WHO REALLY PAYS FOR URBAN INFRASTRUCTURE?

The Impact of Developer Infrastructure Charges on Housing Affordability in Brisbane, Australia

Lyndall Elaine Bryant

Dip AppSci (Diagnostic Radiography with Distinction), QUT
B.AppSci (Property Economics with Distinction) QUT,
Grad Dip(Applied Finance and Investment) Securities Institute, Australia

Submitted in fulfilment of the requirements for the degree of
Doctor of Philosophy

Science and Engineering Faculty
Queensland University of Technology
January 2015
Keywords

- Infrastructure charges
- Developer fees
- Impact fees
- House prices
- Housing
- Housing affordability
- Housing supply
- Land development
- Land supply
- Property development
- Real estate
Abstract

Housing affordability is an agenda item at all levels of government in Australia and many other countries around the world. Affordability is more than just house prices. It also includes ready access to public transport, schools and good road networks, and of course access to all the basic utilities. However, in fast growing areas, governments don’t have the funds to build all the infrastructure new housing estates need and existing communities refuse to pay for it by way of higher rates and taxes. So, developer infrastructure charges have been introduced as a “user pays” method of funding new urban infrastructure. These infrastructure charges are levied on property developers by local authorities at the time of development approval. Property developers claim that it is uneconomical for them to pay, and that these infrastructure charges are passed on to home buyers, making new homes unaffordable. In the United States, research suggests that for every extra $1.00 of infrastructure charge, new house prices increase by around $1.60. In Queensland, where the maximum infrastructure charge for a new house was set at $28,000 in July 2011, if we apply the US models and the $1.00:$1.60 ratio, this one charge alone could equate to an increase to new house prices of $45,000. Quantitative research on the impact of infrastructure charges on house prices has been undertaken in the US/Canada for the past three decades. However to date, no such studies have been undertaken in Australia.

This research investigates whether the US models are applicable in Australia, and how much infrastructure charges increase new house prices by in Australia. Why is this question important? Because the Queensland State Government has dual policies of housing affordability and developer-levied infrastructure charges. However to date, there has been no evidence of the impact of one policy objective on the other.

In understanding this flow on effect to housing affordability, this sequential, mixed method research firstly, identifies and analyses a number of empirical studies in the US where infrastructure charges have been in existence since the 1970’s. A comparative analysis of the structure of the US systems, and housing markets to those in Queensland, Australia is then carried out to identify key similarities and
differences and test the external validity of the US models. The findings of this first qualitative stage informs the second quantitative stage of research. Stage two develops an econometric model that estimates the extent of shifting or “over-shifting” of infrastructure charges to home buyers in Brisbane, Australia.

This research makes two important contributions to the existing research. Firstly, it provides the first empirical estimation of the impact infrastructure charges have on house prices in Australia. This data is important as industry and policy makers are at odds as to the causes of declining housing affordability across the country. It is important that policy makers are equipped with evidence based data on the flow on effects of infrastructure charges so as to be fully informed on the housing affordability impacts of the infrastructure charging policies. Secondly, this study tests the house price effects of infrastructure charges outside of North America where these effects have been well established. This research adds to the international literature by identifying factors that need to be considered when specifying such models in markets with different institutional environments. This is important as it establishes a framework for analysis of this topic in other countries, adds an international perspective to the well established US literature and challenges the external validity of the US conclusions.

Stage 2 of this study employs hedonic regression methods to estimate the impact of infrastructure charges on house prices and vacant residential lot prices in Brisbane, Australia during 2005-2011, using a data set of 29,752 house sales, comprising 4,699 new house sales and 25,053 existing house sales and 13,739 lot sales. The regression results for the effect of infrastructure charges on house prices in Brisbane indicated that for every $1.00 of infrastructure charge levied on developers, all house prices increase by $3.95, with existing house prices increasing by $3.56 and new house prices increasing by $4.69. These findings were higher than expected and higher than the US model average findings, particularly for new housing. Findings for the vacant lot models indicated that for every $1.00 of infrastructure charge levied on developers, all vacant lot prices increase by $1.69.

In summary, understanding “Who really pays for urban infrastructure” is critical to both the housing affordability and infrastructure funding debates in Australia and this research provides the first empirical data for policy makers to assess their policy objectives and outcomes against.
Table of Contents

CHAPTER 1: INTRODUCTION ....................................................................................................... 1
  1.1 Introduction .................................................................................................................. ............... 1
  1.2 Problem Statement ....................................................................................................................... 5
  1.3 Research Questions ................................................................................................................... 11
  1.4 Research Objectives ............................................................................................................... 11
  1.5 Research Hypothesis .............................................................................................................. 12
  1.6 Research Methodology .............................................................................................................. 12
    1.6.1 Stage 1 ............................................................................................................................ 16
      Archival Research .................................................................................................................. 16
      Semi-structured Interviews ................................................................................................. 17
    1.6.2 Stage 2 ............................................................................................................................ 20
      Econometric Modelling ...................................................................................................... 20
  1.7 Scope ......................................................................................................................................... 24
  1.8 Definitions ............................................................................................................................... 25
  1.9 Thesis Outline ............................................................................................................................ 27
  1.10 Chapter Summary ...................................................................................................................... 28

CHAPTER 2: THEORY AND LITERATURE REVIEW.............................................................. 31
  2.1 Introduction .................................................................................................................. ............. 31
  2.2 Infrastructure Charge Effect Theory .......................................................................................... 32
  2.3 The Actors in Who Really Pays for Urban Infrastructure? ........................................................ 34
    2.3.1 The Property Developer .................................................................................................. 35
    2.3.2 The Original Landowner ................................................................................................ 37
    2.3.3 The New Home Buyer .................................................................................................... 39
    2.3.4 Other Parties ................................................................................................................... 40
  2.4 Australia ..................................................................................................................................... 41
    2.4.1 Infrastructure Charging Regime ..................................................................................... 41
    2.4.2 Queensland ..................................................................................................................... 42
    2.4.3 Search for Empirical Evidence ....................................................................................... 45
  2.5 United Kingdom ........................................................................................................................ 48
    2.5.1 Infrastructure Charging Regime ..................................................................................... 48
    2.5.2 Search for Empirical Evidence ....................................................................................... 49
  2.6 United States .............................................................................................................................. 50
    2.6.1 Infrastructure Charging Regime ..................................................................................... 50
    2.6.2 Search for Empirical Research ......................................................................................... 53
    2.6.2.1 House Price Impacts (On-Passing) ................................................................................. 55
    2.6.2.2 Lot Price Impacts (On-passing) ...................................................................................... 60
    2.6.2.3 Undeveloped Land Price Impacts (Back Passing) .......................................................... 60
    2.6.2.4 Housing Supply Impacts .............................................................................................. 61
| 2.6.3 | Over-Passing: Benefit or Burden .................................................................................. 63 |
| 2.6.3.1 | Old View - Burden ........................................................................................................ 63 |
| 2.6.3.2 | New View - Benefit ....................................................................................................... 66 |
| 2.7 | Other ............................................................................................................................. 67 |
| 2.8 | Chapter Summary .......................................................................................................... 68 |

**CHAPTER 3: ECONOMETRIC MODEL ANALYSIS .................................................. 71**

| 3.1 | Introduction .................................................................................................................... 71 |
| 3.2 | What is a Hedonic House Price Model? ........................................................................ 72 |
| 3.3 | Variables That Effect House Prices ........................................................................... 75 |
| 3.4 | Analysis of Extant Models to Estimate Infrastructure Charge Effects ...................... 79 |
| 3.5 | Lawhon ........................................................................................................................... 81 |
| 3.5.1 | PhD 1996 .................................................................................................................. 81 |
| 3.5.2 | Journal Paper 2004 .................................................................................................... 84 |
| 3.6 | Shaughnessy ................................................................................................................ 85 |
| 3.6.1 | PhD 2003 ................................................................................................................... 85 |
| 3.6.2 | Ihlanfeldt and Shaughnessy 2004 ................................................................................ 89 |
| 3.7 | Mathur .......................................................................................................................... 90 |
| 3.7.1 | PhD 2003 ................................................................................................................... 90 |
| 3.7.2 | Mathur, Waddell and Blanco 2004 .............................................................................. 96 |
| 3.7.3 | Mathur, 2007 ............................................................................................................... 97 |
| 3.8 | Campbell ....................................................................................................................... 97 |
| 3.8.1 | PhD 2004 ................................................................................................................... 97 |
| 3.9 | Burge ............................................................................................................................ 101 |
| 3.9.1 | PhD 2005 ................................................................................................................... 102 |
| 3.9.2 | Burge and Ihlanfeldt 2006 ......................................................................................... 108 |
| 3.10 | Evans-Cowley and Rutherford ..................................................................................... 109 |
| 3.10.1 | Evans-Cowley, Forgey and Rutherford 2005 ............................................................. 109 |
| 3.10.2 | Evans-Cowley, Lockwood, Rutherford and Springer 2009 ........................................ 113 |
| 3.11 | Chapter Summary ....................................................................................................... 118 |

**CHAPTER 4: STAGE 1 FINDINGS ........................................................................ 121**

| 4.1 | Introduction .................................................................................................................... 121 |
| 4.2 | Independent Variable Analysis .................................................................................... 122 |
| 4.2.1 | Structural Characteristics ......................................................................................... 122 |
| 4.2.2 | Locational Characteristics ........................................................................................... 124 |
| 4.2.3 | Jurisdictional Characteristics .................................................................................... 125 |
| 4.2.4 | Thematic Conclusions ............................................................................................... 127 |
| 4.3 | Selection Of Study Area, Duration and Scale .............................................................. 128 |
| 4.3.1 | Thematic Conclusions ............................................................................................... 129 |
| 4.4 | Model Specification ...................................................................................................... 130 |
| 4.4.1 | Thematic Conclusions ............................................................................................... 130 |
| 4.5 | On Passing Ratio Analysis .......................................................................................... 131 |
List of Figures

Figure 1.1 Brisbane Dwelling Commencement and House Price Growth 2002 - 2011 ............................................ 8
Figure 1.2 Research Design and Methodology ................................................................................................. 15
Figure 1.3 Forming an Econometric Model ....................................................................................................... 22
Figure 1.4 Thesis Outline ..................................................................................................................................... 28
Figure 2.1 The actors in who really pays for urban infrastructure? ................................................................. 34
Figure 2.2 Average Non-Utility Fees by US State for a Single Detached Dwelling ............................................ 53
Figure 3.1 Factors that influence house prices ................................................................................................. 76
Figure 4.1 Thesis Outline ..................................................................................................................................... 150
Figure 5.1 Residential Land and Dwelling Prices - Brisbane 2001 - 2013 ......................................................... 156
Figure 5.2 Residential Land and Dwelling Sales - Brisbane 2001 - 2013 ......................................................... 156
Figure 5.3 Infrastructure Charge Register Provisions ....................................................................................... 169
Figure 7.1 Research Design and Methodology ................................................................................................. 205
Figure 7.2 Thesis Outline ..................................................................................................................................... 208
Figure 7.3 Who really pays for urban infrastructure? ....................................................................................... 217
List of Tables

Table 1.1  Mixed Method Characteristics .................................................................14
Table 2.1  Infrastructure Charges for Greenfield Developments (S,000 per lot in 2010) ........42
Table 2.2  Local Authority Infrastructure Charges (as at June 2010) .............................43
Table 2.3  House Cost Increases Due to Government Charges 2010 (a) ..........................46
Table 2.4  Infrastructure Charges Payable in US States ............................................52
Table 2.5  US Empirical Research Models and Findings – All Home Impacts ..................57
Table 2.6  US Empirical Research Models and Findings – New Home Impacts ................58
Table 2.7  US Empirical Research Models and Findings – Existing Home Impacts ..............59
Table 2.8  US Empirical Research Models and Findings – Lot Price Impacts ...................60
Table 2.9  US Empirical Research Models and Findings – Undeveloped Land Price Impacts (Back Passing) ..................................................................................61
Table 2.10 US Empirical Research Models and Findings – Housing Supply Impacts .............62
Table 3.1  Burge (2005) Sample Set Characteristics ..................................................103
Table 4.1  Structural Characteristics Data ....................................................................123
Table 4.2  Locational Characteristics Data ....................................................................124
Table 4.3  Jurisdictional Characteristics Data .................................................................126
Table 4.4  Key features of the US and Australian Infrastructure Charge Regimes ...............140
Table 5.1  IRSAD Included Variables ..........................................................................163
Table 5.2  IRSAD Excluded Variables ..........................................................................164
Table 5.3  IRSAD Ratings – Brisbane Northside .............................................................164
Table 5.4  IRSAD Ratings – Brisbane Southside .............................................................165
Table 5.5  Jurisdictional Data Source ...........................................................................167
Table 5.6  Variable Legend .........................................................................................175
Table 5.7  Summary Statistics – Housing .....................................................................176
Table 5.8  Summary Statistics – Lots – Brisbane .............................................................177
Table 6.1  Step Wise Process Model Summary- Houses ..................................................182
Table 6.2  Regression Results – Brisbane Houses .........................................................184
Table 6.3  Step Wise Process Model Summary- Existing Houses ....................................185
Table 6.4  Regression Results – Existing Houses ............................................................186
Table 6.5  Step Wise Process Model Summary- New Houses ........................................187
Table 6.6  Regression Results – New Houses .................................................................188
Table 6.7  Step Wise Process Model Summary- Two-Way Interaction: Existing and New Houses \(^d\) .................................................................................................................................................. 189

Table 6.8  Regression Results – Two-Way Interaction: Existing and New Houses ................. 190

Table 6.9  Step Wise Process Model Summary- Lots \(^d\) ........................................................................................................................................ 191

Table 6.10  Regression Results- Lots ......................................................................................................................... 192
### List of Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABS</td>
<td>Australian Bureau of Statistics</td>
</tr>
<tr>
<td>BCC</td>
<td>Brisbane City Council</td>
</tr>
<tr>
<td>COAG</td>
<td>Council of Australian Governments</td>
</tr>
<tr>
<td>GFC</td>
<td>Global Financial Crisis</td>
</tr>
<tr>
<td>HIA</td>
<td>Housing Industry Association</td>
</tr>
<tr>
<td>IRSAD</td>
<td>Index of Relative Socio-economic Advantage and Disadvantage</td>
</tr>
<tr>
<td>LGA</td>
<td>Local Government Area</td>
</tr>
<tr>
<td>NHSC</td>
<td>National Housing Supply Council</td>
</tr>
<tr>
<td>PCA</td>
<td>Property Council of Australia</td>
</tr>
<tr>
<td>PIP</td>
<td>Priority Infrastructure Plan</td>
</tr>
<tr>
<td>Qld</td>
<td>Queensland, Australia</td>
</tr>
<tr>
<td>RBA</td>
<td>Reserve Bank of Australia</td>
</tr>
<tr>
<td>RDC</td>
<td>Residential Development Council (Australia)</td>
</tr>
<tr>
<td>SEIFA</td>
<td>Socio-Economic Index for Areas</td>
</tr>
<tr>
<td>UDIA</td>
<td>Urban Development Institute of Australia</td>
</tr>
<tr>
<td>UK</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>US</td>
<td>United States of America</td>
</tr>
</tbody>
</table>
Statement of Original Authorship

The work contained in this thesis has not been previously submitted to meet requirements for an award at this or any other higher education institution. To the best of my knowledge and belief, the thesis contains no material previously published or written by another person except where due reference is made.

Signature:

Date: 15 January 2015
Acknowledgements

This thesis is dedicated to my family: to my parents who instilled in me their values and who taught me the gifts of unconditional love, forgiveness and independence; to my grandmothers who were role models of grace and dignity throughout my life; to each of my sisters whom I continue to learn life’s many lessons from; to Thomas who is the wisest and kindest soul I know, and who inspires me to be a better person every day; and to Neil who has loved, supported and encouraged me from the beginning, the middle and to the end of this journey.

Completion of this work would not have been possible without the expert direction and guidance of my supervisor Professor Chris Eves and associate supervisor Dr Connie Susilawati. I am sincerely grateful for all of their input, support, feedback, suggestions, encouragement, good humour and patience throughout my candidature.

I am also indebted to the academics and impact fee experts from the US that gave so generously of their time and wisdom to me during my visit in 2012. These include in order of my tour: Fred Forgy, Tim Shaughnessy, Shishir Mathur, Doug Campbell, Greg Burge, Chris Nelson, Julian Juergensmeyer, Clancy Mullen, Trey Trosper, Tom Springer, Ron Rutherford and Vicki Been. Without their expertise and wise counsel, I would have been unable to comprehend the intricacies of the US impact fee and taxation systems and how these contrast the Australian systems. By better understanding the fundamentals underscoring their empirical models I was able to better conceptualise mine.

Last, but by no means the least, I want to give thanks and recognition to my many dear friends and colleagues, who without their ongoing love, support, encouragement and patience, I would not have been able to contemplate this journey. Thank you to each and every one of you, your kindness and interest in my work, my progress and well-being will remain with me always.
Chapter 1: Introduction

1.1 INTRODUCTION

Housing is widely touted as the largest investment most Australians make in their lifetime, however despite all levels of government having housing affordability policies, housing affordability remains at critical levels in Australia (Demographia, 2013). Affordability is more than just house prices. It also includes ready access to public transport, schools and good road networks, and of course access to all the basic utilities. However, in fast growing areas, governments don’t have the funds to build all the new urban infrastructure new housing estates need. Sourcing this funding for the provision of new urban infrastructure in growing communities has been a policy dilemma for governments since the 1950s (Neutze, 1995). Existing communities refuse to pay for this new infrastructure by way of higher rates and taxes. So instead, developer infrastructure charges have been introduced as a “user pays” method of funding new urban infrastructure. In this way, governments appease existing residents by shifting the responsibility of funding new growth related infrastructure from the government (community) to the development industry (Burge, 2006); however the passing-on of these costs to new homeowners is said to directly contribute to reduced housing affordability (Been, 2005). The question is then raised: who really pays for urban infrastructure? The purpose of this thesis is to empirically examine the impact of current government infrastructure funding policies on housing affordability in Brisbane, Australia.

In the United States (“US”), research suggests that for every extra $1.00 of infrastructure charge, new house prices increase by around $1.60 (Nelson, Bowles, Juergensmeyer and Nichols, 2008). In the State of Queensland, where the maximum infrastructure charge for a new house was set at $28,000 in July 2011 (Persign, 2011), if we apply the US models and the $1.00:$1.60 ratio, this one charge alone could equate to an increase to new house prices of $45,000. Quantitative research on the impact of infrastructure charges on house prices has been undertaken in the
US/Canada for the past three decades. However to date, no such studies have been undertaken in Australia.

This research investigates whether the US models are applicable in Australia, and how much infrastructure charges increase new house prices by here. Why is this question important? Because to date there has been no empirical evidence on the linkage between the Queensland State Government’s dual policy objectives of housing affordability and developer-levied infrastructure charges. Whilst it is acknowledged that the issue of housing affordability is a wider issue than that of house prices alone, the initial and ongoing capital costs associated with housing is a significant contributor to the housing affordability conundrum and is the focus of this research.

House price movements are frequently reported on in the media, with specific focus often on affordability issues and much debate ensues on the relative causes. Australian housing is reported to be some of the most unaffordable in the world, with more than 75% of Australian housing markets considered severely unaffordable, with Australia ranked second behind Hong Kong as providing the most unaffordable housing on an international scale (Demographia, 2013).

Looking at the drivers of house prices in Australia, both demand and supply factors are identified as contributing to this phenomenon. Demand factors that contribute to escalating housing prices are: the availability of cheaper and more accessible finance, combined with strong economic and population growth, as well as tax and other incentives such as negative gearing and the first home owners grant (Worthington, 2012) together with low unemployment rates and strong household income growth (Reserve Bank of Australia, 2012). Supply side contributors to escalating house prices in Australia are suggested to be due to unresponsive housing supply resulting from governmental policy in the land release and zoning process, as well as in building and environmental regulation and infrastructure cost recovery (Ruming, Gurran and Randolph 2011, Australian Government, 2012).

With all of this conjecture as to the causes of rising house prices, it is unsurprising that there is little consensus on how house prices are determined, what contributes to house price increases and hence how government policies impact house prices. Data from empirical studies is required to ensure evidence based policy can be formulated.

Chapter 1: Introduction
The focus of this research is to examine the impact of infrastructure charges which are a government growth management tool, on house prices in Brisbane, Australia. Sourcing appropriate funding for the provision of new urban infrastructure has been a policy dilemma for governments around the world for decades. This is particularly relevant in high growth areas where new services and amenities are required to support rapidly growing populations (Ellickson and Been, 2005). The Australian infrastructure funding policy dilemmas are reflective of similar matters to some extent in the United Kingdom (“UK”), and to a greater extent the US and Canada. In these countries, infrastructure cost recovery policies have been in place since the 1940’s and 1970’s respectively (Evans, 2004b; Been, 2005).

The term “Infrastructure Charges” is a term that is used to encompass the estimated proportionate cost of providing trunk and other off-site urban infrastructure such as local roads, stormwater, community facilities and parks to new developments (refer to Section 1.8 for more detailed definition). These costs historically were borne by the public purse, however in high growth areas, local governments have been increasingly reluctant to fund such infrastructure through general revenue. Hence, various user-pays infrastructure charging schemes have been introduced in Australia in recent years (Productivity Commission, 2011) following patterns of development in other industrialised countries such as the UK and US. Industry has argued that the quantum of these charges in many jurisdictions have made development uneconomical and housing unaffordable (Housing Industry Association, 2003; Urban Development Institute of Australia, 2007; Residential Development Council, 2006 and 2007).

It is important to note that the State of Queensland is not a pioneer in Australia in its desire to shift the cost of new infrastructure from public to private funding. Nor is the debate on the associated impact on house prices only an issue in the Queensland state capital of Brisbane. Each of the seven States and Territories in Australia has relevant cost recovery legislation that enables the cost of new infrastructure to be recouped from developers at the time of statutory approval.¹ The

¹ See Chapter 6 of Productivity Commission 2011 for an overview of each State and Territory’s legislative provisions.
debate on the responsibility for funding new urban infrastructure and the impact of infrastructure charges on housing affordability started with the industry bodies from as early as the 1970s, and has more recently been identified as a policy issue by all levels of government. At a Federal Government level these include a number of inquiries into housing affordability at the highest level including: Ken Henry’s 2010 report into Australia’s Future Tax System (see Commonwealth of Australia, 2010), the Council of Australian Governments (“COAG”) Communique (see COAG, 2010), the Housing Supply and Affordability Reform Working Party Report (see COAG, 2012), three reports by the National Housing Supply Council (see National Housing Supply Council 2008, 2010 and, 2013), two reports by the Productivity Commission (see Chan, Forwood, Roper and Sayers 2009 and Productivity Commission 2011) and the yet to be concluded 2013 Senate Economics References Committee review on affordable housing. At a state level, review of infrastructure charges was formalised in Queensland in 2011 when the State Government established the Infrastructure Charges Taskforce to examine the issue (See Infrastructure Charges Taskforce, 2011).

Despite these state and federal government reports, there remains limited evidence based research on the impact of infrastructure charges on house prices from which policy makers can base decisions on in Australia. This poses a significant gap in the research on this topic. Formulation of a relevant model to quantify the impact of infrastructure charges on house prices in Australia will be the outcome of this research. This work is a keystone in the housing affordability debate, with state governments in high growth areas having user-pays infrastructure charging policies operating in tandem with housing affordability objectives, with no empirical evidence of the impact of one policy objective on the other. The contribution of this research is to provide Australian policy makers with the first quantitative study of its kind, providing empirical evidence of the impact of growth enabling infrastructure charges on house prices.

This initial chapter sets the scene for this research project. Further to this introduction, the problem statement is presented in Section 1.2. The research questions are set out in Section 1.3, followed by the research hypothesis in Section 1.4. Sections 1.5 and 1.6 outline the research methodology adopted and objectives respectively. Infrastructure charges for the purposes of this research are defined in
section 1.7. Section 1.8 describes the outline of the remaining chapters of this thesis and finally, Section 1.9 concludes this introductory chapter.

1.2 PROBLEM STATEMENT

All levels of government in Australia are under pressure to provide growth enabling urban infrastructure, as well as maintaining existing infrastructure in older established suburbs. Various funding mechanisms are available, however ratepayers and voters in general resist the introduction of new rates and taxes to fund infrastructure for which they perceive no benefit (Evans-Cowley and Lawhon, 2003) and debt adverse governments refuse to consider infrastructure bond issues (Chan et al., 2009). This is particularly relevant in high growth areas where new road, water, sewerage and waste water and other public services are required to support rapidly growing populations with limited public-purse budgets and equally limited debt appetites. As indicated in Section 1.1, the result has been the introduction of government policies for any new urban infrastructure to be paid for by the property developer as a condition of approval (Productivity Commission, 2011). However, property developers claim that these costs are merely passed on to home buyers, with a corresponding erosion of housing affordability (Residential Development Council of Australia, 2006, 2007; Urban Development Institute of Australia, 2007).

This section provides the background for the policy dilemma in Queensland, whereby over the study period, despite an increasing population and the effects of the Global Financial Crisis (“GFC”), house prices increased and housing supply fell. Developers claim the fall in supply and increase to house prices was due to the high infrastructure charges that government levied on new development at the time. This section will outline how the Queensland State Government’s growth management and housing affordability policies appear to be having outcomes that are at odds with their stated objectives over this period. The study period for this research of 2005 – 2011 co-incides with a period of high population growth in Queensland, as well as the time for which the Priority Infrastructure Plan provisions of the Integrated

---

2 For further details of Priority Infrastructure Plans refer to Productivity Commission, 2011 (Chapter 6) and Queensland Government, 2009 (sections 88, 89 and 625).
Chapter 1: Introduction

Planning Act 1997, Integrated Planning and Other Legislation Amendment Act 2003 and its successor the Sustainable Planning Act 2009 were in effect (see Queensland Government, 1997, 2003 and 2009)\(^3\). It also straddles the years of the GFC where booming housing markets stalled further to global credit constraints and falling asset values. Further details of selection of the study area and period are provided in Section 5.3.

The State of Queensland, Australia was the subject of significant population growth over the decade to 2010, growing at an average rate of 2.5%. This growth was significantly in excess of the national population growth average of 1.6%. In real numbers, this equated to an average influx to Queensland of approximately 112,900 new residents per annum; or at 2.6 persons per household demand in the order of over 43,000 new households each year (Queensland Government, 2010). Approximately half of this growth occurred in the Greater Brisbane region (Brisbane Marketing, 2014). This amount of growth placed significant demand on the State’s planning systems specifically on the availability of appropriately zoned and serviced land, including the provision of new infrastructure as well as the upgrading of existing systems, amenities and services. In order to manage this growth, the State Government responded with a number of policy responses. These policy responses were aimed at managing the supply of new housing, with the overriding intent to be for new housing to be provided where sufficient infrastructure was available, and that housing remained affordable (Queensland Government, 2009).

The legislative response to manage this growth was to introduce amendments to the Integrated Planning Act 1997 in 2003 (see Queensland Government, 2003) whereby new housing developments became liable for the cost of the infrastructure required to service that growth for the first time (Nicholls, 2011) with further provisions contained in the Sustainable Planning Act 2009 (see Queensland Government, 2009). Further to the 2003 enabling legislation, local authorities within Queensland increasingly sought to recoup from developers not only 100% of the proportionate costs of new trunk infrastructure (i.e. on site) to service new estates, \(^3\) For further details of the legislative reform process see England, 2010 and Steele and Dodson, 2014.
but also the partial costs of offsite infrastructure be it for district, regional or even State wide services. Infrastructure charges were able to be levied on a wider range of social and economic infrastructure including: water supply, sewer, transport, bikeways, roads, community purpose, parks, recreation waterways and stormwater (Urbis JHD, 2010).

This 100% cost recovery change to the infrastructure charging regime lead to significant and rapid increase in infrastructure charges in many local government areas. Examples of the subsequent rapid and significant increases in infrastructure charges provided by the development industry include: water headworks charges increasing 1300% in four years; an increase from $6,000 to $50,000 per lot for infrastructure charges in one increment; an increase from $8,000 to $47,000 in another example; as well as a number of examples where infrastructure and other charges increased between $5,000 and $40,000 per lot during the time taken for the assessment of the development application (Urban Development Institute of Australia, 2007). Infrastructure charges in one South East Queensland region were reported to have increased 41% each year in the years 2006 to 2010 effectively increasing from $8,000 per lot to $32,000 per lot (Urbis JHD, 2010). In Brisbane, infrastructure charges were reported to have increased 100% between 1995 and 2006 (Productivity Commission, 2011). By 2010, infrastructure charges in Greater Brisbane were reported to be $25,000 - $30,000 per lot in many areas and up to $50,000 and $60,000 per lot for greenfield developments (Urbis JHD, 2010).

Over the same period, a number of authors identified a chronic and growing undersupply of housing supply in Queensland, with many citing poor planning policy as a key cause (see Commonwealth Government, 2008; Residential Development Council, 2006, 2007; Urban Development Institute of Australia, 2007; Urbis JHD, 2006; National Housing Supply Council, 2008, 2010, and 2013). Research commissioned by the Residential Development Council in 2006 indicated that South East Queensland was forecast to have a deficit of 10,484 lots by 2016 due to new land release constraints. This however pre-dated the GFC and subsequent figures released by Queensland Government and ABS indicated new housing approvals dropped 16% in 2008 and new housing starts a further 24% in 2009, despite the persistent population growth of 2.8% - 2.4% in the same period (ABS, 2011). The National Housing Supply Council (“NHSC”) (2010) reported a similar deficit on a
national level with an estimated gap in the number of dwellings of 178,400 as at June 2009, up from 99,500 just a year prior, with that gap forecast to grow.

Over the corresponding period, house prices in Queensland went through unprecedented growth averaging 18.8% increase per annum between 2002 and 2010 (ABS, 2010) and housing affordability became a key policy issue for all levels of government (Queensland Government, 2007).

Housing statistics for Brisbane from the Australian Bureau of Statistics (“ABS”) illustrate this conundrum. Figure 1.1 demonstrates a growing average house price (solid line to right hand axis) combined with falling new commencements (dashed line from left hand axis, together with downward sloping fine trend line). It can be seen that during the study period, Queensland’s housing market experienced significant stresses from high demand, combined with growing undersupply. These conditions lead to steep house price growth as demand outstripped supply.

Figure 1.1
*Brisbane Dwelling Commencement and House Price Growth 2002 - 2011*

Source: (ABS, 2011)
Industry bodies and developers claimed that the rapid and significant increases to infrastructure charges were responsible for pushing house prices to a level that was unaffordable to the market (Housing Industry Association, 2003; Residential Development Council, 2006, 2007; Urban Development Institute of Australia, 2007). This was occurring by virtue of the combined effects of:

- Developers passing these additional costs on to home buyers; and
- These additional costs rendering projects commercially unviable, and with fewer projects proceeding, demand drove up prices in an environment of reduced supply.

On the other hand, other industry experts such as AEC Group (2009) claimed that there is little relationship between infrastructure charges and housing affordability, with charges more likely to be reflected in lower developer profit margins, or lower land prices.

This evidence of increasing house prices occurring in concert with rapidly increasing infrastructure charges appears to be in direct conflict with the State Government’s 2007 Housing Affordability Strategy where the primary aim was “(to) ensure that the State’s land and housing is on the market quickly and at the lowest cost.” (Queensland Government, 2007, p. 1). This was to be achieved via a number of measures which specifically included regulating infrastructure charging across the State (Queensland Government, 2007).

What is clear, is that the policy objectives of the Queensland 2007 Housing Affordability Strategy and the Sustainable Planning Act 2009 (and its 2011 amendments4) appear to be at odds. On one hand the government believes it is facilitating affordable housing supply via developer paid infrastructure charges, whilst on the other hand developers claim these charges are merely passed onto new home buyers. In the United States, research suggests that for every extra $1.00 of

---

4 A number of key provisions of the Sustainable Planning Act 2009 relating to infrastructure charges were amended by the Sustainable Planning (Housing Affordability and Infrastructure Charges Reform) Amendment Act 2011, which introduced “maximum adopted infrastructure charges” in November 2011 (see Queensland Government, 2011). The impact of the 2011 legislation is outside the scope of this thesis as explained further in Chapter 5.
infrastructure charge, new house prices increase by around $1.60 (Nelson et al., 2008). In Queensland, where the maximum infrastructure charge for a new house was set at $28,000 in July 2011 (Persign, 2011), if the US models can be applied to the Australian housing markets and the $1.00:$1.60 ratio is valid, then this one government charge alone could equate to an increase in new house prices in the order of $45,000.

Quantitative research on the impact of infrastructure charges on house prices has been undertaken in the US/Canada for the past three decades. However to date, no such studies have been undertaken in Australia. This is a significant gap in the research in Australia, with a lack of empirical evidence to support the claims of either side of the debate as to whether or not infrastructure charges increase the price of housing.

The purpose of this thesis is to examine the question of who really pays for urban infrastructure within the residential sector and the corresponding impact infrastructure charges have on housing affordability in Australia. This research question is important because governments throughout Australia have dual policies of housing affordability and growth management. However to date there has been no empirical evidence of the linkage between the dual policy objectives of housing affordability and user-pays provision of infrastructure in Australia. Whilst it is acknowledged that issue of housing affordability is a wider issue than that of house prices alone, the initial and ongoing capital costs associated with housing is a significant contributor to the housing affordability conundrum and is the focus of this research.
1.3 RESEARCH QUESTIONS

The specific purpose of this research is to address the following questions:

1. Is there empirical evidence in Australia that the imposition of infrastructure charges by governments increases the price of housing?

2. Is there empirical evidence internationally that the imposition of infrastructure charges by governments increases the price of housing?

3. Can international models be used to assess the impact of infrastructure charges on the price of housing in Brisbane, Australia?

4. What is the impact of infrastructure charges on the price of housing in Brisbane, Australia?

The outcome of this research will be to produce empirical evidence of the impact of infrastructure charges on house prices in Australia. This is important as these results will inform policy makers on the outcomes of their growth management strategies and the consequent impact infrastructure charges have on the objectives of their housing affordability policies. This research will provide evidence in response to the overarching thesis question of: who really pays for urban infrastructure?

1.4 RESEARCH OBJECTIVES

The purpose of this research is to provide empirical evidence on outcomes of the parallel policy objectives of the State Government’s growth management policy (developer paid infrastructure charges) and its housing affordability strategies.

Specifically it will develop a model that will estimate the impact of infrastructure charges on the price of housing in Brisbane, Australia. This will be achieved through the use of an econometric model to estimate these price impacts. In doing so, this research will provide evidence to inform the ongoing policy debate on the contribution of infrastructure charges to Australia’s declining housing affordability and thus respond to the question of who really pays for urban infrastructure.
1.5 RESEARCH HYPOTHESIS

The hypothesis for this research is that infrastructure charges are a cost of development, or in other words a supply chain input. Whilst these charges are levied on developers by government, in an uncertain and rapidly changing infrastructure charging regime, these costs are not borne by developers but are passed on to home owners, thus increasing house prices and adversely affecting housing affordability.

Further, it is hypothesised that infrastructure charges are not passed on in a dollar for dollar fashion to home buyers, but that these costs are “over passed” with the impact on house prices being in excess of the actual amount of the infrastructure charge itself.

1.6 RESEARCH METHODOLOGY

This research will seek to quantify the effect of infrastructure charging policies to house prices in Brisbane, the State capital and major metropolitan area of Queensland, Australia during the years 2005 - 2011. In undertaking the preliminary exploratory phases of this research, two key sub-issues became apparent. Firstly, a number of US studies on this topic were identified that employed a range of differing econometric techniques. Whilst there was a reported consistency in their findings of overpassing of infrastructure charges in the range of $1.50 - $1.70 (Nelson et al., 2008), there appeared to be little consistency in approach and there appeared little evidence of a preferred econometric methodology or evidence of preferred model evolution over time. Study area, study duration, study size, and data requirements varied considerably between studies also, giving little indication as to a preferred approach for use in the Australian context, particularly given such a study would be the first of its kind identified outside of the US/Canada. Detailed examination of these matters was considered important to ensure an appropriate econometric technique, data set and study area/duration/size was selected for use in this study.

Secondly, nuances of the US housing market were apparent in these studies that did not apply in the Australian context. Whether these institutional factors could be removed from the models, and the models adapted for the Australian context without affecting their predictive qualities, was an important consideration in determining the external validity of these studies, their findings and conclusions.
Addressing these issues within the research questions requires a multifaceted approach that includes: pragmatism, deductive and inductive logic, integrated qualitative and quantitative data collection and analysis, which are all features of mixed methods research (Teddlie and Tashakkori, 2009). The sequential and exploratory nature of the research questions lends itself to an exploratory mixed method research design, beginning qualitatively to explore the phenomenon of the incidence of infrastructure charges on house prices in the US in depth and then measure its prevalence in Australia.

Mixed methods provide a means for combining the strengths of both qualitative and quantitative approaches to best understand the research problem (Creswell, 2008). A two stage, exploratory sequential mixed method design has been adopted, consistent with Creswell and Plano Clark’s (2007) framework for an instrument development model. This is an appropriate methodology as it provides for qualitative data to be collected and analysed in the first stage, with those results then used to specify the model to be tested quantitatively in the second phase (Creswell, 2011). This design typology focuses on the qualitative phase, the findings of which are used in the development of an instrument for use in the qualitative phase (Creswell and Plano Clark, 2007).

Mixed methods research is often described as the third research paradigm as it bridges the gap between quantitative and qualitative research (Burke-Johnson and Onwuegbuzie, 2004). The advantages of an exploratory mixed method design are that the separate phases make it easy to describe, implement and report on; it is easily applied to multi-phase research and can answer a broader and more complete range of research questions because the researcher is not confined to a single method or approach; it can provide stronger evidence for a conclusion through convergence and corroboration of findings; it can add insights and understanding that might be missed when only a single method is used; qualitative and quantitative research used together produce more complete knowledge necessary to inform theory and practice; and despite its qualitative emphasis, makes its findings more acceptable to quantitative audiences (Burke-Johnson and Onwuegbuzie, 2004; Creswell and Plano Clark, 2007).

However this methodology is not without its challenges. These include extended timeframes for implementation due to the two stage approach; unknown
nature of the quantitative stage at the outset; the researcher has to learn multiple methods and approaches and understand how to mix them appropriately; and deciding which data to use from the qualitative stage to build the quantitative instrument (Burke-Johnson and Onwuegbuzie, 2004; Creswell and Plano Clark, 2007).

The mixed methods approach is appropriate for this study as it meets each of the criteria for Teddlie and Tashakkori’s (2011) “Eight Contemporary Characteristics of Mixed Methods Research” (p. 287) as indicated in Table 1.1.

Table 1.1

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Study Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Methodological eclecticism</td>
<td>Combination of qualitative and quantitative methodologies</td>
</tr>
<tr>
<td>2. Paradigm pluralism</td>
<td>Pragmatism, post positivism, interpretivism</td>
</tr>
<tr>
<td>3. Emphasis on diversity at all levels of the research enterprise</td>
<td>Diverse range of exploratory and confirmatory research questions</td>
</tr>
<tr>
<td>4. Emphasis on continua rather than a set of dichotomies</td>
<td>“Either-or” dichotomies are replaced with integrated sequential questions and innovative methods</td>
</tr>
<tr>
<td>5. Iterative, cyclical approach to research</td>
<td>Sequential research questions and research design</td>
</tr>
<tr>
<td>6. Focus on the research question (or research problem) in determining the methods employed</td>
<td>Research questions/problem have directed the path of the research and the research design</td>
</tr>
<tr>
<td>7. Set of basic “signature” research designs and analytical processes</td>
<td>Exploratory sequential instrument development model adopted</td>
</tr>
<tr>
<td>8. Tendency toward balance and compromise that is implicit within the “third methodological community”</td>
<td>Pragmatic approach that combines the strengths of both qualitative and quantitative methodologies</td>
</tr>
</tbody>
</table>

Source: Teddlie and Tashakkori’s (2011) and author

The two stages of this exploratory sequential instrument development model are illustrated in Figure 1.2. Stage 1 of this research encompasses the qualitative techniques of archival research and semi-structured interviews to address the two sub-issues identified above. The data collected from these two methods are then triangulated with the ongoing literature review to establish the basis for the second
quantitative stage of this research. The findings of Stage 1 informs the specification of the econometric model which is then used for quantitative analysis in Stage 2.

Figure 1.2
Research Design and Methodology

This approach is consistent with Creswell’s (2008) data mixing approach whereby the quantitative and qualitative data is mixed by connecting the data analysis step of the first stage to the data collection step of the second stage, thus building on the first stage findings. One advantage of using mixed methods research is that the use of both qualitative and quantitative approaches will provide a more complete understanding of the research problem than either approach alone (Creswell, 2008).

The activities associated with each stage of this exploratory sequential instrument design approach and how these address the research questions are detailed below.
1.6.1 Stage 1

Stage 1 research is the qualitative phase of this thesis and is designed to address the first three research questions. As indicated in Figure 1.2 this stage triangulates the literature review and the qualitative techniques of archival research and semi-structured interviews. The purpose of the archival research phase is to reveal any evidence of econometric methodological evolution from prior works on this topic. The semi-structured interviews will inform this process by providing a deeper level of insight into implicit assumptions in the model and data selection process, as well as insight into the functionality and characteristics of the international housing markets that are relevant to econometric model design and assumptions. This Stage is important to ensure that the econometric model design utilised in Stage 2, and the underlying assumptions adopted are appropriate in the Australian context. It will also be important to understand the respective housing markets and institutional characteristics to ensure appropriate data is utilised and the results interpreted in a practical and applied manner.

The theoretical basis for the selection of these qualitative research methods is described below:

Archival Research

Archival research involves “the locating, evaluating, and systematic interpretation and analysis of sources found in archives” (Archival Research, null). Archival research is appropriate for a wide range of research activities due to its versatility and wide range of knowledge that can be served (Berg, 2009). The premise of archival research lies is the observational nature of the research, where researchers can examine a phenomenon without interfering with it or changing it (Teddlie and Tashakkori, 2009). Often related to social research, this technique is appropriate as it includes collecting data from existing sources (Kellehar, 1993).

Archival research can apply to a range of data sources, be these privately or publicly held (Berg, 2009) and include written and audio-visual records as well as material culture (Kellehar, 1993). Repositories of such data include: registries, archives, libraries and museums (Kellehar, 1993).

For this research, it is the written record that is of interest, specifically scholarly journal articles and other prior works such as PhD theses. The strengths of
this technique lie is in its unobtrusive nature and that it can be used for historical data, which is readily available from web linked databases (Teddlie and Tashakkori, 2009) such as university PhD repositories and other academic databases.

Kellehar (1993, p53) outlines four advantages of this technique when applied to published sources:

- Provision of a comprehensive data source (both primary and secondary data as well as support literature);
- Data gathered is often unique (historically, methodologically or administratively);
- Provision of a source of longitudinal data; and
- Highly reliable data source which can be readily re-checked by others.

A potential limitation of this method is that of information gaps due to incomplete or dated studies, or limited access to information. This potential shortcoming will be sought to overcome through the mixed method design whereby the data gathered from the published works (eg. Journal articles and prior theses) can be supplemented with the interview data from the semi-structured interviews (Teddlie and Tashakkori, 2009) as discussed under the following heading, and triangulation (Berg, 2009).

The primary purpose of the archival research will be to assess and document the evolution of econometric modelling techniques that have been used elsewhere for the purposes of estimating the effect of infrastructure charges on house prices. Further details of this research are provided in Chapter 3. From this basis, the external validity of existing models will be assessed in Chapter 4 and inform the development of the instrument in Stage 2 of this thesis, being the specification and application of a quantitative model to be adopted for this research.

Semi-structured Interviews

As indicated previously, semi-structured interviews have been selected for use in this exploratory sequential instrument design mixed methods approach in order to overcome the limitations of utilising archival research alone (Berg, 2009). Specifically the purpose of this phase is to provide a deeper level of insight into implicit assumptions in the model and data selection process, as well as insight into
the functionality and characteristics of the international housing markets that are relevant to econometric model design and assumptions.

Semi-structured interviews sit on the continuum between structured (questionnaire) and unstructured (observation) interview techniques (Newton, 2010). Given the triangulation nature of this phase of the research, and the fact that each archival source will be unique to its author, these semi-structured interviews will be based on an interview guide that lists only areas for discussion (Plowright, 2011) and open-ended questions (to uncover additional or unforseen information) (Hove and Anda, 2005). This open framework interview design allows a focused, yet conversational, two-way communication between the interviewer and interviewee where they can both give and receive information (Creswell, 2003).

Interviewees will be questioned broadly on the local context surrounding their models, selection of independent variables, implicit assumptions made, housing market structure matters, the interpretation of results and other related items.

A limitation of this method is that it relies on the inter-personal skills of the interviewer and their ability to establish relationship and rapport in order to elicit data (Newton, 2010). A further limitation is that in the interview guide approach topics may be inadvertently missed and the method depends significantly on the skill of the interviewer (Patton, 2002).

Criteria for selection of the interviewees included:

- Have authored (or co-authored) empirical studies on the house price effects of infrastructure charges in the past decade and these works resulted in findings of significance; or
- Were acknowledged industry experts in the field of housing development and infrastructure charges; and
- Were available for interview during this researcher’s three week study tour of the US in September, 2012.

Interviewees will be recruited primarily via direct email approach, with email addresses sourced from internet searches of academic profiles. Face-to-face meetings with the interviewees will be arranged where possible. Opportunistic interviews may occur if further expert/academics that meet the criteria are identified.
and available within the study tour agenda. Further details of these interviews are provided in Chapter 4.

The main purpose of this semi-structured interview process is to aid in the understanding and analysis of the data already gathered by the archival research. Triangulation of this data with that gathered from the archival research, together with the literature review will inform the specification of the model to be developed and applied in Stage 2 of this research. The findings from Stage 1 of this research are detailed in Chapter 4.

The specific activities involved in addressing each of the research questions involved in Stage 1 are detailed below:

**Question 1: Is there empirical evidence in Australia that the imposition of infrastructure charges by governments increases the price of housing?**

- Comprehensive literature review of Australian scholarly literature on the relationship between infrastructure charges (or the interstate equivalent) on house prices;
- Review research and advocacy produced or sponsored by industry bodies in Australia on the relationship between infrastructure charges and house prices; and
- Review state and federal government research and publications that identify infrastructure charges as an impact on housing policy.

**Question 2: Is there empirical evidence internationally that the imposition of infrastructure charges by governments increases the price of housing?**

- Comprehensive and systematic literature review of international scholarly literature on the relationship between infrastructure charges (or the international equivalent) on house prices. International sources will be focused on the US and UK which have comparable planning systems to Australia and established infrastructure cost-recovery policies. Literature from other countries will be searched; and
- Review of any empirical studies used in international literature that quantify the impacts of infrastructure charges (or equivalent) on house prices.
Question 3: Can international empirical models be used to assess the impact of infrastructure charges on the cost of new housing in Brisbane, Australia?

- Archival research of studies identified in the previous step including the critical analysis of the study characteristics, key findings, methodology and assumptions used in those models to determine the level of relevance in comparison with the Queensland market mechanisms, availability of data, appropriateness of variables employed, infrastructure charging policies, and planning and taxation regimes;

- A comparative analysis of the structure of the international taxation systems and housing markets to those in Australia will then be carried out to identify key similarities and differences that may impact underlying assumptions and thus specification of the model; and

- This research will be enriched by a research tour to carry out semi-structured interviews with international academics and other infrastructure charging experts. The purpose of these interviews will be to supplement the archival research of the existing models for the purposes of better understanding the external validity of any prior studies.

1.6.2 Stage 2

Stage 2 comprises the quantitative component of this research. Using the Stage 1 findings, the instrument developed in Stage 2 will be an econometric model appropriate to the Australian housing market characteristics. This technique will quantitatively estimate the direct impact of infrastructure charges on house prices in Brisbane, Australia and provide the empirical evidence of the extent of any on passing or “over passing” of infrastructure charges onto home buyers.

Econometric Modelling

Econometric modelling is the application of mathematical and statistical methods to the analysis of economic data. This quantitative technique aims “to give empirical content to economic relations for testing economic theories, forecasting, decision making, and for ex post decision/policy evaluation” (Geweke, Horowitz, and Pesaran, 2006, p.2). It encompasses a set of quantitative or statistical techniques that are used to quantify the impact of one economic phenomenon on another.
form of multiple regression analysis, econometrics utilises multiple variables, including dummy variables to measure economic impacts or hypotheses (Thomas, 1988).

By quantifying aspects of economic problems, econometrics calls for a marriage of measurement and theory in economics. Theory without measurement, being a branch of logic, can only have limited relevance for the analysis of actual economic problems. While on the other hand, measurement without theory, being devoid of a framework necessary for the interpretation of the statistical observations, is unlikely to result in a satisfactory explanation of the way economic forces interact with each other. Neither measurement nor theory on their own is sufficient to advance our understanding of economic phenomena, hence the evolution of econometrics (Pesaran, null).

The use of econometrics for examining the effect of changes in economic conditions on real estate markets is well established (Brooks and Tsolacos, 2010). Malpezzi (2002) credits Maclennan with publishing the seminal works on the use of econometrics in house price modelling in the mid 1970’s. Since then, advances in computational capacity and data availability have seen the proliferation of these techniques (Cho, 1996).

The steps involved in forming an econometric model are indicated in Figure 1.3 overleaf.
As indicated previously, one of the challenges of an exploratory sequential instrument design approach is the unknown nature of the quantitative stage at the outset. As will become apparent in Chapters 2 and 3, a wide range of econometric techniques are available. As noted by Brooks and Tsolacos (2010) the particular characteristics of a real estate market will affect model outcomes, and “for this reason they should be well understood” (p 6). Hence, the adoption of the mixed methods approach for this thesis. It is important to undertake the Stage 1 qualitative process in order to first understand the particular housing market characteristics of the previous studies, and compare these to the study area in question, to ensure correct specification and interpretation of an Australian model.

