An Investigation into the Potential Relationship between Property Values and High Voltage Overhead Transmission Lines in Ireland

An independent report prepared for

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Part 1 - Report

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Acronyms used in this report

CSO	Central Statistics Office
ESB	Electricity Supply Board
ESRI	Economic & Social Research Institute
HVOTL	High voltage overhead transmission lines
IPAV	Institute of Professional Auctioneers and Valuers
MO	Market Operator (Eirgrid)
ODPC	Office of the Data Protection Commissioner
PTSB	Permanent TSB
SCSI	Society of Chartered Surveyors Ireland
TAO	Transmission Asset Owner (ESB Networks Ltd)
TSO	Transmission System Operator (Eirgrid)

Glossary of terms used in this report

110 kV	The 110 kV network is the most extensive element of Ireland's electricity grid, reaching into every county across the country. The support structures generally consist of twin timber poles. Angle masts, i.e. small steel pylons, are used where the lines change direction. In the case of double circuit 110 kV lines, steel pylons are used rather than twin poles.
220 kV	The 220 kV network comprises a number of single circuit loops around the country and is carried exclusively on steel pylons.
400 kV	The 400 kV network provides a high capacity link between Moneypoint generation station and Dublin on the east. The 400 kV network is carried on steel pylons.
Adjusted R-Squared	Measures the amount of variation in the dependent variable explained by the independent variables in a regression model. The adjusted R-squared is within the range of $0 \leq \text{Adj-}R^2 \leq 1$, with the amount of variation explained by the model increasing as the adjusted R-squared approaches 1.
Appraiser	An appraiser is one who puts a value on property, real or personal. Real estate appraisers value property for a variety of purposes. The term has a similar meaning to that of "valuer".
Coefficient	In a regression model, the coefficient quantifies the relationship between the dependent variable and the independent variable corresponding to the coefficient value.
Confidence Level	A measure of how confident we are that the estimated value of the coefficient lies within a given range. For example, if a coefficient in a regression model is found to be statistically significantly different from zero at a 95% confidence level, this means that in repeated sampling the range for the coefficient would not include zero 95% of the time.
Dependent Variable	The variable being 'explained' by the independent variables in a regression model.
Double Circuit Transmission Line	A double circuit transmission line is one which has two circuits carried through the tower line.
Easement	ESB easements are registered on the title documents and the use of the land is restricted depending on the nature of the easement
Empirical	Research based on observed and measured phenomena.

Studies

Encumbrance	An encumbrance, in this context, refers to a restriction on the use of property and will usually take the form of an easement or wayleave.
Hedonic Price Regression Model	A statistical model that attempts to explain the relationship between the price of a good and a variety of other characteristics that are determined to influence the price.
Independent Variables	The variables used in a regression model to explain the variation in the dependent variable e.g. floor area, property type and year of sale are all independent variables used to explain the variation in property prices.
Median	The median of a finite list of numbers can be found by arranging all the observations from lowest value to highest value and picking the middle one. If there is an even number of observations, then there is no single middle value; the median is then usually defined to be the mean of the two middle values.
Quartile	The quartiles of a set of values are the three points that divide the data set into four equal groups, each representing a fourth of the population being sampled. The first/lower quartile splits the lowest 25% of data, the second/middle quartile is equivalent to the median and the upper/third quartile splits the highest 25% (or lowest 75%) of data.
P-Value	In a regression model, the p-value is the probability of observing a coefficient on the independent variable at least as extreme as the one that was actually observed, assuming that there is no relationship between the dependent and independent variables.
Realtor	A service mark used for a real estate agent affiliated with the National Association of Realtors (U.S. and Canada)
Regression Analysis	A statistical technique for estimating the relationship among variables.
Standard Error of the Coefficient	A measure of the variability in the estimated coefficient – the larger the standard error, the greater the uncertainty associated with the estimate.
Valuer	A valuer is a person who values and assesses land, property and other items such as commercial equipment and art, and who advises on the use and administration of land and property.
Wayleave	An ESB wayleave gives the ESB the right to construct and maintain the power lines subject to the landowner's entitlement to be paid compensation.

Executive Summary

Background to the study

The potential relationship between property values and high voltage overhead electricity transmission lines (HVOTL) and their supporting infrastructure has not previously been the subject of any in-depth examination in Ireland. EirGrid Plc the commercial semi-state organisation with responsibility for the operation of Ireland's transmission system, has commissioned a study on this subject.

Corr Commercial and Land Ltd., Gaynor Corr and Insight Statistical Consulting were appointed to carry out this study. The purpose of the study is to present a framework to better assess the potential impact, if any, of HVOTLs on the value of properties in close proximity to overhead electricity transmission infrastructure.

A review of the existing literature on this topic reveals that the preferred methodology for quantifying impacts on sales values is by using a hedonic price regression model.

This requires access to a dataset containing a significantly large number of property transactions. To be suitable for analysis by the model the following information was required:

- sale prices,
- property characteristics (e.g. property type, size, number of bedrooms, year property built) and,
- the property address/location, which is used to determine the distance from the property to nearby lines and support structures.

A dataset of this sort was not publicly available in Ireland and, therefore, primary research was required.

The approach followed in this study involved gathering transaction data directly from estate agents.

The data collection and subsequent statistical regression analysis was limited to residential properties and agricultural land. However, the results from the regression analysis were supplemented by the findings of the survey of estate agents. The survey of estate agents was designed to obtain their designed to obtain their professional opinion on the impact of HVOTLs on property values. The estate agent survey also included different types of commercial property i.e. retail, offices and industrial.

Four study areas – East Galway, Limerick, Kildare and South Dublin – were selected. These were considered to provide sufficient variation in property types, locations (urban and rural) and HVOTL types (see Appendix 1). Rural land sales were also studied on the 400 kV corridors from Moneypoint to Dunnstown and from Moneypoint to the River Shannon on the northern 400 kV line.

Summary of Literature Review

- ***Potential Impact of HVOTLs on Property Prices – Urban Residential***

  - Most of the research is from the U.S. and Canada and it relates to urban and suburban family homes.
  - About half of the studies did not find a negative property value effect.
  - Where negative impacts were picked up they were in many cases not statistically significant.
  - Where negative impacts were found they were generally low – in the region of 3% to 6% or less.
  - A study in Scotland where there was no easement corridor and had a negative impact of 11.5% on average. There was considerable variation around this average at 6% -17%.
  - Positive impacts were discerned in some North American studies due to the increased visual clearance, privacy and amenity value of the un-built easement corridor.
  - This finding would not be relevant in Ireland where easements are generally not acquired.

- ***Potential Impact of HVOTLs on Property Prices – Rural Properties***

  - The bulk of the research is from US and Canada. No studies in UK or Ireland.
  - There were a low number of agricultural land studies in North America relative to the number of studies for residential, urban or suburban property.
  - The presence of restrictive easement corridors on farms, particularly in relation to irrigation restrictions, makes the results less relevant to the Irish situation.
  - Leaving aside studies where reliability has been questioned (Kroll & Priestly, 1992), the other studies showed generally little or no effect on sales prices from HVOTLs. One study showed reductions of the order of 1.11% to 2.44% but these small differences were not statistically significant (Jackson 2010).
  - A recent study (Chalmers 2013) using appraisal techniques found no impact on agricultural production land or larger parcel size high amenity/recreational type rural properties in rural Montana.
  - Very variable results were obtained by Chalmers (2013) in relation to small parcels suitable for single house development which were adjacent to a 500 kV line easement. The average impact appears to be in the region of 15%. Half of the properties were unaffected. There was a large range found in impacts. This was an appraiser type study.

Where negative impacts were found, the impact of pylons was larger than the impact from the transmission lines, thus emphasising the visual component.

Where an impact was found the effect diminished rapidly with distance from the HVOTLs. The impact from HVTOLs disappears in the region of 150-200 metres.

Greatly increased media coverage of health issues from 1992 onwards does not appear to have had any major impact on study findings.

Where negative impacts were found there is evidence to suggest that the impacts generally decrease with the passage of time. In some cases no impacts were evidenced after ten years. Growth of trees and shrubs would be a factor in this.

There is evidence that properties close to HVOTL Rights of Way appreciate at the same rate as properties located away from HVOTLs.

Results from the survey of estate agents

Estate agents expressed the opinion that the drop in value associated with a residential property being in close proximity to a 110 kV line is on average (median) 3%. However, 220 kV lines are estimated to result in an average decline of 13%, and 20% for 400 kV lines. However there was considerable variation in agent opinions:

- 41% indicating no effect on residential property from 110 kV lines,
- 4% indicating no effect from 220 kV lines and,
- 2% indicating no effect from 400 kV lines.

In the case of agricultural land, they indicated the following:

- 55% no impact from 110 kV lines,
- 30% no impact from 220 kV lines and,
- 27% no impact from 400 kV lines.

The effect on agricultural land values is relatively modest across the different voltage types:

- An average (median) of zero change was recorded for the 110 kV line.
- Broadly similar declines in value for both the 220 kV and 400 kV lines were recorded, in the order of 5% and 6% respectively.

When prompted for the single main cause for HVOTLs potentially affecting property values, an overwhelming majority of respondents stated that their main reasons were due to concerns over health (80%) and visual impact (77%).

Health (47%) and visual impact (50%) were also the most commonly cited reasons for an agent reporting a lower valuation on agricultural land as a result of the presence of a HVOTL.

When asked for their opinion of the impact of eight other types of infrastructure on residential values, agents indicated there would be devaluation in all cases. HVOTL's was on a par with a nearby airfield with motorway proximity following closely at a 15% reduction in value. Landfills were indicated to have a negative impact of 25% and waste water treatment plants 23%. There was a very wide range in the opinions expressed in relation to the negative impacts from the various types of infrastructure.

For residential property, the reduction in value is believed to be at its highest during the following stages:

— around the time that full planning permission is granted for the line,
— during the construction phase and
— one year after the construction is completed.

For agricultural land the largest potential negative effect on values occurs at the time of construction of the line. Although the potential effect on values is minimised relatively quickly one year after the line has been built.

With regard to the scale of the effect on different types of commercial property, the responses suggest that estate agents are of the opinion that such an effect is virtually non-existent. Values remain on average unchanged across all property types.

Analysis of micro data on property sales

The analysis of the micro data on property sales uses a hedonic price regression model to investigate if there is any evidence of HVOTLs affecting:

(i) residential sales values, and
(ii) agricultural land values.

In each instance, a base regression model is estimated. This looks at the relationship between sales values and a range of key property characteristics. The various characteristics used in these models (the independent variables) are found to explain the majority of the variation in sales values (the dependent variables). The price indices generated by both models also offer a good explanation of historical trends in property values observed in the marketplace. A variety of other variables are then introduced into the regression models to look for evidence of HVOTLs affecting property sales values.

For the residential model, these variables include scale measures of distance of the property to the nearest HVOTL line/structure and a variety of dummy variables indicating the proximity of the property at various distances to the nearest HVOTL line/structure. Where possible, this is done for line type (110 kV and 220 kV) and structure type (wooden poles or metal structures). In all, a total of nine different specifications are used to detect a relationship. Two of these distinguish between line type at 100 and 150 metres, and another two between structure types, also at the same distance measures. The analysis fails to find sufficient evidence of residential property values being affected by proximity to any type of HVOTL line or structure.

A similar approach is used when analysing the potential relationship between HVOTLs and agricultural land values. It looks at whether or not a HVOTL line crosses the property, the presence of structures on the property and the proximity of structures and lines to a dwelling on the property (if one is present). A total of seven specifications are tested. One of these distinguishes between line type (110 kV, 220 kV and 400 kV) and the other between structure type (wooden poles and metal structures). As with the residential model, the analysis fails to find any evidence of HVOTLs affecting agricultural land values.

Overall conclusion of this study

The agent's opinions of negative impact from HVOTLs on residential property in the survey part of this research were 3%, 13% and 20% for 110 kV, 220 kV and 400 kV respectively. These reductions were significantly higher than that found generally in

surveys of property professionals in other countries. The reductions were normally in the 8% - 10% range and 5% - 10% in the U.K. There was also a considerable variation in the opinions expressed by agents in this survey with 41% indicating no effect on residential properties from 110 kV. Furthermore 4% of the survey indicated no effect from 220 kV and 2% no effect from 400 kV.

Agents expressed the opinion that there was:

- no impact on the price of agricultural land from 110 kV lines,
- a 5% impact from 220 kV lines and,
- a 6% impact from 400 kV lines.

As with the residential part of the survey there was a considerable variation in the opinions expressed with:

- 30% indicating no effect from 220 kV lines and,
- 27% indicating no effect on agricultural land from 400 kV lines.

Statistical analysis of the sales data for both residential and rural properties showed that prices paid were associated with features of the properties such as location, size and year of sale of the property. Additional information related to HVOTLs was then added into each of these models in order to determine (a) whether the added HVOTL information assisted further in explaining the difference in price between properties and (b) if so, what the size of that impact was.

This study, at a 95% confidence level, did not find a statistically significant negative impact from HVOTLs in close proximity to either residential or farm properties.

1 Introduction

1.1 Study background and terms of reference

The potential relationship between property values and high voltage overhead electricity transmission lines (HVOTL) and their supporting infrastructure has not previously been the subject of any in-depth examination in Ireland. EirGrid Plc is the commercial semi-state organisation with responsibility for the operation of Ireland's transmission system.

EirGrid commissioned a research team to carry out a study on this subject. The purpose of the study is to present a framework to better assess the potential impact, if any, of HVOTLs on the value of properties in close proximity to overhead electricity transmission infrastructure.

1.2 The research team

The Research Team were as follows:

- **Corr Commercial and Land Ltd.** led by Managing Director Tom Corr MAgrSc, MSCSI, MRICS, ACIArb who acted as the lead consultant on the project. Tom Corr worked in Gaynor Corr until the 30th November 2012 and subsequent to that established Corr Commercial and Land Ltd.

- Kevin Miller BAgrSc, BScProp, MSCSI, MRICS and Paul Gaynor BSc. Ft, BSC Prop., MSCSI of Gaynor Miller, Portlaoise, also assisted in the project mainly at the information gathering phase.

- **Insight Statistical Consulting** led by Managing Director David Harmon MA MBS, Senior Statistician Dr Cathal Walsh MA PhD and Quantitative Marketing Researcher Geoff Tucker BA MA.

Tom Corr has over 34 years' experience in the areas of property and agricultural consultancy. With the input of Kevin Miller and Paul Gaynor, a broad base of experience of property consultancy and agronomy/agricultural consultancy was brought to the project.

Insight Statistical Consulting was founded in 1989 and is one of Ireland's leading providers of marketing research and statistical services. The company maintains a unique link with the School of Computer Science and Statistics in Trinity College Dublin. This facilitates close academic links and ensures access to high level statistical skills. Insight Statistical Consulting' client base is drawn from the public and private sector, delivering a number of projects related to enterprise, health, education and utilities infrastructure.

1.3 Overview of the study approach

There is an absence of publicly available micro data on property transactions in Ireland. Primary research was needed to collect the required information. This information was used to carry out a robust statistical analysis of the potential relationship between HVOTLs and property values.

This involved conducting face-to-face structured interviews with estate agents in four pre-determined study areas (East Galway, Kildare, Limerick and South Dublin). The purpose of this was to;

- elicit the opinion of valuers on the effect, if any, of HVOTLs on a range of property types and,
- gather data on residential and agricultural land sales (see Appendix 1 Map of Study Areas).

A unique approach to collecting the micro data was developed. This was to ensure it is consistent with requirements under Irish data protection legislation and at the same time gather the necessary property information. This information related to property sales values, characteristics and distances to/from HVOTLs.

Micro data was collected from the four study areas which are shown in Appendix 1. In addition, micro data was collected along the 400 kV lines, Moneypoint to Dunstown and Moneypoint to the River Shannon on the northern 400 kV line.

2 Overview of Ireland's electricity transmission system

2.1 Introduction

This section provides the context in which the research project takes place. Specifically it outlines:

- the different roles of EirGrid and ESB Networks in developing and maintaining the transmission system,
- the characteristics of the transmission system,
- the types of HVOTLs and support structures used in Ireland and,
- the operation of wayleaves and easements in the Irish context.

2.2 Ownership and operation of Ireland's electricity transmission system

EirGrid plc is a state-owned commercial company in Ireland registered under the Companies Acts.

