HOUSEHOLD INSURANCE WORKING PARTY 1995

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1. Executive Summary

1.1 Introduction

This paper describes the work of the Household Insurance Working Party in 1995. As in 1994 the analysis has concentrated on the subsidence and flood risks. The paper has been divided into three main topics :-

- Tracking the variance in buildings rates for areas of high flood and subsidence risk.
- Assessment of the Halcrow Study on sea defences and comparison with the Greig Fester flood model.
- Assessment of the effect of house sales on the number of subsidence claims reported.

The key findings in each topic are set out below together with the structure of the paper.

1.2 Variance in Buildings Rates

The companies and districts used in the 1994 paper were revisited and the rates compared both by type of risk and over time. The main findings of the investigation are :-

- Since 1994 the areas with a high risk of flood and subsidence have benefited from reductions in rates similar to those of the control group.
- The number of referrals in the subsidence group has fallen.
- The flood group continues to exhibit the highest variance but the level has reduced.
- The variance of subsidence rates has increased suggesting the herd instinct is lessening and insurers are taking more account of their own experience and methodologies.

1.3 Comparison of Flood Models

The Halcrow Flood Study was assessed and compared to the work of Greig Fester with reference to the market reaction. The principle conclusions were :-

- Greig's work attempts to model one catastrophic event whereas the Halcrow Study models the probability of individual sea defence failure.
- The calculation of EMLs is still problematical particularly in the area of quantifying likelihood.
- There are severe limitations in applying findings to rating decisions.
- There is no evidence yet of insurers withdrawing flood cover.

1.4 The Effect of House Sales on Subsidence Notifications

A model of the house buying cycle was constructed to establish whether there would be a significant increase in claims if the housing market picked up. The main findings were :-

- Activity in the housing market is sufficient to explain about 40-60% of claims reported.
- Another housing boom that is similar to the late 1980s would increase subsidence claims by about 10-30% but a gradual improvement would have a much smaller effect.
- A further decline in volume could reduce claims by 10-15%.

1.5 Structure of the Paper

Section 2 Variance in Buildings Rates

Section 3 Comparison of Flood Models

Section 4 The Effect of House Sales on Subsidence Notifications

2. Variance in Buildings Rates

2.1 Objectives

This work was intended to build on the analysis completed in 1994 which was aimed at establishing whether there was any consensus on the appropriate rate for areas known to be liable to subsidence or flood. The specific intentions were :-

- To analyse the variation in rates from the sample insurers for high subsidence and flood risk areas compared to a low risk control group.
- To compare the changes since 1994.
- To monitor the change in the number of refer districts since 1994 (i.e. where the rate is not published and the case must be referred to the insurer).

In this way we hoped to measure the selectivity of building rate to perils such as flood and subsidence.

2.2 Methodology

Three groups were defined, each containing six outward postcodes representative of high risk for that peril. The groups were :-

Subsidence Postcodes where clay shrinkage has generated high levels of subsidence claims since 1989.

Flood Low-lying coastal areas prone to flooding from the sea and areas subject to river flooding.

Control Areas where no peril is thought to be a matter of concern. These areas have benefited from significantly reduced rates in recent years.

The rates of seven major insurers were collated for each postcode selected. These are set out for 1994 and 1995 in Appendices A and B respectively.

In order to compare the variation in rates for the three risk groups the rates in the subsidence and flood groups were proportionately reduced so that their means equalled the mean of the control group. This assumes that each insurer used a multiplicative loading for higher risk areas rather than an additive one.

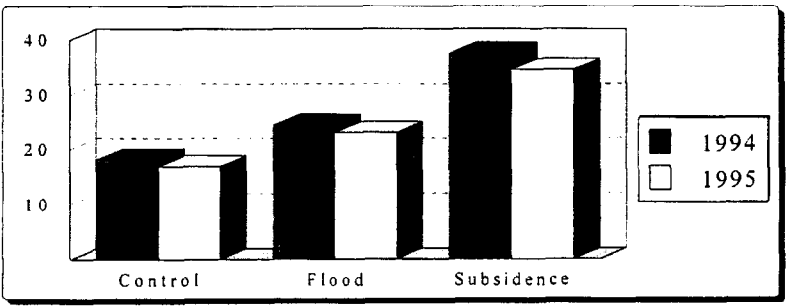
2.3 Comparison of Rates

The average rates for each risk group and year were calculated. It was found that :-

- There have been reductions in rates for all risk groups. The Subsidence group has benefited most and Flood group least.

- Most insurers have maintained or reduced their rates in the Subsidence group but there have been some substantial increases in the Flood group.

Graph 1 : Average Buildings Rate per SI for each Risk Group

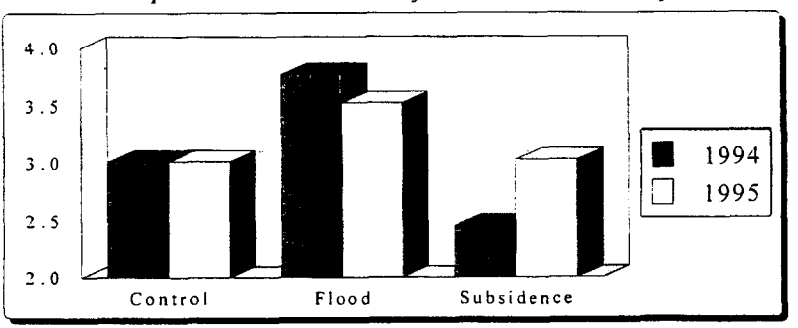


The key findings of the analysis of the sample standard deviation are :-

- The Flood risk group standard deviation has fallen slightly.

- The Subsidence group standard deviation has increased to a level similar to that of the control group.

Graph 2 : Standard Deviation of Rates in each Risk Group



2.4 Conclusions

Although the sample used is small the results appear to indicate the way rates are moving in the market. In particular :-

- Since 1994 the areas which have a high risk of subsidence or flood have benefited from reductions in rates similar to those of the control group.

- The Flood group continues to exhibit the highest variance, although this is falling. This fall may be a sign of more commonality in approach perhaps as a result of the Halcrow study commissioned by the ABI.

- The subsidence variation has increased and the number of referrals in the subsidence group has fallen. These features suggest the herd instinct is lessening and insurers are taking more account of their own experience and methodologies.

3. Comparison of Flood Models

3.1 Introduction

The results of the coastal flood project performed by Halcrow and sponsored by the ABI, Lloyd's and LIRMA were published in October 1994. The study covered the coastline of England and Wales together with the Thames, Tees, Humber and Severn Estuaries.

The overall findings of the project were presented at the 1994 Convention in Glasgow but time prevented a more detailed investigation. Therefore the aims of the Working Party's analysis were :-

- To report on the methodology employed by Halcrow.
- To compare with the Greig Fester model.
- To assess the possible effects on the household rates in areas with a high risk of flood.

3.2 Objectives of the Halcrow Project

The objectives of the project were stated as being :-

"To apply state of the art scientific and engineering information to assist underwriting by facilitating:-

- *Differential rating.*
- *Application of appropriate levels of deductibles.*
- *Determination of acceptability criteria.*
- *Longer-term the establishment of account EMLs".*

3.3 Halcrow Methodology

The basic methodology of the project was to determine the probability of the failure of individual lengths of sea defence as a result of events (varying in severity) and, where failure was a possibility, to assess the vulnerability of inland areas to flooding. In particular :-

- The events were storms of assumed severities with three possible return periods.

- The effectiveness of the sea defences protecting inland areas against each of the assumed storms was assessed.

- Inland areas protected by these defences were broken down into one kilometre squares.

- Risk bands were assigned according to how vulnerable the squares were to each of the storms. The most severe band affecting each square defines the value for the whole square.

The risk bands used are described below :-

Table 1 : Halcrow Risk Bands

Level of Risk	Description
Risk Band 1	Vulnerable to a 50-year return period event.
Risk Band 2	Intermediate level of risk.
Risk Band 3	Should not flood under a 200-year return period event.

Where there is a probability that flooding would occur, the likely depth was assessed using Ordnance Survey maps of local topography. The analysis determined that the water levels associated with the 50 and 200 year events typically ranged between 0.1m and 0.5m.

Given the quality and quantity of ground level data available from OS sheets, this made differentiation of discrete flood plains for the different return period events highly spurious. As a consequence it is the 200 year flood level that has been adopted throughout.