Econometric models suffer from numerous potential errors. These can include errors due to model specification, omitted variables, inclusion of irrelevant variables, adoption of the incorrect functional form, highly correlated variables (multicollinearity) and interpretation errors (Washington, Karlaftis and Mannering, 2011). One of the important purposes of the Stage 1 qualitative stage of this research
is to assist in Step 1 and reduce the potential for such errors, particularly since this is the first Australian study of its kind. The theoretical model for passing of infrastructure charges onto new house buyers is detailed in Chapter 2. Details on established econometric techniques associated with house price models are included in Chapter 3. A limitation of econometric techniques is the availability of the requisite economic data (Meen, 2001) which impacts Step 2. This deficit can impact the effectiveness of this methodology and is identified as a potential limitation of this research as discussed further in Chapter 5, together with the model estimation (Step 3). The results and findings of the Stage 2 model (Steps 4, 5 and 6) are detailed in Chapter 6.

Hence, Stage 2 specifically addresses research question four in a quantitative manner, and the overarching thesis question of “who really pays for infrastructure?” The specific activities that will address this research question are identified below:

**Question 4: What is the impact of infrastructure charges on the price of housing in Brisbane, Australia?**

- Using the findings of Stage 1, an appropriate econometric model will be specified to estimate house price impacts of infrastructure charges in Queensland;

- A data set for the Greater Brisbane region will be gathered. This data set will comprise the relevant structural, locational and jurisdictional characteristics of housing in the study areas. Infrastructure charge data will need to be obtained;

- Testing and validation of the model;

- Application and interpretation of the econometric model to determine how the Queensland infrastructure charges regime impacts the price of housing in Brisbane, Queensland; and

- Separate models for all houses, new houses existing houses and vacant residential lots will be specified in order to estimate any differential effects.
1.7 SCOPE

It is appropriate at this point to clarify the scope of this research project. Given the focus of the research is the residential sector and single unit dwellings in particular, the impact of infrastructure charges on other development types such as commercial, retail or industrial, will not be examined.

This research will focus on detached suburban dwellings, as this is the predominant housing type in Greater Brisbane, particularly in greenfield development areas.

Whilst the focus on this research is on increased house prices, this research project does not specifically examine whether these increases make housing affordable or not. There is certainly an implied connection between the two, however housing affordability is a wider topic that takes into consideration many other consumer factors such as household income and expenditure that are outside of the direct scope of this project, and may be the subject of further research.

Whilst the discussion within this document refers to all of the State of Queensland, the model that is developed will be tested on data from the Greater Brisbane region only. This study area has been selected as data on infrastructure charges at a regional council level has not been made available to the author despite numerous attempts to access such data.

The purpose of this research is not to critique the previous or new legislative provisions in Queensland, nor is it to examine alternative urban infrastructure funding options. The study period selected pre-dates the 2011 introduction of Adopted Infrastructure Charges, due to the temporary nature of that policy change and the complexities associated with its transitionary arrangements (see Queensland Government, 2011). Analysis of the further 2014 legislative changes that were announced during the finalisation of this thesis are also outside of scope.
1.8 DEFINITIONS

As indicated previously, the term “Infrastructure Charges” is a term that is used to encompass the estimated proportionate cost of providing trunk and other off-site urban infrastructure such as local roads, stormwater, community facilities and parks to new developments. It is a one off charge levied on the developer, generally at the time of rezoning/planning approval (Been, 2005; Burge, 2006; Campbell, 2004; Ihlanfeldt and Shaughnessy, 2004; Mathur, Waddell, and Blanco, 2004). These costs historically were born by the public purse, however in high growth areas, governments have been increasingly reluctant to fund such infrastructure through general revenue. Existing home owners resist paying higher rates and taxes to fund new development. Hence infrastructure charges were introduced to shift these costs to the private sector (Burge, 2005).

Around the globe, various terminologies are used to describe what are essentially urban infrastructure funding mechanisms. For example, the term “impact fees” is used throughout the majority of the US, “development charges” is prominent in Canada, “planning obligation”, “planning gain” or “Section 106 agreements” are all terms used to describe the equivalent to an infrastructure charging system in the UK (Evans, 2004a). “Exactions” is a general term used in Indian (3i Network, 2009) and some American literature (Been, 2005), whilst in Australia “infrastructure charges”, “developer contributions” or “development levies” are largely interchangeable terms depending on the jurisdiction (Productivity Commission, 2011). 6

For clarity, this paper uses the term “infrastructure charges” when referring to the one off fees chargeable by a local authority for the provision of urban infrastructure required to support new residential development. The term “local rates” is used to describe regular local jurisdictional levies on existing home owners for the purposes of infrastructure repairs, maintenance and renewal, amongst other local government services. Whilst not directly interchangeable, for the purposes of

6 Clinch and O’Neill (2010) provide a distinction between infrastructure charges and development charges (Ireland). However this distinction is not made in this research.
Chapter 1: Introduction

In this paper, this term is used in lieu of terms such as “property taxes” (US) and “local government taxes” (UK). Given the topic of this research is based on house price impacts, the scope of this review is limited to residential development only, even though infrastructure charges are levied on all development sectors.

Another important definition to clarify at this point is the use of the term “vacant land”. In the residential development sphere, “vacant land” could refer to either the subdivided and serviced developed lot that is yet to have a home built upon it, or the undeveloped (englobo) land (zoned or unzoned) that is awaiting subdivision and the provision of utilities and amenities. In order to avoid confusion, for the purposes of this research, the term “lot” is used to describe the subdivided and serviced developed vacant land; and “land” is used in relation to the description of undeveloped (englobo) land that is awaiting subdivision.

Whilst on the topic of lots, it is acknowledged that any price effect of infrastructure charges technically should impact lots, and not the new house price given infrastructure charges are associated with the subdivision process and not the actual house construction. However, for the purposes of this research, and its contribution to the housing affordability debate, the impact on house prices is the primary focus of this research. This methodology assumes that the house price construction cost remains relatively standard across a market due to the highly competitive nature of this industry, and that new house price fluctuations are largely due to factors associated with the lot price and structural factors associated with the house. In any case, where data is available both house and lot price effects will be examined.

Finally, all dollar figures noted within this thesis are in the currency of the country associated with that study. For example, the references, data and findings of the US literature are expressed in US dollars. The data and references sourced from UK literature is more obvious as it is expressed in pounds. The data and findings associated with this thesis are expressed in Australian dollars. Currency conversion is not required as it is the on passing ratio (amount of the charge compared to the associated increase in house price) that is relevant in this analysis.
1.9 THESIS OUTLINE

This introductory chapter has provided the background and context for this research into the impact of infrastructure charges on house prices in Australia. It has also defined the purpose, significance and scope of study to be carried out.

Chapter 2 reviews the theory behind the conundrum of “who really pays for urban infrastructure”. It goes on to examine the Australian literature on the topic as well as the international literature. In doing so, it addresses the first two research questions.

Chapter 3 documents the findings of the archival research process. It analyses the extant models that estimate the impact of infrastructure charges on house prices. This analysis focuses on the methodology, assumptions, independent variables, theory and findings of recent similar studies. Chapter 4 analyses the data collected from the semi-structured interview process, tying together all the data collected to this stage and presents the findings and contributions from this initial Stage 1. This analysis addresses the third research question and concludes the Stage 1 research.

Stage 2 of this research is addressed in Chapters 5 and 6. It is here that the findings from Stage 1 are utilised to inform specification and application of a suitable model to estimate the house price effects of infrastructure charges in Australia. This process commences in Chapter 5 with a detailed description of the approach, data and model. Chapter 6 presents the findings of this study and contribution to knowledge, responding to research question 4. The conclusions, implications for industry and policy makers, and an agenda for further research are drawn in Chapter 7. This thesis outline is illustrated in Figure 1.4.
This document has been prepared in completion of the requirements for the degree of Doctor of Philosophy. It has been prepared in accordance with Queensland University of Technology Thesis Presentation and Management in Word 2007 document and template.

1.10 CHAPTER SUMMARY

Housing affordability is at critical levels in Australia and the reasons for this are the subject of much debate. Development industry bodies maintain that infrastructure charges are a significant contributor to the supply-side drivers of increasing house prices. Are housing prices being driven by demand only, or are there other contributory factors at play? There is a long established international research base concluding and verifying that infrastructure charges contribute to increased house prices (Evans-Cowley and Lawhon, 2003), and reduced housing affordability (Been, 2005). To date the academic community in Australia has not responded to this issue in an empirical manner. This is a significant gap in Australian research in quantifying these contributory affects and this research seeks
to verify that infrastructure charges are a major contributor to increasing house prices and seeks to quantify that impact for the first time in Australia.

In understanding the flow on effect of infrastructure charges to housing affordability, an exploratory sequential, instrument design, mixed method approach firstly, identifies and analyses a number of empirical studies in the US where infrastructure charges have been in existence since the 1970’s. A comparative analysis of the structure of the US systems, and housing markets to those in Queensland, Australia is then carried out to identify key similarities and differences and test the external validity of the US models. The findings of this first qualitative stage informs the second quantitative stage of research. Stage two develops an econometric model that estimates the extent of shifting or “over-shifting” of infrastructure charges to home buyers in Brisbane, Australia.

This outcome of this research will be to provide empirical evidence of the impact of infrastructure charges on house prices in Australia. These results will inform government on the outcomes of their infrastructure charging policies on housing affordability, providing the first evidence of its kind in Australia.
Chapter 2: Theory and Literature Review

2.1 INTRODUCTION

The purpose of this research is to test the hypothesis that infrastructure charges increase house prices in Australia. Whilst there are numerous government and industry reports that suggest such costs are passed onto the consumer to the detriment of housing affordability, there remains virtually no quantitative research on the impact of infrastructure charges on house prices in Australia from which policy makers can make informed decisions. In a climate where housing affordability is a policy objective for many governments, a clear understanding of the impacts these government charges have on the price of housing is imperative. This gap in research becomes evident from review of the abundance of related literature. This literature review provides an analysis of the Australian and international literature on this topic and provides a platform for the remainder of this research project.

The Australian infrastructure funding policy dilemmas are reflective of similar matters to some extent in the UK, and to a greater extent the US and Canada. In these countries, infrastructure cost recovery policies have been in place since the 1940’s and 1970’s respectively. The purpose of this chapter is to provide a systematic overview of the Australian and international literature on this topic, examining both the theoretical and empirical evidence that suggests infrastructure charges contribute to increased house prices. This review will address the first two research questions of this thesis and form the basis for the later questions which seek to quantify these price impacts on the housing market in Queensland, Australia.

This chapter is arranged as follows: section 2.1 provides the introductory framework for the literature review. Next sections 2.2 and 2.3 present the theory of infrastructure effects on house prices and discuss the various parties that might ultimately bear cost of urban infrastructure: the developer, the original land owner, the new home buyer or other parties. Sections 2.4 and 2.5 present the Australian and UK literature respectively on the house price effects of infrastructure charges.
Section 2.6 reviews the literature from US where a large body of work exists. Here, the phenomenon of “over-shifting” is introduced as are the results of extant empirical models. Relevant literature from other countries is presented in section 2.7, followed by conclusions in section 2.8.

2.2 INFRASTRUCTURE CHARGE EFFECT THEORY

Sourcing appropriate funding for the provision of new urban infrastructure has been a policy dilemma for governments around the world for decades. This is particularly relevant in high growth areas where new services are required to support expanding populations. These new services generally include basic utilities such as local roads, water supply and sewerage, but depending on the services provided at a jurisdictional level, can also apply to broader community services such as regional road, water storage and treatment plants, schools, libraries, police and fire stations (Baden and Coursey, 1999). Existing communities resist the introduction of new taxes to subsidise newcomers into their communities, hence the introduction of infrastructure charges paid by the developer to fund these works has flourished (Brueckner, 1997).

Academics have been theorising on the impact of infrastructure charges on house prices from as early as the 1970’s. Many academics have used urban economic theory and the response of the market to various elasticity conditions via supply and demand curves to argue the relative effects of infrastructure charges on house prices in both the long and short term (see Ellickson, 1977; Huffman et al., 1988; Lawhon, 1996; Singell and Lilydahl, 1990; Baden and Coursey, 1999; Shaughnessy, 2003; Been, 2005). These arguments are based around the theory that additional supply chain costs (for example infrastructure charges), will be absorbed by consumers in situations of high demand (high growth) where there is high price elasticity. Thus increasing house prices in the short term. Where low demand exists (low price elasticity), and the supply chain costs remain high through the imposition of infrastructure charges, supply will drop to meet the diminished demand for houses with higher prices due to increased supply chain inputs. Over the longer term, in the absence of supply of lower priced housing, demand driven price increases will occur. Thus increasing house prices in the long term as well.
The urban growth model is another theoretical basis for such analysis (see Brueckner 1990 and 1997, Burge and Ihlandfeldt, 2006). This model assumes a centralised city form where all development occurs on the urban fringe, with farmland being redeveloped to residential subdivisions at the time when market conditions favour residential uses over farming. This theory takes into account demand factors for new housing by way of increasing house prices and supply factors such as supply chain input costs (the inclusion of infrastructure charges to developer costs). Importantly, this theory is based around growth management, with retardation of urban growth a desired outcome. This is in an environment of wishing to protect the quality of life and level of service and amenity for existing residents. Demand for new housing will push up prices to the extent where the change of use for land on the fringes will be financially viable, even when the cost of providing new infrastructure and services is added to the cost of that housing. Thus house prices are increased in either the long or short term depending on the level of demand.

Yinger (1998) considered yet another alternate house price theory based on household bidding model. This framework is based on the premise that households will pay more for improved services and amenities within their budgetary constraints. It is up to the household to differentiate between different service:tax packages and make housing choice decisions based on the desired amenity. This theory assumes households are mobile and that there are numerous communities from which to choose from. The implication being that there are different service-tax propositions across those communities. This theory relies heavily on the existence of an ongoing property tax for the provision of community services and amenity consistent with the US public finance model and concludes that infrastructure charges will increase house prices to the extent that households perceive a benefit from the services/amenities funded by those charges (that they would not have received in communities without those charges).
2.3 THE ACTORS IN WHO REALLY PAYS FOR URBAN INFRASTRUCTURE?

The premise for any price impact argument is based on the concept of who ends up bearing the cost of the infrastructure charge (Huffman, Nelson, Smith and Stegman, 1988). Infrastructure charges were originally intended to transfer the burden of infrastructure provision in high growth areas from the public purse and existing owners on to developers (Evans-Cowley and Lawhon, 2003). However, the literature indicates there are a number of parties that may be potentially liable for the ultimate payment of these fees. Apart from the developer, these include: the original landowner, the new homeowner (Huffman, et al., 1988), or the existing community (Brueckner, 1997; Singell and Lillydahl, 1990) or even other parties such as the providers of capital (Ellickson and Been, 2005). This concept is illustrated in Figure 2.1 below:

Figure 2.1
The actors in who really pays for urban infrastructure?
There has been much debate since Huffman et al.’s seminal work on the on-passing, back passing, shifting, back shifting (Huffman, et al., 1988), over-shifting (Ihlanfeldt and Shaughnessy, 2004), capitalisation, backward capitalisation (Burge, 2006) etcetera of these fees between the various parties to new development. The following examines the theory of who really pays for urban infrastructure.

2.3.1 The Property Developer

Consider first the original intended payer of infrastructure charges: the property developer. Infrastructure charges are levied on the property developer as a cost of production in the property development process. Basic economic theory tells us that if the cost of production of a good goes up, so too must the cost of the good to the consumer.

The alternative scenario is that if the market is price sensitive and will not pay extra (inelastic), it becomes uneconomical to produce that good, so supply ceases until equilibrium returns to the market. Equilibrium can return to the market by one of two methods: firstly when pent up demand pushes prices up to where production becomes economical again, or secondly if the costs of production are reduced so product can be produced at a price the market is willing and able to pay (Layton, Robinson and Tucker, 2012). A combination of these affects may well be the final outcome. In any case the community in general suffers in the interim through the knock-on effects of interruptions to supply and associated economic activity, business failures and unemployment in the construction and associated sectors and ultimately rising house prices.

Now consider infrastructure charges as a housing supply chain input as discussed in Section 2.2. Upon introduction of infrastructure charges (or the increase of existing charges), consistent with Huffman et al.’s (1988) theory, developers are faced with the dilemma of either increasing sales prices to recoup the additional costs (that is to “pass on” or “shift” the costs), absorb the fees by way of lower profit margins, or pay the land owners less for the englobo land in the first place (that is to “pass back” or “back shift”). This premise is examined widely in the literature. Huffman et al.,(1988) argue that developers do not absorb the costs by way of lower profit margins, as their capital is mobile, and developers will instead choose to invest in locations (or projects) where their benchmark profit margins can be achieved. Yinger (1998, p37) confirms the pass on or pass back effect stating that “to the extent
housing construction is competitive, development fees do not place any burden on developers”. Evans-Cowley and Lawhon (2003) also suggest that developers do not absorb these costs by way of lower profits, as the market (through the land acquisition process) has already set the cost structure at which development is encouraged (passing back). Other research also confirms the premise that developers are likely to make investment decisions based on profitability and if that profitability is reduced in one area, it will move its operations to another to maximize profits (Burge, 2006; Evans-Cowley and Lawhon, 2003; Mathur, Waddell and Blanco, 2004). Watkins (1999) offers the only perverse theory, suggesting that exactly half of any charge is absorbed by the developer by way of reduced profits, with the other half either passed on or passed back. Unfortunately, Watkins does not provide an intuitive explanation for his surprising conclusion, and his findings have been largely ignored by the literature (Been, 2005). Others have tried to argue that if developers can achieve higher sales prices due to market conditions, then they will already be doing so. However as countered by Huffman et al., (1988), in a competitive market profits are already at levels of return consistent with the opportunity cost.

The literature thus indicates that developers are the least likely party to carry this cost burden despite the fact they are the ones the charge is levied upon. The exception to this is if the actual infrastructure charges imposed are greater than anticipated by the developer at the time of acquisition (the only opportunity to pass back) and market inelasticities prevent full passing on (Huffman et al., 1988). Weak market conditions may result in developers accepting lower profits in the short term due to high holding costs, financier demands to repay debt or to maintain consistency of workflow to retain key staff. However, even in these instances, in the longer term the developer will still seek to recoup the difference between the forecast and actual charge by redesigning the project and/or cutting costs to obtain the desired profit margins. Alternatively the fees result in lower (and unacceptable) profits and not only will the developer elect not to proceed with the project (or stage) but financiers would not extend credit (Bryant, 2012) and this will have the further knock-on effect of halting the supply chain of housing (Ruming et al., 2011).

In the case of property developers therefore, given the above and consistent with Been’s (2005) findings, the assumption is that in the medium and long term developers bear none of the charge because if their profit margins were high enough
to absorb the fee in the first place, then competition would already have either reduced the price of housing to the new home buyer or increased the price paid to the original landowner. These other two parties are now discussed.

2.3.2 The Original Landowner

Consider next the original landowner who sells his/her undeveloped land to the developer. When the infrastructure charge is anticipated, and the developer cannot pass those additional supply chain costs on to home buyers due to market conditions, the developer will seek to pay less for the undeveloped land and thus keep total development costs at an economically sustainable level.

Huffman et al.,(1988) argues that this passing back or “back shifting” is unlikely in many instances due to land owner behaviour. Long term land owners have a reservation price below which they will not sell and their holding costs are relatively low. The time value of money and alternative investments are not part of their decision making process Snyder and Stegman (1986). Evans (2004a, 2004b) confirms this phenomenon citing the introduction of a 100% betterment levy in the UK in 1947 which resulted in a freeze of the land market, as there was no incentive for land owners to sell, and the levy was repealed only three years later. Subsequent attempts of betterment taxing in the UK had similar supply constraining impacts and were abolished in 1985 (Evans, 2004b).

Whilst it is outside the scope of this thesis to discuss the various mechanisms for recoupment of the cost of providing urban infrastructure, the concept of a “betterment tax” does have a place in this discussion as it relates to the passing back of infrastructure costs to the land owner and supports the argument for a consequent reduction in supply. The UK has a long history dating back to the 1940s, of taxing land owners for any “betterment” as a result of increases in value subsequent to the provision of infrastructure or from receiving favourable planning approvals. It was thought unfair that the owners of land should be the beneficiaries of increased capital value purely through economic and/or population growth or the provision of public infrastructure (Evans, 2004b). Hence, where this value uplift was due to infrastructure expenditure, this betterment levy or tax was essentially a full passing back of the benefit or the cost of the infrastructure provision.
The Barker Review of Housing Supply (Barker, 2003; Barker, 2004) recommended that the UK government again pursue means to share in windfall profits (ie betterment) that arise as a result of planning approval, suggesting that: “this Planning-gain supplement would fall largely on landowners, with little impact on house prices” (Barker, 2004, p. 8). This recommendation is a clear acknowledgement that the system of developer paid infrastructure charges increases house prices and that the government wishes to reverse that impact back to landowners, and have a mechanism to tax any such betterment.

Passing back of charges to landowners is theoretically possible at the time of acquisition when the amount of the charge to be levied is known, the system is transparent and landowners are well informed about the infrastructure charging regime. In this environment, both parties are negotiating from a knowledgeable position and understand the costs involved in subdivision. Unfortunately this is rarely the case with infrastructure charges often subject to frequent and large increases. Ruming et al., (2011) confirms that back passing is not possible, particularly in an environment of volatility in infrastructure charging regimes. In Australia, the taxing of any capital gain upon disposal of real property assets may be interpreted as a form of betterment taxing, particularly if the capital gain is due to an increase in value subsequent to a planning approval. However, due to the nature of the taxation system with capital gains tax being a federal tax, there is no direct mechanism for any monies collected in this manner to be directed towards the cost of any required local infrastructure. Thus the concept of betterment taxing in Australia is theoretical only.

Whilst the pass-back effect will stall sales in developable land in the short term, Ihlanfeldt and Shaughnessy (2004) argue that over the longer term back shifting can be possible. They suggest this can be due to either “general inflationary price increases” resulting in the reservation price being achievable (i.e. demand driven return to equilibrium), and/or weaker market conditions resulting in lowering of vendor expectations. Whilst the latter does represent true back passing in weak market conditions, surely the former scenario is evidence of forward passing and supports the theory of increasing house prices due to reduced supply (as a direct response to infrastructure charges) as discussed previously assuming at least constant demand, rather than “inflationary pressures”.
Therefore in theory, to the extent that homeowners’ willingness and ability to pay is less than the infrastructure charge itself, the difference should shift backwards to the vendor of the englobo land since developers are mobile and bear no burden in the long run (Yinger, 1998). Whilst this is theoretically sound, in practice this rarely occurs. The literature indicates that passing back does not generally occur at least in the short term as landowners have no compulsion to sell if not for profit (Evans, 2004b) and attempts at back passing instead stymie supply to the detriment of house prices.

### 2.3.3 The New Home Buyer

We consider next the passing on of the infrastructure charge to the consumer or new home buyer. As discussed above, if neither the developer nor land owner is willing to bear the cost of these additional supply chain costs, then the burden must fall to the home buyer by way of higher house prices. This concept is consistently captured by a vast number of academics, particularly in the US over the past three decades (see Ellickson (1977), Snyder and Stegman (1986), Downing and McCaleb (1987), Huffman, et al. (1988), Delaney and Smith (1989a, 1989b), Singell and Lillydahl (1990), Skaburskis and Qadeer (1992), Altshuler and Gomez-Ibanez (1993), Dresch and Sheffrin (1997), Brueckner (1997), Skidmore and Peddle (1998), Yinger (1998), Baden and Coursey (1999), Mayer and Sommerville (2000), Evans-Cowley and Lawhon (2003), Ihlanfeldt and Shaughnessey (2004), Mathur, Waddell and Blanco (2004), Campbell (2004), Been (2005), Evans-Cowley, Forgey and Rutherford (2005), Burge and Ihlanfeldt (2006) and Evans-Cowley, Lockwood, Rutherford and Springer, (2009)).

It is difficult to select just one quote to capture such a weight of evidence and argument. Mathur et al., (2004) chose earlier work by Altshuler and Gomez-Ibanez from 1993 in stating that “under tight market conditions … we would expect the fees to be passed on principally to consumers, while developers and land-owners would absorb most of the cost of the fees in the form of lower profits under soft market conditions”. This is the overwhelming conclusion of the majority of the contemporary literature. Ruming et al.’s (2011) recent Australian research confirms this premise, as does the Australian Productivity Commission’s 2011 report. Nelson et al. (2008) note that most studies assume a relatively normal price elasticity of demand, that is consumers will bear marginal increased prices with no dip in
demand, in the absence of suitable substitutes, such as existing housing. This is deemed reasonable given infrastructure charges are generally used in growing areas, which are characterised by a competitive housing market, further supporting the proposition of a passing on of infrastructure costs to new home buyers.

With such a abundance of supporting literature on this topic, tested and developed over a number of decades, it is little wonder that in current literature it is a given that in a competitive market with elastic housing demand, whilst infrastructure charges in some instances may be borne by the developer and/or land owner in the short run, in the long run these costs are borne by the home owner by way of higher house prices (3iNetwork, 2009; Productivity Commission, 2011; Infrastructure Charges Taskforce, 2011). Therefore, with supporting theoretical literature dating back to the 1970s current international literature now largely assumes it as a given that in the long run, infrastructure charges are passed on to home buyers, thus increasing the price of new housing.

2.3.4 Other Parties

Other parties have been reported to carry the burden of the cost of infrastructure charges as well. US research suggests that existing home owners also share the burden by way of the increased cost of existing housing (Brueckner, 1997; Singell and Lillydahl, 1990; Yinger, 1998). Existing housing generally forms the bulk of a market and plays a central role in price setting. Existing housing may be a close substitute to new housing and if the price of new housing is increasing due to cost pressures and strong market conditions, then the price of existing housing will be drawn up as sellers capitalise on profit taking opportunities. Hence buyers of existing housing are paying for the house price impacts of infrastructure charges in new development areas, for which they receive no benefit.

More recently, it has been acknowledged that if the infrastructure charge does not fully pay for the actual cost of the infrastructure, the gap is paid for by both new and existing home owners by way of increased local jurisdictional rates and taxes (Infrastructure Charges Taskforce, 2011; Chan et al., 2009; Productivity Commission, 2011).

Further, Ellickson and Been (2005) suggests that the burden of infrastructure charge costs in the US may fall on the providers of capital. They argue that if
developers are subject to high infrastructure charges, they will have a lesser propensity to proceed with projects and as a result lenders would have to charge lower interest rates to induce developers to proceed with new projects.

In summary, the theoretical work is consistent in its conclusions that despite market conditions (i.e. relative market elasticities) infrastructure charges in virtually all scenarios are passed onto home buyers if not in the short run, then in the long run and will thus lead to increased housing prices.

2.4 AUSTRALIA

If the international literature is largely consistent in its conclusions that infrastructure charges lead to increased housing prices and by inference reduce housing affordability, the next question that follows is: how much do infrastructure charges increase house prices by? The first research objective of this dissertation is to find evidence of any Australian empirical studies which can provide evidence on this important public policy item. This is the purpose of this section: firstly background on the infrastructure charging regime in Australia and particularly Queensland is provided for context, followed by a summary of the scant empirical evidence.

2.4.1 Infrastructure Charging Regime

In Australia, each state and territory has enabling legislation for its respective infrastructure charging regime. This legislation is generally administered at a local authority level, with individual local authorities determining the amount charged. The amount charged generally relates to formal development contribution plans put in place by the local authority that is to “meet standards of reasonableness and accountability.” (Chan, et al., 2009, p. 120)

The 2011 Productivity Commission report found “there is little consistency across jurisdictions in either the type or the quantum of contributions that developers may be called on to fund” (Productivity Commission, 2011, p. 185). Therefore it is
difficult to compare one local authority to the next\textsuperscript{7}. By way of example, refer to Table 2.1 which indicates the infrastructure charges applicable to selected greenfield projects across Australia.

<table>
<thead>
<tr>
<th>City</th>
<th>Indicative Cost ($000 per lot in 2010)</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sydney</td>
<td>44</td>
<td>15-70</td>
</tr>
<tr>
<td>Melbourne</td>
<td>12</td>
<td>12-17</td>
</tr>
<tr>
<td>Brisbane</td>
<td>26</td>
<td>15-40</td>
</tr>
<tr>
<td>Perth</td>
<td>21</td>
<td>na</td>
</tr>
<tr>
<td>Adelaide</td>
<td>7</td>
<td>na</td>
</tr>
</tbody>
</table>

\textsuperscript{a} Selected regions are Kellyville (Sydney), Wollert (Melbourne), Redbank Plains/Springfield (Brisbane), Wellard (Perth) and Salisbury (Adelaide).


The cost indicated above is difficult to predict the time of land acquisition as it varies considerably across developments, is subject to frequently changing policy and is often subject to negotiation on a case-by-case basis (Reserve Bank of Australia, 2012; Productivity Commission, 2011).

\textbf{2.4.2 Queensland}

Given this research is based on Queensland data only, it is appropriate to provide an overview on the infrastructure charging regime in this State. Local governments in Queensland have had the legislative power to levy infrastructure charges since 2003 when the \textit{Integrated Planning Act 1997} was amended by the \textit{Integrated Planning and Other Legislation Amendment Act 2003}. The 2003 Act defines development infrastructure as the “land or work-in-kind, or both land and work-in-kind, that provide hydraulic (including water supply, sewerage, drainage, water quality), transport and local community services, predominantly in the local area” (Chan, et al., 2009, p. 119). Local governments were required to establish

\textsuperscript{7} For a detailed description of each state’s infrastructure charging legislation as at early 2011, see Productivity Commission, 2011, Chapter 6, as well as its preceding report Chan et al., 2009, Chapter 7. Note however that the Queensland enabling legislation changed in July 2011. See also Infrastructure Charges Taskforce Final Report 2011 - Appendix 3
Priority Infrastructure Plans ("PIPs") and Infrastructure Charging Schedules ("ICSs"), against which development applications would be assessed. However, the complexities of these PIPs and ICSs meant that local governments struggled with their introduction and continued to operate under their existing planning scheme policies rather than PIPs and ICSs, with the only exception being the Gold Coast City Council which commenced issuing Infrastructure Charges Notices for drainage, parks and local roads in 2007 (Nicholls, 2011).

The Integrated Planning Act 1997 was replaced by the Sustainable Planning Act 2009, which commenced in December 2009 (see Queensland Government, 2009b). That legislation further broadened the scope of charges that could be levied on developers including not only site related trunk infrastructure, but also Regional and State based infrastructure. Public infrastructure that was eligible for mandatory contributions (excluding basic infrastructure) included community centres and libraries (cost of land and associated cost of clearing), public transport (land for public transport corridors and associated infrastructure), parks, sports grounds and recreational facilities (including areas of open space) and trunk roads (Productivity Commission, 2011).

This lead to rapidly escalating infrastructure charges resulting in general confusion and uncertainty in the wider development industry around forecast project costs (Nicholls, 2011).

Table 2.2
Local Authority Infrastructure Charges (as at June 2010)

<table>
<thead>
<tr>
<th>Local Authority</th>
<th>Charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Redland City</td>
<td>$40,319</td>
</tr>
<tr>
<td>Gold Coast City</td>
<td>$32,146</td>
</tr>
<tr>
<td>Sunshine Coast Region</td>
<td>$26,089</td>
</tr>
<tr>
<td>Brisbane City</td>
<td>$25,798</td>
</tr>
<tr>
<td>Moreton Bay Region</td>
<td>$24,818</td>
</tr>
<tr>
<td>Townsville City</td>
<td>$24,511</td>
</tr>
<tr>
<td>Cairns Region</td>
<td>$24,158</td>
</tr>
<tr>
<td>Toowoomba Region</td>
<td>$23,952</td>
</tr>
<tr>
<td>Ipswich City</td>
<td>$22,095</td>
</tr>
<tr>
<td>Logan City</td>
<td>$15,271</td>
</tr>
<tr>
<td>Scenic Rim Region</td>
<td>$14,983</td>
</tr>
</tbody>
</table>

In May 2010, the State Government responded to growing pressure from the development and housing industries establishing a new agency, Growth Management Queensland to lead the delivery of infrastructure and affordable housing (amongst other things) as well as independent Infrastructure Charges Taskforce with a mandate to examine how local governments deliver infrastructure for new development in Queensland, including identifying opportunities for simplified charges and greater certainty as well as considering alternative funding arrangements for trunk infrastructure (Infrastructure Charges Taskforce, 2011).

The Infrastructure Charges Taskforce delivered its final report to the State Government in March 2011. This report contained recommendations on reform of local government development infrastructure charging arrangements within the overriding principles of: certainty, transparency and accountability, equity and reasonableness, simplicity and consistency, as well as efficiency and economic impacts. It recommended that a maximum standard charges framework be introduced (Infrastructure Charges Taskforce, 2011).

Government responded with the Sustainable Planning (Housing Affordability and Infrastructure Charges Reform) Amendment Act 2011 being introduced into Parliament in May 2011, and commencing on 1 July 2011 (Persign, 2011; see Queensland Government, 2011). This legislation enabled local governments to set an “adopted infrastructure charge” for residential development which cannot exceed the “maximum adopted standard charge” specified at:

- $20,000 per 1 or 2 bedroom dwelling
- $28,000 for a dwelling of 3 or more bedrooms and
- $28,000 per lot for greenfield subdivisions.

This maximum fee regime was an interim measure, to be in place for three years only. Further reform is underway at the time of writing, including the reversal of exclusions for non-trunk infrastructure such as State controlled roads. Hence, charges at this level are a short term feature only, and are forecast to change again within three years (Nicholls, 2011; Nicholls, Persign and Lamb, 2011). The
temporary nature of this maximum fee regime is one of the reasons why this research ceases prior to the introduction of the adopted infrastructure charges in 2011.

2.4.3 Search for Empirical Evidence

The debate on the responsibility for funding new urban infrastructure and the impact of infrastructure charges on new house prices and housing development in general started with the industry bodies in Australia from as early as the 1970s and has more recently been fuelled by federal government bodies such as Ken Henry’s 2009 report into Australia’s Future Tax System (Commonwealth of Australia, 2009) (see Recommendation 70, and Table 101), two Productivity Commission reports (Chan et al., 2009; Productivity Commission, 2011), a 2012 report to Council of Australian Government (“COAG”) on Housing Supply and Affordability Reform, and biennial reports from the National Housing Supply Council (2008, 2010 and 2013).

On one hand, industry bodies and developers suggest that these increases in their supply chain costs are being added directly to housing prices, pushing prices to a level that is unattainable by the market (Residential Development Council of Australia, 2006, 2007; Urban Development Institute of Australia, 2007). Ruming, Gurran and Randolph (2011) provide a useful summary of industry claims, suggesting all planning related costs can contribute between A$100,000 and A$139,000 per lot/house. However they note these claims are difficult to substantiate due to difficulties accessing data. The Reserve Bank of Australia (2012) utilises Urbis JHD (2010) information to suggest all government charges on developers add between five and fifteen percent to the price of greenfield housing, and two and a half and five percent to new infill housing (refer Table 2.3).

---

8 Refer Chapter 5 Methodology and Data
Table 2.3

*House Cost Increases Due to Government Charges 2010*(a)

<table>
<thead>
<tr>
<th>City</th>
<th>New Greenfield Housing*(a) (%)</th>
<th>New Infill Housing (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sydney</td>
<td>15</td>
<td>5</td>
</tr>
<tr>
<td>Melbourne</td>
<td>5</td>
<td>2.5</td>
</tr>
<tr>
<td>Brisbane</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>Perth</td>
<td>10</td>
<td>2.5</td>
</tr>
<tr>
<td>Adelaide</td>
<td>na</td>
<td>Na</td>
</tr>
</tbody>
</table>

(a) Infrastructure charges plus other government charges on housing development (excluding GST)
(b) Selected regions are Kellyville (Sydney), Wollert (Melbourne), Redbank Plains/Springfield (Brisbane), Wellard (Perth) and Salisbury (Adelaide).


On the other hand, local government maintains it cannot be responsible for increased costs associated with growth and that a user-pays infrastructure charging system helps housing affordability by ensuring essential infrastructure can be funded and thus support greater housing supply (Hoffman, 2011). Further local governments suggest that infrastructure charges comprise only a small proportion of the total house cost and that the developer’s argument is one of self interest and profit taking (Ruming et al., 2011). Abelson and Joteux⁹ (2010) also contend that price increases are small with taxes on new housing only shifting the supply curve marginally, with such taxes being passed back to land owners rather than forwards to home buyers. The supposition that infrastructure charges are readily passed back to land owners is commonplace (See AEC Group, 2009) however this argument does not hold when charges are opaque, negotiable and change during the approval process.

Until now, this debate has gone largely unanswered in Australia by the academic community. Recently Gurran and colleagues considered the issue of planning costs and housing affordability from a broader qualitative perspective using case studies (Gurran, Ruming and Randolph, 2008, Gurran, et al., 2009; Gurran, et al., 2010; Ruming et al., 2011). These examine the impact of all government charges and planning regulations on housing costs in each of the three eastern seaboard States. Amongst other findings, this research limits its findings on the impact of infrastructure charges to concluding that all planning charges have increased at a

---

⁹ In Housing and Tax Policy edited by Miranda Stewart, 2010
greater and disproportionate rate to median house prices, however no empirical evidence of the direct impact of infrastructure charges on house price increases is provided.

Watkins (1999) provides the only empirical study into the impact of infrastructure charges on house prices in Australia. He concluded that exactly 50% of infrastructure charges are paid by the developer, with the remaining 50% paid by either the home buyer by way of higher house prices, or the original land owner by way of lower price paid for undeveloped land. Unfortunately Watkins’ work did not provide any explanation for this finding and no subsequent works were published. Consequently, these findings have been ignored by subsequent authors (Been, 2005).

So whilst there is evidence of Australian house prices increasing, and planning related charges increasing at a greater rate, the extent of this dis-proportionality, and the specific impact of infrastructure charges as a subset of all planning related charges, remains yet to be tested.

It can therefore be concluded that the Australian literature provides scant empirical evidence on the on-passing effect of infrastructure charges to house prices. This finding therefore provides negative evidence in response to the first research question of this dissertation:

1. **Is there empirical evidence in Australia that the imposition of infrastructure charges by governments increases the price of housing?**

The absence of empirical data on this house price effect is fuelling the debate in Australia as to whether infrastructure charges do get passed on to home buyers or not. This is a significant gap in the Australian research, and this dissertation seeks to provide the first empirical study of its kind in Australia to address this gap.

The research thus now turns to the next research objective which seeks to find international literature on house price effects due to the imposition of infrastructure charges, or their equivalent. The UK and US have been selected for comparison with Australia for a number of reasons including: well established and transparent planning regulatory environments and taxation systems, stable governments, similarities in housing market structures and housing types, widespread and well
established use of infrastructure charges to fund urban growth, as well as access to scholarly works.

2.5 UNITED KINGDOM

This section looks to the UK for empirical evidence of the impact of infrastructure charges on house prices. First, an overview of the infrastructure charging regime in the UK is given to provide context against the Australian system. The empirical evidence is then provided.

2.5.1 Infrastructure Charging Regime

As indicated previously, the UK has had a long history dating back to the 1940’s of taxing land owners for any “betterment” as a result of increases in value subsequent to the provision of infrastructure or later, from receiving favourable planning approvals. It was thought unfair that the owners of land should be the beneficiaries of increased capital value purely through economic and/or population growth or the provision of public infrastructure (Evans, 2004b). Hence, where this value uplift was due to infrastructure expenditure, this betterment levy was essentially a full passing back of the benefit of the infrastructure. Note, by taxing a proportion of any capital value uplift on certain properties, there is at best an indirect impact due to the provision of this infrastructure, with no correlation to the actual cost of providing it.

Evans (2004b) reports that the initial 100% betterment levy of 1947 resulted in a freeze of the land market, as there was no incentive for land owners to sell. Under this scheme, the land owner retained none of any capital value uplift, and the levy was repealed just three years later. A similar tax was re-introduced in the late 1960’s at 40% (where the land owners retained 60% of any capital value uplift), and was replaced by a “development land tax” at 80% in the mid 1970’s (where the land owners retained only 20% of any capital value uplift) (Evans, 2004b). The literature provides conflicting signals as to whether this tax/levy remains in force today. Gurran et al.’s (2009) discussion on “betterment tax” implies it is a current phenomenon, however this discussion is unreferenced. Evans (2004b) reports the Development Land Tax, which then applied a betterment levy of 70% was abolished in 1985. Barker (2004) recommends its re-introduction as does Chamberlin (2009).
In any case, “Planning obligation”, “planning gain” or “Section 106 agreements” are all terms used today to describe the equivalent to an infrastructure charging system in the UK (Evans, 2004a). What is important to note, is that it is a process based solely on negotiation between developer and local government to “deliver sustainable development, through which key government, social, environment and economic objectives are achieved” (Bailey, 2005). Chan et al., (2009) suggest a key advantage of this negotiation process is greater flexibility in negotiating outcomes that best suit the specific project and its inherent characteristics. Gurran et al., (2009) suggest that this negotiated approach reduces risks for developers. However, this seems counter intuitive, with any unknown in the costing process adding uncertainty for developers. This uncertainty is further compounded by the unpredictable delays (and costs) incurred in the negotiation process (Bramley and Leishman, 2005; Buitelaar, 2007; Chan et al., 2009). Reliance on negotiated outcomes is also argued to disadvantage smaller developers by virtue of factors such as influence, knowledge, cost and negotiating power (Evans, 2004a). In any case, a fully negotiated outcome with no reference to the actual cost of providing the required urban infrastructure is open to any number of potential imperfections, not the least of which being lack of transparency, potential inequity, or even corruption via political influence.

In summary, Chan et al.(2009) observe that despite claims otherwise, the UK system for payment of urban infrastructure appears to be more focused on capturing betterment or windfall gains for the land owner than on a user-pays cost recovery system. This trend could certainly be interpreted as having roots in the historical evolution of betterment taxation in the UK. Confirmation of this trend is inferred from the Callcut Review’s (Department for Communities and Local Government, 2007) recommendation that an attribution model “similar to that used in Australia” be adopted whereby “the whole or part of the cost of new infrastructure … is met by proportional contributions by developers” (Department for Communities and Local Government, 2007, p. 61).

2.5.2 Search for Empirical Evidence

This review of the literature has been unable to identify any empirical research from the UK on whether its infrastructure charges regime over or under passes the cost of infrastructure provision, whether that be on passed to the home buyer, or back
passed to the land seller. Bramley (2007) provides anecdotal evidence only of a study suggesting required contributions to infrastructure would add £38,000 per dwelling.

Due to the fully negotiated nature of infrastructure charging in the UK, researchers are unlikely to be able to access the requisite data for empirical research. Further, it is possible that the charges applicable on one project might not be reflective of similar charges on another project.

2.6 UNITED STATES

The remainder of this chapter now looks to the US for empirical evidence of the impact of infrastructure charges on house prices. Firstly, background on the infrastructure charging regime in the US is provided for context, followed by a summary of the empirical evidence.

2.6.1 Infrastructure Charging Regime

In the US, infrastructure charges are known as Impact Fees. These fees are “... are one-time levies, predetermined through a formula adopted by the local government unit, that are assessed on property developers during the permit approval process” (Burge, 2005 p2). Whilst there are some that might argue that the definitions of infrastructure charges and impact fees differ, for the majority of jurisdictions they are sufficiently similar to be thought of as interchangeable terms and are used as such within this thesis. When discussing the US literature herein, the term “infrastructure charge” will be used. 10

The responsibility of funding new growth related infrastructure has been shifted from the government to the development industry in many parts of the US since the 1970’s (Evans-Cowley and Lawhon, 2003; Ihlafeldt and Shaughnessy, 2004; Mathur, et al., 2004). Up until 1987 when Texas first introduced its enabling legislation, these charges were based solely on local jurisdictional revenue raising powers, which generated significant appeals in the courts. Near the peak of the US

---

10 For further information on definition of terms, please refer to Chapter 1.
housing boom in 2007, about 60% of all cities with over 25,000 residents along with 40% of metropolitan counties across 27 States used infrastructure charges on new residential developments for public services or infrastructure. In some states such as Florida, 90% of communities used infrastructure charges (Mullen, 2010). The use of fees exploded in 2000’s increasing by 75% between 2004 and 2008 in line with the housing boom, having since contracted in line with housing market conditions. By 2012, 271 jurisdictions within the US plus ten counties in Florida had suspended the use of all infrastructure charges (Mullen, 2012).

The scope for the charging of fees in the US is wider than in Australia and UK, and has its roots in the responsibility for the provision of various infrastructure. In addition to the usual the provision by the local government of infrastructure such as roads, water and parks, fees can also be levied for other community services such as library services, and fires and police protection for the additional population that is caused by the development. Table 2.4 below illustrates the considerable variation in infrastructure charges payable in different US States, remembering that jurisdictional variances exist within states at both the city and county level.
Table 2.4

*Infrastructure Charges Payable in US States*

<table>
<thead>
<tr>
<th>State</th>
<th>Roads</th>
<th>Water</th>
<th>Sewer</th>
<th>Storm Water</th>
<th>Parks</th>
<th>Fire</th>
<th>Police</th>
<th>Library</th>
<th>Solid Waste</th>
<th>School</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arizona (cities)</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Arizona</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Arkansas (cities)</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>California</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Colorado</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Florida</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Georgia</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Hawaii</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Idaho</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Illinois</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Indiana</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Maine</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Montana</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Nevada</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>New Hampshire</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>New Jersey</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>New Mexico</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Oregon</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Pennsylvania</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Rhode Island</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>South Carolina</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Texas (cities)</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Utah</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Vermont</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Virginia*****</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Washington</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>West Virginia</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Wisconsin</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
</tbody>
</table>

* can be imposed by super-majority vote of city council or unanimous vote of county commission
** school construction tax up to $1,600 per unit authorized in districts with populations up to 50,000 (NRS 387.331)
*** development tax of up to $1.00/sq. ft. for residential and $0.50/sq. ft. for non-residential may be imposed by school districts
**** impact fees may be imposed on by-right residential subdivision of agriculturally-zoned parcels for a broad array of facilities under certain circumstances
Source: (Mullen, 2012) Reproduced with permission

The key variance to the Australian system is the inclusion of funding for fire, police and school services in their charges. The dollar amount of average infrastructure charges also varies significantly by State. The average total non-utility
fee (i.e. fees for services other than water, sewer, roads and storm water) for a single detached dwelling is indicated below\textsuperscript{11}.

Figure 2.2

\textit{Average Non-Utility Fees by US State for a Single Detached Dwelling}

State based legislation essentially follows principles established through a long history of case law in that country which established that for impact fees to be constitutionally valid, a \textit{dual rational nexus} test must be satisfied. This test deems that for a fee to be charged it must a) be proven that the new development has an impact on the community and b) the fee charged reflects the cost of that impact (Chan et al., 2009).

\subsection*{2.6.2 Search for Empirical Research}

In the US, there is a well established body of empirical research that has evolved around the cost impact of infrastructure charges on new housing. In excess of a dozen separate US studies on the price impacts of infrastructure charges on new housing, existing housing and vacant residential lots have been published since 1989. The mid 2000s was a time of high growth in many US residential markets as well as in the infrastructure charges programs (by number and dollar amount). This activity,

\begin{quote}
\textsuperscript{11} Data for utility fees is difficult to capture reliably due to the multitude of names used by various jurisdictions (Mullen, 2012).
\end{quote}
together with advances in econometric techniques and improved data availability fuelled fresh academic interest in the topic resulting in a number of new research and publications from 2004 – 2009\textsuperscript{12}. Each of these studies used various forms of econometric modelling techniques for multiple regression analysis. The standard hedonic house price model is the basis for such studies and has evolved from Rosen’s 1974 multiple regression technique (Boymal, de Silva and Liu, 2012) that seeks to separate out the individual contributory effects of any one variable from the aggregate house price of heterogeneous housing stock (Malpezzi, 2002). The published literature includes studies on a range of issues associated with the shifting of impact fees including:


- the price impacts of infrastructure charges on vacant developed residential lots (see Skaburskis and Qadeer, 1992; Evans-Cowley,Forgey and Rutherford, 2005);

- the price of undeveloped land (See Nelson, Frank, Lillydahl and Nicholas, 1992; Ihlanfeldt and Shaughnessy, 2004; Campbell, 2004; Evans-Cowley,Forgey and Rutherford, 2005); and

- the supply of new housing (see Skidmore and Peddle, 1998; Mayer and Somerville, 2000).

\textsuperscript{12} The Global Financial Crisis and residential market crash in the US halted further research into this effect.
The findings and conclusions of each of these studies are presented herein. Details and analysis of the econometric modelling techniques employed are provided in Chapter 3.

2.6.2.1 House Price Impacts (On-Passing)

Review of the existing empirical works reveal it is a danger to assume that passing or shifting of infrastructure charges are at parity (that is $1.00 extra for infrastructure charges equals $1.00 passed on or back). Consistent with theory, the empirical research to date is consistent in providing evidence of on-passing and indeed “over passing” or “over shifting” of infrastructure charges to new (and existing) house buyers. In studies of the new housing market as a whole, a $1.00 infrastructure charge is attributed to a price increase of as little as a $0.25 increase in new house price (Dresch and Sheffrin, 1997) and up to $3.21\(^{13}\) increase in new house price (Singell and Lillydahl, 1990). Singell and Lillydahl (1990) suggest one of the reasons for such high over passing is that builders shift to higher quality homes as fees are easier to shift at the upper end of the market where greater price elasticity exists. Mathur et al., (2004) and Burge and Ihlandfeldt (2006) seek to test this theory by introducing market stratification into their models. Both were able to provide evidence that greater over shifting occurs at the upper end of the market ($3.58 and $1.57 respectively), and under shifting occurs for more affordable homes ($0.60 and $0.38 respectively). Mathur et al., (2004) stratified their market by house quality and Burge and Ihlandfeldt (2006) by house size, both implying that lower quality or smaller housing is more affordable. Their findings are consistent with the hypothesis that there is less price elasticity at the affordable end of the housing market and such impact fees are under shifted, whereas impact fees are over shifted to the higher end of the housing market where there is greater price elasticity.