From the 1st of July 2006 EirGrid became the legal entity with full responsibility for the Transmission System Operator (TSO) and Market Operator (MO) functions. In its role of TSO, EirGrid operates the transmission system, transporting power from the various electricity generators to locations where it is needed around the country. It also controls access to the transmission system.

The Electricity Supply Board is the licensed Transmission Asset Owner (TAO), with responsibility for the management of the transmission capital work programmes. This includes the construction of new high voltage substations and their associated overhead lines and underground cables. It also involves responding to network faults and carrying out planned maintenance and refurbishment works on these assets.

2.3 A Description of Ireland's Electricity Transmission System

The Transmission System, often referred to as "The National Grid", is a meshed network of high voltage transmission circuits. This comprises approximately 6,500km of 110,000 volts (110 kV), 220,000 volts (220 kV) and 400,000 volts (400 kV), overhead lines and underground cables and over 100 transmission stations.

The system can be compared to Ireland's motorway network – delivering power to over 100 bulk transfer points or "nodes" all over Ireland. At these nodes the power can be taken onwards on lower voltage, distribution system lines to individual customers' premises.

Power is generated by power plants and wind farms throughout the country, utilising a variety of fuel or energy sources – including gas, oil, coal, peat, hydro, wind and other sources such as biomass and landfill gas.

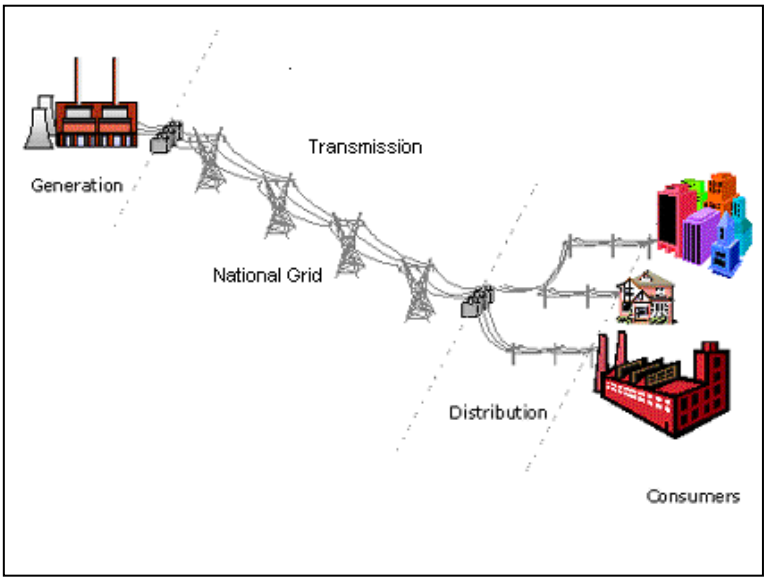
All of the major generating plant feed into the national grid and power is transmitted nationwide. This design of the grid is such that it ensures that power can flow freely to where it is needed. If one power station, power line or transmission station is non-operational, whether due to a fault, for maintenance or for any other reason, there are other options or routes available. High voltages are used to reduce or minimise energy losses which would otherwise occur when transferring power over long

distances in a lower voltage system. For every doubling of the transmission voltage, the amount of power wasted in the form of heat is reduced by 75%.

At the transmission stations power is transmitted from the grid and transformed into medium and low voltages. These are 38,000volts (38 kV), 20,000volts (20 kV) and 10,000volts (10 kV) respectively. The power is diverted into the lower voltage distribution system or directly to large industrial operations.

The distribution system is separately managed by the Distribution System Operator (DSO), ESB Networks and brings power directly to Ireland's domestic, commercial and industrial customers.

Fig.2.3: Transmission System



2.4 Structures used on the transmission system

Ireland's transmission system is predominantly based on overhead lines, except in limited circumstances. For example, such as in the city centres of Dublin and Cork, where underground cables are used or in the case of the East West Interconnector which runs between Wales and Ireland. Some photographic examples of the various structures currently in use can be seen in Appendix 5 which was used as part of the agent survey.

Prior to the 1960s, the transmission system comprised entirely of 110 kV lines. As a result, the 110 kV network is the most extensive element of the grid. There are over 4000 km of 110 kV line reaching into every county across the country. The support structures generally consist of double wooden poles. Angle masts, i.e. steel pylons, are used where the lines change direction. In the case of double circuit 110 kV lines, steel pylons are used rather than double poles.

The 220 kV network comprises of over 1830 km of overhead line network around the country, all of which is carried exclusively on steel pylons.

The 400 kV network provides two high capacity links between Moneypoint generation station and 400 kV stations located at Woodland in Co. Meath and

Dunstown in Co. Kildare. The 400 kV network is currently 440 km in length and is carried on steel pylons. These typically range in height from 26m to 54m and typically have a foot print from10m x 10m up to 16m x 16m.

The maximum distance or span between 400 kV pylons is 500m, however this is dependent on a number of factors. These include the type of terrain over which the line crosses and meeting with specific design criteria. In general, the average span between 400 kV pylons is approximately 350m.

2.5 Electricity wayleaves and easements in Ireland

The Statutory Right to place electric lines across land is by virtue of Section 53 of the Electricity Supply Act 1927, as amended. The right of ESB or any authorised undertaker to place an electric line above or below ground across land is subject to the provisions of this section of the Act.

After planning permission is granted for a new transmission line and prior to construction, wayleave notices are served to all landowners. New transmission lines are constructed subject to the landowner's entitlement to be paid compensation. A wayleave also provides ESB with the right to lop or remove trees that may interfere with the lines. A wayleave is not registered on the landowners land registry folio.

From a practical farming perspective, the land under the lines can be farmed in the same manner as the rest of the farm, obviously with health and safety precautions being taken where relevant with high machines or loads. This is in contrast to easements in the U.S. and Canada, where restrictions on irrigation can mean a significant loss of productivity in the easement corridor.

In Ireland, there is a policy which deals with loss of development. If the line interferes with any viable development of land other than cultivation of the soil the ESB will either move the line to allow full or partial development or compensate the landowner for the loss.

To ensure that there is no risk of injury to anyone from a proposed development because of its proximity to the wires or by weakening the line, the ESB must be notified of development plans in advance. Anyone who intends to erect a building or structure within 25 yards on either side of any transmission wire is statutorily bound to give at least two months' notice in writing to ESB. All relevant particulars of such building/structure should be stated. . If there is no conflict with health and safety or the ESB's requirement to maintain the lines, then approval for the proposed development or use of the land is generally forthcoming.

It is the research teams understanding to date that the primary driver behind any restriction on the use of the land in relation to an ESB wayleave is health and safety considerations.

In Ireland, easements are only purchased by the ESB in certain circumstances. An easement is a legal agreement with the landowner, which precludes the use of the land in a specified corridor for a specific purpose other than agricultural use. There are three main types of easements that are usually brokered, these include; Building, Forestry and Quarry. These types of easement have different criteria which need to be met in order for the easement to be approved. Easements, unlike wayleaves, are registered on the title documents. Compensation is payable in respect of the acquisition of such easements by the ESB, with the amount of the compensation

varying depending on the circumstances of the case. Where agreement cannot be reached, the matter can be referred to statutory arbitration.

3 Literature Review

3.1 General

The purpose of this literature review is to summarise the findings of some of the main surveys and studies, particularly in more recent times. A model to outline the main factors influencing the selling price of any property will be shown diagrammatically. The methodologies and statistical analysis of some of the main studies will be analysed. The relevance of the geographical source of the work will be explained and some of the differences between various jurisdictions will be outlined. Research in relation to agricultural and rural properties will be reviewed separately to the research work in the area of residential property. Some of the main variables in relation to how HVOTLs could affect properties will be examined.

Finally, at the end of this section, all of the above will be summarised and conclusions drawn, in as far as this is possible, with regard to the research work reviewed.

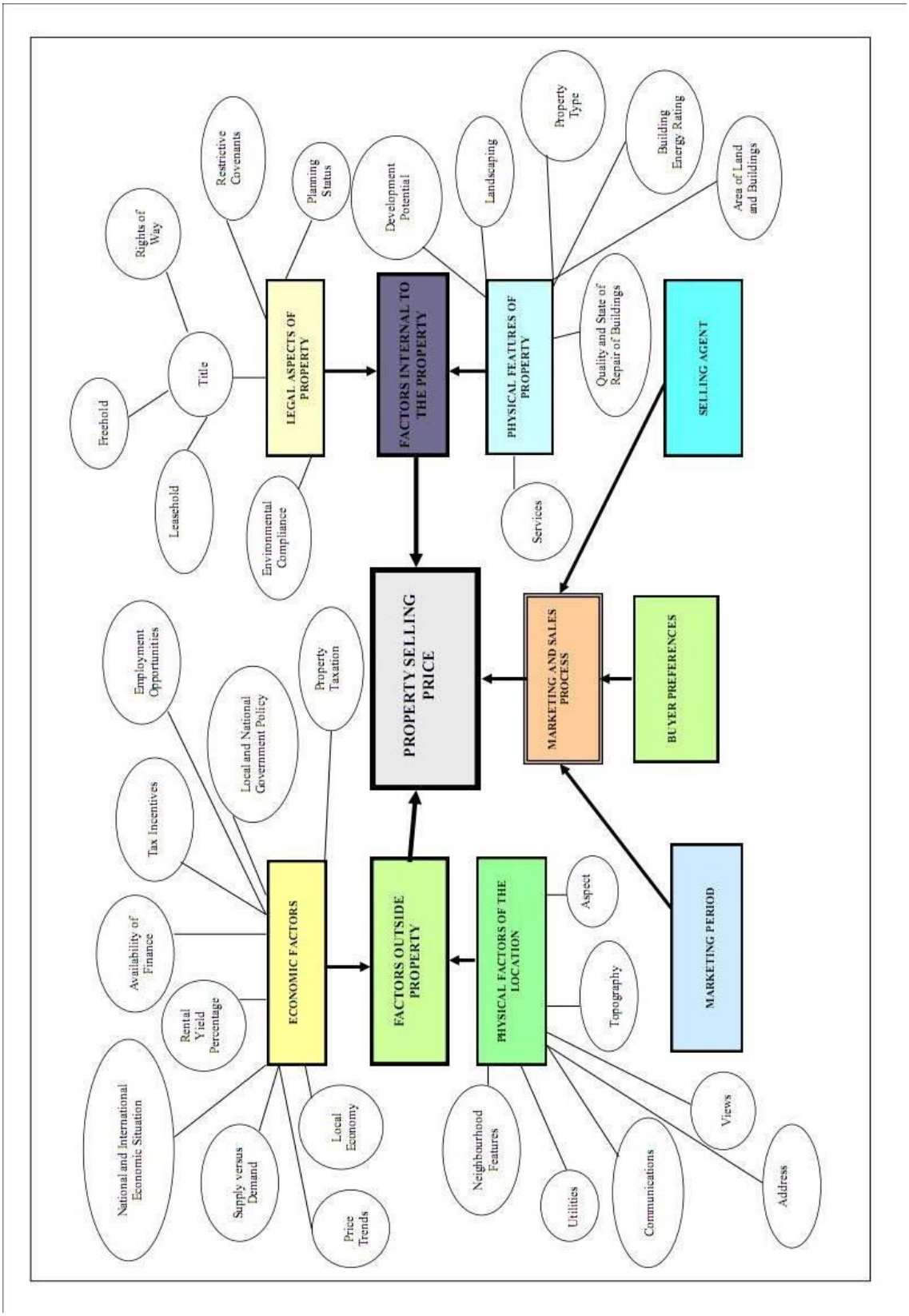
Research in relation to the impact of High Voltage Overhead Transmission Lines (HVOTLs) on property values has been conducted since the 1950's. Most of the work emanates from the U.S. and Canada (Crawford 1955 and Carroll 1956 referred to by Kroll and Priestly 1992). Most of the work prior to 1975 was based on case studies as opposed to more detailed studies and in depth statistical analysis.

3.2 Factors Influencing Selling Price

The complexity of the property purchasing decision is important. The multiplicity of other factors affecting buyer decisions can often outweigh any negative perceptions associated with HVOTLs. Des Rosiers (2002) stated "*In short, most studies conclude that proximity to a HVOTL per se does not necessarily lead to a drop in the value of surrounding properties and that other physical as well as neighbourhood variables prevail in the price determination process.*"

Figure 3.2 overleaf is a diagrammatic summary of some of the multitude of factors that can come into play in the selling of property. This diagram can also be seen in Appendix 15.

Figure 3.2: Factors influencing selling price



From Figure 3.2, it is clear that the selling price of any particular property can be influenced by a multiplicity of factors. The main factors in relation to the property itself have been divided into internal and external factors. In relation to the internal factors these can be further subdivided into legal and physical matters. An outline of some of the headings that would be relevant to legal matters and physical matters is given in the model.

Similarly, external factors have also been subdivided again into two headings i.e. economic factors and external physical factors. Some external physical factors are outlined in the model. In relation to economic factors there are multiplicities of components at play and again some of these are outlined in the model.

Depending on their location, HVOTLs could be an internal or an external factor or possibly a combination of both. If HVOTLs crossed the actual property and there was a legal easement on the property then there would be a legal component as well as a physical component to the HVOTLs. Both of these would be an internal factor in relation to the property. In relation to HVOTLs outside of the boundary, the HVOTL would form a physical external factor; for example a HVOTL tower in the adjoining property. It is important to note that under Irish Law, compensation is only payable in respect of HVOTLs or their associated structures where these are located within the boundary of the relevant property.

The factors depicted in this model are not exhaustive. The purpose of the model is to demonstrate the multiplicity of factors that can come into play in the selling process. Some of these variables will be more important than others. Key variables that are expected to influence selling prices need to be accounted for. (Fridriksson et al (1982).

Fridriksson et al (1982) reviewed studies up to 1982 which they believed failed to control for the effects of multiple variables (see 3.6.1 of this report).

3.3 Geographic Location of Research

Most of the research work in relation to the impact of transmission lines on property has been undertaken in the United States and Canada. It is also the case that the great majority of the research work relates to urban or suburban dwelling houses. It is important to bear in mind that, in general, in the United States and Canada, HVOTLs have certain restrictions on user associated with a legal easement. These restrictions prohibit construction of buildings and planting of large trees etc. in the area comprised in the easement.

In relation to residential units there are many examples in the literature where properties adjacent to these types of easements have in fact experienced a positive price impact from the easement. Positive impacts from the easement can arise under a number of headings. These include:

- larger site areas at the easement,
- improved views in the un-built corridors,
- proximity of a landscaped area,

— increased privacy and,
— in some cases developed amenities within the easement corridor.

Des Rosiers (2002) found that being adjacent to the easement did not necessarily cause a house to depreciate. Where proximity advantages (enlarged visual field and increased intimacy) exceeded the drawbacks then there could be a net increase in value of houses in excess of 7%. In this Des Rosiers study there were negative and positive impacts at play at the easement unbuilt corridors. However the net combined effect was positive on certain properties due to the improved visual clearance and privacy arising from the unbuilt easement corridor.

However the position in New Zealand, the U.K. and Ireland is different in that easements of the type found in North America are not generally acquired. Therefore the above positive impacts from unbuilt corridors found in North America, would not be relevant in Ireland.

There has been some research work in New Zealand and a small amount of work in the U.K. There has been no prior published research work in Ireland in relation to the property impacts of HVOTLs.

3.4 Property Types and Research

The vast majority of research work in relation to the impact of power lines on property values has focused on urban or suburban, single family residential properties i.e. houses. There has been very little research in relation to commercial property of any sort. Some work has been done in relation to rural property, particularly agricultural land. However this has been quite limited compared to the volume of work in the area of urban or suburban residential property.

3.5 Research Methodologies

Research in relation to the impact of power lines on property can be broken down into three broad categories [Kroll & Priestley, (1992) and Jackson & Pitts (2010)].