[We direct anyone interested in the detailed methodology to the Technical Report produced as part of the output. This describes the approach to data collection, analysis and risk assessment.]

3.4 Summary of Halcrow Results

The results have identified a total of almost 5,000 square kilometres at risk from flooding, equating to 3% of the total land area of England and Wales. Most of these

have been assigned a Band 1 classification reflecting that, in reality, failure of only a short length of sea defence could lead to flooding over a wide area.

However when using the findings of the report there are some limitations in terms of both the information available and the scope of the investigation.

Height data

The degree to which the depth of potential flooding can be identified is restricted by the lack of topographical data available below the 5m contour.

The lack of sensitivity within the minimal 0.50m level of flooding shown by Halcrow means that there will be some areas identified as at risk where the depth of flooding is below 0.15m, a level at which insured damage is minimal.

Variance within areas

Findings are presented in terms of the maximum risk identified within each kilometre square. This means that elevated areas which will never flood are identified as being equally at risk as the lowest point within each square kilometre.

Independence of Events

Although the majority of areas are rated as Risk Band 1, it does not mean that all these areas are susceptible to any one single event, simply that they are assumed to have, individually, the same probability of being affected (i.e. there is no analysis of which flood exposed areas would aggregate in a single event).

Severity of Events

While a major storm event may affect large areas of the East, South and West coastal areas of England and Wales, it is improbable that it will be the same return event for all coastal areas and it is likely that a return event will be limited to relatively short lengths of coastline.

The East coast might be the exception and it is possible that a major event could affect large areas.

Duration of Flood

Duration of flood has been excluded. Duration, together with depth of flood, is one of the main determining factors of damage and hence claim size.

Halcrow intends to update its findings with recent surveys of the sea defences.

3.5 Scope and Objectives of the Greig Fester Flood Model

At the start of 1993, Greig Fester's UK Division decided to address the problem of assessing coastal flood risk in the UK. The study covered the East Coast of England from north of the Humber to Romney Marsh in Kent and the Severn Estuary. The aim of the project was stated as being :-

"To investigate and quantify the risk of flood on the East Coast of England at the highest resolution and with the greatest possible accuracy."

The objective of the study is to produce a catastrophic flood model which can provide information to help assess the amount of reinsurance cover required by an insurer.

3.6 Greig Fester Methodology

The basic methodology was to determine the depth and extent of flooding, and therefore the likely buildings and contents loss that would result from extreme East Coast sea conditions. Because of the nature of the catastrophe modelled, it was assumed that the sea defences would be totally ineffective. The key features of the model are:-

- A digital terrain model (DTM) was built which allocated a height estimate to each 5 metre square block of land.
- The surge height data was supplied by the National Rivers Authority (NRA) corresponding to their estimate of 1 in 250 year levels for each point along the East Coast and of 1 in 200 year levels for each point in the Severn Estuary.
- The surge heights were applied to the digital terrain model to estimate flood plains and depths.
- The insured loss was calculated by relating flood depth to damage.
- Full unit postcodes were located on the DTM to identify those affected by flooding and at what depth.

In order to make the model compatible with the postcode detail available, a dataset was created which models the location of every property in the UK. This was then overlaid onto the flood plain to determine which postcodes would be affected by the simulated flood and to what extent.

By making assumptions about the geographical distribution of any subset relative to the property market as a whole, it is then possible to "dis-aggregate" data supplied at either postcode district, sector or unit level.

This produces losses arising from the total property stock. For as insurance market loss it is assumed that 90% of buildings and 85% of contents are insured.

3.7 Results of Greig Fester's Model

There are three main components to the output from the Greig Fester flood model :-

- A digital terrain model which estimates the height of any point.
- An estimate of the likelihood of surges by height for each location.
- An estimate of the amount of property affected and the cost of damage caused.

An example of the digital terrain model is included in Appendix C.

As in the Halcrow study there are some limitations :-

Likelihood of events It is however problematic to assign a probability to the event modelled by Greig Fester. The surge heights used are the National Rivers Authority's estimate of 1 in 250 year occurrence at each point along the coast. The probability of occurrence of an event defined in this way will be somewhat less than 1 in 250 years.

Although the occurrences are not dependent, a 1 in 250 year event at any point along the coast is bound to affect other parts of the coastline.

Quality of data Historical data on floods are extremely limited and damage factors used by Greig Fester, although based on several companies' data, may prove inaccurate if an incident were to occur (e.g. the insured contents loss could be significantly reduced by receiving early warning of the likelihood of a major storm event).

Sea defences Since the model assumes these are ineffective it can only be used for less severe events if an allowance is made to the output.

The model is currently being developed to broaden its scope and usefulness. In particular :-

Sea defences	Greig Fester plan to include some allowance for the presence of sea defences in order to model the effects of less severe events.
Coverage of the coastline	The model is being extended to include Merseyside and the Scottish Coast.

3.8 Comparison of the Two Models

The differences between Greig Fester's own flood model and that of the Halcrow study can be summarised as follows:-

- Greig Fester's work attempts to model one catastrophic event whereas the Halcrow Study models the probability of individual sea defence failure.
- The core of the Halcrow study is their sea defence analysis which allows them to look at events with a return period of 1 in 50 years.
- Greig Fester's model is currently based on the type of catastrophic incident that would be unaffected by sea defences.
- Greig Fester's land-height model is more detailed than that adopted by Halcrow.
- Greig Fester attempts to quantify the potential loss by modelling the geographical distribution of property and combining it with damage factors. Halcrow make no attempt at estimating loss.
- Halcrow's work covers the whole coastline of England and Wales along with the four main estuaries. Greig Fester's work is more limited geographically, with completed work covering the East Coast.

3.9 Applications and Market Reaction

The area which has received most attention to date has been the establishment of the account EMLs using the computer output available. By comparison the calculation of an insurer's exposure to risk in the relevant postcodes is relatively easy. The problems with identifying a single event exposure together with the likely size of claims make the calculation of an EML particularly problematic and subjective.

From the insurer's perspective, consideration has to be given to the very different risks involved in buildings and contents covers. In particular, insured contents loss could be significantly reduced by receiving early warnings of a major storm event. Such events are monitored by the Meteorological Office who in turn inform the National Rivers Authority who put out storm warnings to the likely affected areas. On the East Coast this warning could be as much as 20 hours.

Insurers have now had a year to react to the data produced and there is some evidence that individual companies have increased rates in flood risk areas. This is consistent with the industry's general move in Personal Lines business to charging premiums that are equitable to the exposure. An alternative or additional approach to the risk would be to introduce flood deductibles, but we are unaware of domestic cover being restricted in this way.

There is no evidence of insurance companies reacting to the data by withdrawing flood cover completely. This may be due to the industry's taking a responsible attitude to the new information although it could be a reflection of the current soft market following several years of low weather losses. Hence the situation could change if insurer's were to:-

- Suffer severe weather losses in the near future.
- React to specific rating action by their competitors in the form of increasing selectivity.
- Find greater attention being paid to the flood peril when negotiating their reinsurance renewals.

Any rating action of this sort would undoubtedly incur significant media and political reaction with potentially adverse consequences for the industry.

3.10 Conclusion

The Halcrow study represents significant progress in defining flood risk areas and assessing the effectiveness of the current sea defences. However, as with all such studies, its value has in part been limited by the quality and availability of the data. In commissioning it UK insurers have acted in advance of the event, rather than afterwards as has often been the case in the past.

The Greig Fester model is more ambitious in that it attempts to estimate the likelihood and cost of a specific event but is also constrained by the lack of information. However it uses the available data well and produces valuable information on potential catastrophic flood costs. Hence the principal conclusions are :-

- Greig Fester's work attempts to model one catastrophic event whereas the Halcrow Study models the probability of individual sea defence failure.

- The calculation of EMLs is still problematical particularly in the area of quantifying likelihood.

- There are severe limitations in applying findings to rating decisions.

- There is no evidence yet of insurers withdrawing flood cover.

4. The Effect of the Housing Market on Subsidence Claims

4.1 Objectives

Over recent years there has been a lot of comment about the high level of latent subsidence claims that may be reported once the volume of house sales starts to increase. The aim was to develop a model that would test this assertion. In particular the model attempts to:-

- Use the relevant available macro economic data.
- Test different scenarios of future house buying patterns.
- Assess the effect in different regions of the UK.

The next section describes the method employed. We have used East Anglia to provide an example where appropriate.