Details of the various methods employed and findings of each study into the price effects on all houses are summarised in Table 2.5, new houses in Table 2.6 and

---

\(^{13}\) $3.21 is the midpoint between the $3.80 initial impact ($4,500/$1,182) and the $2.79 impact reported nine months later ($3,300/$1,182)
existing houses in Table 2.7\textsuperscript{14}. A cursory glance will conclude that the methodologies used vary greatly, as do the study areas, sample sets and results. This is perhaps typical of housing price models for which there are a variety of approaches and considerable diversity in both theory and outcomes (Meen, 2001). Consistent across each model is that the study areas all experienced rapid growth during the study period\textsuperscript{15}, and the introduction and/or increases in impact fees. Each uses a form of econometric modelling, but with differing methodologies, variables and inputs\textsuperscript{16}.

For all houses (new and existing pooled), empirical research from the US is varied. Burge and Ihlanfeldt find $1.00 of infrastructure charge is under-passed to small and average homes, but is slightly overpassed to larger homes throughout Florida. Evans-Cowley et al.’s study in the greater Dallas-Fort Worth area revealed significant overpassing to all homes in the order of $5.37 for every $1.00 of infrastructure charge.

\textsuperscript{14} For detailed critiques of models refer to Been (2005), Nelson et al., (2008) and Evans-Cowley and Lawhon (2003).

\textsuperscript{15} The exception to this was Dresch and Sheffrin, 1997 where prices were declining sharply.

\textsuperscript{16} Details of econometric modelling techniques employed are provided in Chapter 3.
### Table 2.5

**US Empirical Research Models and Findings – All Home Impacts**

<table>
<thead>
<tr>
<th>Year/Author</th>
<th>Methodology/Study Area</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006 Burge and Ihlanfeldt</td>
<td>Semi-log fixed effects and random effects regression analysis for all homes in 41 counties segmented by house size (by square footage) and utility and non-utility fees, 1993-2003, Florida (State-wide)</td>
<td>Utility fees non statistically significant. $1.00 increase in non utility fees: Small home +$0.38, Mid size +$0.82, Large home +$1.27</td>
</tr>
<tr>
<td>2009 Evans-Cowley, Lockwood, Rutherford, and Springer</td>
<td>Semi log treatment effects model for 46,420 new and existing houses in 63 cities the greater Dallas- Fort Worth area, Texas, 1999.</td>
<td>Price multiplier per $1.00 fees: All homes +$5.37</td>
</tr>
</tbody>
</table>

Source: Author

When the research is separated for new and existing homes, the results differ. For new houses, empirical research from the US indicates that for every $1.00 increase in infrastructure charges, new housing costs increase on average by around $1.60 (Nelson et al., 2008). That is 160% of the infrastructure charge is passed on to the home buyer. This concept of “over shifting” for new housing is consistent across all of the empirical research dating back to the 1980s. What is also evident is that this price impact is passed on at varying rates depending on the characteristics of the housing, with the implication that more affordable homes bear less of this burden than arguably those who can afford to pay more (and may be less price sensitive) at the other end of the house price spectrum. This is evident in the works by Mathur et al. (2004), Burge and Ihlanfeldt (2006) and Mathur (2007).
Table 2.6

**US Empirical Research Models and Findings – New Home Impacts**

<table>
<thead>
<tr>
<th>Year/Author</th>
<th>Methodology/Study Area</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>1989a Delaney and Smith</td>
<td>General linear regressions on 5,839 new houses, Dunedin (fee) and three (no fee) cities, Florida 1971-1982</td>
<td>$1,150 fee increased new house prices by $3,737</td>
</tr>
<tr>
<td>1989b Delaney and Smith</td>
<td>General linear regressions on 1,055 new and 3,135 existing houses in Dunedin (fee) and 7,292 existing houses in Clearwater (no fee), Florida 1971-1982</td>
<td>$1,150 fee increased new house prices by $2,633 and existing house prices by $1,643</td>
</tr>
<tr>
<td>1990 Singell and Lillydahl</td>
<td>OLS model, using 226 new and 203 existing house sales, Loveland and Fort Collins, Colorado, 1983-1985</td>
<td>$1,182 fee increased new house prices by $3,800 and existing houses by $7,000</td>
</tr>
<tr>
<td>1997 Dresch and Sheffrin</td>
<td>New and existing houses, Contra Cost County, California, 1992-1996</td>
<td>East (less wealthy, weak market) + $0.25</td>
</tr>
<tr>
<td></td>
<td></td>
<td>West (wealthy, strong market) + $1.88</td>
</tr>
<tr>
<td>1999 Baden and Coursey</td>
<td>Double log model on 14,997 new and existing, eight Chicago suburbs, Illinois 1995–1997</td>
<td>Results for eight suburbs provided indicating passing on of 70%-210% of the fee for new housing and 100% for existing housing (with limitations)</td>
</tr>
<tr>
<td>2004 Lawhon</td>
<td>General linear hedonic model, Loveland (fee) and Fort Collins (no fee), Colorado, 380 new and 380 existing house sales, 1983-1986</td>
<td>$1,661 increase to house price per $1,500 fee increase, however not statistically significant</td>
</tr>
<tr>
<td>2004 Mathur, Waddell and Blanco</td>
<td>Semi log hedonic model based on new homes in three quality categories across 38 cities and towns 1991-2000, King County (Seattle), Washington</td>
<td>Low quality + $0.60 (however not statistically significant)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mid quality + $1.66</td>
</tr>
<tr>
<td></td>
<td></td>
<td>High quality + $3.58</td>
</tr>
<tr>
<td>2004 Ihlanfeldt and Shaughnessey</td>
<td>General linear hedonic and double log repeat sales regressions for 39,792 new homes, 107,376 existing homes and 1,000 land sales, Dade County (Miami), Florida</td>
<td>$1.00 of fee increased both new and existing housing by about $1.60 and reduces land by about $1.00.</td>
</tr>
<tr>
<td>2009 Evans-Cowley, et al.</td>
<td>Semi log treatment effects model for 46,420 new and existing houses in 63 cities the greater Dallas- Fort Worth area, Texas, 1999.</td>
<td>Price multiplier per $1.00 fees: New + $1.76</td>
</tr>
</tbody>
</table>

Source: Author

Table 2.7 below indicates the findings of models on the house price effects of infrastructure charges on existing houses. Similar observations can be made about the diversity of methodology, study area, sample sets and results. Findings confirm the theory that existing housing is a close substitute for new housing and as the price of new housing increases, so too does existing housing, with the existing homeowners enjoying a windfall gain and the buyers of existing homes sharing in the
cost burden of new infrastructure for which they arguably receive no benefit. Infrastructure charges levied on new homes have been found to be overpassed to existing house prices from between 142% and 592% in older studies (Delaney and Smith, 1989b; Singell and Lillydahl, 1990) and between 83% (under passed) and 603% in more recent studies (Mathur, 2007; Evans-Cowley et al, 2009).

Table 2.7

<table>
<thead>
<tr>
<th>Year/Author</th>
<th>Methodology</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>1989b Delaney &amp; Smith</td>
<td>Hedonic regressions on existing houses 1971-1982, Dunedin, Florida</td>
<td>$1,150 fee increases existing house prices by $1,643</td>
</tr>
<tr>
<td>1990 Singell and Lillydahl</td>
<td>General linear model, Loveland and Fort Collins, Colorado, using 203 existing house sales in 1983-1985</td>
<td>$1,182 fee increases existing house prices by $7,000</td>
</tr>
<tr>
<td>1997 Dresch and Sheffrin</td>
<td>New and existing houses, Contra Cost County, California, 1992-1996</td>
<td>East (less wealthy, weak market)+ $0.23 West (wealthy, strong market) not sig</td>
</tr>
<tr>
<td>1999 Baden and Coursey</td>
<td>Double log model on 14,997 new and existing, eight Chicago suburbs, Illinois 1995–1997</td>
<td>Results for eight suburbs provided indicating passing on of 100% for existing housing (with limitations)</td>
</tr>
<tr>
<td>2007 Mathur</td>
<td>Semi log hedonic model of existing homes in three quality categories across 38 cities and towns 1991-2000, King County (Seattle), Washington</td>
<td>Low quality +$0.18 (however not statistically significant) Average quality +$0.83 (all homes) High quality +$1.03</td>
</tr>
<tr>
<td>2004 Ihlanfeldt and Shaughnessy</td>
<td>General linear hedonic and double log repeat sales regressions for 39,792 new homes, 107,376 existing homes and 1,000 land sales, Dade County (Miami), Florida</td>
<td>$1.00 of fee increased both new and existing housing by about $1.60 and reduces land by about $1.00</td>
</tr>
<tr>
<td>2009 Evans-Cowley, et al</td>
<td>Semi log treatment effects model for 46,420 new and existing houses in 63 cities the greater Dallas–Fort Worth area, Texas, 1999.</td>
<td>Price multiplier per $1.00 fees: Existing +$6.03</td>
</tr>
</tbody>
</table>

Source: Author

In summary, there is a deep and varied body of evidence on the price impacts of impact fees on all homes as well as segmented by new and existing houses in the US. The purpose of this thesis is to produce a similar model in Australia to assess the associated impacts of infrastructure charges.
2.6.2.2 Lot Price Impacts (On-passing)

Evans-Cowley et al.’s 2005 work took an alternative approach to the majority of the US studies, examining the pass on price effect on the developed lot (that is the vacant subdivided lot, prior to house construction). This work follows on from Skaburskis and Qadeer (1992) in Canada and Nelson, Frank and Nicholas (1992) in US who had previously examined price impacts on vacant lots (as compared to built houses as discussed in the previous section).

The evidence on price impacts for vacant residential lots is thin. Skaburskis and Qadeer (1992) suggested evidence of on-passing of 120% of the impact fee to house prices, whilst Evans-Cowley et al., (2005) provided weak evidence that a $1.00 infrastructure charge is attributed to a price increase of as little as a $0.13 for the developed lot only (Evans-Cowley et al., (2005). This significantly lower passing on result could be interpreted as evidence of profiteering by house builders. This would be a troubling finding as house builders (as opposed to land developers when these are two separate suppliers) are not subject to any infrastructure charges. No discussion on this finding is provided in the literature.

Table 2.8
US Empirical Research Models and Findings – Lot Price Impacts

<table>
<thead>
<tr>
<th>Year/Author</th>
<th>Methodology</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>1992 Skaburskis and Qadeer</td>
<td>General linear hedonic model of three suburban municipalities in Toronto, Canada 1977-86</td>
<td>+1.2 x size of fee (+$1.20 on passing)</td>
</tr>
<tr>
<td>2005 Evans-Cowley, Forgey and Rutherford</td>
<td>Pooled cross-sectional OLS + fixed and random effects models. 1999 data. 43 cities in Austin, Fort Worth, Dallas and Houston, Texas</td>
<td>+ 1.3% (10% significance) (+ $0.13 on passing)</td>
</tr>
</tbody>
</table>

Source: Author

2.6.2.3 Undeveloped Land Price Impacts (Back Passing)

in his data set. Refer to Table 2.9 below. Their results were mixed from findings of no statistical significance (Nelson and Lillydahl et al., 1992), to land prices increasing (Nelson and Frank et al., 1992), to a slight back-passing of $0.04 (Evans-Cowley et al., 2005) and a full back-passing of $1.00 (Ihlanfeldt and Shaughnessy, 2004). Burge’s (2014) findings support partial back-passing of around $0.65. These models suffered from a range of specification deficiencies including very small data sets in early studies, and the extreme heterogeneity of undeveloped land in all studies. It would appear that the extent of back shifting of infrastructure charges is still open to debate with the empirical research being inconsistent and inconclusive (Evans-Cowley et al., 2005).

Table 2.9

<table>
<thead>
<tr>
<th>Year/Author</th>
<th>Methodology</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>1992 Nelson and Lillydahl et al.</td>
<td>Double log hedonic regression of vacant land sales in Lovedale, Colorado</td>
<td>Findings not statistically significant</td>
</tr>
<tr>
<td>2004 Ihlanfeldt and Shaughnessy</td>
<td>Double log repeat sales regression for 1,000 land sale pairs, Dade County (Miami), Florida</td>
<td>-$1.00 undeveloped land</td>
</tr>
<tr>
<td>2005 Evans-Cowley, Forgey and Rutherford</td>
<td>Pooled cross-sectional OLS + fixed and random effects models. 1999 data. 43 cities in Austin, Fort Worth, Dallas and Houston, Texas</td>
<td>-0.042% (- $0.04) undeveloped land</td>
</tr>
<tr>
<td>2014 Burge</td>
<td>Two stage, hedonic and fixed effect panel regressions on 1,547,711 residential sales in 61 counties, 1994 - 2009, Florida</td>
<td>School fees: -0.26% Water and Sewer: -0.83% Roads, police, fire: not sig.</td>
</tr>
</tbody>
</table>

Source: Author

2.6.2.4 Housing Supply Impacts

The effect of infrastructure charges on housing supply has also been the subject of much theoretical discussion and some US empirical research, with findings and conclusions varying. Nelson et al., (2008) provide a theoretical model that concludes “(housing supply) effects are ambiguous rather than definitively positive or negative.” (Nelson et al., 2008, p96). The empirical evidence is similarly mixed.
Skidmore and Peddle’s (1998) model examined the construction rate of new houses from 1977 to 1992 in Dupage County, Illinois (near Chicago). This model provided evidence of a 30% decrease in new housing supply as a result of infrastructure charges being introduced. Taking a different approach, Mayer and Somerville (2000) found the presence of impact fees (fixed, known amounts) had little effect on housing supply in comparison to other regulatory changes that create uncertainty for the developer, such as delays in the approval process. Recent Australian research by Gurrn et al., (2009) on the impact of regulatory processes on housing supply draws similar conclusions. Burge and Ihlanfeldt (2006) found infrastructure charges increased supply in certain housing sub-sectors in certain locations, concluding infrastructure charges make housing more desirable due to the capitalisation of future perceived benefits. They also suggest that the existence of infrastructure charges regimes creates certainty for developers and communities, promoting the rezoning of land for development in the knowledge that growth will be suitably funded, thus reducing approval periods and uncertainty.

Table 2.10
**US Empirical Research Models and Findings – Housing Supply Impacts**

<table>
<thead>
<tr>
<th>Year/Author</th>
<th>Methodology</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000 Mayer and Somerville</td>
<td>Numerous regressions on new single family building permits 44 US metropolitan areas 1985-1996</td>
<td>Little effect (amongst other growth management measures that exacerbated uncertainty)</td>
</tr>
<tr>
<td>2006 Burge and Ihlanfeldt</td>
<td>General linear random trend regression analysis for all homes in 41 counties segmented by house size (by square footage) and utility and non-utility fees, 1993-2003, Florida (State-wide)</td>
<td>Utility fees not statistically significant. Non utility fees: + 82% small homes and 24% large homes in inner suburbs + 36% medium homes and 26% large homes in outer suburbs</td>
</tr>
</tbody>
</table>

Source: Author

Been (2005) observes that if price effects of infrastructure charges exist in situations in which housing supply is increasing, this is likely to be due to demand driven factors and capitalisation of the benefit created, rather than (over) shifting of a tax-like fee for which no benefit is perceived. On the other hand, if price effects of impact fees exist when housing supply is decreasing, models should include variables to account for any other growth controls or other supply limiting factors.
This recommendation appears consistent with the variance in findings and conclusions noted above.

### 2.6.3 Over-Passing: Benefit or Burden

With the concept of on-passing and indeed over-passing of impact fees onto house buyers well established, let us turn to the various potential reasons behind this phenomenon. The conclusions drawn in the literature generally fall into one of two camps: the “old view” versus the “new view”, phrases first coined by Yinger (1998) (See also Nelson and Moody, 2003; Ihlanfeldt and Shaughnessy, 2004; Burge and Ihlanfeldt, 2006 and Nelson et al., (2008)\(^\text{17}\)). These two theories are based around the proposition of whether infrastructure charges are a benefit or burden to the home buyer.

The old view considers infrastructure charges as a traditional “excise tax on developers” (Ihlanfeldt and Shaughnessy, 2004) which is a cost burden passed on to new home buyers. In contrast under the new view, the increase in housing prices as a result of infrastructure charges is due to the home buyer’s willingness to capitalise into the cost of the home the benefit they derive from that infrastructure and/or perceived future rates savings. The difference in these two explanations for over-shifting is explored further herein.

#### 2.6.3.1 Old View - Burden

Let us first discuss the burden effect. This is consistent with the urban economic model whereby any additional costs to the supply chain shift the supply curve to the left thus increasing house prices. Under the old view, infrastructure charges are a “form of taxation that is hidden from housing consumers” (Baden and Coursey, 1999, p1).

A common proposition for the over shifting phenomenon is the suggestion that infrastructure charges add additional uncertainties and delay costs in the approval process, resulting in developers recouping more than the cost of the fees alone as developers seek compensation for the additional risk taken and return on costs

\(^{17}\) See Nelson et al., (2008) for a comprehensive overview of the “old” and “new” views.
(Singell and Lillydahl, 1990; Baden and Coursey, 1999; Campbell, 2004; Mathur, 2003). This over-shifting can also be combined with back passing to land owners (Ihlanfeldt and Shaughnessy, 2004), with developers requiring higher profit margins to compensate them for the additional uncertainty associated with a rapidly changing regulatory environment. Further, any additional development costs are increased by construction period interest and other development costs determined as a percentage of the sale price (Singell and Lillydahl, 1990; Crowe, 2007). So not only are impact fees passed directly onto homeowners, there is an over-shifting effect to compensate developers firstly for the additional uncertainty (risk) and secondly a return of funds invested component, either for the developer, or its financier over the development period (Ellickson and Been, 2005).

Whilst this explanation appears intuitive and in line with common thinking, there are others who argue the opposite, suggesting that infrastructure charges increase certainty. Nelson et al. (1992) supported by Nelson et al. (2008) contend that infrastructure charges reduce uncertainty by virtue of timely provision of public infrastructure, that may expand the supply of buildable land. This argument may hold in an environment where a transparent infrastructure charging regime is in place compared to a fully negotiated system. However, Gurran et al. (2009) suggest that the negotiated approach to infrastructure charges in the UK reduces risks for developers. This seems counter intuitive, with any unknown in the costing process adding uncertainty for developers. This is further compounded by the unpredictable delays (and costs) incurred in the negotiation process (Bramley and Leishman, 2005; Buitelaar, 2007; Chan et al., 2009). The UK infrastructure charges system differs to that in the US and parts of Australia as it is a process based solely on negotiation between developer and the local authority, rather than being based on either future infrastructure construction cost estimates as is the case in much of the US and parts of Australia, or pre-set rates per dwelling (as is the now the case in Queensland, Australia) or scheduled fees (as in the US). Reliance on negotiated outcomes is also argued to disadvantage smaller developers by virtue of factors such as influence, knowledge, cost and negotiating power (Evans, 2004a) and this can be interpolated to further disadvantage the home buyers in those smaller estates who may then be subject to not only higher charges, but also greater over-shifting.
Shifting of developer capital into higher quality homes is another suggested factor under the old view, with the implication being that there is greater price elasticity at the upper end of the market and hence developers can recoup better their direct costs, holding costs and return for additional uncertainty (Huffman et al., 1988, Singell and Lillydahl 1990, Baden and Coursey 1999). Research that stratifies the market confirms this effect with under passing evident in the more affordable housing and over passing evident in the more expensive housing (see Burge and Ihlanfeldt, 2006, Mathur et al., 2004). This perhaps suggests that the provision of infrastructure to the poor is subsidised by the wealthy, a finding that is unlikely to be politically acceptable.

These arguments of cost and risk shifting hold for new housing, however they do not explain the observed inflationary effects infrastructure charges have on existing housing. Very little conclusions on this are drawn in the literature apart from the drag up effect associated with the close substitutability of new and existing housing, resulting in a windfall gain to existing home owners (Huffman et al., 1988, Yinger, 1998, Baden and Coursey, 1999).

As indicated previously, a number of studies consider the supply constraining effects of infrastructure charges. Economic theory explains how any drop in supply without a corresponding drop in demand will lead to increased prices, thus creating an indirect burden in the longer run to home buyers. The evidence of this effect is still ambiguous in the literature and is ripe for further research (Nelson et al., 2008).

Clearly infrastructure charging as a cost shifting concept is a complex issue, and further analysis of the actual policy implementation mechanism is required to ensure comparisons (and assumptions) made are appropriate. In any case, it can be concluded that if over-shifting is due to developers recouping their direct costs, holding costs and return for additional uncertainty associated with the local infrastructure charges regime, then new homebuyers are bearing this additional cost burden by the amount of the over-shifting and existing homeowners are pocketing
the windfall gain of increased house values. This is a critical concept for policymakers to be aware of when designing infrastructure charging regimes.

### 2.6.3.2 New View - Benefit

An alternate proposition is the concept of whether the increase in house prices due to infrastructure charges is a one off excise tax payable by the homeowner for no net benefit, or capitalisation of expected future benefits arising from the provision of said infrastructure. This is the concept of the “old view” versus the “new view” in infrastructure charge price effects, phrases first coined by Yinger (1998) further to Ellickson’s (1977) suggestion that any assessment of infrastructure charge impacts must consider if those infrastructure charges resulted in improved services or amenities. (See also Nelson and Lillydahl et al., 1992; Nelson and Frank et al., 1992; Dresch and Sheffrin, 1997b; Nelson and Moody, 2003; Ihlanfeldt and Shaughnessy, 2004; Burge and Ihlanfeldt, 2006; and Nelson et al., 2008)

The old view considers infrastructure charges as a traditional excise tax on developers and does not take into consideration any value attributed by the homeowner to the amenity received from the infrastructure provided (Ihlanfeldt and Shaughnessy, 2004). The suggested reasons for house price increases as presented in the prior section could be considered as the old view. The new view assumes a number of key differences. Firstly it incorporates the added amenity of the new infrastructure provided by those funds levied. Secondly it assumes capitalisation of future local jurisdictional rates/taxes savings due to the pre-payment of new infrastructure by way of infrastructure charges. Thirdly it assumes new homebuyers are mobile (that is, they will move to an area that does not levy such fees if they do not wish to pay them/value the additional amenity) (Ihlanfeldt and Shaughnessy, 2004). Fourthly, it assumes competition in the property development sector and lastly it assumes infrastructure investments meet a benefit-cost test (Yinger, 1998).

Under the new view, the increase in housing prices as a result of infrastructure charges is due to the home buyer’s willingness to capitalise into the cost of the home

---

18 For a discussion on the issues of efficiency and equity of infrastructure charges see Evans 2000

19 See Nelson et al., (2008) for a comprehensive overview of the “new” view.
the value they derive from that infrastructure and/or perceived future rates savings. These costs will be overshifted to the extent that home buyers value more highly those benefits over the cost of providing them. Given the home buyer receives a benefit which it has paid for (by way of addition house price) there is no burden.

In essence this rationale is based around an increase in demand for housing associated with home buyers willingly and knowingly paying more for housing with the expectation of enhanced amenity and/or lower future rates/property taxes (Burge and Ihlandfeldt, 2006). This is in contrast to the old view, which is an increase in the supply chain costs that are passed onto home buyers.

2.7 OTHER

A thorough search of the literature has been unable to identify any empirical studies on this topic outside of the US and Canada. This is despite the wide spread usage of user-pays urban infrastructure systems throughout the world. It is suggested that this dearth of research has been due to a lack of publicly available data as experience in the UK and Australian research efforts to date.

Nevertheless, in the preceding discussion, it has been established that the international evidence is conclusive that infrastructure charges increase house prices. How much house prices are increased by has been the subject of considerable study only in the US and Canada where the empirical models confirm not only passing on of infrastructure costs to home buyers, but significant “over shifting” of these costs.

Whilst these studies remain inconclusive, not only in range of findings, but also in their explanation of why this over shifting occurs, a mean range of $1.50 to $1.70 for each $1.00 of infrastructure charge is apparent for new houses. However widely varying results prevail for existing houses ($0.83 to $6.03) where reasons for this effect are even more confounding and perhaps concerning when the impact on housing affordability for the wider community (for which they may receive no benefit) is considered. This finding therefore provides evidence in response to the second research question of this dissertation:
2. Is there international empirical evidence that the imposition of infrastructure charges by governments increases the price of housing?

This research now turns to the next research objective which seeks to determine if this US literature provides an established methodology that has external validity and is suitable to use in the Australian context.

2.8 CHAPTER SUMMARY

The purpose of this chapter has been to review the extant literature on the question of “who pays for urban infrastructure?” There is a long established international research base concluding and verifying that infrastructure charges contribute to increased house prices. However a significant gap remains in Australian research in quantifying the contributory effects a user-pays infrastructure policy objective has on housing affordability policy objectives. This chapter has presented both the theoretical and empirical evidence from a number of key international studies providing evidence that infrastructure charges are a contributor to increasing house prices. Various econometric modelling methodologies have been employed by researchers in the US to quantify the extent of over passing to new home buyers.

Specifically, this chapter has addressed the first two research questions, with the first being answered in the negative, and the second in the affirmative:

1. Is there empirical evidence in Australia that the imposition of infrastructure charges by governments increases the price of housing?

2. Is there empirical evidence internationally that the imposition of infrastructure charges by governments increases the price of housing?

In addressing these questions, a rich body of academic literature was identified. The Australian academic literature is surprisingly scant; however, government and industry documents discussing infrastructure charges are in plentiful supply with numerous publications dating up to present day, reflecting the contemporary and
evolving nature of infrastructure charging policy in this country. In the UK, literature in the form of scholarly articles, government commissioned reports, and textbooks on the topic are available on wider structural planning issues affecting its housing prices, however no direct research on the impact of infrastructure charges on house prices is evident.

A number of empirical studies from US and Canada were identified that confirmed significant over-shifting, with house prices consistently increasing by greater than the amount of the infrastructure charge. This extensive body of work is reflective of the maturity of the infrastructure charging regime in North America which has been in effect for over three decades. Clearly, it is not only possible, but also likely that the US models are not directly applicable to the Australian situation. However, they do provide some context, and the only empirical evidence available to date. What is required is the development of an Australian model that can quantify the impact of infrastructure charges on new housing costs, so that governments can develop consistent and evidence based policy to support Australian cities’ continuing growth, whilst retaining a sustainable level of housing affordability. For “… those who craft public policy are just as good as the tools and knowledge available to them in creating and legislating such policies” (Wardner 2011).

In the next chapter, the archival research into the relevant econometric models is presented. The various methodologies that underlie the extant empirical works are analysed, as are the findings. This data is an important component in the Stage 1 (qualitative) component of this research. Together with the literature review and semi-structured interviews, this data will form the basis for the remainder of this thesis which will be the first empirical work of its kind in Australia to estimate the effect of infrastructure charges on house prices.
Chapter 3: Econometric Model Analysis

3.1 INTRODUCTION

As identified in the previous chapters, there have been numerous empirical studies into the effect of infrastructure charges on housing prices over previous decades, almost exclusively from the US. These studies have each employed various econometric techniques. There was a proliferation of these models around the early to mid-2000’s from six US author groups, with each author group taking a different approach to estimate the house price effects of infrastructure charges as predicted in the theory.

The purpose of this chapter is to examine each of the US studies on this topic since the early to mid-2000’s in detail to find evidence of external validity as well as any methodological evolution. Further to the literature review, this is the second phase of Stage 1 of this research project. It comprises the archival research component of this exploratory sequential instrument development mixed method research project. The archival research will unpack the econometric techniques employed, identify the contribution of each model, examine the variables employed, and hence form the basis for specification of the first model of its kind in Australia to estimate the impact of infrastructure charges on house prices. This chapter is designed to inform the third research question of this thesis, considering whether international empirical models can be used to assess the impact of infrastructure charges on the price of housing in Australia.

This chapter starts by outlining the theory of hedonic models for house price estimation in section 3.2 as hedonic models form the basis for the various econometric techniques employed throughout this chapter. Variables that affect house prices are discussed in section 3.3. Section 3.4 introduces the archival research methodology that forms the basis for the remainder of this chapter. Sections 3.5 to 3.10 analyse the extant US hedonic house price models from the past decade, focusing on the model specification, independent variable selection, findings and limitations, with a view to identifying an evolution in methodology and an approach
which might be most appropriate for use in the Australian context. Section 3.11 concludes.

### 3.2 WHAT IS A HEDONIC HOUSE PRICE MODEL?

Theories on house and land pricing models have been pondered since Ricardo in 1817 (DiPasquale and Wheaton, 1996). Various models have since evolved based on the assumption that housing is more expensive when it comprises more utility bearing attributes or characteristics, and that the sum of this bundle of attributes is reflected in the housing price. The marriage of the disciplines of urban economics and econometrics since the 1970’s has led to “a proliferation of empirical studies” that have progressively sought to predict and explain residential property values and the impacts of these various attributes on house prices (Limsombunchai, Grant and Lee, 2004 p193). This proliferation has been due to the increased availability of multiple data sets, improvements in modelling techniques and software, and the subsequent expansion in business applications (Cho, 1996).

Hedonic price models based on multiple regression theory dates back to Waugh in 1928 with other early contributions by Court in 1939 and Stone in 1954 (Hill, 2012). However, it is since the seminal work of Griliches in 1971 and Rosen in 1974 (Meese and Wallace, 2003) that hedonic methods started to receive attention.

In any house price model, it is important to incorporate influences that determine both the willingness of consumers to pay for housing (demand factors) and the factors that determine the costs of development (supply factors) (Singell and Lillydahl, 1990). The models of Griliches and Rosen provide for differentiation of individual supply and demand attributes (vectors of characteristics whose prices are not independently observed) whilst controlling for heterogeneous characteristics that are commonly thought to contribute to house price such as location, neighbourhood, age, number of bedrooms and the like (Dougherty, 2011; Hill, 2012).

Malpezzi (2002) describes the simplified hedonic model form as indicated below:

$$P_{i,t} = \beta_o + \beta_1 S_i + \beta_2 L_i + \beta_3 I_i + u_{i,t}$$

3.1
Where:

\[ P_{i,t} = \text{sale price of house } i \text{ in time period } t \]

\[ S_i = \text{Structural attributes of the house that impact price e.g. house and lot area, number of bedrooms and bathrooms, age of the house etc} \]

\[ L_i = \text{Locational features that might affect the price of the house such as view, water frontage, traffic noise, distance to employment centres, public transport accessibility, distance to amenities etc} \]

\[ J_i = \text{Jurisdictional or regional factors that might affect the price of a house such as household income levels, local crime rates, population growth, housing supply, labour force, unemployment rate, construction cost index, mortgage rate, occupancy costs, infrastructure charges etc} \]

\[ u_{i,t} = \text{error term or noise in the model for the } i^{th} \text{ observation at time } t. \]

The hedonic method is popular as it separates the price of a house into bundles of measurable attributes associated with the house. It uses information generally from sales data, making estimation of individual price series for smaller housing markets possible (Burge, 2005). However, hedonic regression techniques are not without their limitations. Mathur (2003) cites a major limitation to be the inability to separate the impacts of supply and demand side factors that affect house prices as both are included in the equation. The issue of contemporaneous endogeneity is a further complication. An underlying assumption of the hedonic methodology is that the price of housing is determined by the demand and supply conditions of the housing market; that is exogenous. However microeconomic theory indicates that demand and supply factors are endogenous to the price of housing, hence the contemporaneous conundrum (Mathur, 2003).

A further challenge to the use of the hedonic technique is the multitude of functional forms that it can take. Delaney and Smith (1989a) contend that it is possible for several functional forms to perform equally well in predicting price when fitted to a set a data. Messe and Wallace (2003) observe that specification of the model will depend on the type of data available. Limsombunchai et al.(2004) conclude that economic theory provides no guidance with respect to this matter, and
as a result each study may pursue its own form in an attempt to overcome the potential errors identified above. Hansen (2006) confirms this finding in a comparison of hedonic and repeat sales techniques, concluding that “theoretical issues associated with choosing an appropriate specification may be less important for price measurement in practice” (Hansen, 2006 p3).

Hedonic models generally take one of three forms: time series, cross sectional or panel data, the latter which has characteristics of the first two (Brooks and Tsolacos, 2010). A time series model is commonly a two stage process, with the first stage comprising the construction of a constant quality repeat sales house price index. This index is then introduced as a dependent variable in the second stage hedonic analysis (Meese and Wallace, 2003). Whilst being a widely used and accepted method for accommodating housing heterogeneity and the separate price contribution of various attributes, such models must be specified and interpreted with caution (Malpezzi, 2002). Firstly, care must be taken to ensure any first stage estimation error is adjusted for when used in the second stage equation. Also, the results do not account for any trend in average house prices over time (Meese and Wallace, 2003). Further, Shonkwiler and Reynolds (1986) suggest that stringent assumptions on the preferences of market participants is necessary and Limsombunchai et al.(2004) identify hedonic modelling issues are common such as: heteroskedasticity, model specification errors, multicollinearity, independent variable interactions, non-linearity and outlier data points. Cho (1996) also identifies autocorrelation and up to five types of bias that may jeopardise the correct interpretation of these hedonic outputs. However, despite its many apparent challenges, the conventional two-step time series hedonic pricing model remains a relatively simple and popular estimation process.

In contrast, cross-sectional studies are carried out at one time point or over a short period, a snapshot of a market with no account taken of effects over time (Brooks and Tsolacos, 2010). Such static studies may be useful when long time series data is not available or when the dependent variable is constant over time (Meen, 2001).

Panel (or pooled) data models differ from the prior methods by explicitly incorporating linkages in variables over time (DiPasquale and Wheaton, 1996) and may be considered more dynamic in comparison to the prior static methodologies.
Similar to its static counterparts, methodological progressions exploded since the 1970’s (Gujarati and Porter, 2009) with enhanced computational capacity and availability of larger data sets based on cross sections of house sales observed over time (Washington et al., 2011). This is in contrast to the static methods which focus only on movements in specific variables rather than larger data sets, hence requiring significantly fewer data inputs. Dougherty (2011) reports that this theoretical shift divided practitioners into two camps of static and dynamic methodologies, a differentiation that is evident in this research. Whilst dynamic models assist in the understanding and forecasting of housing price trends over time, they bring with them a separate range of issues to be considered by the analyst such as: stationarity, multicollinearity and noncontemporaneous variables just to name a few (Gujarati and Porter, 2009).20

Various econometric modelling techniques have evolved in the past few decades in an attempt to overcome measurement problems associated with: firstly housing’s heterogeneous nature, secondly the infrequency of trades, thirdly the negotiated pricing system and finally the nature and availability of data. The rationale behind various model selection is rarely explicit and may only have its roots in data type and availability (Meen, 2002b). Time series, cross-sectional, pooled/panel data will lend themselves to varying theoretical bases and hence model specifications (Gujarati and Porter, 2009). As will be seen throughout this chapter, no single econometric technique has evolved as the preferred house price model other than the basic hedonic form, with more complex model specification being a function of the type of data available and the skill of the researcher in seeking to identify and eradicate potential errors and bias in the models.

3.3 VARIABLES THAT EFFECT HOUSE PRICES

If model specification is reliant upon the type of data available, then it follows that the researcher must consider what variables impact house prices and hence the

20 Meen (2001) provides a survey of the literature on measurement errors associated with different house price index methodologies.
availability of that data. Figure 3.1 shows the complex set of factors that underpin the relationship between housing supply and demand, with house prices and housing affordability being the net outcome of the interaction of those various factors.

Figure 3.1
Factors that influence house prices

Source: National Housing Supply Council, 2008. Available under a Creative Commons Attribution 3.0 Australia licence
Malpezzi (2002) suggests that a full dataset of independent variables for house price models would include the following:

- Number of bedrooms and bathrooms
- Floor area
- Structure type (attached, detached etc)
- Type of heating and cooling
- Building age
- Other relevant structural features eg. basements, fireplaces, garages etc
- The building’s structural fabric and quality of finish
- Neighbourhood variables including quality of neighbourhood, quality of schools, socioeconomic characteristics and
- Distance to central business districts and other employment centres. Distance/access to shopping, schools and other amenities

However, this list in itself is regional in nature, with a number of the items noted only relevant in certain regions. For example, homes in subtropical climates often operate without heating and cooling; basements and fireplaces are not a common feature in many housing markets. Other housing characteristics may instead be important such as the presence of a pool in a tropical or sub tropical climate. Hence knowledge of the characteristics of the housing market under examination is required for a practical approach to be taken to independent variable selection and care needs to be taken in adopting a model from one market and applying it in another market without consideration of the underlying market fundamentals (Sirmans, Macpherson and Zietz, 2005).

Still, this “full dataset” of Malpezzi’s includes only characteristics of the home itself and its relative location with respect to various amenities. This factor is particularly important when considering the influence government policies have on house prices, as illustrated in Figure 3.1. Other exogenous demand impacts that effect house price are omitted from Malpezzi’s list such as the availability of finance and mortgage interest rates, population growth, government housing policies such as First Home Owners Grant (Australia), let alone any discussion on the supply drivers.
Meen (2001) raises issues associated with modelling housing markets at different spatial scales, with care needed in the specification and interpretation of models at a national, regional or urban level or even sub-market level where consumer behaviour is not determined by arbitrary administrative boundaries.

In designing an econometric model, the researcher must therefore attempt to take account of all significant demand and supply factors from a practical perspective that contribute to house prices across the study area market place in order to construct an accurate and representative model that can track and forecast the change in house prices over time and estimate individual component contributions. This must be balanced against data availability, as at the end of the day “(t)he choice of explanatory characteristics is often determined largely by data availability” (Hill, 2012, p24).

A further challenges associated with hedonic pricing models is the lack of comparability of findings between models. This is due to two factors. Firstly, as can be inferred from the prior discussion on independent variables, the results of such models are location specific and may therefore be inappropriate to generalise findings across different geographic locations (Sirmans et al., 2005). Secondly, comparability becomes even more complicated when different functional forms are adopted (that is linear or semi-logarithmic models) (Sirmans et al., 2005).

The archival research phase of this thesis analyses prior studies on the house price impact of infrastructure charges, with a focus on the issues of econometric technique, interpretation of functional forms and independent variable selection. Issues associated with the different empirical specifications are analysed in the remainder of this chapter. Issues associated with the selection and interpretation of functional form and treatment of independent variables, are analysed in Chapter 4. It is important for this research to gather and analyse this data from the rich body of evidence that exists in the US. In this way, the most appropriate model can be adopted for use in Stage 2 of this research, which is the first of this kind to be undertaken in Australia.
3.4 ANALYSIS OF EXTANT MODELS TO ESTIMATE INFRASTRUCTURE CHARGE EFFECTS

As outlined in the previous chapter, well over a dozen empirical models utilising various hedonic and related econometric techniques have been published in the US since 1989 that seek to estimate the effect of infrastructure charges on house prices. Early models suffered from methodological errors and inappropriateness of data (Nelson et al., 2008) which the later studies in the 2000’s sought to overcome. The remainder of this chapter is focused on analysing these later more advanced extant models in order to select the most appropriate approach to adopt for an Australian model.

Archival research carried out as part of this project uncovered five doctoral theses from the US which specifically examined the effects of infrastructure charges on house prices. These works were carried out between 1996 and 2004, with subsequent journal articles published by a number of the authors21. Each of these works is consistent in their theory, hypothesis and findings that infrastructure charges do increase house prices. As indicated in the previous chapter, various hedonic and related techniques are employed to test the price impacts on a range of house price research problems including: the effect of infrastructure charges on both new and existing house prices as well as on developed vacant lots. A number also look at the price impact on developable land to assess back-passing, and some also run supply models to assess the effect infrastructure charges have on housing supply (construction) rates. In order to remain focused on the topic of this thesis, the following analysis will address the house price and lot models only.

The attractiveness of using theses for archival research purposes is the level of detail provided. In contrast, journal publications provide an annotated version of the research design, background, theory, methodology and findings. A full thesis outlines explicitly all of the researcher’s objectives and assumptions, background information, theoretical bases, all model outputs and details of trials and errors. A further feature of gathering data from prior theses is to gain the benefit of lessons

learnt by prior researchers, and to build off the existing knowledge on the topic. The findings of all but one of the theses examined as part of this research was later published in an academic journal, providing validity to the research and its findings.

The remainder of this chapter is devoted to analysis of these five doctoral theses which provide a deep resource of archival data, as well as a strong methodological basis for estimating the effects of infrastructure charges on house prices. Where published works have followed from the thesis, these subsequent works are analysed as well. Journal publications are useful as they are usually refereed and therefore subject to peer review and external ratification, however they provide less level of detail on assumptions and rationale for the approach adopted.

The authors of the five prior doctoral theses on this topic from the US that are utilised for this archival research are (in chronological order of prior works):

- Dr Larry L Lawhon, Associate Professor Landscape Architecture/Regional and Community Planning, Kansas State University
- Dr Tim Shaughnessy, Associate Professor, Economics/Finance Department, Louisiana State University Shreveport
- Dr Shishir Mathur, Associate Professor, Urban and Regional Planning, San Jose State University
- Dr Doug Campbell, Instructor, Department of Economics, University of Memphis
- Dr Greg Burge, Assistant Professor, Economics, University of Oklahoma

Analyses of Dr Jennifer Evans-Cowley’s (Associate Dean of Academic Affairs and Administration, College of Engineering, The Ohio State University) post doctoral publications on this topic are also included in this chapter, despite her thesis not including an infrastructure charge based house price model (see Evans, 2000). Prof Evans-Cowley’s post-doctoral work is considered relevant to this analysis as it provides the most recent contribution to the literature and is an example of a cross-sectional model in this field of research.

Firstly, the study area for each model is described together with the methodological approach. The purpose of this step is to identify the key study area selection criteria, size and nature of the sample set, and to evaluate each author’s
contribution in the evolution of this topic of research. Secondly the specification of each econometric model is evaluated. This is an important step as it examines the various econometric techniques and functional forms of the existing models and the independent variables included in each analysis. Thirdly, the findings of each model are evaluated. This step tests validity and robustness of assumptions made, interpretation of outputs, conclusions drawn and the appropriateness of data utilised in the context of external validity. Finally, the limitations of each study are evaluated in light of conclusions from the previous steps. The key outcome from this process is to identify the strengths and limitations of the existing models and the conclusions made give an indication as to the appropriate methodology to employ for this study. Issues associated with the selection and interpretation of functional form and treatment of independent variables, are analysed in Chapter 4.

The term “impact fee” is used in the analysis of the US models to retain consistency with the original data sources, remembering however that for the purposes of this study the terms “impact fee” and “infrastructure charge” are deemed interchangeable. The term “infrastructure charge” returns in the analysis in the following chapter.

3.5 LAWHON

Dr Larry Lawhon authored two studies on the effects of infrastructure charges on house prices. The first was his 1996 doctoral thesis submitted to the Texas A&M University in the department of landscape architecture and urban planning, The second was a 2004 journal article published in the Journal of Architectural and Planning Research.

3.5.1 PhD 1996

Lawhon’s (1996) thesis employs a quasi-experimental, cross sectional hedonic model to estimate the house price effects of both impact fees and growth as separate variables. He uses Loveland, Colorado as the impact fee community and Fort Collins as the control community (no fee). The study period is from 1983 – 1986

\[22\] It is inappropriate to directly compare the findings of each study due to differences in their functional forms. Refer to Chapter 4 for further details.
using a random sample of 95 homes sold during each of the four years studied for each community (760 sales). Whether the sample set is of new and/or existing homes is not specified. Lawhon’s contribution is to further investigate Singell and Lillydahl’s (1990) earlier findings for Loveland, Colorado over the same study period. Singell and Lillydahl (1990) found that the July 1984 introduction of $1,182 impact fees increased the price of new housing by $3,800 and existing housing by between $5,000 and $7,000.

Lawhon’s contribution is the introduction of the Fort Collins control group, the separate assessment of the impact of growth on house prices as well as a theoretical discussion on the inequity of impact fees falling disproportionately on the poor. This later point was an objective of the research, but not specifically addressed in the findings.

**Model and Variables**

Lawhon’s initial general linear model comprised nine variables as indicated below:

\[ P = \beta_0 + \beta_1 X_1 + \ldots + \beta_9 X_9 \]

Where

- \( P \) = Price of housing between 1983 - 1986
- \( \beta_0 \) = Constant
- \( X_1 \) = Number of bedrooms
- \( X_2 \) = Number of bathrooms
- \( X_3 \) = Square feet of the house
- \( X_4 \) = Dummy variable for impact fee: 1=impact fee imposed, 0=no impact fee
- \( X_5 \) = Parkland per 1000 residents

\[ \text{Equations throughout this chapter have been standardised by the author in accordance with Malpezzi's (2002) equation for ease of comparison.} \]
\[ X_6 = \text{Growth index: an indicator of growth pressure in the community, consisting of increase in population over previous year divided by number of residential permits issued in year} \]

\[ X_7 = \text{Crime index: violent crimes per year per 1000 residents} \]

\[ X_8 = \text{School quality index: the local school performance score divided by the state level school performance score for each year} \]

\[ X_9 = \text{City difference variable: dummy to account for difference in the price of housing in the two communities: 0=Loveland, 1=Fort Collins} \]

Following Malpezzi’s (2002) protocols, variables \( X_1, X_2 \) and \( X_3 \) could be termed structural having relevance to the house; only the city difference variable \( X_9 \) would fall into the locational category, whilst the remainder are jurisdictional. To test the impact of these jurisdictional variables on the price of housing in the sample communities, a “Backwards Stepwise” procedure was applied, which removed the parkland, crime, school quality and city difference variables one at a time. As would be expected, the results indicated the community attributes were meaningless unless the city difference variable was re-introduced, which became the final model:

\[ P = \beta_0 + \beta_1 X_1 \ldots \beta_4 X_4 + \beta_6 X_6 + \beta_9 X_9 \]

The variables found not to contribute to the model were the Parkland index \( (X_5) \), the Crime index \( (X_7) \) and the School Quality index \( (X_8) \).

**Findings**

From his final model, Lawhon concludes that the $1,182 impact fee increase in July 1984 added $1,661 to house prices in Lovedale, with the growth index contributing $2,652. His sample set pooled new and existing houses so the differential effect was not able to be determined. Unfortunately, an omission from Lawhon’s analysis is his failure to highlight that impact fees are not statistically significant in his model outputs. If the fee effects are not statistically significant, then one cannot draw the conclusion that impact fees increase house prices.
Limitations and Observations

Despite the introduction of a control group and methodological refinements his model suffers from the same limitations of Singell and Lillydahl’s being: the exclusion of neighbourhood characteristics and the short time period of observation (18 months) either side of impact fee introduction (Been, 2005). Neither models use error terms. Lawhon states Fort Collins and Lovedale are close substitutes despite being 35 miles (over 56 kilometres) apart, having an average house price difference of $8,000 and Fort Collins having a population two to three times the size of Lovedale; whilst Singell and Lillydahl identify Lovedale as being a unique market, not having substitutable housing markets. No average house price or other housing characteristics are provided in evidence of substitutability, other than inclusion of dummy to differentiate between the two communities. The rationale for the small sample size is unexplained. The random selection of homes for this study is presumed to incorporate both new and existing homes, and hence provides no separation of the effect, despite impact fees only being applicable to new homes. This is despite Singell and Lillydahl’s earlier model providing this differentiation. Both communities studied reported declining residential permits after 1984, despite Fort Collins not having impact fees; no other external shocks were identified that might have impacted housing demand at this time, for example general economic conditions, mortgage interest rates, government policy changes etc.

Whilst the apparent misinterpretation of the model outputs raises doubt as to the validity of Lawhon’s conclusions, the contribution of the work remains valid albeit with the potential for omitted variable bias. On the other hand, variables that might have been thought to contribute to house prices were found in this instance to be either not significant, or to have sufficient collinearity with other variables as to not add additional predictive qualities to the model being: parkland, crime and school indexes.

3.5.2 Journal Paper 2004

Lawhon’s (2004) journal paper presents a modified version of his PhD model, correcting for his PhD’s error in interpretation of model outputs. The sample used is the same as for the PhD being a random selection of 95 sales in each of the study years for each community totalling 760 observations per community. He clarifies that these are a selection of new and existing homes, however no dummy variable is
incorporated to test the differential effects. His PhD final model is used which regresses: the number of bedrooms and bathrooms, square feet of the house, a growth index, city difference dummy and an impact fee dummy against house price.

The model outputs are identical to the PhD and Lawhon identifies that as the impact fee test is not significant, no conclusions can be drawn about their price impacts. Perhaps it is these errors that have resulted in Lawhon’s work being ignored by the subsequent literature. However, this work provides evidence of a step in the evolution of the use of hedonic house price models to estimate the effect of impact fees.

3.6 SHAUGHNESSY

Dr Tim Shaughnessy authored two studies on the effects of impact fees on house prices. The first was his doctoral thesis submitted to the Florida State University, Department of Economics. The second was a journal article authored with his supervisor Professor Keith Ihlanfeldt.

3.6.1 PhD 2003

Shaughnessy’s dissertation examined the price incidence of impact fees on new and existing housing, as well as vacant undeveloped residential land. He also used this data set to estimate the impacts on house construction due to impact fees (supply effects). His data set comprises sales of 39,792 new homes and 107,376 existing homes and land in Dade County Florida, from 1985 to 2000, where impact fees were introduced from 1989.