(a) Attitudinal Surveys

Attitudinal surveys are, effectively, survey-based studies of opinions and perceptions concerning the impacts of power lines. Many of these survey-based studies also include a further component of sales price analysis. Attitudinal surveys have been mainly conducted with homeowners but also with other property-owners, including farmers and landowners. Surveys have also been conducted in relation to the opinions of valuers and estate agents and also mortgage providers. These types of surveys are useful as they provide information in relation to the perceptions of purchasers and others. These "stated preferences" however, are often not translated into price effects i.e. "revealed preferences". (Kinnard & Dickey, 1995)

Another issue with attitudinal surveys and house selling prices is that they do not take into account market demand. For example, some potential buyers may be put off purchasing properties near a HVOTL; however the full market price may still be attained if there is sufficient demand. No

allowance is made for this effect within attitudinal surveys. Kinnard & Dickey (1995) state "*it is not necessary to attract the entire potential market in order to sell a property at a competitive market price: 10% - 15% of the market is more than sufficient.*"

In surveys, fear is often raised as one reason for negative property price impacts from HVOTLs. However fear in itself is not a measure of diminution in market value (Kinnard & Dickey, 1995),

(b) Appraiser Studies

Appraisal techniques include a mix of study types including case studies, paired sales analysis and sales/re-sale analysis. They have been designated as appraiser studies as many of these types of studies have been conducted by appraisers. It should be noted that appraiser is a term used in the U.S. and Canada and is practically equivalent to the term valuer in the U.K. This type of appraiser study research was very prevalent prior to 1975.

The element of subjective judgment which is inherent in appraiser studies is highlighted in Kinnard & Dickey (1995). They indicated two potential shortcomings of paired sales analysis. Firstly, there is an element of subjective judgment on the part of the analyst/appraiser in identifying what constitutes a pair of "virtually identical properties". Different analysts frequently produce different pairs in the same market. Secondly the scarcity of appropriate matching pairs can render the entire procedure and results questionable.

(c) Empirical Studies – Statistical Analysis – Regression Analysis

The third type of research is empirical studies of sales data using sophisticated statistical analysis. Where sufficient sales data can be gathered it is preferable to the appraiser techniques outlined above. Regression analysis is the main statistical technique used in these studies. Regression analysis is preferable over appraiser studies as it is the least subjective approach. Regression analysis is the only approach to give explicit measures of reliability which helps the user determine what weight to give the results (Chalmers & Voorvaart, 2009).

Kinnard & Dickey (1995) note that regression – based sales price analysis "*reflect what buyers and sellers actually do, opposed to what potential buyers say they might do, under specified hypothetical circumstances*". The same authors go on to indicate that regression analysis based on large sets of sales data "*are more nearly representative of the market than those of paired sales studies*".

In a similar vein Bottemiller & Wolverton (2013) state "*Credible and reliable results are much more difficult to obtain using survey and case study methods*".

3.6 Research in Relation to Residential Property

3.6.1 Empirical Studies

Mountain West Research (Fridriksson et al, 1982) identified a group of key studies up to 1982 in the literature. They were critical of much of this earlier work stating that research approaches varied widely. Research was mainly based on case studies and the findings were ambiguous and sometimes contradictory. Fridriksson et al, (1982) noted that the researchers in these studies had an intuitive belief that the property effects would be obvious. As a result the methodologies adopted were not tightly controlled. These studies nearly all ignored other potentially important aspects of market value such as date of sale, proximity to town or village, quality and size of improvements and proximity to highways. (See Section 3.2 of this report).

In this earlier group of key studies up to 198210 indicated no statistically significant effect, 10 were inconclusive and five concluded that the overall effect was negative. (Source: Furby, Gregory et al 1988 literature review of Fridriksson et al, (1982). Some of the main empirical studies in relation to urban residential properties can be briefly summarised as follows:

Table 3.6: Summary of Some of the Most Widely Cited Empirical Studies on Urban Residential Properties

Author & Country of Study	Finding
Colwell & Foley, 1979 (U.S.)	Minus 6% approx. at between 15m and 61m.
Colwell, 1990 (U.S.)	As above – largest negative impacts 6.6%. Same data as Colwell & Foley.
Hamilton & Schwann, 1995 (Vancouver)	Minus 6.3% for properties adjacent to the easement corridor of 140 metres wide.
Bond & Hopkins, 2002 (Wellington, N.Z.)	No easement. Minus 20% at 10 to 15 metres. Minus 5% at 50 metres. Negligible reduction at 100 metres.
Des Rosiers, 2002 (Montreal)	Reductions of 5% to 12%. Some properties increased in value due to the easement corridor benefits.
Wolverton & Bottlemiller, 2003 (U.S.)	A statistically significant effect was not found.
Sims & Dent, 2005 (U.K.)	Within 100 metres reduction was between 6% and 17%.
Chalmers & Voorvaart, 2009 (U.S.)	No effect found from the lines.

Note: All of these empirical studies are also included in more detail in Appendix 16.

Chalmers & Voornaard (2009) state: "*half of the studies finding negative property value effects and half finding none*." Jackson & Pitts (2010) state "*most studies found no effect…*"

It is clear from the above that there is a lot of variation in any possible impact from HVOTLs on urban and suburban, (Chalmers & Voorvart (2009) residential property prices.

In the Canadian and U.S. studies, where there have been negative impacts identified. These were almost always below 10% and generally in the order of a 3% to 6% reduction in value (Chalmers & Voorvaart, 2009).

The highest impacts in Table 3.6 above were in the New Zealand study (Bond & Hopkins, 2002) and Scotland (Sims & Dent, 2005). This may be due in part to the different legal basis for HVOTLs in these two jurisdictions. The situation in New Zealand and the U.K., as stated, is different. This is because an easement sterilising a defined corridor is generally not obtained or required. This means that there will be no positive "corridor effect". Houses could be located much closer to HVOTLs than in the U.S. or in Canada. As an example of the easement or "right of way" corridor width Hamilton & Schwann (1995) indicate a corridor of 140 metres wide. One of these corridors having two 500 kV lines and one 230 kV line. All lines were supported on steel pylons and this was the subject part of their research in Vancouver, Canada.

There are conflicting findings with regard to whether urban or suburban higher priced homes are more sensitive to possible negative impacts from HVOTLs than lower priced homes. Bottemiller & Wolverton (2013) did find a larger impact on prices for higher value houses from being in close proximity to HVOTLs than was the case for lower priced houses. On the other hand Chalmers & Voorvaart (2009), failed to find any greater sensitivity to HVOTLs for higher valued residential properties when compared to lower value properties.

3.6.2 Survey Based Research

A summary of the survey based research is included in Appendix 16.

Jackson & Pitts (2010) state that Kinnard (1967) found most homeowners did not mind living near power lines.85% indicating that they would purchase again in the same location. Realtors tended to have a more negative view than homeowners in relation to this. Realtors would be equivalent to estate agents in an Irish context. In the U.S., a Realtor is a member of the National Association of Realtors.

Delaney & Timmons (1992), in their survey of appraisers, did find the majority (84%) indicated a negative impact on price. 10% indicated no impact and a small number (6%) said that prices would increase due to the corridor effect. Delaney & Timmons also found that appraisers with no previous experience of valuing properties close to HVOTLs were of the opinion that the effect was greater (11.94%) than those who had such experience (10.0%).

Bond & Hopkins (2002) indicated that the negative feelings indicated in surveys with regard to HVOTLs are often not reflected in the actual prices paid.

Gallimore & Jayne (1999) carried out a survey of valuers and homeowners opinions in the West Midlands, U.K. The background to this survey was a specific professional guideline from the Royal Institution of Chartered Surveyors, GNI.13(e), to take into account the *"public perception that higher than normal electromagnetic fields caused by the presence of high voltage cables...may affect marketability and future value"*.

Gallimore & Jayne (1999) in their literature review of HVOTL studies focused on Kinnard et al (1997) where *"a comprehensive review of the more prominent studies"* indicated that in the pre-1993 studies *"negative impacts from transmission lines (as*

opposed to tower/pole/pylon) proximity ranged between 1% or less, to 6% at 200 feet (61 metres)". Kinnard et al (1997) also noted that only half of these findings were statistically significant.

Gallimore & Jayne (1999) state, in their review of opinion surveys, that Kinnard *et al* (1997) found that property "professionals" are more negative in their opinion of the price impact of HVOTLs than the general public. The professionals' opinion of the magnitude of the effect, at 8 – 10%, is generally higher than what was found in studies based on market data - (Kinnard et al 1997).

In their own study, Gallimore & Jayne (1999) also found valuers' perceived HVOTL risk to be greater than the public's risk perception and this difference was statistically significant. They postulated this higher risk perception among valuers could lead valuers to amplify their client's fears in their advice thus leading to circularity. Gallimore & Jayne (1999) described circularity as follows: *"Circularity here describes the situation where expert's misjudgements about market participants observed behaviour impact upon subsequent participant behaviour, making such misjudgements self-fulfilling."*

Gallimore & Jayne (1999) also found in their survey that people living near power lines placed HVOTL risk lower than those living remote from power lines.

Sims & Dent (2005) compare the results of an attitudinal survey of chartered valuation surveyors and estate agents against the results of a case study in Scotland. In their literature review on the subject they indicated that residential perceptual studies were *"generally considered to be unreliable"* in that *"they had the potential to increase negative attitudes towards HVOTLs and, in turn, reduce both the number of willing buyers and the value of proximate property"*. Sims & Dent (2005) further indicated that the opinions of valuers and agents *"appeared to produce a fairly reliable and accurate assessment of market value"*.

In their actual study of market data, Sims & Dent (2005) concluded that the value of property within 100 metres of HVOTLs was found to be reduced by 6 – 17%. Their perceptual study indicated that valuers and agents perceive an average value reduction of 5 – 10%. They postulate that either the impact in the case study area is unique or that valuers in the U.K. tend to underestimate the impacts from HVOTLs.

Kinnard *et al* (1997) came to the same finding as Gallimore & Jayne (1999) i.e. that property "professionals" are more negative in their general opinion of the price impact of HVOTLs than the general public.

3.6.3 Distance Impacts from HVOTLs

Colwell, (1990), found that selling price of residential property increases with increasing distance from the HVOTLs. He also found that the selling price increases more quickly at the closer distances and less quickly with greater distance i.e. the rate of price increase is not linear as distances from the HVOTLs increase.

Hamilton & Schwann (1995) found that the effects on property values *"are restricted to a narrow band and are primarily due to the visual externalities of the transmission*

pylons". Their work indicated that any negative impacts on property values usually disappear at 200 metres.

Des Rosiers (1998) adopts a micro-spatial approach to examine the impact of high voltage transmission lines on surrounding property values. Their research indicates that a severe visual encumbrance due to a direct view on a pylon causes a drop in value and, on average, the decrease was 9.6% of the mean house price. They found the impact to be approximately 5% higher for luxury higher price properties compared with the lower end of the market. However they found that properties adjacent to the easements usually experienced a positive price impact, due to an increased visual field and increased privacy. This positive price impact was, on average, between 7.4% and 9.2% of the mean house price. The net visual negativity (i.e. the difference between the proximity disadvantages and advantages) reached a maximum between 50 and 100 metres from the easement boundary and it diminished quickly outside of that range. The impact from HVOTLs had disappeared at 150 metres.

In contrast to the above, Chalmers & Voorvaart (2009) found that visibility of a transmission tower did not indicate any systematic price impact with respect to sign or magnitude. Proximity to the lines had no significant effect on sales price.

Chalmers & Voorvaart (2009) came to the conclusion that *"the only variable that appears to have any kind of systematic effect is the encumbrance variable"*, but its statistical significance was variable and the impact was generally low. Encumbrance is the presence of an easement or wayleave.

3.6.4 Visual Impacts from HVOTLs

Bond and Hopkins (2002), in their New Zealand study, found that having a "pylon" close to a particular property did cause a statistically significant negative impact. However the proximity of a "transmission line" in the case study area had a minimal effect but this was not a statistically significant factor in the sales price. The authors indicated that the local hilly terrain in the case study area rendered the results inconclusive due to the total or partial blockage of the line of sight to HVOTLs.

In Ireland 110 kV lines are generally carried on twin timber pole-sets and the 220 kV and 400 kV lines are always on steel pylons.

3.6.5 Health Concerns

Des Rosiers (1998) analysed their data to establish whether there was an impact on house prices from the media coverage of the 1992 Floderus and Ahlborn and Feychting Reports. Although health concerns are outside the scope of this report, these were two Swedish epidemiological studies on electromagnetic fields (EMF) and induced health hazards. Des Rosiers (1998) concluded as follows: *"since none of the resulting parameter estimates emerge as being statistically significant at the 0.05 level, it can be concluded that the Swedish studies had virtually no measurable impact on house prices, which corroborates previous findings"*.

3.6.6 Effect of Time

Colwell (1990) concluded that the impact of the lines diminishes with the passing of time. However in relation to pylons he indicated: *"...there may be a negative value impact of proximity to pylons, but this impact showed no significant signs of diminishing through time"*. Kroll and Priestly (1991) came to the same conclusion.

Where new lines are constructed or existing lines modified, drops in value lessen over time and tend to fade away after four to ten years (Kinnard & Dickey, 1995).

This reduction in impacts over time is partly as a result of the growth of trees and shrubs as well as diminished sensitivity to HVOTLs proximity in the absence of adverse media coverage and publicity (Kinnard & Dickey, 1995).

3.6.7 Appreciation Rates over Time

Wolverton & Bottemiller (2003) did not find any difference in property appreciation over time for properties abutting a HVOTL Right of Way when compared with properties not abutting a HVOTL Right of Way. Ten years later the same authors Wolverton & Bottemiller (2013) found no appreciable difference in price response to changing market conditions for HVOTL abutting and non-abutting homes.

3.7 HVOTLs and Rural Property

3.7.1 General

The volume of research in relation to HVOTLs and rural properties is relatively small compared to the large volume of work investigating the possible impacts of HVOTLs on urban residential property. It is practically all Canadian and U.S. research. Appendix 17 summarises the main rural property research work in this area.

3.7.2 Canadian and U.S. Studies

It is important to be aware that, generally speaking, easements over land are purchased in the U.S. and Canada. The use that the land can be put to in these easements is restricted in particular in relation to irrigation. The restriction on irrigation within the easement corridors could possibly lead to a very substantial reduction in crop yields in the corridor.

This contrasts with the Irish situation where it is normally wayleaves only which are appropriated. Other than being careful in relation to overhead lines and avoiding the structures, farming practice in Ireland is not interfered with in any significant way by the existence of such wayleaves in the vast majority of cases.

3.7.3 Summary of Findings in Relation to Rural Properties

Appendix 17 contains a summary of papers in relation to HVOTLs and rural property values.

Neither Brown (1976) nor Mitchel *et al* (1976) found any statistically significant impact on sales prices of rural properties. Both of these studies were conducted in Canada.

Mitchel *et al* (1976) was conducted by a geography professor with a group of students. Boyer et al (1978) was an extension, using a larger sample, of the first study conducted as a Master of Arts project by one of the students.

The impacts found in the Boyer *et al* (1978) study are summarised in Appendix 17.

The approach and work of both Mitchel *et al* (1976) and Boyer *et al* (1978) are criticised in Kroll & Priestley's literature review (1992). Rudimentary statistics, i.e. difference of means, were used in both studies of these studies.

Many significant property variables were not taken into account by Boyer including year of sale (a ten-year period was being used) and improvements on the property. Access to transportation was a third factor not accounted for.

Both the Mitchel and Boyer studies are therefore of limited value (Kroll & Priestley 1992).

The Woods Gordon (1981) study examined 6 different locations with a wide variation in land use from purely agricultural to land with residential development potential. The results varied hugely from one study area to another. Areas with the greatest level of residential development showed the highest negative impacts. However the mainly agricultural areas showed inconclusive findings ranging from small positive impacts from the lines to negative impacts that were not statistically significant.

Rigdon (1991) found no evidence of a relationship between HVOTLs and sales prices of recreational land.

Jackson (2010) found small reductions (1.11% to 2.44%) in rural land sales prices due to the presence of an actual transmission line easement over the land. These differences were clearly very small and were found not to be statistically significant.

Chalmers (2012) reports on a case study of rural property sales located along 500 kV HVOTLs that stretch across most of Montana. A combination of appraisal techniques including paired sales and sales comparison analysis were used. The case study findings were briefly as follows:

"Production Agricultural Lands" – these showed no price impacts from HVOTLs. Interestingly, the extent of the encumbrance easement, for which the landowners is compensated, showed no impact on the sale price.

"Agricultural Lands with Recreational Influence" – again these showed no influence on price from the 500 kV HVOTL. These were large tracts of land ranging in area from 3,000 acres to 7,943 acres with 76% to 99% of the land being open range.

"Agricultural Lands with High Amenity Recreation and Natural Features" – these were unique type properties and no effect was found on sales price from HVOTLs.