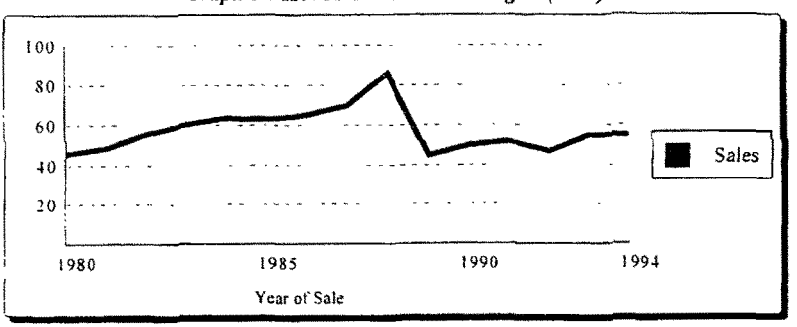
4.2 Methodology

Sales and Purchase

The method assesses the risk of subsidence occurring between the purchases and subsequent sale of a house. Let

$S(i)$ = total no. of houses bought in year i
$S(i,j)$ = no. of houses bought in year i that are subsequently sold in year $i+j$

Graph 3 : House Sales in East Anglia (000s)



Note : The cause of the drop in sales between 1988 and 1989 is obvious.

Distribution of Tenure

In order to model the effect of the housing market on subsidence claims we need to describe the distribution of tenure *(j)* i.e. the time between purchase and sale i.e. let :-

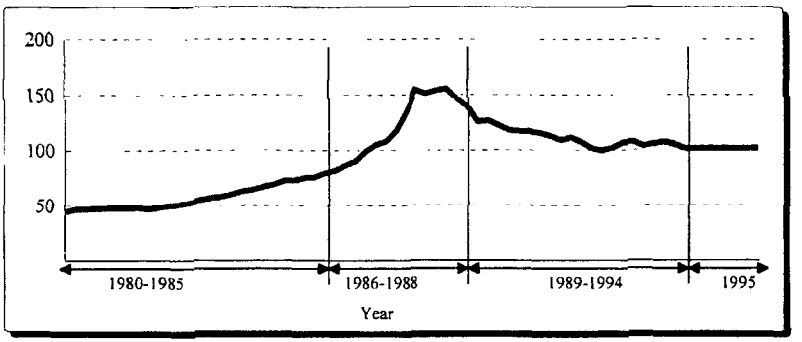
$$J = \text{length of tenure}$$

Assume that tenure has a log normal distribution as it is a real, non negative process i.e.

$$J \sim LN(\mu, \sigma) \qquad \text{(See Appendix D)}$$

In order to take account of the different phases in the housing market let μ be constant in each of the four phases of the housing market since 1980 i.e. :-

Graph 4 : House Price Index for East Anglia



Using Graph 3 and Graph 4 we can estimate the following values for the house tenure distribution.

Table 2 : Example values for μ

Year of Purchase (i)	Value of μ for E. Anglia	Description
1985 and earlier	6	Period of steady growth. Likely to move again quickly.
1986 to 1988	10	The late 1980s boom - negative equity preventing sales.
1989 to 1994	8	Depressed market with modest reduction in house prices and increased negative equity.
1995 and beyond	8	Future scenarios. e.g. no change.

Number of House Sales by Length of Tenure

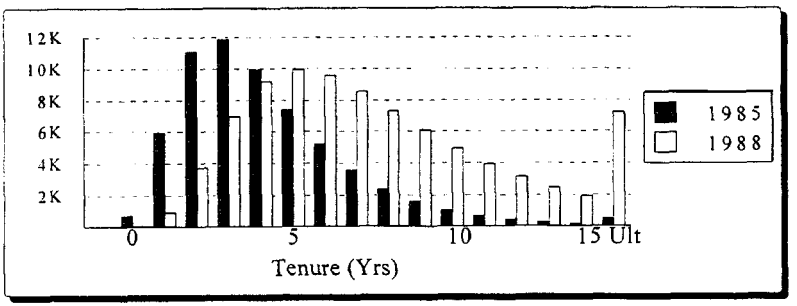
Once the distribution of tenure has been established the number of houses sold in each year can be calculated. Let :-

P(j) = Probability that a house is sold j years after it is bought.

$$S(i,j) = S(i) \times P(j) \qquad \text{Where } j = 0,1 \ldots\ldots \text{ult-1} \ldots\ldots\ldots\ldots (A)$$

$$S(i, ult) = S(i) - \sum_{j=0}^{ult-1} S(i,j) \ldots\ldots\ldots\ldots (B)$$

Graph 5 : Initial Distribution of Tenure S(i,j) for Houses Bought in 1985 & 1988



Note : See Appendix E

Reconciliation of Sales and Purchases

Since any sale at the end of the tenure implies a new purchase we have the condition that for any year:-

Purchases = Sales of existing houses + net new houses

Therefore we can write :-

$$S(k) = \sum_{\forall i+j=k} S(i,j) \quad + N(k) \ldots\ldots\ldots\ldots (C)$$

where

N(*k*) = the no of new entrants into the market in year *k*.

For example, the number of sales in 1990 must equal the number of purchases in 1989 that were followed by a sale after 1 yr. plus the number of purchases in 1988 that were followed by a sale after 2 years etc.

Changes in Housing Stock

We need to model the number of houses available to buy and sell each year in order to establish the estimate of net new entrants. Hence let :-

$$N(k) = H(k) * g \qquad \text{.....(D)}$$

Where

$H(k)$ = housing stock in year k

and

g = net rate of growth in housing stock

Hence

$$H(k+1) = H(k) + N(k) \qquad \text{.....(E)}$$

Where g is constant in the same bands as μ.

Adjustment of the Diagonals

In the initial form sales will not equal purchases and condition (C) will not hold true. Hence the diagonal sums must be adjusted, so let :-

$d(k)$ = the diagonal adjustment required so that sales equal purchases

$$= \frac{\left[\sum_{\forall i+j=k} S(i,j) \quad + N(k)\right]}{S(k)} \qquad \text{.....(F)}$$

So that

$S'(i,j)$= adjusted no. of houses bought in year i that are subsequently sold in year $(i+j)$.

$$= S(i,j)/d(i,j) \qquad \text{.....(G)}$$

End Correction

It is possible the $S'(i,ult)$ could become negative. Hence an end correction $e(i)$ must be applied to ensure that :-

$$S'(i) = \sum_{j=0}^{ult} S'(i,j) \quad \text{.....(H)}$$

And

$$S'(i,j) \geq 0 \qquad j=0,1 \ldots\ldots ult \quad \text{.....(I)}$$

Therefore we can define the correction factor as follows :-

$$e(i) = \frac{-S'(i,ult)}{\sum_{j=0}^{ult-1} S'(i,j)} \qquad S'(i,ult) < 0 \quad \text{.....(J)}$$

$$= 0 \qquad \text{Otherwise}$$

The end correction can then be applied to the number of sales :-

$$S''(i,j) = S'(i,j) \times [1 - e(i)] \qquad j=0,1 \ldots ult-1 \quad \text{.....(K)}$$

$$S''(i,ult) = 0 \qquad S'(i,ult) < 0 \quad \text{.....(L)}$$

$$= S'(i,ult) \qquad \text{Otherwise}$$

Optimisation

As the distribution has been estimated but the total year sales figures $S(i)$ are actual it is unlikely that there is a solution where condition (C) (i.e. sales = purchases) will hold true for every year. Hence let the residual be defined as:-

$R(i)$ = The difference between sales and purchases

$$= S''(k) - \left[\sum_{\forall i+j=k} S''(i,j) - N(k) \right] \quad \text{.....(M)}$$

And let the quantity $\sum_{\forall i} R(i)^2$ be minimised by optimising g (see Appendix F).

Subsidence Frequency

Now that the exposure has been defined the number of claims can be established. Subsidence frequency for each occurrence year is described as :-

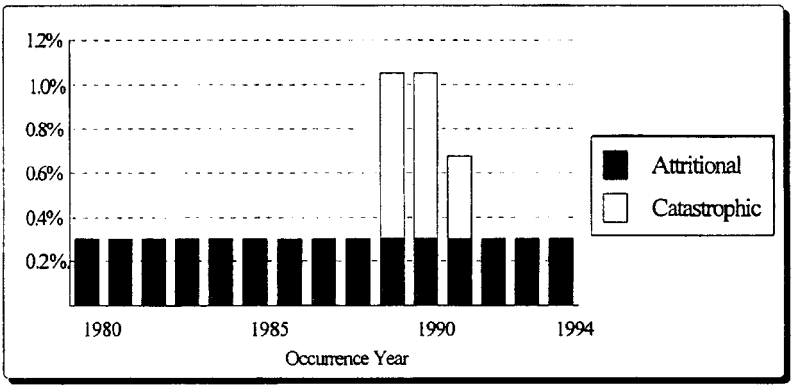
$f(i)$ = Attritional + Catastrophic frequency for occurrence year i

Where

Attritional = Normal levels of claims arising from movement , trees, drains, etc.