His theory relies on Yinger’s (1998) concept of a “new view” wherein buyers knowingly and willingly pay more for housing subject to impact fees, in the expectation of lower property taxes in the future i.e. a prepayment of an expected future benefit. This is in comparison to the “old view” whereby buyers bear the higher cost of housing unwillingly due to the passing, or overpassing of impact fees which is a cost burden to the new home owner.

Shaughnessy’s contribution is to introduce analysis on the topic of on-passing of impact fees to home owners consistent with the new view. His research seeks to address shortcomings of prior research including: outcomes inconsistent with
economic theory (old view), sparsely specified hedonic price models and omission of correlated variables such as neighbourhood and locational variables.

**Model and Variables**

Shaughnessy’s modelling approach is a standard two-step time series model. In the first step, monthly indexes of the price of new and existing houses and undeveloped residential land are constructed utilising both hedonic and repeat sales approaches. For new and existing houses, predictions from a hedonic model in which dummy variables are used to account for both time and location, are used to construct a time series index. For existing houses and vacant undeveloped residential land, a repeat sales model is used to form the index. In the second step, the indices are then used in a time series regression from which the marginal effects of impact fees are obtained.

**Stage 1**

The hedonic estimation takes the usual form, with Shaughnessy including a number of new variables that are additional to prior models:

\[
P_{i,t} = \beta_0 + \beta_1 S_i + \beta_2 N_{i,t} + \beta_3 L_i + \beta_4 J_i + \beta_5 T_t + u_{i,t}
\]

Where

\[P_{i,t} = \text{sale price of parcel } i \text{ in time period } t\]

\[S_i = \text{structural characteristics for house sales (house and lot size, number of bedrooms and bathrooms, age of the house, if zoned low residential density) else nil for vacant land apart from land size, and age excluded for new housing. Note the square of each structural characteristic is modelled also.}\]

\[N_{i,t} = \text{neighbourhood demographic characteristics (percentage ethnic groups, median per capita income, percentage renters) each to census block group level}\]

\[L_i = \text{distance (and distance squared) to major employment centres, (eight centres used) using GIS data}\]

\[J_i = \text{jurisdictional dummy (32 cities within Dade County)}\]
\( T_t \) = time dummies to account for time sold (month and year) (relates to other time related variables such as increases in fees, change in population, economic activity, seasonal fluctuations, other time related dummies)

\( u \) = error term

Shaughnessy then estimates a repeat sales index as it is suggested to overcome the potential of omitted variable bias of hedonic methods. Clearly, it can not apply to new houses, as once a new house is sold it becomes an existing house. A negative feature of this methodology is that it relies on the assumption that significant structural changes do not occur between sales, and that houses that resell multiple times in the study period are representative of the sample. On the other hand, an attraction of this technique is that the only data required is the sale price and sale date from two sales of any house or lot. The last two sales for properties were included with all sales adjusted for inflation.

Stage 2 Stock Flow Model

Once a monthly index of constant quality house price movements over time was established, the second stage model was used to estimate the effect of impact fees on those prices movements of new and existing homes and vacant undeveloped residential land. DiPasquale and Weaton’s 1996 stock flow model is used as indicated below, with the dependent variables of new and existing house price indexes being those constructed in Stage 1:

\[
P_t^* = \frac{1}{a_2} \left[ \frac{S_t}{H_t} - \alpha_1 U_t + \alpha_3 R_t + \alpha_4 Y_t \right]
\]

Where:

\( S_t/H_t \) = housing stock as a percentage of households

\( U_t \) = annual cost of purchasing housing (30 year average mortgage rate, property tax rate, expected house price appreciation, impact fees, marginal income tax rate)

\( R_t \) = housing rent

\( Y_t \) = average income per household
All items are adjusted for inflation. The other adjustment made is a lag in all variables by two months to account for the time between contract signing and settlement. Interestingly, the only variables not lagged are impact fees and property tax rates. Shaughnessy argues that announcements as to impact fee and property tax rates are made prior to their effective dates, so buyers should know what any new amounts would be at time of settlement and will have priced any changes into their purchase amount. See the section on limitations for discussion on this assumption.

Findings, Limitations and Observations

Shaughnessy’s results indicate that for every additional $1.00 of impact fee, the price of both new and existing housing increases by $1.64 and $1.68 respectively using both hedonic and repeat sales methods, and that vacant undeveloped residential land decreases by $1.00 (100% back passing). He argues his case for the new view theory in relation to new and existing housing, maintaining that home owners have the capacity to price in expected future property tax savings. Under this theory, no “over passing” occurs (developers seeking to recoup the additional costs of supply) rather the price increase is reflective of the buyer’s knowledge of the services paid for by the fee, ability to price in the expected benefit of that service as a form of pre-payment and increased house prices are the measure of their willingness to do so. This argument appears inconsistent, particularly when combined with Shaughnessy’s acknowledgement of fees being levied at the time of planning approval which by his own admission may be many months or years prior to the time a buyer actually purchases a home. That is, if a fee is levied, say two years prior to the home being sold due to subdivision works and construction time frames, then the relevance of the scheduled fee (or any announced increases and the services it provides for) at the time of purchase is questionable. The use of lags could have addressed this issue, and yet this opportunity was missed with questionable rationales focused purely on the “new view” theories rather than acknowledgement of property market

24 Shaughnessy rounds both of these outputs down to $1.60 in his conclusions.
fundamentals. Refer to Section 2.6.3.2 for the requisite assumptions required for the new view to hold.

The propensity of home buyers to capitalise expected future property tax savings is questionable. This assumption is based on highly educated and financially fluent home buyers existing in a transparent impact fee and property tax regime. Such a community would be the exception rather than the norm and if so, it would have been appropriate to explain Dade County’s unique features. Been (2005) was highly critical of this theoretical basis for the new view and Shaughnessy’s conclusions.

In his focus on the new view, Shaughnessy fails to identify that his results suggest evidence of both on-passing and back passing occurring contemporaneously. This back passing is attributed to developer uncertainty regarding future increase in fees and yet the new view assumes fee certainty and ability of buyers to forecast future fees and property taxes. If a developer is able to contemporaneously pass backwards and forwards a cost of supply, then the developer’s profit would increase by the amount of the impact fee (plus any overpassing less any fee increases). This is an important finding that may have lead to quite differing conclusions.

Inconsistent terminology in relation to the nature of the “land” in this research creates confusion. Clarity is required around whether unsubdivided (englobo) land or subdivided (and serviced) vacant lots is being examined. This clarification does not become apparent until late in this study.

3.6.2 Ihlanfeldt and Shaughnessy 2004

Ihlanfeldt and Shaughnessy (2004) published Shaughnessy’s thesis findings with similar theories and conclusions to those reported above. The argument posed for the new view may be convincing at a theoretical level, however it is inconsistent with the practical function of the property development process and time frames involved, and thus mix long and short run effects in its justifications. The findings note that impact fee increases create uncertainty for the developer (and hence the propensity to bid down land prices) and yet the model assumes sufficient certainty in relation to expected property tax increases for home buyers to efficiently capitalise impact fees and future property tax increases into house prices. The present value of
future property tax savings is estimated to be $1.20 for each additional $1.00 of impact fee, however the notes to this calculation are scant and lack external validity.

Despite criticism of the new view conclusions, Shaughnessy’s work is an important addition in the evolution of models that estimate the impact of impact fees on house prices. The model findings are significant and the model specification overcomes earlier omissions with a wider range of house price variables incorporated. A full list of the independent variables utilised by Shaughnessy and a comparison with other authors is included in Chapter 4.

3.7 MATHUR

Dr Shishir Mathur has authored a number studies on the effects of impact fees on house prices. The first was his doctoral thesis (2003), the second was a journal article authored with his supervisor Professor Paul Waddell and Professor Hilda Blanco in 2004, and a third article was published in 2007. Mathur’s 2008 and 2013 publications are derivations of his original data set and address sub-issues not directly associated with house prices and hence are not examined here in detail.

3.7.1 PhD 2003

Mathur’s doctoral thesis was based on research comprising a dataset of 14,103 new and 148,700 existing house sales, across 38 jurisdictions in King County, Washington which had a strong real estate market over the study period and Snohomish County, Washington which had a soft real estate market over the study period. The study duration was 1991 – 2000 (10 years) and findings include those for existing housing as well as new housing. It examines the whole new home data set via a hedonic price regression model, as well as segmentation into low and high quality housing. This thesis was submitted to the University of Washington in the department of Urban Design and Planning.

Mathur’s theoretical framework is based around microeconomic demand and supply theory, with a strong focus on market conditions as a primary driver of house prices. His theory includes a discussion on the national, regional and country level trends that affect housing markets, factors overlooked in much of the other literature.
**Contribution**

Mathur’s contribution is two-fold: firstly he tests for the differential price affects of impact fees on new housing categorised as either of high or low quality, with his hypothesis being that impact fees may have differing effects on house prices as price elasticity increases with increased quality. Secondly, he tests this theory that in a strong real estate market any increase in the supply costs of housing is borne by the buyer.

Mathur’s view is that hedonic methods, whilst well established, fail to resolve into component parts the demand and supply factors that affect house prices. His expanded data set and revised methodology seeks to correct for this omission of prior works.

The study area is selected as it represents a highly urbanised region of the state with a large and diverse housing market. It supports the primary population base and economic centre for the state and both counties have similar impact fee regimes. His model is designed to take into account many regional and jurisdictional level housing demand and supply factors omitted in earlier studies and hence is claimed to provide more accurate information about the house price effect of impact fees to policy makers.

**Model and Variables**

This study incorporates both a hedonic regression and an instrumental variable regression method to examine the effect of impact fees on a) new and existing housing and b) the differential effect across different quality of housing c) in varying market conditions.

This study differs to others by virtue of its attention to variables associated with house price drivers and its explicit attempt to include factors of both housing demand and supply. This study was the first to introduce the spatial effects of transportation accessibility factors, distance to urban growth boundaries as well as a measure of the quality of the view from the house. This research had the benefit of data of thirteen housing quality categories as captured by the King County valuation office, and nine categories for Snohomish County.
Mathur firstly utilised the standard form linear hedonic model in the usual form:

\[ P_{i,t} = \beta_o + \beta_1 S_i + \beta_2 L_i + \beta_4 J_i + u_{i,t} \]  \hspace{1cm} 3.6

Where

\( P_{i,t} \) = natural log sale price of parcel \( i \) in time period \( t \)

\( S_i \) = Structural attributes: log of house size, lot area, number of bathrooms and age of the house; number of bedrooms and fireplaces; building quality grade and associated high/low quality dummy

\( L_i \) = Locational attributes: quality of view over mountain and lake, traffic noise, log of travel time to CBD, accessibility to non-retail/retail jobs by car, log of auto accessibility, log of transit accessibility; inverse of distance to urban centres, inverse of distance to urban growth boundary

\( J_i \) = Jurisdictional/Regional demand side attributes that affect the rate of change of the population of in town or city \( j \), at time period \( t \): per capita municipal expenditure; school expenditure per pupil, property tax rate, property and violent crime rates, increase in median household income, annual population change for the city and county, number of new building permits in city and county, labour force, unemployment rate, construction cost index, mortgage rate and impact fees

\( u \) = error term

Mathur then employed a two-step instrumental variable regression method to correct for the endogeneity of aggregate demand and supply factors, a limitation of hedonic regressions. First, two sets of aggregate supply and demand variables are estimated together with exogenous variables. The estimations from this first step are then regressed in the hedonic equation to estimate the affect of aggregate demand and supply on house prices.
The demand equation form is:

\[ D_{j,t} = \beta_0 + \beta_1 J_{j,t} + \beta_2 T_d + \beta_3 J_d + u_{i,t} \]  

Where

- \( D_{j,t} \) = the rate of change of population of in town or city \( j \), at time period \( t \)
- \( J_{j,t} \) = Jurisdictional/Regional demand side attributes that affect the rate of change of the population of in town or city \( j \), at time period \( t \), property tax rate, property and violent crime rates, per capita municipal expenditure, school expenditure per pupil and mortgage rate
- \( T_d \) = time (year) dummies
- \( J_d \) = jurisdiction dummies

The supply equation form is:

\[ S_{j,t} = \beta_0 + \beta_1 J_{j,t} + \beta_2 T_d + \beta_3 J_d + u_{i,t} \]  

Where

- \( S_{j,t} \) = the number of new house approvals in town or city \( j \), at time period \( t \)
- \( J_{j,t} \) = Jurisdictional/Regional supply side attributes that affect the rate of change of the population of in town or city \( j \), at time period \( t \), construction cost index, property tax rate, impact fees
- \( T_d \) = time (year) dummies
- \( J_d \) = jurisdiction dummies

The final multiple regression model takes the usual form:

\[ P_{i,j} = \beta_0 + \beta_1 S_t + \beta_2 L_i + \beta_3 J_i + u_{i,t} \]  

Where

- \( P_{i,j} \) = natural log of the sale price of house \( i \) in city or town \( t \)
- \( S \) = Structural attributes: log of house size, lot area, number of bathrooms and age of the house; number of bedrooms and
fireplaces, building quality grade and associated high/low quality dummy

\[ \mathbf{L} = \text{Locational attributes: quality of view over mountain and lake, traffic noise, log of travel time to CBD, accessibility to non-retail/retail jobs by car, log of auto accessibility, log of transit accessibility, inverse of distance to urban centres, inverse of distance to urban growth boundary} \]

\[ \mathbf{J} = \text{Jurisdictional/Regional attributes: per capita municipal expenditure, expenditure per pupil, property and violent crime rate, increase in median household income, labour force; unemployment rate, construction cost index, mortgage interest rate, impact fees, rate of change in population (aggregate demand derived from IV approach), and building approvals (aggregate supply derived from IV approach)} \]

A semi-log specification is used for the final model estimation, with the log of sale price of the house as the dependent variable. A full analysis of the data set inputs for this model, and comparison with other authors is included in the following chapter.

**Findings**

Mathur provides the first evidence of differential impact fee driven price effects across housing quality types. Overall he finds impact fees increase house prices with the amount of shifting and over shifting dependent upon the house quality (and inferred affordability level). His findings provide evidence of impact fees adding $0.75 to low quality new houses (however with weak statistical significance \( t = 1.48 \)), $1.35 to $1.38 to all new houses (average of all pooled) using the hedonic and instrumental variable regression methods respectively, and $2.46 to high quality new houses in King County. The findings for Snohomish County where the real estate market was soft, were not statistically significant.

For existing housing, he found evidence of impact fees adding $0.82 to low quality new houses, $1.47 to $1.28 to all new houses (average of all quality levels pooled) using hedonic and instrumental variable regression methods respectively,
and $1.70 to high quality new houses in King County. The findings for Snohomish County were not statistically significant.

This study’s contribution was twofold finding that:

- In a strong real estate market (King County), impact fees have an inflationary effect on both new and existing house prices, with no observed effect in periods of soft market conditions (Snohomish County); and
- This increase is significant and elastic with mid to high quality housing (both new and existing) increasing in excess of the fee respectively (over passing), with evidence of under-passing to low quality housing (existing and new).

Limitations and Observations

Mathur’s theoretical framework is sound and well articulated. He spends considerable time considering market drivers of house prices, and takes care to include associated independent variables. His data set is somewhat unique however in its level of detail. Firstly, the local government assessment office collected detailed data on each house, rating its quality into one of thirteen house quality categories, as well as rating the quality of any view or locational feature. Secondly, Mathur’s supervisor’s expertise was in transport studies and thus enabled access to data set/s on distance to freeway on-ramps, public transport and employment centres. Whilst it might be desirable to include such variables in future studies, the compilation of such datasets on either of these factors if not already available, is likely to be prohibitive.

Mathur claims that his detailed dataset provides more accurate information about the house price effect of impact fees to policy makers. When considering the complexity of this model compared to the relative simplicity of others, it is interesting that Mathur’s findings remain consistent with the other literature on such price effects. This could be interpreted as evidence that a more complex model does not necessarily add additional accuracy in its estimations. Conversely, it could be argued that with an $R^2 = 0.861$, after dropping out more common variables such as unemployment rate, income rate and a number of other jurisdictional/policy level
attributes, perhaps Mathur’s control for less common variables such as house quality and accessibility reveal the true drivers of house prices.

Mathur explicitly assumes the ready availability of zoned land suitable for subdivision in his supply equation. This is an important assumption that other authors are silent on. It is assumed they make this assumption also. However it raises the question of the impact of planning constraints on supply and thus house prices. The Australian development community and other Australian research outlets often cite the lack of suitably zoned land for subdivision as a significant market imperfection and a contributor to the housing affordability debate (See Urban Development Institute of Australia, 2006; National Housing Supply Council, 2010). However in the absence of a suitable independent variable to reflect potential land availability, it appears that this assumption is a necessary evil and perhaps a limitation of each study.

3.7.2 Mathur, Waddell and Blanco 2004

Mathur together with his supervisor Waddell and Blanco published part of Mathur’s thesis findings, including results only King County. Snohomish County may have been excluded given its results in the earlier analysis were statistically insignificant. New house sales results only are presented. Existing homes in King County are not included in this paper.

Additional descriptive statistics for the continuous variables for new homes are provided with the resultant impact fee coefficient applied against a mean house price of $246,000, rather than $200,000 as utilised in the thesis version. Findings indicate impact fees increase the price of all new housing (that is the average of all quality levels pooled) by $1.66, with the effect being more pronounced with high quality homes at $3.58 and a marginally statistically significant (t = 1.5) finding for low quality new homes of $0.37. Mathur et al.’s rationale for these findings are generally consistent with the old view, being in compensation for additional holding costs and the presence of an elastic market due to high demand pressures. The one new view conclusion was attributed to editor contribution (ie. Capitalisation of perceived future benefits).
3.7.3 Mathur, 2007

This subsequent hedonic price regression model examines the effect of impact fees on existing houses in King County over the same study period as above, similarly segregated by high and low quality ranges. Some descriptive variables have been omitted from the model. The findings again support the hypothesis of overpassing to high quality homes at $1.03, $0.83 for all existing homes, and statistically insignificant for low quality existing homes.

Mathur’s work is an important addition in the evolution of models that estimate the impact of impact fees on house prices. The model findings are significant and the model specification overcomes earlier omissions with a much wider range of house price variables incorporated, including spatial elements that detailed data for which had previously been available. A full list of the independent variables utilised by Mathur are included in the analysis in the following chapter.

3.8 CAMPBELL

Dr Doug Campbell authored one study on the effects of impact fees on house prices, his doctoral thesis which was completed at Georgia State University’s economic department. No publications have been forthcoming from this work.

3.8.1 PhD 2004

Campbell’s research investigates the effects of impact fees on house prices within the Orlando statistical area in Florida which consists of six counties and 70 cities and town. He employed hedonic models to measure the price effect on 103,444 new and 175,877 existing house sales over a five year study period (1997 – 2001). The population of the study area was 2.5 million people in 1997.

Contribution

Campbell sought to overcome the “paucity of data as well as insufficient methodological rigor” (Campbell, 2004, pxi) of earlier models. Specifically

---

\(^{25}\) Campbell incorporated early work by Shaughnessy which was presented in a 2002 conference paper.
Campbell sought to address the issues of endogenous impact fees, spatial relationships in housing markets and heteroskedasticity by incorporating more descriptive structural variables and limited locational (spatial) variables over a large and diverse data set. These issues were identified to be a function of the dynamics of the impact fee usage by local jurisdictions, the nature of the housing market studied and the type of data examined. Campbell sets out to achieve this goal by expanding the data sets of previous studies including numerous structural variables accessed from over 100 data sources applied to nearly 280,000 individual house sales. This approach was designed to overcome criticisms of repeat sales models that assume: a constant-quality home may mis-represent the true underlying market values and violate the assumption of random selection of observations. This data was collated and regressed at the city/town, county and statistical division level and included GIS data where available.

**Model and Variables**

Campbell went to great lengths to gather very detailed data sets for each of the 70 cities and townships in his study area. This enabled three main sets of regression models to run for all housing in: the Orlando statistical area, in each of the six counties and in each of the 70 cities and townships. This totalled 75 sets of hedonic housing model regressions. For each of these sets, linear and semi-log models were run for all housing, new housing and existing housing in the form:

\[
\frac{P_i}{HPI} = \beta_0 + \beta_1 S_i + \beta_2 IF_i + \beta_3 M_i + \beta_4 G_i + \beta_5 I_i + \beta_6 Y_i + \beta_7 T_i + \beta_8 C_i + \beta_9 L_i + u_i \tag{3.10}
\]

and

\[
\ln \frac{P_i}{HPI} = \beta_0 + \beta_1 S_i + \beta_2 IF_i + \beta_3 M_i + \beta_4 G_i + \beta_5 I_i + \beta_6 Y_i + \beta_7 T_i + \beta_8 C_i + \beta_9 L_i + u_i \tag{3.11}
\]

Where:

- \( P_i \) = sale price of house \( i \)
- \( HPI \) = appropriate housing price index for each sample year (changes in housing costs for the national housing market)
- \( S \) = structural characteristics of the house
- \( IF \) = impact fee
- \( M \) = millage rate (property tax)
\( G \) = population growth rate  
\( I \) = percentage change in median income  
\( Y \) = year of sale dummy  
\( T \) = township dummy  
\( C \) = county dummy  
\( L \) = weighted spatial matrix (counties with GIS data only)  
\( u \) = error term

Within many of the independent (right hand side) variables listed above sit a number of sub-data sets, particularly within the structural characteristics variable. For a full analysis of the data set inputs for this model, refer to Table 4.1, Table 4.2 and Table 4.3 in the next chapter.

Non arms-length transactions were excluded from the data, as were outliers. Houses were considered “new” if sold within one year of the date of construction. GIS data was collected for each parcel (for the two counties with GIS data available) and the weighted spatial matrix was created that incorporated the distance of each house sold to major roads and thoroughfares, lakes, rivers and other waterways and jurisdictional boundaries. Property taxes were lagged one year to control for potential endogeneity with impact fees, however this rationale is not explained and is counter intuitive. Theoretical arguments tend to support lagging impact fees not property taxes, this is a potential specification error.

**Findings**

Campbell’s findings are difficult to draw conclusions from at the town/city and county level because the house price effects vary so considerably across jurisdictions, fluctuating from very large amounts in the positive (house price increases) to equally large amounts in the negative (house price reductions). In saying that, findings for more than half of the individual towns/cities are consistent with the theory that impact fees increase house prices for both new and existing houses.

However, overall for the Orlando statistical division, Campbell found for every $1.00 of impact fee, new house prices increase by $1.44 whilst for existing houses, prices increase $1.07 (on passing, with little over passing). These are the findings
for the linear models, with the semi-log models findings not reported due to wide variances. Campbell provided rationale for the unexpected variations in his findings, however no conclusions were drawn on the reasons for overpassing of these fees onto home buyers.

**Limitations and Observations**

Campbell’s findings have received criticism in later literature due to the vastly varying and contradictory results at the city/township and county level. By way of example his results indicate in one county, new house prices increase $14.87 for each $1.00 of impact fees, whilst in other county new house prices decrease by $16.72 for each $1.00 of impact fee. Over the entire study area his findings average out to be consistent with the findings of prior literature, however it is apparent that despite Campbell’s efforts to incorporate all independent variables possible, effects are occurring which are not observed. Omitted variable bias appears to remain, which is recognised by Campbell in relation to his spatial analysis.

The weighted spatial matrix attempts to correct for spatial autoregression in the model, which is the differential effect location to local amenities/features has on house prices, or in other words, house prices are driven by “location, location, location”. His approach was reported to take into consideration each house’s distance to major roads and thoroughfares, lakes, rivers and other waterways and jurisdictional boundaries “and so on” (p72). However no account was taken of other house price drivers associated with location such as proximity to schools, shops, employment centres, CBD, public transport, beaches etc. Campbell acknowledges this deficiency himself in his conclusions. It is a shame in collation of such a detailed data set he focused on the features of the individual houses, rather than their relative location to amenities as the key value driver.

An observation of Campbell’s data set is the high proportion of new house sales in comparison to existing house sales in the study period. Of the 280,000 or so house sales in the five year study, approximately 37% of these were for new houses, with an average house price for the full data set of $72,000. This is suggestive of a unique market, undergoing extremely high growth, that may not meet usual methodological assumptions and warrants further consideration when considering the external validity of this model. Campbell did not provide comment on this feature of the Orlando housing market.
Despite the limitations of this work, the overarching observation from Campbell’s research is the final consistency of its findings to earlier work, the shortcomings of which he sought to overcome. His consistency in average results for the full study area is obtained despite a different and more significantly detailed methodology. This finding could be interpreted as lending weight to Meen’s (2001) and Malpezzi’s (2002) assertion that data availability is what drives econometric house price model specification rather than theory.

3.9 BURGE

Dr Greg Burge has authored a number of works on the topic of the effects of infrastructure charges on house prices. The first was his doctoral thesis in 2005 submitted to the Florida State University, Department of Economics. The findings of his thesis were published in 2006 co-authored with his thesis supervisor Professor Keith Ihlanfeldt. In 2007 Burge collaborated with Professor Arthur (Chris) Nelson and John Matthews to publish on the effects of proportional-share impact fees, and in again 2008 contributing a chapter in Chris Nelson et al.’s 2008 book “A Guide to Impact Fees and Housing Affordability” (see Burge, Nelson and Matthews, 2007 and Nelson et al., 2008). This section will focus on Burge’s thesis model that estimates the impact of impact fees on house prices (single family homes only).

It is noteworthy that Shaughnessy’s, Mathur’s and Campbell’s works were carried out in isolation of each other, occurring virtually contemporaneously in three different states around the US. Burge had the benefit of their prior contributions to consider when developing his theories and methodologies, as well as sharing a supervisor with Shaughnessy. Evans-Cowley et al.’s 2005 work had also been published prior to completion of Burge’s thesis and is included in his review of the literature.
3.9.1 PhD 2005

Burge’s doctoral thesis sought to measure the price effects of impact fees on starter homes. To do this, Burge examines a panel of houses in 41 counties throughout all of Florida over 11 years (1993-2003) that utilise impact fees. His theory is based on an extension of the standard urban model, whereby all development occurs on the urban edge, with the price of housing diminishing as the cost of commuting increases.

Contribution

Burge’s contribution is to assess the price effects of impact fees on the price of housing as estimated across three different segments of the housing market, being small, medium and large homes as defined by house size. Burge further categorises this effect by testing separately for the price effect of utility fees (water and sewerage) and community services fees (non-water and sewerage) on each house size. The implication in this work is that smaller houses are more affordable, and larger houses less affordable. By testing the differentiated price effects of impact fees across the housing market, evidence is gathered as to the relative effect impact fees have on housing affordability and the differential effect of utility versus non-utility fees.

Model

Burge employs a two-stage time series process, firstly estimating a constant quality house price index using all home sales for each of the three tiers of the housing market (i.e. small, medium and large homes) as well as all homes on an annual basis. The data set was not segmented by new and existing homes. Similarly to Shaughnessy, this annual index is then employed in the second step where both fixed effects and random effects models are run for both utility fees (water and sewerage) and community services fees (non-water and sewerage) on each house size. The house size categories were selected to divide the data approximately into thirds across the whole state of Florida. Impact fees are charged by house size in

---

26 A starter home is the first which a person or family can afford to purchase. It commonly refers to a small one- or two-bedroom home in low-cost new developments (Burge, 2014b).
Florida, with the house size implying the number of bedrooms in the home. As a matter of interest and for comparison with the Australian housing market, Burge’s housing categories have the following characteristics:

Table 3.1

<table>
<thead>
<tr>
<th>Item</th>
<th>Small</th>
<th>Medium</th>
<th>Large</th>
</tr>
</thead>
<tbody>
<tr>
<td>House size</td>
<td>600-1500sqft (56-140sqm)</td>
<td>1501-2200sqft (141-204sqm)</td>
<td>2201-5000sqft (205-465sqm)</td>
</tr>
<tr>
<td>Number of bedrooms</td>
<td>1-2 bedroom</td>
<td>3 bedroom</td>
<td>4 bedroom</td>
</tr>
<tr>
<td>2002 average house</td>
<td>$106,185</td>
<td>$139,384</td>
<td>$228,189</td>
</tr>
<tr>
<td>price (Florida)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source:  Burge (2005) and author

**Stage 1 – Repeat Sales Model**

The repeat sales method for construction of a house price index for the study period is selected over a hedonic approach due to the limited data on structural characteristics in Burge’s data set. Given structural, neighbourhood and locational variables are assumed to remain constant between each repeat sale, they drop out of the model:

\[
\left( \frac{P_{i,t}}{P_{i,t-n}} \right) = \sum_{k=1}^{T} B_k D_{i,k} + u_{i,t,t-n}
\]

Where

\[
P_{i,t} = \text{most recent selling price of property i at time t}
\]

\[
P_{i,t-n} = \text{previous selling price of property i at time t-n}
\]

\[
B_k = \text{log of cumulative price index in time period t}
\]

\[
D_{i,k} = \text{dummy -1 at initial sale, +1 at second sale, else 0}
\]

\[
u = \text{error term}
\]

Burge chose annual increments for the repeat sale model specification. His justification being that annual indices allow smaller sample communities to contribute to the estimation procedure, by virtue of allowing more sales to enter each time period and thus increasing the accuracy of the repeat sales estimator. A minimum of 100 pairs of sales per county over the study period was adopted. Cumulative nominal price appreciation rates were generated for each size category, as well as all categories. Using 2003 average house price data for each category in
each county (valuation assessments) as the benchmark, a series of annual constant quality nominal prices was constructed for each segment. Nominal prices were then transformed into real prices using inflation to create a real constant quality price index per county for the study period 1993-2003. Separate indexes for each county were generated in an attempt to ensure estimated price impacts on housing took county-specific housing market variables into consideration. Burge’s stratification of house prices by size and county identifies variation not only between counties, but also between categories within counties.

**Stage 2 – Fixed and random effects models**

The natural log of each estimated price index from Stage 1 was used as the dependant variable in the second stage, which regressed separately for the price effect of utility fees (water and sewerage) and community services fees (non-water and sewerage) on each house size. Note, community service fees are those for services traditionally funded by property taxes such as schools, law enforcement, fire protection, libraries and other community facilities. Both fixed effects and random trend models were run to deal with potential sources of endogeneity bias. Impact fees were lagged by one year given the fee levels used are those applicable at the end of the previous year.

The two way fixed effect model (county and time) provides for impact fees to differ depending on the level of constant quality house prices across counties:

\[
P_{i,t} = \alpha_i + T_t + \beta_0 WSIF_{i,t-1} + \beta_1 NWSIF_{i,t-1} + u_{it} \tag{3.13}
\]

Where

- \(P_{i,t}\) = constant quality real price of housing for county in i in year t
- \(\alpha\) = fixed effect for area, accounts for unobserved heterogeneity
- \(T\) = fixed effect for time, controlling for factors uniformly effecting all counties over time (ie. interest rates, policy changes, growth)
- \(WSIF\) = water and sewer impact fee
- \(NWSIF\) = non water and sewer impact fee
- \(u\) = error term
The random effect model (county specific price level and trends) provided for impact fees to differ based on both county-specific price levels and county-specific trends in house price appreciation. By adding a county specific time trend \((g_i)\) to the fixed effect equation, each county was allowed to have its own time trend in house prices, thus further mitigating the potential for endogeneity bias:

\[ P_{i,t} = \alpha_t + \gamma_t + g_i t + \beta_0 W S I F_{i,t-1} + \beta_1 N W S I F_{i,t-1} + u_{it} \]  

Where all variables are as per the previous equation but for:

\(g_i\) = county specific time trend

**Findings**

Burge’s models provide evidence that impact fees increase the price of small, medium and large sized homes by $0.39, $0.82 and $1.27 respectively. This implies that impact fees are not passed on at the same rate for affordable homes and more expensive homes. Indeed, under-passing occurs for smaller (and by inference more affordable) homes, which is consistent with Mathur’s findings using house quality as a proxy for affordability. The degree of on-passing appears to be approximately proportional to the price of the home and thus by inference, the ability to pay. This finding could lead to the somewhat contentious conclusion that the rich subsidise the provision of infrastructure for the poor. Neither Burge nor Mathur draw this conclusion.

Burge further finds that utility fees (water and sewerage) add little to house prices, whereas the community fees (non-water and sewerage) fees are highly correlated with increases in house prices the following year. Whilst Burge’s conclusions don’t go as far as Shaughnessy is extolling the virtues of the “new view”, he does conclude from his findings that increased community fees raise demand for housing (due to the expectation of future property tax savings) and thus have a positive effect on house prices. An alternative and more plausible proposition

---

27 All models are first differenced equations
could be that an increase in expected or actual services could drive demand for housing in an area, however this conclusion was not drawn.

**Limitations**

A strength of Burge’s model is its simplicity and restricted data set. Keeping in mind the only data inputs to Burge’s model are repeat sales data (sale price and date over a ten year period), size of the houses re-sold, county, impact fees applicable per county and inflation, there is the potential for omitted variable bias, with the model not relying on any other structural, locational or jurisdictional data. The even stratification of the housing data within each county, together with the cut off limit of a minimum of 100 paired sales per annum does appear to overcome these concerns by virtue of the sample size. Burge does not record his sample size however it is noteworthy that the population of Florida in 2003 was over 17 million people (US Census Bureau, 2014). By inference, to replicate this model in Australia with a similar sized data set, virtually the whole country would need to form the study area.

Burge implicitly assumes that house size equates to affordability, and that smaller houses are more affordable and larger houses are more expensive. Whilst this assumption may hold in some instances, it takes no account of other house price drivers such as quality, or intra-county locational variables, such as inner city versus urban fringe housing. Further, the affordability for moderate income households was not tested nor any data provided. It is possible that this market segmentation may be a nuance of the Florida market that may not have external validity.

The sample group provides evidence of a highly segregated market, with small (two bedroom), medium (three bedroom) and large (four bedroom) homes being almost evenly represented by number and the state wide average price for a large house being more than double that for a small house. This may be representative of a previously unidentified cultural difference between US and Australian planning systems and development patterns. Australian planning systems and development patterns generally seek to promote a range of housing choice within communities. Modern Australian master planned communities take a “salt and pepper” approach to house size to encourage community diversity. However despite calls for greater housing affordability, a predominance of three and four bedroom housing remains. A survey of houses listed for sale in the greater Brisbane area at the time of writing indicate only 3% of houses with two bedrooms or less, 22% of houses with three
bedrooms, 41% of houses with four bedrooms and 33% of houses with five or more bedrooms (realestate.com.au, 2014)\textsuperscript{28}.

Other conclusions of Burge’s can be identified as differences between the US and Australian housing markets that may flag a lack of external validity in his assumptions. One such counter-intuitive conclusion is that the introduction of impact fees may actually increase supply due to a) reduced project approval costs payable by developers and b) by relaxing implicit limits on the percentage of development applications that are approved. For the introduction of impact fees to have positive effects on supply, it can be inferred that in the absence of impact fees (which are set out in public schedules in the US) that developers suffer greater uncertainty in the approval process, which is likely to be priced in by way of higher profit and risk factors such as uncertainty driven house price increases, which supports the Australian developer’s arguments in relation to infrastructure charges increasing house prices (See Urban Development Institute of Australia, 2007). The second part of Burge’s supply enhancing conclusion implies that a large proportion of development applications in Florida are refused, due to some unstated growth control limitations. Growth limiting policies are not a feature of the vast majority of housing markets in Australia\textsuperscript{29}. The other key conclusion that cannot be transferrable to Australia is Burge’s (and Shaughnessy’s) assertion that impact fees increase the demand for housing because they reduce home buyer’s expected future property tax liabilities. As Australia does not have an equivalent property tax regime, any house price impact in Australia due to infrastructure charges that is identified by this study would be in evidence against this “new view”.

These comments are not a limitation of Burge’s work as such nor does it take anything away from Burge’s findings. Rather it highlights differentiating features of the Florida and Australian markets that should be taken into consideration when analysing Burge’s conclusions and considering the external validity of this model.

\textsuperscript{28} Houses for sale in the Greater Brisbane region as at February, 2014 as listed on www.realestate.com.au

\textsuperscript{29} Noosa in Queensland is one notable exception.
3.9.2 Burge and Ihlanfeldt 2006

In this publication, Burge and Ihlanfeldt refine Burge’s thesis model by adding further suburb level stratification to his panel, whilst also estimating the effects of impact fees on house construction (supply). The panel of small, medium and large homes across Florida is further categorised into: central cities, inner suburbs, outer suburbs and rural area. This addition overcomes some of the limitations of the earlier model. The 41 counties that comprise the panel are identified as: 19 central counties (which contained a city centre), 15 suburban counties or “outer suburbs” and 7 rural areas. The 19 central counties were further refined into “central cities” and “inner suburbs”.

The house price model remains unchanged but for the additional stratification, with the same reported house price effect findings as the thesis model.

In both his thesis and journal publication, Burge also runs a supply model estimating the effect impact fees have on housing supply. The results indicate that community fees increase supply of all house sizes within inner suburbs (where the majority of Florida’s population resides) with the greatest increase in small houses; and increase the supply of medium and large homes in outer suburbs. This increase in supply is concluded to be due to these community impact fees: increasing the demand for housing in those areas, increasing the number of projects obtaining development approval and reducing approval costs, despite increasing the total fees payable by the developer. As with the thesis, population growth and income variables per county were added to the model but not found to have significant effects. It still appears possible that an omitted variable such as change of policy (eg urban consolidation), change of buyer preferences (inner city gentrification), increased land releases in inner areas (in fill development), increased demand for affordable home ownership (facilitated by the predatory lending practices rife in the US prior to the global financial crisis) or other demand shifts could explain these observations.

In their own words, from a supply perspective together these models “strongly contradict conventional wisdom as well as prior empirical evidence” (Burge and Ihlanfeldt, 2006, p304). If this study can generate evidence of on passing of impact fees in Australia where no property taxes exist, then this may refute the “new view” conclusions of Shaughnessy and Burge.
3.10 EVANS-COWLEY AND RUTHERFORD

Professors Jennifer Evans-Cowley and Ron Rutherford have published two empirical studies on the effects of infrastructure charges on house prices. The first was with Fred Forgey in 2005 and the second was with Tom Springer and Larry Lockwood in 2009. The data from both of these works was sourced from Evans-Cowley’s 2000 thesis\textsuperscript{30}. As both of these works are journal articles, less detailed archival evidence is available from which to base analysis. These are however valid contributions to the evolution of impact fee based house price models.

3.10.1 Evans-Cowley, Forgey and Rutherford 2005

In this research Evans-Cowley, Forgey and Rutherford (2005) seek to provide evidence of the price effect of impact fees on vacant residential lots as well as undeveloped land\textsuperscript{31}. They use a pooled cross-sectional panel of 43 Texas cities with impact fees, across the metropolitan areas of Dallas, Fort Worth, Austin and Houston. 1999 valuation assessment data is used for a sample set from which was derived 48,805 vacant residential lots and 5,425 vacant land parcels.

This study is included for its contribution to the literature in relation to developed residential lots, given it is the subdivision of englobo land into individual lots that triggers the impact fee liability. Works on this topic tend to focus on the end house price, as the actual house price is the final cost of the good (shelter) to the consumer (home owner) and is the link to the housing affordability debate.

**Contribution**

As indicated above, Evans-Cowley et al.’s (2005) contribution is to evaluate empirically the relationship between impact fees and the value of land (both subdivided and englobo) across cities while controlling for property characteristics and market conditions. Given this thesis is focused on the passing-on effects to house prices, only the lot effects will be included in this analysis.

\textsuperscript{30} Evans-Cowley’s thesis titled: “Evaluating the equity, efficiency and effectiveness of development impact fees” did not seek to measure the price effects on housing. It was supervised by Larry L. Lawhon. (See Evans, 2000).

\textsuperscript{31} Refer to Chapter 1 Definitions for clarification on use of the terms *Lot* and *Land* within this thesis.
Model and Variables

Four models are estimated: a hedonic model, a fixed effects model and two random effects models, one with and one without latitude and longitude controls. The hedonic model takes the usual form and incorporates the following variables:

\[ V_i = \beta_0 + \beta_1 A_i + \beta_2 A_i^2 + \beta_3 IF_i + \beta_4 G_i + \beta_5 P_i + \beta_6 C_i + \beta_7 M_i + \beta_8 I_i + \beta_9 L_i + u_i \] 3.15

Where

- \( V_i \) = natural log of the assessed market value of lot \( i \)
- \( A \) = area of the lot (square feet/1000)
- \( A^2 \) = area of the lot (square feet/1000) squared
- \( IF \) = impact fee in thousands of dollars per typical lot
- \( G \) = city population annual growth rate
- \( P \) = average city housing price per square foot
- \( C \) = housing construction cost estimate per square foot
- \( M \) = city property tax rate
- \( I \) = mean city income
- \( L \) = latitude and longitude in thousands
- \( u \) = error term

Given the annotated form of published works, little explanatory information is provided in relation to the study area and its selection, the nature of its market conditions and these independent variables. Information on the derivation of vacant lots and the applicable impact fee is provided and is commented on further under Limitations and Observations. Notably this regression was run without city dummies.
The fixed effect model took the form:

\[ V_{ij} = \beta_0 + \beta_1 A_{it} + u_{ij} \]  \hspace{1cm} (3.16)

Where

- \( V_{i} \) = natural log of the assessed market value of lot \( i \) in city group \( j \)
- \( F_{it} \) = a vector of attributes describing lot \( i \) in city \( j \): area of the lot (square feet/1000), area of the lot (square feet/1000) squared and impact fee in thousands of dollars per typical lot
- \( u \) = error term

The random effects model took the following form, using the generalised least squares (GLS) approach over the traditional ordinary least squares (OLS) method. As this method is deemed to overcome the multi-collinearity of the city-invariant variables dropped from the fixed effect model, these re-enter the model:

\[ V_{ij} = \beta_0 + \beta_1 A_{it} + u_{ij} \]  \hspace{1cm} (3.17)

Where

- \( V_{i} \) = natural log of the assessed market value of lot \( i \) in city group \( j \)
- \( F_{it} \) = a vector of attributes describing lot \( i \) in city \( j \): area of the lot (square feet/1000), area of the lot (square feet/1000) squared and impact fee in thousands of dollars per typical lot, city population annual growth rate, average city housing price per square foot, housing construction cost estimate per square foot, city property tax rate and mean city income. (Latitude and longitude included for model 3 and excluded for model 4)
- \( u \) = error term

**Findings**

Evans-Cowley et al. (2005) provide regression results for all four models, but present the findings only for model 4. The price effect of impact fees on developed vacant lots is statistically significant and positive at 0.01297 indicating that for every
$1,000 in impact fees (dollar amount used in model), lot values increase by approximately 1.3%.

Evans-Cowley et al.’s conclusions in relation to lot value increases appear to be consistent with Yinger’s (1998), Shaughnessy’s (2003) and Burge’s (2005) new view. They conclude that increases in lot prices are not due to increased demand, but rather the expectation of lower future property taxes than would have been possible without the impact fees.

**Limitations and Observations**

Some of the observations made about this model are a function of not having the benefit of a full description of the study area, data and methodology as with the full theses associated with prior analysis.

The assumptions made about vacant lot data set and the calculation of impact fees for inclusion in the model is confounding. The data set includes any vacant lot within city limits smaller than three acres (approximately 1.2 hectares). Given the relevant city impact fee is applicable for lots under half an acre (approximately 2,000 sqm), the authors estimate the applicable fee based on the number of lots these larger lots could be subdivided into. A ratio of 3.5 lots to the acre is used. Given that these larger lots were yet to be subdivided and hence no impact fees yet levied upon them, the question remains as to why they were not classified in the other sub-set as *land*, to which a developer may seek to pass the fee back to. No information is provided as to how many observations in the lot sub-set this methodology was applied to. This might be an explanation for why the findings from this research were so low in comparison to earlier works.

Evans-Cowley et al. (2005) provide regression results for all for models, but present the findings only for model 4. Examination of the regression results for the hedonic model (model 1) indicates it had similar predictive qualities to model 4. Indeed, each of the four models produced similar results: positive fee impact (1.1% - 1.5%), t-statistics (4.5 to 7.4) and adjusted $R^2$ (0.2156 - 0.3065). This suggests evidence of the value of the hedonic technique despite its reported limitations.

The final model (model 4) excluded any locational variables. Given this was a study of four major metropolitan areas within Texas, being Dallas, Fort Worth, Austin and Houston, this study could have been enhanced by considering the effects
of impact fees on lot prices in each of these markets. The inclusion of city and/or
country dummies would have enabled stratification of the findings to determine if
differential effects exist between these diverse housing markets. Latitude and
longitude variables were included in model 3, however these seem somewhat
inappropriate as they are continuous variables, thereby bearing inherent order among
them. By using a coordinate system, they assess values that can be meaningfully
ordered (this is a continuous variable), when a priori we have no assumption of how
the cities of Dallas, Fort Worth, Austin and Houston are ordered with respect to
pricing of houses. An alternate approach could code each city as dummy variables,
and see if there are any differences between prices in these cities. In their present
form, the authors assume that moving from north to south will change the house
prices in the same linear fashion regardless of whether we move from Dallas to
Austin or Dallas to Houston. Similarly, under the current specifications, moving
from Houston to Dallas will have the same impact on house prices as moving from
Dallas to Austin.

The authors utilise a cross-sectional methodology which captures only data
from one year (1999 in this instance). Such cross-sectional models run the risk of
returning biased results due to omitted variables and factors unobservable in a static
model. The much lower adjusted $R^2$ for the models in this work compared to the
earlier models could be a reflection of this methodology.

3.10.2 Evans-Cowley, Lockwood, Rutherford and Springer 2009

In this study Evans-Cowley, Lockwood, Rutherford and Springer (2009)
examine the price effect of impact fees on new and existing houses in 63 cities in the
Dallas-Fort Worth metropolitan area (Texas), 38 of which use impact fees and 25 of
which do not. A cross-sectional two-step treatment effects model is employed on a
data set of 5,572 new and 40,848 existing house sales in 1999.

Contribution

Evans-Cowley et al. (2009) extend the standard hedonic pricing model in two
ways. First, they include cities that have no impact fee system in place as a control.
Second, they introduce a latent choice variable, which is related to several variables
presumed to affect the decision of a city to set up an impact fee. The theoretical
basis for this evolution is implied at best. This two-step treatment-effect approach
accounts for the endogeneity of the choice of a given city to impose impact fees, suggesting it produces more reliable estimates of the impact fee effect.

**Model and Variables**

A cross-sectional hedonic pricing model with a two-step treatment effects is employed. The first step comprises a number of stages to generate the appropriate inputs into the final model. The initial step is in the usual hedonic form:

\[ P_i = \beta_0 + \beta_1 S_i + \beta_2 J_i + \beta_3 L_i + \beta_4 D_i + u_{i,t} \]  

Where

- \( P_i \) = the natural log of the house sale price \( i \)
- \( S \) = Structural characteristics of the house: days on the market; size of house (square feet divided by 100), number of bedrooms, bathrooms and fireplaces, pool and garage dummies (1 yes, 0 no), occupancy dummy (1 vacant, else 0), rental dummy (1 rental, else 0), lot size dummy (1 if lot is greater than half an acre, else 0), age of home, age dummy (0-2 years for new homes, 3-5 years for existing homes), seasonal dummy
- \( L \) = Locational characteristics of the house: county dummy
- \( J \) = Jurisdictional/Regional attributes: job growth rate, number of years since fees introduced, impact fee (\$'000), city tax rate
- \( D_i \) = Treatment effect dummy: 1 for houses in impact fee cities, else 0 plus jurisdictional other price driver dummy’s (see next equation)
- \( u \) = error term

As with their previous works, nominal explanation is provided regarding the selection of variables. No locational variables are included other than at a county level.
Next, controls are introduced for any self-selection bias and endogeneity of the decision to impose impact fee, variable $D$. This variable is introduced to accommodate sales price differences between houses located in cities with and without impact fees not captured by the prior step hedonic variables. This process adds the following treatment effect variables to the regression:

$$D_i^* = \beta_4 T_i + u_i$$  \hspace{1cm} 3.19

Where:

$D_i = \text{treatment effect dummy used in the initial hedonic model}$

$T_i = \text{treatment effect variable: all jurisdictional variables from the initial equation plus other jurisdictional price driver dummies: city population (divided by 10,000), average population growth rate (past five years times 100), labour force (divided by 10,000), property tax revenue per person, municipal debt per person}$

$u = \text{error term}$

The final part of this first step is to use the coefficient output from these earlier two models to estimate the inverse Mills ratio for each observation\(^{32}\). The second step utilises GLS estimates (correcting for heteroskedasticity) to regress the following final model:

$$P_i = \beta_0 + \beta_1 S_i + \beta_2 J_i + \beta_3 D_i + \beta_4 IMR_i + u_i$$  \hspace{1cm} 3.20

Where

$P_i = \text{the natural log of the house sale price } i$

$S = \text{Structural characteristics of the house}$

$J = \text{Jurisdictional/Regional attributes}$

$D_i = \text{treatment effect dummy}$

\[ IMR = \text{inverse Mills ratio} \]
\[ u = \text{error term} \]

**Findings**

Regression results for All houses, New houses and Existing houses are presented. For all houses (pooled) the results indicate that every $1,000 increase in impact fee lead to a price increase of 3.728%, or $7,893 for an average house price of $144,033, or a price multiplier of 5.37 when the impact fee lag is incorporated (as measured by the years since fee variable is introduced). The results for new and existing homes differ when examined separately with a price multiplier for new homes of 1.76 compared to 6.03 for existing homes. The authors state the reported results are statistically significant, however it is difficult to gauge if results are weak or strong as no t-values or p-values are provided.

