variables and the flood variable. They concluded that it had not changed the outcome. Collinearity can be dealt with by a number of methods such as principal components analysis or residualisation, see Donnelly (1989) for an application of residualition.

5. CONCLUSIONS

The outcome of published analyses into the effect of flooding on property prices has produced a wide range of estimates. This is in part due to differing definitions of flood effect and also to the proximity of a flood event. The consensus is that the impact of a flood event declines over time as people forget about it and permanent capitalisation of flood risk into price is largely due to regulated disclosure of flood designation. This implies that in modelling the long-term effect of flood it is vital to choose stable time periods or to use the shortest possible time period. Alternatively models could

recognise the temporally adaptive nature of the market and not force flood response to be constant over time.

The measured effect of flooding is also highly dependent on local issues such as frequency of flooding and availability of alternative housing. Some studies observed that there was no depreciation due to flooding. One counter-intuitive result is observed in which flooded houses increased in value relative to non-flooded. This could be explained by the impact of reinstatement resulting in betterment. It seems unrealistic to expect all UK flood risk zones to demonstrate the same pattern. Equally it does not seem possible to say a priori, from the literature, exactly which factors will come into play in a given flooding scenario. For the UK the development of local models is a logical first step. A build up of experience may make national generalisations possible in the longer term.

In the published research some form of hedonic modelling is the preferred methodology where sufficient data is available. Data availability often dictates methodology. Repeat sales analysis is a methodology that allows for testing of flood events and reduces the requirements for explanatory variables. Great care needs to be taken in defining test and control groups as lack of precision could lead to erroneous results. Sub markets need to be considered, certain property types or neighbourhoods may be more vulnerable to the effects of floods than others.

In the UK detailed data on property transactions is not so readily available as in other markets. UK studies have used surveys to canvass expert opinion and from this research availability of insurance is identified as a possible mechanism for disclosure of flood risk. The UK work also highlights a river view as a positive driver for house price. This would be a severe nuisance factor for a study concentrating on riverside properties. An examination of the general UK housing literature would help to identify key explanatory variables specifically relevant within the UK housing market.

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