Catastrophic = Claims arising from exceptionally dry weather and shrinkage.

Graph 6 : Subsidence Claims Frequency by Year of Occurrence



To assess the likelihood of subsidence occurring during the period of tenure let :-

$f(i,j)$ = the accumulated frequency for a house bought in year i and sold in year $(i+j)$.

$$= \frac{f(i)}{2} + \sum_{k=i+1}^{i+j-1} f(k) + \frac{f(i+j)}{2} \qquad \text{.....(N)}$$

(See Appendix G)

Number of Claims Arising from House Sales

We can now calculate the number of subsidence occurrences that are discovered when the house is surveyed by a potential purchaser. Let

$C^S(i,j)$ = the number of subsidence claims as a result of house sales

$= S''(i, j) * f(i, j)$ .....(O)

Hence let

$C^S(k)$ = claims notified in any one year

$$= \sum_{\forall i+j=k} C^S(i,j) \quad \text{.....(P)}$$

Subsidence Noticed through Inspection by the Owner

Next the claims reported after the owner has noticed cracks must be calculated, i.e. C^N. If we assume that all opportunities for making subsidence claims are noticed by the owner we can write :-

$C^N(i)$ = claims notified in year i as a result of noticing cracks etc.

$C^N(i, j)$ = claims notified in year i, j years after occurrence.

= housing stock in year $(i-j)$ * subsidence frequency in year $(i-j)$

$= H(i-j) * f(i-j)$ .....(Q)

Hence the total number of claims notified in year i can be expressed as :-

$$C^N(i) = \sum_{\forall j} C^N(i,j) \quad \text{.....(R)}$$

Proportion of Claims Discovered at Sale

If we use C^N to represent the total number of potential claims the proportion of claims notified as a result of sales p can be estimated as :-

$$p = \left[\sum_{\forall i} C^S(i)\right] \times \left[\sum_{\forall i} C^N(i)\right]^{-1} \quad \text{.....(S)}$$

Hence

$C^T(i)$ = the total claims notified in year i

$$= C^S(i) + (1 - p) * C^N(i) \qquad \text{.....(T)}$$

Obviously higher values for p will mean the reporting of subsidence claims is more dependent on the state of the housing market.

4.3 Scenarios Tested

The example used in section 4.2 was for East Anglia. The other regions tested were the North and the South East. Each has its own characteristics :-

East Anglia High levels of sales in the 1980s boom and relatively high incidence of subsidence.

North Moderate levels of sales in the 1980s boom and low levels of subsidence.

South East Very high levels of sales in the 1980s and high incidence of subsidence.

The model was run with three scenarios to investigate different future housing markets. They were intended to be indicative of the type of conditions that prevail rather than give an accurate forecast :-

Slump Sales are further reduced from current levels.

Flat Sales continue at the current levels.

Boom Sales increase to boom levels of the late 1980s.

The values for the average tenure in years were:-

Table 3 : Values of μ for Each Scenario

Year of Purchase (*i*)	Slump	Flat	Boom
1985 & before	6	6	6
1986 to 1988	10	10	10
1989 to 1994	8	8	8
1995 & beyond	10	8	6

The assumed future sales volumes were :-

Table 4 : Future House Sales in East Anglia S(i) for each Scenario

Year of Purchase *(i)*	Slump (000s)	Flat (000s)	Boom (000s)
1995	55	55	55
1996	45	55	70
1997	40	55	80
1998	40	55	80
1999	45	55	65
2000	55	55	55

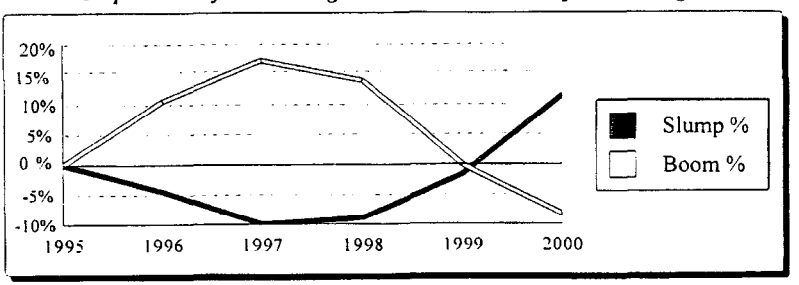
Similar assumptions were made for the South East and the North.

4.4 Results

Each scenario was run for each region. The number of notifications for the Boom and Slump scenarios were then compared to the Flat scenario. The East Anglian example gave the following results :-

- Around 40% of the claims were explained by house sales.
- The Boom scenario generates a maximum 17% extra claims in 1997.
- The Slump scenario reduces claims by a maximum of 12% in 1997.
- Over the five year period there is little difference in the number of claims.

Graph 7 : Projected Change in Subsidence Claims for East Anglia



The results obtained for the other two regions tested are as follows:-

Table 5 : Model Results by Region

Year	East Anglia		North		South East	
	Slump	Boom	Slump	Boom	Slump	Boom
1995	0%	0%	0%	0%	0%	0%
1996	-4%	11%	-8%	1%	-5%	6%
1997	-10%	17%	-13%	7%	-12%	27%
1998	-9%	14%	-11%	5%	-10%	22%
1999	-2%	0%	-4%	-6%	0%	-7%
2000	11%	-8%	9%	-11%	10%	-17%

Table 6 : Estimate of the Proportion of Claims Arising from House Sales (p)

Region	East Anglia	North	South East
Est p	43%	48%	60%

The differences in the way the regions behave are primarily due to :-

- The number of house sales relative to the housing stock.
- The size of the 1980s boom.
- The incidence of subsidence.

Clearly, changes in the economic or demographic trends would have a profound affect on the results.

4.5 Conclusions

Although the model represents a simplified view and the results are indicative as opposed to predictive there are some interesting results :-

- Activity in the housing market is sufficient to explain about 40-60% of claims reported.
- Another housing boom similar to the late 1980s would increase subsidence claims by about 10-30% but a gradual improvement would have a much smaller effect.
- A further decline in volume could reduce claims by 10-15%.

Sample Building Rates 1994

Appendix A

Subsidence Group

	Insurers							Average/ Total
	1	2	3	4	5	6	7	
District 1		32.0		40.0	41.5			37.8
District 2		32.0	38.0	28.0	41.5	37.0	24.0	33.4
District 3		32.0		40.0	41.5			37.8
District 4		40.0		40.0	41.5			40.5
District 5		40.0		40.0				40.0
District 6		40.0		40.0	41.5			40.5
Average	**N/A**	**36.0**	**38.0**	**38.0**	**41.5**	**37.0**	**24.0**	**37.5**
Refers	**6.0**	**0.0**	**5.0**	**0.0**	**1.0**	**5.0**	**5.0**	**22.0**

Flood Group

District 1	24.0	22.0	25.0	22.0	21.5	21.0	14.0	**21.4**
District 2	30.0	26.0	29.0	22.0	24.5	28.0	20.0	**25.6**
District 3	24.0	22.0	25.0	22.0	21.5	21.0	14.0	**21.4**
District 4	30.0	26.0	29.0	25.0	28.5	21.0	17.0	**25.2**
District 5	30.0	22.0	29.0	22.0	24.5	37.0	15.0	**25.6**
District 6	30.0	32.0	29.0	22.0	24.5	32.0	17.0	**26.6**
Average	**28.0**	**25.0**	**27.7**	**22.5**	**24.2**	**26.7**	**16.2**	**24.3**

Control Group

District 1	15.0	18.0	21.0	18.0	17.5	17.0	14.0	**17.2**
District 2	15.0	18.0	21.0	18.0	17.5	17.0	14.0	**17.2**
District 3	15.0	18.0	21.0	18.0	17.5	17.0	14.0	**17.2**
District 4	15.0	22.0	25.0	22.0	21.5	21.0	15.0	**20.2**
District 5	15.0	22.0	25.0	18.0	21.5	21.0	14.0	**19.5**
District 6	15.0	18.0	21.0	18.0	17.5	17.0	14.0	**17.2**
Average	**15.0**	**19.3**	**22.3**	**18.7**	**18.8**	**18.3**	**14.2**	**18.1**