The authors make an important observation on the nature of impact fee on passing and house price growth. They observe that in a rising market, the on or over passing of impact fees is masked by the general appreciation of house prices, and yet will compound the negative wealth effects in a falling market. They conclude that “even though impact fees are a viable public financing alternative, they are best associated with a growing market” (Evans-Cowley et al., 2009, p188). This is the first such conclusion to appear in the literature. This may be due in part to the post GFC climate in which this research was written, and is supported by recent reductions in impact fee schemes throughout the US as evidenced in Mullen (2012) and in various Australian jurisdictions.

**Limitations and Observations**

This research explores more advanced econometric techniques to earlier studies, and its findings are consistent with the theory of on and over passing, however the presentation of the model is unclear and the rationale for selection of variables is unknown with little explanation provided. For example, the theoretical basis for inclusion of variables such as the number of years since fee introduced, occupancy dummy, days on the market etc are not explained. The model states it controls both for the unique characteristics of houses and contrasting growth features.
of cities, however and with no locational variables incorporated, any spatial differences within counties are not adjusted for.

A further limitation of this work is its use of only one year of house sales data. The authors acknowledge that this is sub-optimal, however they suggest that 1999 was “a typical year” (Evans-Cowley et al., 2009, p191). Growth in the Texas median house price for the period 1991 – 2007 was cited in evidence of this, being 4.5% for that full 16 year period and 4.9% in 1999 the median year. The years either side of the study period however displayed higher than average growth, being 5.8%, 5.0% and 6.2% in 1996, 1997 and 1998 respectively and 11.1% in 2000. State wide house price growth dropped to below the long term average in 2002 – 2004. An alternate interpretation of these statistics is that the years 1996-2000 were a period of high growth, or boom conditions. Further if price growth of 4.9% was evident in the study period, this was not controlled unless through use of the seasonal dummy, however this was not disclosed.

This paper is another example of how one must take care with interpretation of results. The authors note that non-impact fee cities have a much higher average house price for the full sample. On closer examination, this holds true for existing homes, but not new homes. The authors suppose this to be is due to sufficiently high tax bases in those localities. An alternate and perhaps more intuitive reason could be that existing homes predominate in mature established suburbs in inner ring locations that are well serviced, whist new homes tend to develop in newer suburbs on the city fringes away from employment centres where land is cheaper and community building lags house construction. Stratification of the data set through inclusion of distance variables (such as those Mathur employed) may have enabled this effect to be better explained and perhaps provided further explanation for the high price effect findings for existing housing in this study.

In summary, the work by Evans-Cowley et al.(2005 and 2009) add to the literature on the use of hedonic (and other) house price models to estimate the effect of impact fees on house prices in the US. Variations on the usual variables are incorporated particularly in the later work, but unfortunately the theoretical basis for which is not provided.
3.11 CHAPTER SUMMARY

The purpose of this chapter has been to detail the archival research component of this exploratory sequential instrument development mixed method research project. In doing so it examined each of the US studies since the early to mid-2000’s on the topic of house price effects of infrastructure charges. The purpose of this phase of research has been to find evidence of external validity of these prior studies as well as any methodological evolution. This analysis has been performed to assess the methodological suitability of such extant models to estimate the impact of infrastructure charges on house prices in Australia. In doing so it has provided a systematic review of the relevant international econometric house pricing models concerned with infrastructure charges.

This archival research has unpacked the econometric techniques employed, identified the contribution of each model, and hence informs specification of the first model of its kind in Australia to estimate the impact of infrastructure charges on house prices. This chapter has informed the third research question of this thesis, considering whether international empirical models can be used to assess the impact of infrastructure charges on the price of housing in Australia. Data gathered in this archival process is further analysed in the following chapter, and supplemented with data gathered in the final phase of this qualitative Stage 1 research.

Specifically, this chapter documented the findings from the archival research component of this research and was designed to inform the third research question of this thesis:

3. Can international empirical models be used to assess the impact of infrastructure charges on the cost of housing in Australia?

Further analysis of data is required in responding to this research question and this is provided in Chapter 4.

A number of US empirical studies on the house price effects of infrastructure charges were sourced and analysed with a view to identifying the strengths and limitations of each model, and hence form the basis for specification of the first model of its kind in Australia. This analysis included examination of the specification and functional form of model, the study area, its contribution, the assumptions made, findings and conclusions.
This archival research examined key works from six author groups that researched the impact of infrastructure charges on house prices in the US. The complexity of econometric housing price models evidences itself in these studies by the range of different theories adopted, variables utilised and their role as to how they explain or relate to housing price. An observation of these models is that they appeared to have developed contemporaneously, with the various methodologies having evolved in isolation of the other studies of the day. The rationale behind various model selection is rarely explicit and one can infer it may only have its roots in data type and availability.

It was found that whilst each author group utilised the established hedonic house price model theory, there is little consistency between the models employed or the data sets utilised. Specification appears dependent upon data availability rather than sound theoretical grounding. However, as noted in the literature, this is a characteristic and limitation of econometric modelling. Hedonic methodology formed the basis for each of the models and alternate econometric techniques were also tested and resulted in comparable findings. Often the alternative and more complex techniques did not result in findings of significance and only the basic hedonic results were reported and analysed.

This systematic review of the extant models therefore suggests there is limited evidence of the evolution of a preferred model. They also suggest that the comparatively simple form of the standard hedonic regression remains effective for estimations of the house price effects of infrastructure charges.

The following chapter presents the findings from Stage 1 of this research and further addresses the third research question as to whether international models may be suitable to assess the impact of infrastructure charges on the cost of housing in Australia. It triangulates the findings from the literature review, this systematic analysis of the extant models as well as the results of the semi-structured interviews that are detailed further therein.
Chapter 4: Stage 1 Findings

4.1 INTRODUCTION

Further to the literature review in Chapter 2 and the archival research in Chapter 3, this chapter forms the final phase of Stage 1 of this research project. This chapter synthesises the findings from the archival research phase, details the semi-structured interview phase and findings, and triangulates these to conclude the qualitative component of this thesis and provide detail on the key themes that have emerged. In doing so, it sets the framework for the Stage 2 component which seeks to specify, test and apply an econometric model that will estimate the house price impacts of infrastructure charges in Australia for the first time.

The preceding chapter detailed the findings from archival research into extant econometric models that estimate the house price effects of infrastructure charges. Whilst the findings from these studies demonstrated a consistency in outcomes to support the hypothesis of over-passing, the approaches and rationales varied significantly. The purpose of that analysis was to seek to uncover a preferred methodological approach for use in the Australian context. Whilst that analysis lead to the conclusion that a hedonic approach may be suitable, other questions remained unanswered such as: availability of data and appropriateness of variables employed; study area selection; the underlying characteristics of the US housing market in comparison with the Australian market mechanisms; and other institutional impacts such as the effects of property and personal taxation regimes.

This chapter further analyses these extant studies. It also incorporates the data from the semi-structured interview process that was designed to complement the archival research component, and thus fill the gaps in the analysis. In doing so it draws together the findings of Stage 1 of this mixed method research focusing on five key areas: independent variable analysis; study area selection; model specification; on-passing ratio calculation and comparative features of US and Australian housing markets. These findings complete Stage 1 and are a contribution to knowledge in themselves. These findings are then used to inform the remainder of
In this work, wherein the methodology for empirical study into the house price effects of infrastructure charges in Australia will be designed, tested and applied.

4.2 INDEPENDENT VARIABLE ANALYSIS

This section provides further analysis of the choice of independent variables and thus data requirements of each of the models examined in the previous chapter, grouping these under the hedonic approach headings of Structural, Locational and Jurisdictional factors. The purpose of this analysis is to provide an audit of the range of independent variables utilised and thus potential data requirements for any Australian study. This analysis will demonstrate the vast extent of data collected for some of these models, and conversely how little is required for others. The outcome of this analysis is a key theme associated with independent variable selection. This theme provides a basis for the selection of independent variables for use in the Stage 2 instrument design and quantitative data analysis.

4.2.1 Structural Characteristics

Table 4.1 indicates the structural data on housing used by each author group analysed as part of the archival research component. Only variables included in the final model are included. Surprisingly, house size, house age and a time dummy are the only data field consistent across each model. Campbell sits at one end of the spectrum, having collected data on a very wide range of housing structure characteristics, Mathur is at the other end of the spectrum with very few housing structure data requirements, with the remainder somewhere in the middle.
Table 4.1

*Structural Characteristics Data*

<table>
<thead>
<tr>
<th>Structural Feature</th>
<th>Lawhon</th>
<th>Shaughnessy</th>
<th>Mathur</th>
<th>Campbell</th>
<th>Burge</th>
<th>Evans-Cowley et al. 2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sale price</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Sale date</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Sale type (arms length)</td>
<td>x</td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lot size</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>House size</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Year house built/age</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Bedrooms</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Bathrooms</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Fireplaces Y/N</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basement Y/N</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pool Y/N</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Garage Y/N</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. Storeys</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building Quality</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prior sales</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Time dummy</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Days on Market</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Zoning</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Land Use</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Vacant Y/N</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tenanted Y/N</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Irregular property</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>House configuration</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No type of fixtures</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exterior construction,</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heating method, Fuel Type, Roof Material,</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Estimated lifespan remaining, Flooring material, Foundation method, Interior walls, Roof structure, Building Frame, Air conditioning</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>

Source: Author
4.2.2 Locational Characteristics

The locational characteristics data incorporated by each author are indicated below in Table 2. Again there is significant divergence between models and the locational factors the authors consider to impact house prices. This time it is Mathur that captures the most locational data and Evans-Cowley et al. again the least. This may be due to a number of factors other than omitted variable bias. It may be an indication of a highly segmented market in Mathur’s study area where house prices are highly variable due to accessibility issues. Evans-Cowley et al.’s study area may be more homogenous from an accessibility perspective. Care must be taken not to introduce multicollinearity into the model through the introduction of superfluous variables. The other three authors all captured “Suburb” data, which may be adequate to capture the locational characteristics at a macro level. A number of studies incorporated GIS data which is deemed superior to the latitude/longitude coordinate system (as in Evans-Cowley et al.) in that it allows for the distance between two points to be computed and thus addresses spatial autoregression.

Table 4.2
Locational Characteristics Data

<table>
<thead>
<tr>
<th>Locational Characteristics</th>
<th>Lawhon</th>
<th>Shaughnessy</th>
<th>Mathur</th>
<th>Campbell</th>
<th>Burge</th>
<th>Evans-Cowley et al.2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>GIS data</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Street Address</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Suburb</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Post code</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>County</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Location dummy</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unique identifier</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>View Quality</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Traffic Noise</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Travel time to CBD</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accessibility/ distance to nonretail and retail jobs by car</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Auto Accessibility</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transit Accessibility</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distance to Urban centres</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distance to urban growth boundary</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
4.2.3 Jurisdictional Characteristics

The jurisdictional or demographic characteristic data used for each of the study areas is indicated in Table 4.3 below and again there is a wide variance in data collected. This table is somewhat confusing when incorporating the two and three stage models of Burge and Shaughnessy respectively. Despite this, it can be seen how different authors attempted to incorporate the supply and demand features of the study area into the house pricing equation. Supply is incorporated in data such as building approvals and house completions, whilst demand factors are captured in data such as population growth and income and so forth. Infrastructure charge data is incorporated in this group, and it is interesting that only Mathur matches this with data on municipal expenditure. The only other consistent data set across all studies is the construction cost index. Shaughnessy and Campbell are the only author to consider lag effects, however both theories appear flawed. It would seem appropriate to lag infrastructure charges given they are levied at the time of planning approval, many months if not years before the house is completed and sold. Shaughnessy lags a number of variables by the two months between contract signing and settlement, however his new view theory contends that buyers are aware of the relevant infrastructure charge at the time of contract signing and knowingly price this into their purchase price. This assumption is inconsistent with the fundamental basis of infrastructure charges being levied at the time of planning approval, not house completion. Campbell lags property tax (millage) rates by one year “in order to control for potential endogeneity between infrastructure charges and millage rates.” (Campbell, 2004, p74) It is unclear whether this is an attempt to allow for the time between infrastructure charges being levied and the completed house being sold.

<table>
<thead>
<tr>
<th>Locational</th>
<th>Lawhon</th>
<th>Shaughnessy</th>
<th>Mathur</th>
<th>Campbell</th>
<th>Burge</th>
<th>Evans-Cowley et al.2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Road Zones</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Proximity to Amenities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Miles of country roads, School Enrolments, Acreage of parks, Library services, No Police and fire stations, No. Fire hydrants</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>

Source: Author
Table 4.3
Jurisdictional Characteristics Data

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase in median household income</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Per capita income</td>
<td></td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Census block group</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Population</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Population change of city</td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Population change of county</td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Building approvals in City</td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building approvals in County</td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>House completions</td>
<td>x</td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>House removals</td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of households</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unemployment rate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Labour Force</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Job growth rate</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Property and violent crime rate</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construction cost index</td>
<td></td>
<td>x</td>
<td>x</td>
<td></td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Short term interest rate</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30 year mortgage rate</td>
<td></td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Infrastructure charges</td>
<td></td>
<td>x</td>
<td>x</td>
<td></td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Other Infrastructure charges</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water and Sewer infrastructure charges</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Non Water and Sewer infrastructure charges</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Years since fee introduced</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Fee charged Y/N</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Property taxes</td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Debt per person</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Municipal expenditure per capita</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Expenditure per pupil</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inflation</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Expected rate of future house price appreciation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Median selling price in region</td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Housing price index</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>-----------------------</td>
<td>--------</td>
<td>-------------</td>
<td>--------</td>
<td>----------</td>
<td>-------</td>
<td>-------------------------</td>
</tr>
<tr>
<td>Rent of primary residence</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Black, % Hispanic</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Rental</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lag</td>
<td>2 months for most. 1 year</td>
<td>1 year for prop tax</td>
<td>1 year for IF</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Author

**4.2.4 Thematic Conclusions**

The purpose of the above has been to critically analyse the independent variables selected for use in the various extant models. This has been necessary because the decision making for selecting of independent variables for inclusion or exclusion is rarely made explicit. Often, the reader must infer what the study area house price drivers are by examining the independent variable list. For example, Shaughnessy’s model includes a variable for percentage of Black and Hispanic residents. It could be inferred that this feature is a factor in house prices in his study area. Conversely, readers are also left to infer why other variables that are commonly linked with house prices are omitted, for example only Mathur’s model includes a variable associated with unemployment. As previously indicated, the choice of explanatory characteristics is often determined largely by data availability (Hill, 2012) and if key data is not available at the requisite scale for the study area, it is helpful to the reader, and to avoid the suggestion of omitted variable bias, if such data issues are made explicit.

Data availability may not be the only driver of the diversity of these models. Given the spatial heterogeneity of housing markets, perhaps rather than being a slave to theoretical models, the researchers have implicitly incorporated drivers of local house prices. For example in a very cold climate, good heating would be favoured by purchasers, as would the opposite in a hot climate. Similarly, other factors such as government policy may drive house prices such as the First Home Buyers Grant scheme in Australia.
Sirmans, MacDonald, Macpherson and Zietz (2006) examine these data selection effects across a number of house price models in the US. Firstly they suggest there are nine characteristics that appear most often in hedonic pricing models for detached dwellings, being: house size, lot size, age of the house, number of bedrooms, number of bathrooms, garage, swimming pool, fireplace, and air conditioning. Sirmans et al. (2006) research confirms that if the estimated coefficients vary by geographical location, time, type of data, and model specification, the results show that the estimated coefficients for some characteristics vary significantly.

Hence, the existing models may lack external validity not only outside of the US, but even outside of their study area. This research confirms great care must be taken to ensure the study areas are sufficiently similar, as well as the market fundamentals, before a pre-existing methodology is replicated in another jurisdiction. It is therefore imperative that the researcher has a thorough understanding of the local housing market drivers in the selected study area and that models are specified to incorporate such features of the market. It is also helpful for researchers to fully articulate data collection issues to avoid suggestions of omitted variable bias when data is not available.

### 4.3 SELECTION OF STUDY AREA, DURATION AND SCALE

This archival analysis of the existing US econometric models has been useful for the purposes of identifying relevant selection criteria for the study area, study duration and scale of the sample set. These are not clearly stated in the majority of the models, and appear to be implicit assumptions.

Analysis of the models detailed in the previous chapter give little enlightenment as to the study area or durations selected. Study areas in each instance are major metropolitan centres (or the full state as with Burge) that charge impact fees. The studies vary in length from 1 year (Evans-Cowley et al.) and 15 years (Shaughnessy), with infrastructure charges being introduced before the start date for some studies and after the start date for others. With the exception of Evans-Cowley et al. (2009) no rationale is provided for study durations, apart from the implication that those are the periods that data was available for. This is an unsatisfactory
finding and gives little guidance on the selection of study areas or durations for any subsequent works.

The scale of the study is determined somewhat by the duration i.e. more records over a longer time period. These studies showed considerable variance from the smallest (Lawhon: 760) to the largest (Campbell: 279,321). Hence the size of the available data set in itself does not appear to be a key selection criterion.

Further, whilst some studies examined the impacts on all housing, no comparisons were made between the proportions of new to existing homes, with some studies having high new to existing ratios, indicating a rapidly growing and changing housing market likely to have increased requirements for new infrastructure (Campbell 1 new:1.7 existing); whilst others had comparatively low new to existing house ratios indicating a well established housing markets with perhaps lower demands on new infrastructure (Mathur 1:10.5).

4.3.1 Thematic Conclusions

This archival analysis of the existing US econometric models has been useful for the purposes of identifying relevant selection criteria for the study area, study duration and scale of the sample sets used in the extant studies. Unfortunately the selection criteria for each of these items are not clearly stated in the majority of the models. One is left to infer selection criteria from general discussion. Perhaps this finding is consistent with Meen’s (2002) theory of data driven models, with study area, duration and scale being a function of what data is available, rather than any firm theoretical premise.

One relevant market feature that was common to all studies was the presence of higher than average population growth in each of the study areas. Therefore, it is this criterion that is deemed to be the overriding factor in study area and duration selection, over scale, or proportion of new to existing housing. This analysis will assist in identifying potentially suitable study areas (and durations) for this Australian research and other future research.
4.4 MODEL SPECIFICATION

As previously established, hedonic regression methodology of varying functional forms, is well established for this type of analysis, however a number of these authors elected to also incorporate additional econometric techniques. Lawhon utilises linear hedonic regression only. Mathur combines semi-log hedonic regression with instrumental variable approach with comparable results. Shaughnessy employs linear hedonic and double log repeat sales methods, again with comparable results. Campbell specifies two identical models, one linear hedonic and one semi-log hedonic, with vastly different results of which he only reports the linear hedonic findings. Burge utilises a two stage model with the first stage generating a linear repeat sales index, the natural log of which becomes an independent variable in the second stage fixed effects and random trend models that appear to produce similar result. Evans-Cowley et al.’s (2005) study on lot prices employs four semi-log models: a hedonic, a fixed effect and two random effect models each with similar results and strong significance; only the fourth model is reported on despite the hedonic model having a higher Adjusted $R^2 = 0.3065$. Evans-Cowley et al.’s (2009) study on house price impacts utilises a semi-log hedonic model and a treatment effect model as inputs into a second stage semi-log hedonic model to produce a single set of results.

4.4.1 Thematic Conclusions

This evidence suggests that despite various attempts at overcoming the limitations of basic hedonic models, the results in the literature are relatively consistent and more complex econometric forms may not add any additional accuracy to the estimation of the house price impacts of infrastructure charges. Hence, hedonic analysis may remain appropriate for future studies, with only its functional form open to debate. Further, the existing models and literature give little indication as to the preferred functional form. Indeed, Delaney and Smith (1989a, p46) noted:

“Hedonic theory is deficient with respect to the a priori specification of the “best” functional form of the hedonic model to be used in analysis of a particular market (Halvorsen and Pollakowski, 1981). It is possible that several functional forms perform equally well in
predicting price when fitted to a set of data. As Butler (1982) noted, “researchers who have compared alternative functional forms for hedonic indexes of housing have found little basis for choosing one form over another” (p 97). Consideration of the nature of capitalisation of infrastructure charges suggest the use of a linear reduced form equation for estimating the hedonic model.”

Thus despite the various functional forms employed by these authors, a simple linear reduced form equation may remain appropriate.

4.5 ON PASSING RATIO ANALYSIS

A variety of econometric methods and model specifications were evident in the US models. These differences in approach and functional forms can make interpretation and comparison of findings difficult. Difficulty in comparison between models is also compounded by the variances in the adopted functional form, prevailing average house price, treatment of regression results and presentation of findings.

For ease of comparison, this research has derived an “on-passing ratio” to enable consistency in the interpretation and comparison of findings. This is the ratio of infrastructure charge to house price effect (increase). Any ratio in excess of 100% is evidence of over passing of the infrastructure charge to the house buyer, with a ratio of less than 100% being evidence of under passing. A ratio of 0% would indicate no passing of infrastructure charges to home buyers. The on-passing ratio expressed in the following expresses the infrastructure charge driven house price effect as a dollar amount for each additional $1.00 of infrastructure charge charged, however due to variations in functional form, care must be taken comparing results between studies. The numbers in parentheses herein are the regression result coefficients for infrastructure charges for each model.

Lawhon

Whilst Lawhon’s (2004) findings for infrastructure charges were not statistically significant ($t=0.4672$), for demonstration purposes the on-passing ratio will be calculated. Given Lawhon’s model is linear, the correct interpretation is: $\Delta y=\beta_1\Delta x$. That is, if you change $x$ (infrastructure charge) by one (dollar), we’d expect $y$ (house price) to change by $\beta_1$ (infrastructure charge co-efficient) (Kephart,
However as the infrastructure charge is a dummy variable in this instance, the dollar amount of the fee drops into the denominator. Lawhon’s model produced an infrastructure charge coefficient $\beta = 1661$, for an infrastructure charge of $1,182$. Hence, the on passing ratio is 141% ($=1661/1182*100$) albeit not statistically significant in this instance.

**Shaughnessy**

Given Shaughnessy’s (2003; 2004) hedonic model incorporates a linear functional form and the infrastructure charge is a continuous variable, the correct interpretation of the coefficient outputs is $\Delta y = \beta_1 \Delta x$. That is, if you change $x$ (infrastructure charge) by one (dollar), we would expect $y$ (house price) to change by $\beta_1$ (infrastructure charge co-efficient) (Kephart, 2013). Shaughnessy’s (2003; 2004) model produced an infrastructure charge $\beta = 1.64$ for new and $\beta = 1.68$ for existing housing. Hence, the on passing ratio is 164% ($=1.64/1*100$) for new and 168% ($=1.68/1*100$) for existing housing.

Turning to his repeat sales methodology which employs a log-log functional form, an average house price in the study area is $100,000 for both new and existing homes, the correct interpretation of the coefficient outputs is $\% \Delta y = \beta_1 \% \Delta x$. That is, if $x$ (infrastructure charges) changes by one (percent), we’d expect $y$ (house prices) to change by $\beta_1$ percent. Shaughnessy’s (2003; 2004) repeat sales model produced an infrastructure charge $\beta = 1.67$. Hence the on passing ratio for existing houses using the repeat sales method is 167% ($=0.0000167 * 100,000$), which is not different from the findings using the hedonic methodology.

**Mathur**

Given Mathur’s (2003) thesis equations are semi-log models, the correct interpretation of the coefficient outputs is: $\% \Delta y = 100 \cdot \beta_1 \cdot \Delta x$ (Kephart, 2013). That is if $x$ (infrastructure charges) change by one (dollar), we would expect $y$ (house prices) to change by 100 $\cdot \beta_1$ percent. Mathur’s (2003) model produced an infrastructure charge $\beta = 6.76e^{-6}$ for all houses and $\beta = 1.23e^{-5}$ for high quality new housing, where an average house in the study area was $200,000 for all houses (i.e. with no quality or type differentiation). Hence the on passing ratio is 135% ($=6.76e^{-6} * 200,000$) for all and 246% ($=1.23e^{-5} * 200,000$) for high quality new housing.
Turning to his instrumental variable regression methodology, the on passing ratio for all new houses using the instrumental variable regression method is 138% ($=6.92e^{-6} * 200,000*100$) which is not significantly different from the findings using the hedonic methodology.

In Mathur et al.’s 2004 article, using the same regression results (coefficients) he stratifies the average house prices of $246,000 and $291,000 for all and high quality houses respectively, generating different on-passing ratios of 166% (compared to 135%) and 358% (compared to 246%) for all and high quality houses respectively. This demonstrates how when non-linear specifications are used, it is inappropriate to interpret the “headline” on-passing ratio as a linear relationship. As this effect will change dependent upon the predominating average house price in the study area. Therefore care must be taken in interpretation as it is inappropriate to extrapolate these findings into other jurisdictions where the underlying housing market may be different.

Campbell

Campbell (2004) runs two hedonic models, one in linear form and one semi-logarithmic. Considering first the linear model for the full data set of new and existing houses, the correct interpretation of the coefficient outputs is $\Delta y=\beta_1 \Delta x$ (Kephart, 2013). That is, if $x$ (infrastructure charges) change by one (dollar), we’d expect $y$ (house prices) to change by $\beta_1$. Campbell’s (2004) model produced an infrastructure charge $\beta=1.43$ for new houses and $\beta=1.07$ for existing houses. Hence, the on passing ratio is 143% ($=1.43/1*100$) for new and 107% ($=1.07/1*100$) for existing housing.

For the semi-logarithmic version of the full data set for new and existing houses, the correct interpretation of the coefficient outputs is: $%\Delta y=100 \cdot \beta_1 \cdot \Delta x$. That is if $x$ (infrastructure charges) change by one (dollar), we’d expect $y$ (house prices) to change by $100\cdot\beta_1$ percent and hence the on passing ratio is 429% ($=5.91e^{-5} * 72,000$) for new and 246% ($=5.97e^{-6} * 72,000$) for existing new housing. Clearly the findings between these two methods differ considerably, however Campbell does not provide any discussion on the findings from his second equation, nor the relatively low adjusted $R^2$ for all but the last model: 0.12 new linear, 0.25 new semi-log, 0.19
existing linear and 0.65 existing semi-log. These findings may be considered weak apart from the existing semi-log model.

**Burge**

Burge (2005; Burge and Ihlanfeldt, 2006) estimates a two-way (area and time) fixed effect ("FE") semi-log hedonic model and a random trend ("RT") model. For Burge’s FE model, the correct interpretation of the coefficient outputs is $\% \Delta y = 100 \cdot \beta_1 \cdot \Delta x$ (Kephart, 2013). That is, if we change $x$ (infrastructure charges) by one (dollar), we’d expect $y$ (house prices) to change by $100 \cdot \beta_1$ percent. Burge’s model produced an infrastructure charge $\beta = 5.4e^{-6}$ for all houses, $\beta = 5.76e^{-6}$ for small houses, $\beta = 7.53e^{-6}$ for medium houses, $\beta = 5.81e^{-6}$ for large houses. Hence the on passing ratio for all houses is 72% (= $134,000$ average house price*0.0000054), small houses is 42% (= $73,000*0.00000576), medium sized houses is 91% (= $121,000 * 0.00000753) and large houses is 134% (= $230,000*0.00000581). These calculations are derived from Burge and Ihlandfeldt (2006) as not all summary statistics are provided in the PhD version. They are similar to Burge’s (2005) reported findings of $0.39$ for small, $0.82$ for medium and $1.28$ for large homes. It is assumed that Burge uses all housing in his data set (pooled new and existing).

The RT findings are similar to the FE findings, however none are statistically significant and thus calculation of the on-passing ratio adds little to this discussion.

**Evans-Cowley et al.**

Evans-Cowley et al.(2009) is the only study to provide calculation details to assist with interpretation of their co-efficients:

> "The coefficient on the Years Since Fee variable is 0.0013 and the average Years Since Fee for all homes in fee cities equals 7.62. Therefore, for the average home in fee cities, the effect of a $1,000 infrastructure charge equals 3.728% \[\exp(0.0267 + 7.62 \times 0.0013) - 1 = e^{0.03661} - 1\], which translates to a house price increase of $7,893 (0.0372 \times $144,033 \times 1.47), a percentage difference of 5.48% and a price multiplier of 5.37 ($7,893/$1470).

The effects of infrastructure charges differ between new and existing homes. The infrastructure charge coefficient is 0.0311 for new homes versus 0.0268 for existing homes. The sign on the Years Since Fee
variable is negative for new homes (-0.0031) and positive (0.0023) for existing homes, suggesting differences between the short-run and long-run effects of infrastructure charges. Consider the average new home selling for $210,054 in a ‘fee’ city 7.33 years after the fee is imposed in the city (i.e., the new home sample averages). For the average new home, a $1,000 infrastructure charge causes sales prices to increase by 0.84% \[\exp(0.0311 - 7.33 \times 0.0031) - 1\]. This translates to a price increase of $3,035 for the average new home, with an average infrastructure charge of $1,720. Thus, for new homes, the average percentage change and price multipliers are 1.44% and 1.76%, respectively.” p185

Similarly, an on-passing ratio of 603% is calculated for existing houses.

4.5.1 Thematic Conclusions

As demonstrated in a number of these examples when non-linear specifications are used, it is inappropriate to interpret the “headline” on-passing ratio as a linear relationship. The house price effect will change dependent upon the predominating average house price in the study area only. Hence the on-passing ratio is an output of such models, and it may be inappropriate to use such ratios to approximate effects in other jurisdictions. This conclusion further underscores the importance of undertaking separate research in Australia on this topic so as to correctly estimate the house price effects of infrastructure charges and thus inform industry and policy makers.

4.6 SEMI-STRUCTURED INTERVIEWS

As detailed in Chapter 1, Stage 1 of this research project incorporates a qualitative mixed methods approach that incorporates an exploratory sequential instrument development design. The approach triangulates the literature review, with archival research and semi-structured interview process. This approach was designed to ensure a detailed and systematic review of prior works on this topic was undertaken and that any information gaps due to incomplete or dated studies, or limited access to information could be overcome with interview data from the semi-structured interviews (Berg, 2009). Specifically the purpose of the semi-structured interview phase is to provide a deeper level of insight into implicit assumptions in
the model and data selection process, as well as insight into the functionality and characteristics of the US housing markets and Australian housing markets that are relevant to econometric model design and assumptions.

Potential US interviewees were selected from prior author lists identified as part of this research, and other published experts in the field of the house price effects of infrastructure charges (impact fees). Criteria for selection of the interviewees included:

- Have authored (or co-authored) empirical studies on the house price effects of infrastructure charges in the past decade and these works resulted in findings of significance; or
- Were acknowledged industry experts in the field of housing development and infrastructure charges; and
- Were available for interview during this researcher’s three week study tour of the US in September, 2012.

Interviewees were recruited primarily via direct email approach, with email addresses sourced from internet searches of academic profiles. Face-to-face meetings with the interviewees were arranged subject to the interviewee’s availability. The majority of interviews were held in the interviewees work place, with the remainder occurring at one of two US conferences the author attended and presented at being the: 2012 International Conference on Construction and Real Estate Management (Kansas City) and the 2012 Growth and Infrastructure Consortium (Atlanta, Georgia).

Interviewees were questioned broadly on the local context surrounding their models, selection of independent variables, implicit assumptions made, housing market structure matters, the interpretation of results and other related items. The interviewees included:

- Dr Tim Shaughnessy, Associate Professor, Louisiana State University Shreveport, Economics/Finance Department, Louisiana
- Dr Shishir Mathur, Associate Professor, Urban and Regional Planning, San Jose State University, California
Dr Gregory S. Burge, Associate Professor, Economics, University of Oklahoma, Norman, Oklahoma

Dr Douglas Campbell, Instructor, Department of Economics, University of Memphis, Tennessee

Professor Fred Forgey, Professor of Finance, UTA College of Business, Director, Graduate Real Estate Programs, UTA Fort Worth, Texas

Professor Ron Rutherford, Professor of Finance, University of South Florida, Tampa, Florida

Professor Thomas M. Springer, Professor of Finance and Real Estate, Associate Director, Richard H. Pennell Center for Real Estate Development, Clemson University Clemson, South Carolina

Professor Arthur C (Chris) Nelson, Presidential Professor of City and Metropolitan Planning, Director of Metropolitan Research, College of Architecture + Planning, University of Utah, Salt Lake City, Utah

Professor Julian C. Juergensmeyer, Professor and Ben F. Johnson Jr. Chair in Law and Director, Center for the Comparative Study on Metropolitan Growth, Georgia State University College of Law, Atlanta, Georgia

Professor Vicki Been, Professor and Director Furman Center for Real Estate and Urban Policy, New York University School of Law, New York, New York

Mr Clancy Mullen, Executive Vice President, Duncan and Associates, Houston, Texas; Convenor Growth and Infrastructure Consortium; author annual National Impact Fee Surveys; and webmaster for www.impactfees.com.

Dr Larry Lawhon was not contacted for interview as he did not meet the selection criteria. Professor Jennifer Evans-Cowley did not respond to requests for interview, however three of her co-authors were interviewed.

The purpose of these interviews and discussions was to supplement the archival research analysis of the existing models for the purposes of better understanding the external validity of these prior studies. Each interview lasted for
one to two hours, being a combination of questions associated with their published works and free flowing discussion on similarities and differences between the US and Australian housing markets and economies in general. Questions relating to their research focused on implicit assumptions, approach and methodology, selection of independent variables, access to data, data collection issues and suggestions for future research.

Australian (Queensland) property development experts were more widely available for interview given the author was based in Brisbane, in proximity to the study area/s. The purpose of the interviews with Queensland property development experts was similar to that for the US experts in relation to housing market functionality, development fundamentals, and the prevailing infrastructure charging regime. These interviews were less formal in nature, with the focus of the questions being in clarification of the author’s own knowledge of the market33. This process ensured bias was not introduced into the analysis. Interviews were a combination of face to face interviews and telephone interviews. Due to the potentially politically sensitive nature of this study, the identity of all Queensland interviewees was withheld. The interviewees were a combination of industry professionals and government officers.

The data gathered in these interviews has informed a thematic analysis of the structure of the US housing markets to those in Brisbane, Australia. This enabled the identification of key similarities and differences in the two housing markets and institutional factors that impact underlying assumptions associated with functionalities of housing markets and thus specification of house price models. The data from these semi-structured interviews inform the remainder of this chapter and are an important component in the formation of thematic conclusions and the overall contribution of this research.

33 The author has 20 years experience in the Brisbane residential development industry.
4.6.1 Features of US Infrastructure Charge Schemes

The literature review in Chapter 2 indicated that infrastructure charging regimes differ not only from country to country, but in many countries, including Australia, it varies from State to State, and in countries such as the US may even differ between neighbouring local jurisdictions (counties). Further, an important outcome of the archival research was identification of the need to gain an understanding of the features of the US housing market when considering the application of these models in the Australian context. Hence, an understanding of the key features of the infrastructure charging regime in each study area is important, as it is relevant when making comparisons between jurisdictions.

When making international comparisons, it is also important to be aware of any underlying structural differences in the respective housing markets and taxation regimes, to take any relevant factors into account when comparing the methodologies and results of prior studies. This is particularly relevant for this research, where the findings of theoretical and empirical international works form the basis of the next quantitative stage of research.

Preliminary phases of this research identified that the US and Australian (and in particular, Queensland) infrastructure charging systems contain some similar features, as well as critical differing aspects. Understanding these similarities and differences are important to ensure assumptions made in the model specification process are appropriate for the study area context.

The main purpose of the semi-structured interview process was to aid in the understanding and analysis of the data already gathered by the archival research. Triangulation of the semi-structured interview data with that gathered from the archival research and the literature review has enabled a number of key themes to be identified that inform the specification of the model to be developed and applied in Stage 2 of this research. These key themes focus on the similarities and differences in both the US and Australian infrastructure charge systems and housing market functionality. These themes are important as they highlight to the researcher areas where external validity of prior models exists, and areas where study area specific adaptation is required. These themes are tabulated in Table 4.4 and discussed in the text following.
Table 4.4

Key features of the US and Australian Infrastructure Charge Regimes

<table>
<thead>
<tr>
<th>Feature</th>
<th>US(^{34})</th>
<th>Australia (Queensland)(^{35})</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time fees levied</td>
<td>Upon planning approval or building permit</td>
<td>Upon planning approval</td>
</tr>
<tr>
<td>Time fees paid</td>
<td>On platting of lots</td>
<td>On sealing of lots</td>
</tr>
<tr>
<td>Fees levied by</td>
<td>Local jurisdiction (city or county)</td>
<td>Local jurisdiction (local authority)</td>
</tr>
<tr>
<td>Basis for charge</td>
<td>Rational nexus and proportionality test as well as benefiting the new residents who paid for it. However often not representative of the marginal cost</td>
<td>Full cost recovery of the marginal cost of infrastructure determined via a Priority Infrastructure Plan.</td>
</tr>
<tr>
<td>Other development costs</td>
<td>Exactions</td>
<td>Conditioning</td>
</tr>
<tr>
<td>Fee increases</td>
<td>Frequent and high fee increases via scheduled increases</td>
<td>Fees negotiated at development approval are escalated by inflation each year. Adhoc additional annual fees can be levied. Negotiated fees increasing rapidly 2003 – 2011.</td>
</tr>
<tr>
<td>Scope of fees payable</td>
<td>Water, sewerage, power, storm water, public transport, roads, parks, schools, police and law enforcement, fire services, government services</td>
<td>Water, sewerage, power, storm water, public transport, roads, parks, libraries. Schools, police and law enforcement, fire services and government services are provided at a state level funded by general state taxes.</td>
</tr>
<tr>
<td>Certainty of fee amounts and increases</td>
<td>Fee amounts scheduled by county/city each year, with annual increases announced in advance of coming into effect</td>
<td>Opaque, fully negotiated system with fees increasing rapidly pre- 2011. (Productivity Commission, 2011)</td>
</tr>
</tbody>
</table>

\(^{34}\) It is acknowledged that wide variances may exist between jurisdictions and infrastructure charge schemes across the US. Unless otherwise indicated, the features noted herein are based on the study areas documented in the archival research, being parts of Texas, Florida and Washington and information provided by the interviewed authors.

\(^{35}\) Consistent with the selected study period this analysis pre-dates the Sustainable Planning (Housing Affordability and Infrastructure Reform) Act, 2011 that introduced maximum charges for a three year interim period.
### Feature | US | Australia (Queensland)
--- | --- | ---
Property taxes | Annual charge to home owners to fund city/county services. Similar to council rates in Australia, but much more expensive to cover the wider range of services provided at a city or county level | Nil generally for residential property. Council rates are payable to provide capital for the services provided at a local level. Land Tax (State tax) is not generally payable on residential land.
Nature of home building industry | Land development and home building carried out by the same entity. Buyers purchase completed home. | Land developers generally separate from diverse home building market. Majority of new home buyers purchase land separately and then enter into construction contract with third party builder.
Average house price | Seattle, Washington $246,000 in 2003, Texas $149,000 in 1999, Florida (Orlando) $72,000 in 2002, Florida (Dade county) $100,000 in 2003, Florida (all) $230,000 in 2004 | Brisbane, Queensland $305,000 in 2004 (ABS, 2013)
Fee amounts | $900 - $5,726 | Reported to be between $15,000 and $40,000 in 2010 (Productivity Commission, 2011)

Source: author, interviewees

As can be observed from the table above, the key similarities between the US infrastructure charge and Australian infrastructure charge systems are that both fees are levied by local authorities on property developers as a condition of planning approval and payable at the end of development when the lot is created (“platting” in the US or “plan sealing” in Australia). The definition and application of infrastructure charges and impact fees are therefore sufficiently similar for them to be considered interchangeably for the purposes of this research. The underlying principles of nexus, rationality and proportion are also alike although policies for full cost recovery are varied. Fees/charges are not the only developer expenses in both countries, with developers often also required to contribute either land or other in-

---

36 Some authors would argue that infrastructure charges are wider reaching, being a financial measure of all externalities (impacts) on the community (Been, 2005).
kind works as a condition of the development approval. This is commonly termed “exactions” in the US and “conditioning” in Queensland. These works are sometimes able to be offset against infrastructure charges/impact fees in both countries and are negotiated on a case by case basis. Hence they are either excluded from the US models (explicitly or implicitly), as is the explicit intention with this dissertation. The market conditions in each jurisdiction were strong in the period leading up to the global financial crisis (pre-2008), with house price growth and increases in infrastructure charges a common feature.

Key differences in two the systems are the services for which the fees can be levied. In the US, a far greater range of services are provided at a city or county level such as police, schools and fire services. In Australia, infrastructure charges are levied primarily for local utilities and services only. This feature is discussed further in the following paragraph in relation to property taxes. Another key difference is the certainty of the fee amount: in the US these fees are set and scheduled with data publicly available; in Queensland the provisions of the Integrated Planning Act, 1997 (and its 2003 amendments) and the Sustainable Planning Act, 2009 require fees to be charged in accordance with a local authority Priority Infrastructure Plan (“PIP”). Whilst the intention of the PIP process was to provide transparency, their complexity instead drove uncertainty with rapid, steep and unforeseeable increases resulting in charges being negotiated privately between developer and local authorities and varying greatly from project to project.

Whilst State legislation requires Queensland councils to maintain an infrastructure charge register, the data contained lacks sufficient detail to be interpreted in a meaningful manner. It is the observation of this author that difficulties in accessing regional level data on infrastructure charges would appear to be a key factor as to why this type of research has not previously been carried out in Australia.

37 With the exception only of Mathur’s (2003) Snohomish county which did not produce findings of significance.

38 As at October 2010, Gold Coast City Council was the only local council in Queensland with a PIP in place (Nicholls, 2011).
Other key differences between the US and Queensland fee regimes stem from institutional differences. One of these is the levels of government and the services provided by each. The US has four levels of government being: federal, state, county and city. The majority of economic and social infrastructure services are provided at a county or city level, funded by property taxes levied on property owners. These taxes are a significant occupancy cost and are explicit to the service/amenity provided. For example, your children may only attend a school in the city/county in which you live and pay for through your property taxes. It is these property taxes and the services they provide that form the basis of the “new view” associated with on passing of infrastructure charges discussed previously\(^{39}\). Within a metropolitan area, there may be a number of “cities” for which the level of services/amenity varies greatly, with resident access determined by their home address. Clearly some counties/cities are better funded than others and are able to provide a higher level of service/amenity. It follows that these neighbourhoods are more desirable, with residents willing to pay higher house prices to live in these well serviced locations.

In contrast, Australia has three levels of government: federal, state and local authority. Responsibility for social infrastructure (schools, hospitals, fire and police services) lies mainly at a state level funded through consolidated revenue raised through general state taxes. Only local economic infrastructure (utilities, roads, public transport etc) are funded at a local authority level, which residents pay for via council rates, and these do not vary significantly between jurisdictions. The effect of this is that every resident in the State of Queensland has access to essentially the same level of services and amenities and hence proximity to one service/amenity over another is not a primary decision making factor for the majority of households. Further, jurisdictions in Queensland are very large, and each usually discrete to a metropolitan centre. The capital city of Brisbane is the only exception to this, with the Greater Brisbane region spanning five local government areas.

The nature of the new housing market also differs significantly between the two countries. Firstly, the Australian new house market is dominated by a few

\(^{39}\) Refer to section 2.6.3.2 for a description of the “new view”
corporatised land developers, and multitudes of cottage home builders. Land estates are heterogeneous with planning authorities having little appetite for repetition of similar looking housing product within estates. It is the land developers that are responsible for payment of the infrastructure charges, and enjoy a return on cost (profit) commensurate with the risk undertaken in purchasing the land, navigating the often extended approval process, obtaining finance, commissioning the requisite civil works together with marketing and selling the completed (vacant) lots. House builders operate on low margins, building non-standardised homes either speculatively or under contract to the end home owner. Multiple house builders generally operate on any one subdivision. Consistency in housing design and materials used in an estate is determined by the land developer and enforced with builders through covenants. In contrast the US new housing system is dominated by home builders who subdivide the land, build standardised housing for sale to end users. This feature of the two markets is important in data analysis and in the differentiation of a New versus an Existing house for data categorisation purposes in Australia and is discussed further in Section 5.4.1.

Secondly, the US housing market appears highly segregated as previously discussed in Section 3.9.1, with two, three and four bedroom homes being almost evenly represented by number and the Florida state wide average price for a four bedroom house being more than double that for a two bedroom house. Modern Australian master planned communities take a “salt and pepper” approach to house size to encourage community diversity. However despite calls for greater housing affordability, a predominance of three and four bedroom housing remains. A survey of houses listed for sale in the Greater Brisbane area at the time of writing indicate only 3% of houses comprise two bedrooms or less, 22% of houses comprise three bedrooms, 41% of houses comprise four bedrooms and 33% of houses comprise five or more bedrooms (realestate.com.au, 2014,)\(^40\). Thus the Australian housing market could be said to be more heterogenous than the US from a house design perspective,

---

\(^{40}\) Houses for sale in the Greater Brisbane region as at February, 2014 as listed on www.realestate.com.au
but more homogenous from a housing size/product perspective, with larger homes being the predominating housing type in the study area.

A further differentiating factor that has an effect on the housing markets of the two countries is the personal income tax system. In the US, many personal expenses are tax deductible such as: home loan mortgage payments and property taxes (Poterba and Sinai, 2008) where expenses associated with income producing properties are not. The contrary situation exists in Australia, whereby no personal expenses associated with one’s principle place of residence are tax deductible, but a phenomenon called “negative gearing” encourages high income earners to purchase homes as an investment, with all expenses associated able to be tax deductible. This feature of the tax system in Australia incentivises investment in the residential market with a reported 18% of tax payers in Australia being landlords (Rowland, 2009).

The final differentiating feature of the two housing markets is the level of fees and average house prices. The average house price in the US models varied from $72,000 (Orlando, 2002) to $246,000 (Seattle, 2003), whilst the average house price in Brisbane at the same time was $305,000. The average infrastructure charges in the US are low ($900 - $5,726) compared to Queensland ($15,000 - $40,000) and are thus a lesser proportion of the average house price at the same time.

4.7 STAGE 1 CONTRIBUTION TO KNOWLEDGE

It is appropriate to recognise the contributions of this Stage 1 qualitative research. Its exploratory sequential instrument design mixed methods approach triangulates archival research with semi-structured interviews and literature review. This approach is consistent with established two-stage mixed methods theory (See Creswell and Plano Clark, 2007) and has enabled a detailed analysis of the existing body of work on the house price impacts of infrastructure charges.

In relation to contributions to knowledge, firstly, this research has provided a systematic review of extant models. Other reviews of these works provide summaries of the findings, contributions and limitations of each study, with the most recent review concluding with 2004 works. This review has instead approached the analysis from an investigative perspective, analysing selection of the variables...
employed and study areas selected by each author. It has examined the wide variances in approach, study durations and data requirements, pondering the author’s choices from the perspective of a researcher seeking to uncover evidence of an evolution in the methodologies employed. This evidence was not found. Instead, this research has revealed that comparable and significant results can be generated from studies with both limited and numerous data inputs; from studies of long or short duration. The one requisite factor appears to be strong growth in the study area, and yet that factor is in itself a contravention of the core assumptions for econometric models of normal growth. In summary, this research has provided evidence that authors contemplating similar studies in other countries should not be deterred by the apparent extensive data requirements and complexity of some of these models. This research suggests that simple form standard hedonic models, with relatively basic data inputs may produce significant and useful results.

This research has also considered an interesting question for the applied econometrician: which comes first, data or model specification? Much like the “chicken and the egg” conundrum, model specification and data collation are an iterative process, rather than one based in theory, a process that appears to be remain largely undocumented. The literature tells us that the choice of independent variables for use in house price models is often determined largely by data availability (Hill, 2012). However, data availability may not be the only driver of the diversity of the models examined herein and the researcher must consider other factors. Given the spatial heterogeneity of housing markets, perhaps rather than being a slave to theoretical models, the authors have implicitly incorporated local drivers of house prices in their data sets and model specification. For example in a very cold climate, good heating would be favoured by purchasers, as would the opposite in a hot climate. Proximity to quality amenities and services segment some housing markets, whilst more homogenous features prevail in others. Other factors such as exclusionary or stimulatory government policy may drive house prices. It is therefore imperative that the researcher has a thorough understanding of the local housing market drivers in the selected study area and that models are specified to incorporate such features of the market. Hence, the US models in their existing form may lack external validity and great care must be taken to ensure the characteristics of study areas are sufficiently similar, as are the market fundamentals, before pre-
existing methodologies are replicated and their findings and conclusions are adopted in other jurisdictions.

The issue of comparison of the US findings has also been an important finding from this Stage 1 research. In unpacking the methodologies, specification and functional forms of these models, it has become apparent that it is inappropriate to compare the findings of one model with another due to the varying functional forms. In order to address this gap in the literature, this research has highlighted the correct interpretation of various functional forms, and calculated on-passing ratios for all models. This ratio facilitates the more appropriate comparison of model findings and highlights potential risks to researchers in the interpretation of findings.

Finally, this research has provided a useful comparison of the key features of the US and Australian housing markets, infrastructure regimes and taxation systems. It has highlighted a number of similarities between the two countries, and equally importantly it has considered key differences in the functionality of the two housing markets and institutional factors. These factors become important when considering the external validity of the US models into other markets, and the rationales provided for findings. For example, a number of the more recent authors are supporters of the “new view” theory, which suggests that infrastructure charges do increase house prices, but that this is due to homeowners willingly capitalising the benefits associated with additional services and amenities into the house price, and thus saving on property tax increases in the future. The link between house prices, access to quality services/amenities and property taxes is implied at best in most of this literature but is a strong underlying assumption of the new view. However property taxes are not used as infrastructure funding mechanisms in all countries, and hence this assumption could not hold where property taxes (or similar) do not exist. This new view does have its detractors in the US (see Been, 2005) and does not ring true in an egalitarian market where a relatively constant level of services and amenities are provided to all, funded from consolidated revenue, as in Australia. Hence it is imperative that the researcher fully understand the drivers of house prices in the study area and ensure models are appropriately specified, and findings interpreted according to the local market conditions and local institutional factors. Further research on the comparative features of these two housing markets and taxation systems would provide researchers and policy makers with insights into the relative
performance of housing markets in each country. This could be particularly informative in the post GFC environment where the US housing market crashed and the Australian housing market remained stable.