"Rural Residential Subdivisions – Lot Size Less than 5 acres" – Residential use dominated in these small plots where locating a house away from the 500 kV line would be difficult due to the small parcel size. These parcels were in effect house sites with either an easement on the parcel or they were located adjacent to the 500 kV line. In addition at the time of these sites being offered to the market significant numbers of relatively homogeneous sites were offered to the market at the same time. The results were mixed with 3 of the locations showing evidence of a negative price impact from the HVOTL. The impact appeared to average around a 15% reduction but with a large range. The results were extremely variable with half of the parcels showing no impact and some properties showing large impacts. In another case where a one acre parcel was offered to the market the implied listing price discount equated with the area of the site restricted by the easement for which compensation would have been payable.

"Rural Residential Subdivisions – Lot Size 5 acres or Greater" – There were six properties in this category ranging from 5 to 30 acres. Evidence suggested 3 suffered a negative impact and 3 did not. The discounts were up to 30%. Some of these parcels had easements traversing them. Again the results varied widely with half of the parcels showing no impact.

"Large Acrage Rural Residential Tracts" – These properties ranged from 60 to 591 acres and negative price impacts were not found in any of the cases.

"Rural Recreational Tracts/Cabin Sites" – In two of the fourteen cases there was a possible adverse sale price effect but the evidence for this was far from conclusive.

3.8 HVOTLs and Commercial Property

The volume of research in the area of HVOTLs and commercial property is very small. Dean Chapman (2005) conducted several surveys between 2000 and 2005 to determine if HVOTLs have an effect on "industrial property" value. The surveys included over 100 interviews with buyers, sellers, tenants, property managers and brokers in Northern California, Salt Lake City and Las Vegas.

The following is a summary of the Dean Chapman (2005) papers:

"Industrial property" in this study included business parks, offices and even service – orientated retail uses. The HVOTLs in the study area were carried on pylons and had associated easements.

The importance of the easement restrictions on building construction or planting of trees is highlighted in this research. The impact of an easement on the value of a parcel of commercial land is not always negative. In many cases a site can be developed out to its full potential by incorporating the easement into the site layout.

Dean Chapman was surprised to find "absolutely no impact on value for typically shaped, level parcels encumbered with transmission line easements up to about 30% of the parcel's size". These properties had site coverage ratios of up to 50%. The remainder of the site was typically used for parking, roads, outdoor storage and landscaping which are all uses allowed for in the HVOTL easements.

Dean Chapman found several sales of parcels that had a 50% encumbrance from transmission lines with only a 10% - 20% drop in value. The most important consideration for the buyers in those cases was the achievement of the full building size that would have been possible on a unencumbered parcel. The visual aspect of the transmission lines was inconsequential to buyers from this research.

It was also found that having to construct two buildings instead of one or changing the building dimensions due to an easement could potentially decrease a parcel price. The location of pylons and associated buffers are important in analysing the overall impact according to this research.

Visual Impact – Commercial Property

Dean Chapman was surprised to find in this survey that large transmission lines went virtually unnoticed in a business park setting. Dean commented that "*simply because 10% of the market would never locate next to a transmission line, that doesn't mean value has been damaged*".

Leaving aside the impact of an easement on the building potential of a parcel there appeared to be little or no evidence to suggest that commercial property values are negatively impacted by HVOTLs.

Dean Chapman's conclusion was as follows: "*For the most part, the attitude from participants in my survey is basically summed up by a broker in Roseville who sold a medical office building within 20 feet of a large lattice tower for 230 kV lines. He said I wish they weren't there, but the property would have sold for the same price with or without them.*".

3.9 Summary of Literature Review

3.9.1 Potential Impact of HVOTLs on Property Prices – Urban Residential

- Most of the research is from the U.S. and Canada and it relates to urban and suburban family homes.
- About half of the studies did not find a negative property value effect.
- Where negative impacts were picked up they were in many cases not statistically significant.
- Where negative impacts were found they were generally low – in the region of 5 to 6% or less.
- A study in Scotland where there was no easement corridor and a negative impact of 11.5% on average was found but there was considerable variation around this average at 6% -17%.
- Positive impacts were discerned in some North American studies due to the increased visual clearance, privacy and amenity value of the un-built easement corridor.
- This finding would not be relevant in Ireland where easements are generally not acquired.

3.9.2 Potential Impact of HVOTLs on Property Prices – Rural Properties

- The bulk of the research is from US and Canada. No studies in UK or Ireland.
- Low number of agricultural land studies in North America relative to the number of studies in relation to residential property, urban or suburban property.
- The presence of restrictive easement corridors on farms, particularly in relation to irrigation restrictions, makes the results less relevant to the Irish situation.
- Leaving aside studies where reliability has been questioned (Kroll & Priestly, 1992), the other studies showed generally little or no effect on sales prices from HVOTLs. One study showed reductions of the order of 1.11% to 2.44% but these small differences were not statistically significant (Jackson 2010).
- A recent study (Chalmers 2013) using appraisal techniques found no impact on agricultural production land or larger parcel size high amenity/recreational type rural properties in rural Montana.
- Very variable results were obtained by Chalmers (2013) in relation to small parcels suitable for single house development which were adjacent to a 500 kV line easement. The average impact appears to be in the region of 15%. Half of the properties were unaffected. There was a large range found in impacts. This was an appraiser type study.

3.9.3 Visual

Where negative impacts were found, the impact of pylons was larger than the impact from the transmission lines, thus emphasising the visual component.

3.9.4 Distance Effect

Where an impact was found the effect diminished rapidly with distance from the HVOTLs. The impact from HVTOLs disappears in the region of 150-200 metres with the maximum impact at even closer distances.

3.9.5 Health Concerns

Greatly increased media coverage of health issues from 1992 onwards does not appear to have had any major impact on study findings.

3.9.6 Effect of Time

Where negative impacts were found there is evidence to suggest that the impacts generally decrease with the passage of time and in some cases had faded away after ten years. Growth of trees and shrubs would be a factor in this.

3.9.7 Appreciation Rates over Time

There is evidence that properties close to HVOTL Rights of Way appreciate at the same rate as properties located away from HVOTLs.

4 Design of the research methodology

4.1 Outline of Study Methodology

The study involved three components as follows:

a) Literature review
b) Survey of agent's opinions
c) Collection and analysis of sales data

The literature review has already been dealt with in section 3 above. This section will outline the approach to the agent survey and the collection and preparation of sales data for statistical analysis.

4.2 Development of the survey questionnaire and data collection spreadsheets

The questionnaire was designed jointly by Tom Corr, Kevin Miller and Insight Statistical Consulting and draws on previous research highlighted within the literature review, most notably Delaney and Timmons (1992) and Sims and Dent (2005).

It was designed so that each respondent was asked the same set of questions using identical wording, with the responses recorded by the interviewer. There was a mix of closed and open-ended questions collecting quantitative and qualitative responses across nine different sections, which were as follows:

1. Details about the interviewee, including qualifications, position in firm and area of expertise.
2. Initial valuations of sample residential and agricultural land.
3. Quantify the effect, if any, of different types of infrastructure on residential and agricultural land values:
    a. motorway;
    b. rail line;
    c. air field;
    d. HVOTL;
    e. wind farm;
    f. telecommunications antennae;
    g. waste water treatment plant;
    h. high pressure mains natural gas transmission pipeline; and
    i. major landfill (non-hazardous waste).
4. The effect, if any, on residential and agricultural land values at different stages of HVOTL construction and reasons for the effect.
5. Experience of interviewees valuing properties in close proximity to HVOTLs.
6. Quantify the effect, if any, of HVOTLs on commercial property (retail, offices and industrial).
7. Valuations of sample residential and agricultural land used in Section 2, but now with presence of HVOTL – (see 2 above).
8. Details about the interviewee's firm.
9. Any additional information or comments from the interviewee in relation to HVOTLs and property values.

Please see Appendix 3 for full copy of the questionnaire.

4.3 Spreadsheet Templates for Property Sales Data Collection

Spreadsheet templates were created for the estate agents to enter data on property transactions, with each agent assigned a unique identification number on each relevant spreadsheet. The variables requested for completion of the spreadsheets is outlined in Table 4.3 below (see Appendices 7 & 8).

Table 4.3: Variables requested for property transactions

Residential	**Agricultural land**
	Price (separate file to other variables)
Price (separate file to other variables)	Farm area (hectares) House area sq. m Road frontage suitable for sites Area of farm buildings sq. m.
Full property address Property type (detached/semi-d/terraced) Plot area (hectares) Dwelling floor area (square metres) Number of bedrooms in dwelling Year property built Month/year property was "sale agreed"	Forestry% Rating of sales location (poor, medium, strong) Access Method of sale Date "sale agreed" Percentage of total land area described as: a) Non productive b) Suitable for forestry c) Poor quality grassland d) Medium quality grassland e) Good quality grassland f) Suitable for any use

The variables used in the case of residential sales and agricultural land sales were the ones that the research team felt was most important in relation to the determination of the selling price.

In addition, for rural residential and agricultural land, vendor/purchaser details were gathered to pinpoint the location of properties and their folios (see Appendices 7 & 8).

4.4 Deciding on the Approach to Data Collection

The main objective of the study was to evaluate the residual impact, if any, of 400 kV, 220 kV and 110 kV lines on property values in urban, suburban and rural locations. A review of the existing literature on this topic reveals that the preferred methodology for quantifying impacts on sales values is by using a hedonic price regression model.

This requires access to a dataset containing a significantly large number of property transactions with information on:

- sale prices,
- property characteristics (e.g. property type, size, number of bedrooms, year property built) and,
- the property address/location, which is used to determine the distance from the property to nearby lines and support structures.

A dataset of this sort was not publicly available in Ireland and, therefore, primary research was required.

Subsequently a new Residential Property Price Register was commenced 30th September 2012. This register is produced by the Property Services Regulatory Authority. It includes information on residential properties purchased since the 1st January 2010, as declared to the Revenue Commissioners for stamp duty purposes. It covers all residential sales and includes only Date of Sale, Price and Address. The information is the same as that which is filed for stamp duty purposes with the Revenue Commissioners by those doing the conveyancing of the property.

The approach followed in this study involved gathering transaction data directly from estate agents. However, this process was complicated by Irish data protection law. This prevents estate agents from providing achieved sale prices for identified properties to third parties without first obtaining permission from both the vendor and the purchaser.

In order to comply with data protection requirements, it was decided to separate the data collection process between the personnel undertaking the research:

- Tom Corr and Kevin Miller collected the data on property address and characteristics directly from estate agents, and,
- Insight Statistical Consulting collected the data on property sales values.

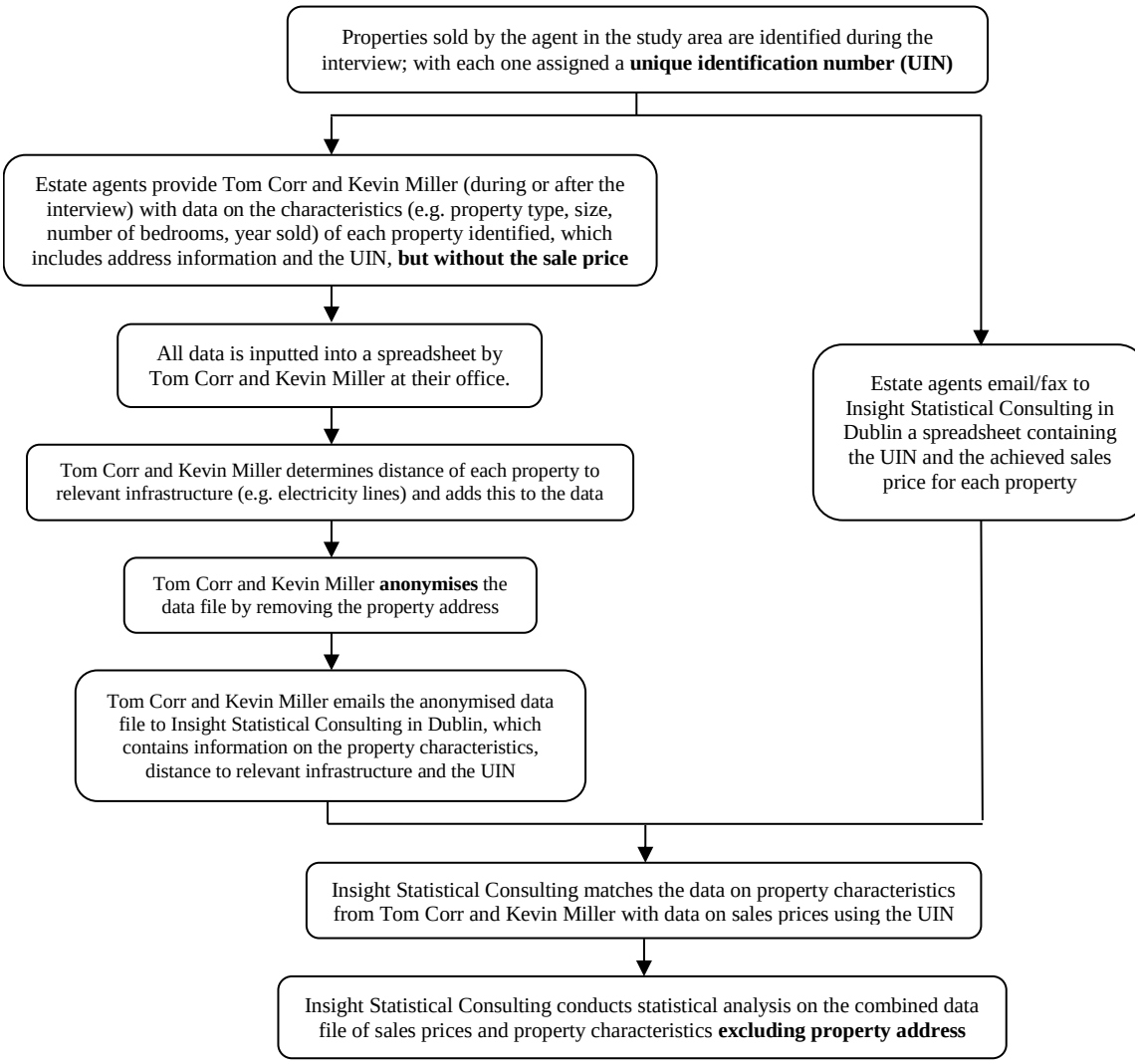
Tom Corr and Kevin Miller determined the relevant distances from each property to the HVOTLs. They removed the property address field from the dataset and then sent the anonymised dataset on property characteristics to Insight Statistical Consulting. This dataset was then matched with the data on sales values received by Insight Statistical Consulting using the unique identification number which was assigned to the sale. This anonymised dataset with sales values and distances from HVOTLS was then used to construct a hedonic price regression model.

An illustration of the data collection process is presented in Figure 4.4. In order to confirm that this approach satisfied data protection requirements, formal approval was sought from the Office of the Data Protection Commissioner (see Appendix 9) This approval letter was used during the fieldwork as an additional reassurance to respondents that the data collection process was acceptable (see Appendices 7 & 8 for data collection sheets).

The procedure for data collection in the four study areas consisted of providing agents with maps of the study area on which 2-kilometre corridors were highlighted (see Appendix 14). These shaded corridors were along 110 kV, 220 kV and 400 kV HVOTLs. This corresponds to the methodology recommended by Kinnard & Dickey, 1995. By this methodology the sales data was collected from the relevant area.

In the case of the 400 kV lines, the sales of farms from 1990 up to the end of March 2012 were obtained from the farming press. This information was sent by post to agents so that any missing information could be completed. The potentially affected farms were identified by matching townlands from the farming press to the townlands list for the 400 kV lines. The actual location and boundary of these farms was worked out from a combination of brochures, agent information and the gathering of vendor/purchaser names to identify folios. This work was carried out by Tom Corr, Kevin Miller and Paul Gaynor.

Figure 4.4: The data collection process for urban properties



The data collection and subsequent statistical regression analysis was limited to residential properties and agricultural land. However, the results from the regression analysis were supplemented by the findings of the survey of estate agents, designed to elicit their professional opinion on the impact of HVOTLs on property values, including different types of commercial property i.e. retail, offices and industrial. The survey of estate agents also facilitates an investigation into the following research questions:

- Relative to other types of major infrastructure (e.g. utilities and transport), to what extent do HVOTLs affect property values?

- Does the potential relationship between property values and HVOTLs vary over time, during different stages of construction of the line?
- In the event that an effect is perceived to exist, what are the main factors believed to be causing it?

Please see Appendix 2 for a full copy of the questionnaire.