Sample Building Rates 1995

Appendix B

Subsidence Group

	Insurers							Averag
	1	2	3	4	5	6	7	
District 1		33.9		39.0	41.5		40.0	**38.6**
District 2		30.3	34.0	27.0	41.5	37.0	35.0	**34.1**
District 3		26.1		39.0	41.5		40.0	**36.7**
District 4		26.1		39.0	41.5		24.0	**32.7**
District 5		30.3		39.0			40.0	**36.4**
District 6		22.0	34.0	39.0	41.5		17.0	**30.7**
Average	**N/A**	**28.1**	**34.0**	**37.0**	**41.5**	**37.0**	**32.7**	**34.6**
Refers	**6.0**	**0.0**	**4.0**	**0.0**	**1.0**	**5.0**	**0.0**	**16.0**

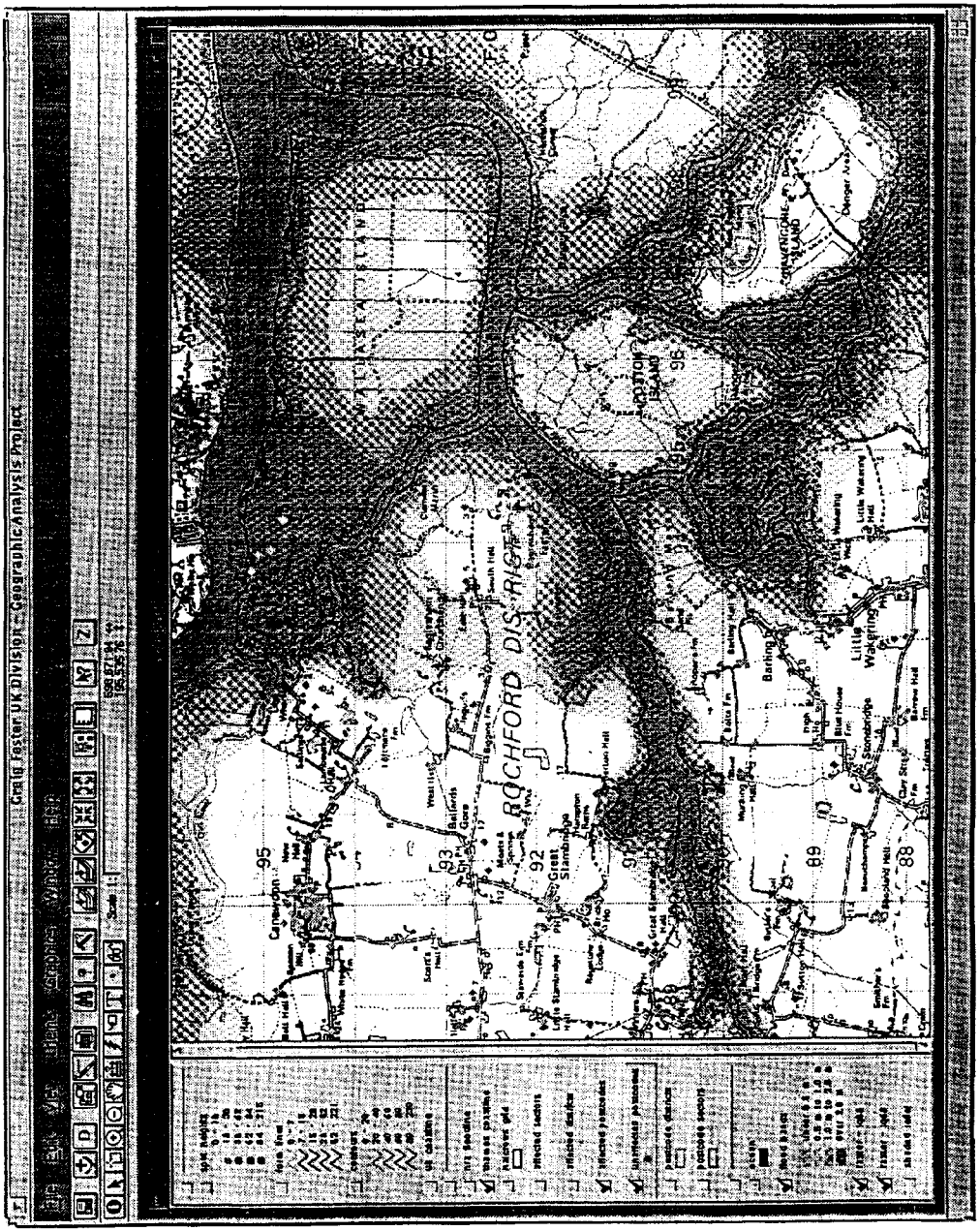
Flood Group

District 1	22.0	30.3	21.0	21.0	21.5	21.0	14.0	**21.5**
District 2	27.0	30.3	25.0	21.0	21.5	28.0	20.0	**24.7**
District 3	15.5	22.0	21.0	21.0	21.5	21.0	14.0	**19.4**
District 4	27.0	26.1	23.0	24.0	28.5	21.0	17.0	**23.8**
District 5	27.0	15.6	23.0	21.0	24.5	37.0	17.0	**23.6**
District 6	27.0	26.1	23.0	21.0	24.5	32.0	20.0	**24.8**
Average	**24.3**	**25.1**	**22.7**	**21.5**	**23.7**	**26.7**	**17.0**	**23.0**

Control Group

District 1	15.0	25.6	16.0	17.0	15.0	17.0	14.0	**17.1**
District 2	15.0	14.7	16.0	17.0	17.5	17.0	14.0	**15.9**
District 3	15.0	15.6	18.0	17.0	17.5	17.0	14.0	**16.3**
District 4	15.0	16.5	18.0	21.0	21.5	21.0	15.0	**18.3**
District 5	15.0	16.5	18.0	17.0	21.5	21.0	14.0	**17.6**
District 6	15.0	16.5	16.0	17.0	17.5	17.0	14.0	**16.1**
Average	**15.0**	**17.6**	**17.0**	**17.7**	**18.4**	**18.3**	**14.2**	**16.9**

Appendix C


Craig Foster UK Division – Geographic Analysis Project
File
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Scale 1:
spot heights
contours
ROCHFORD DISTRICT
Canewdon
Great Stambridge
Little Stambridge
Barling
Little Wakering
Stonebridge
POTTON ISLAND
HAVENGORE ISLAND
95
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Appendix D

Lognormal Density Functions

Yrs	Mean	Mu	Var	Duration to Sale (yrs)																
				0.5	1.5	2.5	3.5	4.5	5.5	6.5	7.5	8.5	9.5	10.5	11.5	12.5	13.5	14.5	15.5	Ult
Up to 85	6.00	1.54	0.50	0.00	0.01	0.11	0.28	0.47	0.63	0.75	0.83	0.88	0.92	0.95	0.96	0.98	0.98	0.99	0.99	1.00
86 to 88	10.00	2.05	0.50	0.00	0.00	0.01	0.05	0.14	0.24	0.36	0.47	0.57	0.65	0.72	0.78	0.83	0.86	0.89	0.92	1.00
89 to 94	8.00	1.83	0.50	0.00	0.00	0.03	0.12	0.26	0.40	0.53	0.64	0.73	0.80	0.85	0.89	0.92	0.94	0.95	0.97	1.00
95 Onwards	6.00	1.54	0.50	0.00	0.01	0.11	0.28	0.47	0.63	0.75	0.83	0.88	0.92	0.95	0.96	0.98	0.98	0.99	0.99	1.00

Lognormal Probability Functions

Yrs	Mean	Mu	Var	Duration to Sale (yrs)																
				0.5	1.5	2.5	3.5	4.5	5.5	6.5	7.5	8.5	9.5	10.5	11.5	12.5	13.5	14.5	15.5	Ult
Up to 85	6.00	1.54	0.50	0.00	0.01	0.09	0.18	0.19	0.16	0.12	0.08	0.06	0.04	0.03	0.02	0.01	0.01	0.01	0.00	0.01
86 to 88	10.00	2.05	0.50	0.00	0.00	0.01	0.04	0.08	0.11	0.12	0.11	0.10	0.09	0.07	0.06	0.05	0.04	0.03	0.02	0.08
89 to 94	8.00	1.83	0.50	0.00	0.00	0.03	0.09	0.13	0.14	0.13	0.11	0.09	0.07	0.05	0.04	0.03	0.02	0.02	0.01	0.03
95 Onwards	6.00	1.54	0.50	0.00	0.01	0.09	0.18	0.19	0.16	0.12	0.08	0.06	0.04	0.03	0.02	0.01	0.01	0.01	0.00	0.01

Notes

i) The lognormal function was chosen because it it continuous and non-negative

ii) Mean was set to allow differentiation according to the level of negative equity (particularly for purchases in the period 1986 to 1988).

iii) Var was set to control the weight in the distribution's tail (i.e. so that most activity was complete by year 15).