4.8 CHAPTER SUMMARY

This chapter forms the final phase of Stage 1 of this research project, further to the literature review in Chapter 2 and the archival research in Chapter 3. This chapter synthesises the findings from the archival research phase, details the semi-structured interview phase and emergent themes, and triangulates these to conclude the qualitative component of this thesis. In doing so, it sets the framework for the Stage 2 component which seeks to specify, test and apply an econometric model that will estimate the house price impacts of infrastructure charges in Australia for the first time.

Specifically, this chapter has further analysed the information derived from the US literature, as well as that from the semi-structured interview process to consider whether the US and Australian infrastructure charging regimes and housing markets are sufficiently similar for the international empirical models to be used as a basis for assessing the impact of infrastructure charges on the price of housing in Australia.

This research highlights the variances in data requirements for studies that essentially test for the same effect, which is the impact of infrastructure charges on house prices. Some studies collect data in great detail, whilst others use only a selection. In considering the external validity of any or all of these studies, one must consider that detailed data may not be readily available in all countries and/or jurisdictions. This factor may be one reason why all available works on this topic come from the US where such data is relatively readily available, and yet the issue of developer paid infrastructure charges adversely affecting housing affordability exists in many developed and developing countries. Other developed countries such as UK and Australia do have readily available data on housing markets, however their historically opaque infrastructure charging systems may have stymied attempts at such analysis in those countries to date.

The main purpose of the semi-structured interview process was to aid in the understanding and analysis of the secondary data already gathered by the archival
Interviewees were questioned on the local context surrounding their models and the selection of variables, implicit assumptions made, market structure matters and the interpretation of results and other related items. Triangulation of this data has revealed a number of important factors that will inform specification of the model to be developed and applied in Stage 2 of this research.

In identifying and analysing the similarities and differences of these models, as well as the fee schemes, housing market structures and taxation systems, this chapter has addressed the third research question of this thesis:

3. **Can international empirical models be used to assess the impact of infrastructure charges on the cost of housing in Australia?**

The findings from this qualitative stage of research suggest that the theoretical premise of international empirical models is relevant to house price models. However, due to structural and institutional differences in housing markets great care and skill must be employed by the researcher to ensure study area specific demand and supply side independent variables are appropriately selected and that the model is specified to be appropriate for local housing market characteristics.

Further research on this topic in any jurisdiction will first need to establish what housing data, including infrastructure charge data is readily available and then gain an understanding of the nature of the study area housing market drivers to ensure models are correctly specified. In saying that it is nonetheless apparent that even relatively sparse data can be sufficient for a functional model and that the theoretical bases for these models does have external validity.

The analysis to this point ends Stage 1 of this research project. As detailed in Section 1.5, Stage 1 was designed to address the first three research questions via a process of literature review, archival research and semi-structured interviews. This process and the findings have been documented in Chapters 2, 3 and 4 and are illustrated in Figure 1.4.1 overleaf.
The remainder of this thesis now turns to the Stage 2 research component, and the final research question, whereby an appropriate econometric model is specified which seeks to estimate the price impacts of infrastructure charges on house prices in Brisbane, Australia. In Chapter 5, the approach adopted, available data, study area and model specifications are detailed. Chapter 6 provides the findings of Stage 2 of this research which provides the first estimate of its kind in Australia from which policy makers can base decisions upon. Chapter 7 concludes.
Chapter 5: Stage 2 Data and Approach

5.1 INTRODUCTION

The previous chapters have provided the Stage 1 research and findings for this research into the question of who really pays for urban infrastructure by examining the effect of infrastructure charges on house prices. Chapter 1 established the significance of the research problem as having roots in both the housing affordability and infrastructure funding debates. Chapter 2 presented the theory of on-passing of infrastructure charges and reviewed the literature, revealing no empirical evidence from Australian researchers despite the issue of infrastructure charge impacts on housing affordability being identified in many government and industry reports. However, a deep body of empirical work exists in the US from which to draw upon for this thesis.

Chapter 3 described the first half of the archival research phase of this two stage exploratory sequential instrument design mixed method research. It analysed the various different econometric techniques used by US researchers to estimate the price effects of infrastructure charges on house prices over the past decade. Chapter 4 completed the archival research phase, focusing on the independent variable selection, study area and study duration selection, and interpretation of findings from models with differing functional forms. This past chapter also presented findings from semi-structured interviews with prior authors from which a comparative analysis of the US and Australian housing markets and taxation systems was presented. Chapter 4 concluded with presentation of the Stage 1 findings and the contributions to knowledge from the qualitative exploratory stage of this research.

Stage 1 of this research thus provided the thematic framework for the remainder of this work which will now design and apply an econometric instrument to estimate the effect of infrastructure charges on house prices in Brisbane, Australia for the first time.
The remainder of this thesis now turns to the Stage 2 research component, and the final research question, whereby an appropriate econometric model is specified which seeks to estimate the price impacts of infrastructure charges on house prices in Brisbane, Australia. This chapter describes the approach, model and data for this research project. The next section, 5.2 explains the basis for the approach in this study. The study area and study period are outlined in section 5.3, with the data and its source described in section 5.4. This chapter concludes with details the econometric model specification adopted in section 5.5. Chapter 6 provides the findings of this research which provides the first estimate of its kind in Australia from which policy makers can base decisions upon.

5.2 APPROACH

Technological advances in software packages and institutional data collection have made analysis of housing markets at a national, state, regional and metropolitan level a relatively simple process (Meen, 2001). However, despite seemingly extensive institutional data capture, it is the availability of data that often drives model specification, rather than pure theoretical basis (Meen, 2002). With model specification driven by the suitable econometric technique, let us begin by firstly selecting a suitable econometric technique. Data availability will be addressed in the following section.

5.2.1 Econometric Technique

As demonstrated in the previous chapters, econometric models tend to become anything other than simple as they attempt to overcome ongoing limitations of data availability, model specification pitfalls and market function fundamentals. The previous chapters outlined various techniques that have been employed in the literature over the past three decades in an attempt to estimate the effect of infrastructure charges on house prices. In all cases, hedonic models formed the basis of the extant analysis, with other techniques employed such as repeat sales indices, stock flow models, instrument variable regression, fixed and random effects and treatment effects. However in many cases, the more complex models provided insignificant findings and supplied no additional evidence over the basic hedonic method. This evidence suggests that despite various attempts at overcoming the limitations of basic hedonic models, the results in the literature are relatively
consistent and more complex econometric forms may not add any additional accuracy to the estimation of the house price impacts of infrastructure charges. Hence it can be concluded that despite the numerous econometric model variations undertaken to date, no single technique has emerged as the preferred house price model over the basic hedonic methodology and that a simple linear form equation may remain appropriate.

5.2.2 Approach Adopted

As discussed previously, review of the empirical models used internationally to estimate the effect of infrastructure charges on house prices suggests that the use of an ordinary least squares (‘‘OLS’’) hedonic regression model is appropriate for this study. The hedonic approach described in earlier chapters is a relatively straightforward method once the requisite data is acquired and transformed into the appropriate scale and format. The relative simplicity of the hedonic approach is one of its strengths and hence why it has been in use since Rosen’s (1974) seminary work and forms the core of each of the prior studies described in Chapter 3.

A linear hedonic regression model is appropriate for use in this research because:

a) It is a well-established method of decomposing various housing characteristics into measurable prices and quantities;

b) The interpretation of the effect of infrastructure charges on house prices is straightforward and not subject to misinterpretation;

c) The traditional model can be adapted to incorporate independent variables suitable to reflect the characteristics of the local housing market and associated institutional factors that affect house prices; and

d) A linear hedonic regression model that is specified for Australian market conditions is an advance over the existing literature, for which only US literature exist.
5.3 STUDY AREA AND STUDY PERIOD

This study examines the effect of infrastructure charges on new and existing houses in Brisbane, Queensland, Australia. Brisbane is the State capital of Queensland and is the major metropolitan centre of South-East Queensland which is Australia’s third largest metropolitan region. South East Queensland is populated by 3.1 million people, of which approximately 70% reside in the Greater Brisbane area, accounting for approximately half of the State’s population (Australian Bureau of Statistics, 2012). The Greater Brisbane population has grown rapidly over the decade to 2012, averaging 2.2% annually, or a total of over 440,000 new residents, bringing the population to over 2.1 million people. Much of Brisbane and Queensland’s population growth is driven by overseas and interstate migration, which contributed approximately two-thirds of the state’s new residents in 2012 (Brisbane Marketing, 2014).

Consistent with Meen’s (2002) theory of data driven models, the study area selection is a function of the availability of data (or lack thereof). The study period selected is also a function of the availability of data, together with the evolving nature of infrastructure charging legislation in Queensland in recent years. The study period for this research is from 2005 to 2011. This time frame co-incides with a period of high growth in population as well as in infrastructure charges. It also corresponds with the dates for which the Priority Infrastructure Plan ("PIP") provisions of the Integrated Planning Act 1997 were in effect. The study period end co-incides with the late 2011 introduction of maximum adopted infrastructure charges. This maximum fee regime set a fixed price by way of a maximum charge for the first time in Queensland, replacing the pre-existing full cost recovery PIP regime. This 2011 legislation was designed to be an interim measure only, to be in place for three years while further reform investigation took place. Hence, maximum “fixed” charges are potentially a short term feature only, and were forecast to change again within three years (Nicholls, 2011; Nicholls, Persign, and Lamb, 2011). Thus the reasons why and end date of 2011 was chosen for this research are: the temporary nature of this maximum fee structure, the non-uniform transitional period arrangements, and long project lead times meaning some projects undertaken after 2011 may still be operating under old PIP approvals. The start of the study period corresponds with the availability of data as described further in Section 5.4.4.
Data limitations also influenced the study area selection within Brisbane. New development in Brisbane stretches along the major transportation routes to the north and south of the central business district and to a lesser extent the east and west due to geographical constraints. The data used for this study includes a sample of suburbs in Brisbane’s northern growth corridor as well as the same in Brisbane’s southern growth corridor. The northside study area sits in Brisbane’s outer northern suburbs, within the Moreton Bay Regional Council (South) local authority and incorporates the area formerly known as Pine Rivers Shire Council\textsuperscript{41}. The southside study area is located in Brisbane’s middle ring southern suburbs and is defined by the boundaries of the local government area “BCC (Yeerongpilly)”\textsuperscript{42} as defined by State Government records. The terms “northside” and “southside” are familiar in Brisbane and reference a location depending on which side of the Brisbane River it is situated on. The suburbs included in both the northside and southside study areas are outlined in Table 5.3 and Table 5.4 respectively.

The market conditions in each study area were similar for the duration of the study period. Strong market conditions existed in the lead up to the global financial crisis in 2008/2009. Government stimulatory policy came into effect in 2009 which sustained the local housing market, through a “soft landing”\textsuperscript{43} (Priemus and Whitehead 2014). Prices of both new and existing houses in Brisbane have maintained positive growth over the post GFC period, albeit at declining volumes as indicated in Figure 5.1 and Figure 5.2.

\begin{itemize}
    \item \textsuperscript{41} In the 2008 local government amalgamations, the Moreton Bay Regional Council replaced three established local government areas: the City of Redcliffe and the Shires of Pine Rivers and Caboolture.
    \item \textsuperscript{42} The Brisbane City Council (“BCC”) local government area is subdivided broadly into parishes for government data collection purposes.
    \item \textsuperscript{43} For details of the Federal Government’s First Home Owners Grant see Section 5.4.4
\end{itemize}
Figure 5.1
Residential Land and Dwelling Prices - Brisbane 2001 - 2013


Figure 5.2
Residential Land and Dwelling Sales - Brisbane 2001 - 2013

5.4 DATA DESCRIPTION

As discussed previously, it is access to required data sets that often drives model specification. This section details the sources and nature of structural, locational, jurisdictional and policy data obtained, issues with data availability and the requisite assumptions made to enable analysis.

5.4.1 Structural Data

Full sales record data for all residential sales for the period 2003 – 2011 in the local government areas in this study was provided by Price Finder, a commercial re-seller of the state and local government sales records. This provided the structural data for all single unit (detached) house sales in the study areas over the study period. The structural data provided included:

- address
- real property description
- lot size
- sale price
- sale date (contract date)
- settlement date
- number of bedrooms
- number of bathrooms
- number of carparks
- zoning
- sale type
- land use and
- buyer and seller details.

Sirmans et al. (2006) identified the nine most used data categories for hedonic house price models as being: house size, lot size, house age, number of bedrooms, number of bathrooms, and the presence of a garage, swimming pool, fireplace, and air conditioning. Comparing the available data for Brisbane with Sirman et al.’s
most commonly used independent variables, it can be seen that lot size, number of bedrooms, number of bathrooms, and the presence of a garage were able to be utilised. Data on the size of the house and the age of the house were not available in the Brisbane data set, nor were data for the presence of swimming pool, fireplace, and air conditioning. These factors do not render this dataset invalid. Sirmans et al.’s (2005) study on the composition of 125 hedonic house price models indicated that only approximately 42% of models incorporate house size; 25% included variables for the presence of a swimming pool, 47% for a fireplace and 30% for air conditioning, However 63% incorporated an age variable, and this is important in this study particularly in the differentiation between new and existing housing. How this categorisation was achieved in the absence of house age data is detailed over leaf in the discussion on the Lot, Existing house or New house categorisation.

Recall also the findings from the Stage 1 qualitative process revealed that a model with few or many independent variables could result in significant findings. Thus given the data available comprises a reasonable match with hedonic house price literature, these variables are deemed appropriate for use in this study. However data cleansing was required as detailed below.

The Brisbane Sales data was cleansed to remove: related party transactions, part sales, multiple transaction sales, and court order transactions as these sales are unlikely to reflect market value. These were able to be identified via the “sale type” category. Sales of multiple unit dwellings were removed, as were land uses that are incompatible with suburban single unit dwellings such as group title, rural, industrial or commercial uses, indentified via the “land use” category. This removed any attached or detached housing that was identified as “group title” or “building units” for example townhouses and apartments respectively. Sales in the top and bottom percentiles of sales prices and lot area were also removed: sales less than $5,000 and/or less than 100 sqm were removed; sales greater than $2 million and/or 4047sqm (1 acre) were removed. The zoning category was not used to cleanse the data set, as it was deemed not reliable as it appeared not to have been updated when planning approvals were achieved. For example, new estates that had been developed were still zoned “future urban”. This resulted in a data set of all single
residential house and vacant lot sales that had sold in arms length transactions in the Brisbane northside and southside study areas between 2003 and 2011.

Each sale record was then categorised as either a vacant Lot, Existing house or New house. This was necessary to split the data set by one of these three categories in order to identify any differential pricing effects. The data categories used for this process were: real property description, address, sale date and buyer and seller details. The decision making criteria for this categorisation was somewhat complex due to the nature of the local house building industry and the fact that “house age” data is not available.

In Queensland, land developers generally sell vacant lots to home buyers, who then enter into a construction contract with a house builder. The vacant lot sale details are captured by government records due to the transfer of title, however the value of the combined “house and land package” when it is first constructed is not captured due to the private nature of the construction contract between the builder and the consumer. An exception to this occurs when the builder constructs a “spec⁴⁴” house and on-sells the completed new home to a home buyer and the full sale price is reflected in the sale price, however this is the exception rather than the norm, with significant transfer duty savings possible by the separate contract approach. Hence in order to categorise the sales data, data rules were established:

- **Lot** – an IF/THEN formula was used to categorise a sale as a Lot where the land use type in the sale record was “Vacant Urban Land” or “Vacant Large House Site” as categorised in the data set;

- **Existing v. New** house – any house which sold (or resold) within four years of the initial lot sale was deemed to be a New house sale⁴⁵. Four years was selected as this provides time for pre-selling of the lot prior to registration of the lot, as well as construction of the house post registration of the lot, a holding period to

⁴⁴ “Spec” is short for speculative where a builder buys the lot from a developer and builds a home “speculatively” upon it, with the intention of on-selling it to a new home buyer.

⁴⁵ The contract date was used as this is the date the price is agreed between the parties and is used for initial mortgage security purposes.
avoid capital gains tax\textsuperscript{46} and a selling period. Any house sale that did not meet these \textit{New} house criteria, was categorised as an \textit{Existing} house. Hence an \textit{Existing} house became any house sold more than four years after the sale of its vacant lot in either a new or established suburb. Individual house sales were able to be identified via both their address and real property description (unique lot and plan number) which were provided in the data set. The sales data was also checked by vendor to ensure any corporate house builder sales were correctly categorised as \textit{New} even if a prior \textit{Lot} sale had not been recorded. Whilst the study period commences in 2005, 2003 and 2004 sales data was included in the dataset. This enabled the categorisation of \textit{New} sales from the 2003 and 2004 \textit{Lot} data.

Other relevant structural data provided with the data set was the lot area, number of bedrooms, number of bathrooms and number of carparks (eg. garage spaces) associated with each house sale. Bedroom, bathroom and carpark data was missing for approximately one third of the data set. The sales with incomplete data were removed.

This resulted in a total Brisbane data set of 29,662 house sales, comprising 4,699 new house sales and 25,053 existing house sales and 13,739 lot sales during 2005-2011.

5.4.2 Locational Data

The sales data set supplied full address details for each sales record, including the suburb the house was located in. Surprisingly in Sirmans et al.,’s (2005) review of 125 hedonic house price models, only 7\% included location variables, 12\% included distance (from amenities, transportation, CBD etc.) variables and 8\% included school district data. These findings could be due to the fact that many studies are of finite locations to start with, and hence no further sub-categorisation is deemed necessary. Alternatively it could be due to the GIS data, which facilitates such analysis, only becoming readily available in more recent years.

\textsuperscript{46} Capital gains tax is not payable in Australia for a principle place of residence owned by an individual tax payer for greater than one year (Australian Government, 2013).
The study area used in this research incorporates a large part of the major metropolitan area in this capital city. Sub markets exist across the city on both the northside and southside, and this location was deemed to be a significant independent variable for inclusion. Location is often a proxy for other housing market drivers such as proximity to major transportation corridors, employment centres, good schools, flood prone areas (negative) or socio-economic factors. GIS data can be used to generate data on such factors where available. Unfortunately, no GIS data was available in the dataset sourced for this research to derive any proximity variables from. How a “location” category could be incorporated from the available data as detailed below.

As uncovered in the Stage 1 research, the US property tax system and access to the services it finances, is considered an important factor in many of the extant house price models that estimate the impact of infrastructure charges. That is, a house in an area that has well funded services and amenities is more desirable. Thus buyers are willing to pay more to live in those areas, than those which are less well serviced (ie. lower quality schools, roads, fire departments, law enforcement etc.) This is in contrast to the egalitarian nature of Australian society where such services and amenities are largely funded by general revenue from State taxes and available to all residents.

Both the Brisbane northside and southside study areas incorporate established suburbs as well as newly developing suburbs, with new and existing housing being close substitutes from a services and amenities perspective. That is, all suburbs in the study areas have access to essentially the same level of basic utilities, roads, schools, public officials, law enforcement, fire and community services. Each study area includes only one local authority sub-area. This is a characteristic particular to the Queensland market, where very large local government areas exist\(^47\). The local authority sub-areas were selected as they are roughly consistent with the catchment areas for housing markets, assuming residents wish to buy within a desired locality. It is acknowledged that substitutability at the fringes with the neighbouring sub-areas

\(^{47}\) For example, the Brisbane City Council area is some 1,380 square kilometres.
will exist to some extent, however as this is a two-way effect, it is fair to assume a net zero outcome.

Whilst in theory, all residents have access to the same level of services and amenities regardless of the suburb they live in, housing markets do vary within the study areas, with some suburbs in the study areas being more or less desirable than others. In order to take such factors into consideration the Australian Bureau of Statistics’ (“ABS”) “Index of Relative Socio-economic Advantage and Disadvantage” (“IRSAD”) has been utilised. This index summarises information about the economic and social conditions of people and households within an area, including both relative advantage and disadvantage. This index provides a 1 – 10 rating at a suburb level as a relative measure of socio-economic advantage and disadvantage. A low score indicates relatively greater disadvantage and a lack of advantage in general. A high score indicates a relative lack of disadvantage and greater advantage in general (ABS, 2013). This 1-10 suburb rating has been used in this study as a proxy for the desirability of a house’s “location”, with a score of 10 being a highly desirable location for house buyers, and a score of 1 being a less desirable location for house buyers. It therefore follows that one would expect house prices to be higher in the more desirable suburbs, and lower in the less desirable suburbs by virtue of the nature of the suburb as detailed below.

The variables that are included in the IRSAD index can be found in Table 5.1. Each variable has a loading that indicates the correlation of that variable with the index. A positive loading indicates an advantaging variable whilst a negative loading indicates a disadvantaging variable.

---

48 Socio-Economic Indexes for Areas (SEIFA) is a product developed by the ABS that ranks areas in Australia according to relative socio-economic advantage and disadvantage. The indexes are based on information from the five-yearly Census. IRSAD of one of the SEIFA indexes.
### Table 5.1

**IRSAD Included Variables**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
<th>Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>INC_HIGH</td>
<td>% of people with stated household equivalised income greater than $52,000 per year</td>
<td>0.84</td>
</tr>
<tr>
<td>HIGHMORTGAGE</td>
<td>% of occupied private dwellings paying mortgage greater than $2,800 per month</td>
<td>0.70</td>
</tr>
<tr>
<td>DIPLOMA</td>
<td>% of people aged 15 years and over whose highest level of educational attainment is a diploma qualification</td>
<td>0.63</td>
</tr>
<tr>
<td>OCC_PROF</td>
<td>% of employed people classified as Professionals</td>
<td>0.62</td>
</tr>
<tr>
<td>HIGHBED</td>
<td>% of occupied private dwellings with four (4) or more bedrooms</td>
<td>0.52</td>
</tr>
<tr>
<td>OCC_MANAGER</td>
<td>% of employed people classified as managers</td>
<td>0.42</td>
</tr>
<tr>
<td>HIGHRENT</td>
<td>% of occupied private dwellings paying rent greater than $370 per week</td>
<td>0.40</td>
</tr>
<tr>
<td>SPAREBED</td>
<td>% of occupied private dwellings with one or more spare bedrooms</td>
<td>0.37</td>
</tr>
<tr>
<td>ATUNI</td>
<td>% of people aged 15 years and over at university or other tertiary institution</td>
<td>0.36</td>
</tr>
<tr>
<td>HIGHCAR</td>
<td>% of occupied private dwellings with three (3) or more cars</td>
<td>0.35</td>
</tr>
<tr>
<td>NOEDU</td>
<td>% of people aged 15 years and over who have no educational attainment</td>
<td>0.37</td>
</tr>
<tr>
<td>OVERCROWD</td>
<td>% of occupied private dwellings requiring one or more extra bedrooms</td>
<td>0.45</td>
</tr>
<tr>
<td>NOCAR</td>
<td>% of occupied private dwellings with no cars</td>
<td>0.49</td>
</tr>
<tr>
<td>OCC_SERVICE_L</td>
<td>% of employed people classified as low skill Community and Personal Service workers</td>
<td>0.51</td>
</tr>
<tr>
<td>OCC_DRIVER</td>
<td>% of employed people classified as Machinery Operators and Drivers</td>
<td>0.57</td>
</tr>
<tr>
<td>SEP_DIVORCED</td>
<td>% of people aged 15 years and over who are separated or divorced</td>
<td>0.57</td>
</tr>
<tr>
<td>LOWRENT</td>
<td>% of occupied private dwellings paying rent less than $166 per week (excluding $0 per week)</td>
<td>0.67</td>
</tr>
<tr>
<td>DISABILITYU70</td>
<td>% of people under the age of 70 who have a long-term health condition or disability and need assistance with core activities</td>
<td>0.67</td>
</tr>
<tr>
<td>UNEMPLOYED</td>
<td>% of people (in the labour force) who are unemployed</td>
<td>0.69</td>
</tr>
<tr>
<td>ONEPARENT</td>
<td>% of one parent families with dependent offspring only</td>
<td>0.69</td>
</tr>
<tr>
<td>OCC_LABOUR</td>
<td>% of employed people classified as Labourers</td>
<td>0.78</td>
</tr>
<tr>
<td>CHILDJOBLESS</td>
<td>% of families with children under 15 years of age who live with jobless parents</td>
<td>0.80</td>
</tr>
<tr>
<td>NOYEAR12ORHIGHE</td>
<td>% of people aged 15 years and over whose highest level of education is Year 11 or lower</td>
<td>0.82</td>
</tr>
<tr>
<td>NONET</td>
<td>% of occupied private dwellings with no internet connection</td>
<td>0.82</td>
</tr>
<tr>
<td>INC_LOW</td>
<td>% of people with stated household equivalised income between $1 and $20,799 per year</td>
<td>0.89</td>
</tr>
</tbody>
</table>

Source: ABS (2013)

Table 5.2 indicates variables that ABS initially considered for the index, but were subsequently excluded due to low loadings (not adding enough value to the final index).
Table 5.2

*IRSAD Excluded Variables*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>DIALUP</td>
<td>% of occupied private dwellings with a dialup internet connection</td>
</tr>
<tr>
<td>FEWBed</td>
<td>% occupied private dwellings with one (1) or no bedrooms</td>
</tr>
<tr>
<td>CERTIFICATE</td>
<td>% of people aged 15 years and over whose highest educational attainment is a certificate III or IV</td>
</tr>
<tr>
<td>OWNING</td>
<td>% of occupied private dwellings owning dwelling without a mortgage</td>
</tr>
<tr>
<td>OCC_SALES_L</td>
<td>% of employed people classified as Low-Skill Sales</td>
</tr>
<tr>
<td>ENGLISHPOOR</td>
<td>% of people who do not speak English well</td>
</tr>
</tbody>
</table>

Source: ABS (2013)

A list of the relevant IRSAD ratings for the suburbs included in the Brisbane northside and Brisbane southside study areas may be found in Table 5.3 and Table 5.4 respectively. These have been derived from the 2011 census data. It is assumed that these ratings are relatively time invariant and will have remained stable over the study period.

Table 5.3

*IRSAD Ratings – Brisbane Northside*

<table>
<thead>
<tr>
<th>Suburb</th>
<th>Rating</th>
<th>Suburb</th>
<th>Rating</th>
<th>Suburb</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Albany Creek</td>
<td>10</td>
<td>Femy Hill</td>
<td>9</td>
<td>Mount Samson</td>
<td>10</td>
</tr>
<tr>
<td>Arana Hills</td>
<td>9</td>
<td>Griffin</td>
<td>9</td>
<td>Murrumbia Downs</td>
<td>8</td>
</tr>
<tr>
<td>Bray Park</td>
<td>6</td>
<td>Highvale</td>
<td>10</td>
<td>North Lakes</td>
<td>9</td>
</tr>
<tr>
<td>Brendale</td>
<td>3</td>
<td>Joyner</td>
<td>9</td>
<td>Petrie</td>
<td>7</td>
</tr>
<tr>
<td>Bunya</td>
<td>3</td>
<td>Kallangur</td>
<td>4</td>
<td>Samford Valley</td>
<td>10</td>
</tr>
<tr>
<td>Cashmere</td>
<td>10</td>
<td>Karwongbah</td>
<td>8</td>
<td>Samford Village</td>
<td>10</td>
</tr>
<tr>
<td>Dakabin</td>
<td>7</td>
<td>Lawnton</td>
<td>3</td>
<td>Strathpine</td>
<td>4</td>
</tr>
<tr>
<td>Dayboro</td>
<td>8</td>
<td>Mango Hill</td>
<td>9</td>
<td>Warner</td>
<td>10</td>
</tr>
<tr>
<td>Eatons Hill</td>
<td>10</td>
<td>Mount Glorious</td>
<td>9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Everton Hill</td>
<td>9</td>
<td>Mount Nebo</td>
<td>9</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: ABS (2013)
Table 5.4
IRSAD Ratings – Brisbane Southside

<table>
<thead>
<tr>
<th>Suburb</th>
<th>Rating</th>
<th>Suburb</th>
<th>Rating</th>
<th>Suburb</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acacia Ridge</td>
<td>1</td>
<td>Heathwood</td>
<td>10</td>
<td>Rocklea</td>
<td>3</td>
</tr>
<tr>
<td>Algester</td>
<td>7</td>
<td>Inala</td>
<td>1</td>
<td>Runcorn</td>
<td>7</td>
</tr>
<tr>
<td>Archerfield</td>
<td>2</td>
<td>Kuraby</td>
<td>9</td>
<td>Salisbury</td>
<td>6</td>
</tr>
<tr>
<td>Calamvale</td>
<td>9</td>
<td>Macgregor</td>
<td>7</td>
<td>Stretton</td>
<td>10</td>
</tr>
<tr>
<td>Carole Park*</td>
<td>1</td>
<td>Moorooka</td>
<td>7</td>
<td>Sunnybank</td>
<td>6</td>
</tr>
<tr>
<td>Coopers Plains</td>
<td>4</td>
<td>Mt Gravatt</td>
<td>7</td>
<td>Sunnybank Hills</td>
<td>7</td>
</tr>
<tr>
<td>Doolandella</td>
<td>5</td>
<td>Nathan</td>
<td>8</td>
<td>Tarragindi</td>
<td>10</td>
</tr>
<tr>
<td>Drewvale</td>
<td>9</td>
<td>Oxley</td>
<td>8</td>
<td>Upper Mt Gravatt</td>
<td>6</td>
</tr>
<tr>
<td>Durack</td>
<td>2</td>
<td>Pallara</td>
<td>6</td>
<td>Wacol</td>
<td>2</td>
</tr>
<tr>
<td>Eight Mile Plains</td>
<td>9</td>
<td>Parkinson</td>
<td>10</td>
<td>Willawong</td>
<td>5</td>
</tr>
<tr>
<td>Ellen Grove</td>
<td>1</td>
<td>Richlands</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forest Lake</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Suburb not included. Rating derived from neighbouring suburb ratings.

Source: ABS (2013)

5.4.3 Jurisdictional data

Jurisdictional data incorporates regional or macro-economic factors that might affect the price of housing such as household income levels, local crime rates, population growth, housing supply, labour force, unemployment rate, construction cost index, mortgage interest rates, and other occupancy costs. This data is not supplied in the sales record database, hence other data sources were required to build the requisite data set for this study.

Sirmans et al.’s (2005) survey of 125 hedonic house price models gives little guidance as to the preferred independent variables to include taking account of jurisdictional features. A crime rate variable featured in 6% of the studies and foreclosure in 4% as the only jurisdictional factors regularly appearing in hedonic house price models. A house price trend variable was however included in over 10% of the models, which could be interpreted as a proxy for general housing market movements that incorporate the prevailing macro-economic environment. Also, remembering that Sirmans et al,’s (2005) study noted that a characteristic of hedonic house price models is that they are location specific (supported in their findings with only 7% incorporating location variables), if the prevailing macro-economic
conditions impact the full study area consistently, then it could be argued that there is little to be gained from their inclusion. The exception to this is unless changes in house prices due to changes in macro-economic conditions are the subject of the research or are a known or suspected variable of significance in house price movements over the study duration.

The inclusion of jurisdictional factors was considered important for this study due to two factors. Firstly, given there are two sub-study areas it is possible that jurisdictional factors impact these differently. Where possible, separate data for Brisbane northside and southside was gathered. Secondly, the extant models devoted considerable attention to jurisdictional variables, attempting to account for a variety of house price drivers from both the demand and supply perspective.

The selection of demand and supply variables for this study was a process driven by a number of factors including: reference to the extant models, exclusion of variables that were not of relevance to the Australian market (for example property tax and service/amenity measure variables), consideration of the drivers of house prices in the study area (refer Figure 3.1) and availability of the required data sets over the study period at the requisite scale and at the required intervals.

Jurisdictional data for this study was sourced from the ABS web site, with the exception of data on the 30 year home mortgage interest rates, consumer sentiment and inflation, which was sourced from the Reserve Bank of Australia (“RBA”) web site. Where monthly or quarterly data existed, annual averages were derived (by calendar year) to remain consistent with the annual intervals selected for this study (refer section 5.4.4).

Data on supply and demand house price drivers were sought at a local government level (rather than State level) to ensure regional sub-market effects were suitably accommodated. The local government area of “Brisbane” was used for the southside data set, and “Moreton Bay” used for the northside data set, with both being part of the Greater Brisbane metropolitan area.

Demand variables for which the requisite data was available include: changes to household income, population change, unemployment, change in project home construction costs, 30 year average variable mortgage interest rates, and consumer sentiment data.
From the supply perspective, data at a State-wide level was available for: building approvals, building commencements and building activity (each able to be segmented for new residential construction). However, only the building approval data was available at a local government level, captured from 2006. Whilst it is acknowledged that not all buildings that are approved proceed to construction, and that either of the other two data sets might be more desirable, access to approval data at the local government level was deemed superior to only state-wide data for commencements and activity. Using State-wide data, simple linear regression was used to estimate pre 2006 data for change in building approvals at the local government level (\(R^2 = 81\%\) Brisbane, 91\% Moreton Bay) in order to populate the requisite fields for 2005. Similarly, the increase in median household income data at a local government level was available only between 2005 and 2010 at a local government level. A similar technique was used to estimate missing data for 2011 from the State-wide data that was available (\(R^2 = 98\%\) Brisbane, 90\% Moreton Bay).

Unless otherwise stated herein, each of these data sets was available over the full study period, some available at a local government level, whilst others were only available at a national level as indicated in Table 5.5. Inflation data was used to adjust all variables to 2005 dollars.

**Table 5.5**

*Jurisdictional Data Source*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Jurisdiction</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change in building approvals</td>
<td>LGA</td>
<td>ABS Cat 8731.0 - Building Approvals, Australia, Jan 2014, Local Government Area: Queensland, 2006-2012, TABLE 03. Number of Dwelling Units Approved, by Sector, all series - Queensland</td>
</tr>
<tr>
<td>Increase in median household income</td>
<td>LGA</td>
<td>ABS, Cat 6524.0.55.002 - Estimates of Personal Income for Small Areas, Time Series, 2005-06 to 2010-11, Table 3</td>
</tr>
<tr>
<td>Population change</td>
<td>LGA</td>
<td>ABS, Cat 3218.0 Regional Population Growth, Australia, Table 3</td>
</tr>
<tr>
<td>Unemployment rate</td>
<td>LGA</td>
<td>ABS Cat 6291.0.55.001 Labour Force, Australia, Detailed - Electronic Delivery, Table 16. Labour force status by Region (SA4) and Sex</td>
</tr>
<tr>
<td>Construction cost index</td>
<td>Brisbane</td>
<td>ABS, Cat 6416.0 - House Price Indexes: Eight Capital Cities, Mar 2012, Project homes percentage change from the corresponding quarter of previous year (Brisbane)</td>
</tr>
<tr>
<td>30 year average mortgage rate</td>
<td>Australia</td>
<td>RBA Statistical Tables, F5 Indicator Lending Rates, Bank Variable Standard lending rate</td>
</tr>
<tr>
<td>Consumer sentiment</td>
<td>Australia</td>
<td>RBA Statistical Tables, G8 Indicators Of Spending And Confidence, Westpac-Melbourne Institute consumer sentiment index</td>
</tr>
<tr>
<td>Consumer price index (inflation)</td>
<td>Australia</td>
<td>RBA Statistical Tables, G2 Consumer Price Index, All Groups</td>
</tr>
</tbody>
</table>

* LGA = Local Government Area. “Brisbane” for southside, “Moreton Bay” for Northside. Source: Author
Property tax variables are a feature of the majority of the prior US models, however none have been incorporated in this model. As discussed previously, this is primarily due to the fact that Queensland does not have a property tax regime. Local authority rates are the closest comparable tax item applicable in Queensland. Local authority rates are charged to home owners for the provision of services such as: roads, bridges, kerbing and channelling and parks and gardens, immunisation, libraries and community activities, free trees, and pest eradication (Brisbane City Council, 2014). However, due to the utility nature of services provided, and the economies of scale from the large local government areas, these rates are not of the scale of property taxes in the US which can be in the order of tens of thousands of dollars per annum and are a significant annual occupancy cost. In contrast, a suburban house in Brisbane would expect annual rates in the order of $1,200 - $1,500. Water and sewerage consumption charges are invoiced separately by Queensland Urban Utilities.

Local government rates are essentially constant across a jurisdiction, levied against the site value of the lot. The “site value is its expected realisation under a bona fide sale assuming all non-site improvements for the land had not been made” and is assessed every three years (Queensland Government, 2014a, p22). Site value data was provided as part of this data set and was considered for use as a separate variable given its relationship to the physical and locational nature of the lot as well as the prevailing market conditions. However site value was discarded as an independent variable as the valuation dates provided in the data set were inconsistent and not up to date and thus deemed not reliable.

5.4.4 Policy Data

Policy data is not traditionally a separate component of the hedonic model, despite the effect of government policy on housing markets and thus prices being well documented. Policy items such as decisions to levy infrastructure charges are usually incorporated with jurisdictional data, however they have been classified separately in this study to draw attention to the impact of such government initiatives on house prices. The two government policy variables that are relevant to house prices over the study period in Australia are: infrastructure charges and the First Home Owners Grant.
Infrastructure Charge Data

In Queensland, infrastructure charges are levied at a local authority level, negotiated at the time of planning approval. The cost base and negotiation process for determining these charges over the study period was opaque given that neither Brisbane City Council nor Moreton Bay Regional Council (or its predecessor Pine Rivers Shire Council) had Priority Infrastructure Plans (“PIPs”) in place, despite being required to do so by the State legislation. Each developer negotiated separately the relevant charges for each development application. Thus obtaining data on levied infrastructure charges proved difficult. Given this research pivots on access to infrastructure charge data at a lot level, it is this factor that has driven the approach to this research and selection of the study area/s.

Infrastructure charge data at a local authority level was initially sought for this study. Section 724 of the Integrated Planning Act states that each local authority in Queensland is required to maintain an Infrastructure Charge register (Queensland Government, 2009b). The relevant provision of the Act is indicated in Figure 5.3:

Figure 5.3
Infrastructure Charge Register Provisions

(3) The infrastructure charges register and the regulated infrastructure charges register must, for each charge levied, include each of the following—

(a) the real property description of the land to which the charge applies;
(b) the schedule under which the charge was levied;
(c) the amount of the charge levied;
(d) the amount of the charge unpaid;
(e) the number of units of demand charged for;
(f) if the charge was levied as a result of a development approval or compliance permit—the approval or permit reference number and the day the approval or permit will lapse;
(g) if infrastructure was to be provided instead of paying the charge—details of any infrastructure still to be provided.

(4) Also, the infrastructure charges register must include—

(a) the charge rate, stated in the infrastructure charges schedule, for each charge levied; and
(b) if the charge rate has been adjusted for inflation—
   (i) details of how it was adjusted; and
   (ii) the adjusted charge rate.

Source: Queensland Government, 2009b, s 724
Three of the five largest local authorities in South East Queensland were approached to supply data from their Infrastructure Charge Register for this research. After initial positive responses from each party, each cited “legal reasons” for not supplying the requested data, and one cited high workloads and the cost prohibitive nature of extracting the requested infrastructure charge data. One local authority was willing to provide a copy of its Infrastructure Charge Register in pdf format (not database compatible). Examination of this Register revealed two issues with the data that rendered it not useful. Firstly the infrastructure charge data recorded was at a “parent lot” level; that is it stated the total amount of infrastructure charges levied on a parcel of unsubdivided land. This was unhelpful as it did not identify the subsequent subdivision, the number of “child lots” that it was to be subdivided into, nor the land use applicable (hence residential subdivisions could not be delineated from other development types). Secondly the data set was incomplete with many fields not populated. Discussions with other local governments revealed that Infrastructure Charges Registers held did not aggregate or relate data to other systems and could only be used to enquire on a specific charge/application on a case by case basis.

The State government department responsible for infrastructure was then approached to supply the requisite infrastructure charge data for this study. After examination of its records, the State revealed it did not hold data on infrastructure charging in Queensland from which a charge per lot could be derived. Thus despite legislative provisions for infrastructure charge data to be publicly available, this proved not to be the case on a large scale basis necessary for regional analysis. This opaque nature of the Queensland infrastructure charging regime is a key differentiating factor from the US studies whereby infrastructure charges are transparent and certain, being a scheduled and published rate per lot.

In the absence of regional level infrastructure charge data, data at a project level within the identified local government areas was targeted. The assumption was made that infrastructure charges applicable to one (or more) typical projects in a region may be assumed to be of a similar scale to the typical charges levied on other projects undertaken at that time in the same local government area. The limitations of this necessary assumption are discussed in Section 6.5.
Large private land developers were approached to supply infrastructure charge data for their projects. Private developers were targeted over the publicly listed entities that are active in this market due to a number of factors including: similar scale and nature of projects, professional and experienced staff, long term business models, access to decision makers for the release of information and the limited risk of shareholder backlash should findings become public\textsuperscript{49}.

The developers that were approached supplied data on the infrastructure charges levied on their typical projects in the study area. The total infrastructure charges applicable to each stage in those projects was divided by the number of lots in that stage to determine the typical charge per lot. The applicable infrastructure charge per annum for the study period was derived from the year each stage was released and sold. Given the “lumpy” nature of this data, annual intervals were chosen for this study, with weighted averages adopted for infrastructure charge data when more than one stage was sold in a calendar year.

Consideration was given as to whether a lag should be incorporated, given infrastructure charges are levied at the time of development approval, which is often a year or more prior to the sale of the lot/house. This lag effect is applied inconsistently in the US studies, despite the same timing effects between charges being levied and sale of the house/lot being similar to that in Australia. The decision to incorporate a one year lag in this study took into consideration a number of factors:

- The plan seal date for the project was used to determine the applicable weighted average infrastructure charge per lot across the local government area for that calendar year. The plan seal date reflects completion of that stage of subdivision;
- Analysis of the sample projects indicated that development approvals lagged plan sealing dates on average by 15 months, however with variance up to four years;

\textsuperscript{49} Each developer involved wished to remain anonymous and hence no project identifiers are included in this research.
• Settlement of lots can only occur after plan sealing dates, but presales may have occurred up to nine or more months prior. The (market) price of the lot is determined at the sale date i.e. contract date (be that a presale or a normal sale). The timing of selling or pre-selling is opportunistic and largely determined by market demand;

• Developers will only bring stages onto the market at a time when they are profitable, hence older approvals may be held until market demand warrants further supply of lots. Hence if higher charges are levied (making stages unprofitable in prevailing market conditions) those lots will be brought to the market when market conditions are more favourable;

• The complexities in the data analysis associated with: pre-selling or post selling of lots, as well as the delay or bringing forward of stages might apply equally to all projects in the study area. Hence this effect is determined to be random and thus fits the requisite assumptions for regression analysis. Hence the use of the infrastructure charge per lot applicable to a stage sold in any calendar year, lagged by one year (project average of 15 months rounded down to one year) is deemed appropriate as an average measure.

As mentioned previously, the end of the study period aligned with the 2011 introduction of maximum adopted infrastructure charges. The start of the study period aligns with the commencement date of the projects for which data was made available. In both the northside and southside study areas, this was 2004. Hence sales data from 2005 is the commencement of this study period, to allow for the one year lag in infrastructure charge data. The basis for deriving the annual charges for each study area is described below.

**Northside** - The northside infrastructure charges were adopted from a 430 lot development with connection to all usual urban infrastructure and access to a wide range of local services and amenities. This project was developed in stages from 2003 through to 2011. The annual infrastructure charge per lot started at $4,268 in 2004, increasing steadily up to $13,597 per lot in 2011.

**Southside** - The southside infrastructure charge data was derived from two projects by the same developer from 2004 to 2009. The first project was a 200 lot residential subdivision developed in three stages from 2004 to 2007. The second
project was a 150 lot development, developed in four stages from 2006 through to 2009. Both projects had connection to all usual urban infrastructure and access to a wide range of local services and amenities. The annual average infrastructure charge per lot started at $5,751 in 2004, increasing steadily up to $14,555 per lot in 2009.

The significant increases in infrastructure charges per lot over the study period in both localities are consistent with the industry concerns over that time that lead to the 2011 infrastructure charges reform (refer Chapter 1). This was a period of considerable uncertainty and lack of transparency as local governments sought to move to a full cost recovery regime and yet Priority Infrastructure Plans were not in place. Lagging of infrastructure charges by one year resulted in a study period for the northside of 2005 – 2011 and southside of 2005 – 2010.

**First Home Owners Grant**

The First Home Owners Grant (“FHOG”) and other associated government initiatives are an important feature of the Australian housing market due to their stimulatory objectives. The impact of the FHOG on house prices is well documented and thus warrants inclusion in any house price model discussion. In summary, in July 2000 the Federal Government introduced the FHOG in the amount of $7,000 to offset the cost of the GST on houses. This grant was given to any buyers entering the housing market for the first time and was not means or income tested. It was initially designed to incentivise first home owners into the housing market, counter the effects of the GST and to maintain activity in the housing sector. From time to time the Federal and State Governments increase the grant amount for set periods in order to stimulate activity in the housing market. Transfer duty or other concessions may also be introduced by governments as fiscal policy measures. Some of these incentives have not discriminated between existing and new housing, whilst others apply to new housing only in order to stimulate the construction sector (Randolf, Pinnegar and Tice, 2013; Blight, Field and Henriquez, 2012; Dungey, Wells and Thompson, 2011).

---

50 For full details of the FHOG and various other State initiatives see Randolf et al., 2013, Blight et al., 2012, Dungey et al., 2011.
The study period for this research of 2005 – 2011 incorporates the strong housing market in the lead up to the GFC in 2008 as well as the post GFC market retraction. Stimulatory policy by both State and Federal Governments is credited with stabilising the housing market post GFC (Primeus and Whitehead, 2014). This incorporated an increase to the FHOG of up to $21,000 for new homes combined with transfer duty and other savings at the State level. The net effect of assistance to first home buyers from 2000 to 2010 is reported by Dungey et al. (2011). The net assistance of government incentives (as a percentage of mean house price) in Queensland over the study period for both new and existing houses was relatively flat, below 2% until mid 2008. The post GFC stimulatory policies increased these incentives to near 6% of the mean house price for new houses, and 4% for existing houses in 2009, falling back to pre-GFC levels in 2010 (Dungey et al., 2011).

Preliminary model specifications for this thesis attempted to incorporate the stimulatory impact of the FHOG in 2009 for both new and existing homes, and for new homes only in 2011. Dummy variables were introduced for these years consistent with Dungey et al.’s (2011) findings which reported on the change to government incentives as a percentage of mean house prices in each Australian state over the study period. Unfortunately inconsistent results were produced due to limitations of the data. These limitations are largely attributed to the interval selected for this study. As discussed previously, the nature of the infrastructure charge data necessitated the used of annual intervals, however in the post GFC period when the government stimulatory packages were in effect, the FHOG payment was not in effect for full calendar years. The $14,000 additional payment to the FHOG was initially in effect from end 2008 to 30 June 2009. It was extended til 30 September 2009 and then halved til 31 December 2009, falling back to $7,000 thereafter. In August 2011, the Queensland Government introduced a further incentive of $10,000 (on top of the Federal $7,000 FHOG) payable on new house and land packages up to $600,000, which was in effect until 30 April, 2012 (Queensland Government, 2014b). As can be seen the short term nature of these policies does not fit in an annual model, with the effects not consistent across the full interval.

Hence due to data limitations, the FHOG was not incorporated into the final model. Should more detailed infrastructure charge data be available in the future that
enables shorter study intervals (say quarterly), then it would be desirable to incorporate the FHOG into such a model.

5.4.5 Data Summary

The final data set for this study comprised a total of 29,752 house sales in Brisbane from 2005 - 2011, comprising 4,699 new and 25,053 existing house sales and 13,739 lot sales. Table 5.6 describes the final independent variables adopted for this study in the model estimation. As mentioned previously, inflation was used to adjust all variables to 2005 dollars.

Table 5.6
Variable Legend

<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>IA_Price</td>
<td>House price</td>
</tr>
<tr>
<td><strong>Structural Attributes</strong></td>
<td></td>
</tr>
<tr>
<td>Area</td>
<td>Lot size in square metres</td>
</tr>
<tr>
<td>Bedrooms</td>
<td>Total number of bedrooms</td>
</tr>
<tr>
<td>Bathrooms</td>
<td>Total number of bathrooms</td>
</tr>
<tr>
<td>Carparks</td>
<td>Total number of car parking spaces</td>
</tr>
<tr>
<td>Type</td>
<td>Dummy variable indicating whether the house is Existing (0) or New (1)</td>
</tr>
<tr>
<td></td>
<td>Lot data was a separate data set not requiring a Type variable</td>
</tr>
<tr>
<td><strong>Locational Attributes</strong></td>
<td></td>
</tr>
<tr>
<td>SEIFA</td>
<td>1-10 ranking of suburb as indicated by the Index of Relative Socio-economic Advantage and Disadvantage (IRSAD)</td>
</tr>
<tr>
<td>Region</td>
<td>Dummy variable indicating whether the house is Brisbane Northside (0) or Southside (1)</td>
</tr>
<tr>
<td><strong>Jurisdictional Attributes</strong></td>
<td></td>
</tr>
<tr>
<td>Year</td>
<td>Time dummy for year of sale</td>
</tr>
<tr>
<td>AC_Inc</td>
<td>Percentage rate of change in population (LGA)</td>
</tr>
<tr>
<td>AC_Pop</td>
<td>Percentage increase in median household income (LGA)</td>
</tr>
<tr>
<td>AC_Bul</td>
<td>Percentage change in building approvals (LGA)</td>
</tr>
<tr>
<td>A_Upr</td>
<td>Unemployment rate (LGA)</td>
</tr>
<tr>
<td>A_Cci</td>
<td>Construction cost index for Brisbane (capital city)</td>
</tr>
<tr>
<td>A_Mgr</td>
<td>Average 30 year mortgage rate (Australia)</td>
</tr>
<tr>
<td>A_Css</td>
<td>Consumer confidence index (Australia)</td>
</tr>
<tr>
<td><strong>Policy Attributes</strong></td>
<td></td>
</tr>
<tr>
<td>IA_Ife_1L</td>
<td>Annual infrastructure charge adopted on a per lot basis, based on year of sale of lot, lagged by one year</td>
</tr>
</tbody>
</table>
The summary statistics for the full data set (All housing), as well as New and Existing housing is provided in Table 5.7 and for Lots in Table 5.8.