4.5 Obtaining Vendor or Purchaser Details

The approach outlined above in Section 4.4 worked well in practice for all urban properties where the address was sufficient for Tom Corr and Kevin Miller to pinpoint the actual property location. However, an issue arose in relation to rural properties in that the address was insufficient of itself to identify the precise location of the property. After further discussions with participating agents, it was felt that the only practical way of addressing this matter was to obtain vendor or purchaser details so as to enable a folio search in a particular study area.

There is a lag time between "sale agreed" and the actual purchaser becoming the registered owner on the Land Registry website. Due to this it was decided to obtain purchaser details for sales up to and including 2009 and vendor details for sales after 1st January 2010.

After discussions with the Office of the Data Protection Commission, it was decided to request agents to send the vendor/purchaser details to Dr. Cathal Walsh at a postal address in Trinity College. Although Dr. Walsh was part of the research team the separate postal address at Trinity College provided a third location for receiving and processing data while preserving the integrity of the research methodology.

Dr. Walsh, through the Property Registration Authority, obtained a list of all the folios with that particular name in the study area where the particular agent was located. The list of folios was then sent by Dr. Walsh to Tom Corr and Kevin Miller and they matched particular folios to the particular addresses. This was not successful in all cases in identifying the location of rural properties. However it proved very useful in that most of the rural properties were identified by this means (see Appendices 7 & 8).

4.6 Sample Selection - Four Study Areas

Four study areas – East Galway, Limerick, Kildare and South Dublin – were selected as these were considered to provide sufficient variation in property types, locations (urban and rural) and HVOTL types (see Appendix 1). A list of agents in each area was drawn up based on the membership of the two representative bodies for estate agents in Ireland: the Society of Chartered Surveyors Ireland (SCSI) and the Institute of Professional Auctioneers and Valuers (IPAV).

Agents were initially contacted by a letter sent from Gaynor Corr. This invited them to participate in a study looking at the effect of various different types of infrastructure on property values. It was decided by the project team that estate

agents would not be told that the study was focusing specifically on HVOTLs and their effect on property values, so as not to engender bias in their responses.

The initial letter was followed up by phone calls so as to procure 10 to 12 agents willing to participate in the survey initially. The phone calls were made to agents across the study area, to obtain a reasonable spread of agents geographically within each study area. After the desired number of agents had been reached no more agents were contacted.

Estate agents were offered two types of incentive to participate in the study:

- points allocated towards continuous professional development programmes in both the SCSI and IPAV for taking part in the interview and,
- remuneration for providing data on residential and farm sales.

The remuneration consisted of €50 for completing the questionnaire interview and €10 for each sale detail. For rural properties an additional €10 was paid for Vendor or Purchaser details bringing the total payment up to €20 per sale.

4.7 400 kV Rural Land Sales

In order to gather information in relation to 400 kV lines specifically, the team decided to collate information on farm sales from the farming press from 1990 up to March 2012. This was based on the townlands where the Moneypoint to Dunstown 400 kV line crossed the country. Initially, a list of all the townlands affected by the 400 kV line was obtained. The farming press articles on farm sales were then examined for sales where the townland corresponded with the 400 kV line. However, in February 2012, it was clear that there had been a relatively low response from agents in relation to farm sales in the County Galway study area. In order to increase the potential to gather more sales in the area west of the Shannon, the northern 400 kV line from Moneypoint as far as the Shannon was included. The same methodology was followed as that outlined above for the Moneypoint to Dunstown 400 kV line.

A separate set of spreadsheets were sent to the agents who had sold farms in townlands along the 400 kV line. The information sought was the same as that outlined in section 4.3 above.

In order to expand the data on farm sales, records on sales held by Tom Corr and Kevin Miller which were a minimum of one kilometre from HVOTLs were also included.

4.8 Fieldwork – Pilot Survey

Prior to commencing the fieldwork proper, the survey process was piloted using three estate agents. These were located outside the study area so as not to limit the potential sample within the study area. Some adjustments were made to the questionnaire on completion of the pilot. This primarily involved modifications to the wording of questions, rather than making substantive structural changes.

4.9 Response of Agents to Survey

Tom Corr and Kevin Miller conducted all of the agent surveys. It was decided to limit the number of personnel conducting the survey in order to reduce the possibility of there being any significant difference in the manner in which the survey was conducted. A total of 45 agents undertook to complete the survey providing a reasonable spread of agents from each region. The target from the outset was to interview in excess of 9 agents in each of the study areas.

The agents were contacted by phone in order to ascertain if they would participate in the study. When the requisite number of co-operating agents was arrived at, no more phone calls were made. The phone calls were all made in an unbiased and completely random manner, see above section 4.6.

The number of agents in each of the study areas was as follows:

Study Area	**Number of Agents**
Galway	11
Kildare	12
Limerick	12
South Dublin	10
Total	**45**

The majority of these agents were active in the residential area, i.e. a total of 44 agents. There was only 1 agent who was not involved in either residential or agricultural land and specialised solely in commercial property.

There were a total of 23 of the agents that were actively involved in commercial property. In relation to agricultural land there were 27 agents who indicated that they were active in the agricultural land market.

5 Results from the survey of estate agents

5.1 What is the estimated effect (if any) of HVOTLs on residential property and agricultural land values?

Question 3.1.4 in Appendix 2 related to a line in very close proximity to a house. The wording was *"High voltage overhead electricity line – 50 metres from the rear of the house and carried on pylons with one visible"*. Question 3.2.4 related to lines crossing a farm with one pylon on the land.

Based on the responses to Question 3.1.4 and Question 3.2.4, the estate agents surveyed on average were of the opinion that HVOTLs result in a reduction in property values. They indicated there was median drop in value in the order of 18% for residential properties and 5% for agricultural land values.

However in response to Q2 and Q7 (see Appendix 2) there was considerable variation in agent opinions' with:

- 41% indicating no effect on residential property from 110 kV lines,
- 4% indicating no effect from 220 kV lines and,
- 2% indicating no effect from 400 kV lines.

In the case of agricultural land:

- 55% indicated no impact from 110 kV lines,
- 30% indicated no impact from 220 kV lines and,
- 27% indicated no impact from 400 kV lines.

Question 3.1.4 queried whether there would be an impact either positive or negative from a HVOTL *"50 metres from the rear of the house and carried on pylons with one visible"*. Question 3.2.4 put forward the same question in relation to agricultural land as follows "*Lines cross at the side of the farm with one pylon on the land*".

All but one of the 45 valid responses to the question suggested the effect was negative for residential properties. In contrast, around one-in-three surveyed (15 out of the 44 valid responses) believed that HVOTLs had no effect on agricultural land values. None of the agents recorded an increase in either residential property or agricultural land values as a result of being in close proximity to HVOTLs.

5.2 To what extent does the effect of HVOTLs on property values vary across the three main transmission line types i.e. 110 kV, 220 kV and 400 kV?

Comparing the responses to Q.2 (valuation of property with no HVOTL) and Q.7 (valuation of same property with different overhead line voltages and support structures) results in a notable difference in the estate agents opinions of the impact across voltage types (see Table 5.1 overleaf). Estate agents indicated that the drop in value associated with a property being in close proximity to a 110 kV line is on average (median) a very modest 3%. However, 220 kV lines were estimated in the

opinion of the estate agents to result in an average decline of 13%, while the fall in value is estimated at 20% for 400 kV lines.

Table 5.1: Median percentage change in property values as a possible result of proximity to HVOTLs

	Residential				Agricultural land			
	Valid N	110 kV	220 kV	400 kV	Valid N	110 kV	220 kV	400 kV
All respondents	45	-3	-13	-20	44	0	-5	-6
BY OFFICE LOCATION								
- Galway	11	0	-10	-20	10	0	-1	-1
- Kildare	12	-5	-15	-20	12	0	-6	-6
- Limerick	12	-6	-13	-26	12	-2	-7	-9
- South Dublin	10	-3	-12	-18	10	-4	-9	-12
BY AREA OF SPECIALITY (Q.1.5.)								
- Residential	44	-4	-12	-20	43	0	-5	-7
- Commercial	23	-5	-14	-22	23	0	-5	-5
- Agricultural land	27	-5	-15	-20	26	-1	-5	-5
BY MAIN PROPERTY SECTOR (Q.8.4.)								
- Residential sales/valuations is highest turnover	36	-4	-13	-20				
- Agricultural land sales/valuations is highest turnover					6	0	-4	-8
BY VALUATION OF HVOTL EXPERIENCE (SECTION 5)								
- Never valued a res property near HVOTL	5	0	-10	-20				
- Valued a res property near HVOTL	40	-4	-13	-20				
- Valued a res property near HVOTL in last five years	28	-4	-14	-20				
- Valued a res property near HVOTL in last 12 months	14	-4	-11	-20				
- Never valued an agri-land property near HVOTL					15	0	-5	-9
- Valued an agri land property near HVOTL					28	0	-5	-5
- Valued a agri land property near HVOTL in last five years					18	0	-3	-5
- Valued an agri land property near HVOTL in last 12 months					5	-1	-5	-7

From Table 5.1 the effect on agricultural land values is relatively modest across the different voltage types, with an average (median) of zero change recorded for the 110 kV line and broadly similar decline in value for both the 220 kV and 400 kV lines in the order of 5% and 6% respectively.

Table 5.1 also shows that the results are relatively consistent across a range of variables: agents office location; the respondent's own area of property in which they specialise; the respondent's experience of valuing properties in close proximity to HVOTLs; and the main area of property in which the respondent's firm specialises.

Table 5.2 shows the count/proportion of agents who reported that there was no impact on property values.

Table 5.2: Percentage survey respondents reporting HVOTLs having no impact on property values

	Residential				Agricultural land			
	Valid N	110 kV	220 kV	400 kV	Valid N	110 kV	220 kV	400 kV
All respondents	45	41%	4%	2%	44	55%	30%	27%
BY OFFICE LOCATION								
- Galway	11	55%	18%	9%	10	80%	50%	50%
- Kildare	12	33%	0%	0%	12	58%	33%	33%
- Limerick	12	42%	0%	0%	12	42%	17%	8%
- South Dublin	10	40%	0%	0%	10	40%	20%	20%
BY AREA OF SPECIALITY (Q.1.5.)								
- Residential	44	41%	5%	2%	43	53%	28%	26%
- Agricultural land	23	39%	9%	4%	23	52%	35%	30%
- Commercial	27	44%	4%	4%	26	50%	35%	31%
BY MAIN PROPERTY SECTOR (Q.8.4.)								
- Residential sales/valuations is highest turnover	36	39%	0%	0%				
- Agricultural land sales/valuations is highest turnover					6	50%	33%	33%
BY VALUATION OF HVOTL EXPERIENCE (SECTION 5)								
- Never valued a res property near HVOTL	5	60%	20%	20%				
- Valued a res property near HVOTL	40	40%	3%	0%				
- Valued a res property near HVOTL in last five years	28	39%	0%	0%				
- Valued a res property near HVOTL in last 12 months	14	43%	0%	0%				
- Never valued an agri land property near HVOTL					15	60%	33%	33%
- Valued an agri land property near HVOTL					28	54%	29%	25%
- Valued a agri land property near HVOTL in last five years					18	56%	33%	28%
- Valued an agri land property near HVOTL in last 12 months					5	40%	20%	20%

From Table 5.2, a sizeable proportion of agents believe that there is little impact on residential or agricultural property values when 110 kV lines are considered and this proportion decreases as line voltages increases, especially for residential properties.

When prompted for the single main cause for HVOTLs potentially affecting property values, an overwhelming majority of respondents stated that their main reasons were due to concerns over health (80%) and visual impact (77%). Other issues such as noise (14%) and safety (7%) were mentioned by only a small proportion of respondents.

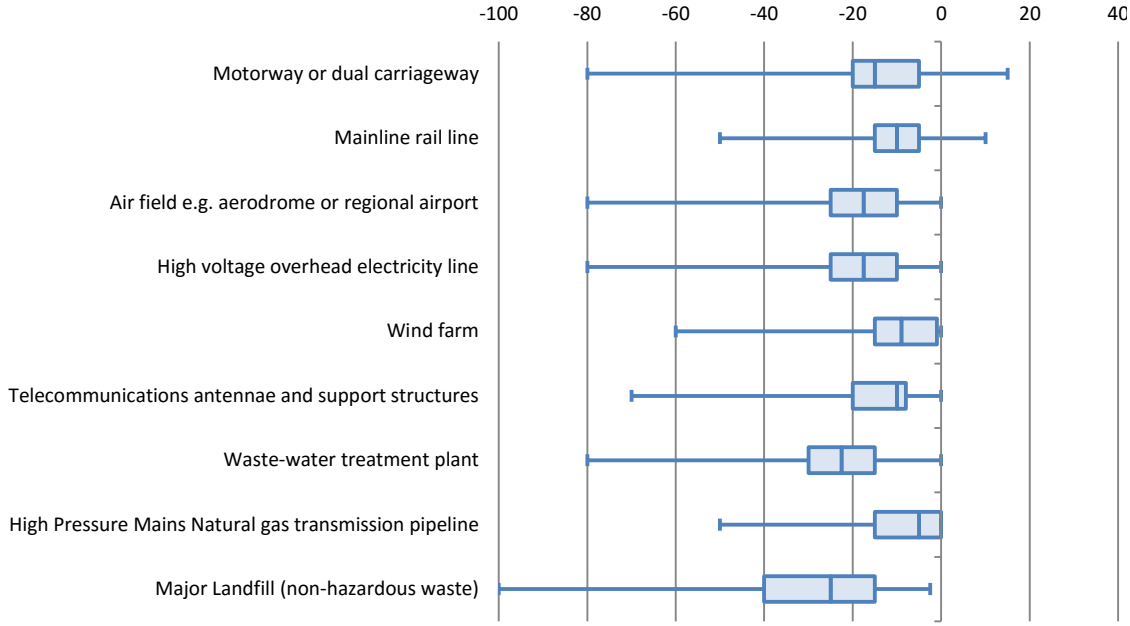
Health (47%) and visual impact (50%) were also the most commonly cited reasons for an agent reporting a lower valuation on agricultural land as a result of the presence of a HVOTL. However, other concerns featured as well, including the impact on farming activities (22%) and safety concerns (19%).

5.3 In terms of the potential to affect residential property and agricultural land values, how do HVOTLs compare to other types of infrastructure?

Figure 5.1 illustrates the potential impact of each transport and utility infrastructure to residential properties as indicated by agents.

Figure 5.1: Infrastructure and residential property values

Q.3.1 *I am going to list-off a range of different types of transport and utility infrastructure. In each instance, please provide an estimate of the extent to which you feel the residential property you just valued would be affected, positively, negatively or at all in value by being located in close proximity to each transport and utility infrastructure. Please provide your answer in terms of percentage change in value.*



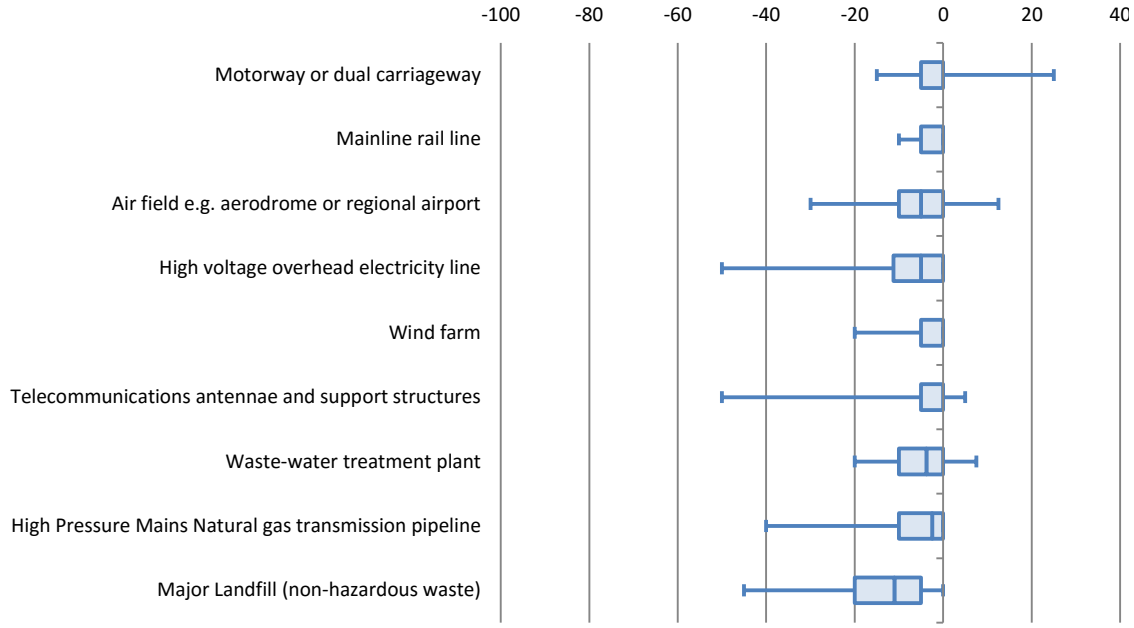
The boxplot illustrates the **median** for a particular variable and the range of values around this. The ends of the boxplot represent the minimum and maximum values. The bottom (or left wall) of the box denotes the lower quartile and the top (or right wall) of the box denotes the upper quartile. The line that crosses through the box is the median. In some cases the values may overlap.