Initial Comparison of Sales and Purchases

Year of Purchase (i)	Number of Purchases S(i)	Number of Sales Sum S(i,j)	New Entrants N(i)	Total Sold	Residual R(i)	Diagonal Adjustment d(i)	Sales by Duration of Tenure (yrs) S(i,j) 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Ult
1964	26,637						0	307	2,503	4,692	5,016	4,204	3,133	2,200	1,499	1,007	672	449	301	203	137	94	219
1965	27,554						0	317	2,589	4,854	5,189	4,349	3,241	2,276	1,551	1,041	696	465	311	210	142	97	227
1966	28,503						0	328	2,678	5,021	5,368	4,498	3,353	2,354	1,604	1,077	719	481	322	217	147	100	235
1967	29,485						0	340	2,770	5,194	5,553	4,653	3,468	2,435	1,659	1,114	744	497	333	224	152	104	243
1968	30,500						0	351	2,866	5,373	5,744	4,813	3,587	2,519	1,716	1,153	770	514	345	232	157	107	251
1969	31,550						0	364	2,964	5,558	5,942	4,979	3,711	2,606	1,775	1,192	796	532	357	240	163	111	260
1970	32,637						0	376	3,066	5,749	6,146	5,151	3,839	2,696	1,837	1,233	824	550	369	248	168	115	269
1971	33,761						0	389	3,172	5,947	6,358	5,328	3,971	2,789	1,900	1,276	852	569	381	257	174	119	278
1972	34,923						0	402	3,281	6,152	6,577	5,511	4,108	2,885	1,965	1,320	882	589	395	266	180	123	288
1973	36,126						0	416	3,394	6,364	6,804	5,701	4,249	2,984	2,033	1,365	912	609	408	275	186	127	298
1974	37,370						0	431	3,511	6,583	7,038	5,898	4,396	3,087	2,103	1,412	943	630	422	284	193	132	308
1975	38,657						0	445	3,632	6,810	7,280	6,101	4,547	3,193	2,175	1,461	976	652	437	294	200	136	318
1976	39,988						0	461	3,757	7,044	7,531	6,311	4,703	3,303	2,250	1,511	1,009	674	452	304	206	141	329
1977	41,365						0	477	3,886	7,287	7,790	6,528	4,865	3,417	2,328	1,563	1,044	697	467	315	214	146	341
1978	42,790						0	493	4,020	7,538	8,058	6,753	5,033	3,534	2,408	1,617	1,080	721	484	326	221	151	353
1979	44,263						0	510	4,159	7,797	8,336	6,985	5,206	3,656	2,491	1,673	1,117	746	500	337	228	156	365
1980	45,787	38,458	12,742	51,200	(5,413)	89.43%	0	528	4,302	8,066	8,623	7,226	5,386	3,782	2,577	1,730	1,156	772	517	349	236	161	377
1981	48,823	39,782	13,181	52,963	(4,140)	92.18%	0	563	4,587	8,600	9,195	7,705	5,743	4,033	2,747	1,845	1,232	823	552	372	252	172	402
1982	55,725	41,169	13,635	54,804	921	101.68%	0	642	5,236	9,816	10,495	8,794	6,554	4,603	3,136	2,106	1,407	940	630	424	288	196	459
1983	60,315	42,784	14,105	56,888	3,427	106.02%	0	695	5,667	10,625	11,359	9,519	7,094	4,982	3,394	2,279	1,522	1,017	682	459	311	213	497
1984	63,604	45,035	14,590	59,626	3,978	106.67%	0	733	5,976	11,204	11,978	10,038	7,481	5,254	3,579	2,403	1,605	1,072	719	484	328	224	524
1985	62,989	48,045	15,093	63,138	(149)	99.76%	0	726	5,918	11,096	11,863	9,941	7,409	5,203	3,545	2,380	1,590	1,062	712	480	325	222	519
1986	65,085	51,465	18,157	69,622	(4,537)	93.48%	0	32	718	2,819	5,303	6,964	7,519	7,233	6,475	5,534	4,587	3,724	2,983	2,368	1,869	1,470	5,489
1987	70,000	53,967	18,884	72,851	(2,851)	96.09%	0	35	772	3,032	5,703	7,490	8,087	7,779	6,964	5,952	4,933	4,006	3,208	2,547	2,010	1,581	5,903
1988	86,000	51,313	19,640	70,954	15,046	121.21%	0	42	949	3,725	7,007	9,202	9,935	9,557	8,556	7,312	6,061	4,921	3,942	3,129	2,469	1,942	7,253
1989	45,000	44,948	6,603	51,551	(6,551)	87.29%	0	99	1,427	4,072	5,995	6,476	5,950	4,990	3,966	3,051	2,302	1,716	1,272	940	694	513	1,538
1990	50,000	40,118	6,688	46,807	3,193	106.82%	0	110	1,585	4,524	6,661	7,196	6,611	5,545	4,406	3,390	2,557	1,907	1,413	1,044	771	570	1,708
1991	52,000	39,595	6,775	46,370	5,630	112.14%	0	114	1,649	4,705	6,928	7,484	6,876	5,766	4,583	3,526	2,660	1,983	1,470	1,086	802	593	1,777
1992	47,000	42,628	6,863	49,491	(2,491)	94.97%	0	103	1,490	4,253	6,262	6,764	6,215	5,212	4,142	3,187	2,404	1,793	1,328	981	725	536	1,606
1993	55,000	46,823	6,952	53,774	1,226	102.28%	0	121	1,744	4,976	7,328	7,916	7,273	6,099	4,847	3,729	2,813	2,098	1,554	1,149	848	627	1,879
1994	55,000	50,391	7,042	57,433	(2,433)	95.76%	0	121	1,744	4,976	7,328	7,916	7,273	6,099	4,847	3,729	2,813	2,098	1,554	1,149	848	627	1,879
1995	55,000	52,792	11,160	63,952	(8,952)	86.00%	0	634	5,167	9,689	10,358	8,680	6,469	4,543	3,095	2,078	1,388	927	622	419	284	194	453
1996	70,000	54,872	11,384	66,255	3,745	105.65%	0	807	6,577	12,331	13,183	11,047	8,233	5,782	3,939	2,645	1,767	1,180	791	533	361	247	577
1997	80,000	59,504	11,611	71,116	8,884	112.49%	0	922	7,516	14,092	15,066	12,625	9,410	6,608	4,502	3,023	2,019	1,349	904	609	413	282	659
1998	80,000	66,398	11,843	78,242	1,758	102.25%	0	922	7,516	14,092	15,066	12,625	9,410	6,608	4,502	3,023	2,019	1,349	904	609	413	282	659
1999	65,000	73,345	12,080	85,426	(20,426)	76.09%	0	749	6,107	11,450	12,241	10,258	7,645	5,369	3,658	2,456	1,641	1,096	735	495	336	229	536
2000	55,000	78,637	12,322	90,959	(35,959)	60.47%	0	634	5,167	9,689	10,358	8,680	6,469	4,543	3,095	2,078	1,388	927	622	419	284	194	453

Notes

i) The sum of sales must equal the sum of purchases in each calendar year.

ii) The no. of sales is actual regional sales back to 1987, apportioned actual national sales back to 1980 and estimated for 1979 and before.