Table 5.7
Summary Statistics – Housing

<table>
<thead>
<tr>
<th>Variable</th>
<th>All</th>
<th>New</th>
<th>Existing</th>
</tr>
</thead>
<tbody>
<tr>
<td>IA_Price</td>
<td>471,863.63</td>
<td>523,341.08</td>
<td>462,208.40</td>
</tr>
<tr>
<td>Area</td>
<td>687.58</td>
<td>575.6831</td>
<td>708.5697</td>
</tr>
<tr>
<td>Bedrooms</td>
<td>3.63</td>
<td>3.93</td>
<td>3.58</td>
</tr>
<tr>
<td>Bathrooms</td>
<td>1.78</td>
<td>2.09</td>
<td>1.72</td>
</tr>
<tr>
<td>Carparks</td>
<td>1.93</td>
<td>1.96</td>
<td>1.92</td>
</tr>
<tr>
<td>Type</td>
<td>0.16</td>
<td>a</td>
<td>a</td>
</tr>
<tr>
<td>Region</td>
<td>0.47</td>
<td>.39</td>
<td>.48</td>
</tr>
<tr>
<td>SEIFA</td>
<td>7.26</td>
<td>8.28</td>
<td>7.07</td>
</tr>
<tr>
<td>Year</td>
<td>2007.61</td>
<td>2007.52</td>
<td>2007.63</td>
</tr>
<tr>
<td>AC_Inc</td>
<td>2.77</td>
<td>5.0220</td>
<td>4.9825</td>
</tr>
<tr>
<td>AC.Pop</td>
<td>4.99</td>
<td>2.8792</td>
<td>2.7444</td>
</tr>
<tr>
<td>AC_Bul</td>
<td>-4.70</td>
<td>-2.7188</td>
<td>-5.0676</td>
</tr>
<tr>
<td>A_Upr</td>
<td>3.59</td>
<td>3.4126</td>
<td>3.6197</td>
</tr>
<tr>
<td>A_Cci</td>
<td>4.23</td>
<td>4.3238</td>
<td>4.2087</td>
</tr>
<tr>
<td>A_Mgr</td>
<td>7.56</td>
<td>7.6020</td>
<td>7.5467</td>
</tr>
<tr>
<td>A_Css</td>
<td>105.29</td>
<td>105.6387</td>
<td>105.2292</td>
</tr>
<tr>
<td>IA_IFC_1L</td>
<td>12,080.79</td>
<td>114,381.16</td>
<td>122,013.32</td>
</tr>
<tr>
<td>n</td>
<td>29,752</td>
<td>4699</td>
<td>25053</td>
</tr>
</tbody>
</table>

a. Type = 1, b Type = 0
Structural elements of a house are dropped in the Lot model as this model relates to the price of subdivided and serviced vacant residential lots only. The house type (New or Existing) is not required as the Lot sales data set has been separated from the house sales data set.

Table 5.8

Summary Statistics – Lots - Brisbane

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Std Dev</th>
</tr>
</thead>
<tbody>
<tr>
<td>IA_Price</td>
<td>261,164.48</td>
<td>101,415.57</td>
</tr>
<tr>
<td>Area</td>
<td>633.70</td>
<td>379.99</td>
</tr>
<tr>
<td>Region</td>
<td>0.31</td>
<td>0.46</td>
</tr>
<tr>
<td>SEIFA</td>
<td>8.41</td>
<td>1.78</td>
</tr>
<tr>
<td>Year</td>
<td>2007.52</td>
<td>1.76</td>
</tr>
<tr>
<td>AC_Inc</td>
<td>5.03</td>
<td>1.41</td>
</tr>
<tr>
<td>AC_Pop</td>
<td>2.95</td>
<td>0.70</td>
</tr>
<tr>
<td>AC_Bul</td>
<td>-1.94</td>
<td>16.01</td>
</tr>
<tr>
<td>A_Upr</td>
<td>3.42</td>
<td>0.99</td>
</tr>
<tr>
<td>A_Cci</td>
<td>4.03</td>
<td>2.56</td>
</tr>
<tr>
<td>A_Mgr</td>
<td>7.50</td>
<td>0.88</td>
</tr>
<tr>
<td>A_Css</td>
<td>106.24</td>
<td>7.86</td>
</tr>
<tr>
<td>IA_Ifc_1L</td>
<td>10,973.33</td>
<td>4,377.38</td>
</tr>
<tr>
<td>n</td>
<td>13,739</td>
<td></td>
</tr>
</tbody>
</table>
5.5 MODEL SPECIFICATION

As detailed in the previous chapters, despite the various functional forms employed in the literature, a simple linear reduced form equation may be equally appropriate, and is the adopted form for this study:

\[ P_{i,t} = \beta_0 + \beta_1 S_i + \beta_2 L_i + \beta_3 J_i + \beta_4 G_i + u_{i,t} \]  

5.1

Where

\( P_{i,t} \) = sale price of house \( i \) in time period \( t \)

\( S_i \) = Structural attributes of the house: lot area, number of bedrooms, bathrooms and car parking spaces, dummy for new or existing home

\( L_i \) = Locational features: region, socio-economic suburb rankings

\( J_i \) = Jurisdictional factors: changes to household income levels, population growth, new housing supply, unemployment rate, construction cost index, mortgage interest rates; consumer confidence

\( G_i \) = Government policy: infrastructure charges

\( u_{i,t} \) = error term or noise in the model for the \( i^{th} \) observation at time \( t \).

A model for house prices in Brisbane was run firstly for the pooled data set (All Houses). Separate models for both New and Existing houses were run to determine if a differential effect between new and existing housing was evident. Given new and existing homes are close substitutes for each other, theory supports the premise that a change in the price of one house type (be it new or existing) could impact the price of the other house type. Hence, the interaction of Type (New/Existing) was then tested for. The interaction between new and existing house prices was tested for in the form:

\[ P_{i,t} = \beta_0 + \beta_1 IA_{i,t} + \beta_2 TYPE_i + \beta_3 TYPE_{ij} + u_{i,t} \]  

5.2
Where

\[ IA_{fc,1}L_t = \] Annual infrastructure charge adopted on a per lot basis, based on year of sale of lot, lagged by one year

\[ TYPE = \] New (1) or Existing (0)

Similarly, separate regressions by Region (North and South) were attempted; however these were unsuccessful due to the very high multicolinearity of the jurisdictional variables and produced large changes in the coefficient estimates. Removing the jurisdictional variables still resulted in inexplicable results that reflect the limitations of the data. Testing for interactions between Type and the two Regions was attempted utilising equation 5.3:

\[ P_{lt} = \beta_0 + \beta_1 IA_{fc,1}L_t + \beta_2 TYPE_t + \beta_3 IC.TYPE_t + \beta_4 REGION_t + \beta_5 IC.REGION_t + u_{lt} \]  

Where

\[ IA_{fc,1}L_t = \] Annual infrastructure charge adopted on a per lot basis, based on year of sale of lot, lagged by one year

\[ TYPE = \] Dummy variable indicating whether the house is New (1) or Existing (0)

\[ REGION = \] Dummy variable indicating whether the house is on Brisbane Southside (1) or Northside (0)

However these results were unsatisfactory, and upon reflection was likely due to there being no direct interaction between the southside and northside housing markets. Hence this analysis was not included in the final models.

Lastly a separate regression for Brisbane Lot prices was run utilising Equation 4.1, however dropping the structural elements (apart from lot area) which become superfluous when no house is yet constructed on the lot.
The results of the regressions from the final models and discussion on the findings are provided in the following chapter.

5.6 CHAPTER SUMMARY

The purpose of this chapter has been to describe the methodological approach, data and model adopted for use in estimating the effect of infrastructure charges on house prices in Brisbane.

After encountering some difficulty, infrastructure charge data from two regions in the State capital of Brisbane was sourced, enabling analysis of the effect of infrastructure charges on all, new and existing housing, as well as the effect on vacant residential lots.

Drawing on the thematic conclusions of the exploratory Stage 1 research, the quantitative component of this study was able to be conceptualised. A hedonic approach has been utilised as it is a well established approach for which interpretation is relatively straightforward.

The limitations of the adopted approach are acknowledged in the following chapter, however this study is an important first step in addressing the research gap that exists in this area. This model is the first of its kind in Australia that seeks to provide empirical evidence of the effect of infrastructure charges on housing affordability.
Chapter 6: Stage 2 Findings

6.1 INTRODUCTION

The purpose of this chapter is to complete the Stage 2 component of this thesis. It presents the findings of the quantitative component of this study into the impact of infrastructure charges on house prices and lot prices in Brisbane, Australia. In so doing, this chapter addresses the final research question of this thesis:

4. What is the impact of infrastructure charges on the price of housing in Australia?

Firstly this chapter outlines the regression results for houses in section 6.2 and then vacant residential lots in section 6.3. A discussion on these findings is presented in section 6.4. Section 6.5 outlines the limitations of this research and the chapter concludes in section 6.6.
6.2 REGRESSION RESULTS – HOUSES

The final data set for this study comprised a total 29,752 house sales in Brisbane from 2005 - 2011, comprising 4,699 new and 25,053 existing house sales and 13,739 lot sales. As indicated in the previous chapter, a model for house prices in Brisbane was run firstly for the pooled data set (All houses). Separate models for both New and Existing houses were run and lastly the interaction between house type (New or Existing) was then tested. The regression results for each of the final models are indicated below.

6.2.1 Step-Wise Process

A step-wise approach was adopted to test the additional predictive value of the model upon the inclusion of more independent variables (Washington et al., 2011). The structural elements were regressed initially, with locational elements added in a second step, then the jurisdictional and government (policy) elements added in the final step. The model summary for the step-wise process using the All Brisbane house data are indicated in Table 6.1.

Table 6.1

<table>
<thead>
<tr>
<th>Model</th>
<th>R</th>
<th>Adjusted R Square</th>
<th>Std Error of Estimates</th>
<th>R^2 Change</th>
<th>F Change</th>
<th>df1</th>
<th>df2</th>
<th>Sig. F change</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.683^a</td>
<td>.467</td>
<td>.467</td>
<td>108443.541</td>
<td>.467</td>
<td>5210.0</td>
<td>5</td>
<td>29746</td>
</tr>
<tr>
<td>2</td>
<td>.743^b</td>
<td>.552</td>
<td>.552</td>
<td>99457.403</td>
<td>.085</td>
<td>1873.6</td>
<td>3</td>
<td>29743</td>
</tr>
<tr>
<td>3</td>
<td>.756^c</td>
<td>.572</td>
<td>.571</td>
<td>97222.509</td>
<td>.020</td>
<td>173.89</td>
<td>8</td>
<td>29735</td>
</tr>
</tbody>
</table>

a. Predictors: (Constant), Type, Carparks, Area, Bedrooms, Bathrooms (Structural)
b. Predictors: (Constant), Type, Carparks, Area, Bedrooms, Bathrooms, Year, Region, SEIFA (Structural + Locational)
c. Predictors: (Constant), Type, Carparks, Area, Bedrooms, Bathrooms, Year, Region, SEIFA, A_Cci, A_Css, AC_Inc, AC_Bul, IA_ifc_1L, AC_Pop, A_Mgr, A_Upr (Structural + Locational+ Jurisdictional + Policy)
d. Dependent Variable: IA_Price

These findings indicate that the predictive qualities of the house price model improve as the additional independent variables are added, as would be expected. This process was followed for each of the regressions performed.
6.2.2 All House Prices

The regression results for the pooled data set for Brisbane houses are provided in Table 6.2. All outputs are of the expected sign and significance at five percent with the exception of building approvals (significance only) and consumer sentiment (sign and significance). Unemployment is significant at seven percent.

The independent variables of building approvals, consumer confidence and unemployment are problematic in all models due to their high multicolinearity, which is a feature of the observational nature of the data. On one hand it is tempting to remove these variables from the models all together. However that leaves one open to criticism of potential omitted variable bias. A number of the extant studies omit variables that theory would indicate have an impact on house prices. It is unknown as to whether these variables were purposefully excluded in those models due to similar multicolinearity issues, or omitted in the model design process. In this instance, the decision was made to leave these variables in the models despite their apparent lack of statistical significance due to a combination of factors: firstly, whilst the jurisdictional variables add to the predictive value of the model, their contribution is incremental rather than substantial. Secondly, these variables are consistent with house price theory and for them to remain avoids criticisms of omitted variable bias. Thirdly, the variables in question are not the direct subject of this research; and finally given highly correlated variables may not necessarily cause estimation problems, it is commonplace to leave them in a model, particularly one that relies on observational data (Washington et al., 2011).

Moving on to the regression results, given the linear nature of our model, the interpretation of the infrastructure charge coefficient (IA_Ifc_1L) output of 3.952 together with a significance of .000, this indicates that these results provide strong evidence that a $1.00 increase in infrastructure charges increases all house prices in Brisbane by $3.95.
Table 6.2
Regression Results – Brisbane Houses

<table>
<thead>
<tr>
<th>Model</th>
<th>Beta</th>
<th>t</th>
<th>Sig.</th>
<th>Lower Bound*</th>
<th>Upper Bound*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>(Constant)</td>
<td>71170.133</td>
<td>22.120</td>
<td>.000</td>
<td>64863.908</td>
</tr>
<tr>
<td>Area</td>
<td>141.856</td>
<td>71.420</td>
<td>.000</td>
<td>137.963</td>
<td>145.750</td>
</tr>
<tr>
<td>Bedrooms</td>
<td>32808.207</td>
<td>30.774</td>
<td>.000</td>
<td>30718.635</td>
<td>34897.778</td>
</tr>
<tr>
<td>Bathrooms</td>
<td>89582.075</td>
<td>70.089</td>
<td>.000</td>
<td>87076.915</td>
<td>92087.236</td>
</tr>
<tr>
<td>Carparks</td>
<td>9939.191</td>
<td>10.960</td>
<td>.000</td>
<td>8161.724</td>
<td>11716.658</td>
</tr>
<tr>
<td>Type</td>
<td>34338.842</td>
<td>19.099</td>
<td>.000</td>
<td>30814.854</td>
<td>37862.830</td>
</tr>
<tr>
<td>2</td>
<td>(Constant)</td>
<td>-31193538.821</td>
<td>-44.497</td>
<td>.000</td>
<td>-32567566.003</td>
</tr>
<tr>
<td>Area</td>
<td>148.572</td>
<td>80.737</td>
<td>.000</td>
<td>144.965</td>
<td>152.179</td>
</tr>
<tr>
<td>Bedrooms</td>
<td>26844.006</td>
<td>27.341</td>
<td>.000</td>
<td>24919.589</td>
<td>28768.424</td>
</tr>
<tr>
<td>Bathrooms</td>
<td>71547.331</td>
<td>59.308</td>
<td>.000</td>
<td>69182.815</td>
<td>73911.846</td>
</tr>
<tr>
<td>Carparks</td>
<td>10266.891</td>
<td>12.295</td>
<td>.000</td>
<td>8630.169</td>
<td>11903.614</td>
</tr>
<tr>
<td>Type</td>
<td>32969.576</td>
<td>19.736</td>
<td>.000</td>
<td>29695.311</td>
<td>36243.841</td>
</tr>
<tr>
<td>SEIFA</td>
<td>14289.998</td>
<td>56.074</td>
<td>.000</td>
<td>13790.494</td>
<td>14789.502</td>
</tr>
<tr>
<td>Region</td>
<td>48922.196</td>
<td>39.258</td>
<td>.000</td>
<td>46479.670</td>
<td>51364.722</td>
</tr>
<tr>
<td>Year</td>
<td>15534.325</td>
<td>44.487</td>
<td>.000</td>
<td>14849.900</td>
<td>16218.749</td>
</tr>
<tr>
<td>3</td>
<td>(Constant)</td>
<td>-14289656.089</td>
<td>-4.368</td>
<td>.000</td>
<td>-20702008.705</td>
</tr>
<tr>
<td>Area</td>
<td>147.350</td>
<td>81.866</td>
<td>.000</td>
<td>143.822</td>
<td>150.878</td>
</tr>
<tr>
<td>Bedrooms</td>
<td>26614.412</td>
<td>27.729</td>
<td>.000</td>
<td>24733.140</td>
<td>28495.684</td>
</tr>
<tr>
<td>Bathrooms</td>
<td>71745.412</td>
<td>60.830</td>
<td>.000</td>
<td>69433.668</td>
<td>74057.156</td>
</tr>
<tr>
<td>Carparks</td>
<td>10617.273</td>
<td>13.004</td>
<td>.000</td>
<td>9016.939</td>
<td>12217.608</td>
</tr>
<tr>
<td>Type</td>
<td>31499.814</td>
<td>19.376</td>
<td>.000</td>
<td>28295.007</td>
<td>34704.621</td>
</tr>
<tr>
<td>SEIFA</td>
<td>14396.730</td>
<td>57.781</td>
<td>.000</td>
<td>13908.361</td>
<td>14885.998</td>
</tr>
<tr>
<td>Region</td>
<td>53643.331</td>
<td>6.675</td>
<td>.000</td>
<td>37892.328</td>
<td>69394.334</td>
</tr>
<tr>
<td>Year</td>
<td>7211.509</td>
<td>4.447</td>
<td>.000</td>
<td>4032.694</td>
<td>10390.323</td>
</tr>
<tr>
<td>AC_Inc</td>
<td>5791.733</td>
<td>3.011</td>
<td>.003</td>
<td>2022.074</td>
<td>9561.392</td>
</tr>
<tr>
<td>AC_Pop</td>
<td>15909.311</td>
<td>2.968</td>
<td>.003</td>
<td>5402.143</td>
<td>26416.479</td>
</tr>
<tr>
<td>AC_Bul</td>
<td>-198.914</td>
<td>-.702</td>
<td>.483</td>
<td>-754.157</td>
<td>356.328</td>
</tr>
<tr>
<td>A_Upr</td>
<td>-13641.419</td>
<td>-1.806</td>
<td>.071</td>
<td>-28450.071</td>
<td>1167.234</td>
</tr>
<tr>
<td>A_Cci</td>
<td>10284.451</td>
<td>5.009</td>
<td>.000</td>
<td>6259.936</td>
<td>14308.967</td>
</tr>
<tr>
<td>A_Mgr</td>
<td>-36982.961</td>
<td>-4.884</td>
<td>.000</td>
<td>-51823.465</td>
<td>-22142.456</td>
</tr>
<tr>
<td>A_Css</td>
<td>-320.210</td>
<td>-939</td>
<td>.348</td>
<td>-988.604</td>
<td>348.184</td>
</tr>
<tr>
<td>IA_Hc_1L</td>
<td>3.952</td>
<td>7.417</td>
<td>.000</td>
<td>2.907</td>
<td>4.996</td>
</tr>
</tbody>
</table>

*95.0% Confidence Interval
6.2.3 Existing House Prices

Next, the data set was split by Type to test the difference in house price impacts due to infrastructure charges between existing housing and new housing. The literature indicates infrastructure charges have a higher inflationary effect on existing housing compared to new housing. Whilst a higher level of overpassing is consistently observed in the literature (Existing compared to New) the degree to which this overpassing effect is amplified varies considerably between studies. Little theory or rationale is presented as to why infrastructure charges increase existing house prices by more than new house prices.

The stepwise procedure was again followed with the results indicating an improving predictive quality of the model as the jurisdictional and policy variables are added as indicated below. The variable Type is removed as it is superfluous.

Table 6.3
Step Wise Process Model Summary- Existing Houses\

<table>
<thead>
<tr>
<th>Model</th>
<th>R</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std Error of Estimates</th>
<th>R^2 Change</th>
<th>F Change</th>
<th>df1</th>
<th>df2</th>
<th>Sig. F change</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.687a</td>
<td>.472</td>
<td>.472</td>
<td>107759.635</td>
<td>.472</td>
<td>5596.127</td>
<td>4</td>
<td>25048</td>
<td>.000</td>
</tr>
<tr>
<td>2</td>
<td>.750b</td>
<td>.563</td>
<td>.562</td>
<td>98082.742</td>
<td>.091</td>
<td>1729.770</td>
<td>3</td>
<td>25045</td>
<td>.000</td>
</tr>
<tr>
<td>3</td>
<td>.764c</td>
<td>.583</td>
<td>.583</td>
<td>95759.229</td>
<td>.021</td>
<td>154.767</td>
<td>8</td>
<td>25037</td>
<td>.000</td>
</tr>
</tbody>
</table>

a. Predictors: (Constant), Carparks, Area, Bedrooms, Bathrooms [Structural]
b. Predictors: (Constant), Carparks, Area, Bedrooms, Bathrooms, Year, Region, SEIFA (Structural + Locational)
c. Predictors: (Constant), Carparks, Area, Bedrooms, Bathrooms, Year, Region, SEIFA, A_Cci, A_Css, AC_Inc, AC_Bul, IA_Ifc_1L, AC_Pop, A_Mgr, A_Upr (Structural + Locational + Jurisdictional + Policy)
d. Dependent Variable: IA_Price

The regression results for the 25,053 Existing house data set is provided in Table 6.4. All outputs are of the expected sign and significance at five percent with the exception of building approvals (both sign and significance), unemployment (significance only) and consumer confidence (sign only).

Given the linear nature of our model, the interpretation of the infrastructure charge coefficient (IA_Ifc_1L) output of 3.565 and significance of .000, this indicates that these results provide strong evidence that a $1.00 increase in infrastructure charges increases existing house prices in Brisbane by $3.56.
Table 6.4  
*Regression Results – Existing Houses*

<table>
<thead>
<tr>
<th>Model</th>
<th>Beta</th>
<th>t</th>
<th>Sig.</th>
<th>Lower Bound*</th>
<th>Upper Bound*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (Constant)</td>
<td>76752.470</td>
<td>22.662</td>
<td>.000</td>
<td>70114.178</td>
<td>83390.762</td>
</tr>
<tr>
<td>Area</td>
<td>139.140</td>
<td>68.522</td>
<td>.000</td>
<td>135.160</td>
<td>143.120</td>
</tr>
<tr>
<td>Bedrooms</td>
<td>32926.410</td>
<td>29.167</td>
<td>.000</td>
<td>30713.692</td>
<td>35139.128</td>
</tr>
<tr>
<td>Bathrooms</td>
<td>87624.612</td>
<td>65.123</td>
<td>.000</td>
<td>84987.296</td>
<td>90261.928</td>
</tr>
<tr>
<td>Carparks</td>
<td>9567.893</td>
<td>10.267</td>
<td>.000</td>
<td>7741.338</td>
<td>11394.447</td>
</tr>
<tr>
<td>2 (Constant)</td>
<td>-31795355.4</td>
<td>-42.39</td>
<td>.000</td>
<td>-33265479.3</td>
<td>-30325231.5</td>
</tr>
<tr>
<td>Area</td>
<td>146.358</td>
<td>78.335</td>
<td>.000</td>
<td>142.696</td>
<td>150.020</td>
</tr>
<tr>
<td>Bedrooms</td>
<td>26521.479</td>
<td>25.704</td>
<td>.000</td>
<td>24499.095</td>
<td>28543.863</td>
</tr>
<tr>
<td>Bathrooms</td>
<td>68516.353</td>
<td>54.144</td>
<td>.000</td>
<td>66036.015</td>
<td>70996.692</td>
</tr>
<tr>
<td>SEIFA</td>
<td>10029.803</td>
<td>11.761</td>
<td>.000</td>
<td>8358.246</td>
<td>11701.360</td>
</tr>
<tr>
<td>SEIFA</td>
<td>14724.433</td>
<td>54.739</td>
<td>.000</td>
<td>14197.195</td>
<td>15251.671</td>
</tr>
<tr>
<td>Year</td>
<td>15836.439</td>
<td>42.387</td>
<td>.000</td>
<td>15104.128</td>
<td>16568.749</td>
</tr>
<tr>
<td>Region</td>
<td>50179.764</td>
<td>37.402</td>
<td>.000</td>
<td>47550.117</td>
<td>52809.411</td>
</tr>
<tr>
<td>3 (Constant)</td>
<td>-18532657.4</td>
<td>-5.277</td>
<td>.000</td>
<td>-25416832.2</td>
<td>-11648482.6</td>
</tr>
<tr>
<td>Area</td>
<td>145.258</td>
<td>79.592</td>
<td>.000</td>
<td>141.680</td>
<td>148.835</td>
</tr>
<tr>
<td>Bedrooms</td>
<td>26462.432</td>
<td>26.268</td>
<td>.000</td>
<td>24487.873</td>
<td>28436.991</td>
</tr>
<tr>
<td>Bathrooms</td>
<td>68817.871</td>
<td>55.692</td>
<td>.000</td>
<td>66395.850</td>
<td>71239.892</td>
</tr>
<tr>
<td>SEIFA</td>
<td>10378.336</td>
<td>12.461</td>
<td>.000</td>
<td>8745.863</td>
<td>12010.810</td>
</tr>
<tr>
<td>SEIFA</td>
<td>14749.258</td>
<td>56.156</td>
<td>.000</td>
<td>14234.448</td>
<td>15264.068</td>
</tr>
<tr>
<td>Year</td>
<td>9301.686</td>
<td>5.343</td>
<td>.000</td>
<td>5889.205</td>
<td>12714.167</td>
</tr>
<tr>
<td>Region</td>
<td>45712.234</td>
<td>3.536</td>
<td>.000</td>
<td>28921.032</td>
<td>62503.436</td>
</tr>
<tr>
<td>AC_Inc</td>
<td>4333.978</td>
<td>2.087</td>
<td>.037</td>
<td>262.205</td>
<td>8385.750</td>
</tr>
<tr>
<td>AC_Pop</td>
<td>16448.521</td>
<td>2.837</td>
<td>.005</td>
<td>5085.394</td>
<td>27811.647</td>
</tr>
<tr>
<td>AC_Bul</td>
<td>229.834</td>
<td>.757</td>
<td>.449</td>
<td>-365.021</td>
<td>824.689</td>
</tr>
<tr>
<td>A_Upr</td>
<td>-2775.518</td>
<td>-3.42</td>
<td>.732</td>
<td>-18677.966</td>
<td>13126.931</td>
</tr>
<tr>
<td>A_Cci</td>
<td>10471.111</td>
<td>4.756</td>
<td>.000</td>
<td>6156.101</td>
<td>14786.120</td>
</tr>
<tr>
<td>A_Mgr</td>
<td>-27883.372</td>
<td>-3.412</td>
<td>.001</td>
<td>-43903.279</td>
<td>-11863.466</td>
</tr>
<tr>
<td>A_Css</td>
<td>-705.090</td>
<td>-1.912</td>
<td>.056</td>
<td>-1428.071</td>
<td>17.890</td>
</tr>
<tr>
<td>IA_Ifc_1L</td>
<td>3.565</td>
<td>6.266</td>
<td>.000</td>
<td>2.450</td>
<td>4.680</td>
</tr>
</tbody>
</table>

*95.0% Confidence Interval
6.2.4 New House Prices

The same process was then applied to the 4,699 New house data set. The stepwise procedure was again followed with the results indicating an improving predictive quality of the model as the jurisdictional and policy variables are added as indicated below. The variable Type is removed as it is superfluous.

Table 6.5

*Step Wise Process Model Summary- New Houses*<sup>d</sup>

<table>
<thead>
<tr>
<th>Model</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std Error of Estimates</th>
<th>R&lt;sup&gt;2&lt;/sup&gt; Change</th>
<th>F Change</th>
<th>df1</th>
<th>df2</th>
<th>Sig. F change</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.602&lt;sup&gt;b&lt;/sup&gt;</td>
<td>.363</td>
<td>.362</td>
<td>110910.394</td>
<td>.363</td>
<td>667.508</td>
<td>4</td>
<td>4694</td>
</tr>
<tr>
<td>2</td>
<td>.657&lt;sup&gt;c&lt;/sup&gt;</td>
<td>.431</td>
<td>.430</td>
<td>104810.919</td>
<td>.069</td>
<td>188.411</td>
<td>3</td>
<td>4691</td>
</tr>
<tr>
<td>3</td>
<td>.671&lt;sup&gt;d&lt;/sup&gt;</td>
<td>.451</td>
<td>.449</td>
<td>103083.167</td>
<td>.020</td>
<td>20.821</td>
<td>8</td>
<td>4683</td>
</tr>
</tbody>
</table>

a. Predictors: (Constant), Carparks, Area, Bedrooms, Bathrooms (Structural)
b. Predictors: (Constant), Carparks, Area, Bedrooms, Bathrooms, Year, Region, SEIFA (Structural + Locational)
c. Predictors: (Constant), Carparks, Area, Bedrooms, Bathrooms, Year, Region, SEIFA, A_Cci, A_Css, AC_Inc, AC_Bul, IA_Ifc_1L, AC_Pop, A_Mgr, A_Upr (Structural + Locational + Jurisdictional + Policy)
d. Dependent Variable: IA_Price

The regression results for the New house data set is provided in Table 6.6. All outputs are of the expected sign and significance at five percent with the exception again of building approvals (both sign and significance), unemployment (significance only) and consumer confidence (sign only).

Given the linear nature of our model, the interpretation of the infrastructure charge coefficient (IA_Ifc_1L) output of 4.694 and significance of .002, this indicates that these results provide strong evidence that a $1.00 increase in infrastructure charges increases new house prices in Brisbane by $4.69.
### Table 6.6
**Regression Results – New Houses**

<table>
<thead>
<tr>
<th>Model</th>
<th>Beta</th>
<th>t</th>
<th>Sig.</th>
<th>Lower Bound*</th>
<th>Upper Bound*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>(Constant)</td>
<td>37191.848</td>
<td>3.466</td>
<td>.001</td>
<td>16156.191</td>
</tr>
<tr>
<td></td>
<td>Area</td>
<td>195.553</td>
<td>22.305</td>
<td>.000</td>
<td>178.365</td>
</tr>
<tr>
<td></td>
<td>Bedrooms</td>
<td>27913.613</td>
<td>8.441</td>
<td>.000</td>
<td>21430.178</td>
</tr>
<tr>
<td></td>
<td>Bathrooms</td>
<td>113806.119</td>
<td>27.878</td>
<td>.000</td>
<td>105803.054</td>
</tr>
<tr>
<td></td>
<td>Carparks</td>
<td>12963.587</td>
<td>3.435</td>
<td>.001</td>
<td>5565.084</td>
</tr>
<tr>
<td></td>
<td>(Constant)</td>
<td>-29036230.566</td>
<td>-</td>
<td>-15.149</td>
<td>-32793836.877</td>
</tr>
<tr>
<td>2</td>
<td>Area</td>
<td>199.891</td>
<td>23.675</td>
<td>.000</td>
<td>183.338</td>
</tr>
<tr>
<td></td>
<td>Bedrooms</td>
<td>25227.309</td>
<td>8.007</td>
<td>.000</td>
<td>19050.826</td>
</tr>
<tr>
<td></td>
<td>Bathrooms</td>
<td>103082.912</td>
<td>26.516</td>
<td>.000</td>
<td>95461.476</td>
</tr>
<tr>
<td></td>
<td>Carparks</td>
<td>11579.638</td>
<td>3.245</td>
<td>.001</td>
<td>4584.681</td>
</tr>
<tr>
<td></td>
<td>SEIFA</td>
<td>12029.572</td>
<td>15.396</td>
<td>.000</td>
<td>10497.725</td>
</tr>
<tr>
<td></td>
<td>Year</td>
<td>14441.131</td>
<td>15.126</td>
<td>.000</td>
<td>12569.407</td>
</tr>
<tr>
<td></td>
<td>Region</td>
<td>41703.515</td>
<td>12.521</td>
<td>.000</td>
<td>35173.778</td>
</tr>
<tr>
<td></td>
<td>(Constant)</td>
<td>-1231169.278</td>
<td>-1.37</td>
<td>.017</td>
<td>-18909580.924</td>
</tr>
<tr>
<td></td>
<td>Area</td>
<td>193.080</td>
<td>23.103</td>
<td>.000</td>
<td>176.696</td>
</tr>
<tr>
<td>3</td>
<td>Bedrooms</td>
<td>24003.477</td>
<td>7.737</td>
<td>.000</td>
<td>17921.101</td>
</tr>
<tr>
<td></td>
<td>Bathrooms</td>
<td>102232.747</td>
<td>26.703</td>
<td>.000</td>
<td>94727.034</td>
</tr>
<tr>
<td></td>
<td>Carparks</td>
<td>12434.172</td>
<td>3.539</td>
<td>.000</td>
<td>5545.413</td>
</tr>
<tr>
<td></td>
<td>SEIFA</td>
<td>12442.444</td>
<td>16.109</td>
<td>.000</td>
<td>10928.161</td>
</tr>
<tr>
<td></td>
<td>Year</td>
<td>777.255</td>
<td>1.74</td>
<td>.042</td>
<td>-7984.808</td>
</tr>
<tr>
<td></td>
<td>Region</td>
<td>89928.398</td>
<td>3.910</td>
<td>.000</td>
<td>44833.248</td>
</tr>
<tr>
<td></td>
<td>AC_Inc</td>
<td>12479.622</td>
<td>2.409</td>
<td>.016</td>
<td>2321.766</td>
</tr>
<tr>
<td></td>
<td>AC_Pop</td>
<td>16419.595</td>
<td>1.170</td>
<td>.242</td>
<td>-11083.955</td>
</tr>
<tr>
<td></td>
<td>AC_Bul</td>
<td>-1945.120</td>
<td>-2.429</td>
<td>.015</td>
<td>-3515.362</td>
</tr>
<tr>
<td></td>
<td>A_Upr</td>
<td>-54317.090</td>
<td>-2.563</td>
<td>.010</td>
<td>-95869.475</td>
</tr>
<tr>
<td></td>
<td>A_Cci</td>
<td>9469.512</td>
<td>1.683</td>
<td>.092</td>
<td>-1560.995</td>
</tr>
<tr>
<td></td>
<td>A_Mgr</td>
<td>-72085.602</td>
<td>-3.508</td>
<td>.000</td>
<td>-112373.233</td>
</tr>
<tr>
<td></td>
<td>A_Css</td>
<td>1283.543</td>
<td>1.402</td>
<td>.161</td>
<td>-511.572</td>
</tr>
<tr>
<td></td>
<td>IA_ifc_1L</td>
<td>4.694</td>
<td>3.126</td>
<td>.002</td>
<td>1.750</td>
</tr>
</tbody>
</table>

*95.0% Confidence Interval
6.2.5 Interaction between Existing and New House Prices

Finally, the pooled data set was used to test if there was an interaction effect of house price impacts due to infrastructure charges between Existing housing and New housing. This is relevant as infrastructure charges are only levied on new housing, and yet evidence has emerged of an inflationary price effect on both new and existing housing, consistent with the literature. A two-way interaction utilising the Type dummy was employed as described in the previous chapter (see equation 5.2).

The stepwise procedure was again followed for consistency with the results indicating an improving predictive quality of the model as the jurisdictional and policy variables are added as indicated below.

Table 6.7

<p>| Step Wise Process Model Summary- Two-Way Interaction: Existing and New Houses |
|---------------------------------------------|----------------|-----------------|----------------|--------------------|</p>
<table>
<thead>
<tr>
<th>Model</th>
<th>R</th>
<th>Adjusted R</th>
<th>Std Error of Estimates</th>
<th>R² Change</th>
<th>F Change</th>
<th>df1</th>
<th>df2</th>
<th>Sig. F change</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.683a</td>
<td>.467</td>
<td>.467</td>
<td>108443.541</td>
<td>.467</td>
<td>5210.0</td>
<td>5</td>
<td>29746</td>
</tr>
<tr>
<td>2</td>
<td>.743b</td>
<td>.552</td>
<td>.552</td>
<td>99457.403</td>
<td>.085</td>
<td>1873.6</td>
<td>3</td>
<td>29743</td>
</tr>
<tr>
<td>3</td>
<td>.756c</td>
<td>.572</td>
<td>.572</td>
<td>97213.027</td>
<td>.020</td>
<td>155.35</td>
<td>9</td>
<td>29735</td>
</tr>
</tbody>
</table>

The regression results for the pooled data set for Brisbane are provided in Table 6.8. All outputs are of the expected sign and significance at five percent probability, again with the exception of building approvals (significance only) and consumer sentiment (sign and significance) and unemployment significant at ten percent.

Interpretation of these outputs requires reference to Equation 5.2. This result provides evidence that a $1.00 increase in infrastructure charges increases existing house prices by $4.04 ($B_1 = IA_{Ifc\_1L}$) and new house prices by $3.14 ($B_1 + B_3 = IA_{Ifc\_1L} + IC_{Typ}$). This interaction result is of a similar scale to the earlier findings of both the pooled data set and separated data sets (ie. New and Existing)
and hence provides further evidence that the scale of overpassing of infrastructure charges to house prices (both new and existing houses) is in the order of 300% - 400% overpassing. These findings are discussed further in Section 6.4.

Table 6.8
Regression Results – Two-Way Interaction: Existing and New Houses

<table>
<thead>
<tr>
<th>Model</th>
<th>Beta</th>
<th>t</th>
<th>Sig.</th>
<th>Lower Bound*</th>
<th>Upper Bound*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>(Constant)</td>
<td>71170.133</td>
<td>22.120</td>
<td>.000</td>
<td>64863.908</td>
</tr>
<tr>
<td></td>
<td>Area</td>
<td>141.856</td>
<td>71.420</td>
<td>.000</td>
<td>137.963</td>
</tr>
<tr>
<td></td>
<td>Bedrooms</td>
<td>32808.207</td>
<td>30.774</td>
<td>.000</td>
<td>30718.635</td>
</tr>
<tr>
<td></td>
<td>Bathrooms</td>
<td>89582.075</td>
<td>70.089</td>
<td>.000</td>
<td>87076.915</td>
</tr>
<tr>
<td></td>
<td>Carparks</td>
<td>9939.191</td>
<td>10.960</td>
<td>.000</td>
<td>8161.724</td>
</tr>
<tr>
<td></td>
<td>Type</td>
<td>34338.842</td>
<td>19.099</td>
<td>.000</td>
<td>30814.854</td>
</tr>
<tr>
<td>2</td>
<td>(Constant)</td>
<td>-31193538.821</td>
<td>-44.49</td>
<td>.000</td>
<td>-32567566.003</td>
</tr>
<tr>
<td></td>
<td>Area</td>
<td>148.572</td>
<td>80.737</td>
<td>.000</td>
<td>144.965</td>
</tr>
<tr>
<td></td>
<td>Bedrooms</td>
<td>26844.006</td>
<td>27.341</td>
<td>.000</td>
<td>24919.589</td>
</tr>
<tr>
<td></td>
<td>Bathrooms</td>
<td>71547.331</td>
<td>70.089</td>
<td>.000</td>
<td>69182.815</td>
</tr>
<tr>
<td></td>
<td>Carparks</td>
<td>10266.891</td>
<td>12.295</td>
<td>.000</td>
<td>8630.169</td>
</tr>
<tr>
<td></td>
<td>Type</td>
<td>32969.576</td>
<td>19.736</td>
<td>.000</td>
<td>29695.311</td>
</tr>
<tr>
<td></td>
<td>SEIFA</td>
<td>14289.998</td>
<td>56.074</td>
<td>.000</td>
<td>13790.494</td>
</tr>
<tr>
<td></td>
<td>Region</td>
<td>48922.196</td>
<td>44.487</td>
<td>.000</td>
<td>46479.670</td>
</tr>
<tr>
<td></td>
<td>Year</td>
<td>15534.325</td>
<td>44.487</td>
<td>.000</td>
<td>14849.900</td>
</tr>
<tr>
<td>3</td>
<td>(Constant)</td>
<td>-14617444.888</td>
<td>-4.465</td>
<td>.000</td>
<td>-21033903.282</td>
</tr>
<tr>
<td></td>
<td>Area</td>
<td>147.355</td>
<td>81.877</td>
<td>.000</td>
<td>143.827</td>
</tr>
<tr>
<td></td>
<td>Bedrooms</td>
<td>26603.391</td>
<td>27.341</td>
<td>.000</td>
<td>24722.285</td>
</tr>
<tr>
<td></td>
<td>Bathrooms</td>
<td>71735.855</td>
<td>60.828</td>
<td>.000</td>
<td>69424.325</td>
</tr>
<tr>
<td></td>
<td>Carparks</td>
<td>10642.098</td>
<td>13.035</td>
<td>.000</td>
<td>9041.810</td>
</tr>
<tr>
<td></td>
<td>Type</td>
<td>41926.809</td>
<td>9.706</td>
<td>.000</td>
<td>33460.255</td>
</tr>
<tr>
<td></td>
<td>SEIFA</td>
<td>14407.629</td>
<td>57.822</td>
<td>.000</td>
<td>13919.240</td>
</tr>
<tr>
<td></td>
<td>Region</td>
<td>53026.044</td>
<td>44.487</td>
<td>.000</td>
<td>46479.670</td>
</tr>
<tr>
<td></td>
<td>Year</td>
<td>7371.028</td>
<td>4.542</td>
<td>.000</td>
<td>4190.263</td>
</tr>
<tr>
<td></td>
<td>AC_Inc</td>
<td>5646.766</td>
<td>2.935</td>
<td>.003</td>
<td>1875.900</td>
</tr>
<tr>
<td></td>
<td>AC_Pop</td>
<td>16097.713</td>
<td>3.003</td>
<td>.003</td>
<td>5590.616</td>
</tr>
<tr>
<td></td>
<td>AC_Bul</td>
<td>-160.967</td>
<td>-1.568</td>
<td>.120</td>
<td>-216.687</td>
</tr>
<tr>
<td></td>
<td>A_Upr</td>
<td>-12552.951</td>
<td>-1.659</td>
<td>.097</td>
<td>-27382.740</td>
</tr>
<tr>
<td></td>
<td>A_Cci</td>
<td>10250.941</td>
<td>4.993</td>
<td>.000</td>
<td>6226.739</td>
</tr>
<tr>
<td></td>
<td>A_Mgr</td>
<td>-36004.428</td>
<td>-4.750</td>
<td>.000</td>
<td>-50861.699</td>
</tr>
<tr>
<td></td>
<td>A_Css</td>
<td>-359.735</td>
<td>-1.054</td>
<td>.292</td>
<td>-1028.723</td>
</tr>
<tr>
<td></td>
<td>IA_Ifc_1L</td>
<td>4.044</td>
<td>7.575</td>
<td>.000</td>
<td>2.998</td>
</tr>
<tr>
<td></td>
<td>IC_Typ</td>
<td>-902</td>
<td>-2.608</td>
<td>.009</td>
<td>-1.580</td>
</tr>
</tbody>
</table>

*95.0% Confidence Interval
6.3 REGRESSION RESULTS – LOTS

6.3.1 Step-Wise Process

As indicated previously, a step-wise approach was adopted to test the additional predictive value of the model upon the inclusion of more independent variables. This process was also followed for analysis of the Lot sales for consistency. The structural elements were regressed initially, with locational elements added in a second step, then the jurisdictional and government (policy) elements added in the final step. The results of the process using 13,739 Brisbane Lot data are indicated in Table 6.9 below.

Table 6.9
Step Wise Process Model Summary– Lots

<table>
<thead>
<tr>
<th>Model</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std Error of Estimates</th>
<th>R^2 Change</th>
<th>F Change</th>
<th>df1</th>
<th>df2</th>
<th>Sig. F change</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.571^a</td>
<td>.326</td>
<td>.326</td>
<td>.326</td>
<td>6649.6</td>
<td>1</td>
<td>13737</td>
<td>.000</td>
</tr>
<tr>
<td>2</td>
<td>.631^b</td>
<td>.399</td>
<td>.398</td>
<td>.072</td>
<td>551.82</td>
<td>3</td>
<td>13734</td>
<td>.000</td>
</tr>
<tr>
<td>3</td>
<td>.641^c</td>
<td>.411</td>
<td>.411</td>
<td>.013</td>
<td>36.821</td>
<td>8</td>
<td>13726</td>
<td>.000</td>
</tr>
</tbody>
</table>

a. Predictors: (Constant), Area, (Structural)
b. Predictors: (Constant), Area, Region, SEIFA, Year (Structural + Locational)
c. Predictors: (Constant), Area, Region, SEIFA, Year, A_Cci, A_Css, AC_Inc, AC_Bul, IA_Ifc_1L, AC_Pop, A_Mgr, A_Upr (Structural + Locational+ Jurisdictional + Policy)
d. Dependent Variable: IA_Price

Structural variables relating to house characteristics are dropped as this model relates to the price of subdivided and serviced vacant residential lots only. These findings indicate that the predictive qualities of the lot price model improve as the additional independent variables are added, as would be expected, albeit with a lower initial adjusted R^2 and lower incremental effect thereafter when compared to the preceding house models. This is not unexpected as vacant lots are more homogenous in nature than the housing subsequently built upon it.

The regression results for the Lot data set for Brisbane are provided in Table 6.10. All outputs are of the expected sign and significance at five percent probability again with the exception of income, building approvals and unemployment (all sign
and significance); and the construction cost index (sign and significance at ten percent).

Given the linear nature of our model, the interpretation of the infrastructure charge coefficient (IA_Ifc_1L) output of 1.693 and significance of .008, this result provides strong evidence that a $1.00 increase in infrastructure charges increases new Lot prices in Brisbane by $1.69.

Table 6.10
Regression Results- Lots

<table>
<thead>
<tr>
<th>Model</th>
<th>Beta</th>
<th>t</th>
<th>Sig.</th>
<th>Lower Bound*</th>
<th>Upper Bound*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>(Constant)</td>
<td>164571.585</td>
<td>119.155</td>
<td>.000</td>
<td>161864.335</td>
</tr>
<tr>
<td></td>
<td>Area</td>
<td>152.427</td>
<td>81.545</td>
<td>.000</td>
<td>148.763</td>
</tr>
<tr>
<td>2</td>
<td>(Constant)</td>
<td>-21503629.850</td>
<td>-26.810</td>
<td>.000</td>
<td>-23075791.649</td>
</tr>
<tr>
<td></td>
<td>Area</td>
<td>158.724</td>
<td>89.100</td>
<td>.000</td>
<td>155.232</td>
</tr>
<tr>
<td></td>
<td>SEIFA</td>
<td>3635.625</td>
<td>9.534</td>
<td>.000</td>
<td>2888.191</td>
</tr>
<tr>
<td></td>
<td>Year</td>
<td>10767.793</td>
<td>26.963</td>
<td>.000</td>
<td>9984.996</td>
</tr>
<tr>
<td></td>
<td>Region</td>
<td>55220.188</td>
<td>36.313</td>
<td>.000</td>
<td>52239.423</td>
</tr>
<tr>
<td>3</td>
<td>(Constant)</td>
<td>-16734106.193</td>
<td>-4.422</td>
<td>.000</td>
<td>-24151369.149</td>
</tr>
<tr>
<td></td>
<td>Area</td>
<td>158.802</td>
<td>89.938</td>
<td>.000</td>
<td>155.341</td>
</tr>
<tr>
<td></td>
<td>SEIFA</td>
<td>3446.636</td>
<td>9.062</td>
<td>.000</td>
<td>2701.100</td>
</tr>
<tr>
<td></td>
<td>Year</td>
<td>8281.758</td>
<td>4.422</td>
<td>.000</td>
<td>4610.608</td>
</tr>
<tr>
<td></td>
<td>Region</td>
<td>88386.788</td>
<td>8.313</td>
<td>.000</td>
<td>67545.763</td>
</tr>
<tr>
<td></td>
<td>AC_Pop</td>
<td>43476.047</td>
<td>6.991</td>
<td>.000</td>
<td>31286.186</td>
</tr>
<tr>
<td></td>
<td>AC_Bul</td>
<td>186.173</td>
<td>.522</td>
<td>.602</td>
<td>-513.070</td>
</tr>
<tr>
<td></td>
<td>A_Upr</td>
<td>10457.635</td>
<td>1.113</td>
<td>.266</td>
<td>-7952.611</td>
</tr>
<tr>
<td></td>
<td>A_Cci</td>
<td>-4533.609</td>
<td>-1.636</td>
<td>.102</td>
<td>-9966.447</td>
</tr>
<tr>
<td></td>
<td>A_Mgr</td>
<td>20413.933</td>
<td>2.099</td>
<td>.036</td>
<td>1354.505</td>
</tr>
<tr>
<td></td>
<td>A_Css</td>
<td>-971.569</td>
<td>-2.366</td>
<td>.018</td>
<td>-1776.604</td>
</tr>
<tr>
<td></td>
<td>IA_Ifc_1L</td>
<td>1.693</td>
<td>2.633</td>
<td>.008</td>
<td>.433</td>
</tr>
</tbody>
</table>

*95.0% Confidence Interval

These findings are discussed further in the following section.
6.4 FINDINGS

6.4.1 House Prices

This study provides strong evidence that infrastructure charges in Brisbane, Queensland, after accounting for macroeconomic conditions and other factors that influence housing price, significantly increased the price of both new and existing houses during the period of 2005 to 2011, increasing house prices to a magnitude of between three to four times the cost of the infrastructure charge levied per house. This evidence supports the theory that despite infrastructure charges being levied on property developers, these supply chain costs are passed onto the end home buyer, resulting in higher house prices for all houses, and thus reducing housing affordability for all house buyers in the community. This study provides evidence that not only are infrastructure charges being passed onto consumers, they are being significantly over-passed. This finding is positive evidence in support of the research hypothesis for this thesis. Hence, as expected it is home buyers that bear the burden of infrastructure charges and are the party who is really paying for urban infrastructure.