From Figure 5.1, landfills were identified by respondents to the survey as having the largest potential effect on residential property values, resulting in an average (median) drop in value of 25%. Waste water treatment plants also resulted in a similarly high average drop in value of 23%. The potential decline in residential property values associated with HVOTLs was on a par with that associated with a nearby air field. This was relatively closely followed by motorways or dual carriageways with an average drop in value of 15%. The remaining infrastructure types were all also expected to result in some potential decline in the value of the property: both mainline rail and telecommunications antennae and support structures recorded an average drop in value of 10%; wind farms were expected to result in an average fall of 9%; a high pressure mains natural gas transmission pipeline recorded the lowest potential fall in value at an average of 5%.

Figure 5.2 illustrates the potential impact of each transport and utility infrastructure to agricultural properties as indicated by agents.

Figure 5.2: Infrastructure and agricultural land values

Q.3.2 *Once again I am going to list-off a range of different types of transport and utility infrastructure. In each instance, please provide an estimate of the extent to which you feel the agricultural farmland you just valued would be affected, positively, negatively or at all in value by being located in close proximity to each transport and utility infrastructure. Please provide your answer in terms of percentage change in value.*



The boxplot illustrates the **median** for a particular variable and the range of values around this. The ends of the boxplot represent the minimum and maximum values. The bottom (or left wall) of the box denotes the lower quartile and the top (or right wall) of the box denotes the upper quartile. The line that crosses through the box is the median. In some cases the values may overlap.

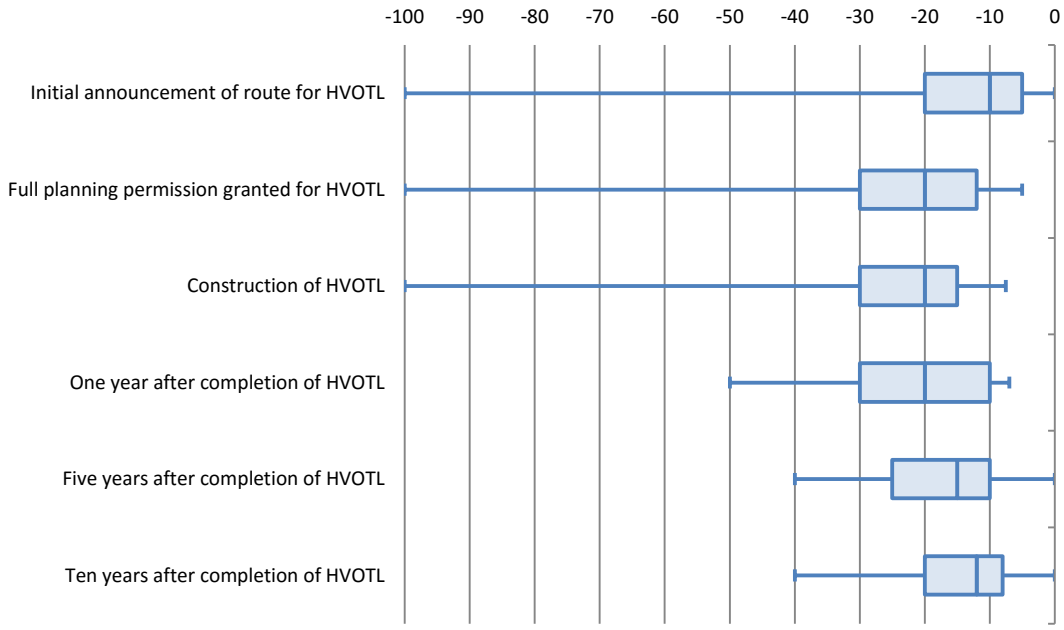
From Figure 5.2 there is a marked difference in estate agents' views on the potential impact of the various types of infrastructure on agricultural land values. Motorways or dual carriageways, mainline rail lines, wind farms, and telecommunications antennae and support structures all recorded an average (median) of no change in the value of the property. High pressure mains natural gas transmission pipeline (-3%), waste-water treatment plant (-4%), airfield (-5%) and HVOTLs (-5%) were all, more or less, at a similar level. The only sizable drop in agricultural land values was that of major landfills, recording an average decline of 11%.

5.4 Does the potential effect of HVOTLs on property values vary over time?

Figure 5.3 illustrates the potential relationship between residential property values and HVOTLs over time.

Figure 5.3: Potential Relationship between residential property values and HVOTLs over time

Q.4.1 *I am going to rotate through the different stages of a typical planning process for high voltage overhead electricity lines (HVOTLs). At each stage please provide an estimate of the extent to which you feel the residential property you just valued would be affected, positively, negatively or at all in value by being near to a planned high voltage overhead electricity line. Please provide your answer in terms of percentage change in value.*



The boxplot illustrates the **median** for a particular variable and the range of values around this. The ends of the boxplot represent the minimum and maximum values. The bottom (or left wall) of the box denotes the lower quartile and the top (or right wall) of the box denotes the upper quartile. The line that crosses through the box is the median. In some cases the values may overlap.

From Figure 5.3, it would appear that estate agents believe the potential effect on residential property varies at different stages of the development of a HVOTL.

For residential property, the reduction in value is believed to be at its highest:

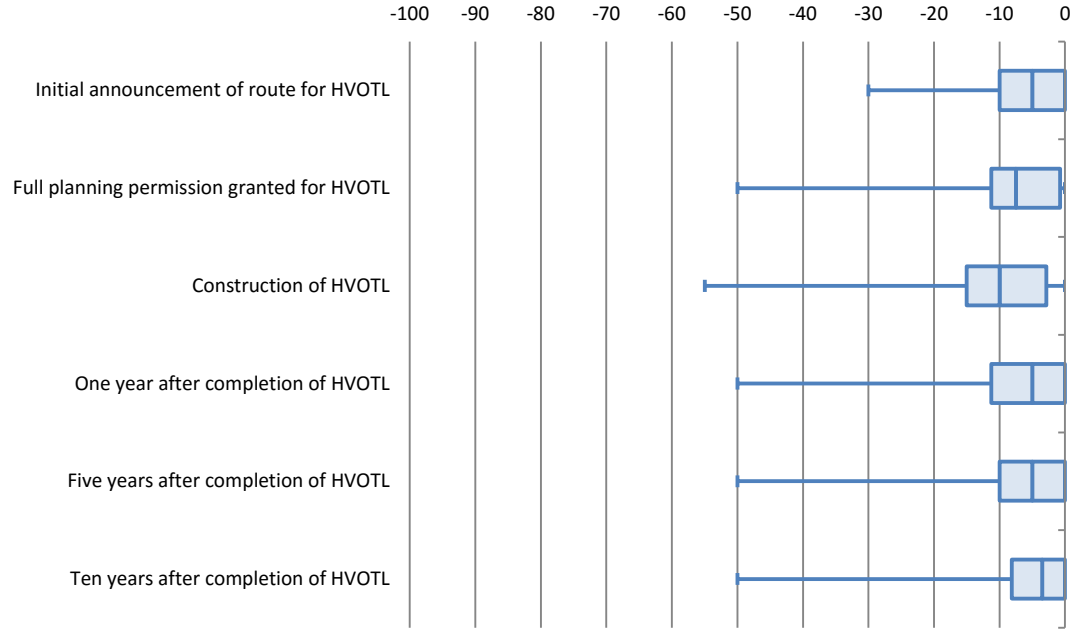
- round the time that full planning permission is granted for the line,
- during the construction phase and,
- one year after the construction is completed.

Notably, however, the potential negative impact of the HVOTL on property values is expected to decrease with time. The negative impact fell from minus 20% at the time of construction to minus 15% within five years after completion of the line and to minus 12% a further five years later.

Figure 5.4 illustrates the potential relationship between agricultural property values and HVOTLs over time.

Figure 5.4: Potential Relationship between agricultural land values and HVOTLs over time

Q.4.3 *Again I am going to rotate through the different stages of a typical planning process for high voltage overhead electricity lines (HVOTLs). At each stage please provide an estimate of the extent to which you feel the agricultural farmland property you just valued would be affected, positively, negatively or at all in value by being near to a planned high voltage overhead electricity line. Please provide your answer in terms of percentage change in value.*



The boxplot illustrates the **median** for a particular variable and the range of values around this. The ends of the boxplot represent the minimum and maximum values. The bottom (or left wall) of the box denotes the lower quartile and the top (or right wall) of the box denotes the upper quartile. The line that crosses through the box is the median. In some cases the values may overlap.

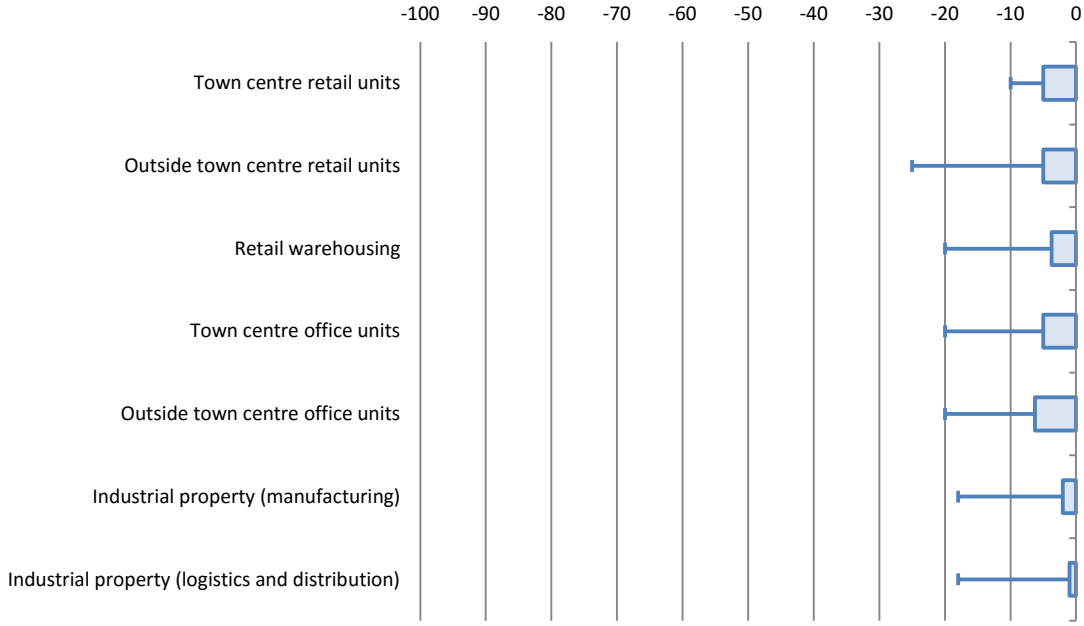
From Figure 5.4, it also appears that estate agents believe the potential effect on agricultural land varies at different stages of the development of a HVOTL. Agricultural land follows a similar pattern to residential land. However, as previously stated, the scale of potential impact is much lower relative to residential property. The largest potential negative effect on values occurs at the time of construction of the line, with agricultural land values estimated to fall by 10%. However, the potential effect on values is minimised relatively quickly; 5% of a reduction one year after the line has been built and remaining relatively unchanged thereafter.

5.5 What is the estimated potential effect of HVOTLs on commercial property values?

Figure 5.5 illustrates the potential relationship between commercial property values and HVOTLs over time.

Figure 5.5: Commercial property values and HVOTLs

Q.6.1 *For each of the following non-residential property types please state whether or not you believe that high voltage overhead electricity lines would affect the value of the property in the event that it is located in close proximity to the property. Please provide an estimate of the extent to which you feel the non-residential property would be affected, positively, negatively or at all in value and provide your answer in terms of percentage change in value.*



The boxplot illustrates the **median** for a particular variable and the range of values around this. The ends of the boxplot represent the minimum and maximum values. The bottom (or left wall) of the box denotes the lower quartile and the top (or right wall) of the box denotes the upper quartile. The line that crosses through the box is the median. In some cases the values may overlap.

From Figure 5.5, respondents are asked to quantify the effect of HVOTLs on different types of commercial property. Overall, the responses suggest that estate agents believe such an effect is virtually non-existent, with values remaining on average unchanged across all property types. Agents were more likely to say that HVOTLs have no effect on industrial properties than on retail or offices, while they were also more likely to cite no change in retail property values when compared to offices. Even the extreme values for commercial property were, in comparison to residential property and agricultural land, quite modest.

5.6 Agent's opinions in other studies and research

Gallimore & Jayne (1999) in their literature review refer to Kinnard *et al* (1997) having found *"that real estate "professionals" take a more negative view of the depreciating effect of HVOTL proximity than do the general public; and that the perceived effect, at 8 - 10%, is generally larger than that found in the market data based MRA studies"*. The average drop in our survey of estate agents (see 5.1 above) is considerably in excess of this, i.e., 18% versus 8% to 10% in the Gallimore & Jayne work. The drop in values predicated by the U.K. Valuers and Agents was in the order of 5% to 10% (Sims & Dent 2005).

6 Analysis of micro data on property sales

This section of the report uses micro data on residential and agricultural land sales data to investigate if a potential relationship exists between the sale price achieved and proximity to HVOTLs. Four study areas – East Galway, Kildare, Limerick and South Dublin – were identified for the residential and agricultural land sales data analysis. The aim was to obtain a balance of properties in urban/rural locations and in proximity to different HVOTL line types. In addition study areas for agricultural land sales were defined as properties along the 400 kV Moneypoint to Dunnstown line and the 400 kV Moneypoint to Shannon on Woodlands line. These agricultural land sales were later supplemented with sales in the same general areas at least one kilometre away from the 400 kV lines.

This section of the report begins by providing a brief overview of the data collection process and a description of the variables contained in each of the datasets. This is then followed by a description of the base regression models for both the residential and agricultural property sales data. The final section then provides details of the results obtained from introducing the HVOTL variables into the base regression models. A variety of specifications were used in order to test whether these variables have any impact on the sale price achieved.

6.1 About the datasets

6.1.1 Residential property sales data

As described earlier, the data collection process was carried out using a two-step procedure. Estate agents who agreed to participate in the research provided Tom Corr and Kevin Miller with information on the characteristics of each property sold in the designated study area.

In order to conform to data protection requirements, the dataset furnished to Tom Corr and Kevin Miller included the property address but excluded the sale price. The sale price was sent as part of a separate piece of information by the agents to Insight Statistical Consulting. A unique ID reference was assigned to each property sale by the estate agents. This was common to each of the datasets provided to Tom Corr and Kevin Miller and Insight Statistical Consulting. Using this unique ID reference, the dataset on sales prices received by Insight Statistical Consulting was then matched to an anonymised version of the dataset received by Tom Corr and Kevin Miller (i.e. excluding the property address details).

Overall the data collection process, due to data protection legislation, was rather cumbersome and was heavily reliant on the co-operation of estate agents. Recruitment of the agents to take part in the process was hindered by the complexity of the data transfer process to the separate study partners. This was despite the offer to the agents of being remunerated for their time and contribution. Most rural addresses were insufficient to accurately pinpoint the location of rural properties (a key requirement for quantifying the distance of properties to the nearest HVOTL line and structure).

Additional data requests from the agents were requested in order to locate rural properties, i.e. the provision of vendor/purchaser details (see Appendices 7 & 8).

The data was fully quality checked prior to undertaking the analysis. This resulted in a total of 503 residential properties spread across the four study areas provided by 15 different estate agents. Table 6.1 provides a summary of the different variables contained in the dataset that relate to property characteristics.