Purchase and Sale Distribution with End Correction

Year of Purchase (i)	Number of Purchases S(i)	Number of Sales Sum S(i,j)	New Entrants N(i)	Total Sold	Residual R(i)	Diagonal Adjustment d(i)	Sales by Duration of Tenure (yrs) S(i,j) 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Ult	End Correction e(i)
1964	26,637						0	307	2,503	4,693	5,016	4,204	3,133	2,200	1,499	1,007	672	449	301	203	137	94	219	0.0000
1965	27,554						0	317	2,589	4,854	5,189	4,349	3,241	2,276	1,551	1,041	696	465	311	210	142	87	237	0.0000
1966	28,503						0	328	2,678	5,021	5,368	4,498	3,353	2,354	1,604	1,077	719	481	322	217	132	93	258	0.0000
1967	29,485						0	340	2,770	5,194	5,553	4,653	3,468	2,435	1,659	1,114	744	497	333	201	140	106	277	0.0000
1968	30,500						0	351	2,866	5,373	5,744	4,813	3,587	2,519	1,716	1,153	770	514	308	214	160	114	297	0.0000
1969	31,550						0	364	2,964	5,558	5,942	4,979	3,711	2,606	1,775	1,192	796	476	329	244	173	119	323	0.0000
1970	32,637						0	376	3,066	5,749	6,146	5,151	3,839	2,696	1,837	1,233	737	507	375	263	180	115	367	0.0000
1971	33,761						0	389	3,172	5,947	6,358	5,328	3,971	2,789	1,900	1,141	786	579	404	274	174	111	438	0.0000
1972	34,923						0	402	3,281	6,152	6,577	5,511	4,108	2,885	1,757	1,217	896	624	421	265	169	118	539	0.0000
1973	36,126						0	416	3,394	6,364	6,804	5,701	4,249	2,668	1,874	1,388	967	650	407	257	179	154	653	0.0000
1974	37,370						0	431	3,511	6,583	7,038	5,898	3,931	2,845	2,138	1,497	1,006	629	395	273	234	115	846	0.0000
1975	38,657						0	445	3,632	6,810	7,280	5,456	4,191	3,247	2,306	1,558	973	609	420	357	174	146	1,052	0.0000
1976	39,988						0	461	3,757	7,044	6,735	5,817	4,783	3,502	2,400	1,508	944	648	518	266	220	158	1,198	0.0000
1977	41,365						0	477	3,886	6,516	7,181	6,638	5,158	3,645	2,322	1,461	1,003	845	408	336	239	138	1,109	0.0000
1978	42,790						0	493	3,595	6,948	8,194	7,160	5,369	3,526	2,251	1,554	1,309	630	517	365	210	154	515	0.0000
1979	44,263						0	453	3,807	7,873	8,776	7,399	5,157	3,394	2,376	2,013	968	792	557	318	232	148	0	0.0070
1980	45,787	34,412	12,742	47,154	(1,367)	97.10%	0	480	4,313	8,432	9,070	7,108	4,964	3,583	3,079	1,489	1,217	854	485	352	223	137	0	0.0139
1981	48,823	36,666	13,181	49,848	(1,025)	97.91%	0	567	4,822	9,096	9,095	7,142	5,471	4,846	2,378	1,954	1,370	775	559	353	215	180	0	0.0085
1982	55,725	41,759	13,635	55,394	331	100.60%	0	680	5,579	9,783	9,801	8,441	7,936	4,014	3,346	2,359	1,334	960	602	364	304	221	0	0.0010
1983	60,315	45,156	14,105	59,261	1,054	101.78%	0	740	5,642	9,913	10,893	11,514	6,181	5,311	3,799	2,160	1,554	972	585	484	350	217	0	0.0020
1984	63,604	47,802	14,590	62,393	1,211	101.94%	0	722	5,519	10,637	14,345	8,657	7,896	5,821	3,358	2,429	1,519	911	750	538	332	169	0	0.0120
1985	62,989	47,750	15,093	62,843	146	100.23%	0	667	5,587	13,215	10,175	10,434	8,164	4,855	3,562	2,240	1,344	1,103	787	482	243	132	0	0.0174
1986	65,085	47,963	18,157	66,120	(1,035)	98.44%	0	31	870	2,461	5,665	7,810	7,140	7,397	6,201	4,759	4,846	4,190	3,050	1,802	1,130	889	6,845	0.0000
1987	70,000	51,653	18,884	70,537	(537)	99.24%	0	42	674	3,239	6,396	7,113	8,271	7,449	5,989	6,288	5,549	4,096	2,441	1,540	1,215	956	8,742	0.0000
1988	86,000	61,847	19,640	81,487	4,513	105.54%	0	37	1,013	4,177	6,654	9,412	9,514	8,219	9,039	8,226	6,197	3,745	2,383	1,892	1,493	1,174	12,825	0.0000
1989	45,000	39,279	6,603	45,882	(882)	98.08%	0	106	1,600	3,867	6,132	6,202	5,117	5,272	4,461	3,120	1,751	1,038	769	568	420	310	4,267	0.0000
1990	50,000	43,039	6,688	49,727	273	100.55%	0	123	1,505	4,627	6,379	6,189	6,985	6,237	4,506	2,579	1,546	1,153	854	631	466	345	5,873	0.0000
1991	52,000	44,845	6,775	51,620	380	100.74%	0	109	1,686	4,506	5,958	7,907	7,735	5,896	3,487	2,132	1,608	1,199	889	657	485	359	7,389	0.0000
1992	47,000	41,220	6,863	48,083	(1,083)	97.75%	0	106	1,427	3,657	6,616	7,609	6,354	3,966	2,505	1,927	1,454	1,084	803	593	438	324	8,137	0.0000
1993	55,000	48,542	6,952	55,494	(494)	99.11%	0	116	1,500	5,258	8,243	8,093	5,534	3,688	2,931	2,255	1,701	1,268	940	694	513	379	11,887	0.0000
1994	55,000	48,366	7,042	55,408	(408)	99.26%	0	104	1,842	5,598	7,492	6,023	4,397	3,688	2,931	2,255	1,701	1,268	940	694	513	379	15,174	0.0000
1995	55,000	45,048	11,160	56,209	(1,209)	97.85%	0	670	5,813	9,906	7,881	5,248	3,912	2,747	1,871	1,257	839	561	376	253	172	117	13,376	0.0000
1996	70,000	57,543	11,384	68,927	1,073	101.56%	0	967	6,725	9,583	7,971	6,680	4,979	3,496	2,382	1,599	1,068	714	478	322	218	149	22,928	0.0000
1997	80,000	66,464	11,611	78,076	1,924	102.46%	0	942	5,719	8,521	9,110	7,634	5,690	3,996	2,722	1,828	1,221	816	547	368	250	170	30,465	0.0000
1998	80,000	67,408	11,843	79,251	749	100.94%	0	701	4,545	8,521	9,110	7,634	5,690	3,996	2,722	1,828	1,221	816	547	368	250	170	31,881	0.0000
1999	65,000	55,424	12,080	67,504	(2,504)	96.29%	0	453	3,693	6,924	7,402	6,203	4,623	3,246	2,212	1,485	992	663	444	299	203	139	26,020	0.0000
2000	55,000	47,230	12,322	59,552	(4,552)	92.36%	0	383	3,125	5,858	6,263	5,248	3,912	2,747	1,871	1,257	839	561	376	253	172	117	22,017	0.0000

Notes

i) An end correction has been applied to ensure that the Ult column is non-negative