This finding of over-passing is consistent with the literature and theory. In saying that however, there are both notable similarities and differences between the US findings and these findings for Australia. Remember it is important to consider the on-passing ratios calculated in Chapter 4 for comparison, rather than the reported findings cited in Chapter 2 that do not take into account the correct interpretation of non-linear models.

Firstly, at $3.95 for every $1.00 infrastructure charge (or 395% overpassing for All), the all house findings are approximately double the average study range quoted in the US literature of $1.50 - $1.70 (Nelson et al., 2008). Whilst this could be due to data limitations, it is also possible that is a reflection of the nature of the Australian housing market. Recall from earlier analysis that the US housing market is highly segmented, with two, three and four bedroom houses representing approximately equal proportions of the housing stock in the State of Florida (Burge, 2005). In comparison, two bedroom houses are rare in the Brisbane market even in the
established house sector, with approximately a quarter of homes having three bedrooms, and the remaining three quarters comprising four or more bedrooms\(^{51}\) (see Section 3.8.1). Burge’s (2005) findings suggested that infrastructure charge impacts were highest in the larger homes, where greater price elasticity is suggested to exist (42% onpassing for small houses versus 134% for large houses). Mathur also stratified his research to test for such differential on-passing effects. Using house quality as an independent variable (rather than house size as for Burge,) Mathur et al.’s (2004) findings also suggested higher overpassing to high quality homes (358% onpassing for high quality housing compared to 166% for average quality). Thus it could be interpreted that the Australian housing market comprises on average higher quality/larger homes than in the US and that these Australian findings are consistent with the US findings that developers can more readily pass additional costs onto higher quality housing.

The high on-passing ratio in Australia could also be a function of the uncertainty associated with a fully negotiated opaque infrastructure charging regime. During the study period, infrastructure charges were escalating rapidly resulting in general confusion and uncertainty in the wider development industry around forecast project costs (Nicholls, 2011). Conversely, in the US studies, set fees per lot were scheduled with annual increases announced in advance. Theory suggests that in a fully transparent system, such supply chain costs are able to be passed back to the land owner, and yet overpassing at a consistent level existed in all US studies undertaken. Indeed Shaughnessy’s (2003) study on land price impacts suggested that back-passing and over-passing were occurring contemporaneously, albeit with weak evidence.

A second comparative finding is that whilst the average of US studies is quoted at $1.50 - $1.70 (Nelson et al, 2008), this may not be representative of all studies. Many authors tested for the differential effects on new and existing houses, however not all authors pooled their datasets to estimate the effect on all housing in the community as was done in this study. Of the US models only Burge (2005) (72%)

\(^{51}\) Detached houses for sale in the Greater Brisbane region as at February, 2014 as listed on www.realestate.com.au
and Evan’s-Cowley et al. (2009) (537%) analysed the infrastructure charge effect on all houses. And only Evan’s-Cowley et al. (2009) then separated their dataset to further examine the differential effects on new and existing houses; a model enhancement followed by this study. This study’s findings of 395% for all houses is within the range of the findings in the literature and provides further evidence that existing home owners share the burden of infrastructure charges by way of the increased cost of existing housing (Brueckner 1997; Singell and Lillydahl 1990; Yinger 1998). Existing housing generally forms the bulk of a market and plays a central role in price setting. Existing housing may be a close substitute to new housing and if the price of new housing is increasing due to cost pressures and strong market conditions, then the price of existing housing will be drawn up as sellers capitalise on profit taking opportunities. Hence buyers of existing housing are paying for the house price impacts of infrastructure charges in new development areas, for which they either receive no benefit, or if there is a benefit (such as new road connections or upgrades) then they have not contributed to the cost of such services. This over passing to existing home owners is a windfall capital gain to existing home owners, to the detriment of housing affordability within the community whereby homes that previously might have been more affordable are dragged up in price due to their close substitutability with more expensive new homes.

Thirdly, it is relevant to compare the observed effect for new houses compared to existing houses. This study suggests the new house effects ($4.69) are higher than for existing houses ($3.56) in Australia. The results of prior studies that test the differential effect on new and existing homes are not consistent in this regard. This Australian finding is consistent with Campbell (2004) ($1.43 new and $1.07 existing). However the converse was found by Evans-Cowley et al. (2009) with existing houses significantly more impacted than new houses ($1.76 new and $6.03 existing). Both Mathur (2003) and Shaughnessy’s (2004) findings were similar for new and existing housing (Mathur: $1.34 new, $1.47 existing; Shaughnessy, $1.64 new, $1.68 existing). Thus the literature is inconsistent in regard to the differential effects between new and existing housing. Indeed, Nelson et al. (2008) questions whether overpassing does actually occur for existing houses, with the evidence to that time ranging from $1.07 (Campbell) to $1.68 (Shaughnessy). Evans-Cowley et
al.’s (2009) subsequent findings ($6.03), together with the findings from this study ($3.56) confirm that overpassing in the existing house market is indeed occurring, albeit at varying rates.

Little commentary is provided in any of the prior studies on this observation in the existing housing market. With existing housing being the predominant housing type in most housing markets, any inflationary price effects to existing housing will have an impact on housing affordability across the wider community. A possible explanation of the impact of infrastructure charges on existing houses is that the effect is a function of local housing markets and the relative substitutability of new and existing houses. In a market with good quality existing homes, new homes of a high standard might be developed to entice existing owners into new housing stock. A propensity of developers to build high quality new housing may lead to higher on-passing consistent with the findings of Burge (2005) and Mathur (2003) discussed in the prior paragraph. In such an environment, new house price effects may be higher than existing house price effects due to elasticity in the quality new home market. On the other hand, existing house prices might be affected to a large extent if the existing housing stock in a local market is of a low quality and new housing is introduced aimed at similar target markets. The price of existing housing is dragged up as home buyers exercise a preference for better located existing housing that can be cost effectively renovated, compared to newer houses built on the urban fringe. Studies that show similar findings may exist in areas with high substitutability in new and existing housing markets. Remembering that in Australia, new and existing housing are close substitutes from a services perspective as all residents have access to essentially the same level of services and amenities. In saying that, many older suburbs have the benefit of better proximity to those services.

Finally, new house effects and existing house effects in this study are close in magnitude. As can be seen from above, with the exception of Evan’s-Cowley et al.,(2009), this is consistent with the literature. Evan’s-Cowley et al.’s (2009) study incorporates a “years since fee introduced” variable to test for short and long term impacts. When this variable is removed (making its approach more consistent with earlier studies) the existing house impact reduces to $2.50.

With the findings of overpassing of infrastructure charges to home buyers in the Australian market now established, the rationale for such a phenomenon requires
consideration. Various reasons for overpassing have been hypothesised in the literature, however no studies have provided evidence in this regard. The rationale provided tends to sit in one of two camps being that of the “old view” where overpassing is a burden to the buyer in compensation to the developer for increased risks, financing and holding costs associated with increases to the supply chain costs and approval time frames (Singell and Lillydahl 1990, Baden and Coursey 1999, Mathur 2003, Campbell 2004); and the “new view” where the extent of overpassing represents a willingness of the buyer to prepay for the provision of services and amenities that would be otherwise funded by future property taxes (Yinger, 1998, Shaughnessy, 2003, Burge, 2004, Evans-Cowley et al., 2009). These are discussed further in Section 7.4 Contributions to the Literature.

6.4.2 Lot Prices

This study also provides evidence to support the hypothesis that infrastructure charges are overpassed to vacant residential lots. Whilst the findings for lots ($1.69) are lower than for houses, this is still positive evidence of overpassing and is an important contribution to the literature on lot price effects.

In contrast to house price studies, the evidence on price impacts for vacant residential lots is thin. This is thought to be due to the nature of the US housing market as described earlier, whereby the land developer also constructs the house thereupon and there is only a limited vacant lot market. Evans-Cowley et al., (2005) provided weak evidence that a $1.00 infrastructure charge is attributed to a price increase of as little as a $0.13 for the developed lot. This is a significant under-passing of the charge. This lower on-passing result when read in conjunction with overpassing at the house level, could be interpreted as evidence of profiteering by house builders. This would be a troubling finding as house builders (as opposed to land developers when these are two separate suppliers) are not subject to any infrastructure charges. No discussion on this finding is provided in the literature.

Hence, the findings of this study are an important contribution to the literature where an active “house and land” market exists, with profit taking by house builders to be a consideration for further research.
6.4.3 Findings Summary

This research provides strong evidence in support of the hypothesis that infrastructure charges increase house prices, with overpassing occurring in all house and lot markets examined. For each $1.00 of infrastructure charge, all house prices in Brisbane increase by $3.95, with new houses increasing by $4.69 and existing houses increasing by $3.56. Evidence of overpassing was also found in the vacant residential lot market, with $1.00 of infrastructure charge increasing lot prices by $1.69.

These results are consistent with the international evidence of overpassing of infrastructure charges and support the hypothesis of this thesis. The Australian evidence in this instance indicates overpassing to new houses in the order of approximately double the US evidence, which is likely due to the nature of Australia’s house sizes and the opaque infrastructure charging regime. Existing house overpassing is within the range established by recent literature, and provides further evidence of the detrimental effect infrastructure charges have on housing affordability across the whole community. The evidence on lot effects is thin and this study provides an important contribution to the literature indicating overpassing occurs in this market also.

6.5 LIMITATIONS

Given this study is the first of its kind in Australia, it is acknowledged that it is subject to a number of limitations. The main limitation of this study is associated with data gathering. Infrastructure charge data collection was a challenge for this project, and is likely to be a reason why work of this nature has remained unexamined up until now. However with a creative applied approach, results of significance have been generated.

In the absence of any usable data from an institutional source, a number of assumptions were required in order to derive an appropriate average infrastructure charge per lot. The approach adopted is described in the previous chapter. The infrastructure charges from a typical project that was developed in the study area during the study period were used to derive an average charge per lot on an annual basis that corresponded with the calendar year the associated stage was completed and sold. This approach assumes the project’s infrastructure charges were typical for
all projects in the study area at the time. It also assumes the time lapse between planning approval and sale of the subsequent lots was typical for other developments in the study area. These assumptions may or may not be correct, however all attempts were made to ensure these assumptions were reasonable. Where more than one stage was developed in a calendar year, the average charges per lot for those stages were combined. On the southside, where the data had the benefit of two overlapping projects, these amounts were averaged. The relative consistency of the northside and southside data provides some comfort as to the reasonableness of the assumptions and approach adopted. However it is acknowledged that it is possible that variance between projects does exist. This can be due to a range of factors from developer negotiating power and skills to timing effects associated with older approvals being subject to one set of policies and new approvals being subject to revised provisions. This is a market imperfection that is commonplace in an environment of rapidly and frequently changing infrastructure charge regimes. The opaqueness of the fully negotiated regime further muddies analysis with the identification of what charges might apply to a specific lot a tortuous and complicated process for a researcher, let alone a potential buyer. This feature of the Queensland infrastructure charge regime would appear to nullify many of the “new view” conclusions drawn by Ihlanfeldt and Shaughnessy (2004), Burge and Ihlanfeldt (2006) and Nelson et al.(2008) whereby new home buyers knowingly and willingly capitalise the forecast benefits associated with these charges into their new home purchase price.

The costs imposed on developers at the time of development approval are not contained to just infrastructure charges (in Queensland) or impact fees (in the US). Often costly conditions are also imposed on development approvals. The colloquial term for this in Queensland is “conditioning” whereas the more formal term “exactions” appears in the US literature. This generally refers to works or the dedication of land over and above that required for the provision of basic services for the new development. These costs are in excess of the reported infrastructure charges/impact fees and thus the inclusion of such costs into econometric price models is likely to further amplify the inflationary effect such policy decisions have on house prices and housing affordability. On the other hand, some works undertaken by developers are allowed to be offset against their infrastructure charge
liability. Every attempt was taken in this study to try to account for the effect of conditions and offsets in the sample projects used. It is acknowledged that each project is unique and that it is an assumption of this study that the sample projects utilised represent an average total infrastructure charge that might be applicable to a typical project in its relative jurisdiction.

Another limitation of the approach adopted is the relatively small sample set from which the average annual infrastructure charge amounts per lot were derived. Whilst a project of some 400 lots is a reasonable size project, it comprises only around 1% of the sample size on the northside and southside respectively. However when compared to the New house sample set of 4,699 the representation improves to a more comfortable level.

A further limitation of this study is associated with the categorisation of sales into New or Existing housing. As discussed in the previous chapter a data rule was established which required manual coding of more than 80,000 sales records from 2003 - 2011. Any manual coding is subject to human error. Critics of this work may also find fault in the four year criteria set for the New house category. It is acknowledged that this time frame is somewhat subjective. A three year time frame was initially set, however it was increased to four years to incorporate all the factors discussed in the Data Description, and to ensure an adequate sample size for the New data set. Further, the number of New sales in the early years of the study period may be understated due to sales data having been collected from 2003 for a study period start in 2005 (a four year resale period applied to New sales, hence any New sales from 2001 and 2002 Lot sales may be incorrectly categorised as Existing).
6.6 CHAPTER SUMMARY

The purpose of this chapter has been to present the findings of the quantitative stage of this research project and thus address the final research question:

4. **What is the impact of infrastructure charges on the price of housing in Australia?**

The findings presented in this chapter provide evidence in support of the theory that despite infrastructure charges being levied on property developers, these costs are passed onto the end home buyer. Not only are these fees being passed onto consumers, they are being significantly over passed for both houses and vacant lots in the order of 395% and 169% respectively. That is, for every $1.00 of infrastructure charge, house prices in Brisbane increase by $3.95 and lot prices increase by $1.69. Further, the effect on new and existing houses was considered separately, with every $1.00 of infrastructure charge increasing the price of a new house by $4.69 and an existing house by $3.56.

These findings consistent with the literature, however they are larger than predicted particularly for new housing. This could be attributed to characteristics of the Australian housing market such as large houses together with the opaque infrastructure charging regime creating uncertainty.

The findings for all housing and existing housing are particularly relevant in the housing affordability debate. This research provides negative evidence of the impact of the Queensland Government’s growth management policies on its housing affordability objectives, with a $28,000 infrastructure charge on developers, flowing through the housing market and wider community to add as much as $131,320 to the price of new houses and $99,680 to existing houses.

This study provides the first empirical evidence that infrastructure charges, after accounting for macroeconomic conditions and other factors that influence housing price, contribute to increases in the price of houses and lots in Australia. This research addresses a significant gap in the literature on the house price effect of infrastructure charges outside of the US.
Chapter 7: Conclusion

7.1 INTRODUCTION

Housing is becoming increasingly unaffordable in Australia, with a number of high level government reports now suggesting developer levies in the form of infrastructure charges on new housing as a contributing factor. This proposition has been suggested by industry over many years as infrastructure charges have rapidly increased in many jurisdictions. However the academic community in Australia has been slow to provide any evidence to inform the debate on who really pays for this urban infrastructure: the developer, original land owner, the new home buyer or the community at large.

Recent research, industry and government reports in Australia provide anecdotal and qualitative support for the proposition that developer levied infrastructure charges are passed onto new home buyers, but to date no empirical studies have sought to estimate the extent of this price effect on housing in Australia. This study is the first such research to address this gap in the literature. This research is important as it informs policy makers at all levels of government on the consequences of user-pays growth management strategies on their parallel housing affordability policies.

This concluding chapter is arranged as follows: section 7.2 recaps the objectives of this research and discusses how the research design met these objectives. It describes the thesis outline and how each of the research questions was addressed. Next Section 7.3 presents an overview of the key findings for each of the research questions. Section 7.4 details this research’s contribution to the literature. Section 7.5 presents an agenda for future research on this important topic, followed by final conclusions in section 7.6.
7.2 RESEARCH OBJECTIVES AND DESIGN

The specific purpose of this research has been to empirically estimate the impact infrastructure charges have on house prices in Australia. This research is important as housing is becoming increasingly unaffordable in Australia, and industry and government are at odds as to the extent that additional supply chain costs, such as infrastructure charges, have on house prices. In addressing this research issue, the following four research questions were examined:

1. **Is there empirical evidence in Australia that the imposition of infrastructure charges by governments increases the price of housing?** (Chapter 2)

2. **Is there empirical evidence internationally that the imposition of infrastructure charges by governments increases the price of housing?** (Chapter 2)

3. **Can international empirical models be used to assess the impact of infrastructure charges on the cost of new housing in Brisbane, Australia?** (Chapters 3 and 4)

4. **What is the impact of infrastructure charges on the price of new housing in Brisbane, Australia?** (Chapters 5 and 6)

These research questions were addressed via an exploratory sequential instrument development model, a mixed qualitative and quantitative methodology as detailed by Creswell and Plano Clark (2007).

The research design for this project was broken down into two stages as illustrated in Figure 7.1. Stage 1 was a qualitative process, designed to address the first three research questions. The findings from Stage 1 informed the methodology adopted for the Stage 2 quantitative work which addressed the fourth and final research question.

This two-stage, mixed methods approach was adopted because of the investigative inquiry nature of the first three research questions, the findings of which would determine the methodology adopted for the final question. Together,
these research questions required a sequential yet concurrent multifaceted mixed methods approach that included: pragmatism, deductive and inductive logic, integrated qualitative and quantitative data collection and analysis.

Figure 7.1
Research Design and Methodology

Stage 1 comprised the qualitative component of this mixed method research. It was necessary to break down each activity into component parts due to the fact that this was the first research of its kind to be undertaken outside of the US/Canada. The effects of infrastructure charges (or their equivalent) in the US has been the subject of academic interest for over 30 years with the findings of overpassing to home owners well established. However the literature review revealed little consistency in the econometric methodologies employed, and questions of external validity of models became apparent due to differing housing market fundamentals between
Australia and the US. Thus the archival research component and semi-structured interviews were built into the research design. The purpose of the archival research phase was to reveal any evidence of econometric methodological evolution. The semi-structured interviews with authors of prior US literature on this topic informed that process by providing a deeper level of insight into their model and data selection process, the challenges they faced, as well as insight into the functionality and characteristics of the US housing market. Stage 1 enabled a comprehensive analysis of the prior works in this field of research that had all occurred in the US. This data and analysis is important as it can now be used to form the basis of research on this topic in other countries around the world. Stage 1 concluded with a comparison of the key US housing market characteristics that are relevant to econometric model design and assumptions, with the Australian housing market characteristics. Completion of this Stage was important to ensure that the econometric model design utilised in Stage 2, and the underlying assumptions are appropriate in the Australian context. It was also important to understand the respective housing markets and institutional characteristics to ensure data was appropriately utilised and the results interpreted in a practical and applied manner.

Stage 2 comprised the quantitative component of this research. Using the Stage 1 findings, an appropriate econometric methodology for this first such study outside of the US was specified. The data appropriate for the Australian context was detailed and the various data sources identified. The empirical findings of the model utilised were detailed, with separate regressions run for both new and existing housing, as well as the pooled dataset, and for lot sales as well. Hence, Stage 2 specifically addressed the final research question and the broader thesis question of “who really pays for urban infrastructure?” with evidence provided supporting the research hypothesis that infrastructure charges are passed on to home buyers. The findings further supported the hypothesis that these charges are passed on in greater than a dollar for dollar fashion, with evidence of overpassing in the order of 300-400% to both new and existing homes provided.
7.2.1 Addressing the Research Questions

This thesis was structured to systematically address each research question in turn. Chapter 1 provided the introduction to the research problem. It outlined the background to the growing debate on infrastructure charges as a contributor to declining housing affordability. It defined the research questions and described the methodology to be adopted. Chapter 2 detailed the theory of the passing on or passing back of infrastructure charges and described the parties likely to be burdened by the cost of new urban infrastructure. Chapter 2 also provided the literature review, responding to the first two research questions, with the first answered in the negative, and the second in the affirmative.

Chapter 3 detailed the archival research component of this thesis, unpacking and analysing extant works on this topic in the search for evidence of a preferred methodology to take forwards into Stage 2. No such evidence was uncovered. Chapter 4 concluded the Stage 1 works. This chapter was also informed by the semi-structured interview process and was designed to start addressing the third research question. It drew on the data from the first three Chapters, as well as the findings of the semi-structured interviews to triangulate the emergent themes and assess the most appropriate econometric methodology to utilise for the first such study to be undertaken outside of the US, and thus address the third research question. This question was addressed in the affirmative, with important provisions relating to the importance of the researcher understanding underlying market drivers and fundamentals in the study area and adapting existing models accordingly.

Chapters 5 and 6 comprise the Stage 2 part of these works and address the final research question. The adopted approach, model and data are described in Chapter 5 and the findings are detailed and analysed in Chapter 6. This thesis outline is illustrated in Figure 7.2.
Figure 7.2

*Thesis Outline*

Source: Created by Author
7.3 KEY FINDINGS

This section is devoted to outlining the key findings associated with each of the
four research questions posed in this thesis.

7.3.1 Question 1

Is there empirical evidence in Australia that the imposition of
infrastructure charges by governments increases the price of housing?

This question was primarily addressed via a comprehensive literature review of
Australian scholarly literature on the relationship between infrastructure charges (or
the interstate equivalent) on house prices. Research and advocacy produced or
sponsored by industry bodies in Australia on the relationship between infrastructure
charges and house costs was also reviewed. A number of recent state and federal
government research and policy publications were found that identify infrastructure
charges as a potential contributor to declining housing affordability in Australia.

The issue of house price increases due to government charges and taxation on
housing affordability has received academic attention in Australia in recent years, as
has the cost of various town planning provisions (both costs and time delays). These
studies are off the back of growing discontent and anecdotal evidence from the
housing and development industries over the past decade on the increasing tax and
regulatory burdens to this sector and the corresponding impact on housing
affordability.

Qualitative and case study findings are provided in the Australian literature but
no empirical studies were found. In any case, none of the existing literature
specifically addressed the impact infrastructure charges have on house prices,
separate from other charges such as application fees, stamp duty/transfer duty and the
like. The existing qualitative work is consistent with the theory that government
charges do get passed onto home buyers, thus increasing house prices.

The only exception to these findings is a 1999 study by Watkins, who
concludes exactly 50% of any infrastructure charge is paid by the developer, with the
remaining 50% being either passed forward to the home buyer or back to the original
land seller. Unfortunately Watkins’ study did not provide any explanation for this
finding and his findings have been ignored by subsequent domestic and international authors.

Thus, no empirical evidence was found in the Australian context to support the hypothesis that infrastructure charges levied by governments are passed on to consumers by way of higher house prices.

7.3.2 Question 2

Is there empirical evidence internationally that the imposition of infrastructure charges by governments increases the price of housing?

The literature review then moved to the international stage to seek evidence on the relationship between infrastructure charges (or the international equivalent) and house prices. This international analysis focused on the UK and US which have comparable planning systems to Australia and established infrastructure cost-recovery policies. Literature from other countries was searched but no studies were identified.

Given Australia’s historical links to the UK, its infrastructure charging system was reviewed first. Theoretical issues concerning the impact of planning and regulation on housing affordability were found to have received considerable attention in the British literature, consistent with in Australia. However, no empirical works were identified. This was likely due to the opaque and fully negotiated nature of the infrastructure charging regime in the UK and the consequent lack of data from which to build a model.

In contrast, the US provided a deep body of literature on this topic with numerous empirical studies into the effect of infrastructure charges on housing prices over the previous three decades. In excess of a dozen empirical studies were found to have examined this very topic in North America (US and Canada), as have innumerable theoretical works over the past three decades. The theoretical argument is well developed and consistent in its findings that infrastructure charges do increase the price of housing in strong markets in the short term, and that prices also increase in the longer term when weaker market conditions prevail. Whilst the empirical evidence is not as consistent, a pattern has emerged over a number of studies that indicates for every $1.00 increase in infrastructure charges, all housing in a
The price impacts of infrastructure charges on the housing market are significant. New house prices increase by $1.50 to $1.70, existing house prices increase by $0.83 to $6.03, and the price of developed vacant residential lots increase by $0.13 to 1.20. The reasons for these price impacts are still under debate, as are the impacts to the supply of new housing and the passing back effect to land holders.

It is somewhat surprising that no empirical work has been carried out on this topic outside of North America, despite the wide usage of infrastructure charges in many countries. The UK’s system of fully negotiated outcomes with no set charges may have resulted in difficulties in obtaining data for any such analysis to occur in that country. Australia’s regime is evolving, fluctuating between cost recovery and fixed fees with no nexus or proportionality rationale. It is important that policymakers are equipped with information on the flow on effects of planning policies so as to fully understand the impacts of the infrastructure charges levied.

Hence at the conclusion of the literature review, there was significant international evidence in support of the hypothesis that infrastructure charges levied by governments are passed on to consumers by way of higher house prices. The international evidence also supports the further hypothesis in the majority of cases that such charges are not passed on in an dollar for dollar fashion, but are “over passed”, increasing the cost of housing by more than the cost of the charge alone.

7.3.3 Question 3

Can international empirical models be used to assess the impact of infrastructure charges on the price of housing in Brisbane, Australia?

From the preceding literature review, two key sub-issues became apparent. Firstly, the extant studies employed a range of differing econometric techniques. There appeared to be little consistency in approach and with many of the more recent studies occurring contemporaneously across the US, there was little evidence of a preferred methodological approach or model evolution. Study area, study duration, study size, and data requirements varied considerably between studies also. Further examination of these matters was important to ensure an appropriate econometric technique, data set and study area/duration/size was selected for use in Australia. Secondly, nuances of the US housing market were apparent that did not apply in the...
Australian context, for example the inter-relationship between property taxes and the range of services and amenities infrastructure charges funded. Whether these items could be removed from the models, and the models adapted for the Australian context without affecting their predictive qualities, were an important consideration in addressing the third research question. Data from the archival research and semi-structured interview process was collected and analysed in order to address these two issues.

The various econometric techniques and functional forms were examined first for the purposes of uncovering evidence of the evolution of a preferred approach. In the recent studies examined, a range of techniques were utilised that claim to overcome limitations of earlier works. In many of these studies, the basic hedonic technique was utilised, together with more advanced techniques that sought to better estimate the house price effect associated with infrastructure charges. It was found that the more complicated techniques provided no stronger evidence than the basic hedonic approach. Further, there was no evidence of model evolution, or emergence of a preferred approach. It was also found that interpretation of model results was somewhat inconsistent and great care is required in determining whether it is appropriate to compare findings between studies in different study areas. An “on passing ratio” was developed in this work to assist in this interpretation and comparison of findings of models with differing functional forms. Given this study was to be the first of its kind outside the US, that the basic hedonic model was found to provide findings of equal or greater significance to more complex models, and the risk of misinterpretation is high with more complex functional forms, it was found that a linear hedonic approach consistent with house price hedonic methodology could be applied for use in Australia.

Unpacking of the extant models also involved an analysis of the range of independent variables utilised in the various approaches. The purpose of this work was to determine what variables were relevant, and whether that data was available for the Australian study area selected. The range of data sets utilised in the existing works was as varied as the econometric approaches. Very little consistency existed between the extant models with some studies utilising very few data, whilst others incorporated an extensive range of items that might be deemed to influence house prices. This finding, whilst confounding was deemed to be consistent with the theory
that availability of data often drives model specification, rather than theory. It also shed light on the importance of the researcher understanding the practical drivers of study area housing markets and ensuring variables were selected that enabled the contributory effects of each to be observed. Mis-specification or omitted variable bias is possible if models from one locality are used in another without appropriate adaptation.

These regional and sub-regional house price drivers and the associated functionality of study area markets were often implicit assumptions and were rarely stated in the published works. However it was apparent that whilst the US housing markets and house price drivers had similarities with those in Australia, there were key differences as well and it was important to determine whether those differences limited the external validity of the US models. Data gathered in the archival research stage was supplemented with data collected in the semi-structured interview process. This enabled a comparison of the US and Australian housing market characteristics to be made. This comparison was important as it highlighted the areas of adaption required for the US model methodologies to be applied in other housing markets.

By triangulation of all the data collected to this point, there was sufficient evidence to conclude that international empirical models could be used to assess the impact of infrastructure charges on the price of housing in Australia, however any such model required careful adaptation to the proposed study area to ensure it was appropriately specified to incorporate the local housing market institutional characteristics, house price drivers and that appropriate data sets be available. This completed Stage 1 of this research.

7.3.4 Question 4

What is the impact of infrastructure charges on the price of housing in Brisbane, Australia?

Stage 2 of this research utilised the findings of Stage 1 to specify an econometric model to measure house price impacts of infrastructure charges in Australia for the first time. A data set for both the Brisbane southside and northside housing markets was gathered. This data comprised the relevant structural, locational and jurisdictional characteristics of housing in the study sub-areas. House
sale data was obtained from a commercial data reseller and other locational and jurisdictional data was derived from various sources including the Australian Bureau of Statistics and the Reserve Bank of Australia. Obtaining infrastructure charge data was a challenge as publicly available sources were not in a useable format and a creative approach was required. Property developers in each study sub-area were approached to supply data from their projects and this was adopted as typical for lots developed in the respective years of the model. The final data set for this study comprised a total 29,752 house sales in Brisbane from 2005 - 2011, comprising 4,699 new and 25,053 existing house sales as well as 13,739 residential lot sales.

Testing and validation of the model resulted in a final model for All, New and Existing housing in the form:

\[
P_{i,t} = \beta_0 + \beta_1 S_i + \beta_2 L_i + \beta_3 J_i + \beta_4 G_i + u_{i,t}
\]

Where

- \( P_{i,t} \) = sale price of house \( i \) in time period \( t \)
- \( S_i \) = Structural attributes of the house: lot area, number of bedrooms, bathrooms and car parking spaces, dummy for new or existing home
- \( L_i \) = Locational features: region, socio-economic suburb rankings
- \( J_i \) = Jurisdictional factors: changes to household income levels, population growth, new housing supply, unemployment rate, construction cost index, mortgage interest rates, consumer confidence
- \( G_i \) = Government policy: infrastructure charges
- \( u_{i,t} \) = error term or noise in the model for the \( i^{th} \) observation at time \( t \).

The Lot model excluded the structural attributes of the house apart from the lot area. The interaction effects of New and Existing housing were also tested for.

The regression results for the effect of infrastructure charges on house prices in Brisbane were of the expected sign and significant. They indicated that for every $1.00 of infrastructure charge levied on developers, all house prices increase by $3.95, with existing house prices increasing by $3.56 and new house prices increasing by $4.69. An alternative interpretation is the on passing ratio of 395% for
all houses, 356% for new houses and 469% for existing houses. These findings were higher than expected and higher than the US model average findings, particularly for new housing. The interaction model findings were consistent with these findings, and proved further support of the scale of the overpassing of infrastructure charges to not only new home owners, but to all home buyers in a community.

These findings provide positive evidence in support of the research hypothesis for this thesis: infrastructure charges are passed on to house buyers, thus increasing house prices. These findings support the further hypothesis that infrastructure charges are not passed on in an dollar for dollar fashion, but are “over passed” to compensate developers for the additional risks and holding costs associated with an opaque and uncertain infrastructure charging regime.

This finding is a significant contribution to the housing affordability debate in Australia. It provides the first empirical evidence of the adverse flow on effects of developer levied infrastructure charges on housing affordability for not only new home buyers, but the whole housing community. Proponents of user-pays infrastructure charges suggest that only those who benefit from the new estate services and amenities bear the associated costs of infrastructure charges, however this study provides evidence that it is the whole community that is bearing the cost by way of increased house prices, even in existing suburbs. Home owners in these existing suburbs benefit by way of windfall capital gain, which in Australia is not generally taxable.

Hence, a charge that government may think it is levying on developers, is being passed on to new home buyers, some of which elect instead to buy established housing in nearby suburbs thus driving up those house prices as well. Housing affordability is very negatively impacted and the consequent windfall capital gain by existing home owners is not taxable. It could be said that the primary winners of this policy situation are the home mortgage providers who benefit from the interest charged on the additional $110,000 or so over the life of the loan, which over a 30 year mortgage will amount to $338,000 in total repayments, or an additional $939
per month mortgage repayments (Commonwealth Bank, 2014). Refer section 7.4.2 for further discussion on this finding.

The large overpassing effect observed in this research as compared to the US literature is likely to be a combination of two effects. Firstly, Brisbane has a predominance of large housing compared to areas of the US such as Florida. US models that tested for the differential effect of infrastructure charges on large houses had findings consistent with this research. Secondly, the US charges are set fees that are published each year, with increases published well in advance of any changes. That is, a transparent and certain system that carried low risk of unexpected increases in charges. This is in contrast to the infrastructure charging system in place in Queensland during the study period, whereby local authorities were operating in a period of flux, moving to a cost recovery system where charges were unpredictable at the time of land acquisition and increasing rapidly. A business environment characterised by uncertainty and lack of transparency carries greater risk for those industry participants. Hence it is likely that the higher than expected findings in this research are at least in part due to developers seeking higher compensation for the additional risk associated with developing residential estates in this uncertain business environment.

Thus the fourth research question has been addressed. Evidence has been supplied for the first time in Australia that infrastructure charges are increasing the price of housing in Australia for both new and existing home buyers as illustrated in Figure 7.3.

\[52\] Based on $110,000 fully amortising loan for a term of 30 years, at 9.61% interest which is the 30 year average variable interest rate (Reserve Bank of Australia, 2013)
Not only do these findings inform Australian policy makers, these findings are also a significant contribution to the international literature in a number of ways. Firstly, this is the first empirical research on the impact of infrastructure charges on house prices identified by this research outside of the US/Canada. It tests the external validity of the US models and findings. With a relatively consistent pattern for new house effects having emerged from the US studies, it is tempting to predict that similar effects might be universal. This research reveals that the magnitude of such price effects may be subject to local macro and micro economic factors and housing market institutional factors. Whilst the theory for these models may have external validity, it is important that the researcher have an intimate knowledge of local market drivers to ensure the model is specified and interpreted in accordance with local market factors.

Secondly, it provides evidence against the “new view” that has become popular in the US literature over the past decade. The new view suggests that overpassing of infrastructure charges to house prices is not a supply chain effect (burden to home
buyers) but a signal of the willingness of home buyers to pre-pay for the expected new amenities and services these charges will provide on the expectation of reduced property taxes in the future (benefit to home buyers). Australia does not have a property tax system for the provision of schools, fire protection, law enforcement and the like. In our egalitarian system, these services are provided to all residents at a state-wide level, funded through general revenue. Hence, in the absence of the underlying assumptions for the new view to prevail, this research provides evidence in support of the old view, or supply chain theory of the incidence of infrastructure charges. Under this theory, infrastructure charges are a supply chain cost which developers pass on to consumers (home buyers) together with a margin to compensate them for the additional holding costs and risks associated with the development of residential land in an opaque, uncertain and rapidly changing infrastructure charge regime.

Thirdly, this study is important as it straddles the very strong pre-GFC housing market, as well as the “soft landing” that followed in Australia. Theory suggests that in a softer housing market, such as after the GFC, there is less price elasticity and developers share the burden of infrastructure charges by way of lower profit margin and/or willingness to pay lower land prices in the short term. This study suggests that even in a soft market, infrastructure charges are over passed to all home buyers in the community.

7.4 CONTRIBUTIONS TO THE LITERATURE

This research makes a number of contributions to the literature on the impact of infrastructure charges on house prices and the wider topics of housing affordability and government housing policy.

7.4.1 First Australian Evidence

This study is the first of its kind in Australia that estimates the house price impacts of infrastructure charges. Whilst there has been considerable debate at a government and industry level, there have been no empirical studies conducted in Australia to inform this debate. Academic literature on the topic of constraints to housing supply and housing affordability in general have provided anecdotal evidence at best to imply the effects of infrastructure charges. In the absence of any
empirical evidence, the question of who really pays for urban infrastructure has remained a political “hot potato”. The findings of this study have the potential to contribute to housing policy at a local, state and even federal government level.

7.4.2 Housing Affordability

This research provides the first evidence to suggest that not only are infrastructure charges passed on to house buyers, but there is a significant over-shifting associated with an on-passing ratio in the order of 395%, or in other words, for every $1.00 of infrastructure charges, all house prices (both new and existing) increase by $3.95. In Queensland, where the maximum adopted infrastructure charge for a new three (or more) bedroom home is $28,000, this one government charge could be adding $110,600 to the price of housing in Brisbane. An additional $110,600 on the cost of housing over a 30 year mortgage, will amount to $337,995 in total repayments, or an additional $939 per month (Commonwealth Bank, 2014).

If we consider that one of the primary objectives of this research was to provide evidence of the effect on the government’s policy of developer-paid urban infrastructure on housing affordability, and thus how this government policy impacts the objectives of its housing affordability policies, then this finding meets that objective. Here we have provided evidence of a $28,000 charge that is levied on the developers of new housing, flowing through the supply chain, the housing market and the community in general and resulting in an additional $939 per month in mortgage repayments for all house buyers. This finding is larger than expected and is likely to cause much discussion at a policy, local government and industry level.

7.4.3 External Validity

This study provides an important contribution to the literature as it is the first such study into the house price effects of infrastructure charges outside of the US/Canada. This is relevant for two reasons: firstly to test the external validity of the extant models and secondly to provide evidence in the “new v. old view” debate, which is covered in the following section.

This research spent considerable time analysing similar studies conducted in the US/Canada over the past 30 years, with particular emphasis on six studies from the past decade. Whilst there were differences in the approach between each of those studies, a consistency emerged in the later studies, particularly in the new house price
effect of around $1.50 - $1.70 over passing. Whereas, existing home effects varied considerably: from between 142% and 592% in older studies (Delaney and Smith 1989b, Singell and Lillydahl 1990) and between 83% (under passed) and 603% in more recent studies (Mathur et al., 2004, Evans-Cowley et al., 2009). There was limited evidence in the lot market.

With a relatively consistent pattern for new home effects having emerged in the US literature over a number of studies, it is therefore tempting to predict that similar effects might be universal. However, it is important to recognise difference in housing markets from urban, regional and national scales as well as between nations (Meen, 2001). This research has highlighted a number of key similarities and differences in the housing markets between the US and Australia that has highlighted the need for adaptation in model specification and data collection. Data collection was a challenge for this project. However with a creative approach, results of significance have been generated. These results support the theory and international evidence of over-passing of infrastructure charges, however it suggests that the magnitude of these effects may be subject to local macro and micro economic factors which need to be taken into consideration. This research has highlighted that the researcher must take care extrapolating results from one housing market to another without due consideration of the underlying fundamentals. An intimate knowledge of the how house price theories apply in local markets are essential to avoid fundamental flaws.

7.4.4 Old v. New View

Turning to the “new v. old view” debate. As identified earlier, this issue shifts the discussion to whether the overpassing of infrastructure charges is a benefit or burden to the home owner. Under the old view, infrastructure charges are a “form of taxation that is hidden from housing consumers” (Baden and Coursey, 1999, p1), whereas under the new view buyers willingly and knowingly capitalise forecast future property tax savings and the value of funded amenities into the upfront capital cost of housing.

The new view has been criticised for its requisite assumption of a sufficiently knowledgeable and optimistic buyer that was capable of attributing a financial value to its desired services and amenities, accurately forecasting their associated property tax liabilities, presuming that future property tax rates would remain steady and
willingly pre-paying this amount up front (Been, 2005). Under the new view, infrastructure charges create no burden on the home owner, as the home owner is knowingly and willingly pre-paying property taxes for services and amenities it values, such as the provision of schools and law enforcement.

This study could be said to provide the first evidence in support of the old view, by virtue of the fact that the requisite assumptions for the new view do not exist in Australia\textsuperscript{53}. Australia as an egalitarian society does not have a property taxation system similar to the US. Non-utility services and amenities that are funded in the US by property taxes are in the main funded in Australia at a state level from broad based consolidated revenue. The new view assumptions stated in the literature are explicit however there are a number of implicit assumptions that the literature appears to have overlooked. For the new view to hold it assumes a mature market that has a well established and predictable infrastructure charge and local jurisdictional rating/taxation system. It also assumes this system and the quantum of costs is well understood not only the policy makers and the development industry, but also the community (land holders and home buyers) (Been, 2005). That is, a fully transparent and predictable system of infrastructure charges and the associated provision of services and amenities must exist. It must assume the local municipality runs a balanced budget, reducing rates/taxes if surplus funds are raised as a result of increased property prices. It must also be assumed that the homeowner does in fact receive the full value of the services and infrastructure provided by these additional fees in the foreseeable future. Further, there must be a precedent for significant reductions in local jurisdictional rates (or property taxes in the US) for home buyers to be willing up pay the upfront cost of such benefits. In a market such as Florida, the study area for a number of extant models, where infrastructure charges have been common place since at least the early 1980’s, this general market knowledge may exist for the new view to prevail. However, not even Been (2005) is convinced of this: “An increase in the value of the home of between $1.00 and $1.68 per $1.00 of impact fee on the promise of a rate rollback seems extraordinarily optimistic on the part of the homebuyers” (Been, 2005, p 162).

\textsuperscript{53} Refer Chapter 2 (Section 2.6) for details on the requisite assumptions for the new view.
The new view rationale for increases in existing house prices is equally as confounding. Theory tells us that if the infrastructure charge does provide a level of amenity to new houses, but not to existing houses, then existing houses “will rise in price only to the extent that the higher value of new houses may provide a reduction in taxes demanded of existing homes” (Been, 2005, p158). The new view literature provides very little interpretation on their findings associated with existing house price increases. Nelson et al.(2008) does respond to Been’s criticisms, providing the example of a new school or road relieving overcrowding/congestion for the existing owners. Such an argument begs the further question of why would overcrowding/congestion exist if not for growth. So if growth is truly paying its own way, then existing owners would not be burdened by overcrowding/congestion and thus not require any benefit from the newly funded (and constructed) infrastructure. Clearly there are potentially short and long term effects that do come into play in such an argument. However, considering the Australian situation, whereby schools particularly, and regional roads are funded at a State level and not via infrastructure charges, then Nelson et al.(2008) argument can hold no weight.

A further premise of the new view is that house buyers are sufficiently informed so as to knowingly and willingly estimate future property tax savings, apply the appropriate discount factor (Ihlanfeldt and Shaughnessy, 2004) and make an upfront payment in advance via an increased house purchase price. For this premise to hold, the infrastructure financing system must be transparent and predictable, and the other implicit assumptions for the new view must also hold. However, in many parts of world, infrastructure finance is evolving policy. For example, in Queensland, Australia the infrastructure charges regime by comparison is in its infancy. After five years of legislative reform, the Sustainable Planning (Housing Affordability and Infrastructure Charges Reform) Amendments Bill 2011 commenced in July 2011, which introduced maximum charges across the State. This followed a period of considerable uncertainty of charges with protracted negotiation of outcomes within a cost recovery framework. This was a temporary measure to be
in place for three years whilst further consultation occurred. The new maximum charge regime may provide certainty for the developers and undeveloped land owners but it is a significant departure from the legal principles of proportionality and nexus that have hither to been a core test in the setting of charges in most jurisdictions other than the UK. In parts of Queensland, infrastructure charges increased by more than 100% in the first decade of this century (Productivity Commission, 2011) and industry now reports significant reduction in charges further to the new maximum set charge regime.

It is therefore fair to conclude that Queensland does not meet the criteria of a well established and predicable infrastructure charging system, and hence it is expected that the old view will prevail for a number of years after stabilisation of the current (or future) system. Under the old view, infrastructure charges are a supply chain cost that is passed onto consumers. Over passing occurs due to a combination of effects. Firstly, additional uncertainty and delay in the approval process, results in developers recouping more than the cost of the charge alone as they seek higher profit margins to compensate them for the uncertainty associated with a rapidly changing regulatory environment (Singell and Lillydahl 1990, Baden and Coursey (1999), Campbell 2004; Mathur 2003). Secondly, interest is charged on these supply chain (development) costs which the developer seeks to recoup from the house buyer in order to maintain profit margins (Singell and Lillydahl 1990). Thirdly, a number of development costs are determined as a percentage of either the sale price or total development costs, thus increasing the house price to maintain developer margins (Crowe 2007). So not only are impact fees passed directly onto homeowners, there is an over-shifting effect to compensate developers firstly for the additional uncertainty (risk) and secondly a return of funds invested component, either for the developer, or its financier over the development period (Ellickson and Been, 2005).

---

54 The Sustainable Planning (Infrastructure Charges) and Other Legislation Amendment Bill 2014 is due to come into effect on 1 July 2014, which further amends the Queensland infrastructure charging regime, largely maintaining maximum adopted infrastructure charges.

55 It is outside the scope of this research to consider how this funding gap will be resolved by local councils.
In conclusion, the literature is still split on the reasons for the over-shifting phenomenon associated with infrastructure charges. If over-shifting is due to increasing supply chain costs and structural uncertainty, then home owners are bearing this additional burden, brought on by the nature of the housing industry and/or implementation of the infrastructure charging policy of the day. However, if the new view premise holds, and infrastructure charges are indeed valued for their amenity providing characteristics, then the outstanding research question evolves. Rather than asking whether infrastructure charges increase housing costs, perhaps the question becomes: Does the home buyer gain the full benefit of the cost for which they have paid? Clearly, further examination of this over-shifting phenomenon is required, and may be the subject of further research.

7.4.5 Impact of GFC

This study period straddled the very strong pre-GFC housing market, and the “soft landing” that followed in Australia. This study is the first to produce significant findings for infrastructure charge related house price impacts in anything other than a strongly growing housing market. This is important as the theory suggests it is easier for developers to pass the cost of infrastructure charges onto home buyers in a rising housing market. Theory suggests that in a softer housing market, such as after the GFC, there is less price elasticity and developers share the burden of infrastructure charges by way of lower profit margins and/or seek to pass the charges back to land owners by way of lower land prices. This study suggests that even in soft market conditions, infrastructure charges are over passed to all home buyers in the community.

7.5 FUTURE RESEARCH

As indicated previously, a key limitation to this research is the lack of available data on infrastructure charges. This necessitated a creative applied approach that derived annual infrastructure charge amounts per lot for a typical project in the study area. Future research would benefit from working closely with local authorities to gain access to more detailed infrastructure charge data, so that the associated house price effects can be more accurately estimated. Should more detailed infrastructure charges be made available, it is hoped that smaller intervals, such as quarterly, could
be utilised consistent with much of the economic data, thus enabling other independent variables such as the First Home Owners Grant to be incorporated.

This research focused on the Greater Brisbane housing market, where a significant majority of the population of Queensland resides. Both the northside and southside study areas incorporated major masterplanned communities as well as smaller infill and greenfield housing estates. However, strong regional markets do exist in Queensland and it is inappropriate to presume that the magnitude of the overpassing effect in the capital city is consistent in regional centres. For example, the North Queensland economic hub of Townsville has a strong regional housing market supported by a major Australian Defence Force base and various other state and federal government agencies. According to Isles (2014), infrastructure charges in Townsville represent up to 18% of lot prices compared to 9% in South East Queensland. Further, each State and Territory in Australia has its own infrastructure charging regime and the consequent effect on house prices and housing affordability warrants empirical examination. Future research in other Australian capital city and regional housing markets is recommended in order to take into account the vagaries of local housing markets and/or differences in underlying market fundamentals.

This research has focused on the effect of infrastructure charges on house prices. Other research has instead examined the effect of infrastructure charges on housing supply, however the findings from such studies is mixed. Market equilibrium models conclude that when increases to supply chain costs raise house prices above the level of demand, supply is reduced until demand led equilibrium returns (Shaughnessy, 2003). Similarly, attempts to pass charges back to land owners stymies supply as land owners refuse to sell below their benchmark price (Evans, 2004b). Other studies suggest that the presence of infrastructure charges (in a transparent system) creates certainty for developers and a framework for a timely development approval process, thus increasing supply (Burge et al., 2007). Again, each of the extant studies are US based and the external validity of the underlying assumptions warrant testing in the Australian market.

This research has focused on single detached dwellings (low density housing). International studies also exist on the price effects to medium density dwellings as well as other non-residential market sectors such as commercial and retail. Further
research into the price effects of infrastructure charges in these markets may also be timely.

7.6 CHAPTER SUMMARY

This chapter has summarised the purpose, activities and findings of this thesis. It has outlined how a two-stage exploratory sequential instrument development mixed method approach was utilised to estimate the impact of infrastructure charges on house prices for the first time in Australia. This research is an important milestone in both the housing affordability and infrastructure funding debates in Australia. It has provided the first empirical evidence that infrastructure charges levied on property developers by government, are not only passed on to new home buyers, but are over passed with a flow on effect to all homes in the community.

This research is an important contribution to the international literature as many countries struggle with providing both housing affordability and cost effective access to urban infrastructure. As the first identified research of its kind outside of the US, it sets a framework for how similar models can be structured in other countries.

This research has set the agenda for future research on this topic and the related topic of infrastructure charge impacts to housing supply, impacts to medium and high density housing, as well as to other property sectors.

In summary, understanding “Who really pays for urban infrastructure” is critical to Australia’s long term growth and this research provides the first empirical data for government to test its policy objectives and outcomes against.
References


Burge, G. S. 2014b. Starter Homes. 6 February, 2014


Campbell, D. A. 2004. The Incidence of Development Impact Fees. Doctor of Philosophy, Department of Economics, Georgia State University


Lawhon, L. L. 1996. Equity considerations of development impact fees and the effect of such fees on the price of housing for low- and moderate-income residents. Ph.D., Texas A&M University, United States


References 237