Table 6.1: Summary of the residential property sales dataset

	East Galway	**Kildare**	**Limerick**	**South Dublin**	**Total**
Number of properties	22	229	101	151	**503**
Floor area – median (sqm)	150	116	110	88	**105**
Plot area – median (ha)	0.22	0.03	0.19	0.02	**0.03**
Number of properties in urban areas	0	191	53	150	**394**
Bedrooms (number of properties)					
One bedroom	0	0	3	2	**5**
Two bedrooms	2	4	10	7	**23**
Three bedrooms	1	123	53	125	**302**
Four bedrooms	18	83	24	14	**139**
Five bedrooms	1	17	11	2	**31**
Six bedrooms	0	2	0	1	**3**
Property Type (number of properties)					
Terraced	0	9	14	65	**88**
Semi-detached	1	141	21	81	**244**
Detached	21	79	66	5	**171**
Year built (number of properties)					
Pre-1961	4	6	39	4	**53**
1961-1970	1	3	3	6	**13**
1971-1980	1	3	4	55	**63**
1981-1990	1	25	10	36	**72**
1991-2000	3	153	10	40	**206**
2001+	12	39	35	10	**96**
Year sold (number of properties)					
2000	0	1	3	2	**6**
2001	1	22	2	11	**36**
2002	4	29	4	14	**51**
2003	2	14	4	9	**29**
2004	2	35	6	15	**58**
2005	2	32	9	19	**62**
2006	4	17	16	11	**48**
2007	3	21	12	3	**39**
2008	0	11	10	12	**33**
2009	2	21	10	16	**49**
2010	1	9	14	18	**42**
2011	1	17	11	21	**50**
Sale price (number of properties)					
Up to €100,000	2	1	17	1	**21**
€100,001 – €150,000	3	3	27	8	**41**
€150,001 – €200,000	5	21	21	22	**69**
€200,001 – €250,000	5	40	24	40	**109**
€250,001 – €300,000	2	39	8	35	**84**
€300,001 – €350,000	4	43	3	20	**70**
€350,001 – €400,000	0	31	1	14	**46**
€400,001 – €450,000	1	11	0	3	**15**
€450,001 – €500,000	0	10	0	4	**14**
€500,001 or more	0	30	0	4	**34**
Sale price – median (€)	215,000	317,000	165,000	256,000	**257,500**

From Table 6.1, just under half (46%) of all observations are situated in Kildare, with a further 30% located in South Dublin. The balance is split between Limerick (20%) and East Galway (4%).All properties in South Dublin, except one, and 83% of properties in Kildare were classified as being in urban areas. In contrast, just over half of properties in Limerick and no properties in East Galway were in urban areas.

The years in which the sales occurred are relatively evenly distributed across the period 2000-2011. Given that the dataset only contains house sales (i.e. excluding apartments) this resulted in only a small proportion having either one or two bedrooms.

Just over half (52%) of all properties in the dataset had a sale price in the range of €150,000 to €300,000. The majority of the higher value properties in the dataset were found in Kildare. The distribution of prices in East Galway and Limerick was more towards the lower price-end of the market. The price distribution amongst the properties in South Dublin was more even, albeit still at the lower to mid-price end of the market.

Table 6.2 provides a summary of the variables relating to the measurement of the proximity of HVOTLs to each of the properties. The distance variables were calculated using Google Earth. The distance was calculated from the structure/line being measured to the centre of the built property.

Table 6.2: Description of HVOTL variables in the residential property sales dataset

	East Galway	**Kildare**	**Limerick**	**South Dublin**	**Total**
Number of properties	22	229	101	151	**503**
Nearest line type (number of properties)					
110 kV	17	195	54	96	**362**
220 kV	5	28	47	55	**135**
400 kV	0	6	0	0	**6**
Nearest structure type (number of properties)					
Twin poles	14	139	46	1	**200**
Pylon or angle mast	8	90	55	150	**303**
Median distance to nearest structure (meters)					
Twin poles	487	712	3,837	124	**788**
Pylon or angle mast	893	704	1,176	707	**752**
All	572	707	2,084	705	**764**
Structure type and distance (number of properties)					
Twin poles within 150m	0	2	0	1	**3**
Pylon or angle mast within 150m	0	6	2	10	**18**
Distance to nearest structure (number of properties)					
Within 150 metres	0	8	2	11	**21**
151-250m	1	12	1	8	**22**
250m+	21	209	98	132	**460**

From Table 6.2, the majority of residential properties (72%) are sited nearby 110 kV lines, with the bulk of the remainder (27%) close to 220 kV lines and six properties located near 400 kV lines. As a percentage of the total, approximately 9% of all properties are within 250 metres of the nearest HVOTL structure. There is a good mix of twin poles (wooden) and angle masts / pylons (steel structures).

6.1.2 Agricultural land sales data

For the 400 kV line corridors newspaper records since 1990, mainly from *Farmer's Journal* and *Farming Independent*, were gathered. This was done by matching the townland reported in the press compared to the list of townlands for the 400 kV line corridors. Agents were contacted to assemble missing information regarding these sales. A relatively poor response was obtained from agents in relation to these sales. This was particularly so for the 1990s before computer recording of sales became more common place. Some farm sales information was also gathered from agents as part of the data collection process in the four study areas. In order to increase the data set of farm sales Tom Corr and Kevin Miller used their own records and agent contacts to identify sales in the same general localities. The locations of the farms were identified by their townland. It was decided to only include farms where the townland was one kilometre away from the nearest HVOTL. This was in case any part of a farm might be close to a HVOTL or indeed have a HVOTL crossing the farm. These farms were therefore in excess of one kilometre from a HVOTL.

A total of 149 valid agricultural property sales were collected for analysis, with a summary of the key variables contained in the dataset provided in Table 6.3 below.

Table 6.3: Summary of the agricultural land sales dataset

	Galway	**Kildare**	**Laois**	**Limerick**	**Total**
Number of farm properties	39	49	33	28	**149**
Farm area (hectares)					
Min	0.83	1.29	3.46	2.19	**0.83**
Medan	7.88	12.70	13.98	12.86	**10.70**
Max	52.60	110.52	82.89	53.88	**110.52**
Number of properties with a dwelling	8	16	9	8	**41**
Type of land (% of total farm area)					
Non-productive	0	2	0	0	**1**
Suitable for forestry	5	1	3	4	**3**
Poor quality grassland	6	3	7	12	**6**
Medium quality grassland	36	7	29	33	**23**
Good quality grassland	48	30	34	34	**35**
Suitable for any use	4	56	28	17	**32**
Year sold (number of properties)					
1991-2003	3	8	5	0	**16**
2004	7	1	3	0	**11**
2005	11	4	7	2	**24**
2006	5	4	2	5	**16**
2007	1	6	4	10	**21**
2008	1	1	1	3	**6**
2009	5	8	2	4	**19**
2010	3	7	3	4	**17**
2011-2012	3	10	6	0	**18**
Sale price (number of properties)					
Up to €250,000	19	14	8	11	**52**
€250,001 – €500,000	13	11	13	8	**45**
€500,001 – €750,000	4	5	6	2	**17**
€750,001 – €1,000,000	1	4	2	0	**7**
€1,000,001 or more	2	15	4	7	**28**
Sale price – median (€)	260,000	495,000	420,000	287,500	**350,000**

From Table 6.3, data was collected for properties across four counties: Kildare (33%), Laois (22%), Limerick (19%) and Galway (26%). Typical farm areas in Galway were notably smaller than those in the three other counties. The majority of farmland in the

database (90% of the total farm area covered) was identified as being at least medium quality grassland or better. Most property sales (89%) occurred between 2004 and 2012. The bulk of high value sales (in excess of €1m) occurring in Kildare and, to a lesser extent, Limerick.

Table 6.4 provides a description of the key HVOTL variables in the agricultural land sales database.

Table 6.4: Summary of HVOTL variables in the agricultural land sales dataset

	Galway	**Kildare**	**Laois**	**Limerick**	**Total**
Number of farm properties	39	49	33	28	**149**
HVOTL crosses the property (number of properties)	5	13	3	2	**23**
110 kV	*2*	*2*	*0*	*2*	***6***
220 kV	*2*	*3*	*0*	*0*	***5***
400 kV	*1*	*8*	*3*	*0*	***12***
Median length of line through the property (meters)	147	382	402	234	**344**
HVOTL structure on property (number of properties)					
Wood twin poles	2	3	0	1	**6**
Pylon	1	9	2	0	**12**
Distance of dwelling to nearest structure (number of properties)					
<=500m	1	11	2	0	**14**
>500m	38	38	31	28	**135**

A HVOTL is deemed to cross the property area for 15.4% of all agricultural properties. Just over half of these in Kildare, a little over half of which are 400 kV lines, with the remainder roughly split between 110 kV and 220 kV. In addition, approximately 11% of properties in the database have a HVOTL structure (wood twin pole or pylon) actually situated on the property.

6.2 Constructing the base analytical model

A hedonic price regression model is being used to investigate if there is any relationship between residential property values and HVOTLs in Ireland. In the event a relationship is detected, the scale of the impact this has on property values is also assessed. This approach is considered within the literature to be superior to other less rigorous statistical tests. This is because it attempts to isolate the relationship between property values and HVOTLs for a range of other variables, such as the year in which the property was sold, location, property type, number of bedrooms and property size.

Consequently, this approach also requires a detailed database on property sales and characteristics The approach followed in this study draws on different modelling techniques used throughout the literature; In particular on that used by Chalmers and Voorvaart (2009), which looks at the potential effects of transmission lines in New England, USA.

The first step in this process is to run the regression analysis excluding any variables associated with measuring the proximity to HVOTLs. This is done to assess if the model is useful in understanding the potential relationship between the property sale price and the individual characteristics of the property. A standard modelling approach is being adopted using a log-linear regression model. This allows for the non-linear relationship between the sales price and the other variables in the model.

6.2.1 The residential base model

The key variables in the dataset that are being used to construct the base model are as follows:

- LNPRICE – the natural log of the property sale price in euro;
- LNPLOT – a scale variable measuring plot area of each property in hectares. This enters the model in logarithmic format in order to allow for a non-linear relationship between sale value and price;
- LNFLOOR – a scale variable measuring the floor area of each property in square metres, which also enters the model as in logarithmic format;
- BUILT – five dummy variables indicating the period during which the property was built (1971 to 1980; 1981 to 1990; 1991 to 2000; and 2001+), with all properties built prior to 1971 as the reference period;
- BED – four dummy variables for the number of bedrooms in a given property, with one each for three-bed, four-bed, five-bed and six-bedroom houses, while one/two bedroom houses are used as the reference point;
- TYPE – two dummy variables denoting the type of property, with one for semi-detached and another for terraced, while detached houses are the comparison reference point;
- REGION – six dummy variables describing the main regional areas in the study. These are Kildare Urban, Kildare Rural, Limerick Urban and Limerick Rural, South Dublin Urban and South Dublin Rural, with East Galway (all rural properties) acting as the reference point; and
- SOLD – ten dummy variables indicating the year in which the property was sold. A dummy for each year from 2002 to 2011 and all properties built prior to 2002 used as the reference period.

The results for the base hedonic price regression model derived from the dataset on property sales and characteristics are presented in Table 6.5 below.

Table 6.5: Residential base model (hedonic price regression results)

Dependent variable: in(Sales_Price)	Coefficient	Standard Error	p-value
Constant	8.335	0.248	<0.01
ln [Plot area (ha)]	0.075	0.017	<0.01
ln [Floor area (sqm)]	0.703	0.056	<0.01
Built between 1961 and 1970	0.047	0.066	0.48
Built between 1971 and 1980	0.141	0.047	<0.01
Built between 1981 and 1990	0.202	0.044	<0.01
Built between 1991 and 2000	0.178	0.043	<0.01
Built from 2001 onwards	0.198	0.043	<0.01
Three bedrooms	0.011	0.050	0.82
Four bedrooms	0.031	0.060	0.61
Five bedrooms	0.028	0.080	0.73
Six bedrooms	0.294	0.147	0.045
Semi-detached	-0.060	0.033	0.07
Terraced	-0.042	0.042	0.32
Kildare Urban	0.748	0.057	<0.01
Kildare Rural	0.782	0.057	<0.01
Limerick Urban	0.100	0.060	0.099
Limerick Rural	0.091	0.054	0.095
South Dublin Urban	0.898	0.064	<0.01
South Dublin Rural	1.268	0.211	<0.01
Sold in 2002	0.109	0.042	<0.01
Sold in 2003	0.211	0.049	<0.01
Sold in 2004	0.327	0.416	<0.01
Sold in 2005	0.444	0.041	<0.01
Sold in 2006	0.578	0.043	<0.01
Sold in 2007	0.665	0.046	<0.01
Sold in 2008	0.458	0.048	<0.01
Sold in 2009	0.243	0.043	<0.01
Sold in 2010	0.095	0.045	0.03
Sold in 2011	-0.141	0.043	<0.01
Number of cases	503		
Adjusted R-squared	0.85		

From Table 6.5, noting that the dependent variable is the natural log of the sale price, the coefficients can be interpreted as the percentage change in the sale price for a unit change in the corresponding independent variable. In the case of LNPLOT and LNFLOOR, the coefficients are interpreted as elasticities, i.e. the percentage change in the sales price achieved relative to a one percentage change in either the plot area or floor area.

Also presented in this table are the standard errors and p-values for each dependent variable. P-values that are (a) less than or equal to 0.01 denote a significant variable at the 99% level of confidence; (b) less than or equal to 0.05 are significant at the 95% level of confidence; and (c) less than or equal to 0.10 are significant at the 90% level of confidence.

The adjusted R-squared (a measure of how good the independent variables are at explaining the variation in the dependent variables) is 0.85, which is quite high and

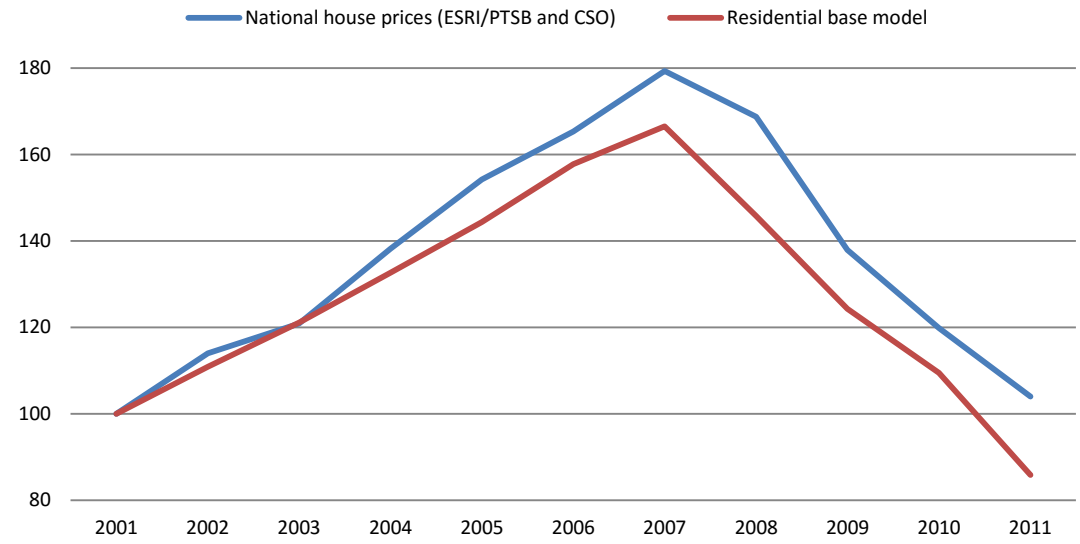
suggests that the different property characteristics do a very good job in explaining the variation in sale prices. For the most part, the dependent variables are significant at either the 95% or 99% level of confidence, with a few exceptions. There is no statistical difference detected in the sales value for properties built between 1961 and 1970 and those built prior to 1961.

The inclusion of the bedroom and property type variables appear to have little impact (the variable for six bedroom properties is significant at the 95% confidence level, although there is a considerable degree of variation associated with this estimate), with the attributes usually associated with these variables most probably accounted for by the inclusion of the natural log of the property floor area and plot area. Finally, there would appear to be little difference between the sale price of properties sold in Limerick (urban and rural) and East Galway.