Accumulative Subsidence Frequency

Occ Yr	Frequency f(i)			Accumulated Frequency by Duration of Tenure (j) i.e. f(i,j)																
(i)	Attritional	Catastrophic	Total	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Ult
1964	0.30%	0.00%	0.30%	0.15%	0.30%	0.60%	0.90%	1.20%	1.50%	1.80%	2.10%	2.40%	2.70%	3.00%	3.30%	3.60%	3.90%	4.20%	4.50%	4.80%
1965	0.30%	0.00%	0.30%	0.15%	0.30%	0.60%	0.90%	1.20%	1.50%	1.80%	2.10%	2.40%	2.70%	3.00%	3.30%	3.60%	3.90%	4.20%	4.50%	4.80%
1966	0.30%	0.00%	0.30%	0.15%	0.30%	0.60%	0.90%	1.20%	1.50%	1.80%	2.10%	2.40%	2.70%	3.00%	3.30%	3.60%	3.90%	4.20%	4.50%	4.80%
1967	0.30%	0.00%	0.30%	0.15%	0.30%	0.60%	0.90%	1.20%	1.50%	1.80%	2.10%	2.40%	2.70%	3.00%	3.30%	3.60%	3.90%	4.20%	4.50%	4.80%
1968	0.30%	0.00%	0.30%	0.15%	0.30%	0.60%	0.90%	1.20%	1.50%	1.80%	2.10%	2.40%	2.70%	3.00%	3.30%	3.60%	3.90%	4.20%	4.50%	4.80%
1969	0.30%	0.00%	0.30%	0.15%	0.30%	0.60%	0.90%	1.20%	1.50%	1.80%	2.10%	2.40%	2.70%	3.00%	3.30%	3.60%	3.90%	4.20%	4.50%	4.80%
1970	0.30%	0.00%	0.30%	0.15%	0.30%	0.60%	0.90%	1.20%	1.50%	1.80%	2.10%	2.40%	2.70%	3.00%	3.30%	3.60%	3.90%	4.20%	4.50%	4.80%
1971	0.30%	0.00%	0.30%	0.15%	0.30%	0.60%	0.90%	1.20%	1.50%	1.80%	2.10%	2.40%	2.70%	3.00%	3.30%	3.60%	3.90%	4.20%	4.50%	4.80%
1972	0.30%	0.00%	0.30%	0.15%	0.30%	0.60%	0.90%	1.20%	1.50%	1.80%	2.10%	2.40%	2.70%	3.00%	3.30%	3.60%	3.90%	4.20%	4.50%	4.80%
1973	0.30%	0.00%	0.30%	0.15%	0.30%	0.60%	0.90%	1.20%	1.50%	1.80%	2.10%	2.40%	2.70%	3.00%	3.30%	3.60%	3.90%	4.20%	4.50%	5.03%
1974	0.30%	0.00%	0.30%	0.15%	0.30%	0.60%	0.90%	1.20%	1.50%	1.80%	2.10%	2.40%	2.70%	3.00%	3.30%	3.60%	3.90%	4.20%	4.73%	5.48%
1975	0.30%	0.00%	0.30%	0.15%	0.30%	0.60%	0.90%	1.20%	1.50%	1.80%	2.10%	2.40%	2.70%	3.00%	3.30%	3.60%	3.90%	4.43%	5.18%	5.81%
1976	0.30%	0.00%	0.30%	0.15%	0.30%	0.60%	0.90%	1.20%	1.50%	1.80%	2.10%	2.40%	2.70%	3.00%	3.30%	3.60%	4.13%	4.88%	5.51%	5.93%
1977	0.30%	0.00%	0.30%	0.15%	0.30%	0.60%	0.90%	1.20%	1.50%	1.80%	2.10%	2.40%	2.70%	3.00%	3.30%	3.83%	4.58%	5.21%	5.63%	5.93%
1978	0.30%	0.00%	0.30%	0.15%	0.30%	0.60%	0.90%	1.20%	1.50%	1.80%	2.10%	2.40%	2.70%	3.00%	3.53%	4.28%	4.91%	5.33%	5.63%	5.93%
1979	0.30%	0.00%	0.30%	0.15%	0.30%	0.60%	0.90%	1.20%	1.50%	1.80%	2.10%	2.40%	2.70%	3.23%	3.98%	4.61%	5.03%	5.33%	5.63%	5.93%
1980	0.30%	0.00%	0.30%	0.15%	0.30%	0.60%	0.90%	1.20%	1.50%	1.80%	2.10%	2.40%	2.93%	3.68%	4.31%	4.73%	5.03%	5.33%	5.63%	5.93%
1981	0.30%	0.00%	0.30%	0.15%	0.30%	0.60%	0.90%	1.20%	1.50%	1.80%	2.10%	2.63%	3.38%	4.01%	4.43%	4.73%	5.03%	5.33%	5.63%	5.93%
1982	0.30%	0.00%	0.30%	0.15%	0.30%	0.60%	0.90%	1.20%	1.50%	1.80%	2.33%	3.08%	3.71%	4.13%	4.43%	4.73%	5.03%	5.33%	5.63%	5.93%
1983	0.30%	0.00%	0.30%	0.15%	0.30%	0.60%	0.90%	1.20%	1.50%	2.03%	2.78%	3.41%	3.83%	4.13%	4.43%	4.73%	5.03%	5.33%	5.63%	5.93%
1984	0.30%	0.00%	0.30%	0.15%	0.30%	0.60%	0.90%	1.20%	1.73%	2.48%	3.11%	3.53%	3.83%	4.13%	4.43%	4.73%	5.03%	5.33%	5.63%	5.93%
1985	0.30%	0.00%	0.30%	0.15%	0.30%	0.60%	0.90%	1.43%	2.18%	2.81%	3.23%	3.53%	3.83%	4.13%	4.43%	4.73%	5.03%	5.33%	5.63%	5.93%
1986	0.30%	0.00%	0.30%	0.15%	0.30%	0.60%	1.13%	1.88%	2.51%	2.93%	3.23%	3.53%	3.83%	4.13%	4.43%	4.73%	5.03%	5.33%	5.63%	5.93%
1987	0.30%	0.00%	0.30%	0.15%	0.30%	0.83%	1.58%	2.21%	2.63%	2.93%	3.23%	3.53%	3.83%	4.13%	4.43%	4.73%	5.03%	5.33%	5.63%	5.93%
1988	0.30%	0.00%	0.30%	0.15%	0.53%	1.28%	1.91%	2.33%	2.63%	2.93%	3.23%	3.53%	3.83%	4.13%	4.43%	4.73%	5.03%	5.33%	5.63%	5.93%
1989	0.30%	0.45%	0.75%	0.38%	0.75%	1.39%	1.80%	2.10%	2.40%	2.70%	3.00%	3.30%	3.60%	3.90%	4.20%	4.50%	4.80%	5.10%	5.40%	5.70%
1990	0.30%	0.45%	0.75%	0.38%	0.64%	1.05%	1.35%	1.65%	1.95%	2.25%	2.55%	2.85%	3.15%	3.45%	3.75%	4.05%	4.35%	4.65%	4.95%	5.25%
1991	0.30%	0.23%	0.53%	0.26%	0.41%	0.71%	1.01%	1.31%	1.61%	1.91%	2.21%	2.51%	2.81%	3.11%	3.41%	3.71%	4.01%	4.31%	4.61%	4.91%
1992	0.30%	0.00%	0.30%	0.15%	0.30%	0.60%	0.90%	1.20%	1.50%	1.80%	2.10%	2.40%	2.70%	3.00%	3.30%	3.60%	3.90%	4.20%	4.50%	4.80%
1993	0.30%	0.00%	0.30%	0.15%	0.30%	0.60%	0.90%	1.20%	1.50%	1.80%	2.10%	2.40%	2.70%	3.00%	3.30%	3.60%	3.90%	4.20%	4.50%	4.80%
1994	0.30%	0.00%	0.30%	0.15%	0.30%	0.60%	0.90%	1.20%	1.50%	1.80%	2.10%	2.40%	2.70%	3.00%	3.30%	3.60%	3.90%	4.20%	4.50%	4.80%
1995	0.30%	0.00%	0.30%	0.15%	0.30%	0.60%	0.90%	1.20%	1.50%	1.80%	2.10%	2.40%	2.70%	3.00%	3.30%	3.60%	3.90%	4.20%	4.50%	4.80%
1996	0.30%	0.00%	0.30%	0.15%	0.30%	0.60%	0.90%	1.20%	1.50%	1.80%	2.10%	2.40%	2.70%	3.00%	3.30%	3.60%	3.90%	4.20%	4.50%	4.80%
1997	0.30%	0.00%	0.30%	0.15%	0.30%	0.60%	0.90%	1.20%	1.50%	1.80%	2.10%	2.40%	2.70%	3.00%	3.30%	3.60%	3.90%	4.20%	4.50%	4.80%
1998	0.30%	0.00%	0.30%	0.15%	0.30%	0.60%	0.90%	1.20%	1.50%	1.80%	2.10%	2.40%	2.70%	3.00%	3.30%	3.60%	3.90%	4.20%	4.50%	4.80%
1999	0.30%	0.00%	0.30%	0.15%	0.30%	0.60%	0.90%	1.20%	1.50%	1.80%	2.10%	2.40%	2.70%	3.00%	3.30%	3.60%	3.90%	4.20%	4.50%	4.80%
2000	0.30%	0.00%	0.30%	0.15%	0.30%	0.60%	0.90%	1.20%	1.50%	1.80%	2.10%	2.40%	2.70%	3.00%	3.30%	3.60%	3.90%	4.20%	4.50%	4.80%