The percentage change in property prices observed across the dataset can also be derived from the base model in order to see how these compare with the published price data on the Irish property market. This comparison is illustrated in Figure 6.1and shows that, while there is some difference between the actual magnitude of price change observed by the base model and the official indices of house prices, the underlying trend is broadly similar – relatively strong levels of growth between 2002 and 2006, followed by a slowing in this pace of growth from 2007 and sharp declines from 2008 onwards. The differences in magnitude in the price changes can be attributed to a number of factors e.g. the dataset upon which the base model is constructed is derived from data for houses only in four specific study areas. The CSO/PTSB figures relate to a variety of different property types and are calculated using a much wider sample of property sales across the country.

Figure 6.1: Comparing the trend in house prices in the base model with published data sources on house prices

Index: 2001=100



National House Prices: the published annual rate of growth observed by the ESRI/PTSB house price index between 2001 and 2004 and the CSO's Residential Property Price Index (RPPI) between 2005 and 2011, both of which are mix-adjusted i.e. calculated using a hedonic price regression model that takes account of the different characteristics of the properties in the data. Prior to the publication of the CSO's RPPI, the ESRI/PTSB was widely accepted as the best measure of price trends in the Irish residential property market. Since the publication of the RPPI, the ESRI/PTSB house price index has been discontinued.

In conclusion, the base model works well in explaining the potential relationship between the sale price and characteristics of the properties recorded in the dataset. Equally, the consolidated data appears to follow a similar trend with regard to prices observed throughout the country during the past decade.

6.2.2 The agricultural base model

The base regression model for the agricultural land sales data is set-up in a similar way to that set-out for the residential base model. However, this is entering somewhat uncharted territory as there are few comparator studies that attempt to construct a similar model for land values, (primarily due to the complex number of variables that have the potential to affect land sales and the absence of published micro data).

The model specification is set out using the logarithm of the sales price achieved as the dependent variables and the following independent variables:

- LNAREA – the natural log of the property area in hectares;
- DWELLING – a dummy variable set equal to one where there is no dwelling on the property and zero otherwise;
- REGION – three dummy variables denoting which county the property is located in, Kildare, Laois or Limerick. Galway is used as the reference for comparison purposes;
- QUALITY – four dummy variables describing the proportion of the land area covered by the different productive types of land based on a qualitative assessment. The "suitable for all uses" is used as the reference variable;
- SOLD – ten dummy variables indicating the year/period in which the property was sold. Some time periods are grouped together given the limited available data for certain years.

The results of the regression model are provided in Table 6.6 with the coefficients, standard errors and p-values provided for each of the relevant independent variables.

Table 6.6: Agricultural land base model (hedonic price regression results)

Dependent variable: in(Sales_Price)	Coefficient	Standard Error	p-value
Constant	9.841	0.247	<0.01
ln [Farm area (ha)]	0.713	0.045	<0.01
Absence of a dwelling	-2.400	0.730	<0.01
Ln (Dwelling size)	0.531	0.141	<0.01
Kildare	0.428	0.122	<0.01
Laois	0.024	0.119	0.84
Limerick	-0.042	0.133	0.75
% non productive or suitable for forestry	-0.015	0.002	<0.01
% poor quality grassland	-0.011	0.002	<0.01
% medium quality grassland	-0.008	0.001	<0.01
% good quality grassland	-0.004	0.001	<0.01
Sold in 1998	0.969	0.284	<0.01
Sold in 2001-2003	1.624	0.278	<0.01
Sold in 2004	1.718	0.242	<0.01
Sold in 2005	1.607	0.216	<0.01
Sold in 2006	1.920	0.228	<0.01
Sold in 2007	2.214	0.222	<0.01
Sold in 2008	1.611	0.279	<0.01
Sold in 2009	1.360	0.221	<0.01
Sold in 2010	1.153	0.221	<0.01
Sold in 2011-2012	1.113	0.219	<0.01
Number of cases	149		
Adjusted R-squared	0.86		

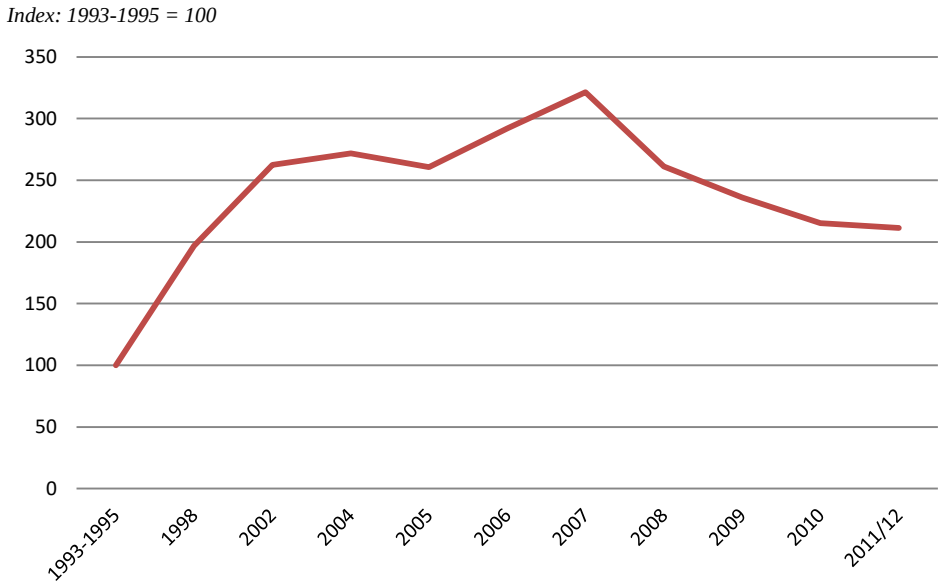
The data appears to fit the model very well, with the adjusted R-square of 0.86. In addition, the coefficients appear logical in terms of sign and scale. There is no statistical evidence of a difference between land sales in Laois or Limerick relative to Galway, although there is a notable difference for those sold in Kildare. The descriptive variables also used to quantify the proportion of the land area covered by different land quality types explain the variation in sales price well.

The variables that have a statistically significant and positive impact on sales price include farm area and dwelling size. The absence of a dwelling has a negative impact on overall value of the holding. The coefficients associated with the county in which the property is located demonstrate that properties in Kildare sold for a higher price than equivalent properties elsewhere. The land quality variables are associated with percentage of land of that type. These are small in magnitude, but statistically significant; it should be noted that since they refer to percentages (which run on a scale up to 100%) these can have a substantial impact on price.

The year of sale has an impact, and this trend over time in the coefficients matches what was observed in the general market.

As with the results from the residential model, it is possible to graph the trend in land sales derived from the model (in Figure 6.2).

Figure 6.2: Trend in land sale prices in the base model



From Figure 6.2, while there is no official published index of land sales, the underlying trend would appear to be reasonable. It reflects the cyclical nature of the market, with a peak in values achieved in 2007 and a subsequent decline and the market bottoming-out in 2011/2012.

6.3 Adding HVOTL measurement variables into the base model

The next step is to add the variables representing proximity to HVOTLs to the base model. For each of the residential and agricultural base models, a number of different specifications are considered. The full regression model results for each specification are not reported here (they are relatively unchanged from those contained in the base model), but rather the coefficients, standard errors and p-values associated with the variable used in each of the models.

6.3.1 Introducing variables representing HVOTLs into the residential sales base model

Table 6.7 presents the results from adding in different measurements of proximity to HVOTLS to the base hedonic price regression model. The first two models use scale variables and relate to the inverted measurements of the distance from the property to the nearest HVOTL structure (A) and to the nearest HVOTL line (B). While both are found to be negative (the closer the property is located to the structure/line, the greater the reduction in the sale price), neither are statistically significant.

Table 6.7: Adding-in different measurements of proximity to HVOTLs to the residential base model

	Coefficient	Standard Error	p-value
A. Inverse of distance (metres) to first structure (scale variable)	-0.765	4.284	0.858
B. Inverse of perpendicular distance from property to line (scale variable)	-0.841	2.663	0.752
C. Perpendicular distance from property to line (dummy variable)			
Within 50 metres	-0.032	0.093	0.727
51-100m	-0.010	0.060	0.870
101-150m	-0.079	0.060	0.183
151-200m	0.094	0.069	0.172
201-250m	-0.086	0.085	0.312
D. Perpendicular distance to line within 100m (dummy variable)	0.026	0.054	0.628
E. Perpendicular distance from property to line type (dummy variable)			
110 kV line within 100m	0.044	0.080	0.585
220 kV line within 100m	0.011	0.074	0.881
F. Perpendicular distance from property to line type (dummy variable)			
110 kV line within 150m	-0.048	0.052	0.355
220 kV line within 150m	0.016	0.064	0.799
G. Distance from property to first structure (dummy variable)			
Within 100 metres	-0.091	0.093	0.329
101-150m	-0.018	0.050	0.720
151-200m	-0.054	0.061	0.370
201-250m	-0.019	0.074	0.803
H. Distance from property to first structure by structure type (dummy variable)			
Twin pole within 100m	-0.069	0.084	0.413
Pylon or angle mast within 100m	0.153	0.147	0.298
I. Distance from property to first structure by structure type (dummy variable)			
Twin pole within 150m	-0.060	0.049	0.229
Pylon or angle mast within 150m	0.155	0.147	0.292

A series of other categorical dummy variables (models C, D, E, F, G, H and I) are then entered into the base model to detect if the potential for a relationship exists between HVOTLs and residential sales values. The coefficients of these variables can

be interpreted in the same way as has already been done for the variables related to properties themselves.

So, for example, the coefficient associated with being within 50 meters of a line estimates the impact on values relative to being outside this distance. The coefficient itself quantifies the size of the impact, if any, on value. The standard error estimates the uncertainty associated with this estimate. This depends on the variability of values in the population, and the number of affected properties. The p-value is a measure of the strength of evidence of a non-zero effect. Small p-values (i.e. less than 0.05) can be interpreted as evidence that a factor impacts on property values. In all of the instances here, none of the variables are statistically significant, which leads to the conclusion that there is no evidence from these data of HVOTLs having an impact on residential property sale values.

6.3.2 Introducing variables representing HVOTLs into the land sales base model

A similar approach is adopted for the agricultural land sales base model, with different specifications for the HVOTL variables used and the results outlined in Table 6.8 below.

Table 6.8: Adding-in different measurements of proximity to HVOTLs to the agricultural land base model

	Coefficient	Standard Error	p-value
J. Presence of any structure on the property	-0.020	0.136	0.88
K. Presence of structure on the property			
Pylons	-0.085	0.168	0.61
Twin poles	0.028	0.231	0.902
L. If line crosses any part of the property	-0.103	0.124	0.41
M. If line crosses by HVOTL type			
110 kV	0.320	0.257	0.22
220 kV	0.315	0.222	0.16
400 kV	-0.111	0.177	0.53
N. Length of line through the property	-0.0001	0.0003	0.71
O. Distance of dwelling to the nearest structure			
>=250m and <500m	-0.364	0.287	0.21
>=500m	-.251	0.262	0.34
P. Distance of dwelling to the line			
>=250m and <500m	-0.313	0.294	0.29
>=500m	-0.276	0.261	0.29

The coefficients can be interpreted in the same way as has been done already. In this case there is considerable variation in the size of the coefficients. This is due to the smaller size of the agricultural dataset. Despite the variety of different HVOTL variables incorporated into the base model (presence of a structure on the property; type of structure on the property; if a line crosses the property; the voltage of the line that crosses the property; the length of the line that crosses the property; distance of a dwelling on the property to the nearest structure/line), the model does not find any evidence of HVOTLs having an impact on agricultural land sales values.

6.4 Conclusions

Overall the data collected produces a robust model that describes the potential relationship between sale prices achieved and the varying underlying property characteristics for both residential and agricultural land properties. When adding variables to the base model that describe the proximity relationship of HVOTLs to the property, there is no evidence of a statistically significant effect. In addition, when the data is explored further there is no evidence of the different line types or the different structure types having a statistically significant negative effect.

7 Summary and Conclusions

7.1 Literature Review

The results of the literature review are summarised in Section 3.9. Generally speaking about half of the residential studies have found a negative impact from HVOTLs. Where negative impacts were detected they were generally low in the region of 3% to 6% or less. In many cases these negative effects were not statistically significant. The vast majority of the research on residential property was conducted in the U.S. and Canada in urban and suburban locations.

In relation to any negative impact on farm sales a lot less research has been carried out. No clear picture of any significant negative impact showing up of any significance is evident. Again, the research on farm sales is almost exclusively from the U.S. and Canada.

Impacts on residential property diminished rapidly with increasing distance from HVOTLs. Where an impact was found it was deemed to be mainly from the visual impact of HVOTLs with no evidence appearing that would suggest that health concerns were impacting on prices. Where negative impacts were found there is evidence to suggest that they generally decrease with time.

7.2 Survey of Estate Agents

When asked to compare values of a house with either no HVOTLs close by or alternatively, with 110 kV, 220 kV or 400 kV HVOTLs in close proximity, estate agents, on average, indicated reductions in value of 3%, 13% or 20% respectively. For residential properties, other than the 110 kV lines, these opinions of negative impact exceed what has generally been found in similar surveys of agents and professionals in other countries (Kinnard et al, 1997) where the reduction was in the region of 10%. Sims and Dent (2005) found that valuers and agents in the UK were of the opinion that the average value reduction in the case of residential property in close proximity to HVOTLs was of the order of 5% – 10%. There was also a considerable variation in the opinions expressed by agents in this survey when presented with the same scenarios.

Agents indicated that the impact on residential properties was similar to mainline rail and motorways. As with most of the survey, the opinions expressed varied widely in relation to the impacts from the various types of infrastructure.

7.3 Findings of the analysis of micro data on property sales

The analysis of the micro data on property sales uses a hedonic price regression model to investigate if there is any evidence of HVOTLs affecting: (i) residential sales values; and (ii) agricultural land values. In each instance, a base regression model is estimated, which looks at the relationship between sales values and a range of key property characteristics. The various characteristics used in these models (the independent variables) are found to explain the majority of the variation in sales values (the dependent variables). The price indices generated by both models also offer a good explanation of historical trends in property values observed in the

marketplace. A variety of other variables are then introduced into the regression models to look for evidence of HVOTLs affecting property sales values.

For the residential model, these variables include:

— scale measures of distance of the property to the nearest HVOTL line/structure and,
— a variety of dummy variables indicating the proximity of the property at various distances to the nearest HVOTL line/structure.

Where possible, this is done for line type (110 kV and 220 kV) and structure type (wooden poles or metal structures). In all a total of nine different specifications are used to detect a relationship. Two of these distinguish between line type at 100 and 150 metres, and another two between structure types, also at the same distance measures. The analysis fails to find sufficient evidence of residential property values being affected by proximity to any type of HVOTL line or structure.

A similar approach is used when analysing the potential relationship between HVOTLs and agricultural land values. It looks at whether or not a HVOTL line crosses the property, the presence of structures on the property and the proximity of structures and lines to a dwelling on the property (if one is present). A total of seven specifications are tested. One distinguishes between line type (110 kV, 220 kV and 400 kV) and the other between structure type (wooden poles and metal structures). As with the residential model, the analysis fails to find any evidence of HVOTLs affecting agricultural land values.

7.4 Overall Conclusion of this Study

The agent's opinions of negative impact from HVOTLs on residential property in the survey part of this research were 3%, 13% and 20% for 110 kV, 220 kV and 400 kV respectively. These reductions were significantly higher than that found generally in surveys of property professionals in other countries. The reductions were normally in the 8% - 10% range and 5% - 10% in the U.K. There was also a considerable variation in the opinions expressed by agents in this survey with 41% indicating no effect on residential properties from 110 kV. Furthermore 4% of the survey indicated no effect from 220 kV and 2% no effect from 400 kV.

Agents expressed the opinion that there was:

- no impact on the price of agricultural land from 110 kV lines,
- a 5% impact from 220 kV lines and,
- a 6% impact from 400 kV lines.

As with the residential part of the survey there was a considerable variation in the opinions expressed with:

- 30% indicating no effect from 220 kV lines and,
- 27% indicating no effect on agricultural land from 400 kV lines.

HVOTL's were deemed to be similar in impact to mainline rail and motorways but again the opinions expressed in relation to the impact from various types of infrastructure varied widely.

Statistical analysis of the sales data for both residential and rural properties showed that prices paid were closely associated with features of the properties such as location, size and year of sale of the property. Additional information related to HVOTLs was then added into each of these models in order to determine (a) whether the added HVOTL information assisted further in explaining the difference in price between properties and (b) if so, what the size of that impact was. This study, at a 95% confidence level, did not find a statistically significant negative impact from HVOTLs in close proximity to either residential or farm properties.